Prognostic value of the ESPEN consensus and guidelines for malnutrition: prediction of post-discharge clinical outcomes in older inpatients

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Abstract:

Introduction: Our study aimed to determine whether malnutrition and nutrition-related conditions using the European Society for Clinical Nutrition and Metabolism (ESPEN) consensus were associated with functional status, institutionalization, readmissions, and mortality in older patients at 3-month follow-up.
Methods: A cohort of 102 consecutive deconditioned patients was assessed at three months postdischarge from postacute care. Inclusion criteria were age ≥70 years, scores of Mini-Mental Status Examination ≥21/30, and admission for rehabilitation after an acute non-disabling disease. Malnutrition as defined by ESPEN consensus and nutrition-related conditions (frailty, sarcopenia, overweight/obesity, nutrient deficiency, and cachexia) were assessed, and related to postdischarge clinical outcomes at 3-month follow-up.
Results: Of 95 included patients (84.5±6.5 years; 63.2% women), 31 (32.6%) had unintentional weight loss and 19 (20%) fulfilled malnutrition criteria defined by the ESPEN consensus. Nutrition-related conditions were frequent: 94 (99%) patients had frailty, 44 (46.3%) sarcopenia, 58 (61.1%) overweight/obesity, and 59 (62.1%) nutrient deficiency. Sarcopenia reduced functional status at 3-month follow-up (median difference: -25.5; 95%CI -46.4 to -4.3, p=0.008). Institutionalization was related to unintentional weight loss in univariate analysis (OR= 3.9; 95%CI 1.3 to 12.4, p=0.018). Meeting the basic ESPEN definition of malnutrition was related to institutionalization in univariate (OR=3.4; 95% CI 1.0 to 11.3, p=0.042) but not multivariate analysis, and was not significantly associated with readmissions or mortality at 3-month follow-up.
Conclusions: Further research is needed on the potential value of the ESPEN consensus and guidelines to identify older patients at risk of worse functional status, institutionalization, readmissions, and mortality at 3-month follow-up postdischarge.

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INTRODUCTION

Malnutrition is associated with poor functional status and increased mortality in older people (1)(2)(3). The main consequences of malnutrition and its related syndromes, such as frailty or sarcopenia, include increased risks of infections (4)(5), loss of independence (6), worsening health-related quality of life (7), and death (8)(9)(10)(11). Given the lack of consensual malnutrition guidelines, the European Society for Clinical Nutrition and Metabolism (ESPEN) recently made an effort to establish a definition of malnutrition that would be applicable in all adult age-ranges and healthcare settings, independent of etiology (1). The ESPEN consensus definition of malnutrition guidelines on definition and diagnoses has provided clinicians and researchers a practical tool for the hierarchical organization of nutrition disorders, nutrition-related conditions, and nutrition-related syndromes (2).

The ESPEN consensus definition of malnutrition has been applied in both acute (11)(12)(13) and postacute care (14)(15). In a large population of hospitalized older patients with diabetes, malnutrition lengthened the hospital stay, increased the probability of in-hospital death by a factor of 2.7, and decreased the probability of being discharged home rather than to an institution (13). Early management of nutrition disorders and nutrition-related conditions (1), once detected, could improve the life course of patients (16)(17).

The objective of this longitudinal study was to determine whether the malnutrition and nutrition-related conditions diagnosed during hospitalization using the ESPEN consensus definition were associated with post-discharge clinical outcomes (functional status assessed by Barthel index, institutionalization, hospital readmissions, and mortality) among older patients at 3-month follow-up.

METHODS

Design

Cohort study of postacute inpatients who participated in a larger prospective study on malnutrition and sarcopenia (14). The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement (18) was followed (Additional file 1).

Setting

The study was conducted in a postacute geriatric rehabilitation care unit in a university hospital. The unit focuses specifically on a 2-week period of rehabilitation and functional recovery, after which patients are expected to be discharged home.

Participants

Consecutive patients aged ≥70 years hospitalized in the postacute geriatric rehabilitation care unit due to functional loss resulting from a non-disabling medical disease were included from January to August 2011. Patients with general and/or cognitive conditions (Mini-Mental State Examination score <21/30) that prevented completion of the diagnostic tests or absence of information regarding weight loss in the previous year were excluded.

Procedure

All inpatients were screened for risk of malnutrition at admission by the Mini-Nutritional Assessment Short-Form (MNA-SF) (19)(20). The diagnosis of malnutrition as defined by the ESPEN consensus was then retrospectively applied in all patients identified as at risk of malnutrition (MNA-SF scores ≤11). The ESPEN definition pro-

poses two alternative ways to diagnose malnutrition: body mass index (BMI) <18.5 kg/m^2 (alternative 1) or unintentional weight loss (>10% indefinite of time, or >5% over the last 3 months) combined with age-related BMI (BMI <20 kg/m^2 in <70 years, or <22 kg/m^2 in ≥70 years) or fat-free mass index (<17 kg/m^2 in men and 15 kg/m^2 in women) (1). **Unintentional weight loss** was obtained from medical records. If data for the last 3 months were unavailable, weight loss was assessed by patient and caregiver interview or from weight data recorded in the medical record during the last year. **BMI** was calculated from height and weight (kg/m^2): height was measured in all patients able to stand safely, otherwise a knee height equation (21) was applied; body weight was measured to the nearest 0.1 kg. **Fat-free mass** (FFM), expressed in kg, was measured by bioimpedance (Bodystat 1500, Bodystat Ltd., Isle of Man British Isles) as previously described (14)(22). The FFM values were divided by height squared to obtain the **fat-free mass index** (FFMI), expressed in kg/m^2 and compared with those of the reference population (23).

Nutrition-related conditions (sarcopenia, frailty, overweight/obesity, and nutrient deficiency) were also considered (1). The term "nutrition-related syndrome" was used to refer to a condition included in the definition, such as sarcopenia and frailty that is also identified as a geriatric syndrome. **Sarcopenia** was assessed following The European Working Group on Sarcopenia in Older People (EWGSOP) criteria: low muscle mass in presence of low muscle function or low physical performance (24) assessed with bioimpedance analysis, isometric handgrip dynamometry, and gait speed in a 4-m walk test as previously described (14)(22). Gait speed was considered 0 m/s in bedridden patients unable to stand. **Frailty** was assessed by the Frailty Phenotype (25) in presence

of three of the following criteria: weight loss, weakness, exhaustion, slow walking speed, and low physical activity. **Overweight and obesity** were considered following World Health Organization recommendations: BMI 25-30 kg/m^2 and ≥30 kg/m^2, respectively. **Nutrient deficiency** was noted for total proteins, total cholesterol, triglycerides, homocysteine-related markers (folic acid and B12 vitamin), iron profile (serum iron, ferritin), and altered values of thyroid-stimulating hormone, ionogram (sodium, potassium), and renal profile (creatinine, urea and glomerular filtration rate from the equation developed by the Modification of Diet in Renal Diseases Study). Diagnostic criteria for **cachexia** (wasting disease) in adults were applied. These included weight loss of at least 5% in previous 12 months or less, in the presence of underlying illness and three of the following criteria: decreased muscle strength, fatigue (defined as physical and/or mental weariness resulting from exertion), anorexia (total caloric intake <20 kcal/kg body weight/day or <70% of usual food intake), low FFMI, or abnormal biochemistry (hemoglobin <12 g/dl or low serum albumin <3.2 g/dl) (26).

Outcome variables

Main outcome variables were **functional status** assessed by Barthel index**, institutionalization, readmissions**, and **mortality.** Functional status was recorded after discharge by an investigator blinded to the study, obtained by telephone interview with the patient or caregiver. Institutionalization, readmissions, and mortality were collected from caregiver telephone interview and medical records at 3-month follow-up. After follow-up was completed, survival was assessed annually for the whole cohort in the same way. Data on sex, age, comorbidity (Charlson index), cognitive status (Short

Portable Mental Status Questionnaire) (27), and instrumental activities of daily living (Lawton index) were obtained from medical records.

Ethics

National and international research ethics guidelines were followed (28), including the Deontological Code of Ethics, Declaration of Helsinki, and Spain's confidentiality law concerning personal data (*Ley Orgánica* 15/1999, 13 December, *Protección de Datos de Carácter Personal*). Written informed consent to participate was signed by all participants and the study was approved by the local Clinical Ethics Committee.

Statistical analysis

Descriptive analysis of the sample used percentages with frequency distributions for categorical variables and means with standard deviation for quantitative continuous variables. Univariate analysis was used to check clinical and functional characteristics of the study participants according to the diagnosis of malnutrition as defined by ESPEN consensus. Qualitative variables were compared by Chi-square or Fisher exact test, as appropriate and quantitative variables by Student *t* test. As histograms and Q-Q plot showed that Barthel Index at 3 months was not normally distributed, median regression was applied to check median differences (MD) with 95% confidence interval (CI). The analysis of factors associated with institutionalization was performed using binary logistic regression. These associations were expressed by odds ratios (OR). Associations with post-discharge readmissions and mortality were evaluated by Cox regression. Kaplan-Meier curves for readmissions and for mortality, by malnutrition, were compared using the corresponding log-rank test at 3-month follow-up. Univariate

and multivariate analyses were performed for all outcomes to examine possible associations with covariables. Furthermore, the proportional hazards assumption was checked for each Cox model; there was no evidence of any violation from proportional hazards. P-values <0.05 were considered significant. Statistical analysis was performed using R for Windows (V.3.1.3).

RESULTS

Of 102 eligible patients discharged from the unit during the study period, 95 met inclusion criteria (mean age 84.5 (SD 6.5) years, 63.2% women). Of the 31 (32.6%) patients with unintentional weight loss, 19 (20%) fulfilled the criteria for a diagnosis of malnutrition as defined by the ESPEN consensus. Nutrition-related conditions were frequent: 94 (99%) patients met Fried criteria for frailty, 44 (46.3%) for sarcopenia, 58 (61.1%) for overweight/obesity, 59 (62.1%) had nutrient deficiency, and 20 (21.1%) patients had cachexia. Clinical and functional characteristics of the study participants during their stay in the postacute care unit and at 3-month follow-up are detailed in **Table 1**. Post-discharge clinical outcomes in patients with malnutrition and other nutrition-related conditions are described in **Table 2**.

Tables 3 to 6 show univariate and multivariate analysis according to clinical outcomes (Barthel index, institutionalization, readmissions, and mortality) at 3-month follow-up. Sarcopenia was the only nutrition-related syndrome that affected Barthel index at 3-month follow-up, both in univariate analysis (median difference [MD]= -25; 95% CI: -43.2 to -6.8; p= 0.008) and in multivariate analysis (MD= -25.5; 95%CI: -46.6 to -4.3; p= 0.019) (**Table 3**).

As shown in **Table 4**, age and sex showed a significant association with institutionalization in the multivariate analysis. Institutionalization was also related to unintentional weight loss in univariate analysis (OR= 3.9; 95%CI: 1.3 to 12.4; p= 0.018) and showed a strong trend in multivariate analysis (OR= 5.5; 95%CI: 0.9 to 31.6; p= 0.058). Similarly, malnutrition was significantly associated with institutionalization in

univariate analysis (OR= 3.4; 95% CI: 1.0 to 11.3; p= 0.042), but the association was not maintained under multivariate analysis.

At 3-month follow-up, 18 patients had been readmitted; there were no differences in readmissions by clinical characteristics, malnutrition, and other nutrition-related conditions (p >0.05) (**Table 5**). Readmissions also did not differ by malnutrition as defined by the ESPEN consensus (log rank p-value= 0.685), as shown in **Figure 1**.

Finally, neither malnutrition nor nutrition-related conditions were related to any differences in mortality in the analysis performed (**Table 6**). Age and comorbidity were the only variables affecting mortality under multivariate analysis. The Kaplan-Meier curve showed no differences in mortality by malnutrition diagnosis, as defined by the ESPEN consensus (log rank p-value= 0.533) (**Figure 2**).

DISCUSSION

This cohort study assessed the association of malnutrition and nutrition-related conditions with clinical outcomes in older patients at 3 months postdischarge from a postacute care unit. We found that applying malnutrition criteria as defined by the ESPEN consensus had no additional value in predicting poor mid-term outcomes in the studied sample of geriatric patients. Instead, unintentional weight loss (i.e., one of the subscores of the consensus definition) was associated with an increased likelihood of postdischarge institutionalization, and sarcopenia was associated with poorer functional status at 3-month follow-up.

The prognostic value of malnutrition as defined by the recently published ESPEN consensus and guidelines has not been explored thoroughly. To the authors' knowledge, the only study reporting an association between malnutrition as defined by the ESPEN consensus and clinical outcomes was carried out in an acute care setting and was limited to analyzing the length of hospital stay (13). Nutrition disorders diagnosed by ESPEN consensus and guidelines are associated with worse functional prognosis during postacute rehabilitation care (15), but there were no studies on this association after discharge. Data from our study showed that the association between malnutrition and functional status did not persist at 3 months postdischarge, a result that was unexpected. A likely explanation for malnutrition's lack of predictive value for post-discharge clinical outcomes is that nutritional deficiencies were correctly addressed during hospitalization, and the expected poor outcomes due to the presence of malnutrition

were effectively cancelled in these patients after the multidisciplinary intervention performed as part of usual post-discharge therapy.

Unlike malnutrition as defined by the ESPEN consensus, malnutrition-related syndromes such as sarcopenia or frailty seem to have a negative impact on functional status and rehabilitation outcomes in various settings, including postacute care (22)(29)(30)(31). This observation held true for the present sample, in which the presence of sarcopenia was associated with a lower score on the Barthel index after 3 months (14).

Unintentional weight loss was related to institutionalization. In a previous study, unintentional weight loss was also related to worse clinical outcomes during hospital stay (poor functional rehabilitation outcomes and longer length of stay) (15). Other studies have considered weight loss prior to admission the most powerful predictor of poor functional outcomes (32) and frailty (33). Unintentional weight loss has been proposed as a key indicator to assess formal nutrition because of its validity, feasibility, efficiency, and availability for every population and level of healthcare assistance (34). Given that unintentional weight loss is a strong predictor of negative outcomes (1)(33)(35)(36), objective anthropometric measurements (weight and height) should be registered in the medical record in order to detect eventual weight loss in patients' follow-up as part of the comprehensive geriatric assessment (37). This factor appears to be an accessible, feasible and low-cost indicator of malnutrition itself in older adults (33)(37)(38)(39). In the process of creating a consensus on malnutrition diagnostic criteria, now being developed by the Global Leadership Initiative on Malnutrition

(GLIM) (34)(40), it would be desirable that unintentional weight loss be included as a part of this universal tool, suitable for older people.

The key point of malnutrition and malnutrition-related syndromes that has aroused great interest for the scientific community is their reversibility, when properly identified and managed. In the therapeutic approach to malnutrition, frailty, and sarcopenia, the most effective strategies to prevent and treat malnutrition and nutrition disorders seem to be an adequate nutrient intake, nutritional supplementation, and physical exercise (29)(41)(42)(43).

Some limitations may have influenced the results of our study. The criteria for admission to the postacute short-term rehabilitation program constitute an initial selection bias for studies conducted in rehabilitation settings: patients with good initial recovery in the acute care ward as well as those whose physical, cognitive, or functional status prevents them from following a rehabilitation program are excluded. In addition, patients who require a rehabilitation program longer than two weeks are usually sent to other intermediate care settings (14)(22). Therefore, the population is narrowly selected, by definition. It is not surprising that frailty and risk of malnutrition were present in all the sample, given that functional loss resulting from an acute recent process is one of the admission criteria in the postacute care unit. The MNA-SF has been validated for use in Spanish translation and has been recommended as a screening tool by the Spanish Geriatrics and Gerontology Society (20), but the use of the full MNA questionnaire might have improved specificity. On the other hand, malnutrition as defined by the ESPEN consensus is partially based on anthropometric measurements, such as height,

which can be challenging in patients who are unable to stand (12 patients, 13.6%) and require the substitution of knee height; furthermore, height measurement does not take into account possible kyphosis or vertebral osteoporotic degenerative changes (44). These factors might interfere with the accuracy of BMI, FFMI, basic definition of malnutrition, and sarcopenia or cachexia diagnosis. Finally, the relatively small sample size and the overlap between malnutrition and its related conditions should also be considered a potential study limitation.

The diagnostic criteria proposed by the Academy of Nutrition and Dietetics and American Society for Parenteral and Enteral Nutrition (AND/ASPEN) have also been shown to be a reliable tool in the assessment of malnutrition. Both ASPEN/AND and ESPEN criteria have their pros and cons. The categories of malnutrition and the approach to distinguishing the malnutrition context (acute illness or injury, chronic illness, and social or environmental circumstances) are strong points of the ASPEN/AND criteria; however, this is a complex tool using subjective assessment skills rather than objective body composition measures (45). Conversely, the ESPEN consensus definition is based on objective anthropometric measurements (BMI and FFMI), but some of them have limited availability in clinical settings and are overly restrictive. Further research is required in order to achieve a unified consensus suitable to all populations and settings worldwide (1)(40)(46)(47).

Conclusions

Malnutrition as defined by the ESPEN consensus could not predict functional status, institutionalization, readmissions, and mortality at 3 months after discharge from a

postacute care unit. In contrast, unintentional weight loss, i.e. one of the subscores of the consensus definition, was associated with an increased likelihood of postdischarge institutionalization, and sarcopenia was associated with poorer functional status at 3-month follow-up. Further research with larger samples, multicenter cohorts, and more extended follow-up is required to clarify the clinical value of diagnosing malnutrition using the ESPEN consensus and its ability to predict long-term adverse clinical outcomes.

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Conflict of interest

All authors declare they do not have any financial and personal relationships with other people or organizations that could inappropriately influence their work.

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The study was conducted in a postacute geriatric rehabilitation care unit in a university hospital. The unit focuses specifically on a 2-week period of rehabilitation and functional recovery, after which patients are expected to be discharged home.

Participants

Consecutive patients aged ≥70 years hospitalized in the postacute geriatric rehabilitation care unit due to functional loss resulting from a non-disabling medical disease were included from January to August 2011. Patients with general and/or cognitive conditions (Mini-Mental State Examination score <21/30) that prevented completion of the diagnostic tests or absence of information regarding weight loss in the previous year were excluded.

Procedure

All inpatients were screened for risk of malnutrition at admission by the Mini-Nutritional Assessment Short-Form (MNA-SF) (19)(20). The diagnosis of malnutrition as defined by the ESPEN consensus was then retrospectively applied in all patients identified as at risk of malnutrition (MNA-SF scores ≤11). The ESPEN definition pro-

poses two alternative ways to diagnose malnutrition: body mass index (BMI) <18.5 kg/m^2 (alternative 1) or unintentional weight loss (>10% indefinite of time, or >5% over the last 3 months) combined with age-related BMI (BMI <20 kg/m^2 in <70 years, or <22 kg/m^2 in ≥70 years) or fat-free mass index (<17 kg/m^2 in men and 15 kg/m^2 in women) (1). **Unintentional weight loss** was obtained from medical records. If data for the last 3 months were unavailable, weight loss was assessed by patient and caregiver interview or from weight data recorded in the medical record during the last year. **BMI** was calculated from height and weight (kg/m^2): height was measured in all patients able to stand safely, otherwise a knee height equation (21) was applied; body weight was measured to the nearest 0.1 kg. **Fat-free mass** (FFM), expressed in kg, was measured by bioimpedance (Bodystat 1500, Bodystat Ltd., Isle of Man British Isles) as previously described (14)(22). The FFM values were divided by height squared to obtain the **fat-free mass index** (FFMI), expressed in kg/m^2 and compared with those of the reference population (23).

Nutrition-related conditions (sarcopenia, frailty, overweight/obesity, and nutrient deficiency) were also considered (1). The term "nutrition-related syndrome" was used to refer to a condition included in the definition, such as sarcopenia and frailty that is also identified as a geriatric syndrome. **Sarcopenia** was assessed following The European Working Group on Sarcopenia in Older People (EWGSOP) criteria: low muscle mass in presence of low muscle function or low physical performance (24) assessed with bioimpedance analysis, isometric handgrip dynamometry, and gait speed in a 4-m walk test as previously described (14)(22). Gait speed was considered 0 m/s in bedridden patients unable to stand. **Frailty** was assessed by the Frailty Phenotype (25) in presence

of three of the following criteria: weight loss, weakness, exhaustion, slow walking speed, and low physical activity. **Overweight and obesity** were considered following World Health Organization recommendations: BMI 25-30 kg/m^2 and ≥30 kg/m^2, respectively. **Nutrient deficiency** was noted for total proteins, total cholesterol, triglycerides, homocysteine-related markers (folic acid and B12 vitamin), iron profile (serum iron, ferritin), and altered values of thyroid-stimulating hormone, ionogram (sodium, potassium), and renal profile (creatinine, urea and glomerular filtration rate from the equation developed by the Modification of Diet in Renal Diseases Study). Diagnostic criteria for **cachexia** (wasting disease) in adults were applied. These included weight loss of at least 5% in previous 12 months or less, in the presence of underlying illness and three of the following criteria: decreased muscle strength, fatigue (defined as physical and/or mental weariness resulting from exertion), anorexia (total caloric intake <20 kcal/kg body weight/day or <70% of usual food intake), low FFMI, or abnormal biochemistry (hemoglobin <12 g/dl or low serum albumin <3.2 g/dl) (26).

Outcome variables

Main outcome variables were **functional status** assessed by Barthel index**, institutionalization, readmissions**, and **mortality.** Functional status was recorded after discharge by an investigator blinded to the study, obtained by telephone interview with the patient or caregiver. Institutionalization, readmissions, and mortality were collected from caregiver telephone interview and medical records at 3-month follow-up. After follow-up was completed, survival was assessed annually for the whole cohort in the same way. Data on sex, age, comorbidity (Charlson index), cognitive status (Short

Portable Mental Status Questionnaire) (27), and instrumental activities of daily living (Lawton index) were obtained from medical records.

Ethics

National and international research ethics guidelines were followed (28), including the Deontological Code of Ethics, Declaration of Helsinki, and Spain's confidentiality law concerning personal data (*Ley Orgánica* 15/1999, 13 December, *Protección de Datos de Carácter Personal*). Written informed consent to participate was signed by all participants and the study was approved by the local Clinical Ethics Committee.

Statistical analysis

Descriptive analysis of the sample used percentages with frequency distributions for categorical variables and means with standard deviation for quantitative continuous variables. Univariate analysis was used to check clinical and functional characteristics of the study participants according to the diagnosis of malnutrition as defined by ESPEN consensus. Qualitative variables were compared by Chi-square or Fisher exact test, as appropriate and quantitative variables by Student *t* test. As histograms and Q-Q plot showed that Barthel Index at 3 months was not normally distributed, median regression was applied to check median differences (MD) with 95% confidence interval (CI). The analysis of factors associated with institutionalization was performed using binary logistic regression. These associations were expressed by odds ratios (OR). Associations with post-discharge readmissions and mortality were evaluated by Cox regression. Kaplan-Meier curves for readmissions and for mortality, by malnutrition, were compared using the corresponding log-rank test at 3-month follow-up. Univariate

and multivariate analyses were performed for all outcomes to examine possible associations with covariables. Furthermore, the proportional hazards assumption was checked for each Cox model; there was no evidence of any violation from proportional hazards. P-values <0.05 were considered significant. Statistical analysis was performed using R for Windows (V.3.1.3).

RESULTS

Of 102 eligible patients discharged from the unit during the study period, 95 met inclusion criteria (mean age 84.5 (SD 6.5) years, 63.2% women). Of the 31 (32.6%) patients with unintentional weight loss, 19 (20%) fulfilled the criteria for a diagnosis of malnutrition as defined by the ESPEN consensus. Nutrition-related conditions were frequent: 94 (99%) patients met Fried criteria for frailty, 44 (46.3%) for sarcopenia, 58 (61.1%) for overweight/obesity, 59 (62.1%) had nutrient deficiency, and 20 (21.1%) patients had cachexia. Clinical and functional characteristics of the study participants during their stay in the postacute care unit and at 3-month follow-up are detailed in **Table 1**. Post-discharge clinical outcomes in patients with malnutrition and other nutrition-related conditions are described in **Table 2**.

Tables 3 to 6 show univariate and multivariate analysis according to clinical outcomes (Barthel index, institutionalization, readmissions, and mortality) at 3-month follow-up. Sarcopenia was the only nutrition-related syndrome that affected Barthel index at 3-month follow-up, both in univariate analysis (median difference [MD]= -25; 95% CI: -43.2 to -6.8; p= 0.008) and in multivariate analysis (MD= -25.5; 95%CI: -46.6 to -4.3; p= 0.019) (**Table 3**).

As shown in **Table 4**, age and sex showed a significant association with institutionalization in the multivariate analysis. Institutionalization was also related to unintentional weight loss in univariate analysis (OR= 3.9; 95%CI: 1.3 to 12.4; p= 0.018) and showed a strong trend in multivariate analysis (OR= 5.5; 95%CI: 0.9 to 31.6; p= 0.058). Similarly, malnutrition was significantly associated with institutionalization in

univariate analysis (OR= 3.4; 95% CI: 1.0 to 11.3; p= 0.042), but the association was not maintained under multivariate analysis.

At 3-month follow-up, 18 patients had been readmitted; there were no differences in readmissions by clinical characteristics, malnutrition, and other nutrition-related conditions (p >0.05) (**Table 5**). Readmissions also did not differ by malnutrition as defined by the ESPEN consensus (log rank p-value= 0.685), as shown in **Figure 1**.

Finally, neither malnutrition nor nutrition-related conditions were related to any differences in mortality in the analysis performed (**Table 6**). Age and comorbidity were the only variables affecting mortality under multivariate analysis. The Kaplan-Meier curve showed no differences in mortality by malnutrition diagnosis, as defined by the ESPEN consensus (log rank p-value= 0.533) (**Figure 2**).

DISCUSSION

This cohort study assessed the association of malnutrition and nutrition-related conditions with clinical outcomes in older patients at 3 months postdischarge from a postacute care unit. We found that applying malnutrition criteria as defined by the ESPEN consensus had no additional value in predicting poor mid-term outcomes in the studied sample of geriatric patients. Instead, unintentional weight loss (i.e., one of the subscores of the consensus definition) was associated with an increased likelihood of postdischarge institutionalization, and sarcopenia was associated with poorer functional status at 3-month follow-up.

The prognostic value of malnutrition as defined by the recently published ESPEN consensus and guidelines has not been explored thoroughly. To the authors' knowledge, the only study reporting an association between malnutrition as defined by the ESPEN consensus and clinical outcomes was carried out in an acute care setting and was limited to analyzing the length of hospital stay (13). Nutrition disorders diagnosed by ESPEN consensus and guidelines are associated with worse functional prognosis during postacute rehabilitation care (15), but there were no studies on this association after discharge. Data from our study showed that the association between malnutrition and functional status did not persist at 3 months postdischarge, a result that was unexpected. A likely explanation for malnutrition's lack of predictive value for post-discharge clinical outcomes is that nutritional deficiencies were correctly addressed during hospitalization, and the expected poor outcomes due to the presence of malnutrition

were effectively cancelled in these patients after the multidisciplinary intervention performed as part of usual post-discharge therapy.

Unlike malnutrition as defined by the ESPEN consensus, malnutrition-related syndromes such as sarcopenia or frailty seem to have a negative impact on functional status and rehabilitation outcomes in various settings, including postacute care (22)(29)(30)(31). This observation held true for the present sample, in which the presence of sarcopenia was associated with a lower score on the Barthel index after 3 months (14).

Unintentional weight loss was related to institutionalization. In a previous study, unintentional weight loss was also related to worse clinical outcomes during hospital stay (poor functional rehabilitation outcomes and longer length of stay) (15). Other studies have considered weight loss prior to admission the most powerful predictor of poor functional outcomes (32) and frailty (33). Unintentional weight loss has been proposed as a key indicator to assess formal nutrition because of its validity, feasibility, efficiency, and availability for every population and level of healthcare assistance (34). Given that unintentional weight loss is a strong predictor of negative outcomes (1)(33)(35)(36), objective anthropometric measurements (weight and height) should be registered in the medical record in order to detect eventual weight loss in patients' follow-up as part of the comprehensive geriatric assessment (37). This factor appears to be an accessible, feasible and low-cost indicator of malnutrition itself in older adults (33)(37)(38)(39). In the process of creating a consensus on malnutrition diagnostic criteria, now being developed by the Global Leadership Initiative on Malnutrition

(GLIM) (34)(40), it would be desirable that unintentional weight loss be included as a part of this universal tool, suitable for older people.

The key point of malnutrition and malnutrition-related syndromes that has aroused great interest for the scientific community is their reversibility, when properly identified and managed. In the therapeutic approach to malnutrition, frailty, and sarcopenia, the most effective strategies to prevent and treat malnutrition and nutrition disorders seem to be an adequate nutrient intake, nutritional supplementation, and physical exercise (29)(41)(42)(43).

Some limitations may have influenced the results of our study. The criteria for admission to the postacute short-term rehabilitation program constitute an initial selection bias for studies conducted in rehabilitation settings: patients with good initial recovery in the acute care ward as well as those whose physical, cognitive, or functional status prevents them from following a rehabilitation program are excluded. In addition, patients who require a rehabilitation program longer than two weeks are usually sent to other intermediate care settings (14)(22). Therefore, the population is narrowly selected, by definition. It is not surprising that frailty and risk of malnutrition were present in all the sample, given that functional loss resulting from an acute recent process is one of the admission criteria in the postacute care unit. The MNA-SF has been validated for use in Spanish translation and has been recommended as a screening tool by the Spanish Geriatrics and Gerontology Society (20), but the use of the full MNA questionnaire might have improved specificity. On the other hand, malnutrition as defined by the ESPEN consensus is partially based on anthropometric measurements, such as height,

which can be challenging in patients who are unable to stand (12 patients, 13.6%) and require the substitution of knee height; furthermore, height measurement does not take into account possible kyphosis or vertebral osteoporotic degenerative changes (44). These factors might interfere with the accuracy of BMI, FFMI, basic definition of malnutrition, and sarcopenia or cachexia diagnosis. Finally, the relatively small sample size and the overlap between malnutrition and its related conditions should also be considered a potential study limitation.

The diagnostic criteria proposed by the Academy of Nutrition and Dietetics and American Society for Parenteral and Enteral Nutrition (AND/ASPEN) have also been shown to be a reliable tool in the assessment of malnutrition. Both ASPEN/AND and ESPEN criteria have their pros and cons. The categories of malnutrition and the approach to distinguishing the malnutrition context (acute illness or injury, chronic illness, and social or environmental circumstances) are strong points of the ASPEN/AND criteria; however, this is a complex tool using subjective assessment skills rather than objective body composition measures (45). Conversely, the ESPEN consensus definition is based on objective anthropometric measurements (BMI and FFMI), but some of them have limited availability in clinical settings and are overly restrictive. Further research is required in order to achieve a unified consensus suitable to all populations and settings worldwide (1)(40)(46)(47).

Conclusions

Malnutrition as defined by the ESPEN consensus could not predict functional status, institutionalization, readmissions, and mortality at 3 months after discharge from a

postacute care unit. In contrast, unintentional weight loss, i.e. one of the subscores of the consensus definition, was associated with an increased likelihood of postdischarge institutionalization, and sarcopenia was associated with poorer functional status at 3-month follow-up. Further research with larger samples, multicenter cohorts, and more extended follow-up is required to clarify the clinical value of diagnosing malnutrition using the ESPEN consensus and its ability to predict long-term adverse clinical outcomes.

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Conflict of interest

All authors declare they do not have any financial and personal relationships with other people or organizations that could inappropriately influence their work.

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Highlights

ESPEN consensus and guidelines were applied in a longitudinal follow-up after being discharged from a postacute geriatric care unit

ESPEN consensus could not identify older patients at risk of readmissions and mortality in older patients discharged from a postacute care unit

Further research with larger samples, multicenter cohorts, and more extended follow-up is required to clarify the clinical value of the ESPEN consensus to predict long-term adverse clinical outcomes.

Further research is needed on the potential prognostic value of the ESPEN consensus guidelines

Table 1. Clinical and functional characteristics of the study participants according to malnutrition as defined by the ESPEN consensus (n= 95).

	Total sample (n= 95)	Malnutrition (n= 19)	No malnutrition (n= 76)	p
Intrahospital variables				
Age (years)	84.5 (6.5)	84.3 (5.3)	84.6 (6.8)	0.479
Sex:				
• Male	35 (36.8%)	6 (31.6%)	29 (38.2%)	0.595
• Female	60 (63.2%)	13 (68.4%)	47 (61.8%)	
Body mass index (BMI, Kg/m^2)	25.5 (4.3)	21.7 (4.3)	26.3 (3.9)	**0.005**
Fat-free mass index (FFMI, Kg/m^2)	14.9 (2.9)	12.7 (1.7)	15.4 (2.9)	**0.007**
Fat-free mass (Kg)	38.4 (10.3)	32.4 (6.6)	39.7 (10.5)	**0.069**
Unintentional weight loss	31 (32.6%)	14 (73.7%)	17 (22.4%)	**<0.001**
Charlson comorbidity index	2.4 (1.8)	2.5 (2.2)	2.3 (1.7)	0.466
Short Portable Mental Status Questionnaire	4.2 (3.1)	5.1 (3.4)	4.0 (3.0)	0.265
Instrumental activities of daily living	2.6 (2.6)	2.5 (2.9)	2.6 (2.5)	0.577
Barthel index:				
• Prior	71.4 (21.6)	66.4 (25.3)	72.5 (20.8)	0.359
• At admission	27.0 (15.4)	19.1 (14.8)	28.7 (15.1)	0.057
• At discharge	54.3 (26.2)	38.9 (29.1)	57.7 (24.5)	**0.007**
Length of stay in postacute care unit (days)	14.9 (5.8)	18.3 (8.1)	14.1 (4.9)	**0.009**
Postdischarge variables at 3-month follow-up				
Barthel index	48.3 (30.6)	36.5 (27.7)	51.4 (30.7)	**0.055**
Institutionalization	**15 (15.8%)**	**6 (47.4%)**	**9 (11.8%)**	**0.035**
Readmissions	19 (20%)	3 (15.8%)	16 (21.1%)	0.608
Mortality postdischarge	13 (13.7%)	3 (15.8%)	10 (13.2%)	0.765

(*) Data are expressed as numbers and percentages for categorical variables, and as mean and standard deviation (SD) for continuous variables.

Table 2. Post-discharge clinical outcomesaccording to malnutrition and malnutrition-related syndromes at 3-month follow-up (n= 95).

	Malnutrition (ESPEN) (n= 19)	Sarcopenia (EWGSOP) (n= 44)	Frailty (Fried) (n= 94)	Cachexia (Evans) (n= 20)	Total sample (n= 95)
Barthel index	36.5 (27.7)	38.8 (28.2)	48 (30.6)	42.4 (29.0)	48.3 (30.6)
Institutionalization	6 (31.6%)	7 (15.9%)	15 (16.0%)	4 (20%)	15 (15.8%)
Readmissions	3 (15.8%)	8 (18.2%)	19 (20.2%)	3 (15%)	19 (20%)
Mortality	3 (15.8%)	5 (11.4%)	12 (12.8%)	2 (10%)	12 (12.6%)

(*) Data are expressed as numbers and percentages for categorical variables, and as mean and standard deviation (SD) for continuous variables. **List of abbreviations. ESPEN:** European Society of Clinical Nutrition and Metabolism; **EWGSOP:** European Working Group on Sarcopenia in Older People; **BMI:** Body mass index; **SD:** Standard deviation.

Table 3. Factors affecting **Barthel index at 3-month follow-up**, according to clinical characteristics, components of malnutrition as defined by the ESPEN consensus and nutrition-related conditions.

Barthel indexat 3-month follow-up				
	Univariate analysis		**Multivariate analysis**	
	Median difference (95%CI)	**p**	**Median difference (95%CI)**	**p**
Clinical characteristics				
Age	-2 (-3.50 to -0.50)	0.009	-2.19 (-7.28 to 2.89)	0.393
Sex	15 (-8.47 to 38.47)	0.208	**18.05 (-0.41 to 36.51)**	**0.055**
Comorbidity (Charlson >2)	0 (-6.21 to 6.21)	1.00	-2.19 (-7.28 to 2.89)	0.393
Unintentional weight loss	-12 (-34.91 to -10.91)	0.301	-5.29 (-29.28 to 18.69)	0.662
Malnutrition and nutrition-related conditions				
Malnutrition	-20 (-46.65 to 6.65)	0.139	-14.10 (-46.06 to 17.87)	0.383
Sarcopenia	**-25 (-43.22 to -6.78)**	**0.008**	**-25.49 (-46.66 to -4.32)**	**0.019**
Overweight-obesity	15 (-8.86 to 38.86)	0.215	0.24 (-20.58 to 21.07)	0.981
Nutrient deficiency	0 (-22.18 to 22.18)	1.000	12.93 (-5.31 to 31.17)	0.162
Cachexia	-15 (-41.65 to 11.65)	0.266	11.83 (-18.60 to 42.25)	0.441

Table 4. Factors affecting **institutionalization at 3-month follow-up**, according to clinical characteristics, components of malnutrition as defined by the ESPEN consensus and nutrition-related conditions.

Institutionalization at 3-month follow-up				
	Univariate analysis		**Multivariate analysis**	
	Odds ratio (95%CI)	**p**	**Odds ratio (95%CI)**	**p**
Clinical characteristics				
Age	1.08 (0.99 to 1.19)	0.083	**1.14 (1.01 to 1.28)**	**0.033**
Sex	**0.32 (0.10 to 1.0)**	**0.005**	**0.18 (0.04 to 0.72)**	**0.016**
Comorbidity (Charlson>2)	0.88 (0.63 to 1.22)	0.443	0.85 (0.58 to 1.25)	0.420
Unintentional weight loss	**3.95 (1.26 to 12.41)**	**0.018**	**5.46 (0.94 to 31.62)**	**0.058**
Malnutrition and nutrition-related conditions				
Malnutrition	**3.44 (1.04 to 11.31)**	**0.042**	3.69 (0.34 to 40.27)	0.285
Sarcopenia	1.02 (0.34 to 3.07)	0.976	1.51 (0.28 to 8.17)	0.629
Overweight-obesity	1.33 (0.42 to 4.27)	0.628	2.53 (0.49 to 13.15)	0.268
Nutrient deficiency	0.9 (0.29 to 2.78)	0.855	0.63 (0.16 to 2.50)	0.511
Cachexia	1.45 (0.41 to 5.17)	0.563	0.58 (0.05 to 6.30)	0.657

Table 5. Factors affecting **readmissions at 3-month follow-up,** according to clinical characteristics, components of malnutrition as defined by ESPEN consensusand nutrition-related conditions.

Readmissions at 3-month follow-up				
	Univariate analysis		Multivariate analysis	
	Odds ratio (95%CI)	p	Odds ratio (95%CI)	p
Clinical characteristics				
Age	0.93 (0.91 to 1.56)	0.074	0.93 (0.85 to 1.01)	0.095
Sex	1 (0.35 to 2.83)	1	1.09 (0.35 to 3.37)	0.879
Comorbidity (Charlson >2)	1.19 (0.91 to 1.56)	0.211	1.18 (0.88 to 1.59)	0.269
Unintentional weight loss	0.94 (0.32 to 2.77)	0.913	0.82 (0.19 to 3.47)	0.784
Malnutrition and nutrition-related conditions				
Malnutrition	0.70 (0.18 to 2.71)	0.609	0.91 (0.13 to 6.44)	0.929
Sarcopenia	0.81 (0.29 to 2.23)	0.681	1.03 (0.27 to 3.88)	0.964
Overweight-obesity	0.85 (0.30 to 2.36)	0.752	0.59 (0.17 to 2.07)	0.408
Nutrient deficiency	1.41 (0.48 to 4.12)	0.527	1.33 (0.42 to 4.17)	0.623
Cachexia	0.66 (0.17 to 2.50)	0.532	0.52 (0.08 to 3.58)	0.506

Table 6. Factors affecting **postdischarge mortality**, according to clinical characteristics, components of malnutrition as defined by the ESPEN consensus and nutrition-related conditions.

Postdischarge mortality				
	Univariate analysis		Multivariate analysis	
	Odds ratio (95%CI)	p	Odds ratio (95%CI)	p
Clinical characteristics				
Age	**1.05 (1.01 to 1.09)**	**0.005**	1.08 (1.03 to 1.13)	**0.001**
Sex	1.01 (0.61 to 1.69)	0.964	1.10 (0.65 to 1.87)	0.718
Comorbidity (Charlson>2)	1.11 (0.98 to 1.27)	0.105	**1.15 (1.0 to 1.33)**	**0.053**
Unintentional weight loss	1.10 (0.616 to 1.85)	0.711	1.20 (0.56 to 2.55)	0.641
Malnutrition and nutrition-related conditions				
Malnutrition	1.21 (0.67 to 2.18)	0.534	1.28 (0.52 to 3.11)	0.589
Sarcopenia	1.03 (0.63 to 1.69)	0.896	0.85 (0.44 to 1.63)	0.625
Overweight-obesity	1.04 (0.62 to 1.72)	0.889	1.09 (0.57 to 2.10)	0.788
Nutrient deficiency	1.07 (0.64 to 1.76)	0.800	1.13 (0.66 to 1.94)	0.654
Cachexia	0.98 (0.53 to 1.80)	0.940	0.88 (0.39 to 2.01)	0.772

Figure 1. Readmissions curves by malnutrition as defined by the ESPEN consensus

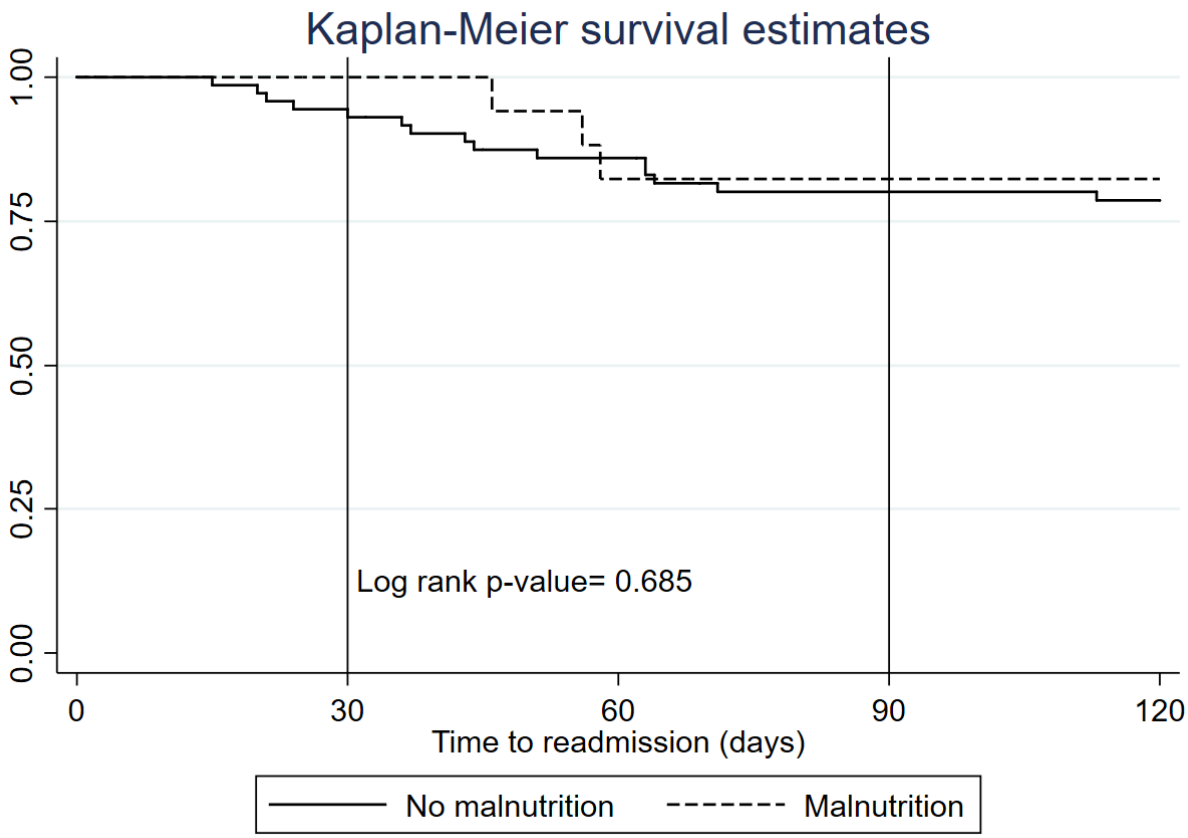
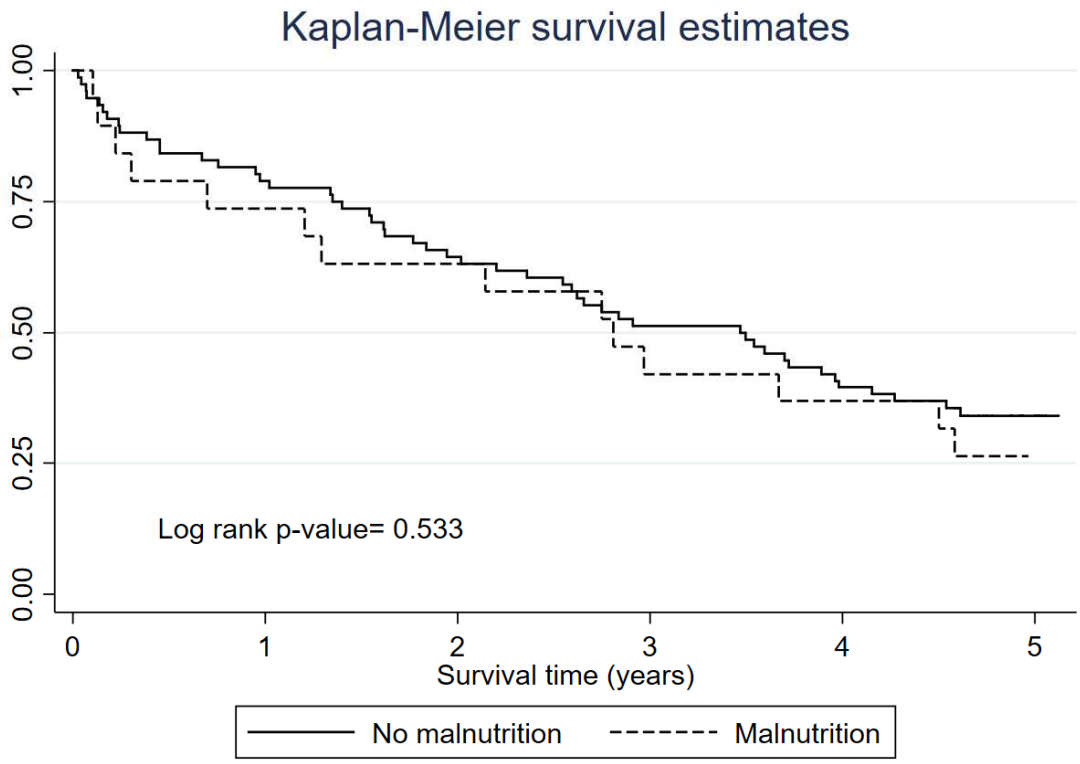


Figure 2. Survival curves by malnutrition as defined by the ESPEN consensus



STROBE Statement—Checklist of items that should be included in reports of *cohort studies*: **Prognostic value of the ESPEN consensus and guidelines for malnutrition: Prediction of post-discharge clinical outcomes in older inpatients**

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract (Title page, Abstract)
		Abstract
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found
		Abstract
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported
		Page1
Objectives	3	State specific objectives, including any prespecified hypotheses
		Page 2
Methods		
Study design	4	Present key elements of study design early in the paper
		Page 3
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection
		Page 3
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up
		Page 3
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed
		Not applicable: this was not a matched study
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable
		Pages 3-4: procedure and data collection Pages 4-6: variables and diagnostic criteria Page 4-6: outcome variables Exposures, predictors, potential confounders, and effect modifiers are not applicable to our study.

Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group Pages 5-6: calculation and cut-off points of outcomes measures; data source for all variables
Bias	9	Describe any efforts to address potential sources of bias Page 12, efforts to minimize errors and bias
Study size	10	Explain how the study size was arrived at Prospective cohort study of all inpatients admitted in postacute care during study period
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why Page 4-6: variables, cut-off points of main outcome variables Table 1, 2
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding Page 8-9, Statistical Methods paragraph
		(*b*) Describe any methods used to examine subgroups and interactions Pages 6-7
		(*c*) Explain how missing data were addressed Pages 13 (patients unable to stand)
		(*d*) If applicable, explain how loss to follow-up was addressed Not applicable
		(*e*) Describe any sensitivity analyses Not applicable
Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed Page 8, Table 1 and 2
		(b) Give reasons for non-participation at each stage Not applicable
		(c) Consider use of a flow diagram Not applicable
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders Page 8 and Tables 1 and 2

		(b) Indicate number of participants with missing data for each variable of interest Page 8 and Tables 1 and 2
		(c) Summarise follow-up time (eg, average and total amount) Page 3
Outcome data	15*	Report numbers of outcome events or summary measures over time Page 8 and Tables 1 and 2
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included Page 8 and Tables 1 to 6, includes 95% confidence interval
		(*b*) Report category boundaries when continuous variables were categorized Pages 8
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period Not applicable
Other analyses	17	Report other analyses done—e.g. analyses of subgroups and interactions, and sensitivity analyses Page 8, Tables 3 to 6
Discussion		
Key results	18	Summarise key results with reference to study objectives Pages 10 (discussion of results) and 13 (Conclusion)
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias Page 12
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence Pages 12-13.
Generalisability	21	Discuss the generalisability (external validity) of the study results Page 12-13
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based Page 15: No internal or external funding was received to support this research.

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.