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Too low protein and energy intake in nursing home residents

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ABSTRACT

Objectives: An optimal diet contributes to reducing malnutrition prevalence in the nursing home population. For this population, recommended daily intakes are ≥1.0 g protein/kg body weight and ≥27 energy kcal/kg body weight. The aim of this study was to identify the protein and energy intake of nursing home residents and to assess groups at increased risk for low intake.

Methods: Cross-sectional data regarding food intake was collected by three-day observations in 189 residents (aged ≥65 y, mean age 85.0 y) of five different nursing homes. Linear mixed models were used to examine associations of protein and energy intake as dependent variables with demographic and disease-related problems as determinants. Results were adjusted for age, sex, and mobility levels and stratified by a protein/energy-enriched diet (P/E+).

Results: The daily protein intake of the residents was 0.80 (SD 0.22) g/kg body weight, with 84.7% having an intake below the recommended daily 1 g/kg body weight. Mean daily energy intake was 20.7 (SD 6.1) kcal/kg body weight, with 85.2% having an intake below recommendation. Protein/energy intake was higher in the P/E+ group compared with standard diet: 0.92 (SD 0.23) versus 0.74 (SD 0.19) g/kg body weight, and 23.9 (SD 6.1) versus 19.1 (SD 5.4) kcal/kg body weight, respectively. The oldest age groups (>85 y), chair-bound residents, women, and residents having difficulties with chewing, dysphagia, a reported decreased food intake, or a decreased appetite were at a higher risk for a low protein/energy intake.

Conclusion: Nearly all nursing home residents were at increased risk for not meeting the minimum protein/energy requirements. Intakes should, on average, be increased with ≥15 g protein and ≥520 kcal to reach the minimum intake targets. Although using a P/E+ diet was associated with higher intakes, even these residents had intakes below the requirements.

Introduction

Between 2002 and 2020, life expectancy at birth in the European Union increased from 77.6 to 80.4 y, resulting in 21% of Europeans being ≥65 y in 2020 [1,2]. This number is expected to double by 2050 and triple by 2100 [3]. Because of age-related decline in functioning, most older adults will become (partly) care-dependent toward the end of life. Most European countries, therefore, implement a policy to facilitate older adults to stay in their environment as long as possible, if necessary, with assisting home care. This “aging-in-place” policy, aimed at reducing the burden on nursing homes, is cost-effective and, importantly, is what most older adults wish for themselves [4]. However, aging-in-place is not always feasible because of progressive disease, declining general health, the risk for falling, social isolation, and medication management [4]. When care requirements become too high, and home care is no longer viable, older adults will eventually be admitted to a nursing home. Thus, in general, older adults only enter nursing homes when they are experiencing (multiple) severe health conditions [5].

An optimal nutritional status is warranted to prevent a further decline in quality of life during a stay in a nursing home. However, the nutritional status of newly admitted residents could be better, as >50% of newly admitted residents have a body mass index (BMI) <23 kg/m^2, and 15% have experienced recent weight loss [6]. Additionally, ~10% of all residents will become malnourished during their stay [7]. These high numbers can be explained by the

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presence of risk factors for malnutrition, such as multimorbidity, decreased appetite, poor oral health, cognitive decline, and the inability to eat alone without help [8]. An optimal food intake, consisting of enough protein and energy, is needed to optimize the nutritional status and reduce the risk for malnutrition and accessory complications such as reduced quality of life and increased risk for comorbidities in nursing home residents [9,10].

For healthy older adults, a daily protein intake of 0.83 g/kg body weight (bw) is advised [11,12]. However, this standard recommendation is still under discussion. Older individuals are thought to need higher amounts of protein for optimal preservation of lean body mass, body functions, and health [13]. According to recent guidelines, a daily amount of 1 to 1.2 g protein/ kg bw is suggested for healthy older adults [13], and expert groups advise even up to 1.2 to 1.5 g protein/ kg bw for frail older adults [14]. Until proven otherwise, the current suggested daily intake of 1 g/kg bw should be ensured for all older adults to maintain and regain muscle mass and function [13].

Individuals require an adequate energy intake to prevent protein from being used as an energy source [15,16]. Energy requirements differ between individuals, but on average, 30 kcal/kg bw daily is advised for older adults [13]. Low activity can decrease energy needs; however, based on indirect calorimetry, 27 kcal/kg bw daily is the lower limit [13,17]. In contrast, daily requirements for underweight older adults are as high as 32 to 38 kcal/kg bw [13,17].

Although a high-quality diet with sufficient energy and protein intake is essential for preserving an adequate nutritional status in older adults [13,18], data regarding food intake in nursing home residents is scarce. Most previously published articles on this topic use proxy measures for food intake, such as decreased appetite or the percentage of last served portion that was eaten, providing no accurate estimate of protein and energy intake [19,20]. Therefore, it needs to be clarified how much energy/protein nursing home residents consume and which (sub)groups are not reaching the recommendations. Data regarding this topic can help identify groups at increased risk of being or becoming malnourished and develop targeted preventive/curative measures for malnutrition. This study, therefore, aimed to assess the protein and energy intakes of Dutch nursing home residents and to examine which groups are at increased risk for not meeting the protein and energy requirements.

Methods

Cross-sectional data were obtained from residents of five Dutch nursing homes from different parts of the Netherlands during two periods (November 2020 to April 2021 and September to November 2021). Acquisition of participating nursing homes was done, among others, via network meetings, dietitians' conferences and through provider of electronic patient files used in nursing homes (InterRAI).

Residents ≥65 y of age were included if they resided in a nursing home and gave informed consent, either by themselves or by their proxy. Residents were excluded if they were bedbound (and consumed food in their rooms, which hindered discrete observing), were receiving end-of-life care, or were using parenteral nutrition.

We did not perform a sample size calculation and based the number of included participants on available residents during the research period.

Measurements

Baseline measurements were performed to obtain a picture of the general health status of the residents and were used to identify groups at risk for poor food intake. Trained students from the bachelor's program, Nutrition and Dietetics, and master's program, Nutrition and Health, performed all measurements.

Malnutrition risk

The Short Nutritional Assessment Questionnaire for Residential Care (SNAQ^{RC}) was used to identify residents at risk for malnutrition. This validated malnutrition screening tool for nursing home residents is based on four items: unintentional weight loss (>3 kg in the last month or >6 kg in the last 6 mo), needing feeding assistance, having a decreased appetite, and low BMI (<20 or 20–22 kg/m^2) [21]. Residents were graded *at moderate risk for malnutrition* when they scored positively on one of the following items: needing feeding assistance, having a decreased appetite, or having a relatively low BMI (20–22 kg/m^2). When residents displayed two or more of those items or had unintentional weight loss (as defined above) or a very low BMI (<20 kg/m^2), they were graded *at severe risk for malnutrition*.

Anthropometry

Because of the COVID-19 restrictions, the body weight and height of the residents were primarily taken from medical records. When record data regarding weight and/or height was missing, residents were weighed wearing clothes, but without shoes, on nursing home scales. Based on weight and height, BMI was classified as underweight (<22 kg/m^2), normal weight (22–27 kg/m^2), and overweight (>27 kg/m^2) [22].

Comorbidities and multimorbidity

The nature and number of comorbidities were assessed alongside a prespecified list: diabetes mellitus, coronary artery disease, stroke or cerebral hemorrhage/infarction, other serious heart problems (heart failure, angina pectoris), cancer, hypertension, lung disease (chronic obstructive pulmonary disease, asthma, emphysema), stomach-liver-bowel disease, kidney or bladder disease, osteoporosis, back disorders, joint damage (arthritis, rheumatism), and "other."

Multimorbidity was defined as the presence of three or more diseases [23].

Protein/Energy-enriched diet

In Dutch nursing homes, a protein/energy-enriched diet (P/E+ diet) is prescribed by a doctor in consultation with a dietitian and nurse [24]. Data regarding a P/E+ diet was obtained from the patient files. Residents who used oral nutritional supplements (ONS) were also categorized as having a P/E+ diet, as these products can only be generally supplied when ordered by a doctor or dietitian.

Other variables

The following characteristics were obtained from the medical files or provided by a first responsible nurse: demographic characteristics (sex, age), polypharmacy (≥5 medications), dysphagia, decreased food intake (severely decreased, moderately decreased, not decreased), chewing difficulties, verbal communication problems (ability to express verbally or non-verbally), type of ward (somatic, psychogeriatric, rehabilitation), mobility level (goes out, able to get out of bed/chair, chair bound), and neuropsychologic problems (severe dementia, mild dementia, no dementia).

Dietary assessment

Three-day structured food records were used to calculate the protein and energy intake of three main meals and in-between moments. Because food registration can be a burden for residents and depends on memory, direct observations were used. Direct observation is considered a gold standard because it is practical, independent of the individual's memory, and can provide objective information on their actual intake [25].

The researchers observed the residents throughout the day and reported their consumed amounts. Residents were informed beforehand that they might be observed but not when. Observers were viewing the residents from a short distance. Before the observation period, the standard dinnerware was measured, and the different sizes of a portion, package, or tableware item were measured to improve estimations of the consumed food/drinks.

Food records were conducted on randomly selected days, preferably including one weekend day to account for possible changes in eating habits during the weekend. For the calculation of nutritional intake, the nutritional calculation program Compl-eat (linked to the Dutch Food Composition Table 2021/7.0 [26]) was used.

Protein and energy intake

Protein and energy intakes were generated from Compl-eat. Data was presented in total protein intake in gram per day (g/d), gram protein/kg bw per day (g/kg bw/d), total energy intake in kcal per day (kcal/d), and energy intake in kcal/bw per day (kcal/kg bw).

As the protein recommendations are expressed in g/kg bw/d, actual body weight can over- and underestimate protein needs [27]. Low fat-free mass (FFM) can lead to overestimating protein needs in overweight residents. In contrast, a relatively high FFM in underweight residents can lead to an underestimation of protein needs [27]. For this reason, adjustments in body weight were made to estimate protein needs optimally. For underweight residents, the adjusted protein intake in g/kg bw/d was based on body weight derived from age-specific cutoff points of BMI, 20 kg/m^2 for age <70 y and 22 kg/m^2 for age ≥70 y. For overweight residents, adjusted body weight was derived from BMI of 27.5 kg/m^2 [28].

Ethics

The ethics committee of the HAN University of Applied Sciences evaluated the study, and it was judged not to fall within the remit of the Medical Research Involving Human Subjects Act (WMO).

Statistical analyses

Statistical analyses were performed using SPSS version 28 (IBM, Armonk, New York, USA). The normality of continuous data was assessed using QQ-plots and box plots. Background characteristics of the population were described by means with SD and frequencies with percentages for categorical data.

Linear mixed models were applied to study associations of total gram protein, adjusted g protein/kg bw/d, total kcal and kcal/kg bw/d with the independent variables.

As the data are clustered both within residents of the same ward and within persons, because the 3-d food record repeats, random intercepts were used based on comparison of the −2 log likelihood of the models with and without random intercepts. For protein intake, random intercepts were included for the ward and resident levels. For energy intake, a random intercept at the resident level was applied.

As having a P/E+ diet was likely a strong predictor for energy and protein intake, with the P/E+ diet being in the causal path between several independent variables and protein/energy intake, adjusting for diet group was inappropriate. Therefore, all results were stratified by P/E+ diet. To assess the difference in regression coefficients between the standard diet group and the P/E+ diet, interaction terms were made (determinant of interest × P/E+ diet [yes/no]). P = 0.1 was considered significant [29].

Furthermore, and where appropriate, the analyses were adjusted for sex, age, and mobility level, as these are well-known factors associated with protein/energy intake [30–33].

Results

Table 1 shows that of the 189 residents included in the study, 62 (32.8%) were provided a P/E+ diet. Most of the residents were women (70.4%), mean age was 85 y (SD 7.3), and the majority lived in a psychogeriatric ward (72.5%). Mean BMI was 26 kg/m^2 (SD 5), and 17.5% had a low age-specific BMI. The risk for malnutrition, as based on SNAQ^{RC}, was high, with 52.9% being at moderate or severe risk. As expected, more residents in the P/E+ diet group had a high malnutrition risk compared with the standard diet group. A large proportion (40.7%) had more than three diseases and 72.5% of the residents used more than five medications per day. Most of the residents (80.4%) had mild/moderate dementia, as indicated by their caregivers/first responsible nurse.

Protein intake

The mean daily protein intake was 56.4 g/d (SD 15), or 0.80 g/kg bw (SD 0.22). For individuals with a P/E+ diet, this was higher with 0.92 g/kg bw/d (SD 0.23), compared with 0.74 g·kg bw·d^{-1} (SD 0.19) in the standard diet group (Fig. 1).

More than half of the residents (59.3%) did not reach the lowest recommendation of 0.83 gP·kg adj. bw·d^{-1}, and an even higher proportion (84.7%) did not reach the recommended 1 gP·kg adj. bw·d^{-1}d, let alone the higher recommendation of 1.2 gP/kg adj. bw/d (93.1%; Table 1, Fig. 1). The proportion reaching 1 g/kg adj. bw/d was higher in the P/E+ group (29%) than in the standard diet group (8.7%).

Energy intake

The total daily mean energy intake in kcal was 1467 kcal (SD 344), or 20.7 kcal·kg bw/d (SD 6.1). For residents with a P/E+ diet, the intake was 23.9 kcal/kg bw/d (SD 6.1) compared with 19.1 kcal/kg bw/d (SD 5.4) for residents on a standard diet (Fig. 1).

Although being in the low proportion, more residents reached the minimum recommendation of 27 kcal/kg bw/d in the P/E+ group (25.8%) compared with the standard diet group (9.4%; Table 2, Fig. 1).

Groups at risk for low protein intake

No differences in total protein intake were seen between residents within the different categories of BMI/weight (Table 3). Consequently, a lower protein intake per kg/bw/d was observed in the higher BMI/weight categories. Factors related to a low total protein intake were mostly related to protein intake in adj. g/kg bw/d.

The characteristics most strongly related to a low total protein intake were, in order of effect size or regression coefficient, difficulties chewing, mobility problems, weight loss of >3 kg in the last 3 mo, decreased appetite, female sex, and older age.

The parameters strongest related to low protein intake based on adj. g/kg bw/d were higher body weight, difficulty chewing,

Table 1
Characteristics of included participants from five different Dutch nursing homes

	Protein/Energy-enriched diet (n = 62)	Standard diet (n = 127)	Total (N = 189)
Sex			
Men	17 (27.4)	39 (30.7)	56 (29.6)
Women	45 (72.6)	88 (69.3)	133 (70.4)
Age (y), mean ± SD	84.3 ± 7.6	85.4 ± 7.1	85 ± 7.3
BMI (kg/m^2), mean ± SD	23.7 ± 4.5	27.2 ± 4.9	26 ± 5
Missing	1	12	13
BMI <2	21 (33.9)	12 (9.4)	33 (17.5)
BMI ≥22–27	29 (46.8)	50 (39.4)	79 (41.8)
BMI ≥27	11 (17.7)	53 (41.7)	64 (33.9)
Weight (kg)			
<60	22 (35.5)	8 (6.3)	30 (15.9)
60–80	33 (53.2)	77 (60.6)	110 (58.2)
>80	7 (11.3)	42 (33.1)	49 (25.9)
Nursing home			
1	43 (69.4)	46 (36.2)	89 (47.1)
2	2 (3.2)	23 (18.1)	25 (13.2)
3	11 (17.7)	21 (16.5)	32 (16.9)
4	2 (3.2)	17 (13.4)	19 (10.1)
5	4 (6.5)	20 (15.7)	24 (12.7)
Ward			
Psychogeriatric	44 (71)	93 (73.2)	137 (72.5)
Somatic	7 (11.3)	27 (21.3)	34 (18)
Rehabilitation	11 (17.8)	7 (5.5)	18 (9.5)
Having dysphagia	26 (41.9)	23 (18.1)	49 (25.9)
Having difficulty chewing	19 (30.6)	8 (6.3)	27 (14.3)
Polypharmacy			
Missing	0	1	1
≥5 medications	50 (80.6)	87 (68.5)	137 (72.5)
Multimorbidity			
≥3 diseases	27 (43.5)	50 (39.4)	77 (40.7)
Verbal communication problems	23 (37.1)	23 (18.1)	46 (24.3)
Weight loss (based on SNAQ^{rc})			
No weight loss	42 (67.7)	118 (92.9)	160 (84.7)
1–3 kg last 3 mo	10 (16.1)	4 (3.1)	14 (7.4)
>3 kg last 3 mo	10 (16.1)	5 (3.9)	15 (7.9)
Having decreased appetite	18 (29)	25 (19.7)	43 (22.8)
Feeding assistance needed	27 (43.5)	25 (19.7)	52 (27.5)
Decrease in food intake			
No decrease	37 (59.7)	94 (74)	131 (69.3)
Moderate decrease	14 (22.6)	29 (22.8)	43 (22.8)
Severe decrease	11 (17.7)	4 (3.1)	15 (7.9)
Mobility			
Goes out	4 (6.5)	23 (18.1)	27 (14.3)
Able to get out of bed	26 (41.9)	70 (55.1)	96 (50.8)
Chair bound	32 (51.6)	34 (26.8)	66 (34.9)
Neuropsychological problems			
No dementia	11 (17.7)	26 (20.5)	37 (19.6)
Mild dementia	15 (24.2)	31 (24.4)	46 (24.3)
Severe dementia	36 (58.1)	70 (55.1)	106 (56.1)
Malnutrition risk (SNAQ^{RC})			
No risk	17 (27.4)	72 (56.7)	89 (47.1)
Moderate risk	16 (25.8)	38 (29.9)	54 (28.6)
Severe risk	29 (46.8)	17 (13.4)	46 (24.3)

BMI, body mass index
Data shown n (%), unless otherwise indicated

mobility problems, decreased food intake, and/or decreased appetite. Low BMI (<22 kg/m^2) was associated with higher protein intake. Small, non-significant associations, for either protein outcome measure, were found for the other determinants investigated.t

Protein/energy-enriched diet group

The effect sizes that were observed in the P/E+ diet group were relatively similar to those in the standard diet group. Effect sizes for sex, age, type of ward, having a decreased appetite, difficulty chewing, and recent weight loss differed between both groups (interaction term $P < 0.10$).

The strongest characteristics related to low total protein intake were higher age, need for feeding assistance, female sex and, to a lesser extent, difficulty chewing and dysphagia. Factors related to a higher intake were type of ward (psychogeriatric and rehabilitation versus somatic) and having multimorbidity.

The strongest characteristics related to low protein intake based on adj. g/kg bw/d were female sex, residents with difficulty

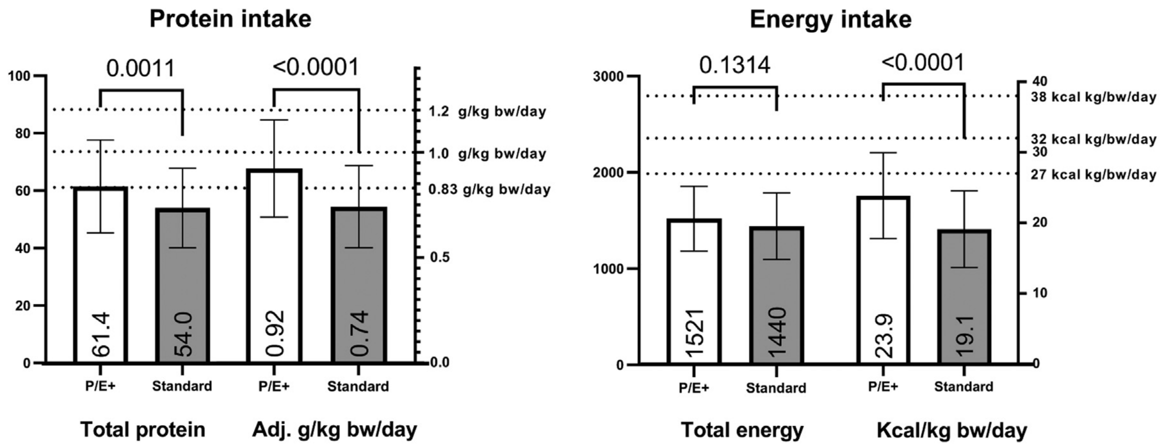

Fig. 1. Overview of recommendations and protein or energy intake of residents from five different Dutch nursing homes. Note: bars represent average intake with standard deviation. Recommendation lines for total protein/energy are based on average population weight (73.6 kg)

chewing, dysphagia, higher weights, and higher age. Low BMI (<22 kg/m^2) was associated with higher intake.

Groups at risk for a low energy intake

Comparable to protein intake, total energy intake was only weakly related to weight/BMI class: Residents within the higher BMI categories and, to a lesser extent, higher weight categories, had a relatively lower energy intake per kg bw daily.

Characteristics related to a low total energy intake were mostly also related to energy intake expressed in kcal/kg bw/day (Table 4).

Energy intake in standard diet group

The characteristics strongest related to total low kcal/d were female sex, having difficulties chewing, weight loss of >3 kg in the last 3 mo, decreased food intake, and low mobility levels. Residents with multimorbidities consumed more energy.

The characteristics strongest related to decreased kcal/kg bw/d were female sex, higher body weight/BMI groups, living in a psychogeriatric or rehabilitation ward, difficulties chewing, poor mobility levels, and having a decreased food intake. Higher intakes were seen in those with neuropsychological problems and those with polypharmacy and/or multimorbidities.

Energy intake with a protein/energy-enriched diet

Based on interaction terms, effect sizes differed significantly ($P < 0.1$) between the standard diet and the P/E+ diet for age group, type of ward, having dysphagia, recent weight loss, and decreased food intake.

The strongest associations with lower total calories per day were female sex, receiving feeding assistance, being older, and, to a lesser extent, dysphagia and/or difficulty with chewing. Type of ward (psychogeriatric and rehabilitation compared with somatic) was associated with higher calorie intake.

The characteristics related the strongest to low kcal/kg bw/d were higher weight/BMI and age, difficulty chewing and/or dysphagia. Having a low BMI (<22 kg/m^2) was associated with higher kcal/kg bw/d.

Small, non-significant associations, for either energy outcome measure, were found for the other determinants investigated.

Discussion

This study demonstrated that residents of Dutch nursing homes need to consume more protein and energy. The highest prevalence of poor protein and energy intake was seen in female residents, older residents, those having difficulties chewing or dysphagia,

Table 2
Energy and protein intake of included participants from five different Dutch nursing homes

	Protein/Energy-enriched diet (n = 62)	Standard diet (n = 127)	Total (N = 189)	*P*-value*
Protein intake/d, mean ± SD				
Total intake (g),	61.4 ± 16.2	54 ± 13.8	56.4 ± 15	0.001
Intake adj. g/kg bw	0.92 ± 0.23	0.74 ± 0.19	0.80 ± 0.22	<0.001
≥0.83 adj. g/kg bw	41 (66.1)	36 (28.3)	77 (40.7)	<0.001
≥1 adj. g/kg bw	18 (29)	11 (8.7)	29 (15.3)	<0.001
≥1.2 adj. g/kg bw	9 (14.5)	4 (3.1)	13 (6.9)	0.004
Energy intake/d, mean ± SD				
Total intake (kcal)	1521 ± 337	1440 ± 345	1467 ± 344	0.131
Daily intake (kcal/kg bw)	23.9 ± 6.1	19.1 ± 5.4	20.7 ± 6.1	<0.001
≥27 kcal/kg bw	16 (25.8)	12 (9.4)	28 (14.8)	0.003

bw = body weight.
Data shown n (%) unless otherwise indicated
*P values are derived based on chi-square (dichotomized data) and t test (continues data)

Table 3
Regression coefficients for protein intake derived from linear mixed models for residents of five different Dutch nursing homes with standard and protein/energy-enriched diet

	Standard diet (n = 127)		Protein/energy-enriched diet (n = 62)	
	Total g/d protein	Adjusted g/kg bw protein daily	Total g/d protein	Adjusted g/kg bw protein daily
Sex				
Women	−6.8	−0.04	−15.1	−0.10
	(−11.3 to −2.2)*	(−0.03 to 0.11)	(−23 to −7.2)*	(−0.23 to 0.03)
Age (y)				
65−75	Ref.	Ref.	Ref.	Ref.
75−85	−3.1	−0.00	−13.3	−0.19
	(−10.9 to 4.6)*	(−0.12 to 0.11)*	(−23.6 to −2.9)*	(−0.36 to −0.02)*
>85	−6.5	−0.06	−11.8	−0.14
	(−14.1 to 1.2)	(−0.17 to 0.06)	(−21.8 to −1.9)	(−0.30 to 0.02)
BMI (kg/m^2)				
<22	2.7	0.12	−3.6	0.03
	(−5.2 to 10.6)	(0.01 to 0.23)	(−11.4 to 4.1)	(−0.09 to 0.16)
22−27	Ref.	Ref.	Ref.	Ref.
>27	2.7	−0.03	3.6	−0.03
	(−2.4 to 7.8)	(−0.10 to 0.05)	(−5.8 to 13.1)	(−0.19 to 0.12)
Weight (kg)				
<60	Ref.	Ref.	Ref.	Ref.
60−80	0.3	−0.13	5.2	−0.03
	(−8.6 to 9.3)	(−0.26 to 0.00)	(−2.2 to 12.5)	(−0.15 to 0.09)
>80	1.8	−0.21	7.6	−0.13
	(−7.5 to 11.2)	(−0.34 to −0.07)	(−4 to 19.2)	(−0.31 to 0.06)
Nursing home				
1	7.6	0.12	4.6	0.01
	(−1.8 to 16.9)	(−0.02 to 0.25)	(−10.9 to 20.1)	(−0.25 to 0.26)
2	7.5	0.15	5.7	0.04
	(−3.4 to 18.3)	(0.00 to 0.30)	(−18.9 to 30.3)	(−0.37 to 0.44)
3	3	0.07	−5.6	−0.05
	(−9.1 to 15.1)	(−0.10 to 0.23)	(−24.7 to 13.5)	(−0.38 to 0.28)
4	5.8	0.11	2.3	0.12
	(−7.5 to 19.1)	(−0.07 to 0.29)	(−24.5 to 29.2)	(−0.33 to 0.58)
5	Ref.	Ref.	Ref.	Ref.
Ward				
Somatic	Ref.	Ref.	Ref.	Ref.
Psychogeriatric	−0.2	−0.06	11.5	0.16
	(−5.7 to 5.3)	(−0.14 to 0.02)*	(0.9 to 22.1)	(−0.01 to 0.34)*
Rehabilitation	4.3	0.03	10.3	0.08
	(−6 to 14.6)	(−0.13 to 0.18)	(1.1 to 19.4)	(−0.07 to 0.23)
Having dysphagia	−2.3	−0.00	−4.8	−0.08
	(−7.9 to 3.3)	(−0.09 to 0.08)	(−11.5 to 2)	(−0.19 to 0.04)
Having difficulty chewing	−14.9	−0.18	−6.7	−0.15
	(−23.8 to −6.1)*	(−0.32 to −0.04)	(−14.8 to 1.4)*	(−0.28 to −0.02)
Polypharmacy				
≥5 medicines	0.9	0.03	2.7	0.03
	(−4.4 to 6.2)	(−0.05 to 0.11)	(−6.4 to 11.8)	(−0.11 to 0.18)
Multimorbidity				
≥3 diseases	−0.1	0.00	6.2	0.06
	(4.7 to 4.4)	(−0.07 to 0.07)	(0.7 to 13.1)	(−0.05 to 0.17)
Verbal communication problems				
	−3.7	−0.05	−4.8	−0.02
	(−9.4 to 2)	(−0.14 to 0.04)	(−12.7 to 3.1)	(−0.15 to 0.11)
Weight loss				
No weight loss	Ref.	Ref.	Ref.	Ref.
1−3 kg last 3 mo	−2.5	0.00	−4	−0.00
	(−15.9 to 10.9)	(−0.20 to 0.20)	(−14.1 to 6.0)	(−0.16 to 0.16)
>3 kg last 3 mo		−		0.05
	−9.5	−0.08	2.8	(−0.10 to 0.20)
	(−20 to 1.1)*	(−0.24 to 0.08)	(−6.4 to 12.1)*	
Having decreased appetite	−7	−0.10	0.5	0.05
	(−12.2 to −1.9)	(−0.18 to −0.02)*	(−7.5 to 8.4)	(−0.08 to 0.18)*
Feeding assistance needed	−4.0	−0.06	−8.0	−0.07
	(−9.7 to 1.8)	(−0.14 to 0.03)	(−15.9 to −0.1)	(−0.20 to 0.07)
Decrease in food intake				
No decrease				
Moderate decrease	Ref.	Ref.	Ref.	Ref.
	−7.9	−0.10	−1.9	0.00
Severe decrease	(−12.8 to −3)	(−0.18 to −0.03)	(−10.7 to 6.9)	(−0.14 to 0.14)
	−3.8	−0.05	−4.4	−0.03
	(−15.4 to 7.7)	(−0.22 to 0.13)	(−14.4 to 5.5)	(−0.19 to 0.13)

(*continued*)

Table 3 (*Continued*)

	Standard diet (n = 127)		Protein/energy-enriched diet (n = 62)	
	Total g/d protein	Adjusted g/kg bw protein daily	Total g/d protein	Adjusted g/kg bw protein daily
Mobility				
Goes out	Ref.	Ref.	Ref.	Ref.
Able to get out of bed	−10.1	−0.12	−7.3	−0.13
Chair bound	(−16 to −4.2)	(−0.21 to −0.04)	(−21.5 to 6.9)	(−0.35 to 0.10)
	−10.4	−0.16	2.2	0.04
	(−16.9 to −4)	(−0.26 to −0.06)	(−12.1 to 16.5)	(−0.19 to 0.27)
Neuropsychological				
No problems	Ref.	Ref.	Ref.	Ref.
Mild dementia	−1.6	0.04	−0	0.04
	(−8.6 to 5.4)	(−0.05 to 0.16)	(−11.9 to 11.9)	(−0.16 to 0.23)
Severe dementia	−0.4	0.06	−6	−0.04
	(−7.7 to 6.9)	(−0.06 to 0.14)	(−17.6 to 5.6)	(−0.23 to 0.16)

Data shown as mean difference (95% CI)
Adjustments (when appropriate) were made for age category (65−75, 75 85, >85), sex, and mobility (goes out, able to get out of bed/chair, chair bound).
*Significant difference ($P < 0.1$) in regression coefficient between standard and P/E+ diet.

those reported to have a decreased food intake or decreased appetite, or those who were chair-bound. Importantly, this does not imply that other groups were not at risk. Basically, the entire study population consumed insufficient protein and energy and was at risk for not meeting the requirements. The P/E+ diet group consumed more protein/energy than the standard diet group. Nevertheless, more than 70% of the P/E+ group still needed to meet the requirements.

Residents included in the present study were comparable to residents in other large cohort studies within the long-term care setting. The overall age of the residents in this study, 85 y (SD 7.3), was slightly older than in a large Canadian (N = 25 744; mean age = 84.7 [SD 7.7]) [34] and European Union cohort (N = 4023, mean age = 83.6 [SD:9.4]) [35] and the average BMI (26 kg/m^2 [SD 5]) was comparable with data derived from nutritionDay in long-term care facilities (N = 11 923; median BMI 25.7 kg/m^2) [36]. Malnutrition prevalence based on screening tools is hard to compare as they strongly rely on the tool used [37]. However, the prevalence of malnutrition risk (based on SNAQ^{RC}) was comparable to a representative cohort in the Netherlands (both 24% at high risk) [38]. Thus, despite some minor differences, the study population discussed here reflects older adults in nursing homes.

In general, a P/E+ diet seemed beneficial for protein/energy intake, which aligns with previous studies [39]. Residents with a P/E+ diet had a higher protein/energy intake than those in the standard diet group. In the latter group, weight loss of >3 kg and a decreased appetite was associated with a decreased protein/energy intake, whereas this was not seen in the P/E+ diet group. Because of the cross-sectional design, no causality could be obtained. However, a P/E+ diet might already have been introduced for residents with involuntary weight loss or an impaired appetite, which could have increased protein/energy intake.

The protein intake of the residents in the present study was relatively low: more than half of the participants did not meet the lower recommendation of 0.83 g protein/kg bw/d and an even smaller proportion (15.3%) met the suggested daily recommendation of 1 g protein/kg bw let alone the recommended intake of 1.2 to 1.5 for frail older adults [14]. Herewith, and regardless of the recommendation used, protein intake was (far) too low for most residents. In general, an additional ∼5, ∼20, or ∼35 g of protein would be needed to reach the daily 0.83, 1, and 1.2 g/kg bw, respectively, meaning that protein intake should increase with ∼25% to 50%. Even individuals with a P/E+ diet consumed too little energy/protein. This suggests that nearly all residents might benefit from a P/E+ diet. Thus, it may be even more efficient and desirable to incorporate more energy and protein in the standard nutrition policy instead of providing a P/E+ diet to those diagnosed with a low energy/protein intake.

ONS are commonly prescribed to increase protein/energy intake in older adults in nursing homes [40]. In previously performed trials with ONS in the hospital and community setting, an average increase of 22 g of protein and 314 kcal was reported [41]. In nursing homes, such an amount would increase the average daily protein intake to ∼1 g/kg bw at the population level. However, it does not rule out ongoing deficiencies at the individual level. It is also unclear whether the 22 g protein increase can be extrapolated to a nursing home setting, as appetite is lower than for older community-living adults [42]. So, residents with a known low intake should still be monitored to ensure they are consuming enough protein as it is expected that it is challenging for those with an already low intake to consume the prescribed ONS.

Furthermore, it is still being determined whether effects of ONS will last a long time as compliance usually declines over time, and the different flavors and textures of ONS do not fulfill the wishes of older adults needs and wishes [43,44]. Next, the decision to use ONS for nursing home residents with dementia is a complex and ethical process [45]. Possibilities to increase the protein intake should consider all nutritional solutions, whereby ONS is only one of them and should be considered carefully [45].

Another intervention to increase protein intake is to replace low-protein foods with alternative protein-enriched foods. In a simulation study by Verwijs et al. [46] in community-dwelling older adults, the percentage that reached the 1 g/kg bw of protein daily increased from 41.1% to 91.4% when low-protein products were substituted with protein-rich alternatives. However, these results were based on simulation data in the community, and it remains to be seen how effective this would be in practice. A replacement strategy without increasing the total volume of the meals might be insufficient to increase protein/energy intake as portions are small and appetite is generally low in nursing home residents. Additionally, older adults prefer only to use products they have known their whole life [47,48], so, in some cases, replacement of products might not be accepted. Enrichment of usual products might be a solution. For example, ice cream and dairy products can easily be modified by adding protein/energy powder.

In addition to changes in products or providing additional products, increasing food intake could be achieved by changing how the food is provided. Providing more small meals and in-between snacks can increase intake [49]. As appetite is limited in older adults [42], foods should be distributed over the course of the day. For example, an additional evening snack before bedtime might

Table 4
Regression coefficients for energy intake derived from linear mixed models for residents of five different Dutch nursing homes with standard and protein/energy-enriched diet

	Standard diet (n = 127) Total kcal/d	kcal/kg bw daily	Protein/energy-enriched diet (n = 62) Total kcal/d	kcal/kg bw daily
Sex				
Women	−204 (−330 to −79)	−1.9 (−4 to 0.1)	−305 (−487 to −124)	−1.9 (−5.5 to 1.8)
Age (y)				
65–75	Ref.	Ref.	Ref.	Ref.
75–85	−25 (−237 to 187)	1.2 (−2.3 to 4.6)*	−190 (−430 to 51)	−2.3 (−7.2 to 2.5)*
>85	−115 (−321 to 91)	−0.2 (−3.6 to 3.1)	−165 (−398 to 68)	−2 (−6.7 to 2.7)
BMI (kg/m^2)				
<22	−58.9 (−270 to 152)	2.9 (−0.4 to 6.1)	−63 (−246 to 120)	5.2 (2 to 8.4)
22–27	Ref. 56 (−77 to 188)	Ref.	Ref. 61 (−163 to 286)	Ref.
>27		−2.8 (−4.9 to −0.8)		−3.2 (−7.1 to 0.7)
Weight (kg)				
<60	Ref.	Ref.	Ref.	Ref.
60–80	126 (−121 to 372)	−4.1 (−7.6 to −0.6)	109 (−61 to 281)	−4.7 (−7.7 to −1.7)
>80	90 (−167 to 348)	−8.9 (−12.6 to −5.3)	160 (−114 to 434)	−9.8 (−14.7 to −5)
Nursing home				
1	77 (−112 to 267)	1.8 (−3.1 to 4.6)	−54 (−407 to 298)	−2 (−8.9 to 4.8)
2	11 (−195 to 217)	3.1 (−1.9 to 7.1)	−29 (−599 to 541)	−1.3 (−12.4 to 9.8)
3	84 (−129 to 297)	3.1 (−1.8 to 8.4)	−153 (−532 to 224)	0.2 (−7.5 to 7.1)
4	39 (−180 to 257)	1.4 (−4.6 to 6.6)	−104 (−691 to 483)	7.7 (−3.7 to 19.2)
5	Ref.	Ref.	Ref.	Ref.
Ward				
Somatic	Ref.	Ref.	Ref.	Ref.
Psychogeriatric	−64 (−206 to 78)*	−2.9 (−5.2 to −0.7)	217 (−30 to 464)*	1.5 (−3.8 to 6.7)
Rehabilitation	−85 (−350 to 180)	−2.2 (−6.4 to 2)	195 (−17 to 408)	−0.7 (−5.3 to 3.7)
Having dysphagia	−10 (−168 to 147)	0.7 (−1.8 to 3.3)*	−136 (−298 to 27)	−3.1 (−6.4 to 0.2)*
Having difficulty chewing	−340 (−595 to −85)	−3.7 (−7.9 to 0.6)	−125 (−319 to 70)	−4 (−7.9 to −0.1)
Polypharmacy				
≥5 medicines	47 (−84 to 177)	1.5 (−0.6 to 3.6)	107 (−103 to 319)	−1.1 (−5.4 to 3.2)
Multimorbidity				
≥3 diseases	107 (−11 to 226)	1.6 (−0.3 to 3.5)	82 (−87 to 251)	−0.7 (−4.1 to 2.8)
Verbal communication problems present	−133 (−286 to 20)	−1.2 (−3.7 to 1.3)	−121 (−301 to 59)	1.4 (−2.2 to 5.1)
Weight loss				
No weight loss	Ref.	Ref.	Ref.	Ref.
1–3 kg last 3 mo	−7 (−336 to 322)	2.6 (−2.9 to 8)	−63 (−297 to 171)	1.2 (−3.6 to 6)
>3 kg last 3 mo	−315 (−611 to −12)*	−1.8 (−6.7 to 3.1)	105 (−119 to 329)*	1.6 (−3 to 6.1)
Having a decreased appetite	−165 (−308 to −21)	−1.7 (−4.1 to 0.7)	15 (−175 to 205)	1 (−2.8 to 4.9)
Feeding assistance needed	−55 (−206 to 95)	−0.7 (−3.1 to 1.8)	−215 (−398 to −33)	−1.6 (−5.5 to 2.2)
Decrease of food intake				
No decrease	Ref.			
Moderate decrease	−225 (−360 to −90)*	Ref.	Ref.	Ref.
Severe decrease	−122 (−445 to 200)	−2.4(−4.7 to −0.1)*	−9 (−212 to 194)*	1.4 (−2.7 to 5.5)*
		−0.4 (−5.8 to 5)	−134 (−372 to 102)	−2 (−6.7 to 2.8)
Mobility				
Goes out	Ref.	Ref.	Ref.	Ref.
Able to get out bed	−147 (−303 to 9)	−1.4 (−4 to 1.1)	−17 (−348 to 314)	−0.8 (−7.5 to 5.9)
Bed or chair bound	−220 (−394 to −47)	−3.5 (−6.3 to −0.7)	−22 (−353 to 310)	−1.3 (−8 to 5.4)
Neuropsychological				
No problems	Ref.	Ref.	Ref.	Ref.
Mild dementia	−106 (−277 to 65)	0.9 (−1.8 to 3.7)	−6 (−256 to 244)	1.7 (−3.5 to 6.9)
Severe dementia	18.6 (−136 to 173)	2.7 (0.3 to 5.2)	−153 (−370 to 63)	0.7 (−3.8 to 5.2)

BMI, body mass index
Data shown as mean difference (95% CI)
Adjustments (when appropriate) were made for age category (65–75, 75 85, >85), sex, and mobility (goes out, able to get out of bed/chair, chair bound).
*Significant difference ($P < 0.1$) in regression coefficient between standard and P/E+ diet.

increase intake without affecting the appetite for the next meal. Another opportunity to increase intake is substituting the water consumed when taking medications with protein/energy-rich liquids [50]. However, dangerous food–drug interactions must be prevented and checked for each resident. Also, care should be given to meal presentation. Increasing ambiance and better presentation of meals have been shown to increase appetite and lead to higher intakes [51]. Finally, staff must be made more aware of the risk for malnutrition. Increasing their knowledge about malnutrition and healthy eating could increase the resident's food intake [51].

Food provides nutrients and gives residents structure, joy, and opportunities to socialize [52,53]. These aspects should be considered when striving to increase protein and energy intake in residents as they provide a good quality of life. As residents are in their last phase of life, this is the most crucial factor to focus on. When changing nutritional policies to improve intake, choices should be guided by nutrient composition and the effects on quality of life [54]. At the individual level, residents and families should be consulted about whether additional food enrichments are desirable in case of deficits, especially toward the end of life [54].

Based on our data, no relation was found between total protein intake and body weight/BMI. Caregivers should know that protein intake per kg/bw could be misleading in low-weight residents.This results in a relatively high protein intake, expressed by gP•kg bw•d, in low BMI/weight residents. This does not directly imply better compliance with the guidelines, as protein recommendations are higher for those with underweight/malnutrition [13,14]. Caregivers should also be aware that, based on their weight, residents with higher BMI have higher protein and energy needs, but requirements must be adjusted to a BMI of 27 kg/m^2. The use of adjusted body weight for low-BMI residents is recommended [28], but ideally, their protein requirement should be based on body composition (e.g., FFM) rather than body weight [55].

Besides a low protein intake, our study population did not reach the energy recommendations. The average energy intake was 1467 kcal, and more than 80% did not meet the daily recommendation of 27 kcal/kg bw let alone the 32 to 38 kcal/kg bw advised for older adults with malnutrition [13]. Considering that 52.9% of the respondents were at risk for malnutrition, the average daily intake of 20.7 kcal/kg bw is too low. However, most residents (84.3%) had no recent weight loss, indicating that they had a neutral or positive energy balance. This discrepancy may be explained by using prediction equations for energy requirements for older adults. Equations have generally been developed in healthy populations or critically ill patients and are considered sufficiently accurate when used at the group level. However, there is a significant chance of deviations from the requirements at the individual level. Within hospitalized and post-discharged older adults, the best equations accurately predicted only 40% to 63% [56]. Fixed factor equations (e.g., 27 kcal/kg) were predicted even worse than equations based on weight, height, FFM, or illness factor. For those with high BMIs, the recommendation of 27 kcal/kg bw daily might be too high [17]. Therefore, comparing energy intakes with energy requirement equations should be interpreted cautiously. A recent study with Belgium nursing home residents (N = 25) based on indirect calorimetry showed that average requirements were ~1575 kcal [57]. This requirement is more in line but still higher than the average intake of the present study population.

A low protein/energy intake could increase the risk for developing or aggravating malnutrition. We did not perform follow-up measurements and thus could not assess this relation. Factors related to low protein intake in the present study, such as mobility problems, difficulty chewing, and feeding assistance were previously shown to be risk factors for developing malnutrition in nursing home residents [6]. In contrast, neuropsychological problems, widely accepted as risk factors for developing malnutrition [58], were not associated with lower intakes in the present study. A previous study by our group showed that residents with multiple cognitive problems are at increased risk for developing malnutrition [7]. We could not test the relationship between multiple cognitive problems on protein and energy intake because we had limited data on neuropsychological problems. As the no-dementia group was relatively small, a lack of power could also explain the absence of significant findings.

Limitations and strengths

Because of the COVID-19 restrictions, weight was often obtained from medical records that could be biased. However, previous studies have shown that medical records are generally a reliable source for weight measurements [59,60]. When measuring food intake, it is well known that most assessment techniques lead to underestimating intake, which results in higher prevalence rates of residents at risk for low protein/energy intake. However, using observations, as in this study, minimizes this effect as this is regarded as the standard for the criterion validity of food intake [61,62]. As stated, protein and energy intakes were compared with general recommendations based on participants' weight. We did not consider that residents could have had individualized advice from a health care provider to lower their energy or protein intake, for example, to lose some weight or because of kidney problems. Finally, with most participants admitted with neuropsychological diseases, we performed measurements at only one rehabilitation ward and two somatic wards. Results are, therefore, more generalizable to neuropsychological than to somatic residents. Moreover, power was low for the associations resulting in large confidence intervals. Associations derived for the type of ward should therefore be interpreted with caution.

Conclusion

Most older adults in the present study population consumed insufficient protein and energy. A P/E+ diet was associated with a higher protein/energy intake in older adults. Nevertheless, most residents who consumed a P/E+ diet had an intake below the requirements. Because of the low intakes, we recommend that a protein/energy-enriched diet be prescribed for all nursing home residents and should be even more enriched compared with the current P/E+ diets to optimize the protein and energy intake. Given the small appetite of nursing home residents, using small servings of energy- and protein-rich foods to enrich meals might be helpful. Future studies are needed to identify which strategies work best to increase protein and energy intake.

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