ORIGINAL ARTICLE

Handgrip strength, functional capacity and cognitive status of centenarians

Força de preensão manual, capacidade funcional e estado cognitivo em centenários

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ABSTRACT

Objective: To compare and correlate handgrip strength (HGS) with functional capacity and cognitive status in centenarians. **Method:** This is a cross-sectional study. The study population consisted of 127 centenarians, of which 78 met the inclusion criteria, with a mean age of 101.7 ± 2.52 years. Cognitive status was assessed using the Mini-Mental State Examination (MMSE) and functional capacity using the Katz Scale. To investigate HGS, we used a manual dynamometer. The level of significance was 5%. **Results:** Centenarian men have higher right (p= 0.005) and left (p<0.001) HGS compared to women. About functional capacity, centenarians more functional present higher right and left HGS (p<0.001) when compared to intermediate and less functional. Furthermore, when analyzing cognition, centenarians with preserved cognitive status have higher right and left HGS (p<0.001) than cognitively impaired elderly. In the relationship analysis, it was possible to verify that the lower the MMSE score, the higher the right (rho= 0.59; p<0.001) and left (rho= 0.57; p<0.001) HGS. Furthermore, the lower the Katz Scale score, the higher the right (rho= -0.53; p<0.001) and left (rho= -0.57; p<0.001) HGS. **Conclusion:** Our results show that male centenarians, more functional and with preserved cognitive status have higher HGS in both hands. Moreover, we found a moderate negative relationship between HGS and functional capacity and a moderate positive relationship between HGS and cognitive status of centenarians.

Keywords: Hand Strength, Sarcopenia, Frailty, Cognitive Aging, Centenarians

RESUMO

Objetivo: Comparar e correlacionar a força de preensão manual (HGS) com a capacidade funcional e o estado cognitivo em centenários. **Método:** Este é um estudo de corte transversal. A população do estudo consistiu em 127 centenários, dos quais 78 preenchiam os critérios de inclusão, com uma idade média de 101,7 ± 2,52 anos. O estado cognitivo foi avaliado utilizando o Mini-Mental State Examination (MMSE) e a capacidade funcional utilizando a Escala Katz. Para investigar o HGS, utilizamos um dinamômetro manual. O nível de significância foi de 5%. **Resultados:** Os homens centenários têm o HGS mais alto à direita (p= 0,005) e à esquerda (p<0,001) em comparação com as mulheres. Quanto à capacidade funcional, os centenários mais funcionais apresentam HGS mais altos à direita e à esquerda (p<0,001) quando comparados com os intermediários e menos funcionais. Além disso, ao analisar a cognição, os centenários com estado cognitivo preservado têm HGS direito e esquerdo mais elevados (p<0,001) do que os idosos com deficiência cognitiva. Na análise da relação, foi possível verificar que quanto mais baixa a pontuação MMSE, mais alta a direita (rho= 0,59; p<0,001) e esquerda (rho= 0,57; p<0,001) HGS. Além disso, quanto mais baixa a pontuação da Escala Katz, mais alta a direita (rho= -0,53; p<0,001) e esquerda (rho= -0,57; p<0,001) HGS. **Conclusão:** Os nossos resultados mostram que os centenários masculinos, mais funcionais e com estatuto cognitivo preservado, têm HGS mais elevado em ambas as mãos. Além disso, encontramos uma relação negativa moderada entre HGS e capacidade funcional e uma relação positiva moderada entre HGS e estado cognitivo dos centenários.

Palavras-chaves: Força da Mão, Sarcopenia, Fragilidade, Envelhecimento Cognitivo, Centenários

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INTRODUCTION

The The number of centenarians has been increasing in recent years. There were 290,000 centenarians in 2010 and projections indicate an increase to 3 million in 2050.[1] However, aging is associated with multisystem changes that lead to declines neuromuscular function, i.e., losses that can increase the vulnerability of older adults, with the consequent development of chronic diseases and cognitive and functional deficits that cause changes in the activities of daily living (ADL) and quality of life of older adults.[2-4] When not stimulated, these individuals have low muscle mechanical function and/or physical performance (locomotion, posture control, and ADL).[5-7]

Furthermore, long-lived individuals are more likely to have reduced handgrip strength (HGS). This reduction, associated with impaired cognitive function, can predict functional limitation[8,9] a higher risk of falls[10] and walking difficulties[11] in older adults. Recent studies demonstrated that the oldest old exhibit marked declines in neuromuscular abilities (strength, power, and endurance) that result in muscle atrophy and sarcopenia.[5,6]

Studies show that HGS measured by the dynamometer is widely recommended as a simple and valid measure of global muscle strength in older adults.[12] Moreover, it is a central marker to identify the onset of sarcopenia[9,13,14] and the frailty in this population9. Within this context, changes in the HGS of older adults are considered important biomarkers.[15,16]

Handgrip strength is known to decrease with age, regardless of sex.[17] However, studies have found that men have higher HGS compared to women.[18,19] A marked decline in HGS was observed in individuals aged 90 years or older, which was associated with falls and reduced functional capacity.[20] Reduced muscle strength is considered a risk factor for cardiovascular diseases and death.[15] According to Kim,[21] reduced HGS is associated with unhealthy lifestyle habits, insufficient physical exercise, low educational level, and inadequate protein intake.

Regarding centenarians, wide variation exists in physical and cognitive functions, disease conditions, and psychological wellbeing.[22] In addition, studies investigating to what extent advanced age and the consequent decrease in muscle strength influence physical and psychological health are scarce. The investigation of HGS, functional capacity and cognitive status in centenarians is therefore important to develop preventive measures and to provide the support necessary for independence and quality of life.[1]

OBJECTIVE

The present study aimed to compare and correlate HGS with functional capacity and cognitive status in centenarians.

METHODS

This is a cross-sectional, descriptive study that is part of the SC100 Project (*Multidimensional Study of Centenarians from Santa Catarina*) conducted by the Laboratory of Gerontology (LAGER), Center for Health and Sports Sciences (CEFID), State University of Santa Catarina (UDESC).[23,24] The study was approved by the Ethics Committee on Research Involving Humans (CEPSH) of the institution (Approval number 1.468.034/2014, Ethical Clearance Certificate 21417713.9.0000.0118), and was conducted in accordance with Resolution 466/2012 of the National Health Council. For participation in the study, the centenarians or a relative/primary caregiver signed the free informed consent form.

One hundred and twenty-seven centenarians were located in the mesoregions of Grande Florianópolis, Vale do Itajaí and southern state of Santa Catarina, Brazil, in addition to the microregion of Joinville. Seventy-eight centenarians who met the following inclusion criteria were selected for this study: 100 years or older in the respective year of data collection, with age confirmed by a personal identity document. Participants who, for any reason, did not undergo the assessments reported in the Instruments item were excluded from the sample.

The Multidimensional Assessment Protocol for the Older Centenary (MAPOC)[22] was used for data collection, which follows the recommendations of the Interview Handbook: Application and Analysis of the Assessment Protocol for Centenarians.[23] Both tools were developed for the SC100 Project of LAGER/CEFID/UDESC. The MAPOC comprises different instruments that were translated, modified and validated for Brazil. These instruments are divided into 16 blocks composed of 220 questions.

Only some blocks and questions of the MAPOC were used in the present study according to its objectives. The following blocks, questions and data were used to characterize the sample of this sample: Block 1- Identification of the Older Adult (questions 1 and 4): age and sex; Block 2- (question 12): Which ear can you hear best with? This question was applied to identify the ear the older adult hears best with for addressing the questions of the study; Block 4- Sociodemographic Data of the Older Adult (questions 48 and 51): marital status and years of schooling.

The cognitive function of centenarians was evaluated by applying questions 13 to 47 of Block 3- (Mental Health of the Older Adult), which refer to the Mini-Mental State Examination (MMSE), Brazilian version modified by Brucki et al.[25] The MMSE comprises the following domains and maximum scores: temporal orientation (5 points), spatial orientation (5 points), immediate memory (3 points), attention and calculation (5 points), recall (3 points), and language (9 points).[26] For the present study, the total score was calculated by summing the scores of each domain. We used the cutoff points for illiterates (≥ 20 points), those who attended school in a period of one to eight years (≥25 points), and for centenarians who attended school for more than nine years (≥28 points).[25]

The functional capacity of centenarians in performing ADL was evaluated by applying questions 130 to 135 of Block 8- Assessment of Functional Capacity of the Older Adult, which refer to the Katz Scale transculturally adapted to Brazil by Lino et al.[27] In the present study, the ADL – bathing, dressing, going to toilet, transferring, continence, and eating (Katz index) – were classified according to Katz and Akpom.[28] Functional capacity was classified as proposed by Rubenstein et al.[29] (Chart 1).

The HGS result (question 216) measured with a dynamometer (Saehan, model SH5001) was recorded in Block 16- of the MAPOC (kinanthropometric and physical assessment). A SAEHAN® model SH5001 dynamometer was

used to measure HGS. The test followed the recommendations of the American Society of Hand Therapists, in which individuals should be comfortably seated with shoulder adducted, elbow flexed to 90º, forearm in a neutral position, and wrist ranging from 0 to 30º in extension.[30] The equipment was presented to the centenary to familiarize himself with the instrument. Afterward, participants were asked to apply as much force as possible. Three measurements were taken in each hand, respecting the rest interval of 20 seconds between each measurement.[31]

Chart 1. Classification of functional capacity (Katz Scale)

Katz index[a]	Classification of ADL
A	Independent in all activities
B	Independent in all activities but one
C	Independent in all activities but bathing and one additional function
D	Independent in all activities but bathing, dressing, and one additional function
E	Independent in all activities but bathing, dressing, going to toilet, and one additional function
F	Independent in all activities but bathing, dressing, going to toilet, transferring, and one additional function
G	Dependent in all activities
Item[b]	Classification of functional capacity
A and B	More functional
C, D and E	Intermediate functionality
F and G	Less Functional

ADL= activities of daily living; Sources: [a]= Katz and Akpom[28]; [b]= Rubenstein et al.[29]

The centenarians who met the inclusion criteria or their legal representative/primary caregiver were contacted by telephone and invited to participate in the study. After the centenarian or primary caregiver agreed to the participation and signed the free informed consent form, the date for application of the PAMIC was scheduled, as shown in Figure 1.

The questions of the MAPOC blocks (Block 1: questions 3 and 4; Block 4: questions 48 and 51; Block 7: questions 89 to 107, 115 and 121; Block 8: questions 130 to 135) were applied by interview. The interviews were mainly held with the primary caregiver to prevent the older adult from getting tired. The data were collected by previously trained researchers following the guidelines of the Interview Handbook: Application and Analysis of the Assessment Protocol for Centenarians.[24] The data were collected from February 2015 to February 2020.

The data were organized with the Excel® program and analyzed with the IBM SPSS Statistics 20.0 software. The variables were explored using descriptive statistics (mean, standard deviation, range, and frequency). The Kolmogorov-Smirnov test was applied to evaluate the normality of the data.

To compare means between groups, we used the independent t-test when data normality was accepted and Mann-Whitney U when normality was rejected. To evaluate

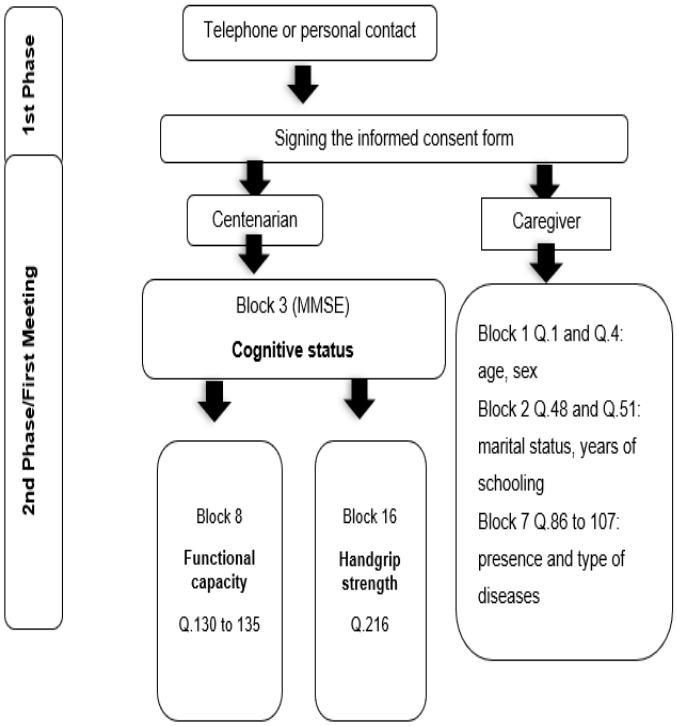

Figure 1. Flow diagram of the instruments and data collection procedures used

differences in left HGS between cognitive status, independent t-test was used. Differences in right HGS between cognitive status were evaluated using the Mann-Whitney U test.

The Kruskal-Wallis test with Dunn's post-hoc test was applied to compare the right and left HGS means according to functional capacity. Spearman's correlation coefficient (data normality rejected) was used to assess the relationship of right and left HGS with cognitive status and functional capacity. A level of significance of 5% was adopted.

RESULTS

Table 1 shows the age, right and left HGS, sociodemographic characteristics, and health conditions of the centenarians participating in the study. Seventy-eight centenarians with a mean age of 101.7 ± 2.52 years were evaluated; there were 55 women (70.5%) and 23 men (29.5%).

Regarding sociodemographic characteristics, 89.9% were widowers, 33% had 4 to 8 years of schooling, and 32% were illiterate. In addition, 88.4% of the participants had diseases, especially hearing problems (52.6%), hypertension (51.3%), and visual impairment (51.3%). The mean right HGS was 12.6 ± 6.2 kg/f (range: 0 - 32 kg/f) and the mean left HGS was 10.73 ± 6.3 kg/f (range: 0 - 32 kg/f). The values "0" kg/f were for centenarians who performed the test and had no HGS.

The comparison of right HGS according to gender, functional capacity and cognitive status of centenarians is shown (Table 2). Male centenarians had higher right and left HGS when compared to centenarian women. Centenarians classified as more functional exhibited a higher right and left HGS compared to older adults classified as intermediate or less functional. In addition, centenarians with preserved cognition exhibited a higher right and left HGS than cognitively impaired centenarians.

Table 1. Characteristics of the centenarians participating in the study (n= 78)

Variable		Mean (SD)	Range
Age (years)		101.7 ± 2.52	99 - 113
Right HGS (kg/f)		12.60 ± 6.21	0 - 32
Left HGS (kg/f)		10.73 ± 6.33	0 -3 2
Sociodemographic		**f**	**%**
Sex	Male	23	29.5
	Female	55	70.5
Marital status	Widowed	70	89.8
	Married/with a partner	4	5.1
	Single	4	5.1
Years of schooling	Illiterate	36	49
	1 to 8	33	40
	> 9	8	11
Health conditions			
Diseases	Yes	69	88.4
	No	10	10.6
Type	Hypertension	40	51.3
	Visual impairment	40	51.3
	Hearing problems	41	52.6
	Cardiovascular disease	20	25.6
	Arthritis	15	19.2
	Osteoporosis	9	11.5
	Cancer	18	23.1
	Arthrosis	22	28.2
	Spine problems	34	43.6
	Urinary incontinence	34	43.6
	Dyslipidemias	6	7.7
	Diabetes	9	11.5
	Depression	10	12.8

HGS= handgrip strength

Table 2. Comparison of handgrip strength (right and left) according to gender, functional capacity and cognitive status of centenarians

Variables	n	Right HGS (mean ± SD)	p-value	Left HGS (mean ± SD)	p-value
Gender					
Male	55	12.6 ± 6.2	0.005	10.0 ± 6.2	<0.001
Women	23	13.9 ± 5.8		13.4 ± 5.9	
Functional capacity					
More functional	30	16.1 ± 6.0	<0.001	14.7 ± 5.7	<0.001
Intermediate functionality	35	11.4 ± 5.5		8.7 ± 6.0	
Less functional	13	7.7 ± 3.5		6.9 ± 2.2	
Cognitive status					
Preserved	21	17.4 ± 6.3	<0.001	15.8 ± 6.1	<0.001
Impaired	57	10.8 ± 5.1		8.9 ± 5.5	

HGS = handgrip strength

Figure 2 shows the relationship of right and left HGS with cognitive status (MMSE score) and functional capacity (Katz score). Right HGS showed a moderate and positive correlation with cognitive status i.e., the higher the MMSE score, the greater the HGS; and a moderate and negative correlation with functional capacity, demonstrating that older adults classified as A and B according to the Katz index are more independent and exhibit greater HGS. Left HGS showed a moderate and positive correlation with cognitive status and a moderate and negative correlation with functional capacity.

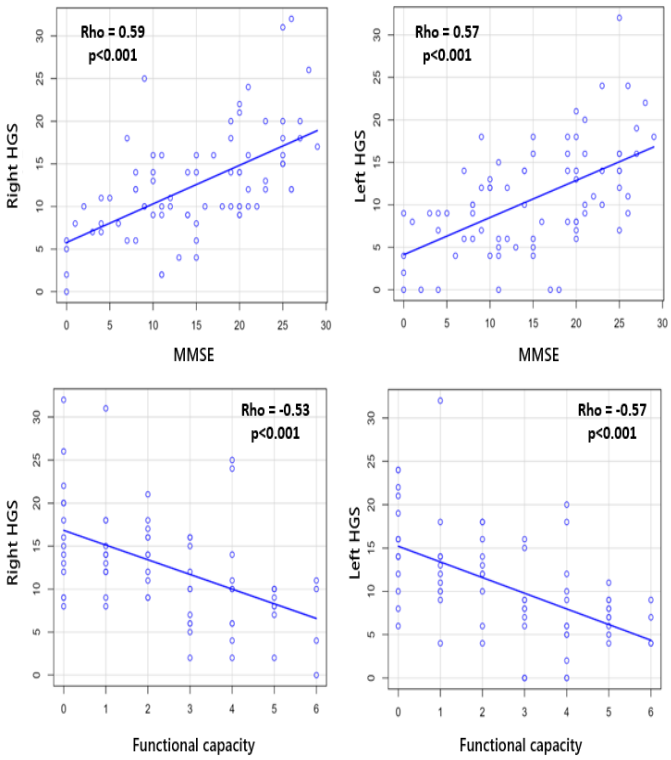

Figure 2. Spearman's correlation coefficient of handgrip strength with functional capacity and cognitive status

DISCUSSION

The present study aimed to compare and correlate HGS with functional capacity and cognitive status in centenarians. The results showed that reduced HGS was associated with functional capacity and cognitive status in centenarians. In addition, a difference in mean right and left HGS was observed regarding gender, functional capacity, and cognitive status.

Although the literature does not present specific reference values for HGS of centenarians, studies with older people between 80 and 99 years old identified means between <14Kg/f and <15Kg/f.[32,33] Thus, it is observed that the values of both hands of the centenarians in our study are lower, which may explain the decrease in strength with advancing age. In the study of Lenardt et al.[32] long-lived individuals were more likely to have reduced HGS, which is an indicator of global muscle strength. Bez and Neri[33] also found that individuals older than 80 years are more likely to be classified as low HGS (< 15 kg/f), with consequences for functional capacity and quality of life.

A relationship exists between muscle strength and cognitive status in centenarians. Stessman et al.[34] showed that reduced HGS is associated with impaired cognition in long-lived older

adults, increasing the risk of functional declines and subsequent death. The results of the present study indicate that the lower the HGS, the greater the cognitive impairment of centenarians; on the other hand, greater HGS is associated with more preserved cognitive performance. The findings corroborate a study on Portuguese centenarians that demonstrated a positive association between motor and cognitive functions, in which greater cognitive impairment was correlated with lower physical capacity of centenarians.[35]

It is worth highlighting that the progressive reduction of muscle strength in older adults is associated with physical disability, reduced mobility, and mortality,[36] i.e., the long-lived population in particular is more vulnerable to the risks of frailty syndrome.[37,38] Furthermore, the older the individual, the more likely he/she is to adopt a sedentary behavior and to become a frail elderly person.[22]

Physical inactivity and sedentarism in the long-lived population need to be addressed in view of the increasing decline in physical skills during the aging process. A decrease in muscle strength is one of the factors responsible for the loss of mobility, functional deficits, and episodes of falls.[38,39] This condition is characterized by criteria that take into account sarcopenia and reduced muscle power, in addition to cognitive deficit, with a consequent decrease in walking ability, increased fatigue and falls, and difficulty in performing ADL.[19,40]

The present results showed a significant difference in mean HGS (right and left) according to functional capacity. Byrne et al.[3] reported an association of reduced muscle mass and power with an increase in functional limitations, affecting ADL.

Similarly, Casas-Herrero et al.[20] studying 43 individuals older than 90 years with mild cognitive impairment, observed a high incidence of low muscle strength and a significant association with falls and reduced functional capacity. Gobbens et al.[41] emphasized that reduced functional capacity is a consequence of frailty, i.e., the frail older adult loses some skills such as muscle strength, mobility, balance, endurance and coordination, which ultimately results in functional deficits.

In addition, sarcopenia negatively affects functional capacity, reducing physical activity and aggravating muscle weakness and fatigue, events that directly influence functional capacity.[42] In a study on institutionalized frail nonagenarians, Cadore et al.[43] observed improvement in muscle strength and power after 12 weeks of a multicompenent exercise intervention, improving the number of falls and functional capacity. Taken together, the results of the cited studies indicate that the higher the level of muscle strength, the better the functional capacity and the lower the risk of falls in older adults.

This study has some limitations, including the fact that the dominant hand of the participants wasn't verified for measuring HGS, which may compromise some analyses related to the laterality of HGS. In addition, since a population of centenarians was evaluated, there are few studies providing reference values, which would be important for the comparison with the present findings. In the other hand, a strength of this study is that it reports the characteristics of the physical phenotype of this population of centenarians.

The findings are of great importance for the long-lived population and may serve as a basis for future studies and interventions for this growing population.

CONCLUSION

This study demonstrated an association of HGS with functional capacity and cognitive status in centenarians. Moreover, a difference in mean right and left HGS was observed regarding gender, functional capacity, and cognitive status. Therefore, the preservation of muscle strength is an important factor to reduce the loss of neuromuscular and cognitive functions associated with aging. These findings highlight the need for healthcare professionals to encourage and intervene so that long-lived individual have an active lifestyle.

For future research, experimental studies are recommended to better understand the relationship between HGS and neuromuscular efficiency. Furthermore, studies that provide reference parameters for HGS, functional capacity, and cognitive status of centenarians will allow for a better understanding of this long-lived population.

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