Mealtime habits and meal provision are associated with malnutrition among elderly patients admitted to hospital

Lisa Söderström[a, b,*], Eva Thors Adolfsson[a,d], Andreas Rosenblad[a,e], Hanna Frid[a,f], Anja Saletti[b,g], Leif Bergkvist[a,c, h]

[a]*Centre for Clinical Research, Uppsala University, Västmanland County Hospital, Västerås, Sweden.*

[b]*Department of Public Health and Caring Sciences: Clinical Nutrition and Metabolism, Uppsala University, Sweden.*

[c]*Department of Surgery, Västmanland County Hospital, 721 89 Västerås, Sweden*

*Corresponding author. Centre for Clinical Research, Uppsala University, Västmanland County Hospital, 721 89 Västerås, Sweden. Tel.: +46 21 173969; fax: +46 21 173733.

E-mail addresses: lisa.soderstrom@ltv.se (L. Söderström), eva.thors-adolfsson@ltv.se (E. Thors Adolfsson), andreas.rosenblad@ltv.se (A. Rosenblad), hanna.frid@ltv.se (H. Frid), anja.saletti@pubcare.uu.se (A. Saletti), leif.bergkvist@ltv.se (L. Bergkvist).

d Tel.: +46 21 174549; fax: +46 21 173733.

e Tel.: +46 21 175130; fax: +46 21 173733.

f Tel.: +46 21 176896; fax: +46 21 173733.

g Tel.: +46 18 6117974; fax: +46 186117976.

h Tel.: +46 21 175803; fax: +46 21 173733.

Abstract

Background & aims: Large-scale studies performed in hospitals with the validated Mini Nutritional Assessment tool (MNA) are scarce. However, factors associated with malnutrition are important for identifying individuals at risk. The aims of the present study were to estimate the prevalence of malnutrition and to examine the association between mealtime habits, meal provision, and malnutrition among elderly patients admitted to hospital.

Methods: This cross-sectional study included patients aged ≥ 65 years admitted to internal medicine, surgical or orthopaedic wards. The MNA was used for their nutritional assessment, and factors potentially associated with malnutrition were recorded.

Results: Of 1771 patients (mean age 78 years), 35.5% were well-nourished, 55.1% were at risk of malnutrition and 9.4% were malnourished. Overnight fasts exceeding 11 hours, fewer than four eating episodes a day, and not cooking independently were associated with both malnutrition and risk of malnutrition.

Conclusions: The risk of malnutrition was high among elderly patients admitted to hospital, whereas the proportion with fully developed malnutrition was lower than expected. A long overnight fast, few eating episodes, and not cooking independently were associated with an increased risk of malnutrition. Knowledge of these factors when providing care to the elderly may assist health-care professionals to prevent malnutrition.

Key words: Malnutrition, Prevalence, Elderly, Hospital, MNA, Risk factor

1. Introduction

The occurrence of protein-energy malnutrition (malnutrition) in hospitals has been acknowledged for many years,[1] but it is still a problem worldwide.[2] In Europe, the prevalence of malnutrition among elderly patients in hospitals has been reported to be 23–39% when assessed with the Mini Nutritional Assessment (MNA) tool,[2-4] an instrument developed to identify elderly patients (≥ 65 years) either with malnutrition or at risk of it.[3] The identification of patients with a poor nutritional status in hospitals is central to the provision of proper treatment, because the condition is associated with increased morbidity[5,6] and mortality.[7-9] However, in Sweden, no large-scale study has used the MNA for the nutritional assessment of elderly patients admitted to hospital.[6,8,10] It is important to obtain up-to-date data on the prevalence of malnutrition to increase our awareness of elderly patients admitted to hospitals who are at risk of malnutrition.

It is also necessary to identify the factors associated with malnutrition to facilitate the identification of elderly with a poor nutritional status. Factors previously shown to be associated with malnutrition are age[4,11,12] and certain diagnoses and conditions, such as dementia,[4,13] depression,[4,13] and functional dependence.[11,13] Other factors suggested to be related to health outcomes are mealtime habits, such as the overnight fast,[14] the number of eating episodes,[15] and meals on wheels.[9,16] However, the association between mealtime habits, meal provision and malnutrition in the elderly remain unclear.

According to the recommendations for food and nutritional care in European hospitals, eating episodes should be spread out over the day to cover most of the waking hours,[17] thereby reducing the length of the overnight fast. This also ensures sufficient time between each meal to allow between-meal snacks in the morning, afternoon, and late evening[17] to generate a sufficient energy and nutrient intake. In the Nordic countries, these recommendations are even more specific, stating that the overnight fast should not exceed 11

hours in the elderly, and that the individual should have at least four eating episodes a day.[18] However, no clinical studies have been undertaken to support the Nordic recommendations; e.g., to confirm that the length of the overnight fast or number of eating episodes is associated with the prevalence of malnutrition.

The aims of the present study were to estimate the prevalence of malnutrition and to examine the associations between mealtime habits, meal provision, and malnutrition among elderly patients admitted to a medium-sized Swedish hospital. The primary hypothesis was that the length of the overnight fast and the number of eating episodes are associated with malnutrition. The secondary hypothesis was that meal provision is associated with malnutrition.

2. Materials and methods

2.1 Study design and setting

This cross-sectional study was conducted over 15 months from March 2008 to May 2009, at a medium-sized county hospital in central Sweden. The hospital, with a total of 443 beds, serves a population of approximately 250,000 inhabitants. Nutritional assessment was performed with the MNA instrument during the patients' hospital stays, and factors potentially associated with malnutrition were recorded.

2.2 Study participants

A total of 2717 patients were assessed for their eligibility to participate in the study. The inclusion criterion was that each patient was ≥ 65 years old when admitted to hospital. The reasons for exclusion are shown in Figure 1. The final sample consisted of 1771 patients in two internal medicine wards (n = 706), two surgical wards (n = 681), and one orthopaedic ward (n = 384). The patients were recruited consecutively during the study period, except on weekends, holidays, and when the wards were closed because of a calicivirus outbreak.

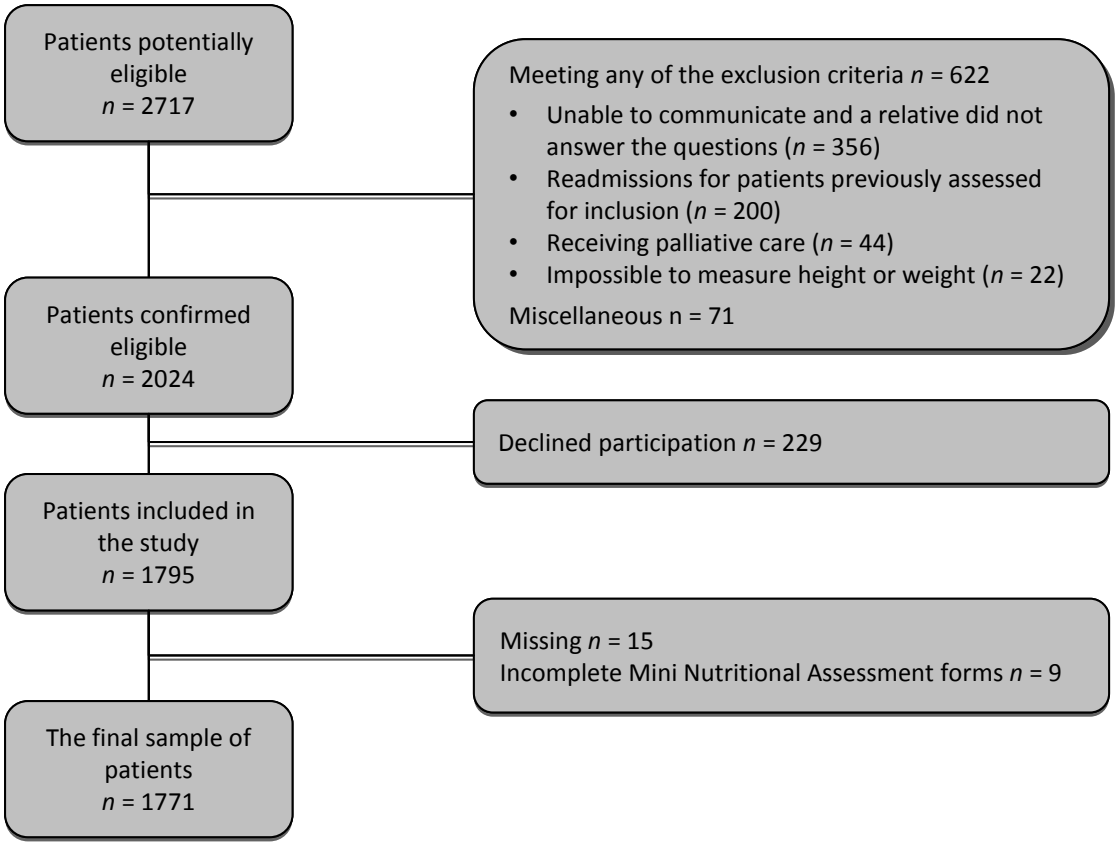

Fig. 1. Flow chart showing patient recruitment.

2.3 Patient characteristics

The data collected were age, sex, body mass index (BMI), waist circumference, and smoking status (current or non-smoker). Medicine use before admission and the patient´s diagnosis at discharge were collected. The diagnoses were registered according to the International Statistical Classification of Diseases and Related Health Problems, 10th Revision (ICD-10).

The patients were asked about their length of overnight fasts, defined as the period between the last eating episode in the evening and the first eating episode the following morning. The number of eating episodes per day was recorded by asking the patients how often they usually ate breakfast, lunch, dinner, and between-meal and evening snacks. How meals were provided (meal provision) was registered as: cooks independently and/or with help from his/her spouse (cooks independently), meals on wheels or meals in a nursing home or restaurant. Multiple

answers were allowed for the question concerning meal provision. Finally, we recorded whether the patient, a relative, or both had answered the questions for the patient´s nutritional assessment and provided the demographic data.

2.4 Nutritional assessment

Nutritional assessment was performed with the MNA, an instrument validated for the nutritional assessment of the elderly[19] and recommended for use in elderly patients in clinical settings by the European Society for Clinical Nutrition and Metabolism (ESPEN).[20] The instrument has been shown to have good inter-observer reliability[21] and has been used in hundreds of studies, demonstrating its usefulness in clinical practice.[3]

The MNA consists of two parts, allowing a two-step screening process.[22] However, in this study, all patients were assessed with the full MNA. The instrument consists of 18 weighted questions concerning decline in food intake, weight loss, mobility, current illness, neuropsychological problems, BMI, housing, medicine use, wounds, dietary intake, and self-perceived nutritional and health status. Measurements of mid-arm and calf circumferences are also included. The responses can sum to a maximum score of 30 points, and they classify the patients into three nutritional groups: well-nourished (MNA 24–30), at risk of malnutrition (MNA 17–23.5) or malnourished (MNA < 17).[3]

2.5 Data collection procedure

The nutritional assessment was performed during the patient´s stay in hospital. In total, 18 personnel collected the data (2–4 registered nurses, assistant nurses, or registered dieticians in each ward). The personnel received training in the use of the MNA before the commencement of the study. The training was provided by the researchers (LS, HF) responsible for the study to increase the inter-observer reliability. The researchers also observed the assessments

carried out by each of the personnel twice during the study period on avarage to maintain the internal validity of the process.

Height was measured to the nearest centimetre with a stadiometer. Patients who were unable to stand upright were measured with a sliding calliper or by calculating their height from their demi-span using the formula (1.40 × demi-span [cm]) + 57.8 for men and (1.35 × demi-span [cm]) + 60.1 for women.[23] With the patient wearing a light hospital robe, weight was measured to the nearest kilogram with a calibrated chair or mobile lift scale after the bladder was emptied. BMI was calculated with the standard formula, weight (kg)/height^2 (m^2). Mid-arm, waist, and calf circumferences were measured to the nearest centimetre with a flexible, inelastic measuring tape.

2.6 Ethical considerations

The study was approved by the Uppsala Ethical Review Board (approval number: 2007-323). All participants provided their written informed consent before entering the study. If a patient was unable to communicate, consent was provided by a relative.

2.7 Statistical analysis

For the descriptive analysis, the univariate differences between the patients' nutritional assessment status (well-nourished, risk of malnutrition, or malnourished) were tested using Pearson's χ^2 test for categorical variables, the Kruskal–Wallis test for ordinal and discrete data, and ANOVA for continuous variables. Categorical data are presented as frequencies and percentages, ordinal data as medians and interquartile ranges (q1–q3), and discrete and continuous variables as means ± standard deviations (SD).

The primary and secondary diagnoses were categorised into the main diagnostic groups of the ICD-10 classification system, and into specific diagnosis groups potentially associated

with malnutrition: diabetes mellitus (E10–E14), cerebrovascular diseases (I60–I69), chronic obstructive pulmonary disease (COPD) (J44), Crohn's disease and ulcerative colitis (K50–K51), rheumatoid arthritis (RA) (M05–M06), and renal failure (N17–N19). For each patient, we registered that a certain diagnosis group was present (yes) if the patient had a primary or secondary diagnosis belonging to the diagnosis group in question. The ICD-10 group "codes for special purposes" (U00–U99) could not be analysed due to too few cases. Thus, 19 main ICD-10 diagnosis groups and six specific diagnosis groups were analysed as possible factors associated with malnutrition.

For the multivariate analyses, a multinomial logistic regression model was used with nutritional assessment status as the dependent variable. All variables that were significant in the univariate analyses, except those that contributed directly or indirectly to the MNA score (weight, height, BMI, number of medications, waist circumference, meal provision, mental and behavioural disorders [ICD 10: F00–F99]) were included as independent variables. Thus, age ≥ 80 years (yes/no), being a woman (yes/no), smoking (yes/no), infectious disease (ICD-10: A00–B99) (yes/no), COPD (ICD-10: J44) (yes/no), RA (ICD-10: M05–M06) (yes/no), number of diagnoses, overnight fast > 11 hours (yes/no), and eating episodes < 4 (yes/no), were included as independent variables in the base model, together with the interaction effects between smoking, overnight fast, and number of eating episodes.

It was not possible to analyse the meal provision variable (independent cooking, meals on wheels, meals in a restaurant or nursing home) for the whole group because this parameter indirectly contributed to the MNA score through the item in the MNA form: "Lives independently" (not in a nursing home or hospital). Furthermore, patients living in nursing homes are not usually able to cook. A subgroup analysis of the 1685 elderly individuals living at home was therefore necessary, from which patients who lived in nursing homes (n = 86) were excluded.

Meal provision, together with the other variables in the full model, and the interaction effects between meal provision on the one hand and smoking, overnight fast or eating episodes on the other hand, were included in the multinomial logistic regression subgroup analysis. The meal provision variable was analysed as a binary variable: cooking independently (yes/no). To obtain the final models, backward stepwise selection was used with an entry probability of 0.05 and removal probabilities of 0.2 for the main effects and 0.05 for the interaction effects. All analyses were performed in SPSS 18.0/20.0 (SPSS 2010/2011). For all statistical tests, a two-sided p value < 0.05 was considered significant.

3. Results

3.1 Patient characteristics

The mean age of the 1771 patients included was 78.1 ± 7.8 years (range 65–99), which was significantly lower than that of the excluded patients (mean age 80.6 ± 8.4 years; $p < 0.001$). Women were predominant (56.1%), with a mean age of 78.9 ± 7.9 years compared with 77.1 ± 7.5 years for men ($p < 0.001$). There was no significant difference in the sex distribution among the excluded and included patients ($p = 0.216$). The mean BMI was 25.9 ± 4.8 kg/m² (range 13–49) and BMI values < 20 kg/m² were found in 8.6% of the patients and a BMI < 22 kg/m² were found in 19.8% of patients.

In total, 97.5% ($n = 1725$) of the patients were able to answer the questions themselves, 1.3% ($n = 23$) answered the questions together with a relative, and the patients relatives answered the questions at the hospital for 1.2% ($n = 22$). One out of 10 ($n = 197$) patients were current smokers. Most of the patients lived at home ($n = 1685$; 95%) before their admission to hospital, and a minority lived in nursing homes ($n = 86$; 4.9%). The patients were taking a mean number of 5.4 ± 4.0 (range 0–24) different medications, and the mean number of diagnoses per patient was 3.1 ± 1.7 (range 1–10) diagnoses. Approximately 78% of the study population experienced overnight fasts exceeding 11 hours, and 49% had fewer than four eating episodes a day.

Table 1 shows the patient characteristics, presented in relation to their nutritional assessment status (well-nourished, at risk of malnutrition, or malnourished). In the malnourished group, the patients had longer overnight fasts, had fewer eating episodes, and received meals on wheels or were served their meals in nursing homes more often than the patients in the well-nourished group.

According to their medical records, a diagnosis of dementia was present in 1.9% ($n = 33$) of the patients and depression in 2.9% ($n = 52$). Table 2 shows patients' diagnoses according

to the ICD-10 classification system, in relation to their nutritional assessment status (well-nourished, at risk of malnutrition, or malnourished). The three most common primary or secondary diagnoses according to this classification system, were diseases of the circulatory system (I00–I99; 1062 patients), endocrine, nutritional and metabolic diseases (E00–E90; 459 patients), and diseases of the digestive system (K00–K93; 426 patients). The prevalence of malnutrition was higher in patients with infectious diseases or mental and behavioural disorders. When six specific diagnostic groups were analysed separately, the prevalence of malnutrition was also higher in patients with COPD and RA but not in patients with diabetes mellitus, cerebrovascular disease, Crohn's disease, or ulcerative colitis or in patients with renal failure.

3.2 Prevalence of malnutrition

According to the MNA, 35.5% (n = 629) of the patients were well-nourished, 55.1% (n = 976) were at risk of malnutrition, and 9.4% (n = 166) were malnourished. The median (q_1–q_3) MNA score was 22.5 (19.5–24.5). There were no significant differences in the prevalence of malnutrition between the medical, surgical and orthopaedic clinics (p = 0.392), or the different nursing wards within each clinic (p = 0.325). A subgroup analysis excluding the 86 patients living in nursing homes, showed that 36.9% (n = 618) of the patients living at home were well-nourished, 54.8% (n = 924) were at risk of malnutrition, and 8.3% (n = 140) were malnourished.

Table 1 Patient characteristics according to their nutritional assessment status (well-nourished, at risk of malnutrition, or malnourished) derived from the Mini Nutritional Assessment (MNA) instrument.

	Well-nourished patients (n = 629)	Patients at risk of malnutrition (n = 976)	Malnourished patients (n = 166)	p value[a]
Age (years), mean ± SD	76.5 ± 7.2	78.6 ± 7.9	81.1 ± 7.9	<0.001
Women, *n* (%)	328 (52.1)	566 (58.0)	99 (59.6)	0.044
Weight (kg), mean ± SD	77.5 ± 13.8	71.4 ± 15.2	58.9 ± 15.8	<0.001
Height (cm), mean ± SD	167.9 ± 9.8	166.4 ± 9.6	166.2 ± 10.6	0.007
Body Mass Index (kg/m^2), mean ± SD	27.5 ± 4.0	25.7 ± 4.7	21.2 ± 4.6	<0.001
Waist circumference (cm), mean ± SD	99.8 ± 12.4	96.5 ± 13.7	86.7 ± 13.7	<0.001
Current smoker, *n* (%)	54 (8.6)	113 (11.6)	30 (18.1)	0.002
Number of medications, mean ± SD	5.1 ± 3.6	5.4 ± 4.1	6.2 ± 4.6	0.095
Number of diagnoses, mean ± SD	2.9 ± 1.6	3.1 ± 1.7	3.5 ± 1.9	0.001
Overnight fast, *n* (%)				<0.001
≤ 11 h	172 (27.4)	182 (18.7)	26 (15.7)	
> 11 h	456 (72.6)	793 (81.3)	140 (84.3)	
Eating episodes, *n* (%)				<0.001
≥ 4	392 (62.3)	460 (47.1)	59 (35.5)	
< 4	237 (37.7)	516 (52.9)	107 (64.5)	
Meal provision[b], *n* (%)				
Cooks independently (yes)	583 (93.1)	827 (84.9)	109 (65.7)	<0.001
Meals on wheels (yes)	34 (5.4)	108 (11.1)	34 (20.5)	<0.001
Nursing home (yes)	12 (1.9)	44 (4.5)	23 (13.9)	<0.001
Restaurant (yes)	20 (3.2)	50 (5.1)	12 (7.2)	0.050

Note: Results based on valid values for $n \geq 1768$ individuals.

[a]ANOVA for continuous variables, Kruskal-Wallis test for discrete variables, and χ^2 test for categorical variables.

[b]Multiple answers allowed.

3.3 Factors associated with the risk and presence of malnutrition

Factors associated with the risk or presence of malnutrition in the multinomial logistic regression analysis are shown in Table 3. Age ≥ 80 years, smoking, having an infectious disease, overnight fasts exceeding 11 hours, and fewer than four eating episodes a day were associated with an increased risk of malnutrition or the presence of malnutrition, whereas the number of diagnoses and having COPD or RA were only associated with the presence of malnutrition. Having RA had the largest OR (4.9) in this model, followed by having an infectious disease (OR 3.7), age ≥ 80 years (OR 3.2), and fewer than four eating episodes a day (OR 3.1). The variables in the regression model explained 11.0% of the variation in the assessed nutritional status.

In the subgroup analysis (n = 1685) that excluded those patients living in nursing homes (Table 4) and included the variable meal provision, cooking independently was associated with an increase in both malnutrition and the risk of malnutrition (OR 5.0). The only difference between the complete sample analysis and the subgroup analysis was that the length of the overnight fast was no longer a statistically significant risk factor for malnutrition in the subgroup analysis. The variables in the subgroup regression model explained 12.7% of the variation in the assessed nutritional status.

The interaction effects between smoking, the overnight fast, eating episodes, and meal provision were analysed in both the full and subgroup models. No significant interactions between the variables were found, and for that reason, no interactions were included in the final regression models.

Table 2 Patients' diagnoses *n* (%), according to the International Statistical Classification of Diseases and Related Health Problems 10th Revision (ICD-10), in relation to their nutritional assessment status (well-nourished, at risk of malnutrition, or malnourished).

ICD-10 code[b]	Diagnostic group	Well-nourished patients (*n* = 629)	Patients at risk of malnutrition (*n* = 976)	Malnourished patients (*n* = 166)	*p* value[a]
A00–B99	Infectious diseases	11 (1.7)	36 (3.7)	11 (6.6)	0.004
C00–D48	Neoplasms	89 (14.1)	145 (14.9)	30 (18.1)	0.450
D50–D89	Diseases of the blood	26 (4.1)	40 (4.1)	11 (6.6)	0.319
E00–E90	Endocrine, nutritional and metabolic diseases	181 (28.8)	239 (24.5)	39 (23.5)	0.121
• E10–E14	Diabetes mellitus	116 (18.4)	156 (16.0)	20 (12.1)	0.116
F00–F99	Mental and behavioural disorders	12 (1.9)	65 (6.7)	21 (12.7)	<0.001
G00–G99	Diseases of the nervous system	57 (9.1)	97 (9.9)	13 (7.8)	0.640
H00–H59	Diseases of the eye and adnexa	10 (1.6)	17 (1.7)	2 (1.2)	0.875
H60–H95	Diseases of the ear and mastoid process	4 (0.6)	14 (1.4)	3 (1.8)	0.261
I00–I99	Diseases of the circulatory system	381 (60.6)	593 (60.8)	88 (53.0)	0.158
• I60–I69	Cerebrovascular disease	93 (14.8)	147 (15.1)	19 (11.4)	0.471
J00-J99	Diseases of the respiratory system	64 (10.2)	120 (12.3)	25 (15.1)	0.172
• J44	Chronic obstructive pulmonary disease	21 (3.3)	45 (4.6)	14 (8.4)	0.019
K00–K93	Diseases of the digestive system	156 (24.8)	229 (23.5)	41 (24.7)	0.812
• K50–51	Crohn´s disease and ulcerative colitis	5 (0.8)	8 (0.8)	2 (1.2)	0.868
L00–L99	Diseases of the skin	9 (1.4)	18 (1.8)	3 (1.8)	0.816
M00–M99	Diseases of the musculoskeletal system	95 (15.1)	152 (15.6)	33 (19.9)	0.310
• M05–M06	Rheumatoid arthritis	8 (1.3)	22 (2.3)	9 (5.4)	0.005
N00–N99	Diseases of the genitourinary system	54 (8.6)	93 (9.5)	23 (13.9)	0.121
• N17–N19	Renal failure	17 (2.7)	26 (2.7)	10 (6.0)	0.055
Q00–Q99	Congenital malformations, deformations and chromosomal abnormalities	6 (1.0)	4 (0.4)	2 (1.2)	0.295
R00–R99	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified	97 (15.4)	154 (15.8)	32 (19.3)	0.468
S00–T98	Injury, poisoning and other consequences of external causes	107 (17.0)	202 (20.7)	36 (21.7)	0.144
V01–Y98	External causes of morbidity and mortality	38 (6.0)	57 (5.8)	17 (10.2)	0.092
Z00–Z99	Factors influencing health status and contact with health services	98 (15.6)	141 (14.4)	22 (13.3)	0.700

[a]Using the χ^2 test.
[b]Main diagnostic groups of the ICD-10 classification system. Specific diagnosis groups potentially associated with malnutrition are marked with a bullet.

Table 3 Factors associated with risk and presence of malnutrition from the final multinomial logistic regression model[a] (n = 1771).

	Patients at risk of malnutrition[a] (n = 974)		Malnourished patients[a] (n = 166)	
	OR (95% CI)	p value[b]	OR (95% CI)	p value[b]
Men	Reference		Reference	
Women	1.227 (0.994–1.516)	0.057	1.331 (0.920–1.926)	0.129
Age 65–79 years	Reference		Reference	
Age ≥ 80 years	1.777 (1.432–2.204)	<0.001	3.193 (2.200–4.632)	<0.001
Non-smoker	Reference		Reference	
Current smoker	1.501 (1.053–2.139)	0.025	2.718 (1.615–4.573)	<0.001
Number of diagnoses	1.036 (0.972–1.104)	0.282	1.168 (1.053–1.297)	0.003
No infectious disease	Reference		Reference	
Infectious disease (ICD-10: A00–B99)	2.184 (1.084–4.400)	0.029	3.685 (1.497–9.075)	0.005
Chronic obstructive pulmonary disease (ICD-10: J44)	1.510 (0.871–2.619)	0.142	2.554 (1.190–5.479)	0.016
Rheumatoid arthritis (ICD-10: M05–M06)	1.862 (0.808–4.291)	0.144	4.900 (1.757–13.661)	0.002
Overnight fast				
≤ 11 hours	Reference		Reference	
> 11 hours	1.462 (1.143–1.871)	0.003	1.674 (1.044–2.685)	0.033
Eating episodes				
≥ 4	Reference		Reference	
< 4	1.878 (1.522–2.318)	<0.001	3.099 (2.141–4.487)	<0.001

Note: Results are based on n = 1768 (99.8%) individuals with valid values on all variables.

[a]The reference category is well-nourished (n = 628).

[b]Multinomial regression with backward stepwise selection was used, with a removal probability of 0.2 and an entry probability of 0.05.

Table 4 Factors associated with the risk and presence of malnutrition according to the subgroup analysis, only including those patients living at home (n = 1685).

	Patients at risk of malnutrition[a] (n = 921)		Malnourished patients[a] (n = 140)	
	OR (95% CI)	p value[b]	OR (95% CI)	p value[b]
Men	Reference		Reference	
Women	1.207 (0.973–1.496)	0.087	1.273 (0.854–1.896)	0.236
Age 65–79 years	Reference		Reference	
Age ≥ 80 years	1.681 (1.346–2.099)	<0.001	2.375 (1.583–3.564)	<0.001
Non-smoker	Reference		Reference	
Current smoker	1.486 (1.036–2.132)	0.031	2.508 (1.429–4.403)	0.001
Number of diagnoses	1.035 (0.969–1.106)	0.304	1.164 (1.038–1.306)	0.010
No infectious disease	Reference		Reference	
Infectious disease (ICD-10: A00–B99)	2.139 (1.055–4.338)	0.035	4.378 (1.750–10.952)	0.002
Chronic obstructive pulmonary disease (ICD-10: J44)	1.433 (0.818–2.511)	0.209	2.410 (1.055–5.508)	0.037
Rheumatoid arthritis (ICD-10: M05–M06)	1.895 (0.818–4.390)	0.136	6.708 (2.405–18.707)	<0.001
Overnight fast				
≤ 11 h	Reference		Reference	
> 11 h	1.455 (1.133–1.870)	0.003	1.425 (0.871–2.332)	0.158
Eating episodes				
≥ 4	Reference		Reference	
< 4	1.883 (1.520–2.333)	<0.001	2.958 (1.983–4.411)	<0.001
Meal provision				
Cooks independently (yes)	Reference		Reference	
Cooks independently (no)	1.949 (1.298–2.927)	0.001	5.041 (2.951–8.611)	<0.001

Note: Results are based on n = 1685 (99.6%) individuals with valid values on all variables.

[a]The reference category is well-nourished (n = 617).

[b]Multinomial regression with backward stepwise selection was used, with a removal probability of 0.2 and an entry probability of 0.05.

4. Discussion

The results of this cross-sectional study indicate that, according to the MNA, one in every three elderly patients admitted to hospital was well-nourished, one in two was at risk of malnutrition, and approximately one in 10 was malnourished. Mealtime habits (the overnight fast and eating episodes) and meal provision (cooking independently vs not cooking independently), were associated with malnutrition and risk of malnutrition.

The prevalence of malnutrition found in this study is relatively low compared with that in a recent review that pooled the analyses of studies that used the MNA in hospitals (n = 1384, mean age 82 years), where the prevalence of malnutrition was 39% and the prevalence of a risk of malnutrition was 47%.[2] In a Belgian multi-centre study (n = 2329), the prevalence of malnutrition was 33% when the MNA was used.[4] However, the study population was older than in the present study (mean age 84 years, compared with 78 years in our study), which may have affected the difference in prevalence, because age is a known risk factor for malnutrition, as shown in the present and previous studies.[4,11,12] The Belgian study also included a higher proportion of patients with dementia than the present study (1.9%), which is a disease known to affect nutritional status. The main reason for these differences in prevalence is probably the different selection procedures used in the studies, and hence the different populations examined. The Belgian study only included wards of elderly patients with geriatric diagnosis, whereas the present study recruited subjects from internal medicine wards, surgical wards, and one orthopaedic ward. However, there is an ethical requirement to include patients with severe cognitive impairment. The most common reason for exclusion from the present study was "unable to communicate and no relative could answer the questions (n = 356)", which excluded a number of patients with dementia. Because the majority of these patients did not have a relative at the hospital who could answer the

questions, a number of patients with cognitive impairment were excluded from the present study.

In our study, several factors were found to be associated with malnutrition or being at risk of malnutrition. These factors might facilitate the identification of patients in elderly care with a poor nutritional status. The most interesting findings of this study are that the length of the overnight fast and the number of eating episodes were associated with both the risk and presence of malnutrition. However, in the subgroup analysis from which the 86 patients living in a nursing home were excluded, the only significant association between the length of the overnight fast and the assessed nutritional status was found in the patients at risk of malnutrition. The statistically significant association between the overnight fast and malnutrition for the complete sample ($p = 0.033$) became insignificant in the subsample of patients living at home ($p = 0.158$). One possible explanation is the substantial reduction in malnourished patients that occurred when the patients living in nursing homes were excluded. Because the latter group included 15.7% ($n = 26$) of the malnourished patients ($p < 0.001$), excluding this group probably resulted in a decisive loss of power.

A possible explanation of the association between the overnight fast and malnutrition is that a long overnight fast allows insufficient time between meals to permit between-meal snacks, especially in the morning and late evening. This, in turn, contributes to reduced energy and nutrient intake. To avoid this course of events, interventions that aim to increase the number of eating episodes and thus to reduce the overnight fast should be evaluated in clinical trials.

The majority of the patients in this study had an overnight fast exceeding 11 hours, and approximately half had fewer than four eating episodes a day. The nutritional recommendations for the Nordic countries state that the overnight fast should not exceed 11 hours in the elderly and that an individual should have at least four eating episodes a day.[18] Furthermore, an overnight fast of less than 11 hours is used as a quality indicator of good

nutritional care when the quality of health care in the Swedish municipalities is compared.[24] The present study supports these recommendations. The findings of this study also have clinical importance, particularly in preventing malnutrition among elderly individuals by identifying the eating habits that increase their risk of malnutrition.

Not cooking independently was associated with an increase in the prevalence of malnutrition and in the risk of malnutrition. This association is supported by a Swedish study of elderly people living at home, which showed that individuals at risk of malnutrition used meals on wheels more frequently and also displayed reduced functions in daily life activities more often than well-nourished individuals.[16] One possible mechanism behind this is that malnutrition leads to functional disabilities and diseases that increase the need for help, in this case in the form of meals on wheels. However, the opposite explanation could well be true; i.e., that functional disabilities lead to malnutrition. A Swedish study of elderly people (*n* = 507) receiving support at home, showed that 89% of the malnourished elderly (MNA score <17) always used one meals on wheels portion for several meals.[9] This could, of course, lead to an insufficient energy and nutrient intake. Regardless of the underlying reason, elderly people who do not have the strength or ability to cook independently should be recognized as individuals at risk of malnutrition.

Several medical conditions may reduce the appetite and influence the developement of malnutrition. Other studies have also found an association between malnutrition and infectious diseases,[25] and between malnutrition and COPD. [4,25] However, a Belgian cross-sectional, multicentre study found no association between malnutrition and RA,[4] contrary to the present study. Also, in our study, being a smoker was associated with an increase in both malnutrition and being at risk of malnutrition. This association has previously been shown in younger hospitalized patients (< 65 years) in Portugal[11] and Germany.[12]

4.1 Strengths and limitations

The strengths of this study are its sample size and the well-validated tool used for the nutritional assessment. The internal validity of the study was strengthened by the training given to the health-care professionals, who collected the data, in how to interpret the questions in the MNA and how to perform the measurements. Detailed instructions were given for the measurements of height, weight, and mid-arm and calf circumferences. The systematic follow-up of the health-care professionals to standardize the assessment process is another strength of this study.

Twenty-four of the 33 patients with dementia answered the questions by themselves. This is a source of uncertainty in our study. However, the diagnosis of dementia does not necessarily imply that the patient has severe cognitive impairment and will therefore give unreliable answers.

A shortcoming of the study is the possibility of selection bias because we did not include patients admitted during weekends or holidays. The major limitation of the study is the excluded patients, because they were significantly older than the included patients. It was not possible to perform a proper drop-out analysis because ethical consideration demand that we respect a patient's inability to communicate or his/her decision not to participate in the study. Analysis of the exclusion criteria showed that the most common reasons for being excluded from the study were "unable to communicate and no relative could answer the questions" and "declined participation". This suggests that the excluded patients may have had a higher risk of malnutrition than those who participated. Consequently, the patients who participated in the study might have been healthier than the average population of elderly individuals found in hospitals, and the true prevalence of malnutrition may have been underestimated in the present population. In contrast, this study supports previous findings of malnutrition prevalence among the elderly living at home.[9] Furthermore, because elderly patients

admitted to hospital are a selected group of individuals, the results of this study cannot be generalized to the whole population of elderly individuals.

Because this was a cross-sectional study, no causal relationships could be identified. Factors shown to be associated with malnutrition in this study could be risk factors for malnutrition but could also be covariates of malnutrition because of causal factors, e.g., sarcopenia and cachexia, which are often associated with a poor nutritional status.[26] To establish causality, a prospective randomized trial should be performed, which would be ethically difficult. However, the findings of other studies support the premise that elderly individuals with a long overnight fast, who have few eating episodes and who do not cook independently should receive information and support from health-care professionals on how to prevent malnutrition. To develope appropriate preventive strategies, an understanding of the underlying causes of a long overnight fast and few eating episodes is essential and a subject for further research.

5. Conclusion

In conclusion, the results of the present study indicate that the prevalence of patients at risk of malnutrition was high in the study population, whereas the proportion with fully developed malnutrition was lower than expected. However, these prevalences might have been underestimated in this study. A long overnight fast, few eating episodes, and not cooking independently were associated with an increased risk of malnutrition, as defined by the MNA. Knowledge of these factors when providing care to the elderly may assist health-care professionals to prevent malnutrition.

Statement of authorship

LS participated in the conception and design of the study, carried out the study, performed statistical analyses, interpreted the results and drafted the manuscript. ETA participated in the conception and design of the study, interpreted the results and drafted the manuscript. AR participated in the conception and design of the study, performed statistical analysis, interpreted the results and drafted the manuscript. HF helped to acquire data, interpreted the results and drafted the manuscript. AS interpreted the results and drafted the manuscript. LB participated in the conception and design of the study, interpreted the results and drafted the manuscript. All authors read and approved the final manuscript.

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Conflict of interest statement

No conflicts of interest stated.

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