



PREDICTIVE FACTORS OF FALLS IN WOMEN PRACTICING PHYSICAL EXERCISE

Fatores preditores de quedas em mulheres praticantes de exercício físico

Factores predictores de caídas en mujeres que practican actividad física

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ABSTRACT

Objective: To identify factors associated with the risk of falls in older women engaged in regular physical exercise. **Methods:** Observational cross-sectional study with a non-probability and intentional sample conducted between April and July 2016 in Petrolina, Pernambuco, with 109 women (60-84 years old) doing Pilates, water aerobics and swimming, with and without history of falls. A questionnaire addressing sociodemographic data, comorbidities and number of medications used was used as the instrument of data collection in addition to Body Mass Index (BMI), gait performance by the Time Up and Go (TUG) test and balance by the Berg Balance Scale (BBS). Data were analyzed using Kruskal Wallis test, Spearman's correlation and linear regression. **Results:** A gait performance deficit was observed with advancing age ($p<0.05$). In the assessment of body balance, octogenarians showed a risk for falling ($p<0.05$). Logistic regression analysis indicated that the risk of falls was increased by 22% due to attention deficit and by 21% due to daily use of more than three types of medication ($p<0.05$). **Conclusion:** Cognitive deficit and the number of medications used were predictors of falls in older women doing regular physical exercise.

Descriptors: Accidental Falls; Risk Factors; Aging.

RESUMO

Objetivo: Identificar fatores preditores de quedas em idosas praticantes de exercício físico. **Métodos:** Estudo transversal, observacional, com amostra não probabilística e intencional, realizado entre abril e julho de 2016, em Petrolina, Pernambuco, com 109 mulheres (60-84 anos) praticantes do método Pilates, hidroginástica e natação, com e sem histórico de queda. Utilizou-se como instrumento de coleta um questionário para dados sociodemográficos, comorbidades, número de medicações, índice de massa corporal (IMC), desempenho da marcha pelo teste Time up and Go (TUG) e equilíbrio pela escala do equilíbrio de Berg (EEB). Para a análise dos dados, utilizou-se o teste de Kruskal Wallis, correlação de Spearman e regressão linear. **Resultados:** Observou-se déficit do desempenho da marcha com o avanço da idade ($p<0,05$). Na avaliação do equilíbrio corporal, octogenárias apontaram risco para queda ($p<0,05$). A análise de regressão logística indicou que o risco de queda foi potencializado em 22% pelo déficit de atenção, e em 21% pelo uso diário superior a três tipos de medicamentos ($p<0,05$). **Conclusão:** O déficit da capacidade cognitiva e o número de tipos de medicações se apresentam como preditores de queda em idosas praticantes de exercícios físicos.

Descritores: Acidentes por Quedas; Fatores de Risco; Envelhecimento.

RESUMEN

Objetivo: Identificar los factores predictores de caídas en mujeres mayores practicantes de actividad física. **Métodos:** Estudio transversal y observacional con muestra no probabilística e intencional realizado entre abril y julio de 2016, en Petrolina, Pernambuco, con 109 mujeres (60-84 años) practicantes del método Pilates, hidroginástica y natación con y sin histórico de caídas. Se utilizó como instrumento de recogida de datos un cuestionario para los datos sociodemográficos, las comorbidades, el número de medicaciones, el índice de masa corporal (IMC), el desempeño de la marcha por la prueba Time up and Go (TUG) y el equilibrio con la escala de equilibrio de Berg (EEB). Se utilizó la prueba de Kruskal Wallis, la correlación de Spearman y la regresión lineal para el análisis de los datos. **Resultados:** Se observó un déficit para el desempeño de la marcha al avance de la edad ($p<0,05$). En la evaluación del equilibrio corporal, las octogenarias presentaron riesgo para caída ($p<0,05$). El análisis de regresión logística ha indicado que el riesgo de caída ha sido potencializado en el 22% por el déficit de atención y el 21% por el uso a diario de más de tres tipos de medicamentos ($p<0,05$). **Conclusión:** El déficit de la capacidad cognitiva y el número de tipo de medicamentos se han presentado como predictores de caída en mujeres mayores que practican actividad física.

Descritores: Accidentes por Caídas; Factores de Riesgo; Envejecimiento.



INTRODUCTION

Human aging is responsible for a set of biopsychosocial transformations that make individuals aged 60 and over more susceptible to diseases⁽¹⁻²⁾. The scope of disease prevention in the older population includes different themes, such as falls and recurrent cases of falls. According to the World Health Organization (WHO), falls are a public health problem⁽³⁾.

One third of the world's population over 65 years old has already suffered one or more falls⁽⁴⁾. This fact emphasizes the importance of carrying out studies in this area, particularly because the risk of fall increases by about 50% in women over 80 years of age. Although 5% of falls result in minor injuries, approximately 30% of them require medical treatment because of serious injuries such as fractures and lesions. Thus, hospitalization may last for days, which generates costs for public and private health services. In addition, falls may lead the older person to death⁽⁵⁾.

Recent research conducted with 729 older people in the urban area of Uberaba, Minas Gerais, found a prevalence of falls of 28.3% among the interviewees. Of these, 44.6% reported one single episode of fall and 55.4% reported recurrent falls⁽⁶⁾. In this regard, the early identification of the risk of falling allows the acquisition of information that can be used to develop measures to prevent falls⁽²⁾. The responsible factors are known^(2,4,5,7); however, the interrelationships and the impact that each factor have not been fully addressed yet⁽⁷⁾. Falls can be caused by intrinsic or extrinsic factors, or even both⁽⁸⁾. Extrinsic factors are related to environmental conditions, such as poor lighting and obstacles placed inadequately in the streets or in the rooms of the house. Intrinsic factors are related to the set of comorbidities that characterize the process of human aging⁽⁹⁾, such as: depression⁽¹⁰⁾; neuromuscular impairment⁽¹¹⁾; cognitive decline, which is responsible for attention and memory deficits⁽¹²⁾; static and dynamic balance control disorders⁽¹³⁾; abnormal gait pattern⁽¹⁴⁾; and side effects resulting from drug interactions⁽⁶⁾.

A known and often used effective and low-cost fall prevention measure is the regular physical exercise (PE)⁽¹⁵⁾. Studies conducted with older people showed that two weekly sessions (50 minutes) of Pilates or water aerobics over 12 weeks were effective in preventing falls, significantly improving muscle strength and balance control and gait pattern^(16,17). Given that, the objective of the present study was to identify factors associated with the risk of falls in older women engaged in regular physical exercise.

METHODS

This is an observational cross-sectional study with a non-probability and intentional sample. Participants were 109 women doing Pilates, water aerobics or swimming twice a week (50 minutes). The activities were part of a physical exercise program (PE) offered to the older people from the cities of Petrolina (Pernambuco) and Juazeiro (Bahia), in Brazil, by the School of Physical Education of the Federal University of the São Francisco Valley (*Universidade Federal do Vale do São Francisco – UNIVASF*).

Inclusion criteria were: age ≥ 60 years, a minimum of six months of PE and a frequency rate of 75% in the activities, which was checked in the attendance sheet. Additionally, the participants could not present with any muscle, joint or bone problems that hindered performance in activities of daily living (ADL) during the study period. Those who did not complete all the phases of the study or who reported neurological problems such as Parkinson's disease or stroke were excluded. The procedures were carried out by two duly trained examiners between April and July 2016. The application of questionnaires and physical fitness assessments took place in the afternoon in the laboratory of the Dance and Gymnastics Studies Group (*Grupo de Estudos em Dança e Ginástica – GEDAGIN/CNPq*), which is located in the School of Physical Education of UNIVASF. The research involved five phases:

Phase 1: Collection of sociodemographic data and information on comorbidities through a questionnaire with the following topics: a) age; b) comorbidities: vision problems, hearing problems, labyrinthitis; c) history of falls in the last 12 months; d) quantification of the types of medication used per day; and e) accounts of attention and memory deficit, checking for cognitive impairment in the performance of ADL and difficulties related to the short-term memory.

Phase 2: Application of the Mini Mental State Examination (MMSE)⁽¹⁸⁾, an instrument to assess the participants' mental health state and identify possible cases of dementia. The MMSE is composed of seven items divided into domains: orientation to time and space; immediate memory and recall; calculation; language-naming; repetition; understanding; writing and copying a picture. In the present study, the cut-off points proposed by Brucki et al.⁽¹⁹⁾ were adopted: up to 20 points for illiterate individuals; 25 points for 1 to 4 years of study; 26.5 points for 5 to 8 years of study; 28 points for 9 to 11 years of study; and 29 points for more than 11 years of study.

Phase 3: Assessment of Body Mass Index (BMI) using the formula: mass (Kg)/height(m²). Measurements were performed using a mechanical scale with a capacity of up to 300 Kg (Welmy, Brazil) and a 2-meter anthropometric ruler. Health status was classified according to the cut-off points proposed by Lipschitz⁽²⁰⁾: underweight (BMI <22 Kg/m²), normal weight (BMI 22 Kg/m²-27 Kg/m²) and excess weight (BMI > 27 Kg/m²);

Phase 4: Assessment of body balance through the Berg Balance scale (BBS)⁽²¹⁾, which allowed the assessment of participants' functional balance to estimate the risk of falls. BBS has high intra- and inter-rater reliability⁽²²⁾ and its 14 items assess situations of ADL, such as standing, walking, reaching forward, transferring and turning in different levels of difficulty. The score ranges from zero (unable to perform the task) to four (normal), with a maximum score of fifty-six points (56). According to Berg⁽²²⁾, a score of forty-five points indicates risk of fall.

Phase 5: Assessment of mobility using the Timed Up and Go (TUG) test, which assesses gait pattern by asking participants to sit in a 45cm high chair with an arm rest and then stand and walk three (3) meters and make a 180° turn around a cone, return and sit back in the chair. The timer was started at the time the examiner said "go" and immediately stopped when the participant sat and leaned against the back of the chair. The results were interpreted according to the guidelines proposed by Bischoff et al.⁽²³⁾, which consider normal (without risk of falls), for independent adults, a time of up to 10 seconds. Time between 11 and 20 seconds indicates independence (low risk of falls) and time longer than 20 seconds indicates mobility deficit (high risk of falls).

The normality of the data was checked by the Kolmogorov-Smirnov test and the results were described using descriptive statistics (mean, standard deviation and frequency). Chi-squared test was used to compare nominal variables. Fisher's exact test was used for expected values of less than five. Kruskal Wallis test was used for comparing groups/age groups of the variables that did not present normal distribution, such as age, BMI, gait performance and body balance.

Significance between two independent samples was determined by the Mann-Whitney U test. Spearman's correlation was used to determine the strength and direction of the relationship between the variables analyzed. Since the risk of falls cannot be explained by a single causal agent, a multivariate linear regression analysis – forward selection – was performed. The data were processed in the Statistical Package for the Social Sciences (SPSS) version 23.0, with significance level set at $p < 0.05$.

All the participants were informed about the study procedures and signed a free informed consent form. The study was approved by the Human Research Ethics Committee of the Federal University of the São Francisco Valley (*Universidade Federal do Vale do São Francisco – UNIVASF*) under Approval No. 1.149.072.

RESULTS

The present study was carried out with physically active women aged between 60 and 84 (67.55 ± 5.37) years. Table I shows the main characteristics of the participants by age groups: 60-69 years (46.7%), 70-79 years (23%) and 80-84 years (2%). Considering the BMI cut-off points⁽²⁰⁾, there was a slight tendency for excess weight among septuagenarians ($p < 0.001$). With regard to the daily use of medications, there was an increase in medication types with advancing age ($p > 0.05$).

Table I - Main characteristics of the population according to age groups. Petrolina, Pernambuco, Brazil, 2016.

Variables	60-69 years (n=71)	70-79 years (n=35)	80-84 years (n=3)	p
Age (years)	64.35±2.77	72.80±2.62	82.33±0.57	<0.001*
BMI (Kg/m ²)	22.80±12.07	27.49±4.62	24.94±2.90	<0.001*
Medications (>3 types a day)	2.59±1.80	2.81±1.94	3.67±3.78	0.240
Falls	1.85±0.36	1.83±0.38	-----	0.740
Vision	1.14±0.35	1.11±0.32	1.33±0.57	0.763
Hearing	1.77±0.42	1.74±0.44	1.33±0.57	0.323
Labyrinthitis	1.82±0.39	1.74±0.44	2.00±0.00	0.647
Attention	1.52±0.63	1.46±0.50	1.33±0.57	0.915
TUG (s)	9.32±2.60 ^a	9.99±3.46 ^a	12.39±0.00	<0.001*
BBS	51.68±2.39 ^a	50.83±3.40 ^b	44.00±7.81 ^{a,b}	0.046*

Legend: BMI: Body Mass Index; Kg: Kilogram; m²: square meter; s: seconds; TUG: Time up and Go; BBS: Berg Balance Scale; ^a $p < 0.05$ (Mann Whitney U); ^{*}Kruskal Wallis. Source: Author

According to Table I, there were no significant differences in self-reported comorbidities and types of medication used among age groups ($p > 0.05$). Fall prevalence rates were 15.5% among sexagenarians (11/71) and 17.1% among septuagenarians (6/35). There were no cases among octogenarians ($p > 0.05$). Septuagenarians and sexagenarians presented similar results in gait performance, while octogenarians appeared to be slow walkers ($p < 0.05$). According to the assessment of body balance (BBS), octogenarians presented with a risk of falling.

When divided according to the history of falls, 15.6% (17/109) of the study population reported having fallen at least once in the last twelve months (Table II). Regarding comorbidities (vision and hearing problems and labyrinthitis), there were no statistical differences, demonstrating homogeneity between the groups ($p > 0.05$). On the other hand, using more than three types of medication per day and attention span differed statistically between the groups ($p < 0.05$).

Table II - Mean values according to history of falls in the last 12 months. Petrolina-Pernambuco, Brazil, 2016.

Variables	Fallers (n=17)	Non-fallers (n=92)	P
	M/SD	M/SD	
Age (years)	66.29±5.00	67.79±5.43	0.293
BMI (Kg/m ²)	28.09±5.77	23.63±10.86	0.666
Medications (>3 types a day)	2.21±0.41	1.97±0.17	0.019*
Vision	1.06±0.24	1.15±0.36	0.309
Hearing	1.82±0.39	1.74±0.44	0.464
Labyrinthitis	1.82±0.39	1.79±0.40	0.779
Attention	1.55±0.52	1.18±0.50	0.005*
TUG (s)	14.04±2.83	13.86±3.25	0.834
BBS	50.88±3.51	51.25±3.13	0.664

Legend: BMI: Body Mass Index; Kg: Kilogram; m²: square meter; s: seconds; TUG: Time up and Go; BBS: Berg Balance Scale; *p≤0.05 (Mann-Whitney U). Source: Author

Table III shows the strength and direction of the relationship between the study variables. There was a moderate correlation between falls and drug interaction (r=0.538, p<0.05) and also between falls and self-reported attention span (r=0.511, p<0.05). Significant differences were also found in the motor tests. The statistical analysis indicated a weak and negative relationship between walking speed and attention span (r=-0.316, p<0.05) and a weak and inversely proportional association between the TUG-BBS tests (r=-0.276; p<0.05).

Table III - Effects of correlations between the study variables. Petrolina, Pernambuco, Brazil, 2016.

	Falls	Medic.	Vision	Hearing	Labyr.	Atten.	TUG	BBS
Falls	1							
Medic.	0.538**	1						
Vision	0.098	0.020	1					
Hearing	-0.071	0.135	-0.018	1				
Labyr.	-0.027	0.131	0.068	0.135	1			
Atten.	0.511**	0.047	0.029	0.180	0.128	1		
TUG	-0.021	-0.164	0.196	-0.012	0.008	-0.316*	1	
BBS	0.042	-0.118	-0.049	0.048	0.146	0.227*	-0.276**	1

Legend: Medic.: Medications (>3 types a day); Labyr.: Labyrinthitis; TUG: Time up and Go; BBS: Berg Balance Scale; **p<0.01, *p≤0.05 in the Spearman's Rho Correlation. Source: Author

The multiple linear regression model estimated the effect of comorbidities, drug interaction and performance in the gait and body balance tests on falls (Table IV). The order of insertion of the variables followed the forward selection approach, from highest to lowest values, respecting the magnitude of the Spearman's correlation coefficient. The analysis resulted in a statistically significant model [F (2.97) = 0.731; p=0.006; R²=0.315]. In the study population, attention span (β=0.220, t=2.278, p≤0.05) and use of more than three types of medications per day (β=0.212, t=2.199; p≤0.05) were predictors of the risk of falls.

Table IV - Regression model adjusted for comorbidities, medications, gait performance and balance. Petrolina, Pernambuco, Brazil, 2016.

Variables	b	Standard Error	95%CI	B	p
Attention	0.163	0.071	0.063-0.004	0.220	0.026*
Medications (>3 types a day)	0.043	0.020	0.021-0.031	0.212	0.027*

Legend: *p≤0.05.

DISCUSSION

The findings of the present study allowed the identification of the main factors responsible for the increased risk of falls in a group of older women (60-84 years old) engaged in regular physical exercises living in Northeastern Brazil. In all, 15.6% of the interviewees reported the occurrence of falls in the last 12 months, demonstrating that the population was predominantly composed of non-fallers. This finding may be indicative of the benefits of regular physical exercise for the prevention of falls.

Studies have shown the positive effects of regular exercise on walking speed, body posture control, lower limb strength and fear of falls^(24,25).

According to the literature on the theme, increasing age has a strong impact on the occurrence of falls^(4,5,10). Therefore, octogenarians are considered potential fallers⁽²⁶⁾. The results of the present study did not corroborate the facts described in the literature, since there were no cases of falls among the octogenarian participants. One possible explanation may be the characteristic of the study population, which was engaged in regular PE. Given that, the findings of the study carried out in Petrolina confirm the results of systematic reviews of studies on falls^(24,25).

Likewise previous research⁽²⁷⁾, the present study showed a higher prevalence of falls among sexagenarians (64.7%), followed by septuagenarians (33.3%). In a household survey carried out with 729 older people living in the urban area of Uberaba, Minas Gerais, the prevalence of falls in the last twelve months was 28.3%⁽²⁷⁾. The results of the same survey revealed a higher proportion of falls among women (33.1%); of these, 26.4% were aged 60-79 years and 35.7% were aged ≥ 80 years.

The analysis of the associated factor showed that 33.8% of fallers had two or more morbidities. In addition, 24.8% of the interviewees used up to four medications a day and 35.9% used five or more medications. The findings of Petrolina were similar to those of Uberaba, where there was a significant association between falls and daily use of more than three types of medication. The linear regression analysis showed that 21% of the risk of falls was due to drug interaction, which means that being physically active is not enough to prevent falls.

In addition to that, older people must pay attention to the rational use of medicines⁽²⁸⁾. This measure includes monitoring the type and number of medications used by older people. Therefore, physical exercise programs should be carried out with this population group within their dynamic educational activities preferably under the responsibility of interdisciplinary health teams⁽¹²⁾. Thus, both older people and their families may learn strategies to facilitate the organization of the medications of the day, reducing medication errors⁽²⁸⁾. Importantly, the combination of hypertensive, diuretic and psychoactive substances may potentiate hypotonia, muscle relaxation and weakness, thereby reducing the person's attention to extrinsic factors that may lead to fall and also reducing the speed of muscle reaction. Therefore, the combination of these factors contributes to the incidence of falls⁽²⁹⁾.

In addition to drug interaction, the adjusted logistic regression model used in the present study indicated that attention deficit was responsible for an increased incidence of falls in 22% of the participants. This finding corroborates the literature on the theme⁽³⁰⁾, which points to the cognitive decline resulting from the aging process as one of the factors responsible for older people's poor concentration and attention and short-term memory deficit⁽³¹⁾. The issue deserves attention – and so does polypharmacy – and requires the creation of educational strategies, since the loss of cognitive function leads to deficits in the performance of ADL. Attention deficit is a problem for older people when they have to perform simultaneous tasks, i.e., situations that require reasoning during motor activities. Thus, the training in the prevention of falls should be supported by a combination of physical exercise and procedures that promote attention, cognition and memory^(12,14,32). Activities of this type are called dual or multiple tasks⁽³³⁾.

In a prospective cohort study with a one-year follow-up, which assessed the influence of sensorimotor and neuropsychological factors and gait performance on the risk of falls⁽³¹⁾, the authors found that older people with a history of more than one fall had a significantly slower walking speed due to the shorter stride length and increased step variability when compared with older people who had suffered only one fall. As a preventive measure to reduce falls, the authors suggested older people's participation in physical exercise programs focused on the maintenance and enhancement of the sensorimotor system.

In this regard, older people's performance in gait and static and dynamic balance tests serves as a predictor of falls^(34,35). In the present study, the gait test presented similar performance means, with no risk of falls, between sexagenarians and septuagenarians. Octogenarians were slower in the test; however, the results were not classified as performance deficits.

Following the order of the results, there was a weak and negative correlation between the TUG and BBS tests, which demonstrates that an increased time in the gait test (TUG) suggests a poor performance in the body balance test (BBS). In practice, slower walkers presented a higher chance of having difficulties in performing their ADL. Regarding the assessment of body balance, octogenarians, even though they did not report fall events, presented with posture control deficit. Not being a faller may be a protective effect from a preserved gait pattern.

Some limitations of the present study should be highlighted, such as the assessment of the variable "attention" through self-report. Thus, the subjectivity in the understanding of the terms attention and memory by the older women may have made data generalization difficult. Therefore, further research should be carried out to assess attention span through specific psychological tests. The main contribution of this research to the scientific community and the population is the dissemination of information about the risk of falls among older people engaged in regular physical exercises.

CONCLUSION

Cognitive capacity and number of medication types are predictors of the risk of falls in older women engaged in physical exercises.

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