Volume 4 issue 1 2024 (162-170)
Contents lists available at APSS
Journal of Advances in Para Sport Science (APSS)
Journal homepage: http://apssjournal.com/

Doi: 10.32604/mcb.2024.0xxxxx

ORIGINAL ARTICLE

Comparison of Two Exercise Protocols on Gait Speed in Older Adults with Locomotive Syndrome

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Received: 10-08-2025; Accepted: 11-08-2025; Published:16-08-2025

Abstract: Locomotive Syndrome (LS) is a prevalent condition among older adults, characterized by reduced mobility and associated with musculoskeletal disorders such as osteoporosis and osteoarthritis. It significantly impacts the quality of life and increases the risk of falls, fractures, and functional decline. This study aimed to compare the effectiveness of two exercise programs, Vivifrail and Locotra, on improving walking speed in elderly individuals with LS. Thirty elderly women aged 65 and older from the Ranginkamanesepid Day Care Center in Isfahan, Iran, participated in this randomized controlled trial, divided into two groups for an eight-week intervention, conducted three times a week. The primary outcome was the 6-meter walking time test, measured before and after the intervention. Both exercise programs demonstrated improvements in walking speed post-intervention; however, no statistically significant difference was found between the two groups. The Vivifrail group had a mean walking time post-test, while the Locotra group also showed improvement. The effect sizes indicated that both programs were effective but did not significantly outperform each other. Both Vivifrail and Locotra exercise programs are beneficial for enhancing walking speed in elderly individuals with LS, and given the lack of significant differences between the two interventions, healthcare providers may consider either program as a viable option for improving mobility in this population. Further research is needed to explore long-term outcomes and the impact of these programs on overall quality of life.

Keywords: Locomotive Syndrome, Elderly, Walking Speed, Vivifrail, Locotra.

Introduction

Inability to perform motor activities such as walking or maintaining balance can be the first sign of a common disorder in older adults, which is associated with decreased muscle function and mobility abilities(Cruz-Jentoft et al., 2018; Koivunen et al., 2020).Locomotive Syndrome(LS) is a condition primarily affecting older adults, characterized by reduced mobility and commonly associated with issues like osteoporosis, low back pain, knee osteoarthritis, and lumbar spinal canal stenosis, aimed at facilitating early intervention for at-risk individuals(Akahane et al., 2019).This syndrome arises from damage to parts of the locomotor system, such as bones, joints, or muscles, and can lead to disturbances in the motor activities of older adults(Akahane et al., 2019).The occurrence of musculoskeletal disorders can lead to weakness in walking ability, an increased risk of falls, bone fractures, persistent pain, and a decrease in physical activity levels among the elderly(Park & Lee, 2020).Approximately 30% of older adults are affected by this syndrome, resulting in limitations in daily activities and a reduced quality of life(Nakamura & Ogata, 2016).Decreased muscle mass and increased body fat are significant factors contributing to the development of LS in older adults(Ahangari et al., 2024).In epidemiological studies, walking speed is used as a key indicator for assessing individual performance and is recognized as a valid predictor of mortality and functional decline(Brach et al., 2002; Elbaz et al., 2013; Studenski et al., 2011).Previous reports have shown that walking speed, as a simple and reliable indicator, can predict the survival of older adults(Studenski et al., 2011). This research indicates that higher walking speeds are significantly associated with increased longevity, suggesting that measuring walking speed can be an effective method for assessing health status and making care decisions for the elderly(Studenski et al., 2011).A decrease in physical activity levels, accompanied by increased sedentary behaviors such as prolonged television watching and continuous sitting, exacerbates the risks associated with reduced mobility in the middle-aged and elderly population(DiPietro et al., 2018).A sedentary lifestyle is associated with decreased physical performance, including reduced walking speed and diminished performance in complex daily activities (Gilchrist et al., 2022).It has been shown that moderate-intensity physical activity (equivalent to ≥3.0 METs) is significantly associated with a reduced risk of developing LS in community-dwelling older women(Ishihara et al., 2022).The Locotra exercise program is designed to enhance and maintain standing and walking abilities in older adults and includes safe exercises that can be performed at home, such as squats and single-leg standing with eyes open(Nakamura & Ogata, 2016).Research has indicated that this program helps reduce the symptoms of LS by improving balance, coordination, and increasing muscle strength(Kikuchi et al., 2020).On the other hand, the Vivifrail program offers exercises aimed at enhancing physical capacity and overall health in frail older adults, which includes strength, balance, flexibility, and endurance exercises(Sánchez-Sánchez et al., 2022).Reports indicate that this program, as an effective and safe method, improves the physical capabilities of older adults suffering from frailty or pre-frailty(Casas-Herrero et al., 2022).Despite the reported positive effects of various exercise programs on improving the motor capacities of older adults, there is conflicting evidence regarding the direct comparison of the effectiveness of these programs in individuals with LS.Previous studies have primarily focused on evaluating a single type of intervention or a general elderly population, while the impact of multiple interventions in at-risk populations, especially older adults with LS, has been less explored. Furthermore,

the differences in the nature of the exercises in the Vivifrail and Locotra programs underscore the importance of comparing these two approaches to determine a more effective intervention for improving walking speed and enhancing functional independence in this group, thereby increasing the significance of the comparison. Therefore, the present study is designed and conducted to compare the effects of eight weeks of Vivifral vs Locotra exercises on the walking speed of older adults with LS. This research can help identify optimal exercise methods for older adults facing mobility issues and lead to improvements in their quality of life. By thoroughly examining these two programs, we can gain a better understanding of the needs and challenges faced by these individuals and provide effective support strategies.

Methods and Materials

This study was conducted on 50 elderly individuals from the Ranginkamanesepid Day Care Center in Isfahan, Iran. Among these individuals, 30 participants aged 65 years and older who met the required criteria were purposefully selected. After attending an introductory session and receiving complete information about the study, they expressed their willingness to participate by signing an informed consent form. The necessary sample size was determined using G Power software version 3.1.0, based on an analysis of variance with a significance level of 5% ($\alpha = 0.05$), a power of 80% ($\beta = 0.2$), and a large effect size ($d = 0.6$). Participants were randomly divided into two groups: the Vivifrail group (15 individuals) and the Locoyra group (15 individuals). The inclusion criteria for the study consisted of elderly women aged 65 years or older, without significant physical or cognitive limitations that would hinder their ability to perform exercise, and who scored one or more on the Loco-chek questionnaire. Additionally, participation in the study required the completion and signing of an informed consent form. Conversely, the exclusion criteria included voluntary withdrawal from the exercise program, inability to continue exercises, absence from three consecutive sessions or a total of eight training sessions, and lack of cooperation in pre-test and post-test assessments. The research commenced with obtaining the necessary permissions and an introductory letter from the General Directorate of Welfare of Isfahan Province. Coordination meetings were held with the management of the Ranginkamanesepid Day Care Center to ensure the safety of the elderly and to review the required training. Eligible individuals were identified, and a comprehensive orientation session was conducted to explain the exercise programs, benefits, risks, and proper execution of the exercises. Participants were asked to refrain from engaging in other exercise programs during the intervention to avoid any conflicting effects. They were also assured that their personal information would remain confidential and would only be reported in aggregate form. Participants could withdraw from the study at any time. After approval from the management, the Loco-chek questionnaire was administered as a criterion for entering the exercise protocols. A demographic questionnaire was provided to all participants, and for those with low literacy, the questionnaires were completed through interviews. Following this, the 6-meter walking time test was conducted(Sadeghi Mahali et al., 2019). The exercise phase lasted for eight weeks, with three sessions per week held in the gym of the Ranginkamanesepid Day Care Center. The post-test for the 6-meter walking time test was conducted after the exercise phase, and interviews were also conducted for participants with low literacy. The multidimensional exercise protocol of Vivifrail was designed to improve physical performance and reduce the risk of falls in the elderly. Participants were

divided into four groups based on their scores from functional tests (SPPB, TUG, and 6MWTT) and cognitive assessments: weak (scores 0 to 3), pre-weak (4 to 6), at risk (7 to 9), and healthy (10 to 12). Individuals with cognitive impairments and at risk of falling received specialized training. Training sessions for each group were supervised by a coach and conducted three times a week for 45 to 60 minutes over eight weeks. Participants received a translated manual, and coaches utilized the Vivifrail training app for greater accuracy. The exercises included strength training, cardiovascular activities, balance exercises, and flexibility training, with the training load adjusted based on individual capacity. Additionally, the Locotra protocol, proposed by the Japanese Orthopedic Association, was designed to improve and manage symptoms of movement syndrome. This program included two main exercises: standing on one leg and squats, along with two supplementary exercises: calf raises and forward lunges, as well as exercises to strengthen the quadriceps and hamstrings. These exercises were conducted three times a week for eight weeks under the supervision of a coach. Each session included 15 minutes of warm-up, 20 minutes of main exercises, and 10 minutes of cool-down, totaling 60 minutes. The collected data were analyzed at both descriptive and inferential levels. Descriptive statistics included means and standard deviations. At the inferential level, analysis of variance was used to compare the effects of the Vivifrail exercise program and Locotra exercises, controlling for the initial scores of these variables (pre-test). The underlying assumptions of the model, including the normality of error distribution, homogeneity of variance, and homogeneity of regression slopes, were examined and confirmed. Independent t-tests were conducted to compare the individual characteristics of the elderly in both groups, considering the normality of data distribution. All tests were performed at a 5% error level using version 27 of SPSS software.

Results

In this study, a total of 26 elderly individuals with LS (14 in the Vivifrail group and 12 in the Locotra group) were examined, with a mean age of 71.86 years (ranging from 65 to 85 years). The mean and standard deviation of age, height, weight, and body mass index (BMI) of the elderly participants in both groups are presented in Table 1. To assess the normality of the distribution of anthropometric data, the Shapiro-Wilk test was used. If normality was confirmed ($p > 0.05$), an independent t-test was employed to compare quantitative variables between the two groups. A significance level of less than 0.05 was considered for all analyses. The results of the independent t-test indicated that there were no significant differences between the two groups in terms of age ($p = 0.191$), height ($p = 0.114$), weight ($p = 0.975$), and body mass index ($p = 0.422$). These results suggest that the initial anthropometric characteristics of the participants in both exercise groups were homogeneous and comparable.

Table 1: Comparison of Individual Characteristics of Participants in Two Groups

Variable	Group	Number	Mean	Standard Deviation	Test Criterion	p-value
Age (years)	Vivifaril	14	73.14	6.50	t=1.344 [a]	.191
	Locotra	12	70.00	5.20		
Height (centimeters)	Vivifaril	14	151.57	5.98	t=-1.641 [a]	.114
	Locotra	12	155.50	6.20		
Weight (kilograms)	Vivifaril	14	66.36	12.92	t=-.031 [a]	.975
	Locotra	12	66.50	9.71		
BMI (kilograms per square meter)	Vivifaril	14	29.03	6.48	t=0.817 [a]	.422
	Locotra	12	27.38	2.84		

Calculated Based on the Independent t-Test

With analysis of covariance and after controlling for the effects of pre-test scores, no significant difference in 6-meter walking time test was observed between the two exercise groups ($p=0.719$, $\eta^2=0.006$). The mean time taken to cover the specified distance (6 meters) improved in both groups after the intervention period; however, the difference between the Vivifrail exercise group and the Locotra exercise group was not statistically significant. This finding indicates that both training programs were somewhat effective in improving walking speed, but neither had a significant advantage over the other.

Table 2: Mean and Standard Deviation of 6-Meter Walking Time Test for Elderly Individuals in Two Groups: Vivifrail Exercises and Locotra Exercises

Index	Test Stage	Vivifrail		Locotra		Analysis of Covariance	
		Mean	Standard Deviation	Mean	Standard Deviation	Pre-Test Effect	Group Effect
6-meter walking time test	Pre-Test	14.06	4.40	10.25	3.41	$p<0.001$ $\eta^2=0.745$	$p=0.719$ $\eta^2=0/006$
	Post-Test	11.25	3.28	8.21	3.42		
	Adjusted Post-Test	9.97	1.82	9.70	1.84		

By controlling for the effect of the pre-test.

Discussion

The findings of this study provide valuable insights into the effectiveness of exercise interventions for improving walking speed in older adults with LS. Both the Vivifrail and Locotra programs demonstrated improvements in walking speed; however, no significant difference was observed between the two

interventions. This aligns with previous research indicating that structured exercise can enhance mobility and functional independence in older populations(Brandão et al., 2018; Haripriya et al., 2018) .

Physical activity is crucial for maintaining and improving muscle function, balance, and overall mobility in older adults(Billot et al., 2020; Paterson et al., 2007). Regular exercise has been shown to mitigate the decline in physical performance associated with aging, thereby reducing the risk of falls and enhancing quality of life(Dipietro et al., 2019; Ikegami et al., 2019). The current study reinforces these findings by demonstrating that both intervention programs effectively improved walking speed, a key indicator of functional ability and overall health status in older adults(Chou et al., 2012; Purser et al., 2005).

The lack of significant differences between the Vivifrail and Locotra programs suggests that both approaches can be beneficial for elderly individuals with LS(Casas-Herrero et al., 2022; Kikuchi et al., 2020; Nakamura & Ogata, 2016). Previous studies have highlighted the effectiveness of multi-faceted exercise programs that incorporate strength, balance, and flexibility training(Gangwar; Lauersen & Andersen, 2017). The Vivifrail program, which emphasizes a multidimensional approach, may offer comprehensive benefits that address various aspects of physical decline(Casas-Herrero et al., 2019; Izquierdo, 2019). Conversely, the focuses on specific exercises aimed at improving core mobility and strength, which are also critical for enhancing walking speed(Ikemoto & Arai, 2018).

Despite the positive outcomes observed in both groups, the absence of a statistically significant difference raises questions about the comparative effectiveness of these programs(Izquierdo et al., 2025). Future research should explore larger sample sizes and longer intervention durations to better assess the long-term impacts of these exercise regimens on mobility and overall health(Yang et al., 2022). Moreover, investigating the specific components of each program that contribute to improvements in walking speed could provide deeper insights into optimizing exercise interventions for older adults with(Xu et al., 2023).

The study also highlights the detrimental effects of a sedentary lifestyle on mobility in older adults(Martins et al., 2021). Increased sedentary behavior, such as prolonged sitting and reduced physical activity, has been linked to declines in muscle strength and walking speed (Felipe et al., 2023). Addressing sedentary behavior through structured exercise programs may be essential for enhancing mobility and preventing the onset of LS in at-risk populations(Fanning et al., 2022; Jiang et al., 2022).

Conclusion

This study highlights the effectiveness of both the Vivifrail and Locotra exercise programs in improving walking speed among elderly individuals with Locomotive Syndrome (LS). While no significant differences were found between the two interventions, both programs effectively enhanced mobility and functional independence.

The results underscore the importance of regular physical activity in mitigating age-related decline and improving the quality of life for older adults. Future research should focus on long-term effects and broader health outcomes to further support tailored exercise interventions for this population.

References

Ahangari, N., Sum, S., Pourhadi, S., Ghadimi, R., Hosseini, S. R., Pourghasem, M., & Ilali, E. S. (2024). Anthropometric indices in older adults with and without Locomotive Syndrome. *BMC geriatrics*, *24*(1), 868.

Akahane, M., Maeyashiki, A., Tanaka, Y., & Imamura, T. (2019). The impact of musculoskeletal diseases on the presence of locomotive syndrome. *Modern Rheumatology*, *29*(1), 151-156. https://doi.org/10.1080/14397595.2018.1452173

Billot, M., Calvani, R., Urtamo, A., Sánchez-Sánchez, J. L., Ciccolari-Micaldi, C., Chang, M., Roller-Wirnsberger, R., Wirnsberger, G., Sinclair, A., & Vaquero-Pinto, N. (2020). Preserving mobility in older adults with physical frailty and sarcopenia: opportunities, challenges, and recommendations for physical activity interventions. *Clinical interventions in aging*, 1675-1690.

Brach, J. S., VanSwearingen, J. M., Newman, A. B., & Kriska, A. M. (2002). Identifying early decline of physical function in community-dwelling older women: performance-based and self-report measures. *Physical therapy*, *82*(4), 320-328.

Brandão, G. S., Oliveira, L. V. F., Brandão, G. S., Silva, A. S., Sampaio, A. A. C., Urbano, J. J., Soares, A., Santos Faria Jr, N., Pasqualotto, L. T., & Oliveira, E. F. (2018). Effect of a home-based exercise program on functional mobility and quality of life in elderly people: protocol of a single-blind, randomized controlled trial. *Trials*, *19*(1), 684.

Casas-Herrero, A., Anton-Rodrigo, I., Zambom-Ferraresi, F., Sáez de Asteasu, M. L., Martinez-Velilla, N., Elexpuru-Estomba, J., Marin-Epelde, I., Ramon-Espinoza, F., Petidier-Torregrosa, R., & Sanchez-Sanchez, J. L. (2019). Effect of a multicomponent exercise programme (VIVIFRAIL) on functional capacity in frail community elders with cognitive decline: study protocol for a randomized multicentre control trial. *Trials*, *20*(1), 362.

Casas-Herrero, Á., Saez 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. (2022). Effects of Vivifrail multicomponent intervention on functional capacity: a multicentre, randomized controlled trial. *Journal of cachexia, sarcopenia and muscle*, *13*(2), 884-893.

Chou, C.-H., Hwang, C.-L., & Wu, Y.-T. (2012). Effect of exercise on physical function, daily living activities, and quality of life in the frail older adults: a meta-analysis. *Archives of physical medicine and rehabilitation*, *93*(2), 237-244.

Cruz-Jentoft, A. J., Bahat, G., Bauer, J., Boirie, Y., Bruyère, O., Cederholm, T., Cooper, C., Landi, F., Rolland, Y., Sayer, A. A., Schneider, S. M., Sieber, C. C., Topinkova, E., Vandewoude, M., Visser, M., Zamboni, M., Writing Group for the European Working Group on Sarcopenia in Older People 2 , & EWGSOP2, t. E. G. f. (2018). Sarcopenia: revised European consensus on definition and diagnosis. *Age and Ageing*, *48*(1), 16-31. https://doi.org/10.1093/ageing/afy169

Dipietro, L., Campbell, W. W., Buchner, D. M., Erickson, K. I., Powell, K. E., Bloodgood, B., Hughes, T., Day, K. R., Piercy, K. L., & Vaux-Bjerke, A. (2019). Physical activity, injurious falls, and physical function in aging: an umbrella review. *Medicine and science in sports and exercise*, *51*(6), 1303.

DiPietro, L., Jin, Y., Talegawkar, S., & Matthews, C. E. (2018). The joint associations of sedentary time and physical activity with mobility disability in older people: the NIH-AARP diet and health study. *The Journals of Gerontology: Series A*, *73*(4), 532-538.

Elbaz, A., Sabia, S., Brunner, E., Shipley, M., Marmot, M., Kivimaki, M., & Singh-Manoux, A. (2013). Association of walking speed in late midlife with mortality: results from the Whitehall II cohort study. *Age*, *35*(3), 943-952.

Fanning, J., Nicklas, B. J., & Rejeski, W. J. (2022). Intervening on physical activity and sedentary behavior in older adults. *Experimental gerontology*, *157*, 111634.

Felipe, S. G. B., Parreira Batista, P., da Silva, C. C. R., de Melo, R. C., de Assumpcao, D., & Perracini, M. R. (2023). Impact of COVID-19 pandemic on mobility of older adults: A scoping review. *International journal of older people nursing*, *18*(1), e12496.

Gangwar, D. Mobility and Strength Training in Older Adults. *Physiotherapy in Geriatric Condition*, 139.

Gilchrist, S. C., Bennett, A., Judd, S. E., Akinyemiju, T., Howard, V. J., Hooker, S. P., Cushman, M., & Diaz, K. M. (2022). Sedentary behavior and physical functioning in middle-aged and older adults living in the US: the REGARDS study. *Medicine and science in sports and exercise*, *54*(11), 1897.

Haripriya, S., Kumar, D., Samuel, S. E., & Soman, A. (2018). Effect of a multi-component exercise program on functional mobility, exercise capacity and quality of life in older adults. *Journal of Clinical & Diagnostic Research*, *12*(7).

Ikegami, S., Takahashi, J., Uehara, M., Tokida, R., Nishimura, H., Sakai, A., & Kato, H. (2019). Physical performance reflects cognitive function, fall risk, and quality of life in community-dwelling older people. *Scientific reports*, *9*(1), 12242.

Ikemoto, T., & Arai, Y.-C. (2018). Locomotive syndrome: clinical perspectives. *Clinical interventions in aging*, 819-827.

Ishihara, Y., Ozaki, H., Nakagata, T., Yoshihara, T., Natsume, T., Kitada, T., Ishibashi, M., Deng, P., Yamada, Y., & Kobayashi, H. (2022). Association between daily physical activity and locomotive syndrome in community-dwelling Japanese older adults: a cross-sectional study. *International journal of environmental research and public health*, *19*(13), 8164.

Izquierdo, M. (2019). Multicomponent physical exercise program: Vivifrail. *Nutricion hospitalaria*, *36*(Spec No2), 50-56.

Izquierdo, M., de Souto Barreto, P., Arai, H., Bischoff-Ferrari, H. A., Cadore, E. L., Cesari, M., Chen, L.-K., Coen, P. M., Courneya, K. S., & Duque, G. (2025). Global consensus on optimal exercise recommendations for enhancing healthy longevity in older adults (ICFSR). *The Journal of nutrition, health and aging*, 100401.

Jiang, Y., Wang, M., Liu, S., Ya, X., Duan, G., & Wang, Z. (2022). The association between sedentary behavior and falls in older adults: A systematic review and meta-analysis. *Frontiers in public health*, *10*, 1019551.

Kikuchi, C., Yamaguchi, K., Kojima, M., Asai, H., Nakao, R., Otake, Y., Nagata, J., Matsunami, S., Horiba, A., & Suzuki, T. (2020). Comparative trial of the effects of continuous locomotion training provided at pharmacies: a pilot study. *Journal of Pharmaceutical Health Care and Sciences*, *6*(1), 24.

Koivunen, K., Sillanpää, E., Munukka, M., Portegijs, E., & Rantanen, T. (2020). Cohort Differences in Maximal Physical Performance: A Comparison of 75- and 80-Year-Old Men and Women Born 28 Years Apart. *The Journals of Gerontology: Series A*, *76*(7), 1251-1259. https://doi.org/10.1093/gerona/glaa224

Lauersen, J. B., & Andersen, L. B. (2017). Multi-faceted exercise programs versus strength training to prevent sports injuries. *Journal of Xiangya Medicine*, *2*(4).

Martins, L. C. G., Lopes, M. V. d. O., Diniz, C. M., & Guedes, N. G. (2021). The factors related to a sedentary lifestyle: A meta-analysis review. *Journal of advanced nursing*, *77*(3), 1188-1205.

Nakamura, K., & Ogata, T. (2016). Locomotive syndrome: definition and management. *Clinical reviews in bone and mineral metabolism*, *14*(2), 56-67.

Park, J., & Lee, K. H. (2020). THE EFFECT OF MUSCULOSKELETAL DISORDERS ON BODY REGIONS AND PAIN LEVELS IN ELDERLY PEOPLE ON DYNAMIC BALANCE ABILITY. *Journal of Men's Health*, *16*(3), 98-108. https://doi.org/10.31083/jomh.v16i3.285

Paterson, D. H., Jones, G. R., & Rice, C. L. (2007). Ageing and physical activity: evidence to develop exercise recommendations for older adults. *Applied physiology, nutrition, and metabolism*, *32*(S2E), S69-S108.

Purser, J. L., Weinberger, M., Cohen, H. J., & Pieper, C. F. (2005). Walking speed predicts health status and hospital costs for frail elderly. *Journal of Rehabilitation R & D*, *42*(4), 535-546.

Sadeghi Mahali, n., Hoseini, M. A., & Norouzi, K. (2019). The Screening Methods for Locomotive Syndrome in the Elderly; An Integrative Review [Review]. *Journal of Gerontology*, *4*(2), 61-73. https://doi.org/10.29252/joge.4.1.61

Sánchez-Sánchez, J. L., de Souto Barreto, P., Antón-Rodrigo, I., Ramón-Espinoza, F., Marín-Epelde, I., Sánchez-Latorre, M., Moral-Cuesta, D., & Casas-Herrero, Á. (2022). Effects of a 12-week Vivifrail exercise program on intrinsic capacity among frail cognitively impaired community-dwelling older adults: secondary analysis of a multicentre randomised clinical trial. *Age and Ageing*, *51*(12), afac303.

Studenski, S., Perera, S., Patel, K., Rosano, C., Faulkner, K., Inzitari, M., Brach, J., Chandler, J., Cawthon, P., & Connor, E. B. (2011). Gait speed and survival in older adults. *Jama*, *305*(1), 50-58.

Xu, L., Gu, H., Cai, X., Zhang, Y., Hou, X., Yu, J., & Sun, T. (2023). The effects of exercise for cognitive function in older adults: a systematic review and meta-analysis of randomized controlled trials. *International journal of environmental research and public health*, *20*(2), 1088.

Yang, Y., Wang, K., Liu, H., Qu, J., Wang, Y., Chen, P., Zhang, T., & Luo, J. (2022). The impact of Otago exercise programme on the prevention of falls in older adult: A systematic review. *Frontiers in public health*, *10*, 953593.