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Research Article

Handgrip Strength and the Perceived Risk of Institutionalization, Hospitalization and Death

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Abstract

Background: Handgrip strength assessment is a simple, quick and low-cost measure, and the presence of low values is predictive of adverse health outcomes such as institutionalization, hospitalization, and death. Weakness and frailty are two intrinsically linked concepts. The need to identify the older adults at risk, living in the community, has led to the development of multidimensional instruments for use in primary health care. The identification of predictors of adverse events is an added value for the referral, development, and planning of appropriate and prompt interventions.

Aim: This study aimed to 1) explore the associations between the HGS and the different variables studied and 2) verify whether the HGS assessment is sufficiently robust to be systematically and routinely used in PHC to identify older people potentially at risk of adverse events over one year.

Methods: 71 men and 103 women aged ≥65 years, community residents and primary health care users, were assessed on different anthropometric parameters, muscle strength and performance, and the perceived risk of institutionalization, hospitalization, and death at one year using the Community Risk Assessment Instrument. T-Test and Spearman correlation were used to identify the relations between variables. To identify the relationship between HGS and the presence or absence of concerns and the perceived risk of institutionalization, hospitalization, and death, an age-adjusted analysis of variance was performed.

Results: Handgrip strength shows significant negative correlations with age, number of diseases, and muscle performance assessed by TUG for both genders. It presents a significant association with problems in Mental State for women (p=0.004), Medical State for men (p=0.025), and ADLs for both genders (Men p=0.001; Women p=0.037). General practitioner perceived risk shows a significant association with the risk of institutionalization (p=0.001) and hospitalization (p=0.004) in women.

Conclusions: The associations found, lead us to suggest the use of handgrip strength measurement as a routine assessment in primary health care services, for preventively identifying people at risk of adverse events. Those assessed as 'weak', taking into account the HGS value, would be targeted for a more in-depth assessment and then referred to interventions designed to respond to the identified problems.

Keywords: Handgrip Strength; Weakness; Ageing; Risk; Frailty

Abbreviations

HGS: Handgrip Strength; SD: Standard Deviation; PHC: Primary Health Care; CARI: Community Assessment of Risk Instrument; GP: General Practitioner; BMI: Body Mass Index; TUG: Timed up and Go.

Background

The assessment of handgrip strength (HGS) is a simple, rapid, low cost, feasible [1], reliable and stable (not visibly altered by acute illness) [2], and its use is recommended for the assessment of muscle strength, both in clinical [3] and research [4]. Muscle strength increases until early adulthood reaching its peak at around 32 years of age in both men and women, although men show higher mean values than women in all age groups [5], with reference values having to be defined and stratified taking into account gender and age [6].

Given the European Working Group on Sarcopenia in Older People (EWGSOP) recommendations, weakness can be defined as strength value at least 2.5 standard deviations below the mean reference value, increases markedly with age, reaching a prevalence of 23% in men and 27% in women at 80 years of age [1,5]. The presence of low muscle strength (weakness) is the first parameter for the diagnosis of sarcopenia, a progressive and generalized skeletal muscle disorder common among older adults [1]. Low HGS values are a strong predictor of adverse outcomes such as greater functional limitations [7,8], hospitalization[9-11], institutionalization [12], and all causes of death [10-14], being a risk factor for the development

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of cardiovascular disease [15] and changes in cognitive functioning [16,17]. Analyzing HGS as a continuous variable, for every 5% loss of strength an increased risk of all-cause mortality is observed [13].

Weakness and frailty are two intrinsically linked concepts, the first being part of the second [18], and the latest being more complex and comprehensive. Frailty is conceptualized as a state of decline in the functional reserves of multiple physiological domains, leading to an impairment of the individual's ability to cope with stressful situations, making the older adults more vulnerable [19-22], increasing the risk of adverse outcomes. Frailty is very prevalent in the Portuguese population aged 65 and over (frail 21.5% and pre-frail 54.3%) [23], being higher than the average values found in Europe over the age of 60 (frail 15% and pre-frail 48%) [24], with weakness being the most prevalent criterion when compared to the other criteria [23].

Therefore, the identification of predictors of adverse events is an added value for the identification, development and planning of appropriate and prompt interventions. However, most measures/instruments are focused on specific areas like functionality, sarcopenia, cognition, etc., and in most cases provide a fragmented view of the individual, without stratifying/quantifying the associated risk. These assessments are time-consuming and complex, especially for application in a clinical context, although crucial for identification and referral in the primary health care (PHC) services. Short screening should be regularly used, leading to more in deep assessment when needed.

The need to identify people at risk, living in the community, led to the development of instruments that combine a multidimensional assessment and the respective stratification of the risk of occurrence of three adverse events: institutionalization, hospitalization, and death [25]. The Community Assessment of Risk Instrument (CARI) assesses the individual's functionality in three domains (mental, ADLs and medical) and the ability of their care network to meet the identified needs. Following this assessment, the general practitioner (GP) identifies the perceived risk of institutionalization, hospitalization, and death at one-year [26], where the presence of frailty, cognitive impairment and functional status are perceived risk markers [27].

However, although the use of multidimensional assessment instruments in PHC services is the ideal scenario, this implies prior knowledge of the health and social condition of the person, which, associated with the limited time and resources, may lead to some limitations to its application. This fact led us to question whether the use of a simple, quick and low-cost measure such as the HGS, which is recognized as a predictor of various risks, does not require prior knowledge of the individual and can be applied by different healthcare professionals, has a significant relationship with the perceived risk of adverse outcomes at one year assessed by the GP.

This fact led us to question whether the use of a simple, quick and low-cost measure such as the HGS, which is recognized as a predictor of various risks, does not require prior knowledge of the individual and can be applied by different healthcare professionals, has a significant relationship with the perceived risk of adverse outcomes at one year assessed by the GP.

Therefore, with this study we aimed to: 1) explore the associations between the HGS and the different variables studied and 2) verify whether the HGS assessment is sufficiently robust to be systematically and routinely used in PHC to identify older people potentially at risk of adverse events over one year.

Methods

Design

The sample used in this study is part of a research project conducted between 2014 and 2016, which aims to characterize the needs of Portuguese primary healthcare users in the mental health domain, living in the community, aged 65 or older [28]. The study was approved by the Ethics Committee of the Regional Health Administration of the North (Opinion no. 6/2014), and the research protocol and procedures were developed according to the Declaration of Helsinki. After a screening phase, where GPs identified individuals who presented problems namely in the mental state domain, individuals who agreed to participate in the study were assessed by the researcher and their GP. The screening instrument used was the Risk Instrument for Screening in Community, a reduced version of the CARI, whose Portuguese version was validated by Santos et al [29].

The first author conducted a face-to-face interview with all participants who agreed to participate in the study, with the following data being collected: socio-demographic data (age, sex, and education level), height and weight, muscle strength, muscle function, and frequency of physical activity.

Height and weight were measured using, respectively, a stadiometer and a calibrated digital scale with a maximum capacity of 150kg and a precision of 100g. Muscle strength was measured using a calibrated handgrip strength device [dynamometer (Takei dynamometer, T.K.K. 5401, Japan)]. Grip strength was tested 4 times, two on each hand, are performed alternately. The final score corresponds to the average value of the highest values obtained on each hand. Values ≤27kg for men and ≤16kg for women [1,5], were considered to identify people with muscle weakness. Mobility/Muscle function was evaluated using gait speed by the Timed "Up and Go" test (TUG) [30]. The person must stand up from an armchair, walk 3m, turn around, walk back to the chair, and sit down. To assess the frequency of physical activity was made an isolated question "How often do you practice any of the following activities (dancing, walking, farming, gardening…)?", considering a 3-point scale: 1-Never/Almost never, 2- One to four times a month, 3-Two or more times a week.

In parallel, the GP identifies the diagnosis present in each individual and, using CARI, assessed the perceived risk of occurrence of institutionalization, hospitalization, and death in the following 12 months (Global risk score). With this instrument, the GP assesses the existence (Yes) or not (No) of problems in 3 domains: Mental State, Activities of Daily Living (ADLs), and Medical State, their severity (mild, moderate, severe), and the caregiver network's ability to respond to them (Can Manage/Carer strain/Some gaps/cannot manage/Absence [25,26,31]. After the identification of the presence of the problem, the GP should specify which problems are at the source of that assessment (e.g. mobility, transfer, dressing, and others, are items of ADLs Domain). In our study, we will only use data regarding the identification of the presence (Yes) or absence (No) of concerns

Table 1: Characterization of the sample by sex.

	Men	Woman	*P*
	n=71	n=103	
Age (years) Mean (SD)	75.30 (7.13)	74.83 (7.09)	0.675
Formal education (years) n(%)			
0	9 (12.7%)	27 (26.2%)	0.008*
1-4	53 (74.6%)	73 (70.9%)	
≥5	9 (12.7%)	3 (2.9%)	
Frequency of Physical Activity n(%)			
Never/almost never	16 (22.5%)	22 (21.4%)	0.395
One to four times a month	5 (7.0%)	14 (13.6%)	
Two or more times a week	50 (70.4%)	67 (65.0%)	
Nº of diseases Mean (SD)	4.59 (2.23)	4.76 (2.49)	0.649
Weight (Kg) Mean (SD)	78.41 (10.04)	70.55 (11.79)	< 0.001*
Height (cm) Mean (SD)	167 (0.61)	153 (0.07)	< 0.001*
Body Mass Index (Kg/m^2)Mean (SD)	28.19 (3.40)	29.99 (4.67)	0.004*
Time up an Go (TUG) (seconds)Mean (SD)	18.43 (12.22)	21.38 (12.09)	0.118
Handgrip strength (Kg)Mean (SD)	28.04 (8.76)	14.81 (4.67)	<0.001*
Not Weak: >27 to Men and >16 to Woman N(%)	37 (52.1%)	46 (44.7%)	0.333
Weak: ≤27 to Men and ≤16 to Woman N(%)	34 (47.9%)	57 (55.3%)	

n – number of subjects | SD – Standard deviation | *p≤0,050

in each domain, increasing the similarity of this instrument with the RISC, a screening instrument similar to the CARI, which has already been validated, and which does not include the subdivision of each domain into sub-items [29]. Based on the assessment carried out, the GP will assess the global perceived risk for the occurrence of institutionalization, hospitalization, and death, in the following 12 months, scoring from 1 (Minimum/Rare) to 5 (Extreme/Sure). The assessment of the perceived risk is based on two pillars: the level of severity and the protective capacity of the care network [49,69]. To facilitate analysis, the risk value assessed in the Global Risk Score was identified as minimal/no risk if assessed as 1 or 2, or maximum/no risk if assessed as 3 to 5 [27]. The GPs who participated in the study were trained in the use of CARI by the project investigators. The training of the researchers was carried out by the authors of the assessment tool and took place on two separate occasions, in Cork (Ireland) and Porto (Portugal), for a total of 16 hours.

Only the participants who met assessments in all the variables studied were included.

Statistics

As the reference values of the HGS are stratified by sex [6], the sample characteristics are presented stratified by sex, the sample characteristics are presented in the same way. To compare both genders, for the categorical variables (formal education, frequency of physical activity, presence of weakness), relative frequencies were used, using the chi-square test for comparison between groups. For the continuous variables (age, number of diseases, weight, height, BMI, TUG, HGS) mean and standard deviation (SD) was presented, and a T-test was used for comparison of means.

After studying the normality of all continuous variables and considering that most of them do not present a normal distribution, it was decided to use Spearman's correlation coefficient for analyzing the correlations.

To identify the relationship between HGS and the presence or absence of concerns and perceived risk of institutionalization, hospitalization, and death, was performed an age-adjusted analysis of variance. The HGS variable fitted the normal distribution for both genders, as well as it was confirmed, in general, the existences of homogeneity of variances through the Levene test.

Data were treated with IBM SPSS software version 27.0 (IBM Corporation, New York, USA). A 5% significance level ($p \leq 0.05$) was considered to determine statistically significant associations.

Results

The sample is composed of 174 individuals, 103 women (56.1%) and 71 men, with a mean age of approximately 75 years for both genders (Table 1). There is a significant difference in the years of education attended by men and women (p=0.008), being the illiteracy rate approximately double in women when compared to men (26.2% vs 12.7%). Regarding the practice of physical activity, the data obtained do not present significant differences between men and women. It should be noted that the majority of the participants in the study (70.4% men and 65.0% women) state that they engage in physical activity 2 or more times per week. Women have a slightly higher mean number of diseases than men (4.76 SD: 2.49 vs 4.59 SD: 2.23), although this is not a significant difference.

Concerning weight and height, and as expected, there are significant differences between men and women, as well as in BMI. Regarding the assessment of muscle function through the TUG, the time required to perform the test is longer in women when compared to men, although not significant. Regarding the muscular weakness

Table 2: Correlations between handgrip strength and others variables.

	Men (n=71)		Women (n=103)	
	Spearman ρ	*p*	Spearman ρ	*p*
Age (years)	-0.342	0.004*	-0.248	0.012*
Nº of diseases	-0.287	0.015*	-0.234	0.017*
Weight (Kg)	0.247	0.038*	-0.025	0.800
Height (m)	0.479	<0.001*	0.130	0.190
Body mass index (Kg/m²)	-0.048	0.689	-0.085	0.393
Time up & Go (seconds)	-0.520	<0.001*	-0.471	<0.001*

n – number of evaluations | ρ – Spearman correlation |**p* ≤0.050

Table 3: Relation between HGS and GPs evaluation for existence of concerns in CARI Domains.

		Handgrip strength[1]							
		Men (n=71)				Women (n=103)			
Presence of Concern		n (%)	Mean (CI 95%)	η_p^2	*p*	n (%)	Mean (CI 95%)	η_p^2	*p*
Mental State	No	20 (28.2)	29.97 [26.25-33.69]	0.021	0.227	22 (21.49)	17.14 [15.37-18.91]	0.079	0.004*
	Yes	51 (71.8)	27.29 [24.96-29.61]			81 (78.6)	14.19 [13.27-15.11]		
ADLs	No	42 (59.1)	30.88 [28.43-33.33]	0.151	0.001*	50 (48.5)	15.77 [14.55-16.99]	0.043	0.037*
	Yes	29 (40.8)	23.93 [20.95-26.92]			53 (51.5)	13.92 [12.73-15.11]		
Medical State	No	14 (19.7)	32.50 [28.18-36.82]	0.072	0.025*	9 (8.7)	16.02 [13.13-18.91]	0.007	0.391
	Yes	57 (80.3)	26.95 [24.81-29.09]			94 (91.3)	14.70 [13.81-15.59]		

n – number of evaluations | CI - Confidence Interval | η_p^2 - Partial Eta Squared (Small effect: 0.01; Medium effect: 0.06; Large effect: 0.14) | **p*≤0.050|
[1]Values adjusted to age

evaluated through the HGS, there is a significant difference between the results obtained by men and women, for men was 28.04Kg (SD: 8.76) and for women was 14.81Kg (SD: 4.67). When we classify the individuals as "Weak" or "Not weak" considering the cut-off values defined for the HGS ("Weak": ≤27kg for men and ≤16kg for women) [1,5], we verify that 55.3% of the women are below that value, contrary situation to what is observed in men.

As expected, age shows a significant negative correlation with HGS (ρ=-0.342 in men and ρ=-0.248 in women), as well as the number of diseases (ρ=-0.287 in men and ρ=-0.234 in women) and physical performance assessed by TUG (ρ=-0.520 in men and ρ=-0.475 in women) (Table 2).

Weight and height only shows a significant correlation in men (ρ= 0.247 in weight and ρ= 0.479 in height). The correlation with BMI is not significant in either gender.

Table 3 shows the relationships between the mean values obtained for the HGS and the presence of problems in mental state, ADLs, and Medical state. In general, lower mean values are identified for the group of people having problems in the three domains.

The difference between the means of the two groups is significant in the Mental State for women (p=0.004), in the Medical State for men (p=0.025), and in the ADLs for both genders (Men p=0.001; Women p=0.037). In addition to the p-value, it is important to report the effect size on the variation of the HGS means. Considering the cut-off values for the Partial Eta Squared [32] we found a large difference (η_p^2=0.15, value greater than 0.14) between the mean values of HGS in the ADLs domain in men. There is a medium effect when we analyze the difference between the means in medical status in men (η_p^2=0.07, value greater than 0.06) and in mental status for women (η_p^2=0.08, value greater than 0.06) and a small effect between the means present in the ADLs domain for women (η_p^2=0.04, value less than 0.06).

About the perceived risk of adverse events in the following 12 months, those at risk present a lower mean HGS, with an exception for men identified at risk of institutionalization. However, these differences are only significant in the perceived risk of institutionalization (p=0.001) and hospitalization (p=0.004) in women (Table 4).

This fact is reinforced by the size of the difference between the means of the two groups (presence versus absence of the problem), with a medium to large effect for the perceived risk of institutionalization (η_p^2=0.11, value greater than 0.06) and a medium effect for hospitalization (η_p^2=0.08, value greater than 0.06) in women.

Discussion

According to Dodds et al [5] the prevalence of weakness increases very rapidly in the older age groups, reaching about ¼ of people at age 80. In our sample, this percentage is more than double in women (55.3% vs 26%) and men (47.9% vs 23%). The mean HGS values obtained are lower 2.26kg for men and 3.19kg for women than those described for the Portuguese population aged 65 or over (Men: 30.3±9.2 vs 28.04±8.76; Women: 18.0±5.4 vs 14.81±4.67) [33], which might be related to the fact that the participants in our study were identified at a screening stage as having mental health problems. A recent meta-analysis, which included nine longitudinal studies, confirmed the presence of consistent and positive associations between linear rates of change in handgrip strength and changes in cognitive functioning [17]. Therefore, taking into account that 71.8% of men and 78.6% of women were identified as having problems in the Mental State Domain, this fact may justify the low values found.

Table 4: HGS and GPs evaluation of the perceived risk of adverse outcomes by GP at 1-year.

		Handgrip strength1							
		Men (n=71)				Women (n=103)			
Perceived Risk		n (%)	Mean (CI 95%)	η_p^2	*p*	n (%)	Mean (CI 95%)	η_p^2	*p*
Institutionalization	No	56 (78.9)	27.87 [25.63-30.12]	0.002	0.748	69 (70.0)	15.86 [14.86-16.87]	0.107	0.001*
	Yes	15 (21.1)	28.67 [24.30-33.05]			34 (33.0)	12.70 [11.23-14.16]		
Hospitalization	No	42 (59.2)	29.62 [27.07-32.17]	0.050	0.062	66 (64.1)	15.79 [14.74-16.83]	0.081	0.004*
	Yes	29 (40.8)	25.10 [22.67-28.85]			37 (35.9)	13.09 [11.68-14.51]		
Death	No	55 (77.5)	28.26 [25.97-30.55]	0.002	0.707	74 (71.8)	15.34 [14.33-16.35]	0.032	0.072
	Yes	16 (22.5)	27.30 [22.91-31.70]			29 (28.2)	13.50 [11.83-15.27]		

n – number of evaluations | CI - Confidence Interval | η_p^2 - Partial Eta Squared (Small effect: 0.01; Medium effect: 0.06; Large effect: 0.14) | *$p \leq 0.050$|
[1]Values adjusted to age

Lower HGS values are also associated with the presence of multimorbidity (2 or more diseases simultaneously) [10,34,35], the increased probability of men having 5 simultaneous diseases [34], and women being 2.57 times (OR 95% CI:1.30-5.07, p=0.007) more likely to have multimorbidity [36]. The average number of diseases is higher than 4.5 in both genders, and multimorbidity is present in more than 87% of the sample, with 48% having 5 or more diseases (values not shown). This variable shows a significant negative correlation with the values obtained for the HGS (Men: ρ=-0.287; Women: ρ=-0.234). Our results corroborate and strengthen the idea that the use of HGS may play an important role in the early identification of multimorbidity.

The TUG shows a moderate negative significant correlation with the HGS (men:ρ=-0.520; women:ρ=-0.471). This test aims to measure general physical performance [1,30,37], and the values obtained in our sample suggest a poor overall physical performance, given the need for more time to complete it than the general Portuguese population [38]. This fact was expected considering that the first part of the TUG involves the transition from sitting to standing position, reflecting the muscular strength of the lower limbs. Taking into account that HGS correlates moderately with strength in other body compartments [1,39] and the HGS values collected are low, strength in the lower limbs should also be low, leading to greater difficulty in performing the tasks inherent to the test. These results were verified by Porta et al, especially in women, who indicate experiencing greater problems in postural transitions [40]. The data for women in our study support these findings, spending almost twice as long as the recommended time for the 65-85 age group (21 vs 12 seconds) [41]. A factor that may also be associated with the need for more time to complete the test, maybe the presence of mental health concerns. As the existence of cognitive impairments explained 25.8% of the variance in TUG scores in a sample aged 70-99 years [42], these appear as a possible moderator of physical performance when associated with age and gender [43]. In a study whose purpose was to identify normative functional fitness standards for the Portuguese older adults, men achieved the fitness standards better than women, indicating a possible premature loss of physical independence [44]. At the same time, the levels of physical activity performed by women, especially activities with more intensity (high) are related to better HGS values in women [45]. In our view, these data reinforce the importance of developing and implementing tailor-made physical activity interventions, especially for women.

Height and weight show a significant positive correlation with HGS only in males, being the correlation with height moderate (ρ=0.479) and low with weight (ρ=0.247). According to Samson et al, weight and height have a significant influence on the differences found in HGS between young and old people, the low values being a partial consequence of changes in height and weight over time [46]. However, variations associated with height may not guarantee adjustments about HGS [6], as happens to women, where the average height is 153cm and the standard deviation is ±0.07, with values very similar across the sample.

The results obtained through individual and specific measures such as the low values of muscular strength (weakness) and low performance in muscular performance, may reflect a decline in functionality and reinforce the idea that we are facing a pre-frailty (presence of 1 or 2 of the following criteria weakness, unintentional weight loss, self-reported exhaustion, slow walking speed, and low physical activity) or frail population [18], potentially at risk of adverse effects. However, being fragile may not necessarily imply that you are at imminent risk of adverse events occurring. Risk reflects the probability of a hazard happening and its impact if it does, so managing it includes identification, assessment and response [47]. CARI allows the assessment of risk, taking into account the severity of the problems identified and the protective ability or lack of it, of the care network [25,27]. Taking into account that the GPs had no previous access to the values obtained in the HGS measurement, the perception of risk of institutionalization, hospitalization, and death was assessed taking into account their knowledge of the individual in the three domains assessed. As expected, the mean HGS values were lower in individuals assessed as having problems in any of the domains and for those assessed at risk, a result that may indicate a good overall knowledge of their patients' condition.

The HGS values showed a significant relationship with the ADLs domain in both genders. The relationship found between the HGS and the ADLs domain was expected taking into account that this domain reflects the functional capacity through the performance of basic and instrumental ADLs. Low HGS may affect the ability to perform the tasks inherent to personal care, feeding, communication, among others, which increases functional decline. These results are in line with the results obtained in a prospective study carried out over 15 years (Jerusalem Longitudinal Cohort Study), where it was concluded that low HGS values predicted the subsequent onset of ADLs dependence and cognitive problems at the follow-ups performed [48]. In our sample, only in women, the relationship between the HGS and the presence of problems in the Mental State

Domain is significant. This may be related to the high prevalence of illiteracy (26.2%) in women, approximately twice as high as in men (12.7%). Illiteracy increases the possibility of having cognitive problems by 2.92 times when compared to people with other levels of education [49]. At the same time, the cumulative effect of muscle weakness (higher prevalence in women) and BMI values that suggest the presence of overweight (higher prevalence in women), may indicate a deterioration of cognitive status [50] and frailty [23]. This fact reaffirms the idea that the sample studied may be in a state of pre-fragility as had already been mentioned concerning the HGS values.

Being frailty is more prevalent in women [24], with weakness being the most prevalent criterion of frailty [23,51] and sarcopenia [52,53] in the Portuguese population aged ≥65 years. These findings may justify the fact that the association between HGS and the risk of institutionalization and hospitalization is significant only for women, where 33% as being at risk of institutionalization, and of these 76.5% (≤16Kg) have muscle weakness (value unknown by the GP as pointed above). In a prospective study that aimed to analyze the association of variables such as frailty with the risk of institutionalization (10 and 18-year follow-up), being woman and pre-fragile significantly increased the risk of institutionalization by 1.85 times during the 18-year follow-up, with the effective percentage of institutionalization for women being higher than for men (48.9% vs 30.2%) [54]. Considering the strong relationship between low HGS and functional decline [8,55,56] and the development of dependence on ADLs [16], and also between this and the increased risk of hospitalization at one year [57], we would expect the existence of a significant relationship between HGS and the perceived risk of hospitalization, however, this was only true for women. Low muscle strength is associated with an increased risk of hospitalization in the mid-term [9,11,58], as well as an increased length of hospitalization [59]. In addition to these facts, a study in a Portuguese Hospital Centre (Porto) revealed increased costs between 16.6-20% (356 to 428 euros per hospitalization) for those with lower HGS values (1st and 2nd quartile) at hospital admission [60]. In our sample, 36% of women were assessed by their GP as being at risk of hospitalization, and of these, 76% of women were assessed as weak. This high percentage reflects the perception of an imminently frail and dependent female population, with a high number of diseases susceptible to acute changes that imply hospitalization [61-63]. Women in our sample have a higher prevalence of problems in mental status, ADLs, and physical status when compared to men. This fact suggests a greater vulnerability to the occurrence of adverse events, a fact verified in the risk assessment performed by the GPs which shows statistically significant associations with the mean values of HGS for institutionalization and hospitalization, only for women.

Although this study has some strength, such as the number of participants, one of the main limitations relates to the fact that the sample was not probabilistic, as it was conditioned by the GPs who agreed to participate in the study. This fact may have introduced a bias in the sample selection, which is minimized by the fact that the patients were randomly assigned to the GPs, as well as the fact that they were randomly selected from the whole Northern area of Portugal. At the same time, the GPs' participation in CARI instrument was around 57%, which limited the access to a wider sample. This fact may be related to the daily workload or the lack of motivation or interest in the instrument used. This issue should be further analyzed and explored to understand the reasons for the non-compliance of the instrument.

Conclusions

The perceived risk of being or not being institutionalized and hospitalized in the next 12 months showed a significant association with the mean HGS values for women, which did not occur for men. Also, the associations found with the problems identified by the GP in the domain of ADLs in both genders, in the mental state for women and in medical state for men, reinforce the importance of using a simple, quick and effective measure such as the HGS, in primary health care as a routine preventive assessment to screen people at risk of adverse outcomes. Increasing age and related changes in health status lead people to make more frequent use of health services, which could facilitate the implementation of an annual HGS assessment from the age of 65 years. People identified as being weak would be referred for more in-depth assessment to identify the existence, or not, of problems in different domains (e.g. CARI), and target them for intervention focused on the problems identified. Referral to exercise interventions/programs with a focus on improving functionality should be an essential part of the interventions.

Ethics Approval and Consent to Participate

The study was conducted according to the guidelines of the Declaration of Helsinki, and approved by Ethics Committee of the Regional Health Administration of North Portugal (ARSN) (Opinion no. 6/2014). Informed consent was obtained from all subjects involved in the study.

Availability of Data and Materials

The datasets generated and/or analyzed during the current study are not publicly available due to on-going research but are available from the corresponding author on reasonable request.

Authors' Contributions

S.S. and C.P. conceptualized the study; S.S. took part in data collection, and was responsible for analyses in collaboration with C.P. S.S. was responsible for the writing process and CP review and approved the final manuscript. All authors have read and agreed to the published version of the manuscript.

References

1. Alfonso J Cruz-Jentoft, Gülistan Bahat, Jürgen Bauer, Yves Boirie, Olivier Bruyère, et al. Sarcopenia: revised European consensus on definition and diagnosis. Age and Ageing. 2018. 48(1): 16-31.

2. Ann Christine Bodilsen, Helle Gybel Juul-Larsen, Janne Petersen, Nina Beyer, Ove Andersen, et al. Feasibility and Inter-Rater Reliability of Physical Performance Measures in Acutely Admitted Older Medical Patients. PLOS ONE. 2015; 10(2): e0118248.

3. Charlotte Beaudart, Eugène McCloskey, Olivier Bruyère, Matteo Cesar, Yves Rolland, et al. Sarcopenia in daily practice: assessment and management. BMC geriatrics. 2016; 16(1): 170-170.

4. Jean-Yves Reginster, Charlotte Beaudart, Nasser Al-Daghri, Bernard Avouac, Jürgen Bauer, et al. Update on the ESCEO recommendation for the conduct of clinical trials for drugs aiming at the treatment of sarcopenia in older adults. Aging Clinical and Experimental Research. 2021. 33(1): 3-17.

5. Richard M. Dodds, Holly E. Syddall, Rachel Cooper, Michaela Benzeval, Ian J. Deary et al. Grip strength across the life course: normative data from twelve British studies. PLoS One. 2014; 9(12): e113637.

6. Luna-Heredia, E., G. Martín-Peña, J. Ruiz-Galiana, Handgrip dynamometry in healthy adults. Clinical Nutrition. 2005; 24(2): 250-258.

7. Fritz NE, CJ McCarthy, DE Adamo. Handgrip strength as a means of monitoring progression of cognitive decline - A scoping review. Ageing Research Reviews. 2017; 35: 112-123.

8. Yoshimi Tanimoto, Misuzu Watanabe, Wei Sun, Keiji Tanimoto, Kanako Shishikura, et al. Association of sarcopenia with functional decline in community-dwelling elderly subjects in Japan. Geriatrics & Gerontology International. 2013; 13(4): 958-963.

9. Peggy Mannen Cawthon, Kathleen M Fox, Shravanthi R Gandra, Matthew J Delmonico, Chiun-Fang Chiou, et al. Do muscle mass, muscle density, strength, and physical function similarly influence risk of hospitalization in older adults?. Journal of the American Geriatrics Society. 2009; 57(8): 1411-1419.

10. Bohannon RW. Grip Strength: An Indispensable Biomarker For Older Adults. Clinical interventions in aging. 2019; 14: 1681-1691.

11. Amelia Guadalupe-Grau, José A Carnicero, Alba Gómez-Cabello, Gonzalo Gutiérrez Avila, Sonia Humanes, et al. Association of regional muscle strength with mortality and hospitalisation in older people. Age Ageing. 2015; 44(5): 790-5.

12. Vasant Hirani, Fiona Blyth, Vasi Naganathan, David G Le Couteur, Markus J Seibel, et al. Sarcopenia Is Associated With Incident Disability, Institutionalization, and Mortality in Community-Dwelling Older Men: The Concord Health and Ageing in Men Project. J Am Med Dir Assoc. 2015; 16(7): 607-13.

13. Carolina H.Y. Ling, Diana Taekema, Anton J.M. de Craen, Jacobijn Gussekloo, Rudi G.J. Westendorp, et al. Handgrip strength and mortality in the oldest old population: the Leiden 85-plus study. CMAJ. 2010; 182(5): 429-435.

14. Eun-Jung Bae, Na-Jin Park, Hae-Sook Sohn, Yun-Hee Kim. Handgrip Strength and All-Cause Mortality in Middle-Aged and Older Koreans. International Journal of Environmental Research and Public Health. 2019; 16(5): 740.

15. Darryl P Leong, Koon K Teo, Sumathy Rangarajan, Patricio Lopez-Jaramillo, Alvaro Avezum, et al. Prognostic value of grip strength: findings from the Prospective Urban Rural Epidemiology (PURE) study. The Lancet. 2015; 386(9990): 266-273.

16. Patricia A Boyle, Aron S Buchman, Robert S Wilson, Sue E Leurgans, David A Bennett. Physical Frailty Is Associated with Incident Mild Cognitive Impairment in Community-Based Older Persons. Journal of the American Geriatrics Society. 2010; 58(2): 248-255.

17. Andrea R Zammit, Andrea M Piccinin, Emily C Duggan, Andriy Koval, Sean Clouston, et al. A Coordinated Multi-study Analysis of the Longitudinal Association Between Handgrip Strength and Cognitive Function in Older Adults. The Journals of Gerontology: Series B. 2021; 76(2): 229-241.

18. L P Fried, C M Tangen, J Walston, A B Newman, C Hirsch, et al. Frailty in Older Adults: Evidence for a Phenotype. J Gerontol A Biol Sci Med Sci. 2001; 56(3): M146-M157.

19. Andrew Clegg, John Young, Steve Iliffe, Marcel Olde Rikkert, Kenneth Rockwood. Frailty in elderly people. The Lancet. 2013; 381(9868): 752-762.

20. Nejma S Macklai, Jacques Spagnoli, Julien Junod, Brigitte Santos-Eggimann. Prospective association of the SHARE-operationalized frailty phenotype with adverse health outcomes: evidence from 60+ community-dwelling Europeans living in 11 countries. BMC Geriatrics. 2013; 13(1): 3.

21. Brigitte Santos-Eggimann, Patrick Cuénoud, Jacques Spagnoli, Julien Junod. Prevalence of Frailty in Middle-Aged and Older Community-Dwelling Europeans Living in 10 Countries. J Gerontol A Biol Sci Med Sci. 2009; 64A(6): 675-681.

22. Roman Romero-Ortuno, Cathal D Walsh, Brian A Lawlor, Rose Anne Kenny. A Frailty Instrument for primary care: findings from the Survey of Health, Ageing and Retirement in Europe (SHARE). BMC Geriatrics. 2010; 10(1): 57.

23. A R Sousa-Santos, C Afonso, P Moreira, P Padrão, A Santos, et al. Weakness: The most frequent criterion among pre-frail and frail older Portuguese. Archives of Gerontology and Geriatrics. 2018; 74: 162-168.

24. Rónán O'Caoimh, Duygu Sezgin, Mark R O'Donovan, D William Molloy, Andrew Clegg, et al. Prevalence of frailty in 62 countries across the world: a systematic review and meta-analysis of population-level studies. Age and Ageing. 2021; 50(1): 96-104.

25. O'Caoimh, R. and W. Molloy, Community Assessment of Risk tool & Treatment Strategies (CARTS). A User Guide. 2012.

26. Clarnette RM, et al. The Community Assessment of Risk Instrument: Investigation of Inter-Rater Reliability of an Instrument Measuring Risk of Adverse Outcomes. J Frailty Aging. 2015; 4(2): 80-9.

27. Rónán O'Caoimh, Yang Gao, Anton Svendrovski, Elizabeth Healy, Elizabeth O'Connell, et al. Screening for markers of frailty and perceived risk of adverse outcomes usig the Risk Instrument for Screening in the Community (RISC). BMC Geriatrics. 2014; 14: 104.

28. Constança Paúl, Laetitia Teixeira, Maria João Azevedo, Sara Alves, Mafalda Duarte, et al. Perceived Risk of Mental Health Problems in Primary Care. Front Aging Neurosci. 2015; 7: 212.

29. Santos Santos, Ronan O'Caoimh, Laetitia Teixeira, Sara Alves, William Molloy, et al. Validation of the Portuguese Version of the Risk Instrument for Screening in the Community (RISC) Among Older Patients in Primary Care in Northern Portugal. Frontiers in Public Health. 2021; 9(1128).

30. Podsiadlo D, S Richardson. The Timed "Up & Go": A Test of Basic Functional Mobility for Frail Elderly Persons. Journal of the American Geriatrics Society. 1991; 39(2): 142-148.

31. Rónán O'Caoimh, Elizabeth Healy, Elizabeth O. Connell, Yang Gao, David William Molloy. The Community Assessment of Risk Tool (CART): Investigation of Inter-Rater Reliability for a New Instrument measuring risk of Adverse Outcomes in Community Dwelling Older Adults. Irish Journal of Medical Science. 2012; 181.

32. Cohen J. A power primer. Psychol Bull. 1992; 112(1): 155-9.

33. Joana Mendes, Teresa F. Amaral, Nuno Borges, Alejandro Santos, Patrícia Padrão. Handgrip strength values of Portuguese older adults: a population based study. BMC Geriatrics. 2017; 17(1): 191.

34. Ching-Lung Cheung, Uyen-Sa D. T. Nguyen, Eleanor Au, Kathryn C. B. Tan, Annie W.C. Kung. Association of handgrip strength with chronic diseases and multimorbidity. AGE. 2013; 35(3): 929-941.

35. Davy Vancampfort, Brendon Stubbs, Joseph Firth, Ai Koyanagi. Handgrip strength, chronic physical conditions and physical multimorbidity in middle-aged and older adults in six low- and middle income countries. European Journal of Internal Medicine. 2019; 61: 96-102.

36. K A Volaklis, M Halle, B Thorand, A Peters, K H Ladwig, et al. Handgrip strength is inversely and independently associated with multimorbidity among older women: Results from the KORA-Age study. European Journal of Internal Medicine. 2016; 31: 35-40.

37. Teresa M Steffen, Timothy A Hacker, Louise Mollinger. Age- and gender-related test performance in community-dwelling elderly people: Six-Minute Walk Test, Berg Balance Scale, Timed Up & Go Test, and gait speeds. Phys Ther. 2002; 82(2): 128-37.

38. Almeida SILd, A Marques, J Santos. Valores normativos do Balance Evaluation System Test(BESTest), Mini-BESTest, Brief-BESTest, Timed Up and Go Test e Usual Gait Speed em pessoas idosas Portuguesas saudáveis. Revista Portuguesa de Medicina Geral e Familiar. 2017; 33(2): 106-116.

39. Angelica Castilho Alonso, Samia Maria Ribeiro, Natália Mariana Silva Luna, Mark D Peterson, Danilo Sales Bocalini, et al. Association between handgrip strength, balance, and knee flexion/extension strength in older adults. PLOS ONE. 2018; 13(6): e0198185.

40. Micaela Porta, Giuseppina Pilloni, Federica Corona, Maria Chiara Fastame, Paul Kenneth Hitchott, et al. Relationships between objectively assessed functional mobility and handgrip strength in healthy older adults. European Geriatric Medicine. 2018; 9(2): 201-209.

41. Heike A Bischoff, Hannes B Stähelin, Andreas U Monsch, Maura D Iversen,

Antje Weyh, et al. Identifying a cut-off point for normal mobility: a comparison of the timed 'up and go' test in community-dwelling and institutionalised elderly women. Age and Ageing. 2003; 32(3): 315-320.

42. Margarita Pondal, Teodoro del Ser. Normative Data and Determinants for the Timed "Up and Go" Test in a Population-Based Sample of Elderly Individuals Without Gait Disturbances. Journal of Geriatric Physical Therapy. 2008; 31(2): 57-63.

43. Azianah Ibrahim, Devinder Kaur Ajit Singh, Suzana Shahar. 'Timed Up and Go' test: Age, gender and cognitive impairment stratified normative values of older adults. PLOS ONE. 2017; 12(10): e0185641.

44. Elisa A Marques, Fátima Baptista, Rute Santos, Susana Vale, Diana A Santos, et al. Normative functional fitness standards and trends of Portuguese older adults: cross-cultural comparisons. J Aging Phys Act. 2014; 22(1): 126-37.

45. Halaweh H, C Willén, U Svantesson. Association between physical activity and physical functioning in community-dwelling older adults. European Journal of Physiotherapy. 2017; 19(1): 40-47.

46. M M Samson, I B Meeuwsen, A Crowe, J A Dessens, S A Duursma, H J Verhaar. Relationships between physical performance measures, age, height and body weight in healthy adults. Age and Ageing. 2000; 29(3): 235-242.

47. Treasury GB. The Orange Book: Management of Risk- Principles and Concepts. 2004: Stationery Office.

48. Jochanan Stessman, Yakir Rottenberg, Matan Fischer, Aliza Hammerman-Rozenberg, Jeremy M Jacobs. Handgrip Strength in Old and Very Old Adults: Mood, Cognition, Function, and Mortality. Journal of the American Geriatrics Society. 2017; 65(3): 526-532.

49. Zhixiong Yan, Xia Zou, Xiaohui Hou. Combined Factors for Predicting Cognitive Impairment in Elderly Population Aged 75 Years and Older: From a Behavioral Perspective. Frontiers in Psychology. 2020; 11(2217).

50. Ana Rita Sousa-Santos, Cláudia Afonso, Nuno Borges, Alejandro Santos, Patrícia Padrão, et al. Sarcopenia, physical frailty, undernutrition and obesity cooccurrence among Portuguese community-dwelling older adults: results from Nutrition UP 65 cross-sectional study. BMJ Open. 2020; 10(6): e033661.

51. Sara Alves, Laetitia Teixeira, Oscar Ribeiro, Constança Paúl. Examining Frailty Phenotype Dimensions in the Oldest Old. Frontiers in Psychology. 2020; 11(434).

52. Ana Rita Sousa-Santos, Cláudia Afonso, Nuno Borges, Alejandro Santos, Patrícia Padrão, et al. Sarcopenia and Undernutrition Among Portuguese Older Adults: Results From Nutrition UP 65 Study. Food and Nutrition Bulletin. 2018; 39(3): 487-492.

53. Ana Rita Sousa-Santos, Cláudia Afonso, Nuno Borges, Alejandro Santos, Patrícia Padrão, et al. Factors associated with sarcopenia and undernutrition in older adults. Nutrition & Dietetics. 2019; 76(5): 604-612.

54. Anna Viljanen, Marika Salminen, Kerttu Irjala, Päivi Korhonen, Maarit Wuorela, et al. Frailty, walking ability and self-rated health in predicting institutionalization: an 18-year follow-up study among Finnish community-dwelling older people. Aging Clinical and Experimental Research. 2021; 33(3): 547-554.

55. Schaap LA, A Koster, M Visser. Adiposity, Muscle Mass, and Muscle Strength in Relation to Functional Decline in Older Persons. Epidemiologic Reviews. 2012; 35(1): 51-65.

56. Maria Vaz-Patto,corresponding, Belén Bueno, Óscar Ribeiro, Laetitia Teixeira, Rosa Marina Afonso, et al. Association between handgrip strength, walking, age-related illnesses and cognitive status in a sample of Portuguese centenarians. European Review of Aging and Physical Activity. 2017; 14(1): 9.

57. W D Spector, S Katz, J B Murphy, J P Fulton. The hierarchical relationship between activities of daily living and instrumental activities of daily living. Journal of Chronic Diseases. 1987; 40(6): 481-489.

58. Hidetaka Hamasaki, Yu Kawashima, Hisayuki Katsuyama, Akahito Sako, Atsushi Goto, et al. Association of handgrip strength with hospitalization, cardiovascular events, and mortality in Japanese patients with type 2 diabetes. Scientific Reports. 2017; 7(1): 7041.

59. Mendes J, A Azevedo, TF Amaral. Handgrip Strength at Admission and Time to Discharge in Medical and Surgical Inpatients. Journal of Parenteral and Enteral Nutrition. 2014; 38(4): 481-488.

60. R S Guerra, T F Amaral, A S Sousa, F Pichel, M T Restivo, et al. Handgrip strength measurement as a predictor of hospitalization costs. European Journal of Clinical Nutrition. 2015; 69(2): 187-192.

61. Ronan O'Caoimh, Yang Gao, Anton Svendrovski, Elizabeth Healy, Elizabeth O'Connell, et al. Risk Instrument for Screening in the Community (RISC): predicting adverse outcomes in older adults. Irish Journal of Medical Science. 2014; 183(7): S306-S307.

62. Devan Kansagara, Honora Englander, Amanda Salanitro, David Kagen, Cecelia Theobald, et al. Risk Prediction Models for Hospital Readmission: A Systematic Review. JAMA. 2011; 306(15): 1688-1698.

63. Pablo J López-Soto, Ignacio Morales-Cané, Fabio Fabbian, Roberto Manfredini, Caridad Dios-Guerra, et al. Characteristics of the Spanish Older People in the Use of Accidents and Emergency Unit Services (2014-2017). Clinical Nursing Research. 2019; 30(4): 406-414.