



Fear of falling and hip muscular strength in independent older adults of the community

Medo de quedas e força muscular do quadril em idosos independentes da comunidade

Miedo a caerse y fuerza muscular de cadera en ancianos independientes de la comunidad

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ABSTRACT | The fear of falling can cause older adults to develop strategies that alter the semi-static and dynamic balance, predisposing them to increased risk of falling. The muscular function of abductors and adductors plays an important role in maintaining postural stability. However, it is unknown whether older people with fear of falling have greater impairment in hip muscular function. Thus, the objective was to compare the isometric peak torque (PT) of hip abductor and adductor muscles among older adults with and without fear of falling. Participants were divided into two groups: with (n=81) and without (n=81) fear of falling. The PT of hip abductors and adductors was obtained with isokinetic dynamometer (System 4 Pro, Biodex, New York, USA). The PT groups were compared using general linear model univariate, adjusted for covariates age, sex, body mass index, physical activity level and history of falls, using the SPSS 17.0 software, with a significance level of 5%. No difference was found between the PT of hip abductor and adductor and the groups after univariate analysis with adjustment. We observed that older people with fear of falling have no muscle function loss of the hip stabilizers when compared with subjects without fear of falling.

Keywords | Torque; Hip; Balance; Aged.

RESUMO | O medo de quedas pode fazer com que o idoso desenvolva estratégias que alteram o equilíbrio semiestático e dinâmico, predispondo-o a um risco

aumentado de cair. A função muscular dos abdutores e adutores de quadril tem importante papel na manutenção da estabilidade postural. Entretanto, não se sabe se idosos com medo de cair apresentam maior comprometimento na função muscular do quadril. Assim, o objetivo foi comparar o pico de torque (PT) isométrico dos músculos abdutores e adutores de quadril entre idosos com e sem medo de quedas. Os participantes foram divididos em dois grupos: com (n=81) e sem (n=81) medo de quedas. O PT dos abdutores e adutores de quadril foi obtido com dinamômetro isocinético (System 4 Pro, Biodex, Nova York, EUA). A comparação do PT dos grupos foi realizada por meio de modelo linear geral univariado, ajustado pelas covariáveis idade, sexo, índice de massa corporal, nível de atividade física e histórico de quedas, utilizando o *software* SPSS 17.0, com nível de significância de 5%. Não houve diferença do PT abductor e adutor do quadril entre os grupos após análise univariada com ajustamento. Observou-se que idosos com medo de quedas não apresentam prejuízos na função muscular dos estabilizadores de quadril quando comparados a idosos sem medo de quedas.

Descritores | Torque; Quadril; Equilíbrio; Idoso.

RESUMEN | El miedo a caerse puede hacer que los ancianos desarrollen estrategias de alteración del equilibrio semiestático y dinámico, predisponiéndolos a un mayor

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riesgo de caídas. La función muscular de los abductores y de los aductores de cadera juega un papel importante en el mantenimiento de la estabilidad postural. Sin embargo, no se sabe si los ancianos con miedo a caerse tienen un mayor deterioro en la función muscular de la cadera. Por lo tanto, el objetivo fue comparar el torque máximo (TM) isométrico de los músculos abductores y aductores de cadera entre los ancianos con miedo y sin miedo a caerse. Los participantes se dividieron en dos grupos: con miedo a caerse (n=81) y sin (n=81) miedo a caerse. El TM de los abductores y aductores de cadera se obtuvo mediante la utilización del dinamómetro isocinético (System 4 Pro, Biodex,

Nueva York, EE.UU.). La comparación del TM de los grupos se realizó mediante un modelo lineal general univariado, ajustado por covariables edad, género, índice de masa corporal, nivel de actividad física e historial de caídas, utilizando el *software* SPSS 17.0, con nivel de significancia del 5%. No hubo diferencias entre el TM del abductor y del aductor de cadera entre los grupos tras el análisis univariado con ajuste. Se observó que los ancianos con miedo a caerse no presentaron daños en la función muscular de los estabilizadores de la cadera en comparación con los ancianos sin miedo a caerse.

Palabras clave | Torque; Cadera; Balance; Anciano.

INTRODUCTION

For mobility and functionality, individuals need multiple joint movements generated by the simultaneous activation of several muscle groups¹. However, aging can lead to progressive declines in physiological systems² that compromise musculoskeletal functions, causing gradual neuromuscular loss³ and increasing propensity to falls⁴.

The muscle weakness of lower limbs, due to aging, is a predisposing factor for losses on postural balance⁵. Thus, the abductor and adductors muscles play an important role in maintaining pelvic stability, coordinating medium-lateral movements and maintaining postural control in narrow base⁶. Nevertheless, regarding the predisposition to falls, there is controversy in the literature as to the weakness of these muscle groups⁶⁻⁸.

Also, as falls are multifactorial events in older adults, other factors increase the risk of falling, among them, the fear of falling, which can cause the individual to develop strategies that alter the semi-static and dynamic balance⁹. Fear of falling can be the result of a fall or precede such event¹⁰ and is associated with long-term negative consequences, such as reduced quality of life, physical dependence, depression, and impaired physical and psychosocial function¹¹.

Regarding losses on physical function, it is unknown whether subjects with fear of falling present losses on hip muscle function, which could damage their postural balance^{5,6}. Thus, the objective was to compare the isometric peak torque (PT) of hip abductor and adductor muscles among older adults with and without fear of falling. The hypothesis of this study is that the muscular strength of hip stabilizers is smaller in the group with fear of falling.

METHODOLOGY

Study design and sample

It is an observational and cross-sectional study conducted with 162 older adults (above 60 years) of both sexes, independent and autonomous, who were divided into two groups in accordance with the self-reported fear of falling: group with fear and group without fear. Volunteers were recruited in the Family Health Centers, in the community, and in groups of social activities in Ribeirão Preto (SP). Assessments occurred between August 2015 and July 2016. We excluded older adults with cognitive impairment indicated in the mini-mental state examination according to schooling¹²; musculoskeletal/neurological disease that influence hip muscle strength; knee and/or hip prosthesis; and individuals with decompensated cardiovascular disease that contraindicated physical exertion.

Procedures

Assessments were made in two days, with an interval of two to seven days between them. On the first day, data were collected to characterize the participants: self-reported fear of falling, weight, height, BMI (body mass index), sex, age, level of physical activity and history of falls.

The fear of falling was assessed by direct questioning "Are you afraid of falling?", and the participants who answered "Yes, I am" participated in the group with fear, while those who answered "No, I'm not afraid" participated in the group without fear of falling. During such questioning, the difference between fear of falling and caution during activities was emphasized.

The international physical activity questionnaire (IPAQ) was used to assess the participants' level of physical activity¹³, according to walking, moderate or vigorous activity. Thus, subjects were classified as having low, medium or high level of physical activity. For the history of falls, the self-report of the number of falls in the last six months of evaluation was considered.

On the first day of collection, the participant became familiar with isokinetic dynamometer, and the test was repeated on the second day to obtain the peak torque (PT) of hip abductors and adductors.

The muscular strength test was performed on the isokinetic dynamometer equipment (System 4 Pro, Biodex, New York, USA), calibrated according to manufacturer's recommendations. Prior to the evaluation of PT, the participants warmed up in stationary bike for five minutes.

Only the dominant lower limb was assessed, being defined as a limb of choice to kick a ball. To obtain the PT of hip abductor and adductor muscles, each participant was positioned in the lateral decubitus position, with the limb to be tested upwards, with trunk and contralateral lower limb fixed by belts. The dynamometer axis was aligned with the intersection of two straight lines: a medial side to the greater trochanter of the femur and other longitudinal side to the posterior superior iliac spine¹⁴. The limb to be tested was fixed at an amplitude of 15 degrees of hip abduction¹⁴. For each muscle group, there were three maximal voluntary isometric contractions with five-second and one-minute interval between them. The mean PT was normalized by the body mass of the subject ($\text{Nm} \cdot \text{kg}^{-1}$) in order to more accurately reflect the function of muscles in relation to the mass of the individual¹⁵.



Figure 1. Positioning to obtain the peak torque of the hip abductors and adductors in isokinetic dynamometer

Statistical analysis

Means, standard deviation and frequency were used to characterize the sample. Comparisons of characteristics between groups were performed using t-test for continuous variables, Mann-Whitney for ordinal variables, and chi-square for nominal variables. Univariate general linear model was used for comparisons between the independent variable (fear of falling) and the dependent variables (peak torque of hip adductors and abductors). To minimize the interference of confounding variables, the statistical model was fitted with the following covariates: age, sex,

BMI, physical activity, and history of falls. The analyses were performed using the Statistical Package for Social Sciences software (SPSS) 17.0, and a significance level of 5% ($p \leq 0.05$) was adopted.

RESULTS

Table 1 shows the characterization data of the sample. The group with fear of falling had a higher number of women ($p=0.005$) and lower height ($p=0.019$) than the group without fear of falling.

Table 1. Characteristics of participants with values reported as mean (standard deviation) and absolute frequency/percentage

| | Fear of falling (n=81) | Without fear of falling (n=81) | p-value |
|-----------------------------|------------------------|--------------------------------|---------|
| Age (years) | 69.41 (5.47) | 68.60 (5.35) | 0.340 |
| Weight (kg) | 69.13 (14.41) | 69.55 (12.27) | 0.804 |
| Height (m) | 1.55 (0.69) | 1.58 (0.80) | 0.019* |
| BMI (kg.m ²) | 28.61 (5.08) | 27.76 (5.47) | 0.231 |
| Female (n/%) | 73/90.12 | 59/72.83 | 0.005* |
| History of falls (%) | 37.03 | 25.92 | 0.129 |
| | <i>Low</i> | 34.57 | 30.86 |
| | <i>Moderate</i> | 59.25 | 62.96 |
| Physical activity level (%) | <i>High</i> | 6.18 | 6.18 |

* $p \leq 0.05$; BMI: body mass index.

Table 2 shows the comparison of the PT of hip abductor and adductor between the groups. Univariate analysis showed that without adjustment the group without fear showed higher PT of hip adductors in

relation to the group with fear of falling ($p=0.007$). However, when the data were adjusted to the model, this difference between the groups was not maintained ($p=0.129$).

Table 2. Univariate general linear model for comparison of peak torque hip adductors and abductors between the groups with and without fear of falling

| | Fear of falling (n=81) | Without fear of falling (n=81) | Effect of the groups (p-value) ¹ | | Difference mean | 95% confidence interval |
|-------------------------------------|------------------------|--------------------------------|---|-----------------------|-----------------|-------------------------|
| | | | Unadjusted | Adjusted ² | | |
| PT abductors (Nm.kg ⁻¹) | 0.75 (0.25) | 0.81 (0.24) | 0.196 | 0.732 | 0.051 | -0.026 - 0.129 |
| PT adductors (Nm.kg ⁻¹) | 0.60 (0.24) | 0.71 (0.25) | 0.007 | 0.129 | 0.108 | -0.029 - 0.187 |

PT: peak torque; ¹p-values compared between groups (general linear model); ²Adjustment: age, sex, BMI, physical activity, and history of falls. Values expressed in mean (standard deviation).

DISCUSSION

This study showed that older people with fear of falling have no muscular strength loss on hip abductor and adductor compared with subjects without fear of falling. The initial hypothesis of the study that the hip muscular strength was lower in the group of older people with fear of falling was based on the fact that these individuals are subject to not only psychosocial harm, but also physical harm¹¹, and the fact they have greater commitment of pelvic stabilizer muscles could be one of the causes that increases postural instability and, consequently, increases the sense of insecurity when performing routine functional activities, being reported by the older adults as fear of falling.

However, the deterioration of muscular function and functional capacity may be a result of fear of falling. In this sense, Park et al.¹² observed that older adults with fear, regardless of having suffered falls, had lower bone mineral density, lower power grip and longer time to run the timed up and go test. A prospective study, which examined the relationship between fear of falls and functional decline,

has shown that older adults with fear of falling develop social isolation, which causes physical deconditioning and decreased functionality, negatively influencing the postural control and generating a consequent increase in the risk of falls⁹. In extreme cases, the fear of falling can induce excessive avoidance of activities, which leads to reduction in the level of physical activity, loss of independence and disability, as it is directly linked to the functional decline^{13,14}. However, in our sample, no difference was found in the level of physical activity among older adults with and without fear of falling, suggesting that the level of physical activity, not the fear of falling itself, may be more relevant for hip muscle function.

Regarding possible physical damage due to the presence of fear of falling in older adults, few studies have evaluated its influence on muscle function of the lower limbs. Young and Williams¹⁵ showed that when individuals with fear of falling are exposed to dynamic functional activities, they develop a "stiffening strategy," reducing the displacement of the center of mass due to reflex co-contraction of the tibialis anterior, gastrocnemius and soleus muscles, resulting

in lower ankle range of motion and reduced body sway, increasing thus the risk of falls. Trombetti et al.¹⁶ corroborate these findings, once they identified association between mass, muscular strength and power of knee extensors with fear of falling, regardless of the presence or absence of mobility restriction. Gadelha et al.¹⁷ investigated the association between muscle quality, balance, fear of falling, and previous falls in older women in the community. For this, the fear of falling has been verified by the falls efficacy scale-international (FES-I)¹⁸, and the PT of the quadriceps muscle in the dominant limb was evaluated using an isokinetic dynamometer, isometrically. Moreover, the muscle quality was defined by the formula: PT (Nm)/muscle thickness (mm), and the individuals who obtained the values $\leq 3.6 \text{ Nm} \cdot \text{mm}^{-1}$ were considered to have low muscle quality. For these variables, the authors concluded that there is an association between muscle quality and fear of falling, and the measurement of quadriceps muscle quality is an important component to assess risk of falls in older adults of the community.

Despite this evidence, there are no studies that specifically investigated the hip muscular strength in older people with fear of falling. Since the hip abductor and adductors muscles are responsible for maintaining pelvic stability and coordination of medium-lateral movements, sustaining postural control in narrow base^{6,19}, the initial hypothesis of this study was that older people with fear of falling could present losses on these muscle groups, which could partly explain the increased risk of falls they are exposed^{9,15}. Although this difference was not found in this study, other musculoskeletal factors may interfere with postural control of older people with fear of falling, such as the co-contraction of the hip muscles when individuals are exposed to a disturbance or even losses on other parameters such as muscle power.

This study has some limitations: the assessment of hip muscular strength was made isometrically, even though the analysis of muscular strength of hip abductors and adductors, performed in a dynamic and functional way, could provide more information about hip muscle function in older subjects with fear of falling. Furthermore, the sample did not contain older adults aged more than 80 years, which has restricted the study to older adults a little bit younger. Still, most of the sample of both groups consisted of physically active older adults (moderate level of physical activity), and the investigation of the influence of the fear of falling on a sample of sedentary older adults can bring additional information to this study.

CONCLUSION

The results of this study suggest that older adults with fear of falling have no losses on muscle strength of hip abductors and adductors compared with subjects without fear of falling.

REFERENCES

- Allison SJ, Brooke-Wavell K, Folland JP. Multiple joint muscle function with ageing: the force-velocity and power-velocity relationships in young and older men. *Aging Clin Exp Res*. 2013;25(2):159-66. doi: 10.1007/s40520-013-0024-y
- Edwén CE, Thorlund JB, Magnusson SP, Slinde F, Svantesson U, Hulthén L, et al. Stretch-shortening cycle muscle power in women and men aged 18-81 years: influence of age and gender. *Scand J Med Sci Sport*. 2014;24(4):717-26. doi: 10.1111/sms.12066
- Barbieri E, Agostini D, Polidori E, Potenza L, Guescini M, Lucertini F, et al. The pleiotropic effect of physical exercise on mitochondrial dynamics in aging skeletal muscle. *Oxid Med Cell Longev*. 2015;1:1-15. doi: 10.1155/2015/917085
- Bento PC, Pereira G, Ugrinowitsch C, Rodacki AL. Peak torque and rate of torque development in elderly with and without fall history. *Clin Biomech*. 2010;25(5):450-4. doi: 10.1016/j.clinbiomech.2010.02.002
- Hashish R, Samarawickrame SD, Wang MY, Yu SS, Salem GJ. The association between unilateral heel-rise performance with static and dynamic balance in community dwelling older adults. *Geriatr Nurs*. 2015;36(1):30-4. doi: 10.1016/j.gerinurse.2014.09.003
- Chang SHJ, Mercer VS, Giuliani CA, Sloane PD. Relationship between hip abductor rate of force development and mediolateral stability in older adults. *Arch Phys Med Rehabil*. 2005;86(9):1843-50. doi: 10.1016/j.apmr.2005.03.006
- Pinho L, Dias RC, Souza TR, Freire MTF, Tavares CF, Dias JMD. Avaliação isocinética da função muscular do quadril e do tornozelo em idosos que sofrem quedas. *Rev Bras Fisioter*. 2005;9(1):93-9.
- Morcelli MH, Rossi DM, Karuka AH, Crozara LF, Hallal CZ, Marques NR, et al. Peak torque, reaction time, and rate of torque development of hip abductors and adductors of older women. *Physiother Theory Pract*. 2016;32(1):45-52. doi: 10.3109/09593985.2015.1091870
- Choi K, Jeon GS, Cho SI. Prospective study on the impact of fear of falling on functional decline among community dwelling elderly women. *Int J Environ Res Public Heal*. 2017;14(5):E469. doi: 10.3390/ijerph14050469
- Legters K. Fear of falling. *Phys Ther*. 2002;82(3):264-72. doi:10.1093/ptj/82.3.264
- Scheffer AC, Schuurmans MJ, van Dijk N, van der Hooft T, de Rooij SE. Fear of falling: measurement strategy, prevalence, risk factors and consequences among older persons. *Age Ageing*. 2008;37(1):19-24. doi: 10.1093/ageing/afm169

12. Park JH, Cho H, Shin JH, Kim T, Park SB, Choi BY, et al. Relationship among fear of falling, physical performance, and physical characteristics of the rural elderly. *Am J Phys Med Rehabil.* 2014;93(5):379-86. doi: 10.1097/PHM.0000000000000009
13. Visschedijk JH, Caljouw MA, Bakkers E, van Balen R, Achterberg WP. Longitudinal follow-up study on fear of falling during and after rehabilitation in skilled nursing facilities. *BMC Geriatr.* 2015;15(1):161. doi: 10.1186/s12877-015-0158-1
14. Hadjistavropoulos T, Delbaere K, Fitzgerald TD. Reconceptualizing the role of fear of falling and balance confidence in fall risk. *J Aging Heal.* 2011;23(1):3-23. doi: 10.1177/0898264310378039
15. Young WR, Williams AM. How fear of falling can increase fall-risk in older adults: applying psychological theory to practical observations. *Gait Posture.* 2015;41(1):7-12. doi: 10.1016/j.gaitpost.2014.09.006
16. Trombetti A, Reid KF, Hars M, Herrmann FR, Pasha E, Phillips EM, et al. Age-associated declines in muscle mass, strength, power, and physical performance: impact on fear of falling and quality of life. *Osteoporos Int.* 2016;27(2):463-71. doi: 10.1007/s00198-015-3236-5
17. Gadelha AB, Neri SGR, Nóbrega OT, Pereira JC, Bottaro M, Fonsêca A, et al. Muscle quality is associated with dynamic balance, fear of falling, and falls in older women. *Exp Gerontol.* 2018;104:1-6. doi: 10.1016/j.exger.2018.01.003
18. Yardley L, Beyer N, Hauer K, Kempen G, Piot-Ziegler C, Todd C. Development and initial validation of the Falls Efficacy Scale-International (FES-I). *Age Ageing.* 2005;34(6):614-9. doi: 10.1093/ageing/afi196
19. Johnson ME, Mille ML, Martinez KM, Crombie G, Rogers MW. Age-related changes in hip abductor and adductor joint torques. *Arch Phys Med Rehabil.* 2004;85(4):593-7. doi: 10.1016/j.apmr.2003.07.022