# Handgrip strength in elderly with dementia: study of reliability

## Força de preensão palmar em idosos com demência: estudo da confiabilidade

Mariana A. Alencar[1], João M. D. Dias[2], Luisa C. Figueiredo[3], Rosângela C. Dias[2]

## Abstract

**Background:** Measuring instruments should have their scientific and clinical value evaluated in different populations. The handgrip strength test is widely used, however little has been investigated about its reliability when used in elderly with dementia and the right stage wich its use should be avoided. **Objectives:** To evaluate the test-retest reliability of the handgrip strength test in elderly with different ratings of dementia. **Method:** The cognitive function of 76 elderly subjects with dementia was measured, and the caregivers were interviewed to allow classification by the Clinical dementia rating (CDR). For these assessments the Mini-Metal State Examination and the Pfeffer, Lawton, and Katz scales were used. Twenty subjects were classified as borderline (83.4± 5.8 years), 19 as mild (82.4±6.8 years), 19 as moderate (85.8±5.6 years) and 18 as severe dementia (84.0±5.1 years). Handgrip strength was assessed with a JAMAR hydraulic dynamometer and after one week it was reevaluated. Reliability was analyzed by Intraclass Correlation Coefficient (ICC). The significance level was set at $\alpha$=0.05. **Results:** Test-retest reliability was excellent for groups with borderline (ICC=0.975; p=0.001), mild (ICC=0.968; p=0.002), and moderate (ICC=0.964; p=0.001) dementia. The analysis of the group with a severe CDR showed no statistical significance and a low ICC (ICC=0.415; p=0.376). **Conclusion:** The handgrip strength test has excellent reliability when used in elderly with borderline, mild, and moderate dementia, which enables its use in research. However, its use is not recommended in elderly classified with severe dementia due to the measure's low reliability and subsequent irrelevance in clinical practice.

**Keywords:** elderly; rehabilitation; dementia; handgrip strength; reliability.

## Resumo

**Contextualização:** Instrumentos de medida devem ser analisados quanto a sua utilidade clínica e científica em diferentes populações. Apesar de o teste da força de preensão palmar (FPP) ser amplamente utilizado, pouco foi investigado quanto a sua confiabilidade ao ser utilizado em idosos com demência e em qual grau de demência seria inviabilizado o seu uso. **Objetivo:** Avaliar a confiabilidade teste-reteste da FPP em idosos com diferentes graus de demência. **Método:** Realizou-se uma avaliação dos aspectos cognitivos de 76 idosos com demência e uma entrevista com o cuidador, permitindo a classificação do idoso segundo os critérios da Escala Clínica de Demência (*Clinical dementia rating* – CDR). Para essas avaliações, foram utilizados o Miniexame do Estado Mental e os questionários Pfeffer, Lawton e Katz. Vinte idosos foram classificados como grau questionável (83,4±5,8 anos); 19, como leve (82,4±6,8 anos); 19, como moderado (85,8±5,6 anos) e 18, como grave (84,0±5,1 anos). Os idosos tiveram a FPP avaliada por meio de um dinamômetro hidráulico JAMAR e, após uma semana, foram reavaliados. A confiabilidade foi estimada pelo Coeficiente de Correlação Intraclasse (ICC). O nível de significância foi $\alpha$=0,05. **Resultados:** A confiabilidade teste-reteste foi excelente para os grupos que apresentaram o CDR questionável (ICC=0,975; p=0,001), leve (ICC=0,968; p=0,002) e moderado (ICC=0,964; p=0,001). A análise do grupo com CDR grave mostrou não haver uma significância estatística e um ICC baixo (ICC=0,415; p=0,376). **Conclusão:** O teste de FPP apresenta excelente confiabilidade ao ser utilizado em idosos com demências questionável, leve e moderada, viabilizando seu uso em pesquisas. Já em idosos classificados como graves, seu uso não é recomendado visto que a confiabilidade da medida é baixa e, portanto, sem relevância clínica para uso na prática.

**Palavras-chave:** idoso; reabilitação; demência; força de preensão palmar; confiabilidade.

[1]Universidade FUMEC, Belo Horizonte, MG, Brazil

[2]Physical Therapy Department, Universidade Federal de Minas Gerais (UFMG), Belo Horizonte, MG, Brazil

[3]Physical Therapist, Brasília, DF, Brazil

**Correspondence to:** Mariana A. Alencar, Rua Piauí, 741/901 Funcionários, CEP 30150-320, Belo Horizonte, MG, Brazil, e-mail: masmaralencar@yahoo.com.br / malencar@fumec.br

# Introduction ::::.

In recent decades, the world's demographic and epidemiological scenario has been changing, and the panorama seen today is one of an aging population and an increase in chronic diseases[1]. Among these diseases, dementia has stood out for being considered an significant public health problem, not only for its high prevalence and the large increase in its incidence in recent years but also for being a major cause of incapacity, loss of autonomy and independence, and of mortality[1-3]. In light of this, there is a need to study dementia further to better understand the factors associated with it, its consequences, and the forms of therapeutic intervention[2].

However, an analysis of the available literature showed the exclusion of elderly with dementia in a large part of the studies[4,5]. In most cases, the justification for exclusion is the uncertainty about the reliability of the measurements, as dementia leads to a progressive loss of memory, judgment, and attention and concomitant manifestation of aphasia and apraxia, which may influence the use of measuring devices[6]. Besides this, a reduction in the ability to concentrate and apprehension in relation to an unfamiliar device may hinder satisfactory measurements[5,7]. In contrast, there are studies that used devices on elderly patients with dementia, without any prior assessment to the reliability of the measuring technique for this population[8-10].

One measurement that has been widely used in research and clinical practice, both in the elderly with and without dementia, is strength assessed by means of the dynamometer hand grip[4,10-12]. The hand grip strength (HGS) test is a relatively inexpensive measurement that provides an approximation of overall muscle strength and which is strongly associated with functionality[4,13,14]. The handgrip dynamometer has had its psychometric properties evaluated in populations without cognitive alterations and has been proven to be valid and reliable (intra-examiner reliability: ICC 0.94-0.98)[14]. However, the reliability of this device is not known when used in elderly patients with cognitive impairment, nor is it known at which degree of dementia its use would become unviable. Some studies found a reduction in HGS as the Mini-Mental State Examination (MMSE) score decreased, but the authors did not assess the reliability of the measurements[10-12].

The reliability of HGS is fundamental for satisfactory data collection, since reliability is in the consistency of the results. In other words, the reliability of a measurement is the confidence it inspires. Reliable results allow the professional to reach conclusions that are minimally affected by external factors, thereby reducing the chances of error[15,16]. Therefore, the objective of this study was to evaluate the test-retest reliability of HGS in elderly subjects with different degrees of dementia.

# Method ::::.

## Sample

76 elderly subjects (83.9±5.8 years) aged 65 or more, of both sexes, with medical diagnoses of dementia (Alzheimer's Dementia or Vascular Dementia) were evaluated. The exclusion criteria adopted in this study were: to be bedridden, wheelchair-bound or in a terminal stage; be institutionalized; have hearing or visual impairments or upper limb disorders that would hinder testing. To reach the sample size, the sample calculation was performed based on a pilot study, assuming a statistical power of 80% and a significance level of 5%.

This study was approved by the Research Ethics Committee of Universidade Federal de Minas Gerais (UFMG), Belo Horizonte, MG, Brazil (ETIC 220/09). Those responsible and/or the elderly subjects and their caregivers were given a detailed explanation of the objectives and evaluation procedures and signed a free and informed consent form agreeing to participate voluntarily in the research.

## Evaluation devices

HGS was assessed using the JAMAR® Hydraulic Hand dynamometer (Model PC-5030J1, Fred Sammons, Inc., Burr Ridge, IL, USA). This device contains a closed hydraulic system that measures the amount of force produced by an isometric contraction applied to the handles and the grip is recorded in kilogram-force[15,17].

To classify the degree of dementia, was used the Clinical Dementia Rating (CDR)[18,19]. The CDR evaluates cognition and behavior, as well as the influence of cognitive loss on the capacity to adequately perform day-to-day activities. This device is divided into six cognitive behavioral categories: memory, orientation, judgment or problem solving, community relations, activities in the home or of leisure, and personal care. Each of these six categories must be classified as: 0 (no change); 0.5 (borderline); 1 (mild dementia); 2 (moderate dementia), and 3 (severe dementia), except the personal care category, which has no 0.5 level. The memory category is considered the most important and has a greater weight than the others[18,19]. The final CDR classification is obtained by the analysis of these classifications by categories, following a set of rules prepared and validated by Morris[19].

In order to assist the classification of elderly subjects in CDR categories, it was necessary to evaluate aspects related to their memory and ability to perform day-to-day activities. Therefore, a semi-structured questionnaire was used to collect

information related to the memory of the elderly subject (consistency of memory loss; capacity to judge dangerous situations and decision making; ability to remember past dates; the impact of memory loss on day-to-day activities and an investigation of the ability to remember facts in the three days prior to the interview), the Mini-Mental State Examination (MMSE)[20,21], an assessment questionnaire on advanced activities of daily living[22], the Lawton Questionnaire (assessment of instrumental activities of daily living)[23], the Pfeffer Questionnaire (assessment of instrumental activities of daily living for the elderly with dementia)[24], and the Katz Index (evaluation of basic activities of daily living)[25]. The classification of the subjects regarding the severity level of their dementia was carried out in consensus between two researchers who had previously undergone classification training in CDR and obtained certification from the Alzheimer's Disease Research Center, Washington University, St. Louis.

## Procedures

Initially, with the help of the elderly subject's caregiver, information on their sociodemographic characteristics, conditions related to memory, and aspects related to the activities of daily living were gathered. In this study, the caregiver was considered to be the closest person to the elderly subject who spent the most time with him/her. Subsequently, the MMSE was applied and the HGS test performed. In its implementation, the recommendations of the American Society of Hand Therapists (ASHT) were adopted, whereby measurement is performed with the individual seated on a chair without armrest and with feet flat on the floor, shoulder adducted, the elbow flexed at 90°, the forearm in a neutral position, and the wrist between 0 and 30° extension[15,17]. The dynamometer's mobile handle was placed in position II for women, position III for men or in another position above or below that mark if the subject's hand was anatomically larger or smaller than average[15].

In order to familiarize the subjects with the procedures, they were given opportunity to handle the dynamometer before measurement recording. The measurement was made on the dominant hand, and a verbal command was given by the examiner, "Now squeeze the hand grip that you are holding. Let's go, squeeze tight, harder…". This command was given for six seconds[15]. This procedure was repeated three times, with a one-minute rest interval between tests. The mean of three measurements in kilogram-force (Kgf) was calculated. HGS was reassessed according to the same procedures after one week.

## Statistical analysis

To perform the data analysis, the statistical program SPSS, version 14.0 was used. A descriptive analysis of the demographic data was conducted, and reliability was tested by the Intraclass Correlation Coefficient (ICC). The significance level was set at 0.05.

## Results

The elderly subjects were divided into four groups according to CDR classification; the borderline group (grade 0.5) was composed of 20 elderly subjects; the mild group (grade 1), of 19 subjects; the moderate group (grade 2), of 19 subjects; and the severe group (grade 3), of 18 subjects. Their clinical and demographic characteristics are described in Table 1.

The test-retest reliability was excellent for the groups with borderline (ICC=0.975, p=0.001), mild (ICC=0.968, p=0.002), and moderate (ICC=0.964, p=0.001) CDR.

In the group with severe CDR, four participants failed to perform the grip test due to difficulty in understanding the command and were, therefore, not included in the analysis. The analysis of the elderly subjects with severe CDR who were able to complete the test showed no significance and a low ICC (ICC=0.415, p=0.376). These reliability results can also be found in Table 2.

**Table 1.** Clinical and demographic characteristics of subjects.

| Variables | n=76 n (%) or mean± SD |
|---|---|
| Age (years) | 83.9±5.8 |
| Female | 64 (84.2%) |
| Marital status | |
|   Married | 19 (25%) |
|   Widow | 57 (75%) |
| Education (years) | 6.2±2.8 |
| MMSE | 12.7±7.2 |
| BADL (Katz) | |
|   Independent in all activities | 19 (25%) |
| IADL | |
|   Lawton | 11.0±3.3 |
|   Pfeffer | 22.6±8.9 |
| AADL | |
|   "Still performs" | 4.03±1.87 |
|   "Stopped performing" | 3.20±1.84 |

n=number; %=percentage; SD=standard deviation; MMSE=mini-mental state examination; BADL=basic activities of daily living; IADL=instrumental activities of daily living; AADL=advanced activities of daily living.

## Discussion :::.

Despite the importance of guaranteeing the reliability of a device thereby ensuring a low margin of measurement error, there is a frequent use of the hand grip dynamometer in elderly subjects with dementia, both in the clinical environment and in research[10-12,26], without any prior assessment as to the reliability of its use in elderly subjects with different degrees of dementia. Therefore, this study aimed to evaluate the reliability of this measurement in this population.

According to the results, when evaluating the reliability of the hand grip strength test on elderly subjects with varying degrees of dementia, this measurement proved reliable (ICC≥0.964, p≤0.002) when used on elderly subjects with borderline (grade 0.5), mild (grade 1), and moderate (grade 2) dementia. However, it was unreliable (ICC=0.415, p=0.376) when used on elderly subjects with severe dementia (grade 3), possibly due to the fact that at this stage of dementia they already suffer from extensive deterioration of memory, judgment, and attention, which significantly compromises the ability to comprehend commands and execute functions[5,27,28].

A major problem could occur during the interpretation of the measurements if the professional uses the grip dynamometer to gauge the strength of elderly subjects with dementia without first assessing the stage of the disease because the researcher ou examiners would not know if the values were real or measurement errors[16]. Some authors argue that, to try to reduce the influence of the symptoms of limited attention and motivation, common in the elderly with dementia, prior training in the handling of the dynamometer should be conducted[26]. However, the results of this study showed that even when the elderly subjects with dementia were given the opportunity to practice and familiarize themselves with the dynamometer in advance, those with grade 3 dementia were not capable of using the dynamometer in a reliable manner. Furthermore, of a total of 18 elderly subjects with grade 3 dementia evaluated in this study, four could not even perform the test, that is, even with familiarization with the procedures, they were not capable of understanding and executing the HGS test.

Thomas and Hageman[5] reported that, even when the instructions and demonstrations on how to perform the test were repeated by examiners and trained, some elderly subjects with cognitive impairment could not complete it. In the study, Thomas and Hageman[5] did not assess the degree of cognitive impairment in the elderly subjects.

Other researchers reported that they had excluded some elderly subjects with dementia from their sample, after data collection, due to their difficulty in comprehending the tests[29,30]. An example of this episode was the epidemiological study by Taekema et al.[29], which evaluated 555 elderly subjects with and without cognitive impairment. Of the total evaluated, 82 had some cognitive impairment and, of these, nine had to be excluded from the sample, since they could not complete the HGS test. The question that still remains, even after the exclusion of the elderly subjects who could not complete the test, would be if the sample still contained elderly subjects who managed to complete the test, but who did so in an unreliable manner, that is, due to their difficulty in judgment and comprehension they may have used submaximal force.

One limitation of this study would be related to the fact that the reliability of the device was measured on the basis of the CDR classification of dementia stages. Therefore, these results cannot be generalized to different scales of dementia classification[31]. Based on these results, it cannot be affirmed that the outcomes would be equal when using the Global Deterioration Scale to classify dementia stages[31]. As such, future studies should evaluate the reliability of HGS using other dementia severity classification scales.

The fact that the hand grip test using the dynamometer is not reliable in elderly subjects with severe dementia must not result in their systematic exclusion from research. The study of elderly subjects at various stages of dementia represents an important means of understanding the disease and of enhancing therapeutic possibilities[32]. Therefore, researchers should review and verify other possibilities for the evaluation of these elderly subjects, occasionally carrying out modifications and adaptations to protocols.

**Table 2.** Characteristics of groups according to the CDR and reliability of handgrip strength.

| Stage of dementia | Number of subjects | Age (years) mean±SD | Handgrip strength (Kgf) mean±SD | ICC | p |
|---|---|---|---|---|---|
| Borderline (0.5) | 20 | 83.4±5.8 | 18.2±4.3 | 0.975 | 0.001 |
| Mild (1) | 19 | 82.4±6.8 | 15.2±5.1 | 0.968 | 0.002 |
| Moderate (2) | 19 | 85.8±5.6 | 14.1±5.9 | 0.964 | 0.001 |
| Severe (3)* | 18 | 84.0±5.1 | 5.7±2.9 | 0.415 | 0.376 |

* Four subjects failed to perform the handgrip test due to difficulty in understanding the command, therefore they were not included in the analysis. SD=standard deviation; Kgf=kilogram-force; ICC= intraclass correlation coefficient.

In conclusion, the HGS test demonstrates excellent reliability when used on elderly subjects with borderline, mild, and moderate dementia which allow its use in research and in clinical practice with the elderly. However, for elderly subjects classified as severe by the CDR, its use is restricted as the measurements are unreliable, therefore its use is not recommended in this specific population.

# References

1.  Awata S. New national health program against dementia in Japan: the medical center for dementia. Psychogeriatrics. 2010;10(2):102-6.

2.  Hampel H, Prvulovic D, Teipel S, Jessen F, Luckhaus C, Frölich L, et al. The future of Alzheimer's disease: the next 10 years. Prog Neurobiol. 2011;95(4):718-28.

3.  Blankevoort CG, van Heuvelen MJG, Boersma F, Luning H, de Jong J, Scherder EJA. Review of effects of physical activity on strength, balance, mobility and ADL performance in elderly subjects with dementia. Dement Geriatr Cogn Disord. 2010;30(5):392-402.

4.  Sallinen J, Stenholm S, Rantanen T, Heliövaara M, Sainio P, Koskinen S. Hand-grip strength cut points to screen older persons at risk for mobility limitation. J Am Geriatr Soc. 2010;58(9):1721-6.

5.  Thomas VS, Hageman PA. A Preliminary study on the reliability of physical performance measures in older day-care center clients with dementia. Int Psychogeriatr. 2002;14(1):17-23.

6.  Campbell KH, Stocking CB, Hougham GW, Whitehouse PJ, Danner DD, Sachs GA. Dementia, diagnostic disclosure, and self-reported health status. J Am Geriatr Soc. 2008;56(2):296-300.

7.  Magalhães MO, Peixoto JM, Frank MH, Gomes I, Rodrigues BM, Menezes C, et al. Risk factors for dementia in a rural area of Northeastern Brazil. Arq Neuropsiquiatr. 2008;66(2A):157-62.

8.  Beloosesky Y, Weiss A, Manasian M, Salai M. Handgrip strength of the elderly after hip fracture repair correlates with functional outcome. Disabil Rehabil. 2010;32(5):367-73.

9.  Buchman AS, Leurgans SE, Boyle PA, Schneider JA, Arnold SE, Bennett DA. Combinations of motor measures more strongly predict adverse health outcomes in old age: the rush memory and aging project, a community-based cohort study. BMC Med. 2011;9(1):42-52.

10. Takata Y, Ansai T, Soh I, Kimura Y, Yoshitake Y, Sonoki K, et al. Physical fitness and cognitive function in an 85-year-old community-dwelling population. Gerontology. 2008;54(6):354-60.

11. Alfaro-Acha A, Al Snih S, Raji MA, Kuo YF, Markides KS, Ottenbacher KJ. Handgrip strength and cognitive decline in older Mexican Americans. J Gerontol A Biol Sci Med Sci. 2006;61(8):859-65.

12. Raji MA, Kuo YF, Al Snih S, Markides KS, Peek MK, Ottenbacher KJ. Cognitive status, muscle strength, and subsequent disability in older Mexican Americans. J Am Geriatr Soc. 2005;53(9):1462-8.

13. Cohen DD, Voss C, Taylor MJD, Stasinopoulos DM, Delextrat A, Sandercock GRH. Handgrip strength in English schoolchildren. Acta Paediatr. 2010;99(7):1065-72.

14. Peolsson A, Hedlund R, Oberg B. Intra – and inter-tester reliability and reference values for hand strength. J Rehabil Med. 2001;33(1):36-41.

15. Figueiredo IM, Sampaio RF, Mancini MC, Silva FCM, Souza MAP. Teste de força de preensão utilizando o dinamômetro Jamar. Acta Fisiátrica. 2007;14(2):104-10.

16. Martins GA. Sobre confiabilidade e validade. Revista Brasileira de Gestão de Negócios. 2006;8(20):1-12.

17. Garcia PA, Dias JMD, Dias RC, Santos P, Zampa CC. A study on the relationship between muscle function, functional mobility and level of physical activity in community-dwelling elderly. Rev Bras Fisioter. 2011;15(1):15-22. http://dx.doi.org/10.1590/S1413.355.5201100.010.0005.

18. Montano MBM, Ramos LR. Validade da versão em português da Clinical Dementia Rating. Rev Saúde Pública. 2005;39(6):912-7.

19. Morris JC. The clinical dementia rating (CDR): current version and scoring rules. Neurology. 1993;43(11):2412-4.

20. Folstein MF, Folstein SE, McHugh PR. "Mini-mental state". A practical method for grading the cognitive state of patients for the clinician. J Psychiatr Res. 1975;12(3):189-98.

21. Brucki SMD, Nitrini R, Caramelli P, Bertolucci PHF, Okamoto IH. Sugestões para o uso do mini-exame do estado mental no Brasil. Arq Neuropsiquiatr. 2003;61(3B):777-81.

22. Fonseca FB, Rizzotto MLF. Construção de instrumento para avaliação sócio-funcional em idosos. Texto Contexto Enferm. 2008;17(2):365-73.

23. Lawton MP, Brody EM. Assessment of older people: self-maintaining and instrumental activities of daily living. Gerontologist. 1969;9(3):179-86.

24. Pfeffer RI, Kurosaki TT, Harrah CH Jr, Chance JM, Filos S. Measurement of functional activities in older adults in the community. J Gerontol. 1982;37(3):323-9.

25. Lino VTS, Pereira SRM, Camacho LAB, Ribeiro Filho ST, Buksman S. Adaptação transcultural da Escala de Independência em Atividades da Vida Diária (Escala de Katz). Cad Saúde Pública. 2008;24(1):103-12.

26. Rogers SD, Jarrot SE. Cognitive impairment and effects on upper body strength of adults with dementia. J Aging Phys Act. 2008;16(1):61-8.

27. Salawu FK, Umar JT, Olokoba AB. Alzheimer's disease: a review of recent developments. Ann Afr Med. 2011;10(2):73-9.

28. Hinton L, Tomaszewski Farias S, Wegelin J. Neuropsychiatric symptoms are associated with disability in cognitively impaired Latino elderly with and without dementia: results from the Sacramento Area Latino Study on Aging. Int J Geriatr Psychiatry. 2008;23(1):102-8.

29. Taekema DG, Gussekloo J, Maier AB, Westendorp RG, de Craen AJ. Handgrip strength as a predictor of functional, psychological and social health. A prospective population-based study among the oldest old. Age Ageing. 2010;39(3):331-7.

30. Avila-Funes JA, Amieva H, Barberger-Gateau P, Le Goff M, Raoux N, Ritchie K, et al. Cognitive impairment improves the predictive validity of the phenotype of frailty for adverse health outcomes: the three-city study. J Am Geriatr Soc. 2009;57(3):453-6.

31. Behl P, Stefurak TL, Black SE. Progress in clinical neurosciences: cognitive markers of progression in Alzheimer's disease. Can J Neurol Sci. 2005;32(2):140-51.

32. Mitchell SL, Black BS, Ersek M, Hanson LC, Miller SC, Sachs GA, et al. Advanced dementia: state of the art and priorities for the next decade. Ann Intern Med. 2012;156(1 Part 1):45-51.