Nutrición Hospitalaria

Nutr Hosp. 2012;27(4):1049-1059
ISSN 0212-1611 • CODEN NUHOEQ
S.V.R. 318

Original

Prevalence and costs of malnutrition in hospitalized patients; the PREDyCES® Study

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Abstract

Background and aims: The main objective of the PREDyCES® study was twofold. First, to analyse the prevalence of hospital malnutrition in Spain, both at admission and at discharge, and second, to estimate the hospital costs associated with disease-related malnutrition.

***Methods:* The study was a nationwide, cross-sectional, observational, multicentre study in routine clinical practice, which assessed the prevalence of hospital malnutrition both at patient admission and discharge using NRS-2002®. A study extension analysed the incidence of complications associated with malnutrition, excess hospital stay and healthcare costs associated with hospital malnutrition.**

***Results:* Malnutrition was observed in 23.7% of patients according to NRS-2002®. Multivariate analysis revealed that age, gender, presence of malignant disease, diabetes mellitus, dysphagia and polymedication were the main factors associated with the presence of malnutrition. Malnutrition was associated with an increase in length of hospital stay, especially in patients admitted without malnutrition but who presented malnutrition at discharge (15.2 *vs.* 8.0 days, p < 0.001), with an associated additional cost of €5,829 per patient.**

***Conclusion:* In Spanish hospitals, almost one in four patients is malnourished. This condition is associated with increased length of hospital stay and associated costs, especially in patients developing malnutrition during hospitalization. Systematic screening for malnutrition should be generalised in order to implement nutritional interventions with well-known effectiveness.**

(*Nutr Hosp.* 2012;27:1049-1059)

DOI:10.3305/nh.2012.27.4.5986

Key words: *Hospital malnutrition. Prevalence. Hospital setting. Nutritional assessment. Costs.*

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Recibido: 19-V-2012.
Aceptado: 23-V-2012.

PREVALENCIA Y COSTES DE LA MALNUTRICIÓN EN PACIENTES HOSPITALIZADOS; ESTUDIO PREDyCES®

Resumen

***Justificación y objetivos:* El estudio PREDyCES® tuvo dos objetivos principales. Primero, analizar la prevalencia de desnutrición hospitalaria (DH) en España tanto al ingreso como al alta, y segundo, estimar sus costes asociados.**

***Métodos:* Estudio nacional, transversal, observacional, multicéntrico, en condiciones de práctica clínica habitual que evaluó la presencia de desnutrición hospitalaria al ingreso y al alta mediante el NRS-2002®. Una extensión del estudio analizó la incidencia de complicaciones asociadas a la desnutrición, el exceso de estancia hospitalaria y los costes sanitarios asociados a la DH.**

***Resultados:* La prevalencia de desnutrición observada según el NRS-2002® fue del 23.7%. El análisis multivariante mostró que la edad, el género, la presencia de enfermedad oncológica, diabetes mellitus, disfagia y la polimedicación fueron los factores principales que se asociaron a la presencia de desnutrición. La DH se asoció a un incremento de la estancia hospitalaria, especialmente en aquellos pacientes que ingresaron sin desnutrición y que presentaron desnutrición al alta (15.2 *vs* 8.0 días; p < 0.001), con un coste adicional asociado de 5.829€ por paciente.**

***Conclusiones:* Uno de cada cuatro pacientes en los hospitales españoles se encuentra desnutrido. Esta condición se asocia a un exceso de estancia hospitalaria y costes asociados, especialmente en pacientes que se desnutren durante su hospitalización. Se debería generalizar el cribado nutricional sistemático con el objetivo de implementar intervenciones nutricionales de conocida eficacia.**

(*Nutr Hosp.* 2012;27:1049-1059)

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Palabras clave: *Malnutrición hospitalaria. Prevalencia. Contexto hospitalario. Evaluación nutricional. Costes.*

Background and aims

Malnutrition is a medical condition caused by nutrients deficiency because of a diminished intake, an increase in losses or increased requirements. In developed countries, malnutrition usually occurs as a result of changes in the population's eating habits or disease, and is a particular problem among hospitalized patients. There are many reasons behind hospital malnutrition, among them the disease itself; certain diagnostic and therapeutic procedures; little knowledge and interest in patients' nutritional status by the healthcare staff; and the lack of strategies to avoid periods of fasting, identify patients at risk of malnutrition, periodically reassess the presence of risk on an individual basis and, when necessary, institute preventive measures and treatment.[1]

There is no universally accepted definition for disease-related malnutrition, despite numerous attempts made by different authors using elements related to clinical and biochemical expression,[2] functional status[3], or the aetiopathogenic concept of the problem as drawn up more recently by the *ad hoc* International Committee ASPEN-ESPEN (The American Society for Parenteral and Enteral Nutrition-The European Society for Clinical Nutrition and Metabolism).[4] Nevertheless, in spite of these difficulties, on June 11th 2009, representatives of the Ministries of Health of the EU Member States, the Czech presidency of the EU, medical experts, representatives of national health services and health insurance groups, ESPEN and ENHA (the European Nutritional Health Alliance) signed the Prague Declaration and arrived at the unanimous conclusion that malnutrition, including disease-related malnutrition, is an urgent public health and healthcare problem in Europe. They also stressed that suitable measures must be taken to prevent malnutrition because of its continuous compromising effect on patient quality of life, unnecessary morbidity and mortality associated, and the fact that it will continue to undermine the efficacy of European health services.[5] These actions were to be integrated into the EU Health Strategy 2008-2013,[6] and feature constantly in the recommendations urged by the Council of Europe resolution Food and Nutritional Care in Hospitals enacted by the Committee of Ministers in 2003.[7]

Previously reported prevalence of disease-related hospital malnutrition ranges from 20-50%.[8-10] The EuroOOPS Study assessed 5,051 patients admitted to European hospitals using the NRS-2002® (Nutritional Risk Screening 2002) screening tool and found 32.6% of patients at risk of malnutrition. It is acknowledged that the first step in prevention and treatment of patients who are undernourished and those at risk of malnutrition is the use of screening tools.[11]

The economic implications of malnutrition are also considerable. Hospital malnutrition is associated with delayed recovery, higher rates of morbidity and mortality, prolonged hospital stay and both increased healthcare costs and a higher early re-admission rate.[12-14] It is recognised that nutritional interventions as oral nutritional supplementation (ONS), in surgical and non-surgical hospitalized patients at medium or high risk of malnutrition, are associated with reductions in length of hospital stay (LOS), reduced bed-day costs, and complication costs compared to patients who receive no ONS.[15] Other publications also confirm the economic impact of having nutritional support teams for hospitalized patients in terms of preventing malnutrition-related complications, reducing LOS and saving in costs.[16-19]

In Spain, studies have shown that prevalence of malnutrition in hospitalized patients ranges from 30-50%,[14,20-22] with increasing rates among patients with longer in-stays. However, these studies refer to limited geographical areas and therefore the real extent of the problem in Spain remains unknown, either from a health (prevalence) or an economic point of view.

In December 2008, the Spanish Ministry for Health and Social Policy consulted the Health Economics Association before drawing up the Pact for Health. Their report underlines the fact that most of the ideas behind implementing policies in areas such as quality and innovation or public health are formed on the basis of partial, local and fragmented studies.[23] With this study, the Spanish Society for Enteral and Parenteral Nutrition (SENPE) therefore aimed to provide the Spanish National Health System with relevant information about the prevalence of hospital malnutrition in Spain and how it is distributed among the different care areas, both at admission and discharge, as well as to estimate associated costs.

Material and methods

This was a nationwide, cross-sectional, observational, multicentre study, in routine clinical practice, which evaluated the prevalence of hospital malnutrition using the NRS-2002® screening test, both on patient admission and at discharge. An extension of this study analysed the excess in-hospital stay and financial cost associated with hospital malnutrition in a subsample of patients. A detailed description of the design, methods and development of the study is provided elsewhere.[24]

Randomized selection of centres was performed among all Spanish public hospitals with general, orthopedic, rehabilitating, geriatric or long-stay purpose and according to geographical distribution and hospital size criteria ensuring they were representative of hospitals included in the Spanish public health system. 50 hospitals were invited to participate in the study and 31 accepted and included patients (fig. 1). From April to September 2009, all patients who met inclusion criteria and none of the exclusion criteria were included in a consecutive manner after informed consent was signed, during monitoring visit days for each hospital.

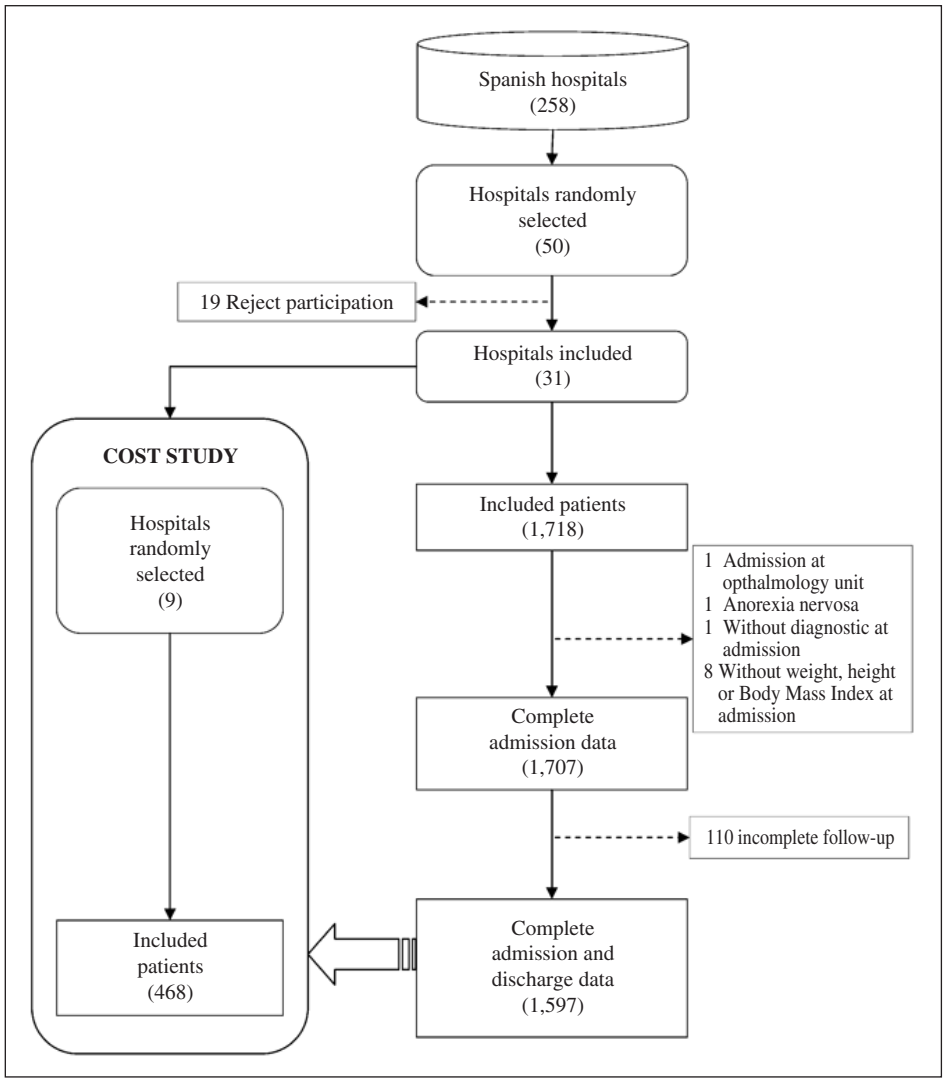

Fig. 1.—Centres and patients recruitment flow-chart for the main prevalence study and cost sub-study.

Patients were eligible if aged 18 years or older, and recruitment was performed before 48 hours after admission. Criteria for patients exclusion were: pregnancy; direct admission to units as intensive care (ICU), obstetrics, dermatology, ophthalmology, short-stay unit, paediatrics, emergency, palliative care, burned unit, psychiatry and an eating disorders unit; patients not willing to participate or with manifest difficulties to understand written language; patients with an expected LOS less than 48 hours; patients with eating disorders according to DSM-IV definition or admitted for a weight loss procedure. 1,718 patients were included in the study. At data analysis, 11 patients were excluded for several reasons, so there were 1,707 patients with complete admission data and analyzed. 110 patients had incomplete follow up data, so 1,597 had complete admission and discharge data, and were analyzed (fig. 1).

Socio-demographic data were obtained for all patients included and nutritional status was assessed using the NRS-2002® screening test within 48 hours of admission and at the time of discharge (or 28 days after admission if discharge was later). For all patients, up to six diagnoses (diseases and health related problems) were recorded at admission according to ICD-9, and were analyzed separately and grouped by diagnostic categories. Sample size was estimated based on hospital malnutrition prevalence rates in local studies previously carried out in Spain (23-55%).[14,20-22] Assuming a 2.75% precision and 5% significance, a sample of 1,252 patients was required. Estimating a 25% loss to follow-up and/or invalid case report forms, final sample was estimated at 1,700 patients.

The study was conducted in accordance to principles of the Declaration of Helsinki and the ICH Harmonised Tripartite Guideline for Good Clinical Practice (1996). Study was approved by the Hospital Universitario de La Paz Ethical Committee (EC) and all participating centres ECs' were informed.

Statistical analysis was carried out with SPSS® 15.0 for Windows (SPSS Inc., Illinois, United States). Arithmetic means and standard deviations were chosen to describe

quantitative variables and frequency and percentage of patients in each category to describe qualitative variables. A logistic regression model was applied to clinically relevant parameters at admission in order to analyze which variables affected prevalence of malnutrition in a multivariate form. Selection of variables to be included in the model was done after analysis of data according to the forward method based on maximum likeliness and the Bayesian Information Criterion. Univariate analysis is expressed as odds-ratio non-adjusted (table V). Statistical significance was established at 0.05.

Cost sub-study

An extension to the study was conducted in order to specifically analyse the excess time in-hospital and the economic impact associated with hospital malnutrition. Before starting recruitment, 9 centres (from the accepting 31) were randomly selected to participate in the cost sub-study. This sub-study was a case-control study nested within a prospective cohort of patients (those included in the main prevalence study). All patients included in the selected centres (468) were considered for this sub-study. Inclusion and exclusion criteria were the same as in the main study (fig. 1). Patients directly admitted to the ICU were excluded, but if after admission and during hospitalization patients were transferred for at least 1 day to the ICU, the stay was recorded for cost analysis purposes. Cases were patients who had hospital malnutrition at admission, while controls were patients without hospital malnutrition at admission. In addition to data collected for the main analysis, for patients included in the cost sub-study, the occurrence of pressure ulcers, infectious and non-infectious complications were registered. Also was registered, use and type of nutritional intervention, number of days spent in ICU and on speciality wards. These variables were registered at discharge (or 28 days after admission if discharge was later). Costs attributable to hospital malnutrition were defined as the difference in costs between patients with and without hospital malnutrition and were based on the results of the study. Unit costs were derived from mean costs per hospitalisation day and service provided by the Ministry of Health and Consumer Affairs.

Results

1,707 patients were included and analysed at admission. Of these, 1,597 cases were analysed at discharge, for which complete information was obtained (fig. 1).

At admission

54% (918/1,707) of all patients included were male, with a mean age of 63 years old. 55% (938/1,707) of all patients included were ≥ 65 years old. Most patients had completed primary education, lived in their own home with their partner or family and were pensioners. Only 25% (431/1,707) of the participants were actively working. Distribution of patients according to hospital size, in-hospital admission service and most common medical conditions at admission are presented in table I.

Table I
Distribution of patients at admission according to hospital size, department and major diagnostic categories

	At admission (n: 1,707) % (n)
Hospital size	
Large-size hospitals (> 500 beds)	62.2 (1,062)
Medium-size hospitals (200-500 beds)	29.5 (504)
Small-size hospitals (< 200 beds)	8.3 (141)
Hospital admission type	
Emergency	71.2 (1,215)
Planned	28.8 (492)
Department	
Internal Medicine	20.1 (343)
General Surgery	19.0 (325)
Traumatology	16.0 (273)
Cardiology	9.3 (158)
Other departments	35.7 (608)
Medical condition	
Circulatory system	17.2 (293)
Cancer	17.2 (292)
Digestive system	16.2 (276)
Injuries and poisonings	10.6 (181)
Respiratory system	9.0 (153)
Genitourinary system	7.9 (134)
Musculoskeletal system	6.1 (104)
Central nervous system	2.8 (48)
Endocrine and metabolic system	2.6 (45)

At admission, overall mean weight was 68.4 kg (standard deviation ±17.0), mean height 164.3 cm ± 9.36 and mean Body Mass Index (BMI) 25.35 kg/m^2 ± 6.05. In 11.4% (194/1,707) of all patients the BMI was below 18.5 kg/m^2.

Regarding assessment of nutritional status by means of the NRS-2002®, 61.8% (1,055/1,707) of patients included responded affirmatively to at least one of the pre-screening questions, so NRS-2002® final assessment was required. Of these, 37.3% (393/1,055) of patients scored positive for malnutrition (NRS-2002® > 3) and were considered to be malnourished, which represents 23% (393/1,707) of all patients at admission. When analysing prevalence of malnutrition according to age, gender and type of hospital admission, it was observed a significantly greater nutritional risk for elderly patients (aged ≥ 70) with respect to the rest (aged < 70), women with respect to men, and those admitted as emergencies also higher than those whose

Table II
Prevalence of malnutrition (NRS 2002®) according to patients' characteristics and primary admitting department

	Prevalence of malnutrition at admission		*Prevale of malnutrition at discharge*	
	%	*p*	*%*	*p*
Gender				
Females	25.7% (586/789)	< 0.001	25.76% (187/726)	< 0.05
Males	20.7% (190/917)		21.41% (182/850)	
Age				
≥ 70 years	37.0% (274/741)	< 0.001	38.08% (262/688)	< 0.001
< 70 years	12.3% (119/965)		12.0% (107/888)	
Type of admission				
Emergency	25.6% (311/1,214)	< 0.001		
Planned	16.7% (82/492)			
Department at admission/discharge				
Medical	29.27% (245/837)	< 0.001	27.4% (208/759)	< 0.001
Surgical	17.03% (148/869)		19.71% (161/817)	

hospital admission was programmed. Malnutrition prevalence rate was higher in patients admitted to medical departments than in those admitted to surgical departments (table II). Prevalence of malnutrition according to age groups is represented in figure 2.

Malnourished patients were, on average, 10 years older ($p < 0.001$), had a mean weight of 58.5 kg (almost 13 kilos less, $p < 0.001$) and a BMI 4 points lower than those who were not malnourished ($p < 0.001$). Brachial and calf circumferences were significantly smaller than those of well-nourished patients ($p < 0.001$). Clinical chemistry results showed serum albumin and lymphocyte counts to be significantly lower than in patients not at nutritional risk ($p < 0.001$) (table III).

Clinical conditions significantly associated at admission with a higher prevalence of malnutrition were dysphagia (42.6%-150/352-; $p < 0.001$), neurological pathologies (36.5%-31/85-; $p = 0.003$), cancer (33.9%-136/401-; $p < 0.001$), diabetes (30.1%-116/386-; $p < 0.001$) and cardiovascular disease (28.3%-229/808-; $p < 0.001$). A high prevalence of malnutrition was observed specifically in patients with degenerative neurological diseases (Alzheimer's, Parkinson's, etc.) (42%-21/50-; $p = 0.001$), and in patients with heart failure (42.1%-32/76-; $p < 0.001$). Moreover, after discriminating oncology patients according to affected organs or systems, a higher prevalence of malnutrition was observed in those with upper digestive tract cancer (oesophageal/gastric) (47.4%-9/19-; $p = 0.023$), with pancreas, liver or biliary system tumours (45.0%-9/20-; $p = 0.029$), with respiratory system tumours (42.9%-18/42-; $p = 0.002$), with lower digestive tract cancer (39.1%-36/92-; $p < 0.001$) and with hematologic cancers (36.8%-25/68-; $p = 0.006$).

Polymedicated patients (report of using ≥ 7 drugs in patients ≤ 65 years old; or ≥ 5 drugs in patients ≥ 65

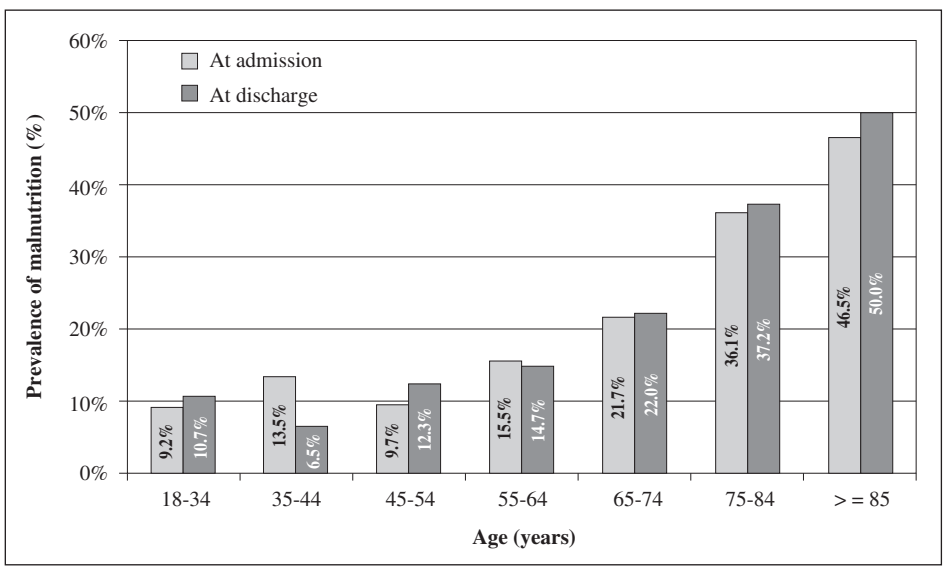

Fig. 2.— Prevalence of malnutrition according to age group.

Table III
Characteristics of the patients according to their nutritional status

	At admission (n: 1,707)			At discharge (n: 1,597)		
	Malnourished	Non-malnourished	p-value	Malnourished	Non-malnourished	p-value
	Mean ± SD	Mean ± SD		Mean ± SD	Mean ± SD	
Age (years)	71.4 ± 15.13	60.89 ± 17.2	< 0.001	72.1 ± 14.82	60.7 ± 17.19	< 0.001
Weight (kg)	58.5 ± 15.47	71.3 ± 16.33	< 0.001	58.4 ± 16.41	70.1 ± 16.07	< 0.001
Height (cm)	162.3 ± 9.26	164.9 ± 9.32	< 0.001	162.3 ± 8.79	165 ± 9.55	< 0.001
BMI (kg/m2)	22.31 ± 6.20	26.25 ± 5.70	< 0.001	22.3 ± 6.33	25.8 ± 5.69	< 0.001
BC (cm)	27.1 ± 4.72	29.5 ± 4.37	< 0.001	26.8 ± 4.48	29.1 ± 4.48	< 0.001
CC (cm)	32.5 ± 5.23	35.9 ± 6.06	< 0.001	32.7 ± 5.71	35.5 ± 5.91	< 0.001
Albumin (g/dl)	3.26 ± 0.68	3.72 ± 0.71	< 0.001	3.10 ± 0.65	3.65 ± 0.67	< 0.001
LC (cells/ml)	1,443 ± 1,154	1,756 ± 1,150	< 0.001	1,534 ± 1,106	1,703 ± 846	< 0.05

BC: Braquial circumference; CC: Calf circumference; LC: Lymphocyte count.

years old at admission), doubled the prevalence of malnutrition compared to non-polymedicated patients (33.6%-256/763-; p < 0.001). Non-polymedicated patients were considered those reporting the use of < 7 drugs in patients ≤ 65 years old; or < 5 drugs in patients ≥ 65 years old at admission.

At discharge

Average hospital stay was 8.9 days ± 6.1 for men and women and all age groups, with a raising tendency of the mean LOS observed as age increased. During hospitalization, 13% (194/1,491) of patients gained at least 1 kg in weight, 48% (712/1,491) maintained the same weight (± 1 kg) and 39% (585/1,491) lost more than 1 kg. 13.3% (197/1,491) of the patients had a BMI below 18.5, with a mean drop of 0.45 points with respect to admission (p < 0.001).

Regarding nutritional status assessment, 66.7% (1,051/1,576) of all patients had to undertake the NRS-2002® final assessment. 35.1% (369/1,051) of patients pre-screened positive were malnourished (NRS-2002® score ≥ 3), which represents 23.4% (369/1,576) of all patients analysed at discharge. As at admission, elderly patients (aged ≥ 70) and women presented significantly higher nutritional risk than those aged < 70 or men, respectively (table II).

Patients at nutritional risk were, on average, 11 years older and their weight, BMI, brachial and calf circumferences, serum albumin and lymphocyte count were significantly lower than those not malnourished (table III).

Conditions which showed significant association with a higher prevalence of malnutrition at discharge were: dysphagia (42.2%-136/322-; p < 0.001), cancer (36.4%-135/371-; p < 0.001), diabetes (29.3%-105/358-; p < 0.001) and cardiovascular disease (28.9%-211/729-; p < 0.001). The prevalence of malnutrition in polymedicated patients at discharge was 14.3% higher than in non-polymedicated patients (34.3%-149/435-; p < 0.001).

14.3% (225/1,574) of all patients analysed at discharge received some type of nutritional support during hospitalization, representing 29.5% (109/369) of malnourished patients at discharge and 27.7% (109/393) of all malnourished patients at admission.

Changes in nutritional status during hospital stay

9.6% (118/1,225) of patients that showed no nutritional risk at admission developed malnutrition during hospitalization, and 72% (252/351) of patients who were malnourished at admission remained malnourished at discharge (table IV). Mean hospital stay was significantly longer in malnourished patients respect to non-malnourished patients, at admission 11.5 ± 7.5 days *vs.* 8.5 ± 5.8 days (p < 0.001) and at discharge 12.5 ± 8.0 days *vs.* 8.3 ± 5.5 days (p < 0.001). A clear relationship was observed between a change in the nutritional status during hospitalization and the LOS, 8.0 ± 5.2 in-days in patients who were admitted and remained non-malnourished compared to 15.2 ± 9.2 in-days in those non-malnourished at admission but who were malnourished at discharge. No statistical significant differences were found in LOS between patients who were malnourished at

Table IV
Evolution during hospitalization of patients' nutritional status

	At discharge		
	Non-malnourished	Malnourished	Total
At admission			
Non-malnourished	90.4% (1,108)	9.6% (117)	1,225 (100%)
Malnourished	28.2% (99)	71.8% (252)	351 (100%)
Total	76.6% (1,207)	23.4% (369)	1,576* (100%)

*Total patients with available data at both at admission and discharge (110 missing cases).

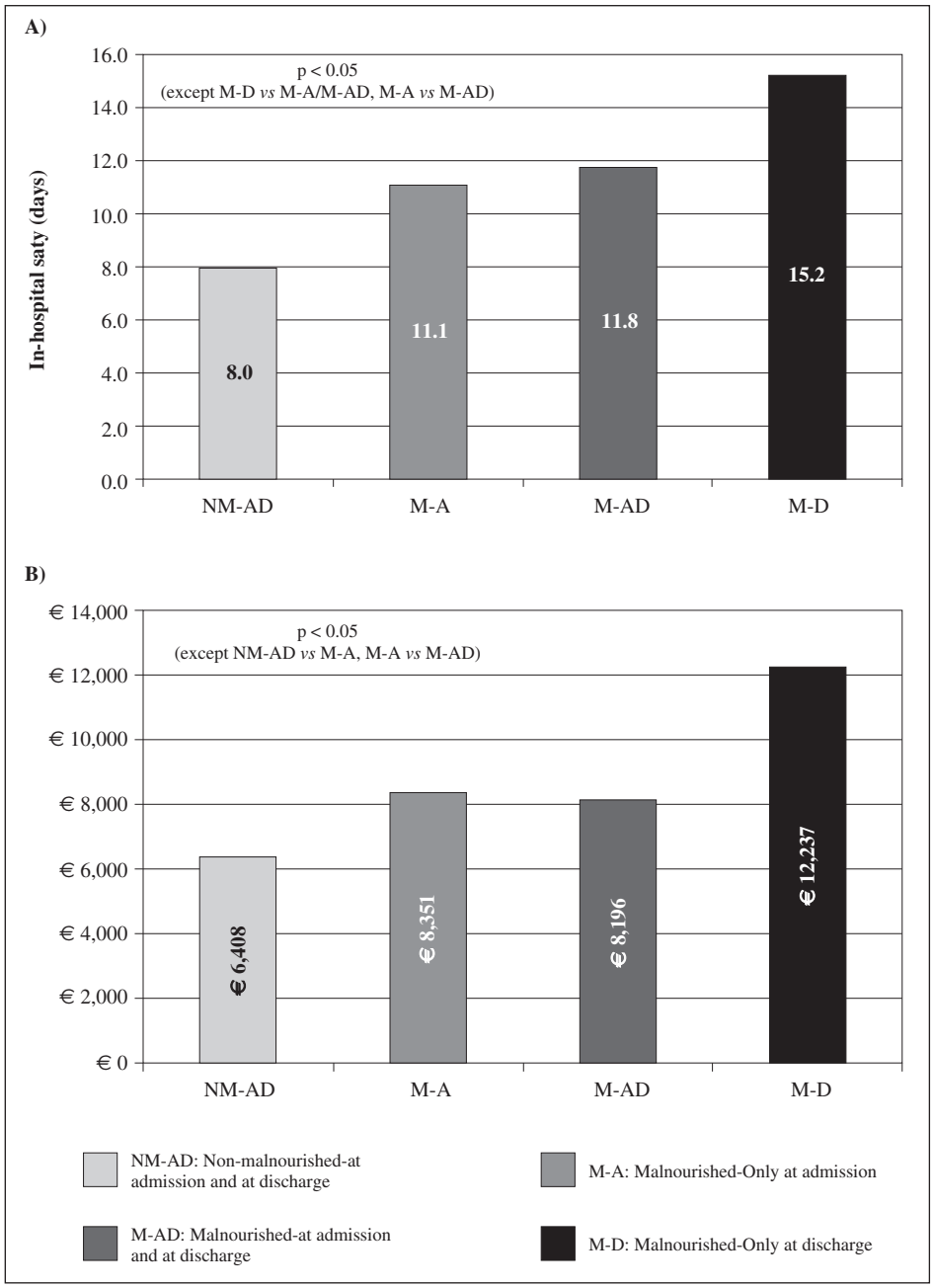

Fig. 3.— In-hospital days and costs related to malnutrition status during hospitalization. A) In-hospital days according to malnutrition status. B) Costs-related to hospitalization according to malnutrition status.

admission and those malnourished both at admission and at discharge (fig. 3).

Multivariate analysis

Logistic model revealed low BMI (< 18.5), being aged 70 or over, diagnosis of neoplasia, or diabetes, referral of dysphagia, and high consumption of medicines or alcohol, to have a greater influence on a higher risk of malnutrition at admission (table V). Although it is recognised that the patient's weight in itself is not a sufficient marker to determine malnutrition, after adjusting for the BMI range, it was observed that for each additional kilogram of body weight at admission the risk of malnutrition was reduced by 3%.

Cost sub-study

The cost sub-study sample (468 patients) had clinical and sociodemographic characteristics comparable to those of the main study sample. A slight difference was observed in the proportion of patients admitted to surgical departments compared to the main analysis (57%-270/471- *vs.* 51%-869/1,706-, p: 0.014).

The prevalence of malnutrition was also similar to that observed in the main study, with values of 24.4%

Table V
Factors associated to malnutrition (logistic regression model). Univariate analysis expressed as Odds ratio non-ajusted

Factors	*Odds ratio (95% CI)*	*p-value*	*Odds ratio non-adjusted (95% CI)*	*p-value*
BMI				
< 15 *vs.* 20-24	8.89 (3.56-22.24)	< 0.001	16.25 (7.73-34.15)	< 0.001
15-18.5 *vs.* 20-24	1.71 (1.03-2.84)	0.038	2.98 (2.03-4.39)	< 0.001
18.5-20 *vs.* 20-24	1.68 (0.99-2.83)	0.053	1.90 (1.22-2.97)	0.005
25-29 *vs.* 20-24	0.64 (0.44-0.94)	0.023	0.52 (0.38-0.71)	< 0.001
≥ 30 *vs.* 20-24	1.08 (0.60-1.96)	NS	0.46 (0.31-0.68)	< 0.001
Weight	0.97 (0.95-0.99)	0.001	0.95 (0.94-0.954)	0.001
Age				
≥ 70 years old	3.47 (2.55-4.71)	< 0.001	4.17 (3.27-5.32)	< 0.001
Prior risk factors				
Polymedicated*	1.86 (1.38-2.51)	< 0.001	2.97 (2.35-3.76)	< 0.001
Risk for alcoholism: medium/high	3.29 (1.78-6.07)	< 0.001	1.67 (0.99-2.81)	NS
Risk for Drug Abuse: sporadic/regular	1.98 (1.38-2.85)	< 0.001	2.25 (1.66-3.05)	< 0.001
Diagnostic				
Cancer (all types)	2.89 (2.14-3.90)	< 0.001	2.09 (1.63-2.68)	< 0.001
Dysphagia	1.85 (1.38-2.50)	0.002	3.39 (2.64-4.37)	< 0.001
Diabetes	1.40 (1.03-1.92)	0.032	1.62 (1.25-2.09)	< 0.001
Constant	0.36			

NS: Non-significant.
*Polymedicated patients report of using ≥ 7 drugs in patients ≤ 65 years old; or ≥ 5 drugs in patients ≥ 65 years old at admission.

(115/471) at admission and 22.6% (104/460) at discharge. Of all malnourished patients, 25% (28/114) received oral nutritional supplementation, 5% (6/114) enteral and 8% (9/114) parenteral nutrition, while 9% (31/354) of non-malnourished patients received supplementation, 3% (11/354) enteral nutrition and 1% (5/354) parenteral nutrition. The incidence of complications was higher in patients with malnutrition than in those without, although no statistically significant differences where found (12.3%-14/114- *vs.* 7.6%-27/354- p; NS). As seen above, mean hospital stay was significantly longer for patients with malnutrition respect to those without malnutrition. In economic terms, differences in LOS translated into higher costs associated with patients malnourished at admission (€ 8,207 for patients malnourished at admission *vs.* € 6,798 for patients not malnourished at admission; $p < 0.05$), with a mean difference of € 1,409 ($p = 0.015$). The most outstanding difference was observed between those patients not presenting with malnutrition at any time and those who were non-malnourished at admission but were malnourished at discharge (€ 6,408 *vs.* € 12,237; $p < 0.001$) (fig. 3).

Discussion

In Spain, clinical practice towards malnutrition is improvable. As clinicians, and knowing this fact, emerged the idea of showing Spanish health authorities the extent of the problem (prevalence) and the economic impact for our health system (cost sub-study). This is the first Spanish nationwide study to show a snapshot of the real and overall state of hospital malnutrition, with data obtained from hospitals of all sizes with or without nutrition units. It is an observational study intended to understand hospital malnutrition in usual clinical practice. It confirms that hospital malnutrition prevalence also is high in our hospitals and even higher in patients over 70 years old. Still more serious is the fact that overall prevalence remains unchanged at discharge, observing a slight drop in patients aged ≥ 70.

Patients with low BMI (< 18.5), being aged 70 or over, with a diagnosis of neoplasia, diabetes, referring dysphagia and high consumption of medicines or alcohol seem to have a higher risk of malnutrition at admission. The logistic multivariate analysis showed that after all other variables are controlled the risk of malnutrition is lower in patients with higher weight. Our analysis does not detect a relationship between weight and prognosis.

The high prevalence of disease-related hospital malnutrition in Spain has been shown before by other multicentre studies, with figures between 24% in Castilla y León[20] and 47% in Galicia.[22] The wide difference between these results, while obtained in well-designed studies analysing representative samples of patients in their respective geographical areas, is probably due to the fact that different methods for diagnosing malnutrition were used. At our knowledge, after the international EuroOOPS study,[11] PREDyCES® is

the first study to use the NRS-2002® questionnaire as the main tool for identifying malnutrition in a nationwide study. Our results are also consistent with similar recently-published studies carried out in Europe.[25-29]

The cost subanalysis carried out in the PREDyCES® study confirmed the excess LOS associated with malnutrition and its financial consequences to the health system. According to the Spanish Ministry of Health reports, mean LOS in 2009 was 7.31 days. If the same wards excluded in our study are left out from these data (paediatrics, ophthalmology, etc.), mean LOS in Spain rises to 8.3 days. Since our study does not include hospital stays less than 48 hours, our estimates and confidence interval includes Spanish official 8.3 days of LOS. Of particular interest is the 7-day increase in the length of hospitalization in patients who developed malnutrition during in-stay respect to those who were not malnourished at any time. This is especially relevant considering that it affected nearly 10% of all study population and led to an extra cost of approximately € 6,000 per patient. The association of malnutrition and increased hospital costs is consistent with the results of other national and international studies[8,10,12-14]. Norman et al. estimated the difference in LOS between malnourished patients and those without malnutrition in 17.2 days *vs.* 9.7 days, and as a consequence, the highlighted impact it exerts over hospital costs.[8]

Our study has revealed that one in every four patients admitted to our hospitals is at risk of malnutrition which is also associated with significant extra costs for the health system. Also, even though in-hospital nutritional interventions have demonstrated to be cost-saving, less than a third of undernourished inpatients received nutritional support. In light of our results it could be said that the quality of nutritional care received and, in consequence, the safety of some of our patients while in-hospital may be compromised in a considerable number of cases. Hospitals' shortages in actions to thwart malnutrition arise in extended LOS and associated costs. Hospital healthcare should be made responsible for patients malnourished during hospitalization and for not taking enough care of those malnourished at admission and avoiding further deterioration.

Limitations to our study should be mentioned. Although it was a purely observational study, the exhaustive recording of variables related to patients' nutritional status might have resulted in some change in the nutritional care received by them. Nevertheless, any effects of this "observer bias" might have affected the patients' status at discharge, but its effects on the primary endpoint of the study (prevalence of malnutrition at admission) would be minimal. In the cost subs-study, even though clinicians knew that our "cases" were malnourished; this piece of information didn't affect the exposure measure, demonstrated by the fact that the majority of malnourished patients at admission remained so at discharge, while others became malnourished during hospitalization. It should also be pointed out that the difference in the incidence of complications observed in the cost sub-study between patients with and without malnutrition was not statistically significant, probably because of the size of the sub-sample studied, which was not defined with this objective in mind. Even so, the relationship between complications, LOS and costs in our study is consistent with that observed in other similar studies.[8,10,12-14] Finally, it is possible that, although specific for each hospital department, the use of an average cost per hospital stay underestimates the extra cost associated with malnutrition, since it is unable to reflect a more intensive use of resources during hospitalization (not only extent of length) which patients with malnutrition probably require. A more detailed analysis of this cost sub-study is underway in order to determine this and other specific aspects of the financial repercussions of malnutrition in our study.

Given the high prevalence of malnutrition and its repercussions in patient morbidity-mortality and healthcare costs, nutritional screening measures must be placed as a first step in an integrated nutritional care plan for patients while in hospital.[30] Up to now, this measure has not been applied, either in the majority of hospitals in Europe or in Spanish hospitals.

Our findings support the recommendation of ESPEN Guidelines on mutritional assessment.[30] Early and periodical nutritional assessment has to be carried out in order to identify malnourished patients in clinical practice who, if not given the right care, will be at greater risk of suffering disease or treatment-related complications. It is also necessary to diagnose the degree of malnutrition and associate it with the need for nutritional therapy and its intensity, since outcome may be improved and resources consumption may be reduced (LOS and other prescriptions). One added difficulty is that there is still no universally accepted nutritional assessment method. In its 2002 guidelines ASPEN recommends using the Subjective Global Assessment, while ESPEN, also in its 2002 guidelines, recommends the use of the NRS-2002® as a tool to assess nutritional status in hospitalized patients.[30] If we are to achieve uniformity in the protocols for care in routine clinical practice, as well as the correct interpretation and comparison of the results of clinical trials conducted to evaluate the efficacy of nutritional support treatments, unification is of vital importance.

Finally, it is accepted that there is mutual influence of disease and undernutrition. In recent guidelines the term "disease-related malnutrition" has been proposed.[4] Clinicians should aim to correct the primary disorder and try to give nutrition support to overcome the diminished intake, or the increased requirements and losses of nutrients seen in admitted patients.

SENPE included this study as part of the national implementation of the Fight Against Malnutrition: Action Plan, within the package of activities backed by ESPEN, with the aim of pointing out to Spanish Health Authorities and the healthcare community the real hospital malnutrition situation in Spain.

At a national level, these results can back-up specific measures to be incorporated into strategy number eight of the National Quality Plan, and at a local level, to reinforce the need to include malnutrition as a preventable risk factor in hospitalized patients in every hospital's Risk Prevention and Management Plan.

Conclusions

Disease-related malnutrition is a common medical condition not only serious, but affecting significantly patient's recovery; and still it is not adequately dealt with in routine clinical practice in Spain. Malnutrition is most often associated with pathologies such as cancer and diabetes, with the presence of dysphagia, being elderly and female as well as with emergency admission to hospital. Measures required for prevention and integrated care of the patient at risk of malnutrition or undernourished are simple, while the cost of malnutrition is much higher, both in economic terms and respect to the course and outcome of the disease. Information provided here may help health teams and authorities in taking necessary measures to alleviate this great problem.

Conflict of interests statement

Nestlé Health Science provided financial and scientific support for this study. Oblikue Consulting provided technical support. All authors, except for P. Garcia Lorda and K. Araujo, declare independence from the sponsoring body in the analysis of results and the compiling of the conclusions and deny any conflicts of interest with organisations mentioned above. Authors previously mentioned did not participate in results analysis and conclusions compiling.

Statement of authorship

All authors, except for K. Araujo and B. Sarto, are members of the study Scientific Committee and participated in the study concept development as well as the study design. M. León-Sanz, S. Celaya-Pérez, and P. García-Lorda participated in the protocol writing and reviewing process, as well as the study take-off. B. Sarto participated in the study take-off as well as in the monitors training process. M. Planas and J. Álvarez-Hernández supervised the field-work, participated in the

Appendix 1
PREDyCES® study collaborators

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H Virgen Del Camino	Ana Zugasti Murillo	María Estrella Petrina Jáuregui
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CHU De Albacete	Francisco Botella Romero	Marta Milla Tobarra
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study-results analysis, and wrote the final manuscript. All authors reviewed and approved the article final version.

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