Prognostic value of handgrip strength and functional indicators in elderly patients in a southern brazilian hospital

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ABSTRACT

Background: the handgrip strength (HGS) is an important functional indicator in the elderly. The aim of this work was to evaluate the prognostic value of HGS, sociodemographic and functional indicators in elderly patients in a hospital in southern Brazil. **Methods:** prospective cohort observational study in individuals aged 60 years or older who were admitted to the clinical sectors in a tertiary Hospital of a southern Brazil. **Results:** a total of 218 participants were evaluated, of which 55% were men, with median age (p25-p75) of 72 years (65.7-78.0). The most prevalent hospitalization diagnoses were respiratory (19.7%) and vascular (19.3%) disorders. The median values (p25-p75) of HGS for men and women were, respectively, 50.00 (25.0-65.0) and 30.0 (20.0-40.0) kgf. As to the outcome, 44 (20.2%) individuals eventually died. The study showed that there was higher chance of mortality in aged patients (OR = 1.063; CI 95% 1.021-1.108) with higher Charlson Comorbidity Index scores (OR = 1.293; CI 95% 1.149-1.256), Glasgow Coma Scale Index scores <15 (OR = 15.656; CI 95% 7.161-34.228), Katz Index scores <6 (OR = 15.617; CI 95% 6.496-37.545), laboratory tests indicating leukocytosis (OR = 4.118; CI 95% 1.984-8.546) and anemia (OR = 3.104; CI 95% 1.307-7.369), lower HGS values (Men: OR = 0.901; CI 95% 0.862-0.941; Women: OR = 0.926; CI 95% 0.896-0.956), and longer length of stay in hospital (OR = 1.088; CI 95% 1.042-1.136). **Conclusion**: HGS and other epidemiological indicators are highly relevant in the prognostic evaluation of elderly people in hospital admission.

Keywords: Frail elderly; Prognosis; Muscle strength dynamometer.

BACKGROUND

As from the 70's, the population over 60 years old began to grow substantially in Brazil. In 2017 elderly people made up 13% of its total population (IBGE, 2018)[1]. Brazil is one of the fastest aging countries in Latin America and the number of people over 65 years old in 2050 is expected to represent at least 20% of its total population[2]. This change in age structure is among the main factors for the increase of non-communicable diseases in this country[3], which generates greater demand for health services, leading to a boost in spending on medical care and hospital admissions[4].

When repeated and prolonged, hospitalizations may produce negative consequences for the health of the elderly, such as decreased functional capacity, lower quality of life, and increased frailty[5]. In addition, multimorbidity increases the occurrence of hospitalization, especially in elderly people who have a private health insurance plan[6]. The occurrence of hospitalization in the adult age group is higher than in the elderly age group, however, the proportion of expenditures is higher with the elderly, thus suggesting the adoption of more comprehensive policies and greater investment in health care actions, disease prevention, and adequate treatment for the most prevalent diseases in the elderly[7].

In light of this reality, studies have shown that handgrip strength (HGS) can be a good indicator to predict total muscle strength and functionality. By associating this indicator with the presence of comorbidities, it is possible to predict the total length of stay of the elderly and hospital outcomes in a simple and inexpensive way[8,9].

It is a fact that as people age, they become more susceptible to chronic non-communicable diseases, which generally have an impact on the reduction of their HGS[9,10]. Cardiac, pulmonary, metabolic, and musculoskeletal diseases cause a reduction in global physical activity, leading to muscle atrophy due to disuse and a decrease in physical condition[11]. In addition, the processes of systemic inflammation, pain, dyspnea, and joint stiffness contribute to functional and structural changes linked to the neuromuscular and cardiorespiratory system, such as decreased voluntary neural activity, muscle atrophy, and reduction of maximum oxygen consumption[9,12].

Besides the HGS, there are other indices that can assist in the prognosis of hospitalized elderly people, such as the Charlson Comorbidity Index (CCI), which is a method that uses selected clinical conditions, registered as a secondary diagnosis - comorbidities – to calculate the risk of death[13], and the Glasgow Coma Scale (GCS), which is used worldwide to assess the level of consciousness at the hospital admission of patients with apparent sensory and motor depression[14].

Research by Roberts et al4[15]. carried out with elderly people at the University of Southampton was the first prospective study to show the inverse relationship between HGS and length of stay in a hospital rehabilitation unit. Leong et al[16]. developed a large study carried out in 21 countries with more than 125,000 participants over four years. During follow-up, it was demonstrated that HGS was inversely associated with mortality in all causes.

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Activities of daily living (ADLs) are complex skills essential to living independently. The Katz Index evaluates hierarchically related ADLs. It is organized to measure the functional capacity in the performance of six functions: bathing, dressing, toileting, transferring, continence, and feeding.[6] Other important parameters for prognostic evaluation during the hospital admission of elderly people are hematocrit levels and leukocyte count in peripheral blood. A study by Franco et al[17]. found that the degree of leukocytosis and decreased hematocrit levels are directly related to a higher mortality rate after surgical procedures to correct femoral fractures in the elderly.

Therefore, there is a need for further investigation regarding the relationship involving HGS evaluation at the hospital admission of the elderly, sociodemographic factors, presence and number of individual comorbidities, and also the outcomes of these patients during the hospital stay. The present study aimed to evaluate the prognostic value of HGS, as well as sociodemographic and functional indicators in elderly patients in a hospital in southern Santa Catarina, Brazil

METHODS

An observational study was carried out with a prospective cohort longitudinal design composed of patients aged 60 years or older who were hospitalized in the clinical sectors of the Nossa Senhora da Conceição Hospital (HNSC) in the city of Tubarão, Santa Catarina, Brazil from March to July 2019. Patients who were transferred to other hospitals or those unable to answer the questions asked were excluded from the study. The project followed the guidelines and regulatory standards for research involving human beings, proposed by the Resolution of the National Health Council No. 466/2012 and Resolution No. 510/2016. It was submitted for evaluation by the Unisul Research Ethics Committee and approved on Report No. 3,156,428.

First, patients aged 60 years or older were selected via electronic medical records in the clinical sectors. Then, either those individuals or their relatives were approached and invited to participate in the research by signing the Informed Consent Form. The study was divided into two parts: at first, an interview was conducted and the participants' handgrip strength was measured according to the protocol. Afterwards, these patients were monitored via electronic medical records. The first contact with the study participants was made within 48 hours after hospital admission. Data on age, sex, and level of education were collected. Handgrip strength was measured with the aid of a dynamometer. Activities of daily living were assessed by using the Katz Index[6], in which the patient is analyzed on a scale of 0

to 6, with 0 being total dependence, and 6 being independence for performance of ADLs. Their diagnosis was defined, and the presence of comorbidities was categorized by the Charlson Comorbidity Index (CCI)[13], in which each pathology has a weight, with 0 indicating no pathology. The patient's level of consciousness was given by the Glasgow Coma Scale (GCS)[14], by assessing motor, verbal and ocular responses, with 3 being the minimum value of the scale, which indicates the patient is in a coma, and 15 the maximum, when the patient has normal responses.

The instrument used to measure handgrip strength was a JAMAR® hydraulic dynamometer (Sammons Preston. Rolyan, 4, Sammons Court, Bolingbrook, IL, 60440, Canada) that presents results in kilogram-force (kgf). As described in the postural protocol proposed by the American Society of Hand Therapists (ASHT), the dynamometer was set to handle position number two, as the patients remained seated in a chair without an armrest with an upright spine. The patients held their shoulders in adduction and performed neutral rotation with their elbow flexed at 90º and forearm in mid-pronation with a neutral wrist. The wrist could be moved up to 30° of extension and the arm kept suspended in the air with the hand positioned on the dynamometer, which was supported by the examiner[18].

After completing the initial protocol, the patients were monitored by electronic medical records, which allowed for the analysis of hematocrit levels and leukocyte count in peripheral blood in the next 48 hours. In that manner it was possible to characterize their progress (length of stay, need for ICU, and outcome). A database was created on Excel® and data was later exported to SPSS 20.0®. Data were presented using absolute and percentage numbers, as well as measures of central tendency and dispersion. Variables were compared in relation to the outcome (discharge or death) by using crude and adjusted logistic regression. For multivariate analysis, variables with $p < 0.2$ in the backward method were considered. The accuracy of HGS results and the multivariate model for predicting mortality were compared using a ROC curve. A 95% confidence interval was considered, with a statistical significance level of 5%.

RESULTS

A total of 221 elderly patients were monitored from March to July 2019 at Nossa Senhora da Conceição Hospital in Tubarão. Of these, three cases were excluded from the study: one of the patients was transferred to another hospital, and two were still hospitalized at the end of data collection. Of the remaining 218 participants,

55% were men and the median age (p25 - p75) was 72.0 (65.7 - 78.0) years. The most prevalent clinical diagnoses were respiratory system conditions (19.7%) and vascular system conditions (19.3%). The CCI resulted in a median (p25 - p75) of 3.0 (1.0 - 5.0). In regard to the functional indicators in the elderly, most patients were categorized as independent in their ADLs by the Katz Index: 137 (62.8%). In the HGS evaluation, 177 (81.2%) declared right-hand dominance, and 35 (16%) had some type of pain or discomfort in

their hands. Nevertheless, according to the research protocol, only the highest HGS value was considered, regardless of which hand was evaluated. The median values (p25 - p75) of HGS for men and women were respectively 50 (25.0 - 65.0) and 30.0 (20.0 - 40.0) kgf. Laboratory tests showed that 100 (45.9%) individuals had leukocytosis and 146 (66%) had some degree of anemia. As for the outcome, 44 (20.2%) individuals ended up dying, and the remaining 174 (79.8%) were discharged from the hospital (two of them with palliative care at home). Table 1 shows the characteristics of the study sample.

Table 1. Characteristics of the study sample.

	n(%)
Age#	72.0 (65.7- 78.0)
Sex	
Male	120 (55.0)
Female	98 (45.0)
Education	
Illiterate	19 (8.7)
Elementary School	170 (77.9)
High school	21 (9.7)
Higher education	8 (3.7)
Clinical diagnoses	
Respiratory	43 (19.7)
Vascular	42 (19.3)
Endocrine	27 (12.4)
Cardiac	25 (11.5)
Oncologic	21 (9.6)
Dermatological	21 (9.6)
Urinary	15 (6.9)
Hematological	7 (3.2)
Infectious	7 (3.2)
Nervous system	3 (1.4)
Rheumatological	1 (0.5)
Charlson Comorbidity Index#	3.0 (1.0-5.0)
Glasgow Coma Scale	
15	164 (75.2)
<15	54 (24.8)
Katz Index	
Katz=6	137 (62.8)
Katz<6	81 (37.2)
Male HGS (kgf) #	50.0 (25.0-65.0)
Female HGS (kgf) #	30.0 (20.0-40.0)
HGS (kgf)#	35.0 (20.0-55.0)
Leukocytes	
Leukopenia	1 (0.5)
Normal	117 (53.6)
Leukocytosis	100 (45.9)
Hematocrit	
Anemia	146 (67.0)
Normal	71 (32.5)
Polycythemia	1 (0.5)
Length of stay in hospital (days)#	7.0 (5.0-12.0)
Outcome	
Discharge	174 (79.8)
Death	44 (20.2)

*Note: # Median (p25 - p75).

In regard to the outcome, there was a greater chance of mortality in older patients with higher CCI results, who were diagnosed with cancer or infectious diseases during admission. Glasgow Coma Scale levels <15, Katz Index score <6, laboratory tests indicating leukocytosis and anemia, lower HGS values, and longer hospital stay were also related to death (Table 2).

Table 2. Comparison between the outcomes Discharge and Death.

	Discharge	Death	OR (CI-95%)	P
Age*	71.0 (65.0 – 77.0)	74.5 (69.0 – 82.0)	1.063 (1.021 – 1.108)	0.003
Sex				
Male	100 (83.3%)	20 (16.7%)	1.000	0.154
Female	74 (75.5%)	24 (24.5%)	1.622 (0.834 – 3.154)	
CCI*	2.0 (1.0 – 4.0)	4.5 (2.0 – 9.0)	1.293 (1.149 – 1.256)	<0.001
GCS				
15	151 (92.1%)	13 (7.9%)	1.000	<0.001
<15	23 (42.6%)	31 (57.4%)	15.656 (7.161 – 34.228)	
Leukocytes				
N/A	105 (89.7%)	12 (10.3%)	1.000	<0.001
Increased	68 (68.0%)	32 (32.0%)	4.118 (1.984 – 8.546)	
Hematocrit				
N/A	64 (90.1%)	7 (9.9%)	1.000	0.010
Decreased	109 (74.7%)	37 (25.3%)	3.104 (1.307 – 7.369)	
Katz Index				
Katz =6	130 (94.9%)	7 (5.1%)	1.000	<0.001
Katz <6	44 (54.3%)	37 (45.7%)	15.617 (6.496 – 37.545)	
Cancer				
No	163 (82.7%)	34 (17.3%)	1.000	0.002
Yes	11 (52.4%)	10 (47.6%)	4.358 (1.715 – 11.076)	
Infectious disease				
No	171 (81.0%)	40 (19.0%)	1.000	0.026
Yes	3 (42.9%)	4 (57.1%)	5.700 (1.227 – 26.483)	
HGS (kgf)*				
Women	30.0 (25.0-40.0)	12.5 (0.0-20.0)	0.901 (0.862 – 0.941)	<0.001
Men	55.0 (35.0-70.0)	2.5 (0.0-20.0)	0.926 (0.896 – 0.956)	<0.001
Length of stay*	7.0 (4.0 – 11.0)	11.5(7.0 – 17.0)	1.088 (1.042 – 1.136)	<0.001

*Note: *Median and percentile 25 and 75.

Table 3 shows the multivariate analysis for men and women considering the outcome Death. The probability of death (%) was determined according to the logistic equation $death\% = 100\% \left[\frac{1}{(1+e^{-\beta})} \right]$.

Table 3. Logistic multivariate regression for the outcome Death.

MEN

$$\beta = -0.234 + (2.083 \ast L) + (-1.938 \ast K) + (-0.064 \ast H)$$

	OR (CI – 95%)	P
L = Leukocytosis		0.008
(0) No	1.000	
(1) Yes	8.025 (1.741 – 36.997)	
K = Katz		0.036
(0) Katz <6	6.946 (1.130 – 42.704)	
(1) Katz=6	1.000	
H = HGS	0.938 (0.902 – 0.976)	0.002

WOMEN

$$\beta = 0.005 + (0.243 \ast C) + (-0.098 \ast H)$$

	OR (CI – 95%)	P
H = HGS	0.907 (0.866 – 0.949)	<0.001
C = Charlson	1.276 (1.039 - 1.566)	0.020

Figure 1 shows the accuracy in the prediction of mortality between HGS and the multivariate model in men and women by means of a ROC curve.
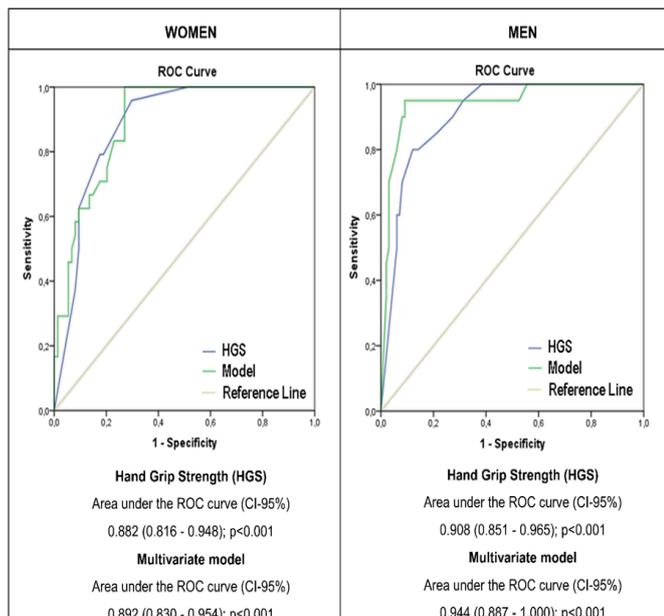

Figure 1. ROC curve for men and women in relation to the outcome.

DISCUSSION

The present study, which aimed to evaluate the prognostic value of HGS and functional indicators at the hospital admission of elderly patients, indicated that higher HGS, and consequently lower sarcopenia, seems to be directly related to a good prognosis in hospital admission and reduced chance of death. The epidemiological profile showed a higher prevalence of men over 70 years old with a low level of education. A similar result was found by Monero-Muños et al[19]., who assessed the prognosis of muscle mass in a group of hospitalized elderly patients composed of 56% men, and in a study carried out with over 1,500 elderly participants from the city of Bagé, in which 78.2% of its sample had a maximum of 8 years of schooling.[6] These data describe similar samples, in which the low level of education can be related to the hospitalization profile, since the patients were hospitalized by the Brazilian Unified Health System (UHS), or to the age group, as some time in the past access to education was more difficult.

In regard to the length of stay in the hospital, the result of this study was different than that of Roberts et al[15]., who also used HGS to evaluate muscle mass loss in elderly people hospitalized in rehabilitation centers in the University of Southampton, and found an average length of stay of 26 days. This variation can be explained by the differences in the hospitalization setting as the present study evaluated elderly inpatients, whereas the study of Roberts et al. evaluated elderly outpatients, by the 11-year difference in the median age of the samples and by the probable socio-cultural differences between the two groups.

There was a significant difference in handgrip strength when comparing the median of discharged and deceased individuals. These results indicate that evaluating HGS when elderly patients are admitted to hospital has a prognostic value and could be used to track negative outcomes. Several studies endorse this thesis, such as that of Bodilsen et al[20]., who evaluated the prognosis of mobility limitations in 368 elderly inpatients by means of the HGS, and obtained medians of 17.4 kgf for women and 31 kgf for men. Another study is that of Leong et al[16]., who gathered data from over 125,000 adults from 21 countries, which demonstrated that HGS is inversely proportional to all non-traumatic death causes and that the median HGS had different values in the different continents analyzed. This difference in the median HGS can be explained by the methods used to measure it. Both aforementioned studies used the second measurement of the dominant hand in their results, whereas the present study used the highest value of the first measurement between both

hands to obtain the results. Besides, the study of Bodilsen et al[20]. presented a sample with median age (p25-p75) of 77.9 years (71.3 - 84.5), which was determinant for the lower medians of HGS.

In two other studies[21,22], the relationship between HGS and outcome had similar results. Olguín et al[21], evaluated 125 patients admitted to the El Pino hospital in Santiago, Chile. Handgrip strength was measured at admission and after 30 days, with the aid of a manual dynamometer. The result showed that 28.8% of the initial sample presented a functional decline during hospitalization. García-Penã et al[22]. had a slightly different result in a prospective cohort study carried out in hospitals in Mexico City. The study had a similar setting, in which 225 patients had their HGS measured at admission and showed functional decline at discharge.

The authors concluded that men with low HGS had increased risk of functional decline at discharge, whereas women did not present a significant association between these two indicators. This result is different from that found in the present study, in which HGS was a prognostic indicator for both men and women.

A study that assessed the use of the main diagnosis at the admission of elderly patients to qualify information about basic causes of natural deaths in Rio de Janeiro[23] verified that the main causes of hospitalization of this age group by the UHS were diseases of the circulatory and respiratory systems, which accounted for 30.3% and 20.5%, respectively, of the total of hospitalizations. Moreover, the admission diagnoses that led to the most deaths were of diseases of the circulatory system and neoplasias. These results corroborate those of the present study and show a pattern in the comorbidities and causes of natural deaths more prevalent in elderly patients treated by the Brazilian Unified Health System[23].

The consciousness level given by the Glasgow Coma Scale had a strong influence on the outcome of the group studied. This can be explained by the fact that patients who did not reach the score of 15 in the GCS generally presented neurological deficits, traumatic brain injury, or different types of sepsis, which are situations related to a high risk of death[24].

In regard to the prognostic evaluation of the individual scores of the Charlson Comorbidity Index (CCI) according to the outcome Death, a directly proportional relationship was observed, which corroborates other studies that also analyzed the multimorbidity and mortality in hospitalizations by means of the same index[25,26]. Broeiro et al[25]. analyzed over 800,000 hospitalizations in Portugal and reached the conclusion that the worst prognoses were from individuals with a CCI score over 6. Cordeiro et al[26]. evaluated in-hospital

mortality in elderly patients of the Brazilian Unified Health System in the southeast region of the country between 2011 and 2012, and observed that the in-hospital mortality rate of the group studied was 12.9% for patients with CCI score of 0, 16.2% for patients with a CCI score of 1, and 27.4% for patients with scores of 2 or higher. Based on this data it is valid to suggest that the use of the Charlson Comorbidity Index can predict the in-hospital prognosis of this age group.

In relation to the Katz Index, the sample pointed to a higher incidence of deaths in patients with some level of dependence in the performance of ADLs. Several studies, such as those of Kalsing et al[27]. and Pereira et al[28]., carried out in the cities of Blumenau and Teresina, respectively, verified that elderly individuals with partial or total dependence in performing ADLs had a higher risk of falling during hospitalization than elderly individuals with independence in these activities. However, little is known about the prognostic value of applying this index in elderly inpatients to evaluate the outcome. The results of the present study suggest that there is an association between a Katz Index score <6 and a poor in-hospital prognosis, which can be used to assist in new research on this subject.

Various studies demonstrate that anemia and leukocytosis are related to functional loss and bad results in elderly patients and, therefore, were identified as additional factors in frailty development[29,30]. According to this premise, the results of this study show a statistical association of a poor diagnosis in elderly patients with the reduction in hematocrit levels and the increase in leukocytes, which once more reinforce the importance of clinical exams for the correct evaluation and care of inpatients.

The multivariate model showed that the handgrip strength was associated with mortality both in men and women. In elderly men, besides a lower HGS, a Katz Index score <6 and leukocytes were predictors for death. As for elderly women, higher CCI score and lower HGS were indicators of a mortality prognosis. The ROC curve of the multivariate model indicated a better prognostic accuracy than only HGS. By means of the logistic equation it was possible to predict mortality with great accuracy in 94.4% of the cases for elderly men and 89.2% for elderly women.

Finally, it is important to highlight that the results achieved in the present study consist in the analysis of a restricted and selected sample by convenience. The participants evaluated were from the clinical sectors of the Brazilian Unified Health System (UHS). Therefore, further research is needed in order to assess the external validity and generalizability of the results.

CONCLUSION

Based on the results obtained, the prognostic value of handgrip strength, sociodemographic and functional indicators in elderly inpatients has suitable accuracy, and thus should be more widespread under the form of a protocol for the hospital admission of elderly patients with the intent to reduce and prevent negative outcomes or to propose palliative approaches.

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