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Research Article

Dynamometer Measurements of Grip Strength in Frail Elderly Inpatients

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Sarcopenia and frailty are two clinical entities that generate loss of independence. Sarcopenia is characterized by loss of skeletal muscle mass and strength and is a risk factor for frailty and physical disabilities [1]. To diagnose fragility must is necessary 3 of the following 5 criteria: unintentional weight loss, decreased walking speed, low physical activity, fatigue and decreased grip strength [2].

Both conditions are related with multiple comorbid factors such as falls, functional decline, osteoporosis, impaired thermoregulation and glucose intolerance that contribute to disability, morbidity and hospital lengstay [3,4].

There are few studies about sarcopenia prevalence according to standards of European study group of sarcopenia in the elderly (EWGSOP) [1], but there is a growing interest in the study of this entity. In fact in our country there are recent studies in hospitalized elderly [5] and some research projects with institutionalized elderly [6].

One of the aspects to be evaluated is the skeletal muscle strength often decline with age in both upper and lower limbs in different proportions.

In young healthy populations, quadricipital strength exceeds prehensile (grip) strength by approximately 25%. With age, quadricipital and grip strength values tend to be on the same level at 1:1 [7], which reflects loss of accelerated strength in lower limbs (by around 27%) as opposed to upper limbs (loss of 14%) in a healthy adult population aged between 60 and 80 years [7,8]. As from 80 years, such loss of strength becomes much more marked [9].

Measuring grip strength and its correlation with lower-extremity strength is a logical construct while physically examining a healthy adult population [10,11] and while also predicting invalidity in an aged population[12]. Recently Sotello et al. describe that lower limb (LL) decline is a sign of frailty in older ambulant subjects [13]. Elderly people hospitalized for several clinical reasons has, in most cases, loss of walk ability that shows sarcopenia and frailty conditions and consequent dependence and disability.

It is unknown if in frail bedridden rate of muscle mass loss between upper and lower limbs is higher than healthy elderly population. In frail bedridden old subjects assessing muscle strength, is not an easy task because often there isn't optimum collaboration for several reasons: difficulty in understanding the exploratory maneuvers existence of cognitive impairment or delirium.

Measuring grip strength by dynamometry is a relatively easy technique, can be done at patient's bedside, and even in patients with a limited level of comprehension.

So we propose the following work whose objectives are:

1) Assess grip strength value in frail elderly inpatients

2) Assess the correlation between grip strength and lower limbs strength in this sample

3) Analyze the influence of cognitive impairment in assess grip strength value.

Materials and Methods

Descriptive longitudinal observational study of all consecutive geriatric, cancer and non-cancer patients admitted to the mid- and medium-term (patient admission for 1-2 months) palliative care unit for non-terminal palliative treatment, convalescence or rehabilitation irrespectively of origin (medical, surgical, intensive units). Patients under 65 years old, patients requiring terminal palliative care, and those with severe cognitive impairment, no qualified carer or with a language barrier that would not allow them to participate in the clinical interview were excluded. Patients were collected from October 2011 to October 2013. Clinical exam was conducted by specialists in Physical Medicine and Rehabilitation familiar with the assessment of physical function as ad hoc protocol between the first and second week of admission.

Method assessment included the following sections:

- Mean manual muscle test (MMT) of the pelvic muscle girdle based on the Medical Research Council Scale (MRC) [14]. This is an ordinal scale for for diagnosis and monitoring of muscle strength. Testing muscle strength goes from 0 (no movement, no contraction) to 5 (Muscle contracts against full manual oppose: normal strength). Tested muscle was: hip flexion, hip abduction muscle and knee extension muscle of both lower limbs as its ability to ensure the standing and walking. We considered strength average for both lower limbs.

- Manual passive joint arch exam of upper and lower limbs in order to assess structured stiffness with a possible impact on the strength training. It was accept joint limitation of over 50% for age.

- Hand grip strength measured with a hydraulic hand dynamometer (Baseline® measurements Fabrication Enterprises, USA) according to the standard protocol[15], which employs the mean of three strength tests as the resultant score for both hands. For each grip strength test, the subject was seated or placed in a semi-seated position (according to the patient's clinical conditions) with shoulder adducted and neutrally rotated, elbow flexed at 90°, forearm in a neutral position, and wrist between 0° and 30° dorsiflexion and between 0° and 15° ulnar deviation.

- Recording cognitive impairment as a confounding variable according to the Short Portable Mental Status of Pfeiffer (SPMSQ)[16,17]. This is shelf-administered questionnaire consisting of 10 items. The cutoff is 3 or more errors in the case of people who at least can read and write and 4 or more for those who do not. From that score is suspected of impairment cognitive.

Statistical Analysis

- Spearman's non-linear correlation was used to check the possible association between an ordinal variable (lower limb muscle) and the two quantitative variables (grip strength of the right and left hands).

- Ordinal regression analysis to determine the probability of obtaining a different pelvic muscle strength score according to the patient's grip strength.

- Ordinal regression analysis to distinguish whether cognitive impairment exists and if it acts as a confounding variable of the strength measure.

All these analyses were done with the R software (version 2.15.3).

Results

The study sample was made up of 138 patients, 71 men and 67 women, whose mean age was 81.14 years (65-98a).

Among the reasons (from the most frequent to the least frequent) for being admitted into hospital, the following predominated: infections (23.9%: 33 patients of the sample), decompensations of a previous lung pathology (21.7: 30 patients) or heart problems (15.9: 22 patients).

Descriptive analysis results

Regarding joint movement most of the study sample presented adequate articular mobility in upper limbs (87.76%, 121 patients) and lower limbs (87.0%, 120 patients) for their age. Sample presented generalized muscle pelvic muscle weakness with a median MMT score of 4 (1^{st}-3^{rd} Q: 3-4). The mean grip strength values between both upper limbs were similar: 12.0 kg (SD: 6.38) right-hand grip strength; 11.25 kg (SD: 6.03); left-hand grip strength. No relation was found between grip strength and handedness. Figure 1 provides details of grip strength and MMT of the pelvic muscle girdle, differentiated by genders. Table 1 shows raw ordinal data with medium, quartiles and dispersion data. When evaluating cognitive status, 36.2% of our patients (N=50) presented cognitive impairment according to the Pfeiffer test.

Non-linear correlation analysis results

Figure 2 depicts how the range of grip strength values varied (left hand, right hand, both hands) for each pelvic muscle strength value. This graphic association between both values is observed as grip strength in both hands (both the right and left hands) increased at the same time as pelvic girdle strength increased (box diagram). Reciprocally, the greater pelvic muscle strength became, the stronger grip strength was.

Table 2 provides the Spearmen's correlation test results. The "rho" values obtained as a measure of the degree of association between the two strength variables (0.42, 0.47 and 0.46)

indicate a positive relation to the extent that if one variable increased, the other also did.

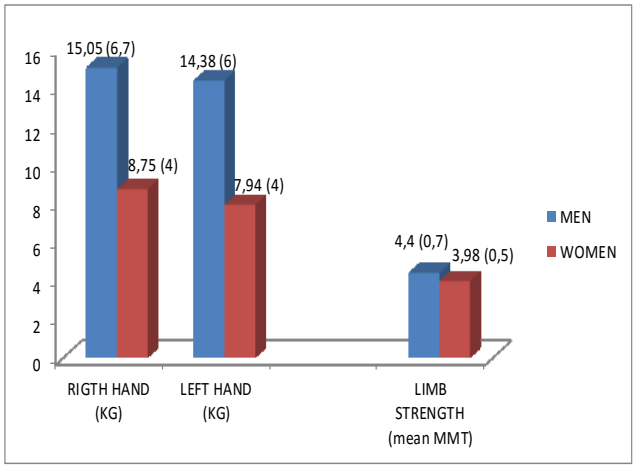
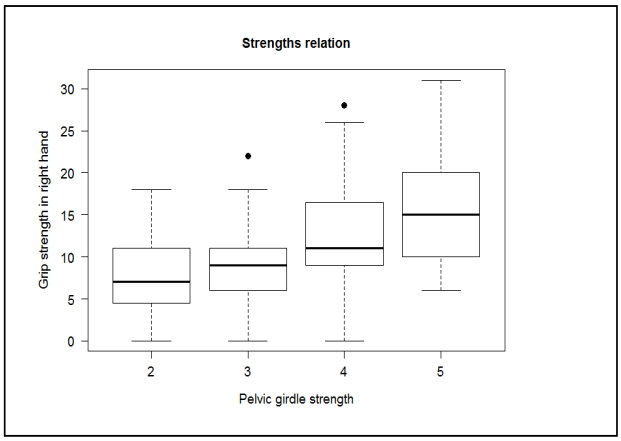


Figure 1. Mean grip strength values for each hand (expressed as kg and mean Manual Muscle Test (MMT) of lower extremities). Standard deviations (SD) are shown in brackets.

Variable	Min	Quartile1	Quartile3	Max	Mean	SD
Age	65	76	87	98	81.13	7.64
MMT upper limbs	2	4	5	5	4.22	0.75
MMT lower limbs	2	3	4	4	3.77	0.91
Rigth hand grip	0	8.37	16	31	12.01	6.38
Left hand grip	0	7.07	14.75	30	11.25	6.03
Charlson index	0	2	3	7	2.67	1.41

Table 1. Raw ordinal data with medium, quartiles and dispersion data.



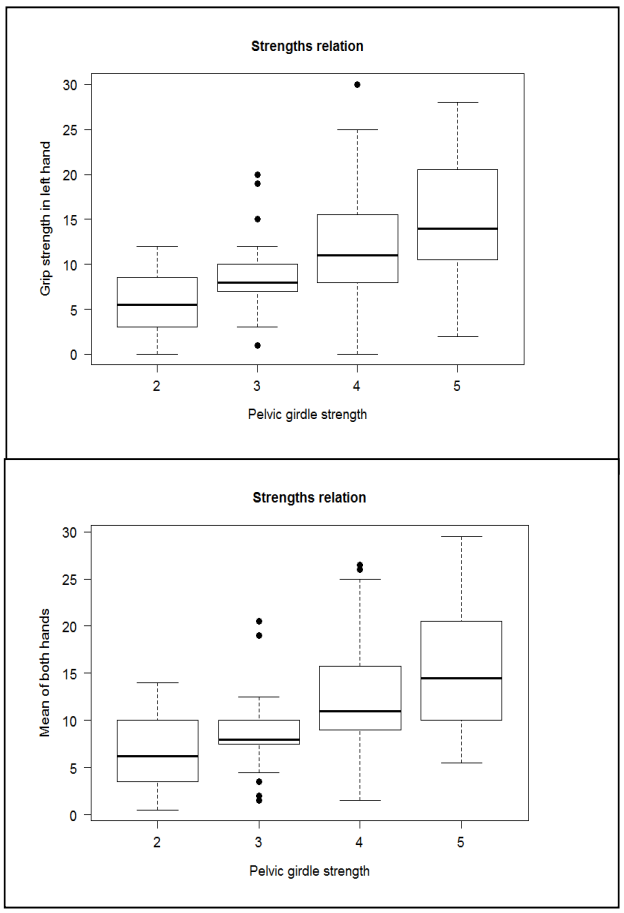


Figure 2. Box diagram between pelvic muscle strength value and grip strength (left hand, right hand, both hands) .

RELATION	P-VALUE	RHO VALUE
Pelvic muscle girdle strength – Right hand	< 0.01	0.42
Pelvic muscle girdle strength – Left hand	< 0.01	0.47
Pelvic muscle girdle strength – Both hands	< 0.01	0.46

Table 2. Spearman correlation test "Rho" values as a measure of the degree of association between muscle strength of lower limbs and grip strength.

Ordinal regression analysis results

Table 3 reflects the ordinal regression analysis results to determine the probability of obtaining an MMT score for pelvic muscle girdle higher than 3 and an MMT value higher than 4 depending on the grip strength exerted. Ordinal regression analysis shows that the association between grip strength and MMT remains statistically significant with or without cognitive impairment (p <0.001).

The ordinal regression model included the variables grip strength, Charlson index and cognitive impairment as predictors and MMT as response variable.

To assess the association between MMT and cognitive impairment a model nested to the first one was fitted without the variable cognitive impairment and a likelihood ratio test was used. Since the p value was not significant we found no evidence that cognitive impairment is associated to MMT values.

Probability	Grip strength (kg)	
	MMT>3	MMT>4
50%	6.5	22
75%	14	29
90%	22	36

Table 3. Ordinal regression analysis determines the probability of obtaining MMT score for pelvic girdle depending on the grip strength exerted.

Minimum grip strength values to achieve a MMT greater than 3 (first-column) or 4 (second column) with a probability of 50% (first row), 75% or 90% (second and third rows).

Discussion

The study of muscle strength in geriatric population is interested because it has been found that their decline is related to disability [9] and mortality[18].

In our study sample, comprised of elderly frail patients whose mean age was 81.4 years, we verified the existence of generalized weakness in grip strength and in lower extremities. We can see that the elderly non-institutionalized population presents strength values that are approximately 3-fold higher than those obtained by the subjects in our sample [19-22].

The decline in skeletal muscle strength is related sarcopenia and frailty. Although there are methodological aspects not measured to define these concepts in the present study, our results are consistent with the concepts of frailty and sarcopenia because the sample has very low values of strength, severe physical function impairment, loss of ambulation and bedridden.

The Spearman's correlation test shows a statistically significant relation ($p<0.01$) between grip strength (both left and right) and strength in lower limbs (hip flexors and abductors muscle, and knee extensors; Table 1). "Rho" values indicate that the positive correlation is moderate (values between 0.5 and 0.69). In figure 2, Box diagram between pelvic muscle strength value and grip strength (left hand, right hand, both hands) graphics this relation. In this sense, is not novel correlation between grip strength and the strength of the quadriceps strength in normal adult population [11] in the population receiving physiotherapy[23] and elderly population population[9,10,22]. Muscle analytical assessment by MMT is commonly used in clinical and constitutes a fundamental tool for the control and monitoring of muscular balance. It is a subjective method although several studies confirm its reliability and validity [24]. The contribution offered by our work is to ensure that this relationship is maintained with a valuation method of the subjective force such as manual muscle test (MMT).

The ordinal regression analysis also establishes pelvic girdle MMT score probabilities according to the grip strength exerted (Table 2). This aspect we consider may be useful in daily clinical assessment in this patient group whose psycho-physical conditions frequently hinder evaluation of their physical function. In line with this, the possible influence of cognitive deterioration on the grip strength exerted has been considered. Thus, the ordinal regression analysis reveals that the association between grip strength and MMT is still statistically significant ($p < 0.001$), which renders cognitive impairment as being a less important confounding variable in our sample. Tappendien et al. in their systematic review, verified that the functional results between a population not presenting deterioration and one with slight or moderate dementia were similar [25], which coincides with our results.

In this patient group, the use of simple evaluation tools that provide reliable, reproducible information on strength is particularly useful. The Jamar dynamometer is considered to be the gold standard, although other instruments, such as the Baseline dynamometer employed in the present work, provide measures that can be interchanged with the first-cited instrument and offer excellent inter-instrumental reliability [26]. In this way, we accept the grip strength results as being valid, which are much lower than those obtained in a healthy geriatric population, as mentioned earlier. Moreover in our study sample, the strength exerted by each (left and right) hand does not differ significantly, and this result is in line with those reported in previous studies [27].

Therefore, measuring grip strength by dynamometry is a relatively simple technique, can be done at the patient's bedside, even among patients whose comprehension is limited. With our findings, we can approximately determine strength of lower extremities from grip strength in patients whose collaboration is deficient and who find it hard to understand the examination manoeuvres involved, or those with cognitive deterioration or confusional syndrome. Therefore, applying hydraulic dynamometry to frail hospitalised patients could be useful to evaluate grip strength. So we think that this method is very useful for assessment lower limb strength without assess it when patient collaboration is very poor.

Conclusion

In elderly frail patients, there is generalised weakness in grip strength and in lower extremities. A statistically significant relation exists between dynamometric grip strength and the lower limbs strength analysed with manual muscle test. Strength of both lower extremities can be approximately deduced from grip strength.

Measuring grip strength by dynamometry is a simple technique that can be applied to frail hospitalised patients with a limited level of comprehension. Authors conclude that with a simple and economical method is objectively possible to approach the lower limbs strength in frail elderly inpatients whose cooperation is very limited and thus establish therapeutic programs to improve their physical function.

Disclosure Statement

The content of this manuscript has not been published or submitted for publication elsewhere. All authors have contributed significantly in this paper and all authors are in agreement with the content of the manuscript.

Authors should declare any financial support or relationships that may pose conflict of interest.

References

1. Cruz-Jentoft A, Baeyens JP, Bauer JM, Cederholm T, Land F et al. Sarcopenia: European consensus on definition and diagnosis. Report of the European Working Group on Sarcopenia in Older People. Age Ageing. 2010, 39(4): 412-423.

2. Fried LP, Walston J. Frailty and failure to thrive. In: Hazzard WR, Blass JP, Halter JB, Ouslander JG, Tinetti ME, editors. Principles of geriatric medicine and gerontology. 5th ed. New York: McGraw-Hill; 2003. p. 1487-502.

3. Cawthon PM, Marshall LM, Michael Y. Frailty in older men: prevalence, progression, and relationship with mortality. J Am Geriatr Soc. 2007, 55(8): 1216–1223.

4. Cawthon PM, Fox KM, Gandra SR, Delmonico MJ, Chiou Cf et al. Health, Aging and Body Composition Study. Do muscle mass, muscle density, strength, and physical function similarly influence risk of hospitalization in older adults?. J Am Geriatr Soc. 2009, 57(8): 1411-1419.

5. Rubio C, Duarte E, Beseler MR, Moreno I, Moral P et al. Prevalence of sarcopenia in a media and long stay unit. Rev Clin Esp. 2014, 214(6): 303-308.

6. Osuna CM, Serra JA, Viña J, Gómez MC, Salvá A et al. Prevalence of sarcopenia in geriatric outpatients and nursing homes. The ELLI study Rev Esp Gerriatr Gerontol. 2014, 49(2): 72-76.

7. Samuel D, Wilson K, Martin HJ, Allen R, Sayer AA et al. Age-associated changes in hand grip and quadriceps muscle strength ratios in healthy adults. Aging Clin Exp Res. 2012, 24(3): 245-250.

8. Samuel D, Rowe P. An investigation of the association between grip strength and hip and knee joint moments in older adults. Arch Gerontol Geriatr. 2012, 54(2): 357-360.

9. Garcia PA, Dias JD, Dias RC, Santos P, Zampa CC. A study on the relationship between muscle function, functional mobility and level of physical activity incommunity-dwelling elderly. Rev Bras Fisioter. 2011, 15(1): 15-22.

10. Arnold CM, Warkentin KD, Chilibeck PD, Magnus CR. The reliability and validity of handheld dynamometry for the measurement of lower-extremity muscle strength in older adults. J Strength Cond Res. 2010, 24(3): 815-824.

11. Bohannon RW, Magasi SR, Bubela DJ, Wang YC, Gershon RC. Grip and knee extension muscle strength reflect a common construct among adults. Muscle Nerve. 2012, 46(4): 555-558.

12. Bohannon RW. Hand-grip dynamometry predicts future outcomes in aging adults. J Geriatr Phys Ther. 2008, 31(1): 3-10.

13. Sotello Batista F, de Oliveira Gomes GA, Liberalesso Neri A, Guariento MA, Cintra FA et al. Relationship between lower-limb muscle strength and frailty among elderly people. Sao Paulo Med J. 2012, 130(2): 102-108.

14. Medical Reseach Council. Aids to the investigation of peripheral nerve injuries. War Memorandum Nº 7. London. His Magesty's Stationery Office;1943.

15. Fess EE, Moran C. Clinical assessment recommendations. Indianapolis: American Society of Hand Therapists; 1981.

16. Pfeiffer, E. A short portable mental status questionnaire for the assessment of organic brain deficit in elderly patients. J Am Geriatr Soc. 1975, 23(10): 433-441.

17. Martínez de la Iglesia J, Dueñas Herrero R, Onis Vilches MC, Aguado Taberne C, Albert Colomer C et al. Adaptación y validación al castellano del cuestionario de Pfeiffer (SPMSQ) para detectar la existencia de deterioro cognitivo en personas mayores de 65 años. Med Clin. 2001, 117(4): 129-134.

18. Newman AB, Kupelian V, Visser M, Simonsick EM, Goodpaster BH et al. Strength, But Not Muscle Mass, Is Associated With Mortality in the Health, Aging and Body Composition Study Cohort. J Gerontol A Biol Sci Med Sci. 2006, 61(1): 72–77.

19. Viana BH, Gómez JR, Paniagua MV, Da Silva ME, Núñez V y Lancho JL. Características antropométricas y funcionales de individuos activos, mayores de 60 años, participantes en un

programa de actividad física. Rev Esp Geriatr Gerontol. 2004, 39(5): 297-304.

20. Patel HP, Syddall HE, Jameson K, Robinson S, Denison H et al. Prevalence of sarcopenia in community-dwelling older people in the UK using the European Working Group on Sarcopenia in Older People (EWGSOP) definition: findings from the Hertfordshire Cohort Study (HCS). Age Ageing. 2013, 42(3): 378–384.

21. Bijlsma AY, Meskers CGM, Ling CHY, Narici M, Kurrle SE et al. Defining sarcopenia: the impact of different diagnostic criteria on the prevalence of sarcopenia in a large middle aged cohort. Age. (2013), 35(3): 871–881.

22. Hicks GE, Shardell M, Alley DE, Miller RR, Bandinelli S et al. Absolute Strength and Loss of Strength as Predictors of Mobility Decline in Older Adults: The InCHIANTI Study. J Gerontol A Biol Sci Med Sci. 2012, 67(1): 66–73.

23. Bohannon RW. Are hand-grip and knee extension strength reflective of a common construct? Percept Mot Skills. 2012, 114(2): 514-518.

24. Brandsma JW, Schreuders TA, Birke JA, Piefer A, Oostendorp R. Manual Muscle strength testing: intraobserver and interobserver reliabilities for the intrinsec muscles of the hand. J Hand Ther. 1995, 8(3): 185-190.

25. TappendenP, Campbell F, Rawdin A, Wong R, Kalita N. The clinical effectiveness and cost-effectiveness of home-based, nurse-led health promotion for older people: a systematic review. Health Technol Assess. 2012, 16(20): 1-72.

26. Roberts HC, Denison HJ, Martin HJ, Patel HP, Syddall H et al. A review of the measurement of grip strength in clinical and epidemiological studies: towards a standardised approach. Age and Ageing. 2011, 40(4): 423–429.

27. Bandinelli S, Benvenuti E, Del Lungo I, Baccini M, Benvenuti F et al. Measuring muscular strength of the lower limbs by hand-held dynamometer: a standard protocol. Aging (Milano). 1999, 11(5): 287-293.