J. Phys. Ther. Sci. 28: 607–612, 2016

The Journal of Physical Therapy Science

Original Article

Association between malnutrition and Barthel Index in a cohort of hospitalized older adults article information

Jorge Hugo Villafañe, PhD, MSc[1)*], Caterina Pirali, MD[1)], Silvia Dughi, MD[1)], Amidio Testa, MD[1)], Sandro Manno, MD[2)], Mark D. Bishop, PhD, MSc, PT[3)], Stefano Negrini, MD[1, 4)]

[1)] *IRCCS Don Gnocchi Foundation: Milan, Italy*
[2)] *University of Brescia, Italy*
[3)] *Department of Physical Therapy, University of Florida, USA*
[4)] *Department of Clinical and Experimental Sciences, University of Brescia, Italy*

Abstract. [Purpose] In this study, we sought to evaluate the relationship between the Barthel Index and the Mini Nutritional Assessment Short Form in a cohort of elderly patients hospitalized in the General Rehabilitation Center. [Subjects and Methods] Three hundred and forty-four patients underwent an extensive evaluation, which included the following tests: 1) a Mini Nutritional Assessment Short Form to evaluate nutritional status; and 2) a Barthel Index assessment to evaluate functional status. We categorized patients into three age groups (65–74 yrs, 75–84 yrs, and >85 yrs). Barthel Index cutoff scores were defined as ≥45 out of 100 for better functional status and <45 for worse functional status. [Results] Significant associations between age distribution and the scores obtained with the Barthel Index and Mini Nutritional Assessment Short Form were found; nutritional status measured with Mini Nutritional Assessment Short Form and functional status measured with the Barthel Index were positively related. [Conclusion] This study shows that the Mini Nutritional Assessment Short Form value was associated with the Barthel Index score, and that these scores varied with age.

Key words: Barthel Index, Mini Nutritional Assessment Short Form, Nutritional status

(This article was submitted Oct. 13, 2015, and was accepted Nov. 17, 2015)

INTRODUCTION

The age of the general population has steadily increased throughout the last century[1)]. The development of strategies to preserve functional capacity of the geriatric population is therefore of paramount importance in improving elderly quality of life and reducing health care costs[2)]. There is growing evidence that the prevalence of malnutrition in elderly people is increasing[3)]. Malnutrition in the elderly was often associated with negative outcomes, for example, an increased risk of falling, anemia, immune dysregulation, impaired cognitive status, reduced muscle function, and increased morbidity and mortality[3–6)]. It is also known that hospitalized elderly patients are at high risk for malnutrition;[7)] the prevalence of malnourished elderly is high in rehabilitative settings[8)] and malnutrition is associated with poor rehabilitative outcomes[9, 10)] and worse functional performance[11)]. Therefore, it is important to assess nutritional status in elderly patients in these settings in order to deliver them appropriate care. There are several tests used to assess malnutrition in the elderly[10)]. The Mini Nutritional Assessment (MNA) is a validated and commonly- used tool. It has high sensitivity and specificity and is effective for evaluating the nutritional status of elderly persons living in different settings[12, 13)].

The MNA consists of 18 items covering four dimensions: anthropometry, dietary assessment, global assessment, and

*Corresponding author. Jorge Hugo Villafañe (E-mail: mail@villafane.it)

self-evaluation. The first 6 items of the full MNA constitute the MNA short-form (MNA-SF). MNA-SF is a screening test used for identifying those who are potentially at risk for malnutrition. Those who are identified as "at risk for malnutrition" are further assessed with the full MNA[14]. Usually the MNA-SF correctly predicts the result of the full MNA[12, 15]. Several studies have shown that the MNA score is associated with functional status and is able to predict the functional decline[16] of older adults living in a community[17] as well as in institutions[18] and acute inpatient wards[19].

There is little data on the relationship between nutritional status and functional performance in elderly inpatients in rehabilitative hospitals. The present study aims to examine the relationship between nutritional status evaluated with MNA-SF, and functional status measured by the Barthel Index (BI) in a cohort of elderly inpatients in a rehabilitative hospital. Our overarching goals were the following: 1) providing support for the hypothesis that in elderly rehabilitative inpatients, nutritional status and functional performance are positively related, and 2) showing that functional and nutritional status decline with aging.

SUBJECTS AND METHODS

In the present cross-sectional study, we observed the relationship between Barthel Index (BI) and Mini Nutritional Assessment Short Form (MNA-SF) in a cohort of elderly inpatients in a rehabilitative center. Informed consent was obtained from all participants and procedures were conducted according to the Declaration of Helsinki. The local ethical committee of the rehabilitation center approved the protocol used in the study.

The initial sample consisted of 344 patients who were admitted at the general rehabilitation center. The inclusion criteria were as follows: 1) patients between 65 and 100 years of age admitted at the general rehabilitation center were included; and 2) the ability to perform functional tests was required. The exclusion criterion consisted of the presence of any illness that could represent a risk to the subject's health during the functional assessment. Thus, two groups of patients were excluded from the items of the BI related to mobility (ambulation or transfers): those medically prohibited from walking or standing, and those reporting dizziness or altered vestibular function during the initial physical examination or immediately prior to the functional assessment. These groups were not included in the final sample. Bedridden patients were also excluded.

Nutritional status: Nutritional status was measured using the Mini Nutritional Assessment Short Form (MNA-SF), a valuable tool for providing rapid and reliable nutritional screening in elderly patients, derived from the MNA. MNA is a tool that evaluates the individual's nutritional status with 18 questions in four areas (basic anthropometrics, dietary intake, global indicators, and self-assessed health status). The MNA is a practical, noninvasive, and cost-effective instrument to assess nutritional status in older people[14]. The MNA is considered a screening and assessment tool with a reliable scale and clearly-defined thresholds, usable by health care professionals[12]. The MNA Short Form, a subset of the full MNA, may come to replace the full MNA[7] as it is sensitive, specific, and accurate in identifying patients at risk for malnutrition[12, 14]. It is adequate in assessing nutrition status in hospitalized elderly patients[8] and it is also able to predict hospital readmission and mortality[10].

Functional status: The BI is one of the most widely used measures of self-care performance. Among all such instruments, the BI has been regarded as the best in terms of sensitivity, simplicity, communicability, scalability, and ease of scoring[20, 21].

The BI was developed as a measure of disability in patients with neuromuscular and musculoskeletal conditions receiving inpatient rehabilitation[22]. The BI has been associated with other scales, for example, the Frenchay Activities Index (FAI), the Nottingham Extended Activities of Daily Living (NEADL)[23], and the Functional Independence Measure (FIM)[24].

The BI is an ordinal scale consisting of ten activities of daily living. The items can be divided into a group that is related to self-care (feeding, grooming, bathing, dressing, bowel and bladder care, and toilet use) and a group related to mobility (ambulation, transfers, and stair climbing). The score ranges from zero, representing a totally dependent bedridden state, to one hundred, which represents the complete independence[23].

All procedures were carried out in accordance with the Declaration of Helsinki. Prior to participation in the study, all patients signed an informed consent form (ICF). All underwent a comprehensive assessment, which consisted of two visits. During the first visit, the patient's history was recorded, a physical examination was performed and the patient signed the ICF. During the second visit 24 hours later, a functional assessment was performed using BI and MNA-SF.

Data were analyzed using SPSS version 20.0 (SPSS Inc., Chicago, IL, USA). The Kolmogorov-Smirnov (K-S) one-sample tests were initially used to assess the normality of the distributions. Next, we categorized patients into three age groups: 65–74 yrs, 75–84 yrs, and >85 yr. We used Kruskal-Wallis H (K-W) tests and Mann-Whitney U (M-W) tests to assess differences among the age groups on the MNA-SF and BI.

Next we categorized patients as "at risk" for malnutrition. MNA-SF scores ranged from 0 to 14, and values below a threshold of 12 were used to identify at-risk patients. Patients were also categorized by functional status. BI cutoff scores were defined as ≥45 out of 100 for better functional status and <45 out of 100 for worse[25]. Kendall tau-b (t) tests were used to evaluate the relationship between BI and MNA-SF, and chi-squared (χ^2) tests were used to compare proportions between age groups. Finally, Spearman's rho (rs) test was used to analyze the association between BI and items within the MNA-SF. Significance for all analyses was assigned at $p = 0.05$.

RESULTS

Three hundred forty-four participants (mean ± SD 77.7 ± 6.8 years; 59.3% female) met all the inclusion criteria and agreed to participate. No significant differences in the mean age were observed between men (mean ± SD: 76.5 ±6.4 years) and women (mean ± SD: 78.5 ±7.0 years) ($p = 0.51$).

Analyses of Kendall's correlation coefficients indicated significant associations between age distribution and the scores obtained with the BI ($t = -0.326$, $p < 0.001$) and MNA-SF ($t = -0.303$, $p < 0.001$). Follow-up Kruskal-Wallis testing indicated significant lowest scores with increased age for the BI (K-W: $\chi^2 = 139.8$, gl = 92, $p < 0.001$) and MNA-SF (K-W: $\chi^2 = 52.6$, gl = 12, $p < 0.001$). In Table 1, Barthel Index scores and MNA-SF scores are reported according to age; with aging, the number of subjects with better functional status (Barthel Index 45–100) and normal nutritional status (MNA-SF 12–14) decreases.

The analysis of the correlation coefficients obtained for the various assessment items used in the functional evaluation of the elderly indicated that the BI scores presented significant correlations with some items of the MNA-SF (Table 2) . Finally, subjects with better functional status (Barthel Index 45–100) tend to have normal nutritional status (MNA-SF 12–14), while subjects with worse functional status (Barthel Index 0–44) are more likely to be malnourished or at risk for malnutrition (MNA-SF 0–11), (χ^2=357.956, p<0.001).

DISCUSSION

The primary finding of the current study is that nutritional status is associated with functional status in a cohort of elderly inpatients in a rehabilitative center. Indeed, MNA-SF scores and BI scores are positively associated, and it is shown that both nutritional and functional status worsen with age. These findings are in agreement with previous studies[11, 12, 26].

Malnutrition has previously been associated with poor functional status. MNA-SF is also a tool capable of predicting functional disability in the elderly. It has been demonstrated to be a good predictor of functional status in institutionalized elderly at risk of malnutrition[27]. A low MNA-SF score has also been related to incident disability in older adults[28]. Moreover, malnutrition identified by the MNA and MNA-SF has been associated with functional status in different settings, for example in elderly persons living in communities, institutions[27], acute care hospitals[19, 29], and in those undergoing

Table 1. Age affects functional status

Assessment Instruments	Age Group	% of subjects per score range		Total
Barthel index		0–44	45–100	
	65–74	23 (19.7%)	94 (80.3%)	117 (34%)*
	75–84	74 (44.8%)	91 (55.2%)	165 (48%)
	>85	47 (75.8%)	15 (24.2%)	62 (18%)
MNA-SF		0–11	12–14	
	65–74	59 (50.4%)	58 (49.6%)	117 (34%)*
	75–84	128 (77.6%)	37 (22.4%)	165 (48%)
	>85	56 (90.3%)	6 (9.7%)	62 (18%)

* Indicates significant difference at the level of p<0.001.
MNA-SF: Mini Nutritional Assessment Short Form

Table 2. Spearman's rank correlation coefficients between the MNA-SF score and the Barthel Index scores

Basal metabolic data	Spearman's r
Barthel-Item-A	0.262*
Barthel-Item-B	0.247*
Barthel-Item-C	0.439*
Barthel-Item-D	0.001
Barthel-Item-E	0.403*
Barthel-Item-F	0.142*

MNA-SF: Mini Nutritional Assessment Short Form
*Significantly different, p<0.05

ambulatory rehabilitation[26, 30]. We verified the hypothesis that the association between malnutrition and functional status also exists for patients hospitalized in a rehabilitative department. Malnutrition is common in the elderly. There are several reasons for this: reduced appetite and energy expenditure, fluid and electrolyte imbalance, altered levels of cytokines and hormones, delayed gastric emptying, and an impaired sense of smell and taste. Moreover, pathologic changes of aging such as chronic disease, depression, cognitive impairment, multiple morbidities, and polypharmacy play an important role in the complex etiology of malnutrition in the elderly[3]. Functional impairment is also common with aging. Inadequate diet and malnutrition[31, 32] results from the lack of functional autonomy, impairing the ability to look after oneself, to prepare food, and to eat properly. The result is reduced food intake[27]. Impaired functional status increases vulnerability and may affect food consumption as well as the quality and the quantity of food consumed[29]. Furthermore, nutritional status becomes particularly critical in patients with cognitive impairments, given that these individuals become progressively more dependent on others to perform the basic activities of daily life, such as feeding oneself[31].

Nutritional status assessment is crucial in rehabilitative setting, as there is an high prevalence of malnutrition in rehabilitative department[8, 33]; it has also been demonstrated that rehabilitative outcomes are influenced by nutritional status[9, 26].

In their study, Charlton et al.[7] concluded that the majority of older patients in the rehabilitation setting are nutritionally compromised and that this adversely influences health outcomes, for example length of hospital stay. Malnutrition also affects clinical course during the hospitalization of elderly patients. It has been shown that malnutrition correlates with pressure sores, infections, and non-infectious complications[34].

The elderly are often transferred to rehabilitation units from acute-care departments, where they may have developed malnutrition as a result of their illness, of certain treatments, or of hospital-associated deconditioning. Therefore, upon admission, prompt and careful evaluation of malnutrition risk is crucial in order to achieve positive rehabilitative outcomes and to reduce the economic burden of malnutrition in this growing segment of the population[35].

The impact of malnutrition on rehabilitative outcomes carries with it a biological assumption: malnutrition has a direct effects on both muscular action and the activity of the nervous system[36]. Therefore, malnutrition may affect both gait and balance as a result of muscle weakness and the inability of the brain to deal with the associated sensorimotor and cognitive demands[31]. Routine functional evaluation and nutritional screening is recommended for all older patients admitted to the hospital, especially in a rehabilitation setting, in order to identify patients with functional disability and at risk of malnutrition[35]. This study reinforces the importance of the MNA-SF as a tool to assess the nutritional status of the elderly hospitalized in a rehabilitative department. It represents a global assessment instrument whose score is related to functional capacity.

The association between nutrition and functional level prompts us to deeply evaluate nutritional status in elderly patients with functional disability. Nutritional status can be an important predictor of disability in hospitalized patients, and should be addressed by interventional strategies.

The prompt identification of hospitalized elderly patients at risk for malnutrition makes it possible to set up specific nutritional treatments. This may result in better clinical and rehabilitative outcomes. More studies are needed to better understand the mechanism of association between nutritional status and functional status in elderly. At this point, the relationship between nutritional intervention and health status in the elderly is still not clear.

The main limitations of this study were the lack of data on indicators of physical function, which limited the interpretation of the impact of nutritional status on physical functional ability. In addition, dietary intake was not assessed, and therefore reasons for malnutrition could not be identified with certainty.

In conclusion, this study reinforces the concept that nutritional status is associated with functional status in elderly patients hospitalized in a rehabilitative department, and that both nutritional and functional status deteriorate with age. In order to understand whether early identification of malnutrition might help to reduce disability in the elderly, further research into the effect of nutritional intervention on disability is warranted.

ACKNOWLEDGEMENT

This study was not supported by any grant and the authors declare that there are no conflicts of interest.

REFERENCES

1) Rousson V, Paccaud F: A set of indicators for decomposing the secular increase of life expectancy. Popul Health Metr, 2010, 8: 18. [Medline] [CrossRef]
2) Artaud F, Dugravot A, Sabia S, et al.: Unhealthy behaviours and disability in older adults: three-city Dijon cohort study. BMJ, 2013, 347: f4240. [Medline] [CrossRef]
3) Ahmed T, Haboubi N: Assessment and management of nutrition in older people and its importance to health. Clin Interv Aging, 2010, 5: 207–216. [Medline]
4) Chang AK, Choi JY: Factors influencing BMI classifications of Korean adults. J Phys Ther Sci, 2015, 27: 1565–1570.

[Medline] [CrossRef]
5) Hong E: Health-related quality of life and health condition of community-dwelling populations with cancer, stroke, and cardiovascular disease. J Phys Ther Sci, 2015, 27: 2521–2524. [Medline] [CrossRef]
6) Shiozu H, Higashijima M, Koga T: Association of sarcopenia with swallowing problems, related to nutrition and activities of daily living of elderly individuals. J Phys Ther Sci, 2015, 27: 393–396. [Medline] [CrossRef]
7) Charlton KE, Nichols C, Bowden S, et al.: Older rehabilitation patients are at high risk of malnutrition: evidence from a large Australian database. J Nutr Health Aging, 2010, 14: 622–628. [Medline] [CrossRef]
8) Kaiser MJ, Bauer JM, Rämsch C, et al. Mini Nutritional Assessment International Group: Frequency of malnutrition in older adults: a multinational perspective using the mini nutritional assessment. J Am Geriatr Soc, 2010, 58: 1734–1738. [Medline] [CrossRef]
9) Wakabayashi H, Sashika H: Malnutrition is associated with poor rehabilitation outcome in elderly inpatients with hospital-associated deconditioning a prospective cohort study. J Rehabil Med, 2014, 46: 277–282. [Medline] [CrossRef]
10) Koren-Hakim T, Weiss A, Hershkovitz A, et al.: Comparing the adequacy of the MNA-SF, NRS-2002 and MUST nutritional tools in assessing malnutrition in hip fracture operated elderly patients. Clin Nutr, 2015. [Medline] [CrossRef]
11) Schrader E, Baumgärtel C, Gueldenzoph H, et al.: Nutritional status according to Mini Nutritional Assessment is related to functional status in geriatric patients—independent of health status. J Nutr Health Aging, 2014, 18: 257–263. [Medline] [CrossRef]
12) Guigoz Y: The Mini Nutritional Assessment (MNA) review of the literature—what does it tell us? J Nutr Health Aging, 2006, 10: 466–485, discussion 485–487. [Medline]
13) Kaiser MJ, Bauer JM, Uter W, et al.: Prospective validation of the modified mini nutritional assessment short-forms in the community, nursing home, and rehabilitation setting. J Am Geriatr Soc, 2011, 59: 2124–2128. [Medline] [CrossRef]
14) Vellas B, Villars H, Abellan G, et al. Overview of the MNA–its history and challenges. J Nutr Health Aging, 2006; 10: 456–463; discussion 463–455.
15) Lee LC, Tsai AC: Mini-Nutritional-Assessment (MNA) without body mass index (BMI) predicts functional disability in elderly Taiwanese. Arch Gerontol Geriatr, 2012, 54: e405–e410. [Medline] [CrossRef]
16) Chang HH, Tsai SL, Chen CY, et al.: Outcomes of hospitalized elderly patients with geriatric syndrome: report of a community hospital reform plan in Taiwan. Arch Gerontol Geriatr, 2010, 50: S30–S33. [Medline] [CrossRef]
17) Kiesswetter E, Pohlhausen S, Uhlig K, et al.: Malnutrition is related to functional impairment in older adults receiving home care. J Nutr Health Aging, 2013, 17: 345–350. [Medline] [CrossRef]
18) Serrano-Urrea R, García-Meseguer MJ: Relationships between nutritional screening and functional impairment in institutionalized Spanish older people. Maturitas, 2014, 78: 323–328. [Medline] [CrossRef]
19) Salvi F, Giorgi R, Grilli A, et al.: Mini Nutritional Assessment (short form) and functional decline in older patients admitted to an acute medical ward. Aging Clin Exp Res, 2008, 20: 322–328. [Medline] [CrossRef]
20) Ohura T, Higashi T, Ishizaki T, et al.: Assessment of the validity and internal consistency of a performance evaluation tool based on the Japanese version of the modified barthel index for elderly people living at home. J Phys Ther Sci, 2014, 26: 1971–1974. [Medline] [CrossRef]
21) Yang M, Ding X, Dong B: The measurement of disability in the elderly: a systematic review of self-reported questionnaires. J Am Med Dir Assoc, 2014, 15: 150.e1–150.e9. [Medline] [CrossRef]
22) Sainsbury A, Seebass G, Bansal A, et al.: Reliability of the Barthel Index when used with older people. Age Ageing, 2005, 34: 228–232. [Medline] [CrossRef]
23) Sarker SJ, Rudd AG, Douiri A, et al.: Comparison of 2 extended activities of daily living scales with the Barthel Index and predictors of their outcomes: cohort study within the South London Stroke Register (SLSR). Stroke, 2012, 43: 1362–1369. [Medline] [CrossRef]
24) Yamasaki M, Someya F: Seasonal changes in activity levels among nursing care insurance service users in areas with different climates. J Phys Ther Sci, 2015, 27: 929–932. [Medline] [CrossRef]
25) Uyttenboogaart M, Stewart RE, Vroomen PC, et al.: Optimizing cutoff scores for the Barthel index and the modified Rankin scale for defining outcome in acute stroke trials. Stroke, 2005, 36: 1984–1987. [Medline] [CrossRef]
26) Chevalier S, Saoud F, Gray-Donald K, et al.: The physical functional capacity of frail elderly persons undergoing ambulatory rehabilitation is related to their nutritional status. J Nutr Health Aging, 2008, 12: 721–726. [Medline]
27) Cereda E, Valzolgher L, Pedrolli C: Mini nutritional assessment is a good predictor of functional status in institution-

alised elderly at risk of malnutrition. Clin Nutr, 2008, 27: 700–705. [Medline] [CrossRef]
28) Martínez-Reig M, Gómez-Arnedo L, Alfonso-Silguero SA, et al.: Nutritional risk, nutritional status and incident disability in older adults. The FRADEA study. J Nutr Health Aging, 2014, 18: 270–276. [Medline] [CrossRef]
29) Oliveira MR, Fogaça KC, Leandro-Merhi VA: Nutritional status and functional capacity of hospitalized elderly. Nutr J, 2009, 8: 54. [Medline] [CrossRef]
30) Furudate S: Effects of estradiol on the prolactin surges and the feedback mechanisms of gonadotropins in pseudopregnant rats. Jikken Dobutsu, 1991, 40: 203–208. [Medline]
31) Reuben DB: Quality indicators for the care of undernutrition in vulnerable elders. J Am Geriatr Soc, 2007, 55: S438–S442. [Medline] [CrossRef]
32) Taş U, Steyerberg EW, Bierma-Zeinstra SM, et al.: Age, gender and disability predict future disability in older people: the Rotterdam Study. BMC Geriatr, 2011, 11: 22. [Medline] [CrossRef]
33) Hertroijs D, Wijnen C, Leistra E, et al.: Rehabilitation patients: undernourished and obese? J Rehabil Med, 2012, 44: 696–701. [Medline] [CrossRef]
34) Norman K, Pichard C, Lochs H, et al.: Prognostic impact of disease-related malnutrition. Clin Nutr, 2008, 27: 5–15. [Medline] [CrossRef]
35) Marshall S, Young A, Bauer J, et al.: Nutrition screening in geriatric rehabilitation: criterion (concurrent and predictive) validity of the malnutrition screening tool and the mini nutritional assessment-short form. J Acad Nutr Diet, 2015. [Medline] [CrossRef]
36) Snijders AH, van de Warrenburg BP, Giladi N, et al.: Neurological gait disorders in elderly people: clinical approach and classification. Lancet Neurol, 2007, 6: 63–74. [Medline] [CrossRef]