Effect of physical exercise program on the balance and risk of falls of institutionalized elderly persons: a randomized clinical trial

Camila Tomicki[1]
Sheila Cristina Cecagno Zanini[1]
Luana Cecchin[2]
Tania Rosane Bertoldo Benedetti[3]
Marilene Rodrigues Portella[1]
Camila Pereira Leguisamo[1]

Abstract

The aim of the present study was to evaluate the effect of an exercise program on the postural balance and risk of falls of institutionalized elderly persons. A randomized controlled trial was performed. The study was conducted in two long-stay philanthropic care facilities for the elderly in a city in the north of Rio Grande do Sul, Brazil. Participants were divided into control (G1) and intervention groups (G2). G1 did not receive any type of intervention whereas G2 participated in an exercise program three times a week for twelve weeks. The groups were evaluated by the Berg Balance Scale (BBS) and the Timed Up and Go Test (TUGT). After the intervention, G2 achieved better scores in both BBS and in the TUGT, indicating a significant improvement in body balance and a reduction in the risk of falls compared to G1. The Spearman ordinal correlation revealed that there was a statistically significant association between BBS and TUGT (p<0.001). G1 did not present positive results compared to G2 both at baseline and in post intervention. It can be inferred that the proposed exercise program was effective in improving body balance and the performance of functional tasks, contributing to an improvement in the risk of falls as a result. REBEC: RBR-5XNYJS.

Key words: Randomized Controlled Trial; Homes for the Aged; Postural Balance; Accidental Falls; Exercise.

[1] Universidade de Passo Fundo, Faculdade de Educação Física e Fisioterapia, Programa de Pós-graduação em Envelhecimento Humano. Passo Fundo, Rio Grande do Sul, Brasil.

[2] Universidade de Passo Fundo, Faculdade de Educação Física e Fisioterapia. Passo Fundo, Rio Grande do Sul, Brasil.

[3] Universidade Federal de Santa Catarina, Centro de Desportos, Programa de Pós-graduação em Educação Física. Florianópolis, Santa Catarina, Brasil.

Correspondence
Camila Tomicki
E-mail: camitomicki@gmail.com

INTRODUCTION

The world is experiencing significant demographic change due to the aging process. The growing elderly segment of the population is more susceptible to a decline in health and to falls, which today constitute one of the most widespread and serious public problems.[1]

Falls are often frequent and limiting for elderly persons. A fall can be defined as an unexpected and unintentional event which results in an individual moving to a lower level relative to their initial position, and which occurs as the result of a total loss of postural balance and due to inefficiencies in the mechanisms necessary for the maintenance of postural control.[2,3]

Aging affects the properties of the central nervous and neuromuscular systems, leading to problems with balance and walking.[4] Balance is an important component of physical fitness that must be maintained in order to prevent falls.[1]

With this in mind, prevention of falls constitutes a public health necessity, with more than a third of people aged 65 and over falling each year, leading to injuries, decreased functional capacity and consequently death.[5,6]

In order to implement effective strategies for the prevention of falls it is vital to discover the relevant risk factors,[7] as while some factors are irreversible, others can potentially be dealt with through appropriate interventions,[8] especially in the context of long-term care facilities for the elderly (LTCF).

Residents of LTCFs are more likely to suffer from falls, due to problems with walking, muscle weakness, dizziness, vertigo, cognitive decline, disease and specific medications. They also tend to be ill, dependent and more fragile than those elderly individuals who remain in the community.[9]

When institutionalized, elderly persons are faced with an environment that is notably different from that of their homes, as well as the absence of family, a loss of autonomy and physical inactivity.[10] A decline in functional capacity ensues, predisposing residents to falls, which often recur.[11]

Muscle weakness, balance deficit and instability when walking are common intrinsic risks which lead to falls. However, these may be modifiable through adherence to regular, planned physical exercise.[4,8,12]

The benefits for musculoskeletal health include improvements in balance as well as a reduction in number of falls and in physical conditions such as sarcopenia.[13] Thus, physical exercise has become an important tool for the prevention and control of falls and is gaining significance in public policy proposals for health promotion.[14]

Efforts to reduce the risk of falling therefore help to maintain the well-being of elderly persons and reduce care costs. In order to achieve these effects it is necessary to discover the determining factors which make falls more likely, as the development and implementation of fall prevention strategies is currently a major public health challenge.[5,16] The implementation of interventions is effective in reducing the frequency of falls and thus has the potential to benefit the health of elderly persons.[17]

In light of the above, this study aimed to evaluate the effect of an exercise program on the postural balance and risk of falls of institutionalized elderly persons.

METHOD

A randomized controlled clinical trial was conducted, carried out in two long-stay philanthropic care facilities located in a municipality in the northern region of the state of Rio Grande do Sul in Brazil. The city had an estimated population of 195,620 people[18] and was home to 21 LTCFs, of which 19 were private and two philanthropic, with a total of 471 institutionalized elderly residents.

In the philanthropic LTCFs that were the object of this study, there were 112 elderly residents, 39 of whom were male and 73 of whom were female. These particular institutions were chosen for reasons of convenience, due to a links that have been built up over the years with the Universidade de Passo Fundo (the University of Passo Fundo) (UPF), through the development of undergraduate and graduate projects (*lacto sensu* and *stricto sensu*).

The inclusion criteria were simple: subjects had to be aged 60 years or over and resident in one of the selected LTCFs. The following were chosen as exclusion criteria: serious illness and/or advanced cognitive impairment, inability to perform the evaluations proposed during the follow-up stage of the study, missing 80% of the exercise sessions and/or hospitalization during the study period.

The sample population was established using cluster sampling. Thirty individuals who met the inclusion criteria were selected and allocated to the control group (G1) or the intervention group (G2) at random (by means of a spreadsheet-based draw), then randomized into blocks with an equal number of participants in each group, in accordance with criteria for randomization in studies with small numbers of individuals.[19] G1 consisted of 15 elderly residents from the two LTCFs, eight from one and seven from the other, while G2 was composed of 15 elderly residents all from a single LTCF.

After randomization, an initial evaluation took place where the individuals were interviewed in order to collect data such as gender, age, marital status, education, previous occupation and time spent institutionalized; as well as clinical data of interest: disease, drugs, polypharmacy, history of falls and fractures. All information was checked against the medical records of the subjects and with the responsible nursing professional in the respective LTCFs.

Next, the individuals completed the Timed Up and Go Test (TUG) and the Berg Balance Scale (BBS), the objective of which was to evaluate their dynamic balance and risk of falls.

The TUG was developed in order to evaluate balance, risk of falls and functional capacity in the elderly. It involves the observation of an individual as he/she gets up from a chair, walks three meters in a straight line then returns to the chair and sits down again. This route is timed in seconds and each individual's performance is graded according to how long they take to perform the task.[20] Total TUG time was used to compare the groups and the cut-off score proposed by Podsiadlo & Richardson.[20] Total TUG time was used in order to compare the groups, using the cut-off score proposed by Podsiadlo & Richardson.[20] These authors advise that a time of less than 10 seconds should be considered as normal for healthy, independent adults not at risk of falls, 11-20 seconds for frail or disabled elderly individuals with partial independence and a low risk of falls, while a time of above 20 seconds would indicate significant problems with physical mobility and a significant risk of falls.[20]

The BBS is used to evaluate balance and risk of falls in the elderly. In the present study, the Brazilian version was adopted, fully validated and adapted into Portuguese.[21] Before the test was carried out, the evaluator demonstrated the activities which make up the evaluation. The test consists of 14 common tasks related to activities of daily living: 1. moving from a seated to a standing position; 2. remaining standing without support; 3. remaining seated without back support, but with feet on the floor or on a stool; 4. moving from standing to a sitting position; 5. transfers; 6. remaining standing without support and with eyes closed; 7. remaining standing without support with feet together; 8. holding arms out in front of the body while standing up; 9. picking an object up from the floor from a standing position; 10. turning round and looking over the right and left shoulders while standing; 11. rotating 360 degrees; 12. putting each foot alternately up on a step or stool while remaining standing without support; 13. remain standing without support with one foot forward; 14. remaining standing on one leg. Each item on the scale is scored with one of five marks

ranging from zero to four points, with zero being awarded where an individual is unable to perform the task and four where he or she can perform it safely. Total scores range from 0 to 56 points, with a maximum score equivalent to an excellent performance in the test and scores of lower than 50 indicative of a likelihood of falls.[21]

The tests were applied by six pre-trained team members. Two members of the research team were responsible for the evaluations and the follow-up. They were not made aware of which individuals were part of the G1 and G2 groups and had not been in contact with the subjects during the three months of the intervention. Both the baseline and the 12 week evaluations were performed without the evaluators knowing which individuals were from which group.

After the baseline evaluations participants selected for G1 did not take part in any kind of intervention. However, those in G2 participated in a regular and organised exercise program for 12 weeks, three times a week on alternate days, with 36 sessions in total, each of which lasted approximately 45 minutes. Participants in both the G1 and G2 groups did not perform any additional physical activity alongside the usual activities of the institutions during the study period.

The exercise program took place between May and August 2014, with the interventions carried out in the institutions themselves in rooms specifically designed for these type of activities. The rooms had good lighting, ventilation and appropriate surfaces. Before each session the blood pressure of the participants was measured (BP) in order to preserve their safety and comfort. In instances where BP was above or below the normal level, individuals were asked to wait a few moments before having the measurement retaken. Where the abnormality persisted they were given a leisure activity to carry out or given an appropriate referral where necessary, and their participation in the exercise session was suspended.

The exercise program included mixed activities. Each session involved:

- Warm up (eight to 10 minutes): walking, dance and ball game activities.
- Main part (15 to 20 minutes): functional exercises of aerobic endurance, muscle strength and endurance, flexibility, static and dynamic balance, agility and motor coordination.
- Stretching and Relaxation (eight to 10 minutes): exercises stretching the major muscle groups utilized during the session, alongside breathing exercises (breathing pattern: fractionated breathing in two periods).

The following items were utilized in the exercise program; chairs with back supports; handballs; rubber balls; steps; elastic bands; bats; hula hoops; adhesive tapes; plastic bowling sets; a stereo; a blood pressure device and a drawing of the Subjective Perceived Exertion Scale.

Team members systematically completed a field diary in order to maintain control over the sessions.

After three months, both the G1 and G2 groups were reassessed with TUG and BBS.

Information regarding history of falls was obtained for the 12 month period preceding the study (baseline), as well as for the three months of the intervention (post-test) and the three months after the study (follow up).

The data was given to the lead researcher who coded and formatted the database in Excel 2010. For analysis of the data, statistical software Statistical Package for Social Sciences for Windows (SPSS), version 22.0® was used.

Numerical variables were expressed as mean and standard deviation or median (25th percentile – 75th percentile), whether or not they conformed to normal distribution. The categorical variables were expressed in terms of absolute and relative frequency. To verify whether there was a statistically significant difference between the independent variables, the Student's t-test was used in the case of normal data and the Mann-Whitney U test was used where the data was abnormal. In order to detect differences between the measurements collected at baseline and those taken after 12 weeks of intervention, the Student's t-test for paired samples (for data with normal distribution) and the Wilcoxon test for paired samples (for data with abnormal distribution) were performed. Associations between categorical variables were evaluated using Pearson's chi-square test with continuity correction where appropriate. The association between risk of falling and BBS score was assessed using logistic regression, while for the correlation between BBS and TUG scores Spearman's ordinal correlation was used, since both scales produce qualitative results, requiring a correlation test appropriate for nonparametric data. Tests with a probability value of <0.05 were considered statistically significant.

The study was approved by the Ethics Committee for Research involving human beings at the Universidade de Passo Fundo (University of Passo Fundo) (CEP/UPF), under protocol number 572.113/2014 (CAAE: 24627913.6.0000.5342). All who agreed to participate signed a Free and Informed Consent Form based on Resolution No. 466/12 of the National Health Council. The research was included in the Registro Brasileiro de Ensaios Clínicos (the Brazilian Registry of Clinical Trials) (REBEC) and can be located using the indicator RBR- 5XNYJS.

RESULTS

All 30 study participants completed all of the assessments and interventions, and they were divided into two groups (G1 and G2) containing 15 participants each. The average age of participants was 76.2 years (±7.9), while 19 (63.3%) were female.

In terms of the sociodemographic characteristics of the groups, the average age of G1 members was 77.3 (±9.3) years while for G2 it was 75.1 (±6.5) years. There was no statistically significant difference between the groups, $p=0.459$. Females were predominant in G1 (60.0%) and G2 (66.7%), $p=0.710$. In terms of marital status, both groups had a high proportion of widowed individuals, who made up 40.0% of G1 and 60.0% of G2, $p=0.222$. Regarding education, elementary was the most common level in both groups at 46.7%, $p=0.879$. Regarding occupation prior to institutionalization, both groups showed a predominance of manual activities, or in other words, activities that require physical exertion, with these individuals making up 66.7% of G1 and 11.5% of G2, $p=0.195$. The median value for period of institutionalization was 24 months among G1 members and 29 months in G2, $p=0.967$.

Table 1 presents information regarding comorbidities, medication, polypharmacy, falls and fractures.

These results show that the elderly persons who did not participate in the exercise program (G1) continued to fall during and after the study period. The individuals who participated in the program (G2), however, did not fall during the three months in which they regularly took part in physical exercises.

Table 2 presents average results for the TUG and BBS, including both baseline and post-intervention data.

Table 1. Comorbidities, medications, polypharmacy, falls and fractures among elderly residents of LTCFs. Rio Grande do Sul, 2014.

Variables	G1 (n=15)	G2 (n=15)	*P*
Comorbidities*			
Neurologic	11 (73,3)	7 (46.7)	0.264
Cardiovascular	2 (13.3)	---	0.143
Psychiatric	1 (6.7)	3 (20.0)	0.283
Orthopaedic	1 (6.7)	2 (13.3)	0.543
N° of medications**	6.3 (±3.4)	5.2 (±2.8)	0.360
Polypharmacy*	11 (73.3)	12 (80.0)	0.666
Falls (last 12 months)*	6 (40.0)	7 (46.7)	0.717***
Fractures (last 12 months)*	1 (6.7)	2 (13.0)	0.543

G1= control group; G2= intervention group; p= probability value; *Data presented as absolute and relative frequency (in brackets); **values express mean and standard deviation. Using the student's t-test; ***Mann-Whitney U test for independent samples.

Table 2. Average scores on TUG and on BBS, pre and post-intervention among elderly residents in LTCFs. Rio Grande do Sul. 2014.

Variables	G1 (n=15)	G2 (n=15)
TUG*		
Baseline	17.0 (13.0–22.0)	17.0 (14.0–28.0)
Post	19.0 (13.0–33.0)	9.0 (7.0–19.0)
P	0.010***	0.000**
BBS*		
Baseline	49.0 (43.0–51.0)	49.0 (43.0–53.0)
Post	46.0 (34.0–49.0)	52.0 (48.0–54.0)
P	0.002***	0.008**

G1= control group; G2= intervention group; p= probability value; BBS= Berg Balance Scale. The results were presented as points; TUG= Timed Up and Go Test. The results were presented in seconds; *Mid values express median (p25–p75); **student's t-test for related samples (data with normal distribution); ***Wilcoxon test for related samples (for data with abnormal distribution).

In relation to the tests and the frequency of falls, the correlation between the baseline scores on the TUG and BBS was statistically significant, rs=-0.80, $p<0.001$.

The chances of an individual having fallen during the past year was not significantly statistically associated with the BBS baseline results, *OR*=0.96 (CI95% 0.87–1.5) for each one-unit increase on the BBS. Post-intervention, results from the BBS and TUG showed a statistically significant correlation, rs=-0.63, $p<0.001$.

The probability of suffering from falls after the intervention was not significantly correlated with post-intervention BBS scores, OR=0.98

(CI95% 0.86 to 1.12) for each one-unit increase on the BBS. Therefore, despite the statistically significant changes between baseline and post-intervention results on the BBS and TUG tests, there was not sufficient evidence to demonstrate an association with a reduction in frequency of falls when compared with the history of the individuals over the three months following the study.

DISCUSSION

One of the main findings of this study was the comparison of the baseline and post-intervention results for the G1 group, which presented negative results with a reduction in body balance and an increased risk of falls after the three months of the study. Members of the G2 group however, showed an improved performance in both the TUG and BBS compared with their initial results after taking part in the intervention exercises.

Studies such as this further demonstrate the well-documented fact that falls occur among elderly persons living in LTCFs.[13,15,22] These residents probably develop a functional clinical and psycho-cognitive profile highly associated with risk factors for falls.[23] Postural instability, a geriatric syndrome with symptoms which directly influence episodes of falls, is particularly common.[24] Due to structural and functional changes that occur as part of the natural aging process, the systems responsible for balance also suffer from changes which greatly impact the lives of the elderly. The systems responsible for postural stability are also affected, with reductions in responsiveness and compensation, resulting in increased instability.[25]

This results of the present study showed that after three months of intervention, the G2 group achieved better scores in both the BBS and TUG, indicating a significant improvement in balance and a reduction in the estimated risk of falls when compared to G1.

According to Buranello et al.,[26] balance and risk of falls are closely related, suggesting that the chance of an elderly person suffering from a fall is connected to the maintenance of balance, with greater maintenance lowering the risk of falls. The effectiveness of physical exercise in reducing the risk of falls has been addressed previously in studies.[16,27,28]

In the study by Soares & Sacchelli,[29] it was possible to verify the effect of a program of kinesiotherapy on the balance of elderly individuals, with the results obtained showing an increase of three points on the BBS following the program. There was also a statistically significant improvement in terms of risk of falls, with the training program including components such as strength, flexibility and somatosensory, vestibular and visual aspects,

Regular physical exercise performed by a group of active elderly women and another group of sedentary elderly women showed that such activity has a positive influence on the maintenance of balance, meaning that the chances of suffering a fall are lower for active elderly women.[26]

The results of a study by Salma et al. [30] indicated that the proposed program, which aimed to stimulate the cognitive and motor factors of elderly people through resistance exercises, stretching, play activities, games, circuits, dance and relaxation, was effective in reducing the risk of falls.

Falls can be prevented through exercise programs, the aim of which is to normalize or restore muscle strength, restore balance and reduce the use of medications.[31]

The present study found significant negative correlations between BBS and TUG, with a strong pre-intervention correlation and a more moderate association afterwards, with individuals with higher scores on BBS performing the TUG more quickly, indicating, according to Gonçalves et al.,[32] that a greater ability to maintain balance leads to better performance in functional tasks and a lower risk of falls.

It worth noting that the TUG and BBS tests are effective tools for assessing the physical functional

performance and balance of elderly persons, as well as being effective instruments for the analysis of the risk of falls in this population.[33] These two variables were correlated in the study by Sabchuk et al.,[34] which showed a moderate negative correlation (r=-0.57) and revealed that it is possible to use simple inexpensive tests to assess this physical functional capacity along with balance, with the TUG and BBS tests the most preferable options.

In terms of the frequency of falls over the 12-month period prior to the study, no significant association with balance, as measured by the BBS, was found, probably due to the low number of falls observed.

It was also evident that the elderly persons continued to suffer from falls after the survey period, since the proposed program was not continued and the changes achieved between baseline and post-intervention in the BBS and TUG tests were not enough to lead to a continued reduction in falls.

Falls occur for many reasons and knowledge of their risk factors is essential when it comes to planning preventive measures. The objectives of these measures, both individual interventions and public policy, are the avoidance of falls or the reduction in their number, as well as the preservation of functionality and improvement in quality of life.[25]

Physical exercise represents a key strategy for the prevention of falls among the institutionalized elderly. However, professionals working in LTCFs must also be more attentive to the factors that predispose the elderly to falls and to develop preventive strategies aimed at improving functional capacity and consequently quality of life.

In terms of the limitations of this study, the difficulty in obtaining a larger sample due to the conditions of the residents should be noted. Indeed, a wider range of individuals would allow for better representation.

CONCLUSION

In this study, the elderly persons from the intervention group (G2) obtained better scores in both the Timed Up and Go Test (TUG) and the Berg Balance Scale (BBS), indicating a significant improvement in balance and a reduction in the estimated risk of falls compared to the individuals in the control group (G1). It can therefore be inferred that postural balance and the risk of falls in institutionalized elderly both before and after the exercise program were interconnected, indicating that individuals with better capacity for the maintenance of balance performed better in functional tasks and consequently had a lower risk of falls.

For Long-term Care Facilities for the Elderly (LTCFs), the importance of the physical exercise program utilized in this study has been clearly demonstrated. This fact should make those responsible for these institutions consider the presence of a Physical Education professional to work as part of their multidisciplinary teams.

The relevance of this study lies in the fact that the proposed exercise program was effective in increasing balance and particularly in reducing the estimated risk of falls among institutionalized elderly persons.

ACKNOWLEDGMENTS

The authors would like to thank the Fundação de Amparo à Pesquisa do Estado do Rio Grande do Sul (the Rio Grande do Sul State Research Support Foundation) (FAPERGS).

REFERENCES

1. Gschwind YJ, Kressig RW, Lacroix U, Muehlbauer T, Pfenninger B, Granacher L. A best practice fall prevention exercise program to improve balance, strength / power, and psychosocial health in older adults: study protocol for a randomized controlled trial. BMC Geriatr 2013;105:01-13.
2. Sociedade Brasileira de Geriatria e Gerontologia. Quedas em Idosos: Prevenção.Bela Vista: Associação Médica Brasileira e Conselho Federal de Medicina; 2008. Projeto Diretrizes.
3. Alves NB, Scheicher ME. Equilíbrio postural e risco para queda em idosos da cidade de Garça. Rev Bras Geriatr Gerontol 2011;14(4):763-8.
4. Granacher U, Muehlbauer T, Gruber M. A qualitative review of balance and strength performance in healthy older adults: impact for testing and training. J Aging Res 2012;7:1-16.
5. Rubenstein LZ. Falls in older people: epidemiology, risk factors and strategies for prevention. Age Ageing 2006;35(2):37-41.
6. Gillespie LD, Robertson MC, Gillespie WJ, Lamb SE, Portas S, Cumming RG. Interventions for preventing falls in elderly people living in the community. Cochrane Database Syst Rev 2012;9:1-6.
7. Axer H, Axer M, Sauer H, Witte OW, Hagemann G. Falls and gait disorders n geriatric neurology. Clin Neurol Neurosurg 2010;112(4):265-74.
8. American Geriatrics Society. British Geriatrics Society, American Academy of Orthopaedic Surgeons Panel on Falls Prevention: Guideline for the prevention of falls in older persons. J Am Geriatr Soc 2001;5:664-72.
9. Almeida LP, Brites MF, Takizawa MGMH. Quedas em idosos: fatores de risco. Rev Bras Ciênc Envelhec Hum 2011; 8(3):384-91.
10. Uchida JEF, Borges SM. Quedas em idosos institucionalizados. Rev Kairós 2013;16(3):83-94.
11. Alvares LM, Lima RC, Silva RA. Ocorrência de quedas em idosos residentes em instituições de longa permanência em Pelotas, Rio Grande do Sul, Brasil. Cad Saúde Pública 2010;26(1):31-40.
12. Franklin RC, Boehm J, Rei J, Newitt R, Grant T, Kurkowski B, et al. A framework for the assessment of community exercise programmes: a tool to assist in modifying programmes to help reduce falls risk factors. Age Ageing 2013;42(4):536-40.
13. Silveira SC, Faro ACM, Oliveira CLA. Atividade física, manutenção da capacidade funcional e da autonomia em idosos: revisão de literatura e interfaces do cuidado. Estud Interdiscipl Envelhec 2011;16(1):61-77.
14. Brasil. Agência Nacional de Saúde Suplementar. Manual técnico para promoção da saúde e prevenção de riscos e doenças na saúde suplementar. Rio de Janeiro: ANS; 2011.
15. Rebelatto JR, Castro AP, 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.
16. Klein DM, Rapp K, Küpper M, Becker C, Fischer T, Büchele G, et al. A population-based intervention for the prevention of falls and fractures in home dwelling people 65 years and older in south germany: protocol. J Med Internet Res 2014;3(1):1-19.
17. Hewitt J, Refsshauge KM, Goodall S, Henwood T, Clemson L. Does progressive resistance and balance exercise reduce falls in residential aged care?: Randomized controlled trial protocol for the SUNBEAM program. Clin Interv Aging 2014;9:369-76.
18. Instituto Brasileiro de Geografia e Estatística. Estimativa da população residente no Brasil e unidades da federação com data de referência em 1º de julho de 2014 [Internet]. Rio de Janeiro: IBGE; 2014 [acesso em 12 mar 2015] . Disponível em: http://www.ibge.gov.br/home/estatistica/populacao/estimativa2014/estimativa_tcu.shtm
19. Medronho RA. Epidemiologia. 2ª ed. São Paulo: Atheneu; 2008.
20. Podsiadlo D, Richardson S. The Timed Up and Go: a test of basic functional mobility for frail elderly person. J Am Geriatr Soc 1991;2:142-8.
21. Miyamoto ST, Lombardi L Jr, Berg KO, Ramos LR, Natour J. Brazilian Version of Berg Balance Scale. Braz J Med Biol Res 2004;37(9):1411-21.
22. Menezes RL, Bachion MM. Estudo da presença de fatores de risco intrínsecos para quedas, em idosos institucionalizados. Ciênc Saúde Coletiva 2008;13(4):1209-18.
23. Mignardot JB, Deschamps T, Barrey E, Auvinet B, Berrut G, Cornu C, et al. Gait disturbances as specific predictive markers of the first fall onset in elderly people: a two-year prospective observational study. Front Aging Neurosci 2014;6:1-13.

24. Paradela EMP. A avaliação clínica do idoso que cai. Rev HUPE 2014;13(2):45-52.

25. Lima DA, Cezario VOB. Quedas em idosos e comorbidades clínicas. Rev HUPE 201;3(2):30-7.

26. Buranello MC, Campos AO, Quemelo PV, Silva Valadares A. Equilíbrio corporal e risco de queda em idosas que praticam atividades físicas e sedentárias. Rev Bras Ciên Envelhec Hum 2011;3:313-23.

27. Antes DL, Schneider IJC, Benedetti TRB, Orsi E. Medo de queda recorrente e fatores associados em idosos de Florianópolis, Santa Catarina, Brasil. Cad Saúde Pública 2013;29(4):758-68.

28. Bento PCB, Rodacki ALF, Homann D, Leite N. Exercícios físicos e redução de quedas em idosos: uma revisão sistemática. Rev Bras Cineantropom Desempenho Hum 2010;12(6):471-9.

29. Soares MA, Sacchelli T. Efeitos da cinesioterapia no equilíbrio de idosos. Rev Neurociênc 2008;16(2):97-100.

30. Salma SS, Coelho FGM, Gobbi S, Stella F. Efeitos de um programa de atividade física nas funções cognitivas, equilíbrio e risco de quedas em idosos com demência de Alzheimer. Rev Bras Fisioter 2010;14(1):68-74.

31. Constantini A, Almeida P, Portela BS. Rev Eletrôn Polidiscipl Voos 2011;3(2):17-30.

32. Gonçalves DFF, Ricci NA, Coimbra AMV. Equilíbrio funcional de idosos da comunidade: comparação em relação ao histórico de quedas. Rev Bras Fisioter 2009;13(4):316-23.

33. Barros SS, Souza GFM, Uchôa EPBL. Correlação entre inatividade física, polifarmácia e quedas em idosos. ConScientiae Saúde 2012;11(1):37-45.

34. Sabchuk RAC, Bento BCB, Rodacki ARF. Comparação entre testes de equilíbrio de campo e plataforma de força. Rev Bras Med Esporte 2012;18(6):404-8.

Received: June 30, 2015
Reviewed: November 22, 2015
Accepted: March 04, 2016