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# Time to act! - A cross-sectional study on how nutritional risk increases during hospitalization and associates with worse outcome

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SUMMARY

*Background & aims:* Nutritional risk is prevalent, and it develops negatively during hospital stay. The aim of this cohort study was to assess the association of nutritional risk with total costs of hospital care, length of stay, and in-hospital mortality.

*Methods:* Cross-sectional study with hospitalized patients (n = 3053). Nutritional risk screening 2002 and outcome were investigated. Chi-square, Fisher, and Mann–Whitney tests, univariable and multivariable generalized linear and binary logistic regression models were used.

*Results:* Nutritional risk was detected in 18% (184/1024) of those patients assessed at admission while the number of patients at risk increased 3-fold (47%,152/265) in those screened 14 days after admission (odds ratio 6.25; 95% CI 4.58–8.53, p < 0.001). Nutritionally at-risk patients had 5.6 days longer length of stay (p < 0.001) and 9% higher adjusted total costs compared with non-risk patients (p < 0.001). Adjusted overall risk for in-hospital mortality was 4.4 (95% CI 2.44–7.92, p < 0.001) for patients at nutritional risk. The screening rate was between 52% and 68%, and only 4% of the nutritionally at-risk patients had dietitian consultation during their hospital stay.

*Conclusions:* The number of patients with nutritional risk increased clearly during hospitalization associating with a four times higher in-hospital mortality and substantially increased hospital costs. The results demonstrate that the nutritional risk and its detrimental influence on the outcome increases during hospitalization emphasizing the importance to screen patients at admission and repeated weekly.


## 1. Introduction

According to 2020 Global Nutrition Report everyone deserves access to high-quality nutrition care [1]. Up till now, around one-third of adult in-hospital patients are at nutritional risk [2–5]. Yet, nutritional risk increases during hospitalization [6,7] and still, weight is measured and risk screening performed only in less than half of hospitalized patients in Scandinavia [8–11]. Of note, nutritional guidelines recommend nutritional risk screening within 24–48 h of hospital admission in order to provide nutrition support for risk patients [12–14] to avoid nutritional status deterioration to malnutrition, and to avoid complications throughout patients' hospitalization and illness period [10,15–18]. Indeed, a growing body of evidence shows that patients receiving nutritional support have lower rates of mortality, decrease in non-elective hospital readmissions, higher intake of energy and protein, as well as greater weight increase than patients without nutritional support [10,19]. Moreover, a recent study showed that many patients

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covered their energy and protein needs if they had been in a contact with a clinical dietitian [10]. Furthermore, since nutritional risk is associated with extended hospital stay and complications, it increases cost of care significantly [7,20–22]. Screening patients for their nutritional risk remains the first step in comprehensive nutrition care and indisputable necessity for high quality hospital care management.

Without auditing nutrition care process, it is impossible to improve in-hospital nutrition care and further studies are warranted to justify the need for nutritional screening. In Finland, nutritional risk and prevalence of malnutrition have been previously studied among older adults including residents in nursing homes and long-term care facilities as well as those living at home [23–25]. Therefore, cross-sectional annual nutritional risk surveys were performed in 2014–2015–2016 at our university hospital. The aim of the current study was to assess the prevalence of nutritional risk in different time-points and its association with total hospital costs, length of stay (LOS), and in-hospital mortality.

## 2. Methods

### 2.1. Patients and study design

Our university hospital manages over 500 000 patients from 24 municipalities in 21 hospitals annually, with a total of 3500 beds, being the major hospital district in Finland. This cross-sectional study took place at three time points in 19 out of the 21 HUS hospitals with different specialties for one audit day in May each year 2014, 2015 and 2016.

The study included the major medical specialties with adult in-patients (≥18 years) who stayed for a minimum of one day in hospital. We included one intensive care unit (ICU) and one high-dependency unit (HDU) in the study as pilot departments due to their special patient populations but excluded units of terminal care and bariatric surgery. Psychiatric hospital and maternity wards were excluded because the validation of NRS 2002 method does not include these patient groups. The register-based study required no patient informed consent or approval from ethics committee. An institutional review and permission statement was obtained (HUS/138/2017).

Various awareness campaigns organized for the hospital staff preceded the study. On the three survey days, all 28 dietitians at the hospital district and four dietitian interns were actively helping in data collection. Weight was measured and height either asked from patient or collected from the hospital information system. The nurses calculated the percentual weight loss either from the one-month previous weight data in the hospital information system or by asking from the patient. Food intake was evaluated subjectively by nurses by asking how much a patient had eaten at home or by the percentual food intake at hospital according to food intake follow-up form. Body mass index (BMI) was calculated from the height and measured body weight and was further categorized as underweight if BMI <20 kg/m$^2$, normal weight if 21–24.9, overweight if 25–30, and obese if > 30. The BMI <20 kg/m$^2$ was used as a cut-off for underweight as the NRS 2002 method classifies patients as ‘not at risk’ if BMI is ≥ 20 kg/m$^2$ [2,14,28].

Point prevalence (hereafter prevalence) of nutritional risk was assessed by NRS 2002 method, which assesses weight loss, body mass index (BMI), dietary intake, severity of illness, and age [26]. Score ≥3 indicates nutritional risk (hereafter nutritionally non-risk = NRS <3 and nutritionally at-risk = NRS ≥3). Trained nurses screened the nutritional risk of all in-patients once during a morning shift; between 7.30 am and 3 pm. At the time of the study, the electronic patient record system did not contain the NRS 2002 method itself and thus either nurses or dietitians entered the NRS 2002 score, current body weight, and height in the electronic patient record. Department of Information Technology collected the following data from the hospital information system (Uranus, CGI Finland Oy, Helsinki, Finland): nutritional risk screening data, age, gender (ascertained by self-report), weight, height, patients' diagnosis (-es), mode of arrival (i.e. emergency, elective, other hospital, another ward, outpatient clinic), location after discharge (i.e. home, other hospital, primary health care ward, nursing home, deceased), surgical procedure(s), dietitian consultations, and date of admission and discharge, or date of death.

The categorization of the main diagnoses was performed according to the International Classification of Diseases and Related Health Problems (ICD-10). Excluded diagnoses were those of pregnancy, childbirth, puerperium (O00–O99), and psychiatry (F-G). The physician responsible for the patient recorded the most relevant diagnoses for the hospitalization as the main diagnosis. The number of diagnoses was calculated as an indicator of the severity of the patient's clinical status.

Data on total costs and LOS were obtained from the hospital accounting database (Ecomed, Datawell FCG). We calculated the LOS in medical, surgical, mixed medical/surgical, and ICU beds for each participant by tracking the units where patients were admitted to and transferred between. Bed days (i.e., LOS) in each unit were calculated by summing all bed days spent in that type of unit.

Total hospital cost was the product of the number of bed days that each patient spent on each unit type (medical, surgical, mixed, and ICU) and cost of a bed day on that unit type as recorded in the hospital accounting database. The total cost includes the cost of a bed day and costs from expensive medication (e.g., chemotherapy), medical imaging, laboratory examinations, blood products, and surgical procedures during the treatment period according to NordDRG (DRG, Diagnosis Related Groups) fees. The cost of bed day includes medical care (e.g., medication, parenteral and enteral nutrition), nursing and other services such as dietitian services as well as meals (i.e., five meals per day), clothing, laundry, cleaning, and logistics. Summation of all these costs estimated the actual cost of patient care.

The LOS and total costs were calculated from the date of admission to the date of discharge or to the date of death. The sum of bed days was calculated from the day of hospital admission to the screening day (i.e., day of screening) and prolonged hospitalization was defined as LOS over 14 days. In-hospital mortality was defined as death occurring during the hospital stay.

### 2.2. Statistical methods

Primary outcome variables were the nutritional risk (NRS ≥3, yes *vs.* no), LOS (days), total costs (euros), and death in hospital (yes vs. no). Patient characteristics gender, BMI, age (≥70 vs. <70 years), ICU stay (yes *vs.* no), number of diagnoses (≥3 *vs.* 1–2 or ≥4 *vs.* 1–3), mode of arrival (elective, emergency *vs*. from other hospital or outpatient clinic) and LOS when appropriate, served as potential categorical covariates. Correlation was analyzed by Pearson's Chi Square or Cramer's V test when appropriate.

Nutritional risk was the primary factor and was forced in the multivariable models in analyzation of LOS, total costs, and in-hospital death. Univariable analyses first screened the associations between the potential covariates and the primary outcome variables. If the univariable analysis resulted in a global *p*-value <0.10, the covariate was introduced to the multivariable analysis. The estimation of multivariable models then used the forward stepping covariate selection procedures, when appropriate. At each step, the criterion for entry was $p < 0.05$ and for removal $p > 0.10$. The number of days from admission to screening was a random factor and a potential confounding factor and was forced to all multivariable models. Also, the first-order interactions between the number of days from admission to screening and nutritional risk were descriptively assessed stratifying the results of LOS, total costs, and death in hospital by nutritional risk and the number of days from admission to screening (1–2 days, 3–7 days, 8–14 days or > 14 days).

For the dichotomous outcome variables, nutritional risk, and death in hospital, we used univariable and multivariable binary logistic regression models. The results are unadjusted and adjusted odds ratios (OR) with 95% confidence intervals (CI).

For LOS and total costs, we used univariable and multivariable generalized linear models. The distributions of LOS and total costs were skewed to the right and underwent a logarithmic (ln) transformation before analysis. The results for each category of covariates are unadjusted and adjusted geometric means with 95% CI. The ratio of geometric means (RGM) with 95% CI indicates the relative difference between categories (e.g., NRS ≥3 *vs.* NRS <3).

The patient characteristics were expressed as frequency (%) for categorical and dichotomous variables, and as median (range) for continuous patient characteristics, or as median (interquartile range, IQR) for continuous outcome variables.

The statistical software was SPSS, Version 27.0 (IBM corp., Armonk, NY). We set the statistical significance level to 5%.

## 3. Results

A total of 3053 out of the 5367 eligible patients underwent screening without crucial missing data on one-day cross-sectional survey in May 2014, 2015, and 2016 (Fig. 1); screening rate was 68% in 2014, 52% in 2015, and 52% in 2016. Between these screening years, we saw no differences in age, gender, nutritionally at-risk proportion, LOS, and in-hospital mortality. The nutritional risk screening took place on a median of hospital day 4 (IQR 2–8); within 2 days of admission in 34%, within 3–7 days in 40%, within 8–14 days in 18%, and >14 days in 9% of the screened. These proportions were similar between the three prevalence days.

According to main diagnoses for hospitalization, 22% of patients had cardiovascular disease and 18% malignancy (Table 1). Majority of patients were either elective (45%) or emergency patients (36%), while 19% included patients from outpatient clinics, other wards, or hospitals (Table 1). The median age was 67 years (range 18–101), and 51% were men. Weight was entered in 62% (1882/3053) and height in 65% (1998/3053) of all patients in the electronic patient record, and thus BMI was available in 54%. Nutritional risk screening scores, main diagnoses, and in-hospital mortality according to time of screening are shown in Table 2. Patients screened after two weeks of hospitalization had more severely impaired nutritional status and greater severity of underlying disease in NRS 2002, more frequently cardiovascular or infectious diseases as their main diagnosis, and higher in-hospital mortality compared with those screened at admission. Patients ≥70 years had more comorbidities, more frequently cardiovascular or respiratory disease as their main diagnosis and were more frequently admitted as emergency patients than younger patients (Supplementary table). Patients with more than three diagnoses were older ($p < 0.001$), had more frequently cardiovascular ($p < 0.001$), infectious ($p = 0.001$), or respiratory disease ($p = 0.028$) as their main diagnosis as well as emergency ($p < 0.001$) and in-hospital admissions ($p < 0.001$), and higher mortality ($p = 0.01$, data not shown) than patients with 1–3 diagnoses. Patients with 1–3 diagnoses had more frequently gastrointestinal ($p < 0.001$), renal ($p = 0.013$), and trauma/poisoning disease ($p = 0.001$) as their main diagnosis and were more often elective patients ($p < 0.001$) than patients with more than three diagnoses.

### 3.1. Nutritional risk

Of the 3035 patients, 921 (30%) were at nutritional risk (Table 1). Of these at-risk patients, 506 (55%) patients had NRS 2002 score of 3, 256 (28%) score 4, and 159 (17%) score ≥5. The proportion of nutritional risk patients increased during hospitalization compared to those screened within 1–2 days of admission ($p < 0.001$; Fig. 2). Nutritionally at-risk patients were older, had lower BMI, and more

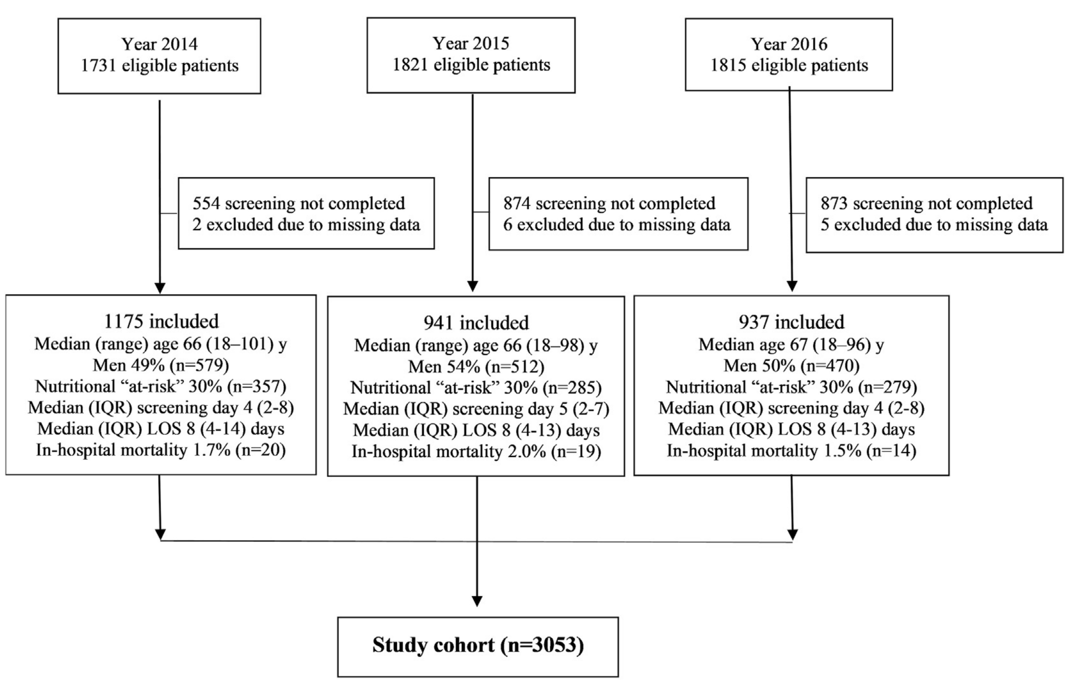



**Fig. 1.** Flow-chart: results from the three nutritional risk screening days.

**Table 1**
Nutritional risk stratified by clinical characteristics.

| | All subjects, n (%) | NRS <3, n (%) | NRS ≥3, n (%) | p–value |
|---|---|---|---|---|
| Total | 3053 (100) | 2132 (69.8) | 921 (30.2) | <0.001 |
| Sex | | | | |
| Males | 1561 (51.1) | 1104 (51.8) | 457 (49.6) | NS |
| Females | 1492 (48.9) | 1028 (48.2) | 464 (50.3) | NS |
| Age, years | | | | |
| 18–39 | 341 (11.2) | 266 (12.5) | 75 (8.1) | <0.001 |
| 40–59 | 695 (22.8) | 551 (25.8) | 144 (15.6) | <0.001 |
| 60–79 | 1467 (48.1) | 995 (46.7) | 472 (51.2) | 0.020 |
| ≥ 80 | 550 (18.0) | 320 (15.0) | 230 (25.0) | <0.001 |
| Age, median (range) years | 67 (18–101) | 64 (18–101) | 72 (18–98) | <0.001 |
| Men | 65 (53–74) | 64 (52–72) | 71 (58–78) | <0.001 |
| Women | 68 (56–78) | 66 (53–76)[c] | 73 (63–81)[b] | <0.001 |
| BMI, $kg/m^2$[a] | | | | |
| ≤ 20 | 163 (9.8) | 61 (5.2) | 102 (20.8) | NS |
| 21–24 | 421 (25.3) | 284 (24.3) | 137 (27.9) | 0.003 |
| 25–30 | 684 (41.2) | 509 (43.5) | 175 (35.6) | <0.001 |
| >30 | 393 (23.7) | 316 (27.0) | 77 (15.7) | <0.001 |
| BMI, median (range) $kg/m^2$ | 25.8 (13–65) | 26.5 (16–65) | 24.2 (13–57) | <0.001 |
| Nutritional risk screening scores | | | | |
| Impaired nutritional status | | | | |
| Absent (Score 0) | 1894 (62.0) | 1788 (83.9) | 106 (11.5) | <0.001 |
| Mild (Score 1) | 745 (24.4) | 335 (15.7) | 410 (44.5) | <0.001 |
| Moderate (Score 2) | 260 (8.5) | 9 (0.4) | 251 (27.3) | <0.001 |
| Severe (Score 3) | 154 (5.0) | 0 (0) | 154 (16.7) | NA |
| Severity of disease | | | | |
| Absent (Score 0) | 1024 (33.5) | 1000 (46.9) | 24 (2.6) | <0.001 |
| Mild (Score 1) | 1390 (45.5) | 988 (46.3) | 402 (43.6) | 0.039 |
| Moderate (Score 2) | 556 (18.2) | 144 (6.8) | 412 (44.7) | <0.001 |
| Severe (Score 3) | 83 (2.7) | 0 (0) | 83 (9.0) | NA |
| Age ≥70 y (Score 1) | 1283 (42.0) | 746 (35.0) | 537 (58.3) | <0.001 |
| Time from admission to screening, days | | | | |
| Day 1–2 | 1023 (33.5) | 839 (39.4) | 184 (20.0) | <0.001 |
| Day 3–7 | 1231 (40.3) | 871 (40.8) | 360 (39.1) | NS |
| Day 8–14 | 534 (17.5) | 279 (13.1) | 255 (27.7) | <0.001 |
| Day >14 | 265 (8.7) | 113 (0.05) | 152 (16.5) | <0.001 |
| Clinical nutritionist referrals | 104 (3.4) | 64 (3.0) | 40 (4.3) | NS |
| Number of diagnoses | | | | |
| 1–3 | 1849 (60.6) | 1362 (63.9) | 487 (52.9) | <0.001 |
| 4–7 | 1097 (35.9) | 717 (33.6) | 380 (41.3) | <0.001 |
| >7 | 107 (3.5) | 53 (2.5) | 54 (5.9) | <0.001 |
| Main diagnoses | | | | |
| Cardiovascular disease | 658 (21.6) | 453 (21.2) | 205 (22.3) | NS |
| Infectious disease | 172 (5.6) | 117 (5.5) | 55 (6.0) | NS |
| Gastrointestinal disease | 312 (6.2) | 206 (9.7) | 106 (11.5) | NS |
| Malignancy | 543 (17.8) | 320 (15.0) | 223 (24.2) | <0.001 |
| Respiratory disease | 255 (8.3) | 176 (8.3) | 79 (8.6) | NS |
| Neurological disease | 119 (3.9) | 92 (4.3) | 27 (2.9) | NS |
| Renal failure | 119 (3.9) | 95 (4.5) | 24 (2.6) | 0.015 |
| Symptoms and abnormal findings | 132 (4.3) | 101 (4.7) | 31 (3.4) | NS |
| Trauma, poisoning | 304 (10.0) | 206 (9.7) | 98 (10.6) | NS |
| Other | 439 (14.4) | 366 (17.2) | 73 (7.9) | <0.001 |
| Total LOS, days | | | | |
| 1–7 days | 1480 (48.5) | 1202 (56.4) | 278 (30.2) | <0.001 |
| 8–14 days | 899 (29.4) | 590 (27.7) | 309 (33.6) | 0.001 |
| 15–21 days | 338 (11.1) | 200 (9.4) | 138 (15.0) | <0.001 |
| >22 days | 336 (11.0) | 140 (6.6) | 196 (21.3) | <0.001 |
| LOS, median (IQR) days | 8 (4–13) | 7 (3–11) | 11 (7–19) | <0.001 |
| ICU bed days | | | | |
| 0 days | 2884 (94.5) | 2044 (95.9) | 840 (91.2) | <0.001 |
| 1–7 days | 126 (4.1) | 74 (3.5) | 52 (5.6) | 0.006 |
| >7 days | 43 (1.4) | 14 (0.7) | 29 (3.1) | <0.001 |
| Total costs, median (IQR) euros | 5805 (3062–11643) | 4906 (2760–9150) | 9101 (4354–18244) | <0.001 |
| Mode of arrival | | | | |
| Emergency | 1084 (35.5) | 756 (35.5) | 328 (35.6) | NS |
| Elective | 1382 (45.3) | 1028 (48.2) | 354 (38.4) | <0.001 |
| From another ward | 275 (9.0) | 147 (6.9) | 128 (13.9) | <0.001 |
| Outpatient clinic | 199 (6.5) | 135 (6.3) | 64 (6.9) | NS |
| Other hospital | 113 (3.7) | 66 (3.1) | 47 (5.1) | 0.007 |

(*continued on next page*)

**Table 1** (*continued*)

| | All subjects, n (%) | NRS <3, n (%) | NRS ≥3, n (%) | p–value |
|---|---|---|---|---|
| Location after discharge | | | | |
| Home | 719 (23.6) | 586 (27.5) | 133 (14.5) | <0.001 |
| Other hospital | 1485 (48.7) | 1101 (51.6) | 384 (41.7) | <0.001 |
| Primary health care ward | 199 (6.5) | 129 (6.1) | 70 (7.6) | NS |
| Nursing home | 597 (19.6) | 299 (14.0) | 298 (32.4) | <0.001 |
| Deceased | 53 (1.7) | 17 (0.8) | 36 (3.9) | <0.001 |

NRS, nutritional risk screening 2002; NRS <3 "non-risk"; NRS ≥3 "at-risk"; BMI, body mass index; LOS, length of stay; ICU, intensive care unit; IQR, interquartile range; NS, not significant; NA, not applicable.
Results are presented as median and range or IQR, or column number and percentage.
p–values were calculated by Mann–Whitney U Test for the difference between medians and by comparison of column proportion for categorial variables between nutritional risk groups.
[a] n = 1661.
[b] p = 0.01 between gender.
[c] p < 0.001 between gender.

**Table 2**
Nutritional risk screening scores and main diagnoses according to the time of screening (n = 3053).

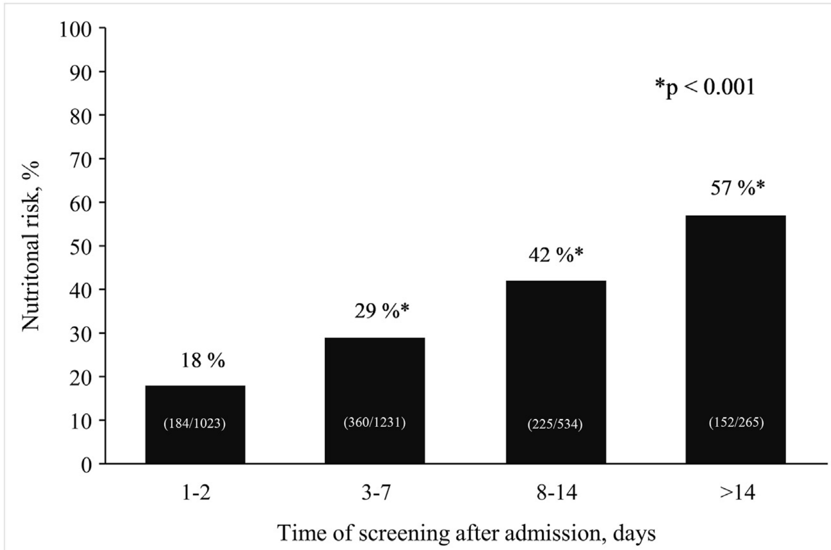
| Screening performed | All subjects | | | | |
|---|---|---|---|---|---|
| | Total, n (%) | Time of screening after admission to hospital, n (%) | | | |
| | | Day 1–2 | Day 3–7 | Day 8–14 | Day >14 |
| | 3053 (100.0) | 1023 (33.5) | 1231 (40.3) | 534 (17.5) | 265 (8.7) |
| Occurrence of nutritional risk[b] | 921 (30.2) | 184 (18.0) | 360 (29.2)*** | 225 (42.1)*** | 152 (57.3)*** |
| Impaired nutritional status scores by NRS 2002 | | | | | |
| Absent (Score 0) | 1894 (62.0) | 749 (73.2) | 769 (62,5)*** | 121 (22.7)*** | 31 (11.7)*** |
| Mild (Score 1) | 745 (24.4) | 180 (17.6) | 319 (25.9)*** | 246 (46.1)*** | 109 (41.1)*** |
| Moderate (Score 2) | 260 (8.5) | 55 (5.4) | 92 (7.5) | 102 (38.5)*** | 102 (38.5)*** |
| Severe (Score 3) | 154 (5.0) | 39 (3.8) | 51 (4.1) | 25 (4.7) | 23 (8.7)*** |
| Severity of disease scores by NRS 2002 | | | | | |
| Absent (Score 0) | 1024 (33.5) | 467 (45.7) | 405 (32.9)*** | 121 (22.7)*** | 31 (11.7)*** |
| Mild (Score 1) | 1390 (45.5) | 444 (43.4) | 591 (48.0) | 161 (49.2) | 69 (46.3) |
| Moderate (Score 2) | 556 (18.2) | 92 (9.0) | 220 (17.9)*** | 76 (23.2)*** | 61 (40.9)*** |
| Severe (Score 3) | 83 (2.7) | 20 (2.0) | 15 (1.2) | 12 (3.7)* | 9 (6.0)*** |
| Age ≥70 years (Score 1) | 1283 (42.0) | 236 (40.9) | 353 (45.0) | 136 (41.6) | 56 (37.6) |
| Main diagnose[a] | | | | | |
| Cardiovascular disease | 658 (21.6) | 162 (15.8) | 273 (22.2)** | 155 (29.0)*** | 68 (25.7)** |
| Infectious disease | 172 (5.6) | 45 (4.4) | 71 (5.8) | 25 (4.7) | 31 (11.7)*** |
| Gastrointestinal disease | 312 (6.2) | 106 (10.4) | 130 (10.6) | 49 (9.2) | 27 (10.2) |
| Malignancy | 543 (17.8) | 229 (22.4) | 169 (13.7)*** | 92 (17.2) | 53 (20.0) |
| Respiratory disease | 255 (8.3) | 64 (6.3) | 130 (10.6)* | 45 (8.4) | 16 (6.0) |
| Neurological disease | 119 (3.9) | 34 (3.3) | 53 (4.3) | 23 (4.3) | 9 (3.4) |
| Renal disease | 119 (3.9) | 50 (4.9) | 45 (3.7) | 16 (3.0) | 8 (3.0) |
| Symptoms and abnormal findings | 132 (4.3) | 40 (3.9) | 63 (5.1) | 20 (3.7) | 9 (3.4) |
| Trauma, poisoning | 304 (10.0) | 88 (8.6) | 148 (12.0)* | 48 (9.0) | 20 (7.5) |
| Other diagnoses | 439 (14.4) | 205 (20.0) | 149 (12.1)*** | 61 (11.4)*** | 24 (9.1)*** |
| In-hospital mortality | 53 (1.7) | 12 (1.2) | 19 (1.5) | 12 (2.2) | 10 (3.8)* |

Results are presented as number of patients and column percentages.
P-value was calculated for categorial values by column proportions with "Day 1–2" as a reference group.
*p < 0.05.
**p = 0.001.
***p < 0.001.
[a] According to ICD–10 classification.
[b] nutritional risk = NRS score ≥3.

diagnoses than non-risk patients ($p < 0.001$, Table 1). Nutritionally at-risk women were older (median 73; IQR 63–81 *vs.* 71; 58–78, $p = 0.01$) than nutritionally at-risk men. The prevalence of nutritional risk increased with age (Table 1). Of the nutritional risk patients, 16% were obese (BMI >30), and 21% had a BMI ≤20. Forty-four percent of the risk patients had mildly impaired nutritional status, and 54% moderate or severe severity of disease according to NRS 2002 (Table 1). Of the nutritionally at-risk patients, 4% had dietitian referrals during their hospital stay. In 48% the at-risk patients had a history of ICU admission. At-risk patients had more often malignancy as a main diagnosis (24%) than non-risk patients (15%, $p < 0.001$) as well as more than three diagnoses (47% *vs.* 36%, $p < 0.001$). At-risk patients had two times higher hospital costs and a median of four days longer LOS compared with non-risk patients. Forty-six percent of patients transferred from another ward and 42% from another hospital were nutritionally at-risk (Table 1). Nutritionally at-risk patients were more often discharged either to another hospital (42%) or a nursing home (32%) than the non-risk patients (Table 1).

Nutritional risk positively correlated with age ($r = 0.184$, $p < 0.001$), LOS ($r = 0.295$, $p < 0.001$), ICU bed days ($r = 0.095$, $p < 0.001$), total costs ($r = 0.253$, $p < 0.001$), in-hospital mortality ($r = 0.133$, $p < 0.001$), and the number of diagnoses ($r = 0.136$, $p < 0.001$).

A multivariate analysis for nutritional risk revealed that the OR increased with the time of screening from 1.79 for those screened within two days of admission to 6.25 screened >14 days of hospitalization (Table 3). Age ≥70 (OR 2.89), and ICU stay (OR 1.63) were associated with an increased likelihood of nutritional risk, while gender, BMI, or number of diagnoses were not. Nutritional risk was




*p-value according to Pearson Chi-Square Test compared to those screened within 1-2 days of admission.

**Fig. 2.** The prevalence of nutritional risk (NRS ≥3) according to time of screening after hospital admission in all 3053 patients.

**Table 3**
Univariable and multivariable binary logistic regression models to assess the association between patient characteristics and nutritional risk.

| Factor | | n | NRS ≥3 | Univariate analyses | | Adjusted multivariate analysis | |
|---|---|---|---|---|---|---|---|
| | | | n (%) | OR (95% CI) | p-value | OR (95% CI) | p-value |
| Gender[a] | Men | 1561 | 457 (29.3) | Ref. | | | |
| | Women | 1492 | 464 (31.1) | 1.09 (0.93–1.27) | 0.27 | | |
| BMI, kg/m$^2$[a] | <20.0 | 162 | 101 (62.3) | Ref. | | | |
| | 20.0–24.9 | 560 | 188 (33.6) | 0.31 (0.21–0.44) | <0.001 | | |
| | 25.0–29.9 | 542 | 124 (22.9) | 0.18 (0.12–0.26) | <0.001 | | |
| | ≥30.0 | 397 | 78 (19.6) | 0.15 (0.10–0.22) | <0.001 | | |
| Age, years | <70 | 1770 | 384 (21.7) | Ref. | | Ref. | |
| | ≥70 | 1283 | 537 (41.9) | 2.60 (2.22–3.04) | <0.001 | 2.89 (2.45–3.42) | <0.001 |
| Days from admission to screening | 1–2 days | 1023 | 184 (18.0) | Ref. | | Ref. | |
| | 3–7 days | 1231 | 360 (29.2) | 1.88 (1.54–2.30) | <0.001 | 1.79 (1.45–2.21) | <0.001 |
| | 8–14 days | 534 | 225 (42.1) | 3.32 (2.63–4.20) | <0.001 | 3.21 (2.50–4.11) | <0.001 |
| | >14 days | 265 | 152 (57.4) | 6.13 (4.58–8.21) | <0.001 | 6.25 (4.58–8.53) | <0.001 |
| ICU stay | No | 2884 | 840 (29.1) | Ref. | . | Ref | |
| | Yes | 169 | 81 (47.9) | 2.24 (1.64–3.06) | <0.001 | 1.63 (1.17–2.29) | 0.004 |
| No. of diagnoses[a] | 1–2 | 1404 | 344 (24.5) | Ref. | | | |
| | ≥3 | 1649 | 577 (35.0) | 1.66 (1.42–1.94) | <0.001 | | |
| Mode of arrival[b] | Other[b] | 587 | 239 (40.7) | Ref. | | Ref. | |
| | Elective | 1382 | 354 (25.6) | 0.50 (0.41–0.62) | <0.001 | 0.65 (0.52–0.81) | <0.001 |
| | Emergency | 1084 | 328 (30.3) | 0.63 (0.51–0.78) | <0.001 | 0.64 (0.51–0.80) | <0.001 |

NRS ≥3, nutritional risk; OR, odds ratio; CI, confidence interval; BMI, body mass index; ICU, intensive care unit.
Ref., reference group.
[a] BMI was not introduced to the multivariable analysis due to 46% of missing information. Adding gender or number of diagnoses did not have statistical significance to multivariable model.
[b] Other = Patient arrived at the hospital either from other hospital or from outpatient clinic, or from another ward.

associated with LOS, cost of care, and in-hospital mortality independently of date of screening (Supplementary table 1).

### 3.2. Length of stay

The median (IQR) LOS was 8 (4–13) days, and it was higher among at-risk than non-risk patients (median 11 *vs.* 7 days, $p < 0.001$, Table 1). The median LOS was one day longer among men (median LOS 8 *vs.* 7 days, $p < 0.001$, data not shown) than among women. Association of LOS with nutritional risk and mode of arrival is shown in Table 1. Elective, nutritionally at-risk patients stayed at the hospital a median of five days longer than non-risk patients (median 9 *vs.* 4 days, $p < 0.001$), while nutritionally at-risk patients transferred from another hospital stayed a median of six days longer (median 14 *vs.* 8 days, $p < 0.001$) than non-risk patients (Supplementary table 2). Majority of patients (94%) were discharged from hospital within 30 days: 89% of the at-risk patients and 97% of the non-risk patients ($p < 0.001$). Multivariable analysis for LOS indicated that nutritionally at-risk patients had a longer LOS (RGM 1.56; Table 4). ICU stay (RGM 2.11), and more than 3 diagnoses (RGM 1.29) were also associated with longer LOS.

### 3.3. Total costs

The median total costs were 5805 euros (IQR 3062–11643). Nutritionally at-risk patients had 46% higher costs than non-risk

**Table 4**
Univariable and multivariable generalized linear models to assess the association between patient characteristics and the length of stay.

| Factor | | N | Univariate analyses | | p-value | Multivariate analysis | | p-value |
|---|---|---|---|---|---|---|---|---|
| | | | LOS (days), unadjusted | | | LOS (days), adjusted | | |
| | | | GM | RGM (95% CI) | | GM (95% CI) | RGM (95% CI) | |
| Nutritional risk | No | 2132 | 6.4 | Ref. | | 10.0 (9.3–10.6) | Ref. | |
| | Yes | 921 | 11.1 | 1.73 (1.63–1.84) | <0.001 | 15.6 (14.5–16.9) | 1.56 (1.47–1.66) | <0.001 |
| Gender[b] | Men | 1561 | 8.0 | Ref. | | 12.9 (12.1–13.7) | | |
| | Women | 1492 | 7.1 | 0.90 (0.84–0.95) | <0.001 | 12.1 (11.3–12.9) | 0.94 (0.89–0.99) | 0.02 |
| Days from | 1–2 days | 1023 | 3.8 | Ref. | | 5.1 (4.8–5.4) | Ref. | |
| admission | 3–7 days | 1231 | 7.6 | 2.03 (1.94–2.13) | <0.001 | 9.4 (9.0–9.9) | 1.87 (1.78–1.96) | <0.001 |
| to screening | 8–14 days | 534 | 14.1 | 3.76 (3.54–3.99) | <0.001 | 16.5 (15.5–17.5) | 3.26 (3.07–3.45) | <0.001 |
| | >14 days | 265 | 30.4 | 8.12 (7.52–8.77) | <0.001 | 33.4 (31.1–35.9 | 6.60 (6.10–7.14) | <0.001 |
| ICU stay | No | 2884 | 7.2 | Ref. | | 8.6 (8.3–8.9) | Ref. | |
| | Yes | 169 | 16.8 | 2.33 (2.05–2.65) | <0.001 | 18.1 (16.1–20.3) | 2.11 (1.87–2.38) | <0.001 |
| No. of diagnoses | 1–3 | 1849 | 6.5 | Ref. | | 11.0 (10.3–11.7) | Ref. | |
| | ≥4 | 1204 | 9.4 | 1.44 (1.35–1.53) | <0.001 | 14.1 (13.2–15.1) | 1.29 (1.22–1.36) | <0.001 |
| Mode of arrival | Other[a] | 587 | 10.3 | Ref. | | 15.0 (13.8–16.2) | Ref. | |
| | Elective | 1382 | 8.7 | 0.84 (0.77–0.91) | <0.001 | 13.4 (12.5–14.4) | 0.90 (0.83–0.97) | 0.005 |
| | Emergency | 1084 | 5.9 | 0.57 (0.53–0.62) | <0.001 | 9.7 (9.0–10.3) | 0.64 (0.60–0.69) | <0.001 |

LOS, length of stay, logarithmically transformed before analysis; GM, geometric mean; RGM, ratio of geometric means; Nutritional risk, NRS≥3; ICU, intensive care unit.
Ref., reference group.
[a] Other = Patient arrived at the hospital either from other hospital or from outpatient clinic, or from another ward.
[b] Adding gender did not have statistical significance to multivariable model.

patients (median 9101 *vs.* 4906 euros, $p < 0.001$; Table 1). Elective patients with nutritional risk had 63% higher median hospital costs than non-risk patients (10,239 euros [IQR 4601–20196] *vs.* 4562 euros [IQR 2610–8326]), $p < 0.001$). Nutritionally at-risk patients had statistically significantly higher costs for more bed days ($p < 0.001$), medication ($p = 0.002$), medical imaging ($p < 0.001$), laboratory examinations ($p < 0.001$), blood products ($p < 0.001$), and surgical procedures ($p = 0.001$) than non-risk patients. In general, hospital bed days accounted for 60% of total costs; 64% of at-risk and 58% of non-risk patients ($p < 0.001$, data not shown).

A multivariate generalized linear model to assess the association between patient characteristics and total costs showed that nutritionally at-risk patients had 9% higher total costs compared with non-risk patients ($p < 0.001$; Table 5). ICU stay increased costs 2-fold ($p < 0.001$) and emergency status by 39% ($p < 0.001$). Length of stay correlated strongly with total costs ($p < 0.001$).

### 3.4. In-hospital mortality

During hospitalization 53 (1.7%) patients died with median age of 72 (IQR 65–82) years. The median age of the deceased was higher than of those who survived (66 [54–76] *vs.* 72 [65–82], $p = 0.001$). The nutritionally at-risk patients had an in-hospital mortality rate of 4%, whereas the non-risk patients had a rate of 0.8% (Table 1, $p = 0.001$). Of the deceased patients, 28% had cardiovascular disease and 21% malignancy as their main diagnosis,

**Table 5**
Univariable and multivariable generalized linear models to assess the association between patient characteristics and the total cost.

| Factor | | N | Univariate analyses | | p-value | Multivariate analysis | | p-value |
|---|---|---|---|---|---|---|---|---|
| | | | Total costs (euros), unadjusted | | | Total costs (euros), adjusted | | |
| | | | GM | RGM[b] (95% CI) | | GM (95% CI) | RGM (95% CI) | |
| Nutritional risk | No | 2132 | 5002 | Ref. | | 8127 (7739–8536) | Ref. | |
| | Yes | 921 | 9056 | 1.81 (1.68–1.96) | <0.001 | 8840 (8375–9321) | 1.09 (1.04–1.14) | <0.001 |
| Gender[a] | Men | 1561 | 6359 | Ref. | | | | |
| | Women | 1492 | 5614 | 0.88 (0.82–0.95) | 0.001 | | | |
| Age, years | <70 | 1770 | 6323 | Ref. | | 9072 (8639–9538) | Ref. | |
| | ≥70 | 1283 | 5544 | 0.88 (0.81–0.94) | 0.001 | 7911 (7510–8333) | 0.87 (0.84–0.91) | <0.001 |
| Days from | 1–2 days | 1023 | 3163 | Ref. | | 8357 (7893–8848) | Ref. | |
| admission | 3–7 days | 1231 | 5563 | 1.76 (1.64–1.88) | <0.001 | 7757 (7379–8154) | 0.93 (0.88–0.98) | 0.004 |
| to screening | 8–14 days | 534 | 11,176 | 3.53 (3.25–3.85) | <0.001 | 8265 (7762–8801) | 0.99 (0.92–1.06) | 0.76 |
| | >14 days | 265 | 27,928 | 8.83 (7.91–9.85) | <0.001 | 8783 (8056–9575) | 1.05 (0.95–1.16) | 0.33 |
| ICU stay | No | 2884 | 5457 | Ref. | | 5687 (5530–5849) | | |
| | Yes | 169 | 28,757 | 5.27 (4.54–6.12) | <0.001 | 12,620 (11,603–13739 | 2.22 (2.04–2.42) | <0.001 |
| No. of diagnoses | 1–3 | 1849 | 5479 | Ref. | | 8665 (8242–9109) | Ref. | |
| | ≥4 | 1204 | 6850 | 1.25 (1.16–1.35) | <0.001 | 8283 (7856–8734) | 0.96 (0.91–1.00) | <0.001 |
| Mode of arrival | Other[b] | 587 | 6956 | Ref. | | 7465 (7030–7927) | Ref. | |
| | Elective | 1382 | 5955 | 0.86 (0.77–0.95) | 0.003 | 7840 (7428–8275) | 1.05 (1.00–1.11) | 0.07 |
| | Emergency | 1084 | 5633 | 0.81 (0.73–0.89) | <0.001 | 10,394 (9897–10,916) | 1.39 (1.32–1.47) | <0.001 |
| | | | Regression coefficient B (95% CI) | | | Regression coefficient B (95% CI) | | |
| lnLOS, days | | | 0.996 (0.97–1.021) | | <0.001 | 0.934 (0.900–0.969) | | <0.001 |

Total costs were logarithmically transformed before analysis; GM, geometric mean; RGM, ratio of geometric means; Nutritional risk, NRS≥3; ICU, intensive care unit; LOS, length of stay.
Ref., reference group.
[a] Adding gender did not have statistical significance to multivariable model.
[b] Other = Patient arrived at the hospital either from other hospital or from outpatient clinic, or from another ward.

and 49% had an emergency admission (data not shown). When adjusted for ICU stays, number of diagnoses, and mode of arrival, the OR for in-hospital mortality in patients with nutritional risk was 4.4 (95% CI 2.44–7.92, $p < 0.001$: Table 6).

## 4. Discussion

The current cross-sectional study indicates that nutritional risk screening according to NRS 2002 at our hospital does not meet the requirements to cover high-quality monitoring and nutrition care. Low use of dietitian services and high number of risk patients related to prolonged LOS were associated with poor outcome. Overall, one third of the hospitalized patients had nutritional risk and it increased clearly after two weeks of hospitalization. Nutritional risk patients spent nearly six days longer at hospital, had higher risk of death during hospitalization and their cost of care was substantially higher compared with non-risk patients. Nutritional risk was associated with these three endpoints independently of date of screening. These findings confirm previous studies in hospitalized patients [2–5,10,20,27–30].

### 4.1. Nutritional risk

This study confers with previous findings stating that around one-third of 60–79-year-old in-hospital patients are nutritionally at risk of malnutrition [2–5]. Even higher rates (33–83%) have been seen in several studies [10,20,27–30]. Furthermore, our results support previous findings that higher age, longer LOS, and ICU admission are risk factors for the likelihood of nutritional risk during hospitalization [2,7,20,30]. Yet, it was expected that the number of risk-patients would have been higher due to the tertiary-care hospital status managing some of the most severe cases in Finland. One explanation for the lower prevalence of nutritional risk at admission in our study may be the age distribution as majority of our patients were aged 60–79 years, which is younger than patients included in some recent studies [20,28]. Another explanation might be the difference in distribution of mode of arrival and proportion of main diagnoses. Malignancies are one of the diagnoses with highest prevalence of nutritional risk (41%–73%) [28,31]. The nutritional risk of oncological patients was lower in our study compared with that reported by Tangvik and colleagues [2] (27% *vs.* 47%). Moreover, some studies have excluded elective patients [28], while in our study nearly half of the patients were elective. In addition, involvement of more complex patient groups, or smaller number of participants compared with our study might be responsible for the higher rate of nutritional risk in some studies [10,27,32,33]. Some underestimation may have occurred during the screening process as the nutritional screening was a relatively new method in our hospital at that time.

Notwithstanding the impact of nutrition screenings on patient outcome, we did not reach the set goal of screening 80% of all inpatients in our current study. Furthermore, the screening rate unexpectedly decreased during the study years. Possible explanations for the low screening rate in our study might be the lack of time resources to perform screening, or the insufficient understanding of the importance of screening. Of note, the challenge to screen is a common phenomenon as was shown in a recent Danish study where nutrition risk score was documented only in less than 40% of patients [11]. Furthermore, some previous studies have shown a modest impact of screening implementation to screening rates. In a Swiss study implementing screening process, screening rate increased from 16% up to 42% [20]. Similar results come from Denmark (40%), while lower screening rates between 16% and 21% were reported in Norway and Sweden [8]. During the time when NRS 2002 was rather a new method, higher screening rates were seen. In a large multicenter study with 12 countries participating, 93% of patients underwent nutritional risk screening within 36 h of admission [3]. Nutritional screening needs to be raised in top priority in patient management. It is time to act to emphasize its importance in high quality nutrition care.

One of our main findings is that the prevalence of nutritional risk was 3-fold higher in those screened after LOS >14 days than in

**Table 6**
Univariable and multivariable binary logistic regression model to assess the association between patient characteristics and in-hospital mortality.

| Factor | | n | In-hospital death | Univariate analyses | | Adjusted multivariate analysis | |
|---|---|---|---|---|---|---|---|
| | | | n (%) | OR (95% CI) | p-value | OR (95% CI) | p-value |
| Nutritional risk | No | 2132 | 17 (0.8) | Ref. | | Ref. | |
| | Yes | 921 | 36 (3.9) | 5.06 (2.83–9.06) | <0.001 | 4.40 (2.44–7.92) | <0.001 |
| Gender[a] | Men | 1561 | 28 (1.8) | Ref. | | | |
| | Women | 1492 | 25 (1.7) | 0.93 (0.54–1.61) | 0.80 | | |
| BMI, kg/m$^2$[a] | <20.0 | 162 | 7 (4.3) | Ref. | | | |
| | 20.0–24.9 | 560 | 5 (0.9) | 0.20 (0.06–0.64) | 0.007 | | |
| | 25.0–29.9 | 542 | 5 (0.9) | 0.21 (0.06–0.66) | 0.008 | | |
| | ≥30.0 | 397 | 5 (1.3) | 0.28 (0.09–0.90) | 0.03 | | |
| Age, years[a] | <70 | 1770 | 21 (1.2) | Ref. | | 8896 (8471–9343) | Ref. |
| | ≥70 | 1283 | 32 (2.5) | 2.13 (1.22–3.71) | 0.008 | | |
| Days from admission to screening[b] | 1–2 days | 1023 | 12 (1.2) | Ref. | | Ref. | |
| | 3–7 days | 1231 | 19 (1.5) | 1.32 (0.64–2.73) | 0.45 | 0.74 (0.30–1.80) | 0.50 |
| | 8–14 days | 534 | 12 (2.2) | 1.94 (0.86–4.34) | 0.11 | 0.60 (0.27–1.34) | 0.21 |
| | >14 days | 265 | 10 (3.8) | 3.30 (1.41–7.73) | 0.006 | 0.73 (0.31–1.74) | 0.48 |
| ICU stay[a] | No | 2884 | 47 (1.6) | Ref. | | | |
| | Yes | 169 | 6 (3.6) | 2.22 (0.94–5.27) | 0.07 | | |
| No. of diagnosis | 1–2 | 1404 | 12 (0.9) | Ref. | | Ref. | |
| | ≥3 | 1649 | 41 (2.5) | 2.96 (1.55–5.65) | 0.001 | 2.23 (1.15–4.31) | 0.02 |
| Mode of arrival | Other[c] | 587 | 15 (2.6) | Ref. | | Ref. | |
| | Elective | 1382 | 12 (0.9) | 0.33 (0.16–0.72) | 0.005 | 0.47 (0.21–1.01) | <0.05 |
| | Emergency | 1084 | 26 (2.4) | 0.94 (0.49–1.78) | 0.84 | 1.10 (0.57–2.12) | 0.77 |

OR, odds ratio; CI, confidence interval; BMI, body mass index; Nutritional risk, NRS≥3; ICU, intensive care unit.
Ref., reference group.
BMI was not introduced to the multivariate analysis due to 46% of missing information.
[a] Adding gender, age, or history of ICU stay did not have statistical significance to multivariable model.
[b] Days to admission to screening was forced to the model.
[c] Other = Patient arrived at the hospital either from other hospital or from outpatient clinic, or from another ward.

those screened at admission. Our finding is in line with a recent study demonstrating that the prevalence of nutritional risk was twice as higher among patients with LOS >15 days compared those with 15 days or less [7]. Lesser increase of 2% was seen in the Zhu et al. study [6]. In the current study, after adjusting for LOS, the probability of nutritional risk increased 6-fold if hospitalization exceeded 14 days. However, due to the study protocol of our study, we were not able to demonstrate that these patients were not with higher disease burden and thus nutritionally at risk already at admission. This might be the case at least in a part of our study population, because 40% of the patients that were screened after two weeks of hospitalization had either cardiovascular disease or infection as their main diagnosis [34]. Indeed, it has been shown that sepsis, congestive heart failure, and stroke are risk factors for prolonged hospitalization alongside with the patient having four or more chronic diseases and weight loss [34] Of note, nutritional risk screening became more emphasized in patients with prolonged LOS.

### 4.2. Length of stay

Nutritionally at-risk patients in our study stayed on average six days longer at hospital than non-risk patients, which is a finding in agreement with previous studies reporting an increase of 3–5 days in the LOS in nutritional risk patients [3,33,35]. Curtis and colleagues [36] showed that nutritional status was strongly associated with LOS with a 27% increase in LOS among moderately and 44% among severely malnourished patients. The association between nutritional risk and longer LOS in our study remained robust after adjusting for history of ICU stays, number of diagnoses, mode of arrival, and gender. Furthermore, increased LOS was particularly frequent among nutritionally at-risk patients with malignancy, renal or gastrointestinal disease, and among those admitted to hospital as an elective patient. This highlights the relevance of focusing nutrition support on these groups and emphasizes the importance of perioperative nutrition.

### 4.3. Total cost

Previously hospital costs have been reported to be 45–54%, or even three times higher in malnourished than in well-nourished patients [36,37]. Our results indicating 2-fold hospital costs in risk patients are in line with these earlier findings. Unexpectedly, in our adjusted model, patients aged $\geq$70, and patients with four or more diagnoses had lower hospital costs than those under 70 and with less than four diagnoses. One explanation might be that elderly and multimorbid patients had more frequently cardiovascular disease as their main diagnosis, emergency admissions, and in-hospital deaths, while patients with higher hospital costs were more frequently admitted electively and had trauma as their main diagnosis, and consequently received more expensive treatments. After adjusting, nutritional risk was associated with an only 9% increase in total costs, which is lower than earlier reported [20] due to a different statistical model. In the current study the LOS and ICU stay had higher impact on cost structure than nutritional risk alone. Nevertheless, nutritional risk involves nearly 150 000 patients in our hospital district and therefore carries a substantial cost.

### 4.4. In-hospital mortality

Nutritional risk and nutritional status affect considerably in-hospital mortality [33,37] even though mortality rate in the current study was slightly lower than previously reported [2,33]. Our study demonstrated that nutritional risk is a strong risk factor for in-hospital mortality, but the finding should be interpreted with caution due to the wide CI indicating a substantial uncertainty of the result. In the current study the severity of disease was a more probable cause of death rather than nutritional risk because majority of deceased patients had either cardiovascular disease or malignancy.

### 4.5. Strengths and limitations of the study

The strength of the present study is the relatively large patient cohort including all internal and surgical wards at the largest hospital district in Finland. The patient population thus appropriately represents Finnish hospital patients and their nutritional risk in general. An additional strength is that nursing staff received extensive education regarding the use of the NRS 2002 as a screening method. Moreover, three audit days accounted for more than half of all eligible participants, which is in line with the generally accepted standards and guidelines [14] and higher than earlier studies have observed [8,20]. As a limitation, the patients with longer LOS were overrepresented due to the cross-sectional nature of the study, whereas previous studies have screened the nutritional risk solely at admission. We had limited data acquisition for comorbidities, surgical procedures and the pre- and post-hospitalization treatments making these data descriptive and not allowing for causative analysis of associations. The weight and height were not recorded in all our screened patients, which is a limitation, but the rate of these measurements was higher than the 19% reported in a European multicenter study [3]. Moreover, the BMI distribution in the current study corresponds to the available BMI data from the Finnish Institute for Health and Welfare. Nevertheless, this implies the necessity to further draw attention to regular measurement of body weight and importing the measurements into the patient records as weight loss is the key diagnostic criterion for nutritional risk and malnutrition. Further limitations are that we were not able to assess energy or protein intake in risk patients, and to perform retrospective malnutrition diagnostics by GLIM or nutrition status assessment by Subjective Global Assessment.

This study raised several research questions, including the evaluation of the type of performed nutritional care and the 30-day and one-year mortality in nutritional risk patients. Moreover, nutritional intake and monitoring of body weight during hospitalization need more detailed follow-up. Furthermore, clinical studies need to assess whether structured nutritional support in a nutritionally at-risk patient is effective in improving patients' care, nutritional status, and outcome in our hospital district.

In conclusion, the prevalence of nutritional risk is high among Finnish hospitalized adult patients and increases with prolonged LOS. In addition, our results clearly show that patients at nutritional risk have longer LOS, higher hospital costs, and increased mortality than non-risk patients. Patients who are transferred from one hospital or specialty to another will need special attention due to the high prevalence of nutritional risk in these subgroups. Furthermore, it is alarming how infrequently the units utilize dietitian services and that utilization did not improve during screening implementation. The routine use of a simple screening procedure for each patient at hospital admission is of paramount importance to increase the quality of care, especially nutritional care. Our results demonstrate that nutritional risk associates with worse outcome and higher hospital costs and that screening rates show a decreasing trend, dietitian services are poorly utilized, and body weight measurement is not a routine in patient care. To conclude, this study reveals a low standard of nutrition care in our hospital compared to international standards and shows the challenge in implementing nutritional risk screening to a patient care. Further efforts are needed to raise the awareness of the importance of nutritional screening during hospitalization.

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## Author contributions

HO was the main investigator, analyzed and interpreted data and drafted the manuscript. HO, AH and KJ designed the study. AM and US supervised the project and assisted with writing the manuscript. PÖ, AP and JT assisted in interpretation of the results and writing the manuscript. All authors read and approved the final manuscript.

## Declaration of competing interest

The authors declare no conflict of interest.

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## Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.clnesp.2023.07.016.

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