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Research Article

Prevalence of Hospital Malnutrition in Patients with Diabetes Mellitus: A Sub-Analysis of the PREDyCES® Study

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Keywords Hospital malnutrition; Prevalence; Diabetes Mellitus; Nutritional Assessment; Costs

Abbreviations BMI; Body Mass Index
HM; Hospital Malnutrition
LOS; Length of Hospital Stay
MBDS; Minimal Basic Data Set
MNA®; Mini-Nutritional Assessment tool
NRS®-2002; Nutrition Risk 2002 screening tool
PREDyCES®; Prevalence of hospital malnutrition and associated costs in Spain study
SENPE; Spanish Society for Parenteral and Enteral Nutrition
95% CI: 95% Confidence Intervals

Abstract

Background: Diabetes mellitus has been associated with an increased risk of hospital malnutrition.

Objective: The aim of this study was to estimate the prevalence of hospital malnutrition and its related costs in hospitalized diabetic patients in Spain.

Methods: We evaluated the prevalence of hospital malnutrition, length of hospital stay and related costs in the subset of patients from PREDyCES® study with diabetes mellitus. PREDyCES® study was a nationwide, cross-sectional, observational, multicentre study in routine clinical practice. Prevalence of hospital malnutrition was assessed both at patient admission and discharge using NRS-2002®.

Results: 387 patients were included, of whom 53.7% were males. Mean age was 69.9 ± 12 y/o. Mean weight and mean body mass index were 69.8 ± 18.3 kg and 26.3 ± 6.9 kg/m^2, respectively. 30.1% patients were malnourished (NRS®-2002 ≥ 3) at admission and 29.3% were malnourished at discharge. Prevalence of malnutrition was significantly higher in women than in men (36.9% *vs*. 24.2%; $p < 0.01$), in ≥ 70 than in < 70 y/o (41.2% *vs*. 15.2%; $p < 0.001$) and in urgent *vs*. programmed admissions (32.7% *vs*. 21.7%; $p < 0.05$). Weight loss during hospitalization was significant in 9.5% of patients and severe in 33.3%. Length of hospital stay and costs were significantly higher in malnourished patients than in patients who were not malnourished (12.3 ± 8.3 *vs*. 8.4 ± 5.5 days; $p < 0.001$; €8 911.3 ± 6 755 *vs* €5 965.1 ± 4 654; $p = 0.001$). 73.3% of patients who were malnourished did not receive nutritional support.

Conclusion: A third of diabetic patients admitted at Spanish hospitals are malnourished. Malnourished diabetic patients have longer hospitalizations and higher costs than those at no nutritional risk.

Introduction

Malnutrition is a health problem of huge magnitude among hospitalized patients. While it is widely recognized that Hospital Malnutrition (HM) has a negative impact both in clinical and in economic terms [1-3], several studies show that malnutrition is still a common condition among hospitalized patients, with prevalence rates ranging between 20 and 50% depending on the country, patients' characteristics and methodology used to assess it [4-7].

Common causes for disease-related malnutrition are poor dietary intake, disease-related metabolic changes and abnormal losses due to malabsorption. The deficiency or imbalance of protein, energy and other nutrients ultimately affects most organs and systems and is responsible for important alterations in the digestive, immune and muscular functions [1,8-12]. As a consequence, patients with HM are at an increased risk of infectious and non-infectious complications such as pneumonia and impaired wound healing [12-13].

In several studies, HM has been associated with increased risks of subsequent morbidity and mortality and increased healthcare costs due to the lengthening of hospital stays and a more intensive use of healthcare resources [14-17].

In spite of the recommendations from medical societies [18-21], malnutrition is often not recognized and not treated by medical teams. Causes for not diagnosing or treating malnutrition are varied and include patients' and physicians' perception and attitude towards nutrition, lack of equipment, insufficient staff, and complex or outdated guidelines [22-24].

To date, the largest study carried out to estimate the prevalence of HM in Spain is the PREDyCES® (Prevalence of hospital malnutrition and associated costs in Spain) study. The PREDyCES® study

was an observational cross-sectional study carried out in 2009 that included 1 707 patients from 50 Spanish centres chosen at random. Malnutrition status was assessed by means of the Nutrition Risk 2002 screening tool (NRS®-2002) and it was reported in 23.7% of patients [5]. Notably, the diagnosis of diabetes mellitus and old age were two factors associated with an increased risk of malnutrition [5].

A few studies have evaluated the prevalence of malnutrition in hospitalized elderly diabetic patients by means of the Mini-Nutritional Assessment (MNA®) tool [25-26], but the true prevalence of malnutrition and the clinical and economic implications of malnutrition in this population still remain elusive. Notably, none of the studies carried out so farin diabetic patients used the NRS®-2002 [27].

The objectives of this study were to describe the prevalence of malnutrition in hospitalized diabetic patients in Spain using the NRS®-2002 screening tool and to estimate the costs of malnutrition in these patients.

Materials and Methods

Study design

This is a subanalysis of the PREDyCES® study. A detailed description of the design, methodology and development of the PREDyCES® study is provided elsewhere [5,28]. The study population comprised all patients included in the PREDyCES study whose primary or secondary diagnosis reported in the Minimal Basic Data Set (MBDS) was diabetes. Diabetic patients from the extension study conducted in order to specifically analyse the excess time in-hospital and the economic impact associated with HM, were identified and analysed for costs in this sub analysis.

Table 1: Age, weight, Body Mass Index (BMI), Brachial (BC) and Calf Circumferences (CC), serum albumin and lymphocyte counts by nutritional status on admission.

	NRS®-2002 score	N	Mean	SD	95% CI		
Age, years	< 3	270	68.51	11.56	67.13	-	69.90
	≥ 3	116	73.20	11.05	71.17	-	75.23
	All	386	69.92	11.60	68.76	-	71.08
Weight, Kg	< 3	270	73.89	17.78	71.76	-	76.02
	≥ 3	116	60.30	15.99	57.36	-	63.24
	All	386	69.81	18.33	67.97	-	71.64
Height, m	< 3	270	164.3	8.83	163.20	-	165.32
	≥ 3	116	160.6	9.71	158.82	-	165.39
	All	386	163.2	9.24	162.24	-	164.09
BMI, Kg/m^2	< 3	270	27.45	6.67	26.65	-	28.25
	≥ 3	116	23.58	6.62	22.36	-	24.80
	All	386	26.29	6.88	25.60	-	26.97
BC, cm	< 3	270	30.06	4.46	29.53	-	30.60
	≥ 3	116	28.3	4.80	27.42	-	28.18
	All	386	29.53	4.63	29.07	-	30.00
CC, cm	< 3	270	35.89	6.03	35.16	-	36.61
	≥ 3	116	32.89	4.79	32.01	-	33.77
	All	386	34.98	5.84	34.40	-	35.57
Serum albumin, g/dL	< 3	178	3.667	0.62	3.58	-	3.76
	≥ 3	84	3.236	0.65	3.09	-	3.38
	All	262	3.529	0.66	3.45	-	3.61
Lymphocyte count, cell/mL	< 3	234	1748	1069	1610	-	1885
	≥ 3	103	1425	761	1276	-	1573
	All	337	1649	995	1542	-	1756

95% CI: 95% Confidence Intervals; BMI: Body Mass Index; BC: Brachial Circumference; CC: Calf Circumference; NRS®-2002: Nutrition Risk 2002 screening tool; SD: Standard Derivation

Variables

Socio-demographic data, anthropomorphic measures (including weight, height, brachial and calf circumferences), main diagnostic and concomitant diseases, drug treatments, biochemical parameters (including serum albumin levels, and lymphocyte count), digestive tract alterations, intake of toxic substances and physical activity were obtained on admission. Anthropomorphic measures and biochemical parameters were also recorded at discharge.

Nutritional status was assessed using the NRS®-2002 screening tool within 48 hours of admission and at discharge (or 28 days after admission if length of hospital stay –LOS- was ≥ 28 days). Prevalence of malnutrition among diabetic patients was calculated on admission and at discharge as the percentage of diabetic patients included in the PREDyCES® study who were malnourished on admission or at discharge (NRS®-2002 score ≥ 3). Stratified prevalence prevalence's of malnutrition by sex and age group were also calculated.

Severe weight loss was defined in patients with LOS of up to 10, 20, 30 or more than 30 days who showed a difference between weight on admission and at discharge of more than 2%, 3%, 4% or 5%, respectively. Significant weight loss was defined in patients with LOS of up to 10, 20, 30 or more than 30 days who showed a difference between weight on admission and at discharge of up to 2%, 3%, 4% or 5%, respectively.

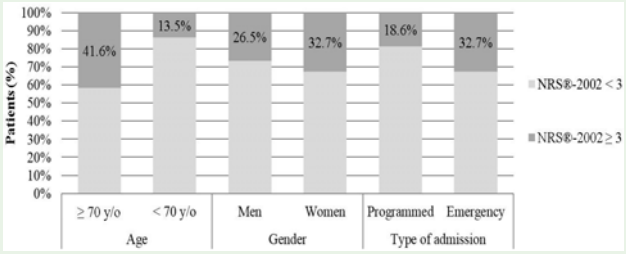
Excess LOS and direct costs associated with HM were estimated for a prospective cohort of patients who took part in the main study. For these patients, the nutritional intervention (use and type), number of days spent in intensive care units and in specialist wards and the incidence of infectious and non-infectious complications were recorded at discharge (or 28 days after admission if LOS was ≥ 28 days).

Sample size and statistical analysis

The sample size was determined by the number of diabetic patients who took part in the PREDyCES® study. In the mentioned study, the sample size was calculated based on the prevalence of HM in local studies carried out in different hospitals and regions in Spain [29-32].

Results

Continuous variables were described by means, standard deviations and 95% confidence Intervals (95% CI) for the mean. Categorical variables were described by absolute and relative frequencies. Differences in anthropometric measures between admission and discharge were compared using paired T-tests and Wilcoxon signed-rank tests. Differences in malnutrition prevalence in relation to age (< 70 *vs* ≥ 70), sex (male *vs* female) and type of admission (programmed *vs* urgent) were evaluated by Chi-squared tests and Fisher exact tests. Differences in mean age, biochemical parameters and anthropometric measures between malnourished and non-malnourished patients were evaluated by T-tests. For all analyses, P values < 0.05 were considered statistically significant. Statistical analysis was carried out with SPSS® 15.0 for Windows (SPSS Inc., Illinois, United States).



NRS®-2002: Nutrition Risk screening tool; y/o: Years old

Figure 1: Prevalence of hospital malnutrition in diabetic patients by age, gender and type of admission.

Ethical approval

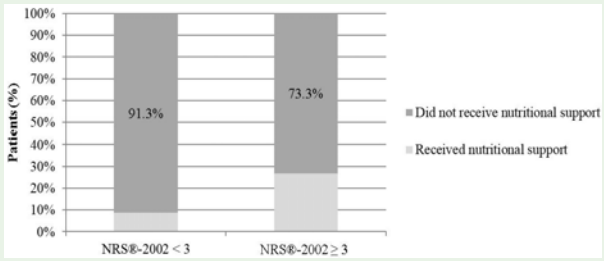
This study was approved by the Ethical Committee from Hospital Universitario La Paz and conducted in accordance to the principles of the Declaration of Helsinki and the ICH Harmonised Tripartite Guideline for Good Clinical Practice (1996). All patients were required to provide written informed consent.

Results

A total of 387 diabetic patients were included. Approximately half of them (53.7%) were male. The mean age was of 70 years, with a standard deviation of 12 years. Most patients (71.8%) were ≥ 65 years old. The mean (± standard deviation) weight, height and BMI were 69.8 kg (± 18.3), 163.2 cm (± 9.2) and 26.3 kg/m^2 (± 6.9), respectively. 17.9% (69/386) of the patients had a Body Mass Index (BMI) lower than 20.5 kg/m^2.

30.1% (116/386) of patients were malnourished (NRS®-2002 score ≥ 3) on admission. Malnutrition was significantly higher among elderly patients (≥70 *vs* < 70; p < 0.001), among women (*vs* men; p < 0.01) and among patients who were admitted to the emergency room (*vs* programmed admissions; p < 0.05) (Figure 1). Compared to non-malnourished patients, malnourished patients were significantly older (+4.7 years, p < 0.001) and had significantly lower body weight (-13.6 kg, p < 0.001), BMI (-3.9 points, p < 0.001), serum albumin levels (p < 0.001), lymphocyte counts (p < 0.001) and smaller brachial and calf circumferences (p < 0.01 in both cases) (Table 1).

29.3% (105/358) of patients were malnourished (NRS®-2002 score ≥3) at discharge. As on admission, nutritional risk was higher for elderly patients (≥ 70) and for women. Similarly, malnourished patients were older (+ 6.46 years, p < 0.001) and had lower body weight, lower BMI, lower serum albumin and smaller brachial and calf circumferences (p < 0.01 in all cases) (Table 2).



NRS®-2002: Nutrition Risk Sscreening tool

Figure 2: Nutritional support during hospitalization by NRS®-2002 score at discharge.

Table 2: Age, weight, Body Mass Index (BMI), brachial (BC) and calf (CC) circumferences, serum albumin and lymphocyte counts by nutritional status at discharge.

	NRS®-2002 score	N	Mean	SD	95% CI		
Age, years	< 3	253	67.87	11.37	66.45	-	69.27
	≥ 3	105	74.32	11.30	72.14	-	76.51
	All	358	69.76	11.71	68.54	-	70.98
Weight, Kg	< 3	234	72.24	16.64	70.10	-	74.38
	≥ 3	101	60.05	17.42	56.61	-	63.49
	All	335	68.57	17.76	66.66	-	70.48
Height, m	< 3	234	136.6	9.17	162.40	-	164.76
	≥ 3	102	161.5	9.51	159.62	-	163.36
	All	336	162.9	9.31	161.95	-	163.94
BMI, Kg/m^2	< 3	234	27.10	6.45	26.27	-	27.93
	≥ 3	101	23.17	6.89	21.81	-	24.53
	All	335	25.91	6.82	25.18	-	26.65
BC, cm	< 3	235	29.69	4.34	29.13	-	30.25
	≥ 3	103	27.54	4.46	26.66	-	28.41
	All	338	29.03	4.48	28.55	-	29.51
CC, cm	< 3	235	35.32	5.60	34.60	-	36.04
	≥ 3	103	33.44	6.13	32.25	-	34.64
	All	338	34.75	5.72	61.13	-	35.37
Serum albumin, g/dL	< 3	91	3.62	0.65	3.48	-	3.75
	≥ 3	55	3.06	0.62	2.89	-	3.23
	All	146	3.41	0.69	3.29	-	3.52
Lymphocyte count, cell/mL	< 3	117	1706	1016.18	1520.12	-	1892.27
	≥ 3	71	1612	823.11	1417.04	-	1606.69
	All	188	1671	946.71	1534.36	-	1806.78

95% CI: 95% Confidence intervals; BMI: Body Mass Index; BC: Brachial Circumference; CC: Calf circumference; NRS®-2002: Nutrition Risk 2002 screening tool; SD: Standard derivation

Interestingly, BMI decreased significantly by 0.5 kg/m2 during hospitalization (p < 0.01) and weight loss during hospital stay was significant in 9.5% of patients and severe in 33.3%. Weight changes during hospitalization were more frequent in patients who were malnourished at discharge. In particular, 75.2% (76/101) of patients who were malnourished at discharge developed significant or severe changes in weight during hospitalization, compared to 36.8% (86/234) of patients who were not malnourished.

In spite of these figures, only 14% (50/358) of patients received nutritional support during their stay, meaning that 73.3% (77/105) of patients who were malnourished at discharge did not receive any type of nutritional support during hospitalization (Figure 2). Regarding the cost-sub study, 11,5% of diabetic malnourished patients presented with infectious complications (including respiratory and urinary infections) and only one patient presented with non-infectious complications. Infectious complications were higher in elderly (>70 y/o) patients (14,9% *vs*. 5,1%).

The mean (± standard deviation) LOS was 9.5 days (± 6.7) in the overall diabetic population, but LOS was significantly longer in

Table 3: Changes in weight by in- hospital Length of Stay (LOS).

	All patients (n=336)		LOS > 20 days (n=28)		LOS 11-20 days (n=72)		LOS 6-10 days (n=126)		LOS 2-5 days (n=109)		LOS 1 day (n=1)	
	n	%	n	%	n	%	n	%	n	%	n	%
Severe weight loss	112	33.30%	12	42.9%	26	36.1%	48	38.1%	26	23.9%	0	0%
Significant weight loss	32	9.54%	1	3.6%	6	8.3%	17	13.5%	8	7.6%	0	0%
Weight maintenance	145	43.20%	7	25%	31	43.1%	40	31.7%	66	60.6%	1	100%
Significant weight gain	8	2.40%	1	4%	1	1.4%	5	4.0%	1	0.9%	0	0%
Severe weight gain	39	11.60%	7	25%	8	11.1%	16	12.7%	8	7.3%	0	0%

LOS: Length of hospital stay

patients who were malnourished at discharge (12.3 ± 8.3 days) than in patients who were not (8.4 ± 5.5) ($p < 0.05$). Weight loss during hospitalization was higher in patients with longer LOS. Weight loss was significant or severe in 31.5% of patients with LOS between 2 and 5 days and in 46.5% of patients with LOS > 20 days (Table 3).

A total of 112 patients were included in the cost sub-study. Of them, 39.3% (44/112) were malnourished at admission and 32.4% (36/111) were malnourished at discharge. As observed for the overall population, mean LOS was significantly longer in patients who were malnourished at discharge than in patients who were not (13.7 ± 9.4 days in malnourished *vs*. 8.8 ± 5.5 days in non-malnourished ($p<0.01$)). The longer LOS observed in malnourished patients translated into significantly higher associated costs (€8 911.3 in malnourished patients *vs*. €5 965.1 in non-malnourished patients; $p = 0.001$).

Discussion

Previous studies have shown that diabetic patients are at a higher risk of malnutrition than non-diabetic patients [5]. This is the first study that evaluates the prevalence of malnutrition and its costs in adult hospitalized patients with diabetes using the NRS®-2002 screening tool.

Our study shows that 30.1% patients with diabetes mellitus admitted to Spanish hospitals are malnourished (NRS®-2002 ≥ 3) and that the prevalence of malnutrition is even higher (41.2%) among patients who are ≥70 years old. These figures are higher than those reported in two previous studies carried out in very old diabetic patients carried out in Spain [25] and in Switzerland [26] using MNA-based screens (MNA® and MNA®-SF) in which prevalence rates were 21.2% and 25.5%, respectively. In spite of the variation in the methodologies and in the results, all the studies highlight that malnutrition is a prevalent condition among hospitalized diabetic patients. Our findings confirm the relevance of implementing malnutrition screenings not only at admission but also periodically throughout the course of the stay.

We observed that malnourished diabetic patients had a LOS approximately 4 days longer than patients who were not malnourished. These results are coherent with those observed in the study carried out in Spain [25], but contradict those observed in the study carried out in Switzerland in which no association between LOS and malnutrition was found [26]. The authors of the latter study [26] attributed the lack of association between malnutrition and LOS to an overriding effect of co-morbidities and acute disease.

As in previous studies [25,26], advanced age and female gender were associated with malnutrition. By contrast, the association between BMI and malnutrition is an interesting topic for discussion. While no association between BMI and malnutrition was observed in the other study carried out in Spanish diabetic patients [25], our data suggest that the risk of malnutrition is higher among patients with lower BMI and lower weight at admission. Interestingly, the Swiss study showed that elderly diabetic patients with lower BMI were also at a higher risk of mortality [26].

Several studies suggest that nutrition support is a cost-effective strategy in malnourished patients as it helps reduce the LOS and the incidence of complications [33-34]. In spite of this, malnutrition often remains under diagnosed and untreated. In our analysis, almost three quarters of the patients who were malnourished at discharge did not receive any type of nutritional support during their hospitalization. The high proportion of patients with severe or significant weight changes during hospitalization suggests that nutritional measures were not appropriate or sufficient.

Diabetes and its complications place an important burden on healthcare systems. Screening for malnutrition in hospitalized elderly diabetic patients is of outmost importance not only because it is the first step to correct malnutrition but also because it can prompt a reduction of unnecessary anti-glycaemic therapy preventing thus hypoglycaemic episodes [35].

In malnourished diabetic patients, diabetic-specific formulations have been shown to improve glycaemic control and reduce the incidence of complications [36-37]. In any case, a better understanding of the aetiology of disease-related malnutrition in diabetic patients could help implement appropriate corrective measures.

There are several limitations that should be considered when interpreting our results. The main limitation of this study was the relatively small sample size. In spite of the relatively low number of patients, the nationwide representativeness of the sample was guaranteed by the inclusion of all diabetic patients who took part in the PREDyCES® study which included a representative sample of Spanish hospitals. Another limitation might be that the diagnosis of diabetes relied on data from the MBDS and patients did not undergo tolerance glucose tests during the study. However, rather than a limitation, this might be seen as a reasonable method to assess the condition of diabetes in this setting in common clinical practice. Likewise, the severity of the underlying disease was not evaluated or taken into account for this analysis. Finally, the use of LOS as a proxy for use of resources probably underestimates the true cost of malnutrition.

We are carrying out a complementary analysis to provide a better estimate of malnutrition-related costs in diabetic patients. Further investigation to ascertain the potential benefits of tailored nutrition strategies in hospitalized diabetic patients is required.

In conclusion, our study shows that malnutrition is a prevalent condition among hospitalized diabetic patients, especially among those with advanced age. In these patients, malnutrition is associated with lengthened LOS and higher costs. A proper assessment of the nutritional status during hospitalization is essential to trigger the implementation of corrective actions that will eventually reduce the risk of age- and diabetes-related complications.

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Conflict of Interest

This study was sponsored by the Spanish Society for Parenteral and Enteral Nutrition (SENPE), with the technical support and funding from Nestlé Health Science. The authors declare that the funding provider was not involved in analyzing the results and preparing the conclusions of this study, and that no conflict of interest exists with the aforementioned organizations.

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