


# SPPB as a predictor of functional loss of hospitalized older adults


*A SPPB como preditora da perda da capacidade funcional de idosos hospitalizados*

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## Abstract

**Introduction:** Immobility is associated with adverse outcomes such as loss of functional capacity and longer hospitalization. **Objective:** To assess intra-hospital mobility at admission as a predictor of loss of functional capacity during older adults' hospitalization. **Methods:** A prospective cohort study was conducted, and personal and hospital related risk factors were assessed at admission and discharge. To determine whether Short Physical Performance Battery (SPPB) on admission could predict loss of functional capacity during hospitalization, a ROC curve was performed and area under the curve (AUC) was calculated. Binary logistic regression models were used to identify predictors of loss of functional capacity. Model 1 contained only SPPB. Model 2 SPPB was matched with age, sex, instrumental activity of daily living (IADL), cognition, depression and surgery. Data were entered into SPSS version 18.0. **Results:** 1,191 patients were included with a mean age of 70.02 ( $\pm$  7.34). SPPB cutoff point of 6.5 (sensitivity 62%, specificity 54%) identified 593 (49.8%) patients at risk for functional loss. In logistic regression, SPPB alone showed prediction of functional loss ( $p < 0.001$ , OR 1.8, 95% CI = 1.5-2.5) between admission and discharge. Model 1 explained between 22 to 32% of the variation in functional capacity. In Model 2, three variables contributed to the loss. SPPB 6.5 increased 1.8 times (95% CI = 1.3-2.4), being a woman increased 1.4 times (95% CI = 1.0-1.8) and not having surgery increased 2 times (95% CI = 1.4-2.8) the chance of having functional loss during hospitalization. **Conclusion:** SPPB is a good instrument to predict loss of functional capacity in hospitalized older adults.

**Keywords:** Aged. Movement. Physical therapy specialty.

## Resumo

**Introdução:** A imobilidade está associada a resultados adversos, como perda da capacidade funcional e maior tempo de hospitalização. **Objetivo:** Avaliar a mobilidade intra-hospitalar na admissão como preditor de perda da capacidade funcional durante a hospitalização de idosos. **Métodos:** Um estudo de coorte prospectivo foi conduzido e os fatores de risco pessoais e relacionados ao hospital foram avaliados na admissão e alta. Para determinar se o Short Physical Performance Balance (SPPB) na admissão poderia prever a perda de capacidade funcional durante a internação, uma curva ROC foi realizada e a área sob a curva (AUC) foi calculada. Modelos de regressão logística binária foram usados para identificar preditores de perda de capacidade funcional. O modelo 1 continha apenas SPPB. O modelo 2 SPPB foi pareado com idade, sexo, atividades instrumentais da vida diária (AIVD), cognição, depressão e cirurgia. Os dados foram inseridos no SPSS versão 18.0. **Resultados:** Foram incluídos 1.191 pacientes com idade média de 70,02 ( $\pm$  7,34). O ponto de corte do SPPB de 6,5 (sensibilidade 62%, especificidade 54%) identificou 593 (49,8%) pacientes com risco de perda funcional. Na regressão logística, o SPPB sozinho mostrou predição de perda funcional ( $p < 0,001$ , OR 1,8, IC 95% = 1,5-2,5) entre a admissão e a alta. O modelo 1 explicou entre 22 a 32% da variação da capacidade funcional. No Modelo 2, três variáveis contribuíram para a perda. SPPB 6,5 aumentou 1,8 vezes (IC 95% = 1,3-2,4), ser mulher aumentou 1,4 vezes (IC 95% = 1,0-1,8) e não ter operado aumentou 2 vezes (IC 95% = 1,4-2,8) a chance de ter perda funcional durante a hospitalização. **Conclusão:** O SPPB é um bom instrumento para prever a perda da capacidade funcional em idosos hospitalizados.

**Palavras-chave:** Idoso. Movimento. Especialidade em fisioterapia.

## Introduction

Functioning is one of the most measured outcomes in medical studies and in nursing and other health professions.<sup>1</sup> The International Classification of Functioning, Disability and Health (ICF)<sup>2</sup> classifies functional capacity under "activity" as the level of activity a person may reach in a standard environment without assistance<sup>3</sup> and can be assessed in many ways. One way is by the ability to perform self-care activities of

daily living (ADL) enclosing bathing, dressing, toileting (including continence) and eating.<sup>1,2</sup> Transferring is also included as ADL activities, but ICF classifies it under mobility concept. Loss of functional capacity during the course of hospitalization has high prevalence (35-70%) and causes serious consequences including longer hospital stay, institutionalization and death.<sup>4-7</sup> A wide array of factors has been identified as contributing to loss of functional capacity in older adults. Zisberg et al.<sup>8</sup> identify two different types of risk factors associated to hospitalization: personal and hospital related processes. Personal risk factors such as preexisting functional changes in performing domestic life activities (evaluated by instrumental activities of daily living - IADL), cognition, age, gender and depression have been shown to predict loss in functional capacity.<sup>6,9</sup> Risk factors associated to hospital related processes include polypharmacy,<sup>1</sup> poor nutrient intake,<sup>9,10</sup> restricted mobility,<sup>9,11,12</sup> surgery,<sup>12</sup> and hospital environment characteristics.<sup>9</sup>

Because loss of function during hospitalization is associated with a wide range of negative outcomes, risk factors for in-hospital loss of functional capacity have been extensively studied.<sup>9,13</sup> In-hospital mobility has received particular attention due to its important relation to loss of functional capacity.<sup>9,14</sup> Some research indicates that 73-83% of the time spent in the hospital by older patients is spent lying in bed.<sup>11</sup> Low in-hospital mobility is often related to bed rest orders, limited access to bedside chairs, high beds, and the use of restraints, including intravenous poles and urinary catheters. Immobility and bed rest are associated with adverse outcomes such as high rates of loss of functional capacity and longer hospital stays, especially in older adults.<sup>14</sup> Muscle strength decreases rapidly as a result of immobilization. After only ten days of bed rest, a healthy elderly person can lose 12-14 % of their muscle strength in the lower extremities.<sup>11</sup> English et al.<sup>14</sup> have demonstrated a clear negative relationship between bed-ridden hospitalized older adults and functional capacity. The consequences usually extend over time and may produce long-term effects.<sup>11</sup>

Some studies have used the Short Physical Performance Battery (SPPB), a set of objective measures of lower extremity capacity, to evaluate mobility of older adults in hospital settings.<sup>15,16</sup> Volpato et al.<sup>5</sup> evaluated the predictive value of SPPB after hospitalization and observed the relationship between the SPPB score at

discharge and the risk of subsequent loss of functional capacity, rehospitalization and death, with patients with lower score at highest risk. When SPPB score was analyzed as a continuous variable, a 1-point increase of the SPPB score at discharge was associated with a 14% reduction of the risk of death or rehospitalization. Despite the extensive findings about the predictive value of SPPB after discharge no results were found regarding its predictive value during hospitalization in older adults. We believe that identifying patients at risk for loss of functional capacity while they are in the hospital is an important step in preventing this event.

In an attempt to fill this gap, the objective of this study is to evaluate if in-hospital mobility measured by the SPPB assessed at admission is predictive of loss in functional capacity during hospitalization of older adults. As a subquestion, the study aims to verify if other variables combined with in-hospital mobility can better predict loss in functional capacity. Therefore, we hypothesized that SPPB would predict loss of functional capacity during hospitalization taking into consideration personal factors as age, gender, instrumental activities of daily living, cognition, depression, and hospital related factors such as surgery.

## Methods

### Study design and data collection

A cohort prospective study was conducted at University Hospital Onofre Lopes (HUOL), located at the Federal University of Rio Grande do Norte, Brazil, between January 1, 2014 and April 30, 2015. Older adults admitted for acute care were screened for eligibility and were enrolled if they met the following inclusion criteria: (a) age 60 years or older; (b) ability to provide informed consent; (c) admitted directly from the community; (d) screening for study eligibility performed in the first 24 hours of admission; (e) be able to walk alone or with the aid of an auxiliary device for walking. Patients were excluded if they had any invasive procedure that influenced their functional capacity or if they were discharged to another hospital or rehabilitation center instead of home.

The study was approved by the ethics committee of the hospital (certificate 496.645/2013) and signed consent was obtained from each participant.

## Measures

### Independent variables

Personal risk factors, measured by interview questionnaires, included:

a) Age: in years;  
 b) Gender: male (score = 0) or female (score = 1);  
 c) Domestic life activities (IADLs activities): evaluated using Lawton and Brody's<sup>17</sup> eight-item scale that includes using the telephone, traveling via car or public transportation, shopping, preparing meals, housecleaning, handling money, doing laundry and taking medications. Each activity is scored 0 (dependent) or 1 (independent) with global score 0-8, as higher scores mean greater independence;<sup>17</sup> Test-retest reliability and concurrent validity for older adults present good results.<sup>18</sup>

d) Cognition: measured by Leganés' cognitive test<sup>19</sup> with a global score of 0-32. This scale was developed to be used in older adults with little formal education and its cutoff point is  $\geq 22$  (indicative of cognitive impairment); this instrument was chosen due to HUOL be a public hospital that serves mostly people with low economic income. Psychometric properties from Leganés' test for older adults sample showed good results.<sup>20</sup>

e) Depression: assessed by the Geriatric Depression Scale (GDS-15). This scale was developed for general older adults, geriatric inpatients and primary care outpatients.<sup>20,21</sup> The scale makes use of a simple response format (yes/no, rated 1 or 0) and total score range from 0 to 15 with a cutoff point of  $\leq 5$  indicating depression.<sup>22</sup> GDS-15 presents good test-retest reliability ( $r = .68$ ) and criterion validity (sensitivity 0.80, specificity 0.75).<sup>23</sup>

Hospital-related risk factors:

a) Mobility (SPPB total score): SPPB is easy to administer in both epidemiological and clinical settings and was first developed by Guralnik et al.<sup>24</sup> to be used in community-dwellers. SPPB is a performance-based instrument used to assess mobility that includes usual walking speed over 4 m, five chair-stands test, and balance test. A score (0-4) is assigned to performance on time to rise five times from a seated position, standing balance, and 4-m walking velocity. Individuals receive a score of 0 for each task they are unable to complete. Participants score in the "unable to perform" category if they try but are unable or if the interviewer or participant feel it is unsafe. Summing the three individual categorical scores, a summary performance score is obtained for

each participant (range: 0-12).<sup>25</sup> SPPB has been used as a predictive tool for possible loss of function in older people<sup>26</sup> and has good test-retest reliability ( $r = .83$  95% CI: 0.73, 0.89)<sup>27</sup> and validity (convergent and construct) for community older adults.<sup>28</sup>

b) Surgery: a dichotomous variable was created based on the interview: yes (score = 0); no (score = 1).

#### *Dependent variable*

Functional capacity: this outcome was defined as loss in functional capacity, measured as a change in Katz Index.<sup>29</sup> The Katz scale contains six ADLs activities (bathing, dressing, transferring, toileting, continence, and eating) scored as independent (score = 1) if able to perform each activity without assistance or dependent (score = 0) if not able to perform or if needed assistance. Scores range from 0 to 6 points, and higher scores mean greater independence.<sup>29,30</sup> Loss of functional capacity was defined as a loss of at least one point on Katz scale between admission and discharge.<sup>30</sup> Test-retest reliability and cross-cultural validity was assessed by Lino et al.<sup>29</sup> and presented good results.

#### **Procedure**

At admission (first 24 hours), ten researchers trained in physical therapy assessed personal and hospital related factors and functional capacity. All information was obtained during a single session. If patient could not answer at that moment, his caregiver was asked to answer questions related to functional capacity of older adult. The SPPB test was performed in the hall of the ward. At time of hospital discharge (12-24h before) older adults answered additional questions about their hospitalization (length of stay, surgery) and some measures were repeated (Leganes test, GDS-15, SPPB and Katz scale). If a death occurred, information such date and reason were obtained from the medical chart. In order to avoid bias, the research assistants were blinded to admission scores.

#### **Analysis**

Data were entered into the Statistical Package for Social Sciences (SPSS) version 18.0 for Windows. Descriptive statistics were used to describe sample characteristics. To determine if SPPB at admission could predict loss of functional capacity during hospitalization, a receiver-operating characteristic (ROC) curve was performed and area under the curve (AUC)

was calculated. The independent variable was SPPB at admission as a continuous variable and the dependent variable was loss of functional capacity (no = 0; yes = 1) assessed by Katz scale. This analysis established the cutoff value of SPPB that predicted loss in functional capacity.

Logistic regression models were used to identify predictors of loss in functional capacity. To evaluate the prognostic value of SPPB alone, a logistic binary regression model was performed (model 1). To assess the impact of SPPB combined with a set of predictors, a second model (model 2) was performed combining the SPPB cutoff point to age, gender, IADL, cognition, depression and surgery. For this step the enter method was used.<sup>31</sup> The reference group used for model 2 was SPPB cutoff point, age 60 to 70, male, independent for IADL, cognition above 22, no depression and performed surgery. Loss of functional capacity (no = 0; yes = 1) assessed by Katz scale was entered as the dependent variable. Adjusted odds ratio (OR) and 95% confidence interval (CI) estimates were generated from the models.

#### **Results**

From all patients admitted in the hospital between January 2014 and April 2015, 1,297 agreed to participate (77%) in the study. From these, 64 (5.1%) patients died during the hospital stay and 41 (3.2%) were lost to follow-up due to incomplete interview. These patients were excluded from the analysis. Thus, 1,191 patients were kept for analysis. Table 1 shows the characteristics of the hospitalized older adults.

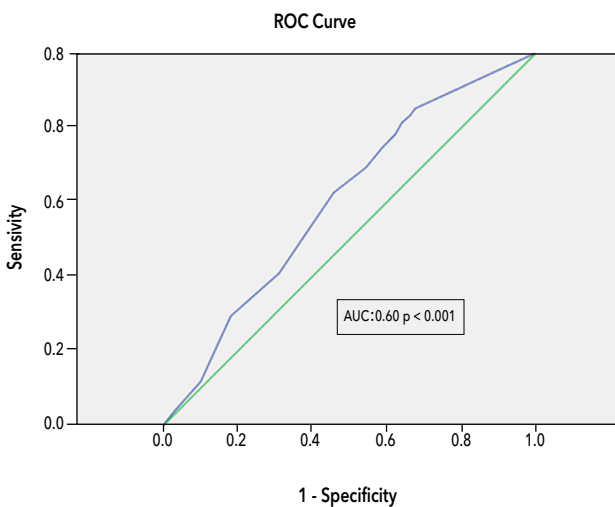
The mean length of hospital stay was 7.65 days ( $\pm$  9.94). Regarding functional capacity for ADL activities, 397 (33.3%) were dependent at admission and these figures had increased at 628 (52.7%) at discharge. Our sample had a high prevalence of surgery (< 70%). The most common surgeries were prostatectomy ( $n = 212$ , 17.80%) followed by cholecystectomy ( $n = 143$ , 12.00%) and hernia surgery ( $n = 95$ , 7.98%).

In an attempt to determine the predictive value of SPPB regarding loss of functional capacity we used a ROC curve. This analysis suggests a SPPB cutoff point of 6.5 as the best relation between sensitivity and specificity (62% and 54% respectively). We identified 593 (49.8%) patients at risk for loss of functional capacity with this cutoff score. Figure 1 shows that area under the curve (AUC) is .603 (moderately predictive of loss of functional capacity) with  $p < 0.001$ .

**Table 1** - Personal and in-hospital characteristics of the hospitalized older adults (n = 1,191)

Variable	Admission	
<b>Personal</b>		
Age (years)	70.02	± 7.34
Gender (%)		
Male	507	42.6
Female	684	57.4
Marital status (%)		
Single	283	23.8
Married	790	66.3
Not married	118	9.9
Domestic life activities (%)*		
Independent	189	15.9
Dependent	1002	84.1
Cognition (%) - Leganés test		
Equal or above 22	997	83.7
Less than 22	194	16.3
Depression (mean) - GDS-15	4.28	± 2.42
<b>In-hospital</b>		
Mobility (mean) - SPPB	5.20	± 3.77
Surgery (%)		
Yes	880	71
No	359	29

Note: \* Lawton and Brody's scale (IADL); GDS = Geriatric Depression Scale; SPPB = Short Physical Performance Battery.



**Figure 1** - Receiver-operator characteristic curve showing sensitivity and 1-specificity for ADL decline.

Note: Diagonal segments are produced by ties.

Subsequently, Table 2 presents the logistic binary regression model performed to assess the impact of SPPB alone and an adjusted model for a number of predictors of loss in functional capacity. Model 1, that contained one independent variable (SPPB cutoff point of 6.5), showed a statistically significant prediction loss of functional capacity ( $p < 0.001$ ) between admission and discharge. This model indicated that patients who had a score on SPPB of 6.5 or less at admission were 1.8 times more likely to experience loss of functional capacity during hospitalization than those who scored above 6.5 (95% CI = 1.5-2.5). The model explained between 22 to 32% of the variance in loss of functional capacity during hospitalization. Model 2 included seven independent variables (SPPB 6.5, age, sex, IADL, cognitive status, depression, and surgery). In this model, three variables (SPPB cutoff point, gender and surgery) had a significant contribution to loss in functional capacity. SPPB below 7 increased 1.8 times (95% CI = 1.3-2.4), being a woman increased 1.4 times (95% CI = 1.0-1.8) and having no surgery increased 2.0 times (95% CI = 1.4-2.8) the odds to present loss of functional capacity during hospitalization. Between 49% to 71% of variability is explained by these sets of variables.

**Table 2** - Logistic binary regression analyses predicting new activities of daily living loss of functional capacity during hospitalization

Variables	OR	95% CI	p
<b>Model 1</b>			
SPPB 6.5	1.9	1.5-2.5	<.001**
<b>Model 2</b>			
SPPB 6.5	1.8	1.3 - 2.3	<.001**
Age	-	-	-
60-70	-	-	.999
71-80	4.49	.000	.999
81-90	4.60	.000	.999
< 90	4.48	.000	.999
Sex	1.4	1.0-1.8	.015*
Domestic life activities (IADL)	.74	.5-1.0	.11
Cognition	.94	.6-1.3	.74
Depression	1.0	.95-1.0	.58
No surgery	2.0	1.4-2.8	<.001**

Note: SPPB = Short Physical Performance Battery; OR = odds ratio; CI = confidence interval; IADL = instrumental activity of daily living. \* $p < 0.05$ ; \*\* $p < 0.001$ .

## Discussion

To the best of our knowledge, this is the first study to investigate the predictive value of SPPB to detect loss in functional capacity in a cohort of hospitalized older adults. Our results show that SPPB is useful for the prediction of loss in functional capacity in ADLs. In addition to SPPB, gender and surgical status improve the detection of cases at risk of functional loss.

Hospitalization of older patients is not without risk because these patients are more prone to adverse events in comparison to younger patients. An important negative health outcome in this population is loss of functional capacity.<sup>32</sup> One risk factor that has been shown to be directly related to loss in functional capacity at discharge is mobility status.<sup>1</sup> Choosing a mobility measure that is practical and easy to use in hospital settings is challenging.<sup>4</sup> In this context, SPPB appears as a valid instrument. The SPPB has many desirable qualities and should be an appealing outcome measure for clinicians who manage patients. The SPPB only requires 5 to 10 minutes to complete, so it can be integrated into patient management without a high cost in time.<sup>33</sup> Corsonello et al.<sup>15</sup> evaluated post-discharged patients with a mean age of 80.1 ( $\pm$  5.9) and found that a cutoff point of 5 correlated to loss of functional capacity and death one year post-discharge. Our results showed that for a hospitalized population with a mean age of 70.02 ( $\pm$  7.3) the SPPB cutoff point of 6.5 (sensitivity, 62%; specificity 54%) has a moderate predictive ability to detect who would be at risk for loss of functional capacity at discharge. The advantage of using a cutoff point to identify patients at risk for loss in functional capacity is the clinically meaningfulness and robust endpoint that is easy to understand and communicate.<sup>34</sup> As SPPB presents results with entire numbers, we determined that older adults who presented score in SPPB below 7 points at admission were considered at risk for loss of functional capacity during hospitalization. We considered a number of characteristics when choosing an optimal point, such as the goals of screening and the hospital resources available.<sup>10</sup> For example, a hospital with fewer resources may wish to adopt a lower cutoff point (SPPB < 6) so the proportion of older adults requiring follow-up would be lower. We encourage using a cutoff point above 7 as a predictor of loss of functional capacity if specificity is not an issue.

Logistic regression showed that in patients with lower SPPB score at admission the risk for loss in functional capacity almost doubled during hospitalization. Beyond other potentially related in-hospital risk such as surgical status, and after controlling for personal risk factors such as age, gender, IADL, cognition and depression,<sup>10,35</sup> mobility remains an important potentially modifiable risk factor for hospitalization functional outcomes. Strategies such as interventions with exercise could help to reduce low mobility in at risk older patients.<sup>13,16</sup> Our results reinforce the fact that mobility is useful for the functional assessment of hospitalized older adults and its assessment over time may help predict those who will need and use more health-related services.<sup>4</sup>

To further assess the association between loss of functional capacity and mobility adjusted for other independent variables including age, gender, IADL, cognition, depression and surgical status, a second model was performed. Adding two variables gender and surgical status increased explained variance from 26% to 71%. We observed that patients who did not undergo surgery had twice as much chances to develop loss of functional capacity during hospitalization. This result is in line with a systematic review by McCusker et al.<sup>10</sup> who examined the correlation between surgery and loss of functional capacity. They observed that being admitted for non-surgery increased more than three times ( $p < .0001$ ) the need of care than surgical patients,<sup>36</sup> although this variable did not remain significant after adjusting for age, sex, marital status, parental status and diagnostic category. Those authors suggested that patients admitted for non-surgery are more likely to have long stays and that functional capacity at admission should be investigated.<sup>36</sup> We believe that this variable may be worth assessing in future research. Gender was also identified as a risk factor associated to loss of functional capacity at discharge; being a woman increased 1.4 times the chance to loss in functional capacity. Gender is a variable measured for many studies, but the results are conflicting.<sup>37</sup> Our results are in line with Beckett et al.<sup>38</sup> that found that men tend to have higher death rates than women, whereas women tend to have higher rates of functional loss than men. However other studies evaluated the correlation between being a woman and loss of functional capacity but did not find a significant correlation (OR = 1.4, CI 0.9-2.4). We believe that we have consistent findings and women admitted at hospital presents higher chances to develop loss in functional capacity.

Although traditional risk factors for loss of functional capacity secondary to hospitalization include age, cognitive status and depression,<sup>1,9,12</sup> we did not observe a significant association between those factors in our sample. Regarding age, some studies<sup>1,10</sup> have observed the association between this variable and loss of functional capacity during hospitalization. Convinsky et al.<sup>12</sup> demonstrated a striking relationship between functional loss during hospitalization and age, with rates exceeding 50% in patients aged 85 years and older. The oldest patients are at particularly high risk of poor functional outcomes because they are less likely to recover functional capacity before admission and are more likely to develop new functional loss during hospitalization. In our sample, the correlation between age and loss of functional capacity was not significant. One reason for this is explained by the large number of hospitalized older adults with 80 years or less. More than 80% of our sample had 75 years or less. Referring cognitive status, few studies<sup>7,39</sup> have associated cognitive impairment with functional change during the course of acute illness and hospitalization. But it is not clear if this association occurs before admission, when most hospital-associated loss of function occurs, or with failure to maintain or recover functioning after hospital admission. This question remains unanswered because we could not find any association between cognition and loss in functional capacity. Finally, regarding depression, our results showed that there were no correlation between depressive symptomatology and loss in functional capacity. Helvik et al.<sup>40</sup> explored the fact that affective disorders are often underdiagnosed and it is not clear how much of the emotional burden is due to a pre-existing condition or represents a consequence of acute illness and hospitalization.

Early screening and assessment of potential problems and the recognition of at-risk patients provide a basis for planning clinical interventions. Identify risk factors at admission related to loss of functional capacity allows clinicians to choose which preventive interventions may help to prevent or minimize functional loss during hospitalization. We suggest that older adults with SPPB below 7 at admission, and particularly women admitted for non-surgery service, should be observed and stimulated to maintain mobility activities during their hospital stay.

Strengths of this study include a large cohort at a university hospital, validated measures of functional

capacity and independent covariates, besides the relevance for the clinical practice. One limitation to be considered in our study is that there were only two mobility evaluations. Volpato et al.<sup>5</sup> showed that sequential assessment of mobility during hospital stay can provide additional information on future health risk in older acutely ill patients. We believe that functional capacity should be assessed systematically in everyday clinical practice. Other limitation was the small sample size of the oldest old. This limitation might influence the correlation between age and loss of functional capacity.

## Conclusion

Our results lead to the conclusions that SPPB is a good instrument to predict loss of functional capacity in hospitalized older adults. A cutoff point of 6.5 or less was the optimal value to identify patients at risk for loss of functional capacity during hospitalization. We also found out that patients combining SPPB 6.5 or less, being a woman and being non-surgery admissions increase the risk for loss of functional capacity. These results may be useful for clinicians looking for a screening tool and risk factors to identify hospitalized older adults at greatest risk for loss of functional capacity, and to help in the targeting of geriatric evaluation and management interventions.

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## Authors' contribution

All authors were equally responsible for the study conceptualization, data curation, formal analysis, funding acquisition, investigation, methodology, project administration, resources, software, supervision, validation, visualization, writing, review and editing, and approval of the final version.

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