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Multicomponent aquatic exercises for falls in older people: a randomized clinical trial

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ABSTRACT. The aim of this study was to evaluate the effects of aquatic multicomponent exercises on the rate of falls and fear of falling in older people. The older people from the community were randomly divided into two groups: Training Group, underwent training with aquatic multicomponent exercises for 16 weeks; and Control Group, did not undergo training. The multicomponent exercise training in water included warm-up, resistance, balance, and trunk and lower limb muscle activation exercises. Clinical and sociodemographic data were collected. The occurrence of falls was verified by monthly phone calls and fear of falling by the Falls Efficacy Scale International-I. No intra-group and inter-group differences were observed in falls and fear of falling after 16 weeks. The Training Group showed a mean adherence to the training sessions of 75.3%. It is concluded that training with multicomponent aquatic physical exercises did not influence the rate of falls and fear of falling in the sample of community-dwelling older individuals. The small sample size, due to the pandemic period, and the need to interrupt training, as well as the low rate of falls reported by the older people at the beginning of the study may have impacted the findings on the effects of exercises on the occurrence of falls and fear of falling in the participants.

Keywords: Aged; Accidental falls; Aquatic therapy; Exercise.

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Introduction

Falls are highly prevalent in older people, affecting approximately 30% of people aged 65 and over per year (Ganz & Latham, 2020). These incidences are associated with restricted mobility, loss of independence and autonomy, institutionalization, depression, and a decline in quality of life, generating socioeconomic implications and overloading health systems (Panel On Prevention Of Falls In Older Persons, American Geriatrics Society, British Geriatrics Society, 2011).

The consequences of falls include anxiety, depression, and a fear of subsequent falls, which can also affect older people who have never fallen (Tinetti, 2003). Experiences of falling generate fear and make the person more vulnerable to a new episode. The fear of falling has a multifactorial etiology (Legters, 2002), when physical, psychological, and socioeconomic factors appear interconnected. Fear of falling can lead to functional decline, changes in postural control, depression, anxiety, and reduced social contact (Fletcher, 2004). In addition, older people with a fear of falling are 12.15 times more likely to fall than older individuals without a fear of falling (Pena et al., 2019).

Different exercise programs can reduce the rate and risk of falls in older people (Cameron et al., 2018; Ferreira et al., 2022). Practicing physical exercise can promote greater independence, prevent diseases, improve cognitive functions, and contribute significantly to maintaining the physical fitness of older people (Antunes et al., 2006).

Among the available exercise modalities is the possibility of performing physical exercises in water. The therapeutic effects of exercising in water are related to the relief of pain and muscle spasms, maintaining or increasing the range of motion of joints, improving circulation, and encouraging functional activities (Biasoli & Machado, 2006). The relief of stress on weight-bearing joints due to the upward thrust action of water encourages older adults to participate in aquatic activity (Campion, 2000). In addition, the aquatic environment is a place where older adults feel safer and less afraid of falling (Bresselet al., 2017).

The existing evidence in the literature shows insufficient conclusions about the effects of aquatic physical exercise on falls and fear of falling. Few randomized clinical trials have included longer intervention periods, with greater training volumes and individual progression. Safe and welcoming options to improve the health and well-being of this population are necessary.

Therefore, the objective of the current study was to evaluate the effects of training with aquatic multicomponent physical exercises on the rate of falls and fear of falling in community-dwelling older people. The hypothesis of the current study was that aquatic multicomponent exercises, performed for 16 weeks, would reduce the rate of falls and fear of falling in community-dwelling older people, compared to those who did not perform the training. This hypothesis is based on the assumption that aquatic multicomponent exercises can improve balance, muscle strength, coordination, and confidence in older people, factors that influence both the frequency of falls and the perception of fear of falling.

Material and methods

This is a controlled, single-center clinical trial with two assessment moments: initial and after 16 weeks of training. Participants were randomly assigned to two groups: Training Group (TG); and Control Group (CG). Random Allocation software was used to ensure the randomness of the groups. Opaque, sealed, numbered envelopes were utilized, containing a card indicating which group the older person would be allocated to. The entire randomization process was performed by a researcher independent of the assessment and training. Thus, the distribution of participants was blind. This research followed the recommendations of CONSORT (2010).

Older individuals, aged 65 years or older, non-institutionalized community residents, were recruited. Participants were recruited by telephone contact with older people who showed interest after dissemination through pamphlets and posters.

The inclusion criteria were: ability to walk alone, with or without a walking aid, and availability to perform training twice a week. The exclusion criteria were: cardiovascular or infectious diseases present in the list of absolute contraindications described in the Physical Activity Readiness Medical Examination (British Columbia Ministry of Health, 2002); a Mini-Mental State Examination score below the cut-off point designated by the level of education minus one standard deviation (Herreraet al., 2002); presence of motor sequelae of stroke and neurological diseases that interfere with cognition or mobility. A physician's approval was also requested to prove that the participant was fit to practice physical exercise in the water. The sample size was calculated using G*Power 3.1 software (Cohen, 1988). Considering: 1) the type of study design; 2) a type I error of 5% ($\alpha = 0.05$); 3) statistical power of 80% ($1-\beta = 0.80$); and 4) a moderate to large effect size (0.2), a minimum of 42 people was required to constitute the total sample. The research was carried out at the Integrated School Clinic (CEI), of Federal University of Mato Grosso do Sul (UFMS) The work was approved by the Research Ethics Committee of UFMS (147881/2018) and registered in the Brazilian Registry of Clinical Trials (REBEC) (RBR48z4vp). All participants signed the Free and Informed Consent Form in accordance with the recommendations of resolution 466/2012 of the National Health Council. The researcher who performed the assessments was blinded regarding the allocation of the older people into the groups. Another independent researcher performed the training. Neither researcher participated in the randomization process of the participants. Clinical and sociodemographic data were collected from the participants, as well as data on the occurrence of falls in the previous six months. Fear of falling was assessed before and after 16 weeks of training using the Falls Efficacy Scale - International (FES-I) (Camargoset al., 2010). Scores greater than or equal to 23 are associated with the occurrence of sporadic falls, and scores greater than 31 points are associated with the occurrence of recurrent falls (Camargos et al., 2010). The older people were asked about the occurrence of falls via telephone or in person during the training. The TG performed aquatic exercises for 16 weeks, twice a week, for 1 hour per session, on non-consecutive days, in groups of 6 older people per session. During the first week of training, the participants were familiarized with the aquatic environment. The training consisted of multicomponent exercises in water, that included warm-up exercises, resistance exercises, muscle activation of the trunk and lower limbs, and balance activities, as detailed in Ferreira et al. (2022). Intensity was assessed weekly using the Modified Borg Scale of Perceived Exertion (BORG-CR10), and should be maintained between 5 and 7 points (Arney et al., 2019). Aquatic resources were used, as well as changes in speed and range of motion to increase overload. Cognitive tasks were applied between sets of aquatic exercises. The physiotherapist who administered the training was previously trained. The CG did not participate in the aquatic training.

As of March 2020, with the onset of the Corona Virus Disease-19 (COVID-19) pandemic in Brazil, the number of participants per session was reduced to 2, in accordance with the biosafety measures established in the country. With the increase in COVID-19 cases in April 2020, it was essential to finalize the study, taking into account the participants who had already completed the 16 weeks of training. Considering this situation, it was deemednecessary to carry out an educational intervention with the TG and CG through periodic calls from the researchers, in which the participants received information about COVID-19, prevention methods, and what to do in the case of symptoms. At the end of the study, both groups received a booklet with physical exercises to be performed at home.

For the statistical analysis of the data, descriptive analysis was initially performed. The Shapiro-Wilk normality test was applied to all continuous variables to verify the distribution of the data. To compare the groups regarding clinical, sociodemographic, and FES-I characteristics, the Chi-square test was used for categorical variables and the independent t-test for continuous variables that presented normal distribution. To investigate the interaction between groups and moments, the two-way ANOVA test was used. SPSS (20.0) software was utilized and the significance level was set at $\alpha = 0.05$.

Results and discussion

Of the 152 eligible individuals in the initial screening, 100 were excluded and 52 were randomized because they met the inclusion criteria. Of these, 26 were allocated to the CG and 26 to the TG (Figure 1). Sixteen TG participants needed to interrupt training due to the isolation period, and one CG participant dropped out of the study and was not reassessed. Thus, 35 older participants were reassessed, the majority of whom were women, between 67 and 75 years of age (Table 1).

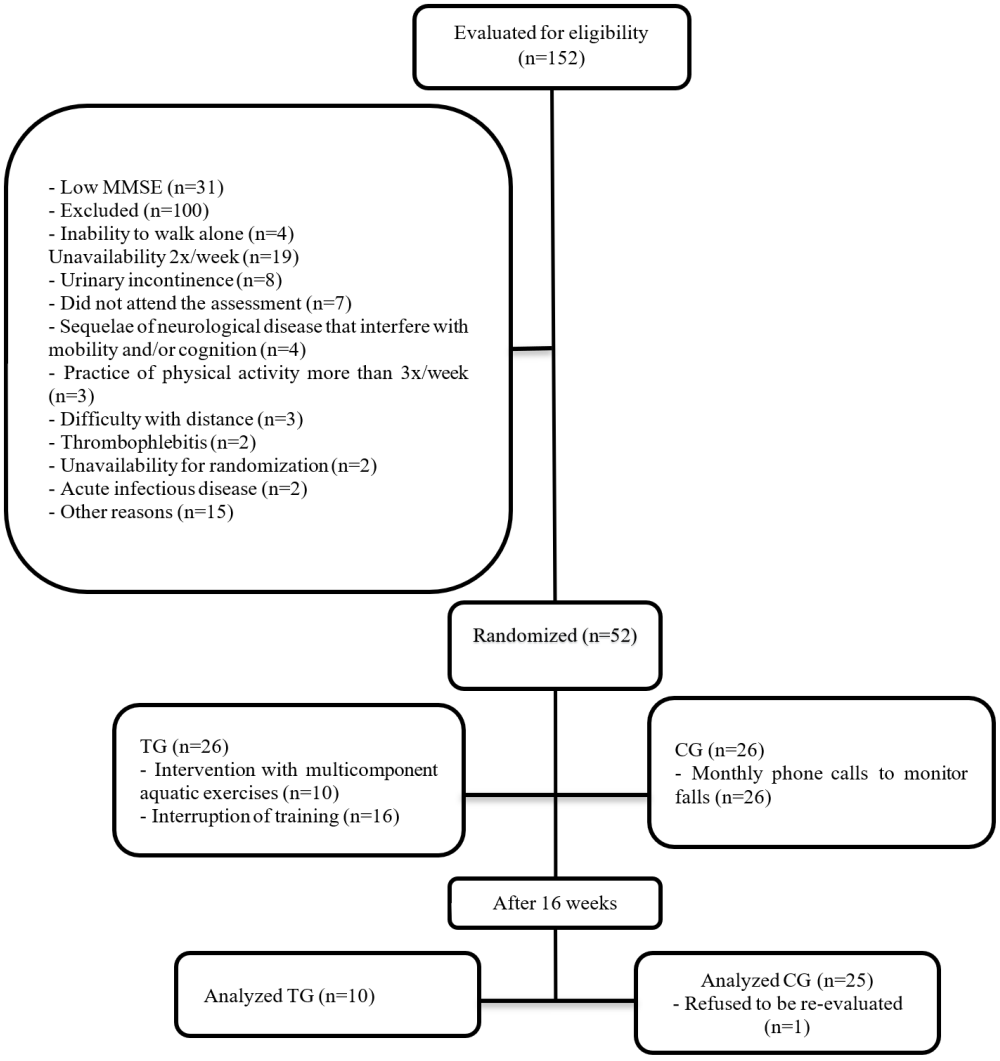

Figure 1. Flowchart of participants (n = 35).

Table 1. Sociodemographic and clinical characteristics of the sample (n = 35).

	CG	TG	p-value
Sample size	25	10	
Female sex n (%)	18.0 (72.0)	11.0 (100)	0.080
Age (years) M(SD)	71.4 (4.6)	68.7 (2.4)	**0.034**
BMI (kgm^{-2}) M(SD)	28.0 (3.9)	31.8(8.2)	0.243
Marital status n (%)			0.796
Married/stable union	15.0 (60.0)	4.0 (40.0)	
Divorced/separated	4.0 (16.0)	2.0 (20.0)	
Widowed	5.0 (20.0)	3.0 (30.0)	
Single	1.0 (4.0)	1.0 (10.0)	
Education (years) M(SD)	5.8 (4.4)	7.2 (5.3)	0.374
Number of comorbidities M(SD)	1.8 (1.2)	2.0 (1.2)	0.682
Number of medications M(SD)	4.0 (2.8)	4.3 (2.0)	0.751
Uses psychotropic medications n (%)	7.0 (25.0)	2.0 (20.0)	0.750
Uses aids n (%)	0.0 (0.0)	1.0 (10.0)	0.090
Uses multifocal or bifocal glasses n (%)	22.0 (88.0)	10.0 (100)	0.281
Falls in the previous 6 months n (%)	4.0 (16.0)	0 (0.0)	0.159

BMI = body mass index; Bold: p<0.005.

The TG and CG showed significant differences in age, while the other clinical and sociodemographic data did not demonstrate differences between the groups.

Regarding adherence to training by the TG participants, 6 (60%) participants attended more than 72% of the sessions and 4 (40%) attended between 56.2 and 65.6% of the sessions. The participants reported missing sessions due to health problems of close family members, personal health problems, and moving to another city.

Regarding the number of falls and fear of falling, no intragroup or intergroup differences were observed (Table 2) in the analyses.

Table 2. Comparisons between CG and TG regarding fear of falling (FES-I) and number of falls before and after 16 weeks of training (n = 35).

	CG (n = 25)		TG (n = 10)				
	Initial	16 weeks	Initial	16 weeks	P-Value Interaction Group X Moments	P-Value Group	P-Value Moment
Falls M(DP)	0.2 (0.7)	0.2 (0.4)	0.0 (0.6)	0.1 (0.3)	0.495	0.309	0.740
FES – I M(DP)	23.7 (4.7)	22.4 (4.2)	23.9 (3.7)	20.3 (4.5)	0.227	0.288	0.067

FES - I = Falls Efficacy Scale – International.

According to the FES-I score, 44.4% of the participants presented a low fear of falling, 50.0% had the possibility of sporadic falls, and 8.3% of recurrent falls (Table 3).

Table 3. Classification and comparison of groups according to the categorization proposed by the FES-I, baseline data (n = 35).

	GC *n(%)*	GT *n(%)*	Total *n(%)*
FES – categorical			
Recurrent falls	3.0 (12.0)	0.0 (0.0)	3.0 (8.3)
Sporadic falls	9.0 (36.0)	7.0 (70.0)	18.0 (50.0)
Low falls	13.0 (52.0)	3.0 (30.0)	16.0 (44.4)

FES - I = Falls Efficacy Scale – International.

The tables presented above include only the data of the TG participants who completed the proposed 16 weeks of training without interruption, and the data of all CG participants. The presentation of the data in this format was chosen to ensure that the conclusion of the study would not be compromised by the data of the participants who were unable to complete the training period of 16 consecutive weeks, due to the seven-month period of social isolation adopted in the country. However, analyses were also carried out of the data of all the participants who were included in the study, with the inclusion of the data of the TG participants who started the training before the pandemic period, interrupted it, and then finished it only after the period of social isolation. The addition of these data did not bring significant results regarding the variables of interest: number of falls and fear of falling.

The older people included in this study were mostly women (80.5%), and only 11.2% of the participants reported having fallen at least once in the six months prior to the initial assessment. Based on these results, it was observed that the current study had a greater number of women and a lower rate of falls compared to previous studies with an older population of a similar age group also carried out in Brazil. In Lopeset al. (2009), the majority of the participants were women (65.95%), but 54.42% of the sample had a history of falls in the previous six months. In Cruzet al. (2017), a majority of women was also observed (62.2%), but 34.1% of the sample reported having suffered a fall episode in the previous year. The fact that our study included training with aquatic exercises may have attracted a greater number of women and a lower number of older fallers, since women seek health services more frequently than men (Campion, 2000). Furthermore, the fact that participants needed to travel to a clinic to undergo the assessments and training may have influenced the sample profile, which had a lower rate of older fallers. Sedentary older people are more susceptible to falls than more active older people (Amorimet al., 2021), so older individuals who seek care, such as those in the current study, may represent a more active group than those who do not seek physical therapy care.

Regarding fear of falling, the older individuals in the current study scored an average of 23.1 (+ 4.5) in the FES-I, which indicates a likely occurrence of sporadic falls. In the study by Lopes et al. (2009), the average FES-I was 24.0 (±7.6) in the older people, and in the study by Cruz et al. (2017), the average FES-I was 24.9 (±8.2). Although the history of falls differed greatly between our study and the other mentioned works, the FES-I score was similar, with a greater variation in the standard deviation in the studies by Lopes et al. (2009) and Cruz et al. (2017), probably due to the larger number of participants, n = 147 and n = 314, respectively. It is possible that once again the greater number of women in our study, in relation to the studies cited, influenced the occurrence of a reasonably high average in the FES-I, despite the low rate of falls. Previous studies have found that women are more afraid of falling and less confident in their ability to maintain balance while performing activities of daily living than men (Denkingeret al., 2015; Santos & Figueiredo, 2019).

The current study also observed that the average adherence to treatment was 75.2%, representing a slightly lower adherence value than other studies. In a study carried out in Spain (Casas-Herrero et al., 2022), it was found that older people, with a mean age of 84.2 years, adhered to 79% of the sessions in the first 4 weeks and 68% in the following 8 weeks of a treatment intervention with multicomponent exercises (balance, strength/resistance training, flexibility, and cardiovascular resistance) carried out in their homes, 5 times a week, for 3 months. In a study carried out in the United Kingdom (Ferraroet al., 2019), older people, with a mean age of 74 years, adhered to, on average, 76% to 79% of the treatment sessions for inspiratory muscle training carried out in their homes. In a study conducted in Finland (Sievänen et al., 2024), older individuals with a mean age of 78.5 years adhered to an average of 86 to 88% of whole-body vibration and conventional training treatment sessions, twice a week for 10 weeks. The mean age of participants in the cited studies was higher than that of our study, which may have influenced adherence, given that younger older adults are economically active and may have less time available than their older peers. It is also possible that adherence among the different studies presented was influenced by the different cultures, the location (home or clinic), and the type of treatment proposed.

The current study presents some limitations, mainly due to the pandemic crisis. Training interruptions and the need for study adaptations compromised the analyses, since 16 participants in the TG needed to interrupt the training before it was finished. Thus, only 10 older adults completed the training, representing a number much lower than the ‘n’ initially estimated by the sample calculation, which indicated a number of 26 participants per group. It is possible that a larger ‘n’ could achieve significant results regarding fear of falling. We also found a lower incidence of older adult fallers in the sample of older individuals in the current study compared to previous Brazilian studies. This may make it difficult to identify the influence of a rehabilitation program on the number of falls. It is suggested that future studies include at least one occurrence of a fall in the previous year as an eligibility criterion.

Conclusion

The training with multicomponent aquatic physical exercises did not influence the rate of falls and fear of falling in community-dwelling older people. The small sample size achieved, due to the pandemic and the need to interrupt training, and the low rate of falls reported by the older adults at baseline may have impacted the ability to evaluate the effects of aquatic exercises on the occurrence of falls and fear of falling in the older adults. Further clinical trials are needed to better understand the effects of aquatic exercises on the occurrence of falls and fear of falling in older adults.

References

Amorim, J. S. C. de, Souza, M. A. N., Mambrini, J. V. de M., Lima-Costa, M. F., & Peixoto, S. V. (2021). Prevalence of severe falls and associated factors in elderly Brazilians: results from the National Health Survey, 2013. *Ciências & Saúde Coletiva*, *26*(1), 185–196. https://doi.org/10.1590/1413-81232020261.30542018

Antunes, H. K. M., Santos, R. F., Cassilhas, R., Santos, R. V. T., Bueno, O. F. A., & Mello, M. T. de. (2006). Reviewing on physical exercise and the cognitive function. *Revista Brasileira Medicina Esporte*, *12*(2), 97e–103e. https://doi.org/10.1590/S1517-86922006000200011

Arney, B. E., Glover, R., Fusco, A., Cortis, C., de Koning, J. J., & Van, E. T. (2019). Comparison of rating of perceived exertion scales during incremental and interval exercise. *Kinesiology*, *51*(2), 150–157. https://doi.org/10.1123/ijspp.2018-0637

Bressel, E., Louder, T. J., & Dolny, D. G. (2017). Age-related changes in postural sway are not consistent between land and aquatic environments. *Journal of Geriatric Physical Therapy*, *40*(3), 113–120. https://doi.org/10.1519/JPT.0000000000000081

Biasoli, M. C., & Machado, C. M. C. (2006). Hydrotherapy: clinical applicability / Hydrotherapy: the use in different clinical disorders. *Revista Brasília Médica*, *63*(5), 225–237. https://pesquisa.bvsalud.org/portal/resource/pt/lil-515172

British Columbia Ministry of Health. (2002). *Physical Activity Readiness Medical Examination (PARmed-X)*. Canadian Society for Exercise Physiology. http://www.csep.ca/cmfiles/publications/parq/parmed-x

Camargos, F. F. O., Dias, R. C., Dias, J. M. D., & Freire, M. T. F. (2010). Cross-cultural adaptation and evaluation of the psychometric properties of the Falls Efficacy Scale - International in Brazilian elderly (FES-I-BRASIL). *Brazilian Journal of Physical Therapy*, *14*(3), 237–243. https://doi.org/10.1590/S1413-35552010000300010

Cameron, I. D., Dyer, S. M., Panagoda, C. E., Murray, G. R., Hill, K. D., & Cumming, R. G. (2018). Interventions for preventing falls in older people in care facilities and hospitals. *Cochrane Database of Systematic Reviews*, *9*(9), 1–328. https://doi.org/10.1002/14651858.CD005465.pub4

Campion, M. R. (2000). *Hydrotherapy: Principles and Practice*. Manole.

Casas-Herrero, Á., Sáez de Asteasu, M. L., Antón-Rodrigo, I., Sánchez-Sánchez, J. L., Montero-Odasso, M., Marín-Epelde, I., Ramón-Espinoza, F., Zambom-Ferraresi, F., Petidier-Torregrosa, R., Elexpuru-Estomba, J., Álvarez-Bustos, A., Galbete, A., Martínez-Velilla, N., & Izquierdo, M. (2022). Effects of Vivifrail multicomponent intervention on functional capacity: A multicenter, randomized controlled trial. *Journal of Cachexia, Sarcopenia and Muscle*, *13*(2), 884–893. https://doi.org/10.1002/jcsm.12925

Cohen, J. (1988). *Statistical Power Analysis for the Behavioral Sciences*. Routledge Academic.

CONSORT Group. (2010). *CONSORT 2010 Statement*. http://www.consortstatement.org

Cruz, D. T., Duque, R. O., & Leite, I. C. G. (2017). Prevalence of fear of falling, in a sample of older people adults in the community. *Brazilian Journal of Geriatrics and Gerontology*, *20*(3), 309–318. https://doi.org/10.1590/1981-22562017020.160176

Denkinger, M. D., Lukas, A., Nikolaus, T., & Hauer, K. (2015). Factors associated with fear of falling and associated activity restriction in community-dwelling older adults: A systematic review. *American Journal of Geriatric Psychiatry*, *23*(1), 72–86. https://doi.org/10.1016/j.jagp.2014.03.002

Ferraro, F. V., Gavin, J. P., Wainwright, T., & McConnell, A. (2019). The effects of 8 weeks of inspiratory muscle training on the balance of healthy older adults: A randomized, double-blind, placebo-controlled study. *Physiological Reports*, *7*(9), Article e14076. https://doi.org/10.14814/phy2.14076

Ferreira, D. L., Christofoletti, G., Campos, D. M., Janducci, A. L., Candanedo, M. J. B. L., & Ansai, J. H. (2022). Effects of aquatic physical exercise on motor risk factors for falls in older people during the COVID-19 pandemic: A randomized controlled trial. *Journal of Manipulative & Physiological Therapeutics*. https://doi.org/10.1016/j.jmpt.2022.08.002

Fletcher, P. C. (2004). Restriction in activity associated with fear of falling among community-based seniors using home care services. *Age and Ageing*, *33*(3), 273–279. https://doi.org/10.1093/ageing/afh077

Ganz, D. A., & Latham, N. K. (2020). Prevention of falls in community-dwelling older adults. *The New England Journal of Medicine*, *382*(8), 734–743. https://doi.org/10.1056/NEJMcp1903252

Herrera, E., Caramelli, P., Silveira, A. S. B., & Nitrini, R. (2002). Epidemiologic survey of dementia in a community-dwelling Brazilian population. *Alzheimer Disease & Associated Disorders*, *16*(2), 103–108. https://doi.org/10.1097/00002093-200204000-00007

Legters, K. (2002). Fear of falling. *Physical Therapy*, *82*(3), 264–272. https://doi.org/10.1093/ptj/82.3.264

Lopes, K., Costa, D., Santos, L., Castro, D., & Bastone, A. (2009). Prevalence of fear of falling in a community-dwelling elderly population and its correlation with mobility, dynamic balance, risk, and history of falls. *Brazilian Journal Physical Therapy*, *13*(3), 223–229. https://doi.org/10.1590/S1413-35552009005000026

Panel on Prevention of Falls in Older Persons, American Geriatrics Society and British Geriatrics Society. (2011). Summary of the updated American Geriatrics Society/British Geriatrics Society clinical practice guideline for prevention of falls in older persons: AGS/BGS clinical practice guideline for prevention of falls. *Journal of the American Geriatrics Society*, *59*(1), 148–157. https://doi.org/10.1111/j.1532-5415.2010.0323

Pena, S. B., Guimarães, H. C. Q. C. P., Lopes, J. L., Guandalini, L. S., Taminato, M., & Barbosa, D. A. (2019). Fear of falling and fall risk: Systematic review and meta-analysis. *Acta Paulista de Enfermagem*, *32*(4), 456–463. https://doi.org/10.1590/1982-0194201900062

Santos, S. C. A. dos, & Figueiredo, D. M. P. de. (2019). Predictors of fear of falling in Portuguese community-dwelling elderly individuals: An exploratory study. *Ciência & Saúde Coletiva*, *24*(1), 77–86. https://doi.org/10.1590/1413-81232018241.29932016

Sievänen, H., Piirtola, M., Tokola, K., Kulmala, T., Tiirikainen, E., Kannus, P., Kiiski, J., Uusi-Rasi, K., & Karinkanta, S. (2024). Effect of 10-week whole-body vibration training on falls and physical performance in older adults: A blinded, randomized, controlled clinical trial with 1-year follow-up. *International Journal of Environmental Research and Public Health*, *21*(7), 866. https://doi.org/10.3390/ijerph21070866

Tinetti, M. E. (2003). Preventing falls in elderly persons. *The New England Journal of Medicine*, *348*(1), 42–49. https://doi.org/10.1056/NEJMcp020719