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Published in:
Clinical Nutrition ESPEN

DOI (link to publication from Publisher):
10.1016/j.clnesp.2023.02.007

Publication date:
2023

Document Version
Publisher's PDF, also known as Version of record

Clinical Nutrition ESPEN 54 (2023) 398–405

Contents lists available at ScienceDirect

Clinical Nutrition ESPEN

journal homepage: http://www.clinicalnutritionespen.com

Original article

Are nutritional sufficiency of ≥75% energy and protein requirements relevant targets in patients at nutritional risk? - A one month follow-up study

Sabina Mikkelsen [a, *], Karen Hougaard Frost [a], Emma Mølgaard Engelbreth [a], Lærke Nilsson [a], Karen Marie Peilicke [a], Randi Tobberup [a], Lotte Boa Skadhauge [a], Henrik Højgaard Rasmussen [a, b], Mette Holst [a, b]

[a] *Department of Gastroenterology, Aalborg University Hospital, Søndre skovvej 5, 9000 Aalborg, Denmark*
[b] *Department of Clinical Medicine, Aalborg University, Denmark*

ARTICLE INFO

Article history:
Received 19 September 2022
Accepted 7 February 2023

Keywords:
Hospitalized patients
Malnutrition
Energy requirement
Protein requirement
Mortality
Readmissions

SUMMARY

Background & aim: Nutrient intake in patients at nutritional risk was recorded with the aim of reaching at least 75% of estimated requirements for energy and protein. However, the cutoff at 75% has only been sparsely investigated. The aim of this study was to re-evaluate the 75% cutoff of estimated energy and protein requirements among patients at or not at nutritional risk in relation to 30-day mortality and readmissions.
Methods: A 30-day follow-up study was performed among hospitalized patients in 31 units at a Danish University Hospital. Data was collected using the nurses' quartile nutrition registration method and electronic patient journals. All patients were screened using the NRS-2002 and classified as either at nutritional risk (NRS-2002, score ≥3) or not at nutritional risk (NRS-2002, score <3). Energy and protein requirements were estimated using weighted Harris–Benedict equation and 1.3 g/kg/day, respectively.
Results: In total, 318 patients were included in this study. Patients at nutritional risk were older, lower BMI, male, more comorbidities and a longer primary length of stay compared to patients not at nutritional risk ($p < 0.05$). After 30-day follow-up, mortality was higher among patients at risk (9.5% vs. 2.0%, $p < 0.05$). Patients at nutritional risk showed increased risk of mortality if they did not achieve 75% of estimated requirements (energy: OR = 8.08 [1.78; 36.79]; protein: OR = 3.40 [0.74; 15:53]). Furthermore, predicted probability of mortality decreased with increased energy and protein intakes. No significant associations were found for readmissions achieving 75% of estimated energy or protein requirements. A cutoff of 76–81% for energy and 58–62% for protein was equivalent with accepting a 6–8% mortality rate.
Conclusion: The results of this study indicate that an energy intake ≥75% of estimated requirement among patients at nutritional risk has a preventative effect regarding mortality within one month, but not for readmissions.

1. Introduction

Malnutrition is characterized as a state of reduced intake or uptake of nutrients, which can lead to changes of body composition and affect both physical and mental functions and disease recovery [1]. Malnutrition is a problem among hospitalized patients [2], as 44–50% of admitted patients have been shown to be either at risk of malnutrition or malnourished to some degree [3,4]. Nutritional

Abbreviations: GLIM, The Global Leadership Initiative on Malnutrition; LOS, Length of stay; ONS, Oral nutritional supplements; OR, Odds ratio; 95% CI, 95% confidence interval; BMR, Basal metabolic rate; PAL, Physical activity level factor; P, Protein requirement (only in tables); E, Energy requirement (only in tables).

* Corresponding author. Aalborg University hospital, Søndre skovvej 5, 9000 Aalborg, Denmark.
E-mail addresses: sabina.mikkelsen@rn.dk (S. Mikkelsen), karen.hougaard.frost@gmail.com (K.H. Frost), emma-engel@live.dk (E.M. Engelbreth), ln19@live.dk (L. Nilsson), km.peilicke@gmail.com (K.M. Peilicke), r.tobberup@rn.dk (R. Tobberup), losk@rn.dk (L.B. Skadhauge), hhr@rn.dk (H.H. Rasmussen), mette.holst@rn.dk (M. Holst).

https://doi.org/10.1016/j.clnesp.2023.02.007

risk and malnutrition should be detected using validated screening and diagnostic tools [1,5]. In Denmark, all hospitalized patients are to be screened with NRS-2002 within 24 h following hospitalization [6,7]. According to instructions from the Danish Health Authority, a treatment plan should be initiated for patients found to be at risk [6]. The Global Leadership Initiative on Malnutrition (GLIM) criteria can be used for diagnosis and severity of malnutrition [5]. Despite actions to prevent and treat malnutrition, its prevalence has not decreased in the last decades [2–4,8].

Malnutrition is associated with multiple complications such as longer recovery, increased morbidity, longer length of stay (LOS), increased tendency toward infections, more readmissions and increased mortality [2,3,9–11]. Thus, malnutrition increases health care costs [3,9,10].

Patients at nutritional risk benefit from receiving adequate nutritional interventions [12,13]. A recent study underlined that an early individualized nutritional support can improve energy and protein intakes and lower the risk of negative clinical outcomes as well as the economic consequences related to malnutrition [13,14]. Furthermore, the study demonstrated that early increased protein and energy intakes was associated with improved functional capacity and quality of life of patients at nutritional risk [13].

Previous studies found that the majority of patients (>90%) with an intake ≥75% of estimated energy requirement had no significant weight loss (≤5% of initial body weight) [15,16]. Based on these studies, an intake of 75% of estimated energy and protein requirements have been adopted as a cutoff point for sufficient intake. The cutoff point has been used as a requirement for monitoring intake in Denmark since 2003 [17]. However, this cutoff point has only been validated in relation to weight maintenance but has not been evaluated in relation to other relevant outcomes such as mortality or readmissions. Therefore, the aim of this study was to re-evaluate the 75% cutoff of estimated energy and protein requirements among patients at or not at nutritional risk in relation to 30-day mortality and readmissions.

2. Material & methods

The data in this study is collected from the “More2Eat” observational cohort study. This article presents data from baseline and at 30-day follow-up.

2.1. Setting

Data was collected from 31 inpatient units at a Danish University Hospital. All included units were somatic, as psychiatric and intensive care units were excluded. The units differ in organizational and logistical structure, e.g., regarding number of beds and number of health care professionals such as physicians, dietitians and staff nurses.

2.2. Inclusion and exclusion criteria

We recruited all inpatients at the 31 different units, who met the inclusion and exclusion criteria on the specific day of data collection in the respective unit. No power calculation was performed.

2.2.1. Inclusion criteria

Patients ≥18 years of age, who were admitted to a somatic unit were included in the study. Furthermore, inclusion criteria required the patients to stay at the hospital for minimum two meals. Patients should be willing to participate and be able to give written informed consent. In addition, patients were required to speak Danish or English or have a relative that could help translate.

2.2.2. Exclusion criteria

Due to time management during data collection, isolated patients were excluded from the study. Patients who were cognitively unable to give written informed consent to take part in the study were also excluded. In addition, dying patients as well as patients who were hospitalized after attempt of suicide were excluded.

2.3. Organization of data collection

The data collection was conducted during one whole day at each unit by the data collection research team (n = 10). Depending on the size of the unit, one to three data collectors collected data from 7 AM until 10 PM at each unit. Between 10 PM and 7 AM the next morning, the unit staff recorded nutritional intake, including enteral and parenteral administration. The next morning the data collector in charge came back to collect the dietary intake registration charts.

2.4. Data collection at baseline

Patients were included from November 3rd, 2021, to January 26th, 2022. Data collection consisted of a 24 h nutritional intake recording covering intake of all foods and drinks, enteral and parenteral nutrition, medical record data and a nutritional screening. In each unit, a nurse provided a list of eligible patients who met the inclusion criteria.

Patients were included after written sign of informed consent in the early morning. All patients were screened using the NRS-2002. Weight and height were measured by the data collectors if the patient had not been weighed or measured within the past week. Patients were asked if they had experienced unintended weight loss within the last three months; and if so, they were asked about the size of the weight loss. For patients with weight loss, the recorded weight loss was adjusted for potential loss of fluid (as seen in e.g., heart failure patients due to diuretic medicine), if indication hereof was found in the electronic patient journals.

2.5. Electronic patient journal collection on admission day

Data collected in electronic patient journals included the following.

- Body weight (kg) and height (cm), if recorded within one week.
- Sex (male/female).
- Age (years).
- Hospitalization diagnosis and co-morbidities (including number and types of co-morbidities).
- Information on the mobility of the patients and their need for nursing care.

2.6. Monitoring nutritional intake

The nurses' quartile nutrition registration method was used for monitoring nutritional intake [18]. When the patients had food or drinks served either from the food trolley or at the bedside, the type and amount served was written on the dietary intake registration charts. When the patient's tray or dish was taken out, the data collectors wrote how much of the portion had been consumed and estimated the quartile ingested. Drinks were monitored by registering the consumed amounts by observing the 50 ml marks of the glass. Administered enteral and parenteral nutrition was registered likewise.

Additionally, the recording included

- Oral food intake, including all intake/main meals, snack meals and liquids containing calories.
- Oral nutritional supplements (ONS) with the opportunity of writing the product name and amount.
- Enteral nutrition with the opportunity of writing the product name and amount.
- Parenteral nutrition with the opportunity of writing the product name and amount.
- Total energy (kcal) and protein intakes (grams) were calculated.

Furthermore, the data collectors registered whether the patient was fasting during parts of the day and whether the patient missed any meals for other reasons. To calculate the total energy and protein intakes, the “Dietary Calculator 2” was used, which contains information of nutrients of hospital meals.

2.7. Data collection at the one month follow-up

The one-month follow-up data collection was performed using the digital medical records. One month was counted as 30 days from the day of collecting the individual's data, and not from admission date. The following data was collected.

- Admission and discharge dates related to the primary hospitalization where baseline data was collected.
- Primary discharge diagnosis.
- Mortality and the time of death.
- Number of readmissions and date(s).
  Only acute readmissions within one month (using the definition of the Danish Health Authority [19]) were included, thus excluding planned hospital visits, e.g., scheduled knee replacements.

2.8. Statistics

Data were stored in REDCap (version 10.6.26) and Stata (version 17.0) was used for the statistical analyses. The study population is described using n (%) for frequencies and median (minimum and maximum) for continuous variables. Normality of data was tested using the Shapiro Wilk test for normality. The study population was grouped into *at nutritional risk* and *not at nutritional risk* based on the nutritional screening by NRS-2002. The differences between patients at nutritional risk and not at nutritional risk were analyzed using Mann–Whitney test for continuous variables, and Chi^2-tests or Fisher's exact tests for frequencies. The mortality and readmissions, both in the at risk and the not at risk group, for patients who did and did not reach the 75% target were compared using Chi^2 or Fisher's exact test. Logistic regression analyses were performed in order to examine the relationship between mortality and energy or protein intakes among the patients at nutritional risk, where odds ratio (OR) as well as a 95% confidence interval (95% CI) were presented. A significant level on 0.05 was selected.

BMI was calculated based on the definition from World Health Organization [20]. Energy requirement was calculated based on basal metabolic rate (BMR) estimated using the Harris–Benedict equation [21] and including the relevant individual activity factor.

For men: $BMR\ (kcal) = (13.8 \cdot weight(kg)) + (5 \cdot height(cm)) - (6.8 \cdot age(years)) + 66.5$.

For women: $BMR\ (kcal) = (9.6 \cdot weight(kg)) + (1.8 \cdot height(cm)) - (4.7 \cdot age(years)) + 655.1$.

The estimated BMR was adjusted with a physical activity level factor (PAL) of 1.1 in bedridden patients and 1.3 in patients who were not bedridden. Protein requirement for all patients was estimated by 1.3 g/kg body weight/day with a maximum of 135 g/day [22–25]. For patients with a BMI≥30, the energy and protein estimated requirements were estimated by using their ideal weight i.e., calculated weight if BMI was 25.

2.9. Ethical considerations

The study was compliant to the Helsinki declaration. The study was approved by the North Jutland protection agency (ID application 2021-097). The study was submitted to the regional ethic committee, which found that according to Danish legislation, the study was exempted from full application. Participation was voluntary and the patients signed the statement of informed consent before included in the study. The patients were informed that participation in the project had no significance for the treatment they received at the hospital. All participants were assigned a personal project number to ensure that information could not be traced back to the individual.

3. Results

As illustrated on Fig. 1, 318 patients were included in this study and no patients withdrew before the one-month follow-up.

Among the included patients, 53% were found at nutritional risk. Patients at nutritional risk were male, older, had lower BMI, had more comorbidities and had longer primary LOS when comparing to the patients not at nutritional risk ($p < 0.05$). At the time of follow-up, 16 patients were still hospitalized (10 patients in the *at nutritional risk group* and six in the *not at nutritional risk group*), and LOS for those 16 patients are not included in Table 1. Demographic data of the two groups are presented in Table 1.

At the one-month follow-up, 9.5% had died in the at nutritional risk group, while 2.0% died in the not at nutritional risk group ($p < 0.05$). Furthermore, more patients in the nutritional risk group had had a minimum of one readmission compared to the not at nutritional risk group, but this association was not significant ($p > 0.05$) (see Table 2).

Among patients at nutritional risk (53.0%), 49.7% reached an energy intake ≥75% of estimated requirement while 30.8% achieved a protein intake ≥75% of estimated requirement. No associations were found regarding age, BMI, sex, comorbidities or LOS when comparing both energy and protein intakes above or below 75% of estimated requirements in the at risk group. In the not at risk group, an association was found for BMI, when comparing both energy and protein intakes above or below 75% ($p < 0.05$) as illustrated in Tables 3 and 4.

Patients at nutritional risk showed increased risk of mortality if they did not achieve 75% of estimated requirements (energy: OR = 8.08 [1.78; 36.79]; protein: OR = 3.40 [0.74; 15:53]). Regarding readmissions, patients at nutritional risk who did not achieve 75% of estimated energy requirement had increased risk of readmission, but the association was not significant (OR = 1.46 [0.67; 3.18]) (see Tables 5 and 6).

Patients not at nutritional risk had lower OR for readmissions if they did not achieve 75% of estimated energy and protein requirements (energy: OR = 0.38 [0.13; 1.10]; protein: OR = 0.35 [0.14; 0.88]). Lower OR for mortality was seen in those not achieving 75% of estimated energy requirement (OR = 0.80 [0.07; 9.07]) (see Tables 5 and 6).

Predicted probability of mortality per energy intake in % of the patients’ energy requirement is illustrated in Fig. 2. With increased energy intake, the predicted probability for mortality decreases. The probability of mortality within one month is 7.5% with an energy intake corresponding to 75%, 3.3% with an energy intake of

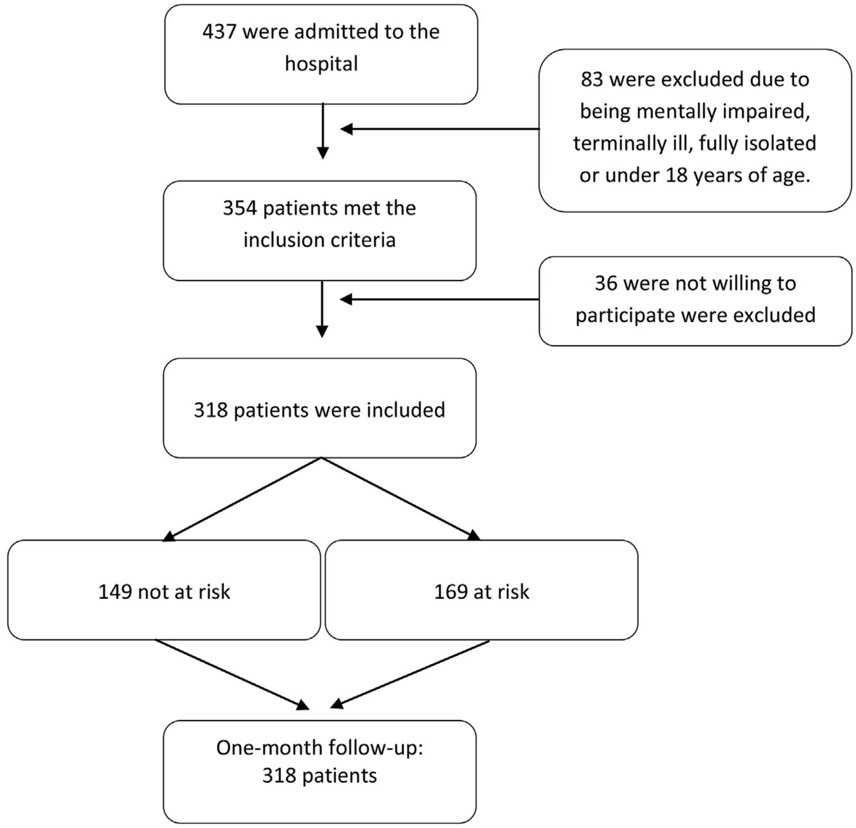

Fig. 1. Flow chart of recruitment and follow-up.

Table 1
Demographic data about the two patient groups: at nutritional risk and not at nutritional risk.

Variable	Nutritional risk		p-value
	At risk (N = 169) N (%) or median (min–max)	Not at risk (N = 149) N (%) or median (min–max)	
Age, years	75 (29–98)	68 (18–91)	<0.001*
BMI, kg/m^2	25.8 (14.3–40.6)	28.0 (18.6–55.5)	<0.001*
Sex, Male	92 (54.4)	87 (58.4)	0.478
Comorbidities			<0.001*
0 comorbidities	12 (7.1)	31 (20.8)	
1-2 comorbidities	100 (59.2)	92 (61.7)	
3+ comorbidities	57 (33.7)	26 (17.5)	
Length of stay, days	12 (1–120)	8 (2–199)	<0.001*

*p < 0.05.

100% and 51.0% with an energy intake of 0% of estimated requirement. It appears that when reaching around 85% of energy intake, the curve flattens noticeably.

Table 2
Associations between mortality and readmission regarding the two patient groups at nutritional risk and not at nutritional risk after one month follow-up.

Variable	Nutritional risk		p-value
	At risk	Not at risk	
Mortality, n (%)	N = 169 16 (9.5)	N = 149 3 (2.0)	0.005*
Readmissions, n (%)	N = 147	N = 142	0.334
0	114 (77.6)	119 (83.8)	
1	28 (19.1)	18 (12.7)	
2+	5 (3.4)	5 (3.5)	

*p < 0.05.

Predicted probability of mortality per protein intake in % of the patients' protein requirement for patients at nutritional risk is illustrated in Fig. 3. With an increasing protein intake, the probability of mortality decreases among patients at nutritional risk. The probability of mortality within one month with an intake of 100% of protein requirement is 1.4% and with a 0% protein intake the probability was 43.3%. It appears when reaching around 70% of protein intake, the curve flattens noticeably. For the protein intake target of 75% of requirement, the probability of mortality within one month is 3.8%.

Accepting a pragmatic predicted probability of 6–7% for mortality within one month with respect to age and disease, the regression analyses point to a cutoff due to intakes of 76–81% for energy and 58–62% for protein of estimated requirements. This suggests that a lower dietary intake is needed within a short period of one month with a 6–7% mortality probability.

4. Discussion

The aim of this study was to investigate whether or not reaching 75% of the estimated energy and protein requirements were associated with mortality and readmission within one month in hospitalized patients at or not at nutritional risk. Within the studied group of 318 patients, 19 had died within the one month. A significant difference in mortality was found between the patients at nutritional risk and not at nutritional risk with a higher mortality among the patients at nutritional risk, which is similar with other studies [10,26]. In the present study, the screening tool NRS-2002 was used to identify patients at nutritional risk. Another study has investigated the agreement between among other NRS-2002 and the GLIM criteria among patients admitted with acute

Table 3
Associations between the two patient groups and energy intake in relation to 75% estimated requirement regarding age, BMI, sex and comorbidities.

Variable	At nutritional risk			Not at nutritional risk		
	≥75% E	<75% E	p-value	≥75% E	<75% E	p-value
Age, n (%)			0.899			0.458
18–49	5 (6.0)	5 (5.9)		13 (14.1)	13 (22.8)	
50–59	11 (13.1)	12 (14.1)		17 (18.5)	9 (15.8)	
60–69	12 (14.3)	16 (18.8)		17 (18.5)	12 (21.1)	
70–79	31 (36.9)	26 (30.6)		30 (32.6)	12 (21.1)	
≥80	25 (29.8)	26 (30.6)		15 (16.3)	11 (19.3)	
BMI, n (%)			0.785			0.014*
Underweight	8 (9.5)	6 (7.1)		–	–	
Normal weight	33 (39.3)	29 (34.1)		28 (30.4)	8 (14.0)	
Overweight	26 (31.0)	30 (35.3)		31 (33.7)	32 (56.1)	
Obese	17 (20.2)	20 (23.5)		33 (35.9)	17 (29.8)	
Sex, Male (n (%))	42 (50.0)	50 (58.8)	0.249	55 (59.8)	32 (56.1)	0.661
Comorbidities, n (%)			0.545			0.513
0 comorbidities	6 (7.1)	6 (7.1)		18 (19.6)	13 (22.8)	
1-2 comorbidities	53 (63.1)	47 (55.3)		60 (65.2)	32 (56.1)	
3+ comorbidities	25 (29.8)	32 (37.7)		14 (15.2)	12 (21.1)	
Length of stay, median (min–max)	12 (2–77)	12 (1–120)	0.440	7 (2–199)	8.5 (2–46)	0.639

*p < 0.05.
- indicate not enough data to perform the analysis.
E: Energy requirement.

Table 4
Associations between the two patient groups and protein intake in relation to 75% estimated requirement regarding age, BMI, sex and comorbidities.

Variable	At nutritional risk			Not at nutritional risk		
	≥75% P	<75% P	p-value	≥75% P	<75% P	p-value
Age, n (%)			0.223			0.599
18–49	5 (9.6)	5 (4.3)		8 (18.2)	18 (17.1)	
50–59	3 (5.8)	20 (17.1)		7 (15.9)	19 (18.1)	
60–69	8 (15.4)	20 (17.1)		6 (13.6)	23 (22.0)	
70–79	20 (38.5)	37 (31.6)		16 (36.4)	26 (24.8)	
≥80	16 (30.8)	35 (29.3)		7 (15.9)	19 (18.1)	
BMI, n (%)			0.059			0.015*
Underweight	8 (15.4)	6 (5.1)		–	–	
Normal weight	22 (42.3)	40 (34.2)		12 (27.3)	24 (22.9)	
Overweight	13 (25.0)	43 (36.8)		11 (25.0)	52 (49.5)	
Obese	9 (17.3)	28 (23.9)		21 (47.7)	29 (27.6)	
Sex, Male (n (%))	28 (53.9)	64 (54.7)	0.918	28 (63.6)	59 (56.2)	0.400
Comorbidities, n (%)			0.276			0.673
0 comorbidities	4 (7.7)	8 (6.8)		11 (25.0)	20 (19.1)	
1-2 comorbidities	35 (67.3)	65 (55.6)		25 (56.8)	67 (63.8)	
3+ comorbidities	13 (25.0)	44 (37.6)		8 (18.2)	18 (17.1)	
Length of stay, median (min–max)	10 (2–77)	12 (1–120)	0.549	8.5 (2–81)	7 (2–199)	0.238

*p < 0.05.
- indicate not enough data to perform the analysis.
P: Protein requirement.

Table 5
Associations between the two patient groups regarding achieving energy intake and mortality as well as readmissions.

Variables	At nutritional risk				Not at nutritional risk			
	≥75% E	<75% E	p-value	OR [95% CI]	≥75% E	<75% E	p-value	OR [95% CI]
Mortality, n (%)	2 (2.4)	14 (16.5)	0.002*	8.08 [1.78; 36.79]	2 (2.2)	1 (1.8)	0.859	0.80 [0.07; 9.07]
Readmission, n (%)	14 (19.2)	19 (25.3)	0.345	1.46 [0.67; 3.18]	18 (20.7)	5 (9.1)	0.068	0.38 [0.13; 1.10]

*p < 0.05.
E: Energy requirement.

Table 6
Associations between the two patient groups regarding achieving protein intake and mortality as well as readmissions.

Variables	At nutritional risk				Not at nutritional risk			
	≥75% P	<75% P	p-value	OR [95% CI]	≥75% P	<75% P	p-value	OR [95% CI]
Mortality, n (%)	2 (3.9)	14 (12.0)	0.096	3.40 [0.74; 15:53]	0 (0)	3 (2.9)	0.257	–
Readmission, n (%)	6 (13.0)	27 (26.7)	0.065	2.43 [0.93; 6.38]	11 (27.5)	12 (11.8)	0.022*	0.35 [0.14; 0.88]

*p < 0.05.
- indicate not enough data to perform the analysis.
P: Protein requirement.

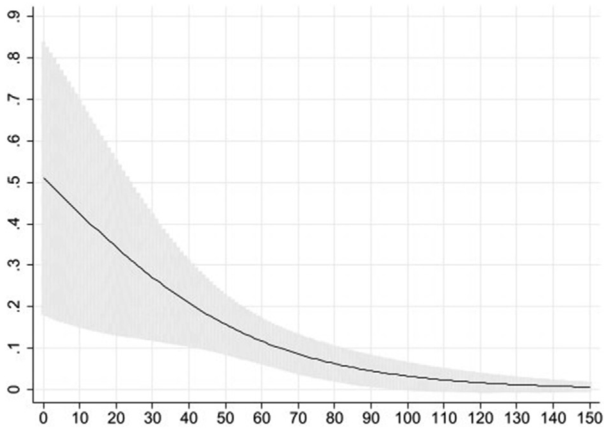

Fig. 2. Predicted probability of mortality (y-axis) within one month per energy intake in % of requirement (x-axis) with 95% CI among patients in nutritional risk. 10% probability of mortality = 65.1% of energy requirement. 5% probability of mortality = 86.8% of energy requirement. 75% intake = 7.5% probability of mortality. 100% intake = 3.3% probability of mortality.

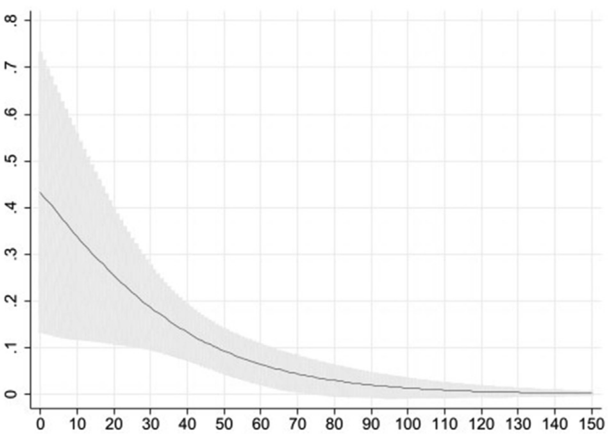

Fig. 3. Predicted probability of mortality (y-axis) within one month per protein intake in % of requirement (x-axis) with 95% CI among patients in nutritional risk. 10% probability of mortality = 47.9% of energy requirement. 5% probability of mortality = 66.5% of energy requirement. 75% intake = 3.8% probability of mortality. 100% intake = 1.4% probability of mortality.

diseases, and found a good agreement [27]. However, the study found that the GLIM criteria was the best method to predict 5-year mortality [27]. Another study found that malnourished patients, based on the GLIM criteria, have significant higher incidence of adverse outcomes and a higher mortality rate compared to not malnourished patients [28]. Based on the above study [27], we must assume that the patients at nutritional risk by screening with NRS-2002 are also malnourished, since a firm association was seen to mortality. However, this could be interesting to investigate in further research as the populations are different between the present study and the aforementioned study.

In the present study, a higher mortality rate was found amongst those at nutritional risk who reached less than 75% of energy requirement, but no associations were seen with regard to reaching 75% of estimated protein requirement. In regard to readmissions, a tendency towards fewer readmissions was found in patients who reached at least 75% of energy and protein requirements. This is supported by another study that found a slight association [29].

A recent Danish study found a mortality of 10% in similar patients not at nutritional risk, while patients at risk had a mortality of 23% within 30 days [30]. This is noticeably higher than the findings of this study. It may be worth considering that they only included patients who were hospitalized for four days or more, resulting in a potentially more ill population. However, their mean LOS was shorter compared to the one found in this study and no differences in prevalence of readmissions and mortality between patients at nutrition risk who reached 75% of energy and protein requirements and those who did not was found [30]. On the contrary, other studies have found a correlation between increased protein intake and reduced mortality in patients at nutritional risk [28,31], which supports the findings of this study. Likewise, the current results demonstrate that different cutoffs for energy and protein intakes may be needed.

A vast amount of studies have shown that it is much easier to reach estimated energy requirement targeted older patients with an energy dense diet using sugar and high fat content compared to reaching estimated protein requirement [4,13,30]. To be able to meet the estimated protein requirement, there is often a need for ONS, protein fortification of foods and the use of enteral and parenteral nutrition for some conditions and individuals [13,32]. This is supported by recent international guidelines for the nutrition community, which also recommend cutoffs for the implementation of enteral and parenteral nutrition when energy and nutrient requirements cannot be met by oral and enteral intakes alone (<50% of caloric requirement) for more than seven days [33]. Unfortunately this guideline does not include recommendations of how requirements should be estimated for each patient, while in other patient groups this is clearly recommended [34]. It is advised to use ONS in combination to dietetic counselling, when enriched diet is not sufficient in reaching nutritional intake of 25–30 kcal/kg/day and 1.5 g protein/kg/day. It is further recommended to use enteral nutrition if patients eat less than 50% of estimated requirement for more than one week or only 50–75% of the required amount of energy and protein for more than two weeks [34]. This has been supported in another study [13]. Compared to the intake shown in our study, energy and protein intakes of 50% in one week and 50–70% in more than two weeks both seem too low, as mortality is visibly elevated at 50% intake. However, due to the lack of power in this study, it is not possible to give an exact recommendation for the intake target. In order to prevent mortality as a result of poor nutritional intake within one month in a very broad population, 75% may be sufficient for energy by 25 kcal/kg/day and 62% for an estimated protein requirement of 1.3 g protein/kg/day. With regard to preventing readmissions, no recommendations for cutoffs can be drawn from the results of this study as no associations were found.

4.1. *Strengths and limitations*

In this study, we included all available and willing patients in 31 units, including both surgery and medical inpatients. The broad variety of specialties provide limitations in terms of interpreting the results in specific patient groups; but this was not the aim of this study. Instead, the variety of patient groups strengthens the generalizability of the study. Nutritional intake monitoring was done by staff experienced in using the method. Still, a subjective evaluation is always made, which may vary between data collectors and staff nurses. The study is also strengthened by the low number of patients refusing to participate as well as none lost to follow up. The study was made as realistic as possible, also including those who were fasting due to surgeries and medical examinations for one or more meals during the day. A limitation to this study method was that it shows only associations and does not explain causes. Regardless of that, it does seem that other studies found similar results, although no other studies looked specifically for cutoffs for the prevention of mortality or whether 75% of requirements are sufficient. Furthermore, this study population is a heterogeneous group, and therefore the results cannot necessarily be repeated in the individual patient group. Due to that, further studies are required. In some of the associations, the confidence intervals are very wide, which may be due to the relatively small sample size, due to the variables being dichotomous or in categories. We assume that a larger sample size will give a smaller confidence interval. In Tables 5 and 6 the confidence intervals are wide regarding the associations between mortality and nutritional intake among patients at nutritional risk. This is also illustrated at Figs. 2 and 3 with a large spread until 40–50% of energy and protein intakes due to the individual requirements. The large spread at the figures may be due to the sample size and the fact, that the nutritional intake is very different across the included patients.

5. Conclusion

This study reevaluated the use of energy and protein intakes ≥75% of requirements as targets in preventing mortality and readmissions within one month for patients both at nutritional risk and not at nutritional risk. There was a significant difference in mortality between patients in nutritional risk who reached ≥75% of estimated energy requirement and those who did not, but no significant difference in mortality for protein intake nor in readmissions for neither energy nor protein. This indicates that an energy intake <75% of estimated requirement is predictive of mortality in patients at nutritional risk, while a protein intake <75% of estimated requirement did not. Regarding patients not at nutritional risk, no significant difference was found for mortality when comparing those who reached and those who did not reach ≥75% of requirements for either energy or protein. In accordance with these findings, using the 75% targets in clinical practice should be re-evaluated.

Funding sources

This study was not funded by external foundation.

Statement of authorship

SM: Investigation, Formal analysis, Validation, Writing - Original Draft, Writing - Review & Editing. KHF: Investigation, Formal analysis, Validation, Writing - Original Draft, Writing - Review & Editing. EME: Investigation, Formal analysis, Validation, Writing - Original Draft, Writing - Review & Editing. LN: Investigation, Formal analysis, Validation, Writing - Original Draft, Writing - Review & Editing. KMP: Investigation, Formal analysis, Validation, Writing - Original Draft, Writing - Review & Editing. RT: Conceptualization, Methodology, Investigation, Validation, Writing - Review & Editing. LBS: Conceptualization, Methodology, Investigation, Resources, Validation, Writing - Review & Editing. HHR: Conceptualization, Methodology, Validation, Writing - Review & Editing. MH: Conceptualization, Methodology, Investigation, Resources, Validation, Writing - Review & Editing, Supervision.

Declaration of competing interest

There is no conflict of interest to declare.

Acknowledgement

The included patients must be thanked for participating in this study. In addition, the staff nurses at the 31 units should also be thanked for the help and positive attitude during the data collection. Furthermore, the authors want to thank seven data collectors for helping with the data collection: Anne Kathrine Larsen, Marie Louise Bergmann, Kamille Nørgaard Sørensen, Jette Kolding, Lea Geisler, Camilla Christine Bundgaard Anker and Steffen Hansen.

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