

Relationship of functional balance and cognitive impairment in elderly.

Relação de equilíbrio funcional e déficit cognitivo em idosos.

Mayra Campos Frância dos Santos¹, João Paulo Manfré dos Santos², Vanessa Fontanela³, Solaine Melchior Spricio³, André Wilson de Oliveira Gil⁴, Deise Aparecida de Almeida Pires-Oliveira⁵

Universidade Norte do Paraná (Unopar), Paraná (PR), Brazil.

Abstract

Introduction: Population aging brings physical changes of its own age. Along with these changes occur in most cases, the comorbidities that maximize the geriatric syndromes. Balance disorders are the class of the most important factors when it comes to instability and falls in the elderly. Thus, the knowledge of what generates or which is associated with balance deficits and therefore predispose the elderly to fall is critical to reduce the frequency of them, but also to the severity of its sequelae. **Objective:** To analyze the relationship between cognitive performance and functional balance in elderly institutionalized and community. **Method:** The sample consisted of 36 participants and 19 older adults and 17 elderly subjects, recruited voluntarily and for convenience. The evaluation presented by sociodemographic form, analyze the risk of falls (TUG) and the Mini Mental State Examination (MMSE), which was used for screening of cognitive impairment in the elderly. **Results:** Through the anthropometric analysis, community elders had a mean age of 73.11 years, weighing 66.90 kg and height of 1.56 m, as the institutionalized group had an average age of 72.06 years, average height and weight 69.88 kg 1.60 m. Elderly community, physically active, showed lower risk for falls compared to elderly subjects ($p < 0.001$), in addition to having better cognitive performance ($p = 0.002$). A moderate correlation between the TUG and the MMSE ($r = -0.513$) was also found. **Conclusion:** Both groups were made up of active seniors, both community and institutionalized, however community elders showed better cognitive status and a lower risk of falls in relation to the institutionalized elderly, noting that the cognitive status increases the risk of falls.

Keywords: Cognitive impairment; Postural balance; Elderly; Falls; Functional ability.

Submission date 12 September 2014; Acceptance date 16 December 2014; Publication date 22 December 2014

1. Master in Ciências da Reabilitação, Universidade Estadual de Londrina (UEL), Universidade Norte do Paraná (UNOPAR), Londrina (PR), Brazil.
2. PhD student at Ciências da Reabilitação, Universidade Estadual de Londrina (UEL), Universidade Norte do Paraná (UNOPAR), Londrina (PR), Brazil.
3. Physical Therapy student, Universidade Norte do Paraná (UNOPAR), Londrina (PR), Brazil.
4. PhD student at Educação Física program, Universidade Estadual de Londrina (UEL), Londrina (PR), Brazil.
5. Professor of master and PhD program in Ciências da Reabilitação, master in Profissional em Exercício Físico e Promoção da Saúde, Universidade Estadual de Londrina (UEL), Universidade Norte do Paraná (UNOPAR), Londrina (PR), Brazil.

Corresponding Author:

Deise Aparecida de Almeida Pires-Oliveira. Rua Marselha, 591, Zip Code: 86041-140, Londrina (PR), Brazil. Phone: (43) 3371-9848. E-mail: deisepyres@yahoo.com.br
The authors declare no conflicts of interest.
Financial support: None.

Resumo

Introdução: O envelhecimento populacional traz consigo modificações físicas próprias desta faixa etária. Juntamente com estas alterações surgem, na maioria dos casos, as comorbidades que potencializam as síndromes geriátricas. Os distúrbios do equilíbrio são a classe de fatores mais importantes quando se trata de instabilidade e quedas em idosos. Sendo assim, o conhecimento do que gera ou do que está associado ao déficit de equilíbrio e, conseqüentemente, predispõe o idoso à queda é fundamental para reduzir a frequência das mesmas, como também à gravidade de suas sequelas. **Objetivo:** Analisar a relação do desempenho cognitivo com equilíbrio funcional em idosos institucionalizados e da comunidade. **Método:** A amostra foi de 36 participantes sendo 19 idosos da comunidade e 17 idosos institucionalizados, recrutados de forma voluntária e por conveniência. A avaliação apresentou-se mediante formulário sociodemográfico, análise do risco de quedas (TUG) e o Mini Exame do Estado Mental (MEEM) que foi utilizado para rastreamento do déficit cognitivo em idosos. **Resultados:** Mediante a análise antropométrica, os idosos da comunidade apresentaram uma média de idades de 73.11 anos, peso de 66.90 kg e altura de 1.56 m, já o grupo institucionalizado apresentou uma média de idade 72.06 anos, peso 69.88 kg e altura média de 1.60 m. Idosos da comunidade, fisicamente ativos, demonstraram menor risco para quedas em comparação aos idosos institucionalizados ($p < 0.001$), além de apresentarem melhor desempenho cognitivo ($p = 0.002$). Também foi encontrada uma correlação moderada entre o TUG e o MEEM ($r = -0,513$). **Conclusão:** Ambos os grupos eram constituídos por idosos ativos, tanto da comunidade quanto os institucionalizados, entretanto os idosos da comunidade apresentaram melhor estado cognitivo e um menor risco de quedas, em relação aos idosos institucionalizados, observando que o estado cognitivo aumenta o risco de quedas.

Palavras-chave: Déficit cognitivo; Equilíbrio postural; Idosos; Quedas; Capacidade funcional.

INTRODUCTION

Population aging is occurring at an accelerated rate, hence there is increased prevalence of chronic degenerative diseases. Thus, older people tend to have multiple comorbidities that enhance major geriatric syndromes such as falls, iatrogenic disorders, dementia and immobility, which compromise the independence and autonomy of these patients, causing disabilities, frailty, institutionalization and death.⁽¹⁾ Among the most common complaints the elderly population is the change in body balance, clinically characterized by vertigo, dizziness, imbalance, gait deviation, nausea, unsteadiness and fall. Balance disorders constitute one of the most important etiological factors of falls and instability in the elderly.^(2,3)

People of all ages are at risk of falling; however, for the elderly these falls are more significant than in other younger population, which may lead them to disability, injury, fear of falling and even death.⁽⁴⁾ The knowledge of risk factors that produce or are associated with balance disorders, predisposing the elderly to fall, it is critical to reduce the frequency of them, but also the severity of its sequelae.⁽⁵⁾ Among the key risk factors for falls are the intrinsic or extrinsic origin, and may be related to functional limitations, increasing age, muscle weakness, environmental hazards and visual impairment, cognitive impairment, chronic degenerative diseases, depression and social isolation.⁽⁶⁾

The annual incidence of falls in people over 65 years living in the community are healthy and reaches 35-40%; even higher rates are observed after 75 years, especially in long-stay hospitals and institutions. Among the falls, 10 to 25% result in fractures and lacerations, resulting in hospitalization. It is estimated that 6% of the total

medical costs in the United States among people over 65 years relate to those falls.⁽⁷⁾

The high rate of fall can be explained by the fact that during senescence, a reduction in the somatosensory system (proprioceptive), visual and vestibular systems are responsible for control balance occurs. Furthermore, the central nervous system (CNS) may undergo several changes, which influence the postural control and balance. Upon this, the muscle strength, especially in the lower limbs, suffers loss with advancing age, causing a decrease in the recruitment and activation of motor units. The same occurs in the elderly with dementia, impacting the increased risk of falls.⁽⁸⁾

The elderly are the most likely individuals to the risk of dementia; according to the Classificação de Transtornos Mentais e de Comportamento (CID-10)⁽⁹⁾ and the Manual Diagnóstico e Estatístico dos Transtornos Mentais (DSM-IV),⁽¹⁰⁾ dementia is characterized mainly by the decline of memory and other higher cortical functions, such as language, the ability to recognize and identify objects, abstraction, capacity planning and scheduling, among others.

Given this, people in older age should always have their assessed cognitive functions. For this purpose, we use recursively the questionnaire of the Mini-Mental State Examination (MMSE), which is composed of several clustered questions into 7 categories, each one has to evaluate specific cognitive "functions", being them orientation to time, orientation to place, registration of three words, attention and calculation, memory of three words, language and visual constructive ability. The score ranges from 0 to a maximum total of 30 points.⁽¹¹⁾

The MMSE is a simple scale to be used application takes about 5 to 10 minutes. Tombaugh and McIntyre⁽¹²⁾ observed that the test has good internal consistency and test-retest reliability, as well as having good to excellent sensitivity and specificity for the diagnosis of dementia. The MMSE has been translated and validated into Portuguese by Bertolucci et al.⁽¹³⁾

The Timed Up and Go (TUG) test is widely used to assess the functional capacity of the elderly, as a predictor of falls.⁽¹⁴⁻¹⁷⁾ Its achievement is simple: consists in evaluating the normal speed at which a person rising from a chair with arms, walk three meters ahead, turns, walks back three meters and sits in the chair again. During this activity the time is timed. His execution is intended to replicate shares that are typically routine and basic mobility, the assessed capabilities are: reaction time, muscle strength of the lower, equilibrium states and the ease of movement.⁽¹⁸⁾ Thus, studies suggest that the longer the test, the lower the average gait speed, indicating the possibility of functional impairment and risk of falls.^(17,19,20)

Thus, social isolation, loss of independence in functional activities and less physical strength culminate in higher cognitive changes, so the institutionalized elderly are more likely to suffer falls than non-institutionalized elderly.^(21,22) Given this framework, the vast majority of the elderly becomes more depressed and weakened, then showing up more prone to falls and chronic diseases.

Thus the aim of this study was to analyze the relationship of cognitive performance with functional balance in older people and observe the differences between these variables in elderly institutionalized and community.

METHODS

This is a study of cross-sectional nature of multidimensional approach with different aspects related to aging. The study was approved by the Ethics and Research of the Universidade Norte do Paraná with number of opinion 276 702.

The study was conducted with elderly community and institutionalized. Such were evaluated at the Universidade do Paraná (UNOPAR), in its own room for evaluation so that they could be reassured regarding the interview and evaluation, after signing an informed consent, in accordance with Resolution 196/196.

Community elders were recruited voluntarily and for convenience; 19 seniors participated in the study, being 6 men and 13 women. Were characterized by physically independent elderly according to the Functional Scale proposed by the Spirduso⁽²³⁾, they are participants in programs for seniors, held in UNOPAR and participants from various other programs of Londrina (PR) community. All seniors signed the informed consent.

Institutionalized elderly were recruited on a voluntary basis after expiry of authorization signed by the management of long-stay institution São Vicente de Paulo, in Londrina

(PR) using a sample of 17 seniors, being 9 men and 8 women.

The eligibility criteria were: people aged over 60 years who were ambulant with or without assistive device (such as canes, crutches, etc.) of both gender and who agreed to participate voluntarily in the study after being informed on the proposal and the same procedures they would be submitted.

The evaluation took place through structured forms focusing on the functional capacity of the elderly (through the scale of risk of falls - TUG)⁽²⁴⁾ and the Mini Mental State Examination (MMSE)⁽¹²⁾ for evaluation of cognitive impairment. The scores used as cutoffs in this sample were: 13 for illiterate; 18 for individuals with 1-7 years of schooling, and 26 for eight years or more of schooling.

After completion of the TUG, groups were divided according to the end time used to perform this test as Lopes et al.⁽²⁵⁾ Thus, were classified as low risk participants to present a time less than or equal to 10 seconds to perform the test; de 10 to 20 seconds were classified as medium risk, with independence in basic transfers and above 20 seconds, high risk, being dependent on many activities of daily living and mobility.

Statistical analysis

Data normality was verified using the Shapiro-Wilk test. Data were presented as median and interquartile range. The Mann Whitney test was used for comparison between the elderly community and the institutionalized and then the linear regression test was performed to verify the relationship between the MMSE and the TUG. The significance adopted was $p > 0.005$ with a confidence interval of 95% for all tests, and the statistical package used was Statistical Package for Social Sciences (SPSS) version 20.0.

RESULTS

The total sample included 36 elderly. Community elders had a mean age of 73.11 years (SD 3.61), mean weight of 66.90 kg (SD 11.76) and mean height 1.56m (SD 0.08). Institutionalized elderly had a mean 72.06 years (SD 8.39), average weight of 69.88 kg (SD 19.20), and average height of 1.60 m (SD 0.10). The demographic data of the institutionalized elderly and the elderly in the community are presented in Table 1.

To analyze the normal distribution of data, the Shapiro-Wilk test was used and it was noted that the TUG and MMSE were not normally distributed ($p < 0.05$), while age, height and weight were normally distributed ($p > 0.05$).

It was observed that elderly practitioners of community physical activity had a lower risk for falls according TUG compared to elderly subjects (Table 2). It was also noted better MMSE cognitive performance in older adults when compared with elderly subjects (Table 3).

Table 1. Socio-demographic data of the elderly.

Variable	Categories	Institucionalized elderly		Community Elderly	
		Absolut Frequency	Relative Frequency %	Absolut Frequency	Relative Frequency %
Gender	Men	9	53	6	31.5
	Women	8	47	13	68.4
	TOTAL	17	100	19	100
Age	60 a 64 anos	3	17.65	0	0
	65 a 69 anos	4	23.53	5	26.3
	70 a 74 anos	3	17.65	5	26.3
	75 a 79anos	4	23.53	9	47.4
	80 anos ou mais	3	17.65	0	0
	TOTAL	17	100	19	100

Table 2. Results comparing TUG in elderly community and institutionalized.

TUGT	Median	1°Q	3°Q	p
Institutionalized	12.75	11.27	20.47	0.000*
Elderly community	8.43	7.88	9.57	

*Statistically significant, Mann-Whitney test.

Table 3. Result of the comparison between MMSE institutionalized and elderly community.

MMSE	Median	1°Q	3°Q	p
Institutionalized	16.00	13.50	22.50	0.002*
Elderly community	25.00	23.00	27.00	

*Statistically significant, Mann-Whitney test.

Furthermore, it was observed that 100% (19) of the elderly in the community had a low risk for falls, whereas only 53% (9) of the institutionalized elderly had low risk for falls, 35.2% (6) medium risk and 11.8% (2) high risk, according to the TUGT.

Through the regression analysis revealed that there is a moderate association between TUG and MMSE (Pearson $r = -0.513$), and the MMSE accounted for 24.2% of the variance in the result TUG positively related to the success of the test. The regression coefficient for the MMSE and TUG was -0.565 (95% CI = $-0.894/-0.236$) as standardized regression coefficient not include positive value, it can be concluded that the regression coefficient for the MMSE and the population is TUG reverse, ie, the higher the MMSE score less time spent on the TUG (best performance). The model is statistically significant ($p = 0.001$ and $F = 12.157$). The relationship between the variables is presented in Figure 1.

DISCUSSION

According to the data presented institutionalized elderly took a longer time to perform the TUG, with an average of 17:04 seconds, which predisposes to increased risk of falls in this population. While older adults performed the TUG with an average time of 9:07, showing better performance

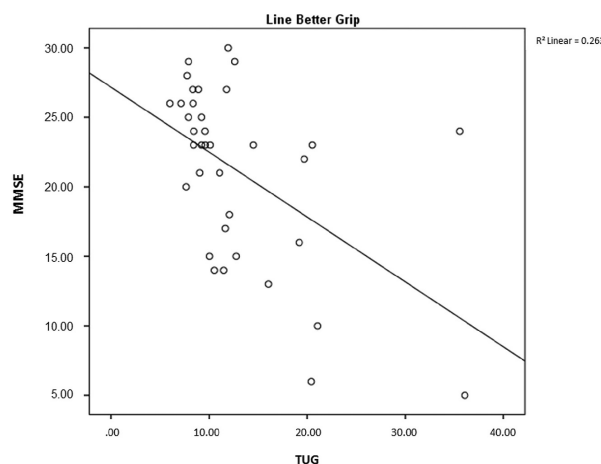


Figure 1. Relation between MMSE and TUG.

on functional capacity, corroborating Lopes et al.⁽²⁵⁾, reporting that the longer the time to perform the TUG, the greater the propensity for falls.

However, it is important to note that community elders are active seniors where they perform various functional activities in the course of their daily lives, differentiating institutionalized elderly, this fact by community elders had better functionality demonstrating better performance for

results the TUG. On the other hand, older people living in long-stay institutions, demonstrate is more limited and more difficult to perform functional activities, becoming more prone to less mobility and larger balance changes,⁽¹³⁾ even these seniors being classified physically active. Oliveira et al.⁽²⁶⁾ demonstrated that the activities of daily living such as bathing, dressing, transfers, and locomotion are directly related to functional ability, and when there is a commitment in this area, there impact on the quality of life of seniors. However, in order emphasizes that the institutionalized elderly are often the only functions performed in their day to day.

Regarding to the examination of cognitive ability was observed that community elders had better performance on the MMSE, which may be explained by the fact that community elders possess greater interpersonal contact which does not occur with the institutionalized elderly, who live prisoners, far from their families, thereby causing loss of autonomy and reduction of functional activity, which is in agreement with the findings of Caixeta and Ferreira.⁽³²⁾ These same authors also argue that institutionalization leads to loss of cognitive ability, given that lack of intellectual activities affect the development of memory and reasoning. Moreover, the findings of Shephard⁽²⁷⁾ show that physical activity improves cognitive functioning of the elderly.

However, community elders obtained a mean of 8 years, thus achieving a score of 26 points for the MMSE. According to the proposed Bertolucci et al.⁽¹³⁾ with this score denotes a cognitive state is preserved. The same pattern holds for the institutionalized elderly, but it is important to emphasize that, as most of these were illiterate, the score has a value of 16 points on the MMSE and, according to these values, also showed

preserved cognitive status, taking into account the study thereof. This fact was verified by Diniz et al.⁽²⁸⁾ found that the lower the education level, the lower are the scores on the cognitive test, which reflects worse on cognitive performance, which is also in line with other studies, which show clearly that high educational level is considered protective for the development of dementia, in particular Alzheimer's disease.⁽²⁹⁻³¹⁾

When relating the TUG with cognitive status, being assessed by the MMSE, the results indicate a moderate correlation between them, which contradicts the findings of Oliveira et al.⁽²⁶⁾, states that no correlation exists between them. However, our results show that people with worse cognitive performance also performed worse in TUG, with 24.2% of the variation can be explained by TUG performance in MMSE, because when there is cognitive impairment in the elderly, they become more prone to falls due cognitive decline, resulting in functional and reduction or loss of everyday skills decline, which may cause postural and locomotor deficits. Thus elderly people may be loss of independence, and as a result, increased risk of falls.⁽³²⁾

Stand out as limitations of the study using a convenience sample, the sample size and the non-temporal continuity of the evaluation to establish a relationship of cause and effect.

CONCLUSION

Both groups were composed of active seniors, both community and institutionalized, however community elders have better cognitive status and a lower risk of falls in relation to the institutionalized elderly, noting that the cognitive status increases the risk of falls.

REFERENCES

1. Gazzola JM, Ganança FF, Aratani MC, Perracini MR, Ganança MM. Caracterização clínica de idosos com disfunção vestibular crônica. *Rev Bras Otorrinolaringol.* 2006; 72(4):515-22. <http://dx.doi.org/10.1590/S0034-72992006000400013>.
2. Perracini MR. Equilíbrio e controle postural em idosos. *Rev Bras Postura Mov.* 1998;2(4):130-42.
3. Castro SM, Perracini MR, Ganança FF. Versão brasileira do Dynamic Gait Index. *Rev Bras Otorrinolaringol.* 2006; 72(6):817-25. <http://dx.doi.org/10.1590/S0034-72992006000600014>.
4. Fabrício SCC, Rodrigues RAP, Costa ML Jr. Causas e conseqüências de quedas de idosos atendidos em hospital público. *Rev Saude Publica.* 2004 Feb;38(1):93-9. <http://dx.doi.org/10.1590/S0034-89102004000100013>. PMID:14963547.
5. Maciel ACC, Guerra RO. Prevalência e fatores associados ao déficit de equilíbrio em idosos. *Rev. Bras. Cienc. Mov.* 2005; 13(1):37-44.
6. Resende SM, Rassi CM, Viana FP. Efeitos da hidroterapia na recuperação do equilíbrio e prevenção de quedas em idosos. *Rev Bras Fisiot.* 2008; 12(1):57-63. <http://dx.doi.org/10.1590/S1413-35552008000100011>.
7. Rigo JC, Rigo JF, Faria BC, Stein A, Santos VM. Trauma associado com uso de álcool em idosos. *Rev Brasília Médica.* 2005; 42(1/2):35-40.
8. Hernandez SSS, Coelho FGM, Gobbi S, Stella F. Efeito de um programa de atividade física nas funções cognitivas, equilíbrio e risco de quedas em idosos com demência de Alzheimer. *Rev Bras Fisiot.* 2010; 14(1):68-74. <http://dx.doi.org/10.1590/S1413-35552010000100011>.

9. Organização Mundial de Saúde. Classificação dos transtornos mentais e do comportamento da CID-10: descrições clínicas e diretrizes diagnósticas. Porto Alegre: Artes Médicas; 1993.
10. American Psychiatric Association. DSM – IV- TR. Manual diagnóstico e estatístico de transtornos mentais. 2004.
11. 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 Nov;12(3):189-98. [http://dx.doi.org/10.1016/0022-3956\(75\)90026-6](http://dx.doi.org/10.1016/0022-3956(75)90026-6). PMID:1202204.
12. Tombaugh TN, McIntyre NJ. The mini-mental state examination: a comprehensive review. *J Am Geriatr Soc.* 1992 Sep;40(9):922-35. <http://dx.doi.org/10.1111/j.1532-5415.1992.tb01992.x>. PMID:1512391.
13. Bertolucci PHF, Brucki SMD, Campacci SR, Juliano Y. O mini-exame do estado mental em uma população geral: O impacto da escolaridade. *Rev Psiquiatr Clin.* 2007; 34(1):13-7.
14. Bohannon RW, Schaubert K. Long-term reliability of the timed up-and-go test among community-dwelling elders. *J Phys Ther Sci.* 2005; 17(2):93-6. <http://dx.doi.org/10.1589/jpts.17.93>.
15. Thrane G, Joakimsen RM, Thornquist E. The association between timed up and go test and history of falls: the Tromsø study. *BMC Geriatr.* 2007; 7(1):1-7. <http://dx.doi.org/10.1186/1471-2318-7-1>. PMID:17222340.
16. Shigematsu R, Chang M, Yabushita N, Sakai T, Nakagaichi M, Nho H, et al. Dance-based aerobic exercise may improve indices of falling risk in older women. *Age Ageing.* 2002 Jul;31(4):261-6. <http://dx.doi.org/10.1093/ageing/31.4.261>. PMID:12147563.
17. Morris S, Morris ME, Ianssek R. Reliability of measurements obtained with the Timed "Up & Go" test in people with Parkinson disease. *Phys Ther.* 2001 Feb;81(2):810-8. PMID:11175678.
18. Lamoureux E, Sparrow WA, Murphy A, Newton RU. The effects of improved strength on obstacle negotiation in community-living older adults. *Gait Posture.* 2003 Jun;17(3):273-83. [http://dx.doi.org/10.1016/S0966-6362\(02\)00101-7](http://dx.doi.org/10.1016/S0966-6362(02)00101-7). PMID:12770641.
19. Steffen TM, Hacker TA, Mollinger L. 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 Feb;82(2):128-37. PMID:11856064.
20. Noonan V, Dean E. Submaximal exercise testing: clinical application and interpretation. *Phys Ther.* 2000 Aug;80(8):782-807. PMID:10911416.
21. Rebelatto RJ, Castro PA, Chan A. Quedas em idosos institucionalizados: características gerais, fatores determinantes e relações com a força de preensão manual. *Acta Ortop Bras.* 2007; 15(3):151-4. <http://dx.doi.org/10.1590/S1413-78522007000300006>.
22. Tier CG, Fontana RT, Soares NV. Refletindo sobre idosos institucionalizados. *Rev Bras Enferm.* 2004 May-Jun;57(3):332-5. <http://dx.doi.org/10.1590/S0034-71672004000300015>. PMID:15782710.
23. Spirduso WW. Dimensões físicas do envelhecimento. Barueri: Manole; 2004.
24. Podsiadlo D, Richardson S. The timed "Up & Go": a test of basic functional mobility for frail elderly persons. *J Am Geriatr Soc.* 1991 Feb;39(2):142-8. <http://dx.doi.org/10.1111/j.1532-5415.1991.tb01616.x>. PMID:1991946.
25. Lopes KT, Costa DF, Santos LF, Castro DP, Bastone AC. Prevalência do medo de cair em uma população de idosos da comunidade e sua correlação com mobilidade, equilíbrio dinâmico, risco e histórico de quedas. *Rev Bras Fisiot.* 2009; 13(3):223-9. <http://dx.doi.org/10.1590/S1413-35552009005000026>.
26. Oliveira DLC, Goretti LC, Pereira LSM. Desempenho de idosos institucionalizados com alterações cognitivas em atividades de vida diária e mobilidade: estudo piloto. *Rev Bras Fisiot.* 2006; 10(1):91-6. <http://dx.doi.org/10.1590/S1413-35552006000100012>.
27. Shephard RJ. Envelhecimento, atividade física e saúde. São Paulo: Phorte; 2003.
28. Diniz BSO, Volpe FM, Tavares AR. Nível educacional e idade no desempenho no Miniexame do Exame Mental em idosos residentes na comunidade. *Rev Psiq Clin.* 2007; 34(1):13-7. <http://dx.doi.org/10.1590/S0101-60832007000100002>.
29. Aevansson O, Skoog I. A longitudinal population study of the mini-mental state examination in the very old: relation to dementia and education. *Dement Geriatr Cogn Disord.* 2000 May-Jun;11(3):166-75. <http://dx.doi.org/10.1159/000017231>. PMID:10765048.
30. Hill LR, Klauber MR, Salmon DP, Yu ESH, Liu WT, Zhang M, et al. Functional status, education, and the diagnosis of dementia in the Shanghai survey. *Neurology.* 1993 Jan;43(1):138-45. http://dx.doi.org/10.1212/WNL.43.1_Part_1.138. PMID:8423878.
31. Liu HC, Teng EL, Lin KN, Hsu TC, Guo NW, Chou P, et al. Performance on a dementia screening test in relation to demographic variables. Study of 5297 community residents in Taiwan. *Arch Neurol.* 1994 Sep;51(9):910-5. <http://dx.doi.org/10.1001/archneur.1994.00540210082016>. PMID:8080391.
32. Caixeta GCS, Ferreira A. Desempenho cognitivo e equilíbrio funcional em idosos. *Rev Neurosci.* 2009; 17(3):202-8.