Relationship between physical activity level and balance in middle-aged and older women

Relação entre o nível de atividade física e equilíbrio em mulheres na meia-idade e idosas

Pedro Rafael de Souza Macêdo [1*]
Sabrina Gabrielle Gomes Fernandes [1]
Ingrid Guerra Azevedo [2]
José Vilton Costa [1]
Dimitri Taurino Guedes [1]
Saionara Maria Aires da Câmara [1]

[1] Universidade Federal do Rio Grande do Norte (UFRN), Natal, RN, Brazil
[2] Universidade Católica de Temuco (UCT), Araucanía, Chile

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*** Correspondence:** p.rafael2012@hotmail.com

Abstract

Introduction: Physical exercise may improve motor skills, such as static standing balance. However, the association between physical activity level based on activities of daily living and static balance is unknown. **Objective:** To assess the association between the physical activity level and static balance in middle-aged and older women. **Methods:** This cross-sectional study involved 589 community-dwelling women. Static balance was assessed using the single-leg stance test (SLST) with eyes open and closed. Physical activity level was assessed using the International Physical Activity Questionnaire Short Form and classified as high, moderate, or low. Kruskal-Wallis test compared balance performance between participants with different physical activity levels. Multiple quantile regression analyses assessed the association between variables adjusted for age, family income, educational level, body mass index, comorbidities, and parity. **Results:** Participants with low physical activity level showed worse SLST performance with eyes open and closed than participants with high physical activity level in the bivariate analysis. However, physical activity level and SLST performance were not associated in the analysis adjusted for covariates. **Conclusion:** Our results suggested that only being active in daily living activities is not associated with better standing balance in middle-aged and older women. Specific physical exercise programs should be implemented to improve balance in this population.

Keywords: Adults. Aging. Exercise. Static balance. Women.

Resumo

Introdução: *O exercício físico pode melhorar as habilidades motoras, como o equilíbrio estático na posição ortostática; no entanto, a associação do nível de atividade física durante as atividades de vida diária e o equilíbrio estático não é conhecida.* ***Objetivo:*** *Avaliar a associação entre o nível de atividade física e o equilíbrio estático em mulheres de meia-idade e idosas.* ***Métodos:*** *Trata-se de um estudo transversal com 589 mulheres residentes na comunidade. O equilíbrio estático foi avaliado usando o teste de equilíbrio unipodal com os olhos abertos e fechados. O nível de atividade física foi avaliado usando o Questionário Internacional de Atividade Física – versão curta e classificado em alto, moderado e baixo. O teste de Kruskall Wallis comparou o desempenho no teste de equilíbrio unipodal de participantes com diferentes níveis de atividade física. Modelos de regressão quantílica avaliaram a associação entre as variáveis ajustada pelas covariáveis idade, renda familiar, escolaridade, índice de massa corporal, condições crônicas e paridade.* ***Resultados:*** *Na análise bivariada, as mulheres com baixo nível de atividade física mantiveram o equilíbrio em pé com os olhos abertos e fechados por um tempo menor do que aquelas classificadas como alto nível de atividade física. No entanto a associação entre nível de atividade física e performance no teste de equilíbrio estático não foi significativa na análise ajustada para as covariáveis.* ***Conclusão:*** *Os resultados sugerem que apenas ser ativa nas atividades de vida diária não está associado a um melhor equilíbrio em mulheres de meia-idade e idosas. Programas específicos de exercício físico devem ser implementados visando um melhor desempenho do equilíbrio nesta população.*

Palavras-chave: *Adultos. Envelhecimento. Exercício. Equilíbrio estático. Mulheres.*

Introduction

The increase in life expectancy in Brazil has been accompanied by an increase in the amount of time living with a disability.[1] Despite living longer, women of advanced age show greater functional decline and worse health outcomes than men.[2] This difference may be explained by gender-related factors.[3]

A component that declines as individuals age is balance.[4] The ability of older adults to move around and recover balance after a perturbation is often reduced.[5] Balance disorders in older adults may result from muscular involution, dysfunctions, and diseases.[6] Previous studies showed that the prevalence of balance disorders in Brazilian older adults ranges from 16.3% to 46%.[6,7] Balance disorders are a well-established risk factor for falls[8] and may also impair the performance of activities of daily living.[9]

Physical exercise may prevent balance disorders and falls,[10] improving quality of life of older adults.[11] Physical exercise is also beneficial for improving muscle mass, strength, bone mineral density, cardiovascular function, walking speed, and functional mobility.[12]

Studies investigating the association between physical activity level (through physical exercises and daily living activities) and static standing balance are scarce. Physical activity level decreases with age. About 60% of older adults without a disability are insufficiently active.[13] Investigating the association between physical activity level and balance may contribute to developing strategies to improve balance in older adults and prevent falls among individuals who do not adhere to regular physical exercises.[14] Among women, physical activity levels may reduce at earlier ages, during the climacteric period, when the level of sex hormones decreases, contributing to the reduction of muscle mass and strength.[15] In this sense, studies investigating aging-related conditions and middle-aged women may be relevant to clinical practice.

This study evaluated the association between physical activity level and performance in the single-leg stance test (SLST) in community-dwelling middle-aged and older women.

Methods

Design

This cross-sectional, observational, and analytical study was conducted in Parnamirim in 2014 and Santa Cruz in 2016, Northeastern Brazil.

Participants

The study population comprised community-dwelling middle-aged and older women (40 to 80 years) living in Parnamirim and Santa Cruz. A convenience sampling was obtained by disclosing the study in all

primary care centers across both cities. Participants with motor or degenerative impairments, any conditions compromising the assessment of physical functions, or cognitive dysfunctions (≥ four errors in the Leganés cognitive test) were excluded. All 589 women evaluated met the eligibility criteria and composed this study sample. All participants were informed about the study aims and signed the informed consent form. This study followed the Declaration of Helsinki and was approved by the research ethics committee of the Universidade Federal do Rio Grande do Norte (number 1.875.802).

Procedures

Trained interviewers conducted the assessments according to the following protocol.

Dependent variable: single-leg stance test

Static standing balance was assessed using the SLST with eyes open and closed. This low-cost and easy-to-perform test assesses static postural stability, predicts falls, and identifies pre-clinical impairments in community-dwelling women.[16,17] SLST has a good reliability for eyes open (intra-class correlation coefficient [ICC]: 0.994; 95% confidence interval [CI]: 0.989 to 0.996) and closed (ICC: 0.998; 95% CI: 0.996 to 0.999).[17] Participants were asked to stand on one leg unassisted by the upper limbs for up to 30 seconds. The test was conducted with eyes open followed by eyes closed for both legs, totalizing four assessments. Performance was expressed as the average time (in seconds) of the tests conducted with each leg and with eyes open and closed.

Independent variable: physical activity level

The International Physical Activity Questionnaire-Short Form (IPAQ-SF) assessed the physical activity level of participants. The IPAQ-SF estimates the time spent seated, walking, and in moderate activities per week. The energy expenditure is calculated based on the metabolic equivalent task (MET) for each activity and classified according to guidelines for data processing and analysis of the IPAQ-SF.[18] Results were obtained by summing all activities and expressed as MET-min/week.

Physical activity level was classified as high (≥ seven days of any combination of walking and moderate- or vigorous-intensity activities achieving at least 3,000 MET-min/week), moderate (≥ three days of vigorous activity for at least 20 min per day or ≥ five days of any combination of walking and moderate- or vigorous-intensity activities achieving at least 600 MET-min/week), and low (participants who did not meet the criteria for moderate or high physical activity levels).[19]

Covariates

Based on previous research, the association between physical activity level and balance performance was adjusted for the following covariates:

Age

Aging contributes to the gradual reduction of physical activity level[13] and increase of balance disorders.[6] Participants self-reported their ages and were classified as middle-aged (40 to 59 years) or older women (≥ 60 years).

Socioeconomic status

Low socioeconomic status is associated with poor physical performance (including balance) and low physical activity levels.[20,21] Socioeconomic status was assessed based on family income and education level. Family income was classified as less than three Brazilian minimum wages (MW) or three MW or more.[3] Educational level was classified as less than elementary school (i.e., up to seven years of education) or elementary school or more (i.e., ≥ 8 years of education).[3]

Body mass index

High body mass index (BMI) is associated with low balance performance[22] and low physical activity level.[23] Interviewers measured weight (kg) and height (m) of participants and classified their BMI (kg/m^2) as normal (18.50 to 24.99), overweight (25.00 to 29.99), or obese (≥ 30.00).[24] No woman was classified as underweight (< 18.50) in this study.

Comorbidities

Increased number of comorbidities is associated with low physical activity levels[25] and poor balance[26] in older people. To assess comorbidities, participants were

asked if a doctor or nurse had told them that they had one of the following conditions: diabetes, chronic lung disease, hypertension, coronary heart disease, arthritis, depression, and cancer. Participants were classified as having zero to two comorbidities or three or more comorbidities.

Parity

High parity can lead to chronic impairments and affect physical function and physical activity level in middle-aged and older women.[27] Participants self-reported parity and were classified as zero to two deliveries or three or more deliveries.

Data analysis

Data were analyzed using SPSS 20.0 (SPSS Inc., Chicago, IL, US) and custom RStudio (RStudio, Inc., Boston, MA) scripts.[28] Descriptive statistics were performed for sample characterization. Mann-Whitney or Kruskal-Wallis test followed by Dunn's post-hoc test compared SLST performance between participants with different physical activity levels.

Multiple quantile regression analyses (modeling medians) adjusted for covariates (age, educational level, family income, BMI, comorbidities, and parity) assessed the association between SLST performance and physical activity level.

Results

Sample characteristics according to physical activity level are presented in Table 1. Physical activity level was significantly associated with age, comorbidities, and parity. The proportion of women with low physical activity level among those aged 60 years or more was greater than among women aged 40 to 59 years. A higher proportion of women with three or more comorbidities presented a low physical activity level than those with zero to two comorbidities. Likewise, a higher proportion of women with three or more children presented a low physical activity level than those who had up to two children.

Table 2 shows the median and the 25th and 75th percentiles of SLST performance. Physical activity level was significantly associated with SLST performance. Participants with high physical activity level stayed longer in balance with eyes open and closed than participants with low physical activity level. Moreover, a prolonged time with eyes open and closed was observed in middle-aged women and those with educational level of eight years or more, normal BMI, zero to two comorbidities, or zero to two deliveries.

Table 1 - Sample characteristics according to physical activity level (n = 589)

Characteristics		Physical activity level n (%)			p-value
		Low	Moderate	High	
Age	40 – 59 years	154 (35.5)	176 (40.6)	104 (24.0)	0.036
	≥ 60 years	70 (45.2)	61 (39.4)	24 (15.5)	
Family income	< 3 minimum wage	150 (36.2)	175 (42.3)	89 (21.5)	0.266
	≥ 3 minimum wage	74 (42.3)	62 (35.4)	39 (22.3)	
Educational level	0 – 7 years	102 (37.1)	121 (44.0)	52 (18.9)	0.148
	≥ 8 years	122 (38.9)	116 (36.9)	76 (24.2)	
Body mass index	Normal	40 (36.0)	44 (39.6)	27 (24.3)	0.825
	Overweight	96 (37.8)	100 (39.4)	58 (22.8)	
	Obese	88 (39.3)	93 (41.5)	43 (19.2)	
Comorbidities*	0 – 2	185 (36.3)	207 (40.6)	118 (23.1)	0.043
	≥ 3	38 (49.4)	29 (37.7)	10 (13.0)	
Parity	0 – 2 children	86 (35.1)	91 (37.1)	68 (27.8)	0.011
	≥ 3 children	138 (40.1)	146 (42.4)	60 (17.4)	
Total	-	224 (38.0)	237 (40.2)	128 (21.8)	-

Table 2 - Median (Q25-Q75) of balance tests according to variables (n = 589)

	Balance with eyes open (s)	Balance with eyes closed (s)
PA		
Low	22.00 (10.26 – 30.00)	4.30 (2.35 – 8.28)
Moderate	26.78 (11.03 – 30.00)	4.90 (2.91 – 9.66)
High	30.00 (14.41 – 30.00)	5.39 (3.11 – 11.00)
p-value[a]	0.003[c]	0.006[c]
Age		
40 – 59 years	30.00 (16.57 – 30.00)	5.35 (3.25 – 10.98)
≥ 60 years	10.61 (4.12 – 29.05)	3.07 (1.84 – 5.46)
p-value[b]	< 0.001	< 0.001
Family income		
< 3 MW	24.45 (10.91 – 30.00)	4.58 (2.70 – 9.66)
≥ 3 MW	30.00 (12.33 – 30.00)	4.90 (2.92 – 8.82)
p-value[b]	0.109	0.400
Education		
0 – 7 years	17.46 (7.34 – 30.00)	4.04 (2.43 – 7.77)
≥ 8 years	30.00 (17.51 – 30.00)	5.41 (3.13 – 10.94)
p-value[b]	< 0.001	< 0.001
BMI		
Normal	30.00 (17.49 – 30.00)	5.45 (3.12 – 12.23)
Overweight	29.00 (11.06 – 30.00)	4.70 (2.75 – 9.73)
Obese	20.55 (9.20 – 30.00)	4.32 (2.60 – 8.02)
p-value[a]	0.006[d]	0.029
Comorbidities*		
0 – 2	29.49 (12.13 – 30.00)	4.81 (2.87 – 10.10)
≥ 3	14.43 (6.94 – 30.00)	3.46 (2.07 – 6.62)
p value[b]	< 0.001	< 0.001
Parity		
0 – 2 children	30.00 (16.68 – 30.00)	5.10 (3.13 – 11.07)
≥ 3 children	21.12 (8.12 – 30.00)	4.43 (2.57 – 8.18)
p-value[b]	< 0.001	0.003

Note: Q25–Q75 = 25th and 75th percentiles. PA = physical activity level; MW = minimum wage; BMI = body mass index; s = seconds; *Two missing values. [a]Mann-Whitney test; [b]Kruskal-Wallis test. Dunn's Test: [c]low < high; [d]normal > obese.

Table 3 shows multiple quantile regressions for SLST performance, physical activity level, and covariates. No significant association was observed between physical activity level and SLST performance when adjusted for the covariates. SLST performance was significantly associated with BMI. Participants with normal BMI stayed longer in balance with eyes closed (β = 0.22; 95% CI: 0.05 to 0.39) than women with obesity.

Table 3 - Results of multiple quantile regressions

	Balance with eyes open (s)		Balance with eyes closed (s)	
	β	95% CI	β	95% CI
PA				
Low	-0.16	-0.38 – 0.07	-0.11	-0.28 – 0.06
Moderate	-0.05	-0.21 – 0.11	0.03	-0.11 – 0.17
Age				
40 – 59 years	1.06	-3.12 – 5.25	0.87	-3.16 – 4.91
Family income				
< 3 MW	-0.13	-0.31 – 0.05	-0.16	-0.32 – 0.00
Education				
0 – 7 years	-0.03	-0.22 – 0.16	-0.09	-0.28 – 0.10
BMI				
Normal	0.19	-0.04 – 0.41	0.22*	0.05 – 0.39
Overweight	0.04	-0.17 – 0.26	0.15	-0,02 – 0.32
Comorbidities				
0 – 2	0.14	-0.40 – 0.69	0.25	-0.42 – 0.91
Parity				
0 – 2 children	0.16	0.00 – 0.32	0	-0.14 – 0.13

Note: PA = physical activity level; MW = minimum wages; BMI = body mass index; s = seconds; CI = confidence interval. *p < 0.05.

Discussion

This study investigated the association between physical activity level and static standing balance in middle-aged and older women. The association observed in the bivariate analysis was not maintained after adjusting the multiple quantile regression analysis for covariates (age, educational level, family income, BMI, comorbidities, and parity).

Regular physical activity improves balance of older adults.[29] Physical exercises (e.g., sports) improve balance and functional mobility more than isolated non-specific exercises in older adults.[29] Maintaining a stable upright posture in different conditions is complex and requires adequate motor control and sensory feedback.[30] Also, balance exercise programs must be specific to the task and conditions intended to improve.[31] Our study assessed the level of energy expenditure in activities of daily living not exclusively related to physical exercise or stable upright posture. Our results suggest that activities of daily living are not sufficient to guarantee good static standing balance in middle-aged and older women. Therefore, balance-specific physical exercise programs should be implemented in this population.

BMI was significantly associated with static balance in our study. Women with normal BMI showed better SLST performance than women with obesity. Ferreira et al.[32] did not observe any association between BMI and balance in a study with 335 Brazilian older adults over the age of 60 years; however, this association was reported in another study.[33] Low balance performance among women with obesity may be explained by reduced stability and the need for increased muscle strength[33] since the forward shift of the center of mass observed in this population requires increased hip control and knee joint torque.[34]

In the bivariate analysis, older age, low educational level, and a high number of comorbidities were associated with low SLST performance. Aging is associated with changes in functional capacity, reduced muscular strength, mobility, proprioception, and balance.[35] Moreover, low educational level may indicate low socioeconomic conditions during the life course. Socioeconomic adversities, even during the first years of life, may negatively impact physical health in the long term.[35] Previous studies also demonstrated associations between low educational level and balance impairments and mobility limitations in older adults.[36,37]

The association between low balance performance and high number of comorbidities was previously reported.[38] Comorbidities may affect several body systems and the ability to maintain a stable upright posture.[39] However, after the multiple quantile regression analysis, we did not observe a significant association between SLST performance and age, educational level, or number of comorbidities. Several factors may explain this result. Age, education, and comorbidities may express a linear relationship in the regression model. For instance, women with low educational level and increased age may also present increased comorbidities. However, the independent predictive value of these variables was not possible to be calculated when both were included in the same model. Also, differences in sample characteristics (e.g., age and socioeconomic status), comorbidities, and methods for assessing static balance may explain differences between our results and previous studies.[35-38] In addition, differences in static balance tests were possibly not big enough to be detected in a relatively small sample. Nevertheless, we did not aim to investigate the association of these variables with static balance. Future studies should investigate the effects of age, educational level, and comorbidities on other balance tests.

This study had some limitations that should be addressed. We could not establish a causal relationship given our study design; therefore, future prospective cohort studies should elucidate causal relationships. Also, physical activity level was self-reported. Although data collection using self-report is accepted in epidemiological studies and the IPAQ-SF is reliable for assessing physical activity level, older adults may under or overestimate their physical activities.[40] Last, we used a convenience sample. However, it is worth mentioning that, based on data from the Brazilian Institute of Geography and Statistics census, participants had similar educational levels and family income to middle-aged and older women from the studied cities, ensuring sample representativeness.

Conclusion

Physical activity level was not associated with balance performance in middle-aged and older women after adjusting the analysis for covariates. This result suggests that only being active in daily living activities is not sufficient to maintain balance performance of middle-aged and older women. Balance-specific physical exercise programs should be prescribed for middle-aged and older women.

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Authors' contribution

PRSM and SMAC were responsible for the study conceptualization, and PRSM for the drafting of the manuscript. SGGF, JVC and SMAC contributed to the statistical analysis; SGGF, DTG and IGA, to the revision of the manuscript. SMAC was responsible for the manuscript revision for important intellectual content. All authors approved the final version.

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