International Journal of Gerontology 18 (2024) 258–262
https://doi.org/10.6890/IJGE.202410_18(4).0011

International Journal of Gerontology

journal homepage: http://www.sgecm.org.tw/ijge/

Original Article

Effects of Physical Cognitive Dual Task Training versus Conventional Single Task Training for Balance and Quality of Life among Older Adults – A Quasi Experimental Study

Hira Jabeen [a], Tahir Mahmood [b *], Wajeeha Mahmood [c], Nazeer Ahmad [b]

[a] *Faculty of Physical Therapy & Rehabilitation, Riphah International University, Lahore, Pakistan,* [b] *Department of Physical Therapy, Rashid Latif Khan University, Lahore, Pakistan,* [c] *Department of Physical Therapy, University of Health Sciences, Lahore, Pakistan*

ARTICLE INFO

Accepted 25 March 2024

Keywords:
cognition,
exercise,
dual task performance,
older adults,
quality of life

SUMMARY

Background: Physical-cognitive dual tasking is an emerging novel modality for reaping the largest cognitive health benefits.
Objective: The objective of this study was to compare effects of cognitive dual-task and conventional single-task training on balance and quality of life in older adults.
Methods: This Quasi-experimental study was conducted on 30 community-dwelling older adults after ethical approval from 20th October 2021 to March 2022. Group A (Experimental) received physical, cognitive dual-task training. Group B received single-motor task training (Conventional Therapy). The outcome measurement tools were the Berg Balance Scale and Quality of Life Index. The data was analyzed using SPSS 21. Depending upon normal distribution, pretest and posttest comparisons were done with Parametric tests, and the p-value was set at 95% CI ($p < 0.05$).
Results: The current study comprised 15 (50%) males and 15 (50%) females, with a mean age in Group A of 59.27 ± 3.73 and Group B of 62.13 ± 5.40 years. While 24 subjects were hypertensive and 17 were diabetic participants. The mean score difference within the Group showed that the pretest-posttest regarding balance in Group A was 3.20 ± 2.96, and in Group B was 1.0 ± 1.77 with a p-value < 0.05. However, Group A was better in outcomes balance compared to interventions in Group B. Similarly, the quality of life mean score improved significantly in Group A compared to B after six weeks of dual-task training.
Conclusion: Physical and cognitive dual-task training shows better results than single-task training in improving balance and quality of life among the elderly population.

1. Introduction

Balance control is an essential component of functional mobility and is considered the most often the major cause of falls among older people. In older people, loss of balance control can greatly impair normal functioning and reduce the overall quality of life. Older people who cannot perform the dual task properly are at great risk of falls.[1] The older adults with instability issues have shown improvement in postural control with proprioceptive and vestibular rehabilitation strategies. In case of age-related balance deterioration, equilibrium measures and balance training strategies can be implemented.[2] Dual tasks have two major categories: motor dual tasks include motor task performance and postural control task simultaneously, and cognition dual tasks require cognitive task and postural control task simultaneously.[3] Until now, it is evident that while performing cognitive tasks, loss of balance control is most commonly seen in people with middle to older age samples.[4] There is consistent evidence that both cognitive and physical training have the potential to maintain cognitive efficiency in the aging population.[5] The reason behind the novelty is because of its larger benefits. Physical dual-task training in balance control, targeting the community's older people, can positively affect older adults by improving their daily activities. There is an increasing trend, and the reason behind this is that focusing on the cognitive and physical tasks requires more attention and will challenge the static and dynamic balance more functionally.[6] Prospective studies have shown an increase in postural sway with age, particularly in mediolateral motion, that predicts falls in older people.[7] Multiple tasks improve fall-related self-efficacy, balance performance, gait speed, and physical function in elders.[8] Still, the dose-response relationship regarding this training is not well identified. The evidence on the proper training period, intensity, frequency, and duration is non-conclusive. It has been reported that balance training is an effective way to improve the static/dynamic balance in otherwise healthy older adults.[9] Previously, dual tasks have been used for stroke,[10] but the literature on rehabilitation protocols for improving balance and reducing the risk of falls in this population is lacking. In Pakistan, various intervention protocols include conventional balance training, Frenkle's exercises, exercises with a wobble board, strengthening, stretching aerobics, and proprioceptive training. Most often, the interventions used consist of single-task training. However, this study was conducted as a first step

* Corresponding author.
E-mail address: tahirmahmoodphysio@gmail.com (T. Mahmood)

towards using the dual-task training approach for balance improvement in Pakistan. The study aimed to measure the effects of physical-cognitive dual-task training versus single-task training on improving balance and quality of life among older adults. So, we assumed no difference in the effects of physical-cognitive dual-task and traditional single-task training in improving balance among older adults. This study will lead to an improvement in the health-related quality of life of the elderly population in Pakistan.

2. Material and methods

2.1. Research participants

The subjects aged 55–70, both genders, walking independently without an assistive device, mini-mental state examination (MMSE) score of 24 or greater, and 30–40 on the Berg balance scale were included. While the subjects with any deficits in neurological, musculoskeletal, or sensory origin that cause balance impairment, visual or hearing impairment not corrected by visual or hearing aids, severe cognitive impairments, and uncontrolled condition for which exercise is not advised, i.e. uncontrolled cardiac illness or metabolic diseases. The researcher followed all the ethical standards of medical research in human subjects. The participants were informed about the nature and safety of the study and informed that they could withdraw at any time. Confidentiality was maintained, and data was collected only after this informed consent.

2.2. Research design

It was a quasi-experimental study after ethical approval was obtained from the Research Ethical Committee (REC), Riphah International University Lahore. The data was collected from the Comprehensive Rehabilitation Center (CRC) from 20th October 2021 to March 2022. The sample size was calculated from Open Epi version 3, and the balance ability parameter in one Group was 0.23 ± 0.03 and in the second Group 0.33 ± 0.1 with variances of 0.008 and 0.01, respectively.[11] Using purposive sampling, data was collected, and subjects were divided into two groups based on intervention.

2.3. Interventions

In group A, participants were given physical motor-cognitive dual-task training; in group B, participants were given single-task motor training. The intervention plan was given weeks-wise and comprised different tasks used in previous literature. In group A (dual task training), 1st week, the cognitive tasks used were TV watching, a random story told along with counting backward and forward, and motor task tandem walking with a taped path; the patient was asked to stand on foam with feet away along with pulling of elastic rubber bands. In the second week, cognitive tasks were the same as in 1st week, in addition to counting letters from the auditory sequence. In the second week, the subject took the same tasks with the addition of lateral reach (low and high) but feet near and lateral-medial steps. The 3rd-week cognitive tasks were previously used in addition to reverse counting starting from 50 and even numbers, and it was repeated with opened and closed eyes for 30 seconds, with three repetitions. The 3rd week comprised lateral reach (low and high) with the addition of anterior-posterior stepping to and fro on the same foam. A BOSU (both sides up) stand was used, and patients were asked to balance disks while keeping their feet away and turning to 360° during 4th week. Cognitive tasks were the same as in 3rd week, but motor tasks were complex. A wobble board (square) was used with one foot on it and the other on a disk, turning 360° while keeping the feet away from each other. However, the 5th and 6th cognitive tasks were repeated as used in the 3rd week of intervention.[12–14] Single motor tasks in 5th-week continuation of 4th along with side steps but on half foam, chair sitting, and the patient was asked to pick a ball placed on the ground and move it to the opposite side while lifting the feet. The last 6th week included chair sitting and picking up the ball as above, but now the patient was asked to move around the edges of the wobble (circular) board in the right and left direction[13] (Details added in Supplementary File). Group B was only given single motor task training. Both trainings were given for 40 minutes/session and three sessions /week for six weeks. Protocol was given to both groups equally.

2.4. Outcome measurements

The subjects were tested before and after for balance ability on the Berg balance scale and quality of life on brief older people's quality of life questionnaire (OPQOL-brief). Berg balance scale (BBS) is a 14 task-based tool developed to measure balance in older people. Berg balance scale assesses balance as necessary in old age due to an increased risk of falls. Each of these 14 tasks in BBS is on five levels, where 0 is for 'cannot perform', and four is for 'normal performance'. The total score ranges from 0 (poor) to 56 (normal). The reliability of BBS is high (0.83–1.0).[15] While quality of life was measured as it is the indicator of well-being and ease in daily activities. The secondary outcome measure was older people's quality of life (OPQOL), which was measured using a brief version of the older people's quality of life questionnaire, a 13-item scale designed to determine the quality of life among the elderly population. Each item on the OPQOL is scored on a 5-point Likert scale where '1' is for 'strongly agree' and '5' for 'strongly disagree'. The reliability of OPQOL was found to be 0.85.[16] Each improvement regarding the treatment outcomes was measured using the Berg balance scale and a OPQOL-brief. Data was collected using a pre-designed Performa, consisting of demographic details (name, age, sex) noted along with the necessary medical history and score of patients on pretest (before intervention) and post-test (after intervention).

2.5. Statistical analysis

Data was analyzed using SPSS V. 21. Quantitative variables were measured by mean $\pm$ SD. Qualitative variables were measured using frequency tables. After the normality was checked using Shapiro-Wilks tests and the p-value of significance of > 0.05. Parametric tests were used for the pretest and post-test comparison of outcomes. Pretest and post-test comparisons within the groups were done using paired sample t-tests. An independent t-test was used to compare the effect of motor-cognitive dual-task and single-task training on improving balance and quality of life between older adults in the two groups. p-value < 0.05 was considered significant (95% CI).

3. Results

In the current study, 30 subjects were recruited and divided into groups A and B. The mean age of participants in group A was 59.27 ± 3.73 years; in group B, it was 62.13 ± 5.40 years. While 17 were diabetic and 24 were hypertensive, which was controlled (Table 1).

The mean balance score in group A was pretest 42.27 ± 4.11, and the post-test improved to 45.47 ± 4.26 with a p-value of 0.00, showing a significant effect of intervention after six weeks of intervention. Similarly, the QOL score in the group was 50.33 ± 5.12 and

increased to 56.53 ± 5.64 with a p value of 0.000, showing significant improvement (Table 2).

The between group comparison using an independent sample t-test showed a dominant difference in improvement with a p value of 0.013 and 0.018, respectively, for the A and B groups. This significant difference shows that cognitive-motor tasks are better for outcomes, including balance and patients' quality of life, than single-task training. This can be seen as the effect size (shown by Cohen D) in group A was greater compared to group B (Table 3).

4. Discussion

The current study aimed to compare the effects of physical and cognitive dual-task training and conventional single-task training in improving balance and quality of life in 30 subjects. The results of the current study have revealed that both dual and single-task training lead to improved balance and quality of life in older adults; however, dual-task training showed better results than single-task training. Performing two or multiple tasks at a time involves a higher level of attention and information processing that can equally allocate attention to the tasks at hand. It was seen that there was an increase in balance capability and reduced postural sway, which shows that attention was properly divided between balance and the cognitive task.[17] Both single and physical-cognitive dual-task training result in an improved balance and reduced risk of falls among older people. Dual-task training plays a significant role in improving dual-task performance. Training durations have also been variable, with the shortest duration of 20 minutes twice a week and the longest of 1 hour five days a week.[18] The results of the current study are consistent with Shin et al.'s finding that motor-cognitive dual-task training improved balance and gait parameters in elderly females.[19] We found that physical-cognitive dual-task training improves balance and quality of life compared to single-task training ($p < 0.05$). The motor and cognitive performance-related benefits were achieved with dual-task training, so it can be assumed that balance-related dual-task performance can be improved by dual-task performance in otherwise healthy elderly.[20] Cognitive rehabilitation improves the quality of life and the number of subjective complaints in older people. This can emphasize the need for intervention based on cognitive tasks as a key indicator of outcomes.[21] But computer-based cognitive training also improves the quality of life.[22] While balance is important to deal with as it increases or decreases the risk of falls, it can be better managed using dual motor task training in older adults.[23] In older adults, simultaneous and combined interventions in a sequence are more dominant compared to single-domain training with favourable outcomes.[24] Park, Cho, and Hwang conducted a study on the influence of dual-task training of the ankle on static and dynamic balance among older people. It was reported that the dual-task training groups significantly improved static and dynamic balance compared to the single-task training group. The studies conducted on physical exercise interventions have shown significant positive changes in physical and cognitive domains and the quality of life of individuals. These improvements were similar in frail and non-frail elderly patients, while patients at risk of cognitive decline can show improved cognition with exercise interventions.[12] Hiyamizu et al. reported that balance training without any equipment could maintain balance, and dual-task training when performed with cognitive tasks, improved balance and dual-task performance compared to conventional balance training.[25] Our experimental group, physical-cognitive managed with dual-task training, had shown dominant effects compared to group B treated with single-task training. The difference between groups showed that older adults' balance and quality of life improved. Cognitive training can improve their skills to understand and re-educate their effector organs for specific movements. However, another piece of evidence stated that balance and movement training was given with or without cognitive tasks for 12 weeks. The physical-cognitive dual-task training in group exercise affects the executive function, which plays an important role in ADLs in old age people.[26] In a study among older women with dual-task training, the fall index of the experimental group with simple balance training was considerably lower than that of the control group with motor tasks-based dual-task training.[19] Despite this, our results show that dual-task training can be an effective intervention among adults in improving balance and quality of life. The results were similar to another trial conducted on measuring the effect of community-based cognitive interventions on balance and gait in older people, showing that cognitive training is an effective approach to improving balance and gait in older people.[27] Dual-task training induces a positive effect on the quality of life and improves ADLs and is considered, but it also needs the addition of manipulation of motor tasks.[14] In line with the current findings, Marcelo stated that dual-task training can benefit performance, quality of life and physical health.[28] Despite the

Table 1
Demographic profile of participants at baseline (N = 30).

Variables	Group A	Group B	p-value*
Gender			0.461
Male	5	8	
Female	10	7	
History of diabetes			0.462
Yes	7	10	
No	8	5	
History of hypertension			0.651
Yes	11	13	
No	4	2	
Mean age	59.27 ± 3.73	62.13 ± 5.40	0.101

* Level of significance < 0.05.

Table 2
Pretest and posttest comparison of outcomes within groups (N = 30).

Outcomes	Groups	N	Pretest (Mean ± SD*)	Post-test (Mean ± SD)	p-value**
Berg balance scale	Group A	15	42.27 ± 4.11	45.47 ± 4.26	.001
	Group B		40.93 ± 5.71	41.93 ± 5.60	.046
Quality of life	Group A	15	50.33 ± 5.12	56.53 ± 5.64	.000
	Group B		49.47 ± 5.62	51.67 ± 6.11	.028

* Standard deviation. ** Level of significance < 0.05.

Table 3
Between group mean differences for outcomes (N = 30).

Outcomes	Groups	N	Mean ± SD*	Cohen D value	Differences	p-value**
Berg balance scale	Group A	15	3.20 ± 2.96	0.765	2.2	.013
	Group B		1.0 ± 1.77	0.177		
Quality of life	Group A	15	6.20 ± 5.10	1.151	4.0	.018
	Group B		2.22 ± 3.45	0.375		

* Standard deviation. ** Level of significance < 0.05.

dose and use of modalities, cognitive dual-motor task training still positively impacts older adults.[29] The current study pretest-posttest found that dual-task training improves balance and quality of life compared to single-task training, having statistically significant effects. Similar to other findings, dual-task training had significant differences from single-task training.[30]

The limitation of this study was that the researcher was directly involved in the intervention provision, and blinding was not possible for this reason. Meanwhile, the older subjects need to deal directly with a professional geriatric trainer who can better understand the subject and communicate easily. Another problem with blinding was that blinding of the patients was done at the time of allocation to groups, but this could not be maintained till the end because of the obvious nature of interventions and outcomes evaluation. Further studies can be conducted with blinding and randomization that can increase the generalization of the study to a larger population. Further, the quality of life with different domains can be studied to enhance the specificity of outcomes using both interventions and different diseases, including heart diseases, stroke and joint diseases, hearing impairments, and psychiatric and cognitive disabilities.

5. Conclusion

The study concluded that dual-task physical cognitive and single-task traditional balance trainings can improve balance and quality of life. However, the beneficial effects of dual-task training were more pronounced than single-task training with a statistically significant difference in improving balance and quality of life.

Declarations about conflict of interest

None to declare.

Funding

There was no funding for this study.

Supplementary materials

Supplementary materials for this article can be found at http://www.sgecm.org.tw/ijge/journal/view.asp?id=31.

References

1. Kinoshita T, Maruyama K, Yamamoto N, Saito I. The effects of dietary licorice flavonoid oil supplementation on body balance control in healthy middle-aged and older Japanese women undergoing a physical exercise intervention: a randomized, double-masked, placebo-controlled trial. *Aging Clin Exp Res.* 2021;33(11):3099–3108. doi:10.1007/s40520-020-01513-3
2. Maïano C, Hue O, Morin AJS, Lepage G, Tracey D, Moullec G. Exercise interventions to improve balance for young people with intellectual disabilities: a systematic review and meta-analysis. *Dev Med Child Neurol.* 2019;61(4):406–418. doi:10.1111/dmcn.14023
3. Baione V, Ferrazzano G, Celletti C, et al. Attention-demanding cognitive tasks worsen postural control in patients with cervical dystonia: a case-control study. *Front Neurol.* 2021;12:666438. doi:10.3389/fneur.2021.666438
4. Prakash RS, Voss MW, Erickson KI, Kramer AF. Physical activity and cognitive vitality. *Annu Rev Psychol.* 2015;66:769–797. doi:10.1146/annurev-psych-010814-015249
5. Erickson KI, Hillman C, Stillman CM, et al. Physical activity, cognition, and brain outcomes: a review of the 2018 physical activity guidelines. *Med Sci Sports Exerc.* 2019;51(6):1242–1251. doi:10.1249/MSS.0000000000001936
6. Sarto F, Cona G, Chiossi F, et al. Dual-tasking effects on static and dynamic postural balance performance: a comparison between endurance and team sport athletes. *Peer J.* 2020;8:e9765. doi:10.7717/peerj.9765
7. Fino PC, Horak FB, El-Gohary M, et al. Postural sway, falls, and self-reported neuropathy in aging female cancer survivors. *Gait Posture.* 2019;69:136–142. doi:10.1016/j.gaitpost.2019.01.025
8. Bjerk M, Brovold T, Skelton DA, Bergland A. A falls prevention programme to improve quality of life, physical function and falls efficacy in older people receiving home help services: study protocol for a randomised controlled trial. *BMC Health Serv Res*. 2017;17(1):559. doi:10.1186/s12913-017-2516-5
9. Bollaert RE, Motl RW. Self-efficacy and physical and cognitive function in older adults with multiple sclerosis. *Int J MS Care.* 2019;21(2):63–69. doi:10.7224/1537-2073.2018-001
10. Iqbal M, Arsh A, Hammad SM, Haq IU, Darain H. Comparison of dual task specific training and conventional physical therapy in ambulation of hemiplegic stroke patients: A randomized controlled trial. *J Pak Med Assoc*. 2020;70(1):7–10. doi:10.47391/JPMA.10443
11. Wongcharoen S, Sungkarat S, Munkhetvit P, Lugade V, Silsupadol P. Home-based interventions improve trained, but not novel, dual-task balance performance in older adults: A randomized controlled trial. *Gait Posture.* 2017;52:147–152. doi:10.1016/j.gaitpost.2016.11.036
12. Nascimento MdM, Maduro PA, Rios PMB, et al. Effects of 12 weeks of physical-cognitive dual-task training on executive functions, depression, sleep quality, and quality of life in older adult women: A randomized pilot study. *Sustainability.* 2023;15(1):97. doi:10.3390/su15010097
13. Ataş Balcı L, Soğukkanlı K, Burcu S, Hanoğlu L. Effects of single-task, dual-task and successive physical-cognitive training on fall risk and balance performance in older adults: a randomized trial. *J Exerc Ther Rehabil.* 2022;9(1):1–11. doi:10.15437/jetr.675975
14. Nascimento MM, Maduro PA, Rios PMB, et al. The effects of 12-week dual-task physical-cognitive training on gait, balance, lower extremity muscle strength, and cognition in older adult women: A randomized study. *Int J Environ Res Public Health*. 2023;20(8):5498. doi:10.3390/ijerph20085498
15. Telenius EW, Engedal K, Bergland A. Inter-rater reliability of the Berg Balance Scale, 30 s chair stand test and 6 m walking test, and construct validity of the Berg Balance Scale in nursing home residents with mild-to-moderate dementia. *BMJ Open.* 2015;5(9):e008321. doi:10.1136/bmjopen-2015-008321
16. Bowling A, Hankins M, Windle G, Bilotta C, Grant R. A short measure of quality of life in older age: The performance of the brief older people's quality of life questionnaire (OPQOL-brief). *Arch Gerontol Geriatr.* 2013;56(1):181–187. doi:10.1016/j.archger.2012.08.012
17. Varas-Diaz G, Kannan L, Bhatt T. Effect of mental fatigue on postural sway in healthy older adults and stroke populations. *Brain Sci.* 2020;10(6):388. doi:10.3390/brainsci10060388
18. Varela-Vásquez LA, Minobes-Molina E, Jerez-Roig J. Dual-task exercises in older adults: A structured review of current literature. *J Frailty Sarcopenia Falls*. 2020;5(2):31–37. doi:10.22540/JFSF-05-031
19. Shin SS, An DH. The effect of motor dual-task balance training on balance and gait of elderly women. *J Phys Ther Sci.* 2014;26(3):359–361. doi:10.1589/jpts.26.359
20. Wollesen B, Voelcker-Rehage C. Training effects on motor-cognitive dual-task performance in older adults. *Eur Rev Aging Phys Act.* 2014;11:5-24. doi:10.1007/s11556-013-0122-z
21. Montoya-Murillo G, Ibarretxe-Bilbao N, Peña J, Ojeda N. Effects of cognitive rehabilitation on cognition, apathy, quality of life, and subjective complaints in the elderly: A randomized controlled trial. *Am J Geriatr Psychiatry.* 2020;28(5):518–529. doi:10.1016/j.jagp.2019.10.011
22. Kazazi L, Shati M, Mortazavi SS, Nejati V, Foroughan M. The impact of computer-based cognitive training intervention on the quality of life among elderly people: a randomized clinical trial. *Trials.* 2021;22(1):51. doi:10.1186/s13063-020-05008-4
23. Purnamasari N, Bachtiar F, Puspitha A. The effectiveness of motor-cognitive dual-task training in reducing risk falls on elderly. *Enferm Clin.* 2020;30(2):317–321. doi:10.1016/j.enfcli.2019.07.110
24. Gavelin HM, Dong C, Minkov R, et al. Combined physical and cognitive training for older adults with and without cognitive impairment: A systematic review and network meta-analysis of randomized controlled trials. *Ageing Res Rev.* 2021;66:101232. doi:10.1016/j.arr.2020.101232
25. Thapa N, Park HJ, Yang JG, et al. The effect of a virtual reality-based intervention program on cognition in older adults with mild cognitive impair-

ment: A randomized control trial. *J Clin Med.* 2020;9(5):1283. doi:10.3390/jcm9051283
26. Hiyamizu M, Morioka S, Shomoto K, Shimada T. Effects of dual task balance training on dual task performance in elderly people: a randomized controlled trial. *Clin Rehabil*. 2012;26(1):58–67. doi:10.1177/0269215510394222
27. Falbo S, Condello G, Capranica L, Forte R, Pesce C. Effects of physical-cognitive dual task training on executive function and gait performance in older adults: A randomized controlled trial. *Biomed Res Int.* 2016;2016:5812092. doi:10.1155/2016/5812092
28. Smith-Ray RL, Makowski-Woidan B, Hughes SL. A randomized trial to measure the impact of a community-based cognitive training intervention on balance and gait in cognitively intact Black older adults. *Health Educ Behav.* 2014;41(Suppl 1): 62S–69S. doi:10.1177/1090198114537068
29. Gallou-Guyot M, Mandigout S, Combourieu-Donnezan L, Bherer L, Perrochon A. Cognitive and physical impact of cognitive-motor dual-task training in cognitively impaired older adults: An overview. *Neurophysiol Clin*. 2020;50(6):441–453. doi:10.1016/j.neucli.2020.10.010
30. Chandran V, Smitha D. Comparison of single task and dual task balance training on the quality of life of elderly with balance impairment. *Indian J Physiother Occup Ther.* 2021;15(4):166–178. doi:10.37506/ijpot.v15i4.16521