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Effects of Multicomponent Exercise Programs on Balance Function and Fall Risk in Older Adults: A Systematic Review

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ABSTRACT

Introduction: Population aging is a global issue, and the elderly are particularly vulnerable to health complications, including frailty and falls. Frailty, characterized by physical decline, increases the risk of falls, which can severely impact the quality of life in older adults. Multicomponent exercise programs (MEPs), which include strength, balance, flexibility, and aerobic exercises, have been identified as an effective strategy for improving balance and reducing fall risk. This systematic review aims to evaluate the effectiveness of MEPs on balance, functional capacity, and fall risk reduction in older adults, based on randomized controlled trials (RCTs).

Methods: A systematic literature search was conducted in PubMed, ScienceDirect, and Google Scholar from January 2012 to December 2022. Studies included were RCTs involving healthy older adults aged 60 or above, residing in the community or institutions. The interventions consisted of MEPs lasting at least 4 weeks and held twice per week. The outcomes assessed were balance, functional performance (SPPB, TUG, BBS), and fall risk. Exclusion criteria included studies without a control group or insufficient data.

Results: Ten studies were included in the review. The majority of studies showed significant improvements in functional capacity, balance, and reductions in fall risk. Multicomponent exercises were found to enhance strength, mobility, and balance, effectively reducing fall risk in elderly participants. The TUG test was the most commonly used outcome measure.

Conclusion: MEPs significantly improve balance and functional capacity and reduce fall risk in older adults. These programs are an effective strategy for fall prevention.

Keywords: balance, elderly, fall risk, frailty, multicomponent exercise

INTRODUCTION

Population aging is an inevitable global phenomenon that poses significant public health challenges in both developed and developing nations.[1] Indonesia, like many other countries, is experiencing a demographic shift as the proportion of elderly individuals continues to rise. Currently, the elderly population in Indonesia is 21.7 million, making up 8.5% of the total population. Of this, 52.8% are women, and 47.2% are men, signaling that the country is entering an era of an aging population, with those aged 60 years and over surpassing 7.0% of the total

population. This aging trend is expected to accelerate, presenting several health and social challenges. [2,3]

Frailty has become a pressing health concern among the elderly, as it represents a condition of increased vulnerability to various stressors due to age-related decline in multiple physiological systems.[4] This state of frailty results in diminished ability to recover from physical stress, leading to adverse health outcomes such as falls, hospitalization, disability, and even mortality.[5] The prevalence of frailty among older adults is strongly associated with a range of adverse health consequences, including poor quality of life and increased dependence on healthcare systems.[6,7]

Falls are a significant health risk for the elderly, with incidence rates ranging from 30–50%, and approximately 40% of these individuals experience repeated falls.[8] As a result, falls and fall-related injuries contribute to a decline in the quality of life and often lead to long-term disability. The World Health Organization (WHO) has highlighted the urgent need to address balance issues that contribute to falls, as left unaddressed, they are likely to increase fall risk in the coming decades.[9]

Exercise, particularly multicomponent exercise programs (MEPs) that combine strength, balance, flexibility, and aerobic activities, has been shown to mitigate these risks effectively.[10] By improving physical strength, balance, and functional capacity, MEPs are considered one of the most effective strategies to address frailty and reduce the risk of falls in older adults.[11] However, despite growing evidence supporting their benefits, more research is needed to comprehensively assess the effects of these programs across different populations and settings.[12]

This systematic review aims to evaluate the effectiveness of multicomponent exercise programs for improving balance and reducing the risk of falls in older adults by synthesizing randomized controlled trial (RCT) results and comparing them with control groups.

METHOD

The study population consisted of healthy older adults aged 60 years or older residing in community settings or institutional care facilities. The intervention involved multicomponent exercise programs (MEPs) that combined strength, balance, flexibility, and aerobic exercises, performed at least twice per week for a minimum of 4 weeks under professional supervision. The control groups received either usual care or other standard interventions, such as single-modality exercise programs or no exercise. The primary outcomes assessed in these studies included balance, functional capacity, and fall risk, measured using validated tools such as the Timed Up and Go (TUG) test, Short Physical Performance Battery (SPPB), Frailty Criteria, and fall risk assessments.

A systematic search was conducted through PubMed, ScienceDirect, and Google Scholar using the medical subject headings terms and free keywords "multicomponent exercise", "elderly", "frail", "balance", and "fall risk" from January 2014 to December 2024, and found all articles that may be related. There were no language restrictions in place. To be included in the present review, articles should have been randomized controlled trials and conducted only with healthy older adults aged 60 years or over residing in the community or in asylum institutions. The training should be multicomponent, with a total duration of at least 4 weeks and a weekly frequency of at least two supervised sessions. The exclusion criteria were as follows: (a) trials without a control group; (b) provided data that were inaccurate or insufficient and unable to give research outcomes; (c) case reports or observational studies; and (d) duplicated prior literature. The PRISMA diagram for the search strategy is shown in Figure 1.

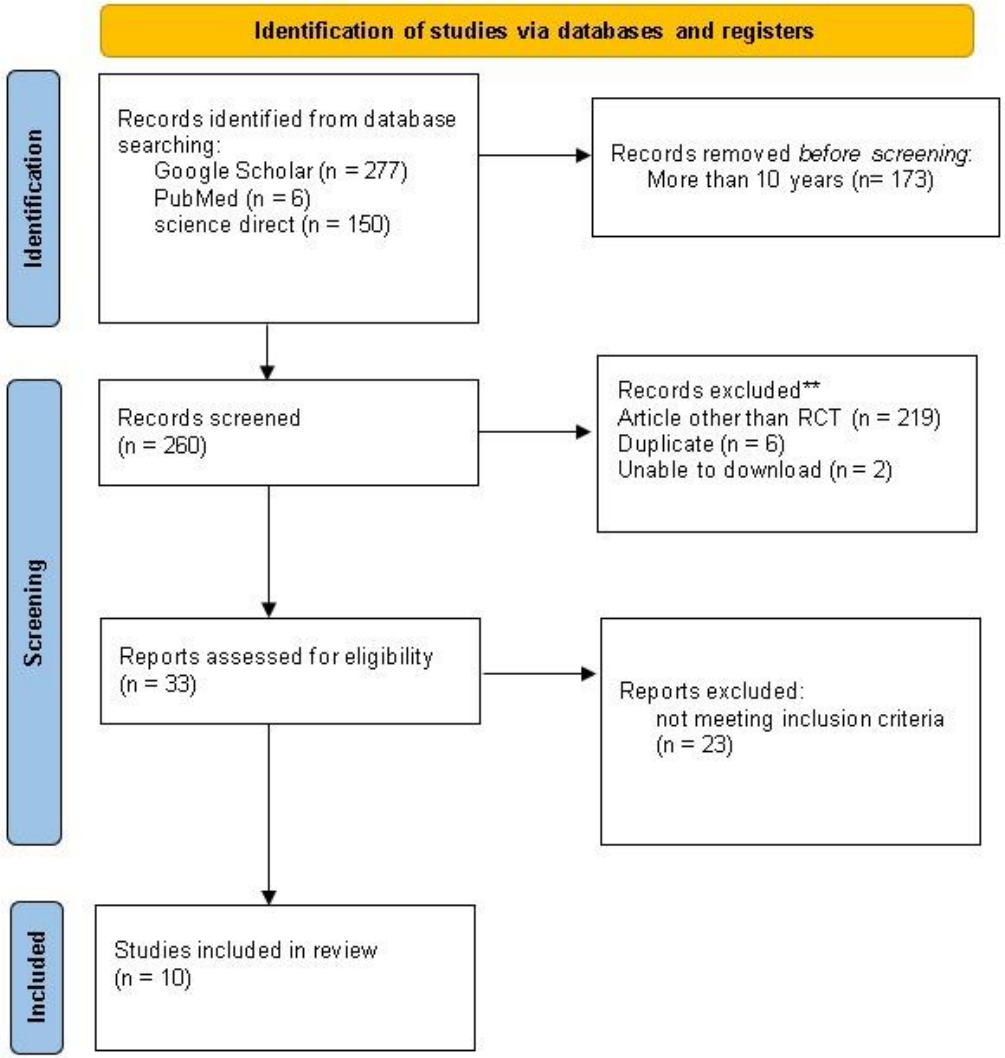

Figure 1. PRISMA Flow Diagram for Search Strategy

RESULT

Table 1 summarizes the studies included in the review, including key details such as study title, participant demographics, type of training, weekly frequency, session duration, total duration, tests used, and reported effects. The majority of the studies showed positive effects of multicomponent exercise on balance, functional capacity, and fall risk.

Table 1. Characteristics of Studies Included in the Systematic Review

Author, year	Type of Training	Performed Activities	Weekly frequency (day/ week)	Session duration (min)	Total duration (weeks)	Test	Effect
Tarazona-Santabalbina, 2016[13]	E: Multi component Exercise C: usual daily activity	proprioception and balance exercises (10-15 minutes), aerobic training (initially at 40% of maximum heart rate increasing progressively to 65%),14 strength training (initially at 25% of 1 repetition maximum to 75%), and stretching	5	65	24	No. of falls (6 m) No. risk factors for falls SPPB Tinetti Balance Index Fried Frailty Criteria	NS NS NS NS P <0.001*
Romero-García, 2021[14]	E: VIVIFRAIL Multi component Physical Exercise Program (MPEP) C: daily physical activity	balance, power, strength, stretching, walking and cardiovascular exercises	3	45-60	12	SPPB Balance Test (pts) SPPB Gait speed test (3m) (sec) SPPB Chair stand test (sec) Gait speed test (6m) TUGT (sec)	NS P<0.001* P<0.001* P<0.001*
Courel-Ibáñez, 2022[15]	E: MCEP C: daily physical activity	endurance, strength, coordination, balance, and flexibility exercises	2 times a week, on non-consecutive days,	60	4 and 24	Balance (One-leg stand) Sit-to-stand Usual walking speed Maximal walking speed TUG TUG-cog	Improve ment in one-leg stand (+46.5%)), mobility (usual walking (+16.7%) and maximal (+55.6%) walking speeds), and transfer capacity (TUG (−2.9%)
Cadore, 2014[16]	E: MCEP C: mobility exercises 30 min per day, 4 days per week, which	muscle power training (8–10 repetitions, 40–60 % of the one-repetition maximum) combined with balance and gait retraining. Strength and power tests were performed on	2	40	12	TUG Balance (single-leg stance) Falls Incidents	P<0.05* NS P<0.001*

	consisted of small active and passive movements	the upper and lower limbs					
Sedaghati, 2022[17]	E: MCFT (multi component functional training) C: conventional exercise	A training program with strength, endurance, and balance parts was conducted in the multi-task conditions to stimulate the physical and cognitive abilities, focusing on the attentional-correct posture	3	60	8	Berg balance test Timed Up and Go with D-T Timed Up and Go SPPB	P = 0.001* P = 0.001* P = 0.001* P = 0.001*
Casas-Herrero, 2022[18]	E: VIVIFRAIL multi component exercise C: usual care	resistance, balance, flexibility, and gait retraining exercises	3-5	30	12	SPPB Falls rate	P<0.001* NS
Yu, 2020[19]	E: multi component intervention program C: usual care	combined program of exercise, computer-assisted cognitive training, and board game activities	2	60	12	FRAIL score Chair stand Balance Test	P<0.001* NS NS
Sunde, 2020[20]	E: group-based high-intensity multi component exercise program C: usual care	two strength exercises for the lower limbs, six balance exercises, high-intensity endurance training,	2	60	16	SPPB 6 min walking test Berg Balance Scale Grip Strength	NS P<0.001* NS NS
Zhuang, 2014[21]	E: combined exercise intervention C: usual daily activities	E: 5-minute warm-up, followed by 15 minutes of balance exercises, 15 minutes of muscle-strength training, 15 minutes of 8-form Yang style Tai Chi Chuan, and ending with 10 minutes of flexibility/stretching and cool-down C: usual daily activity	3	60	12	Functional Reach Test TUG	NS P<0.001*
Chang, 2023[22]	E: home-based multi component exercise program C: usual daily activities	E: muscle-strengthening exercises for the lower limbs, balance training, and stretching. Training sessions per week included warmups, speed-walking, resistance exercises, static balance, and dynamic balance C: usual daily activities	3	60	16	Static balance ability TUG Functional reach test	NS NS NS
Note: E = exercise group. C = Control Group. TUG = Timed-Up and Go. SPPB = Short Physical Battery Test. *= Significant. NS = Not Significant							

The quality of the studies included in this review was assessed using the Centre for Evidence-Based Medicine (CEBM) framework, which evaluates key domains such as randomization, selection bias, allocation concealment, loss to follow-up, and blinding of outcome assessors. Table 2 provides a critical appraisal of each study across these domains, detailing the risk of bias for each included study. Each study was rated for high, low, or unclear risk of bias across these domains.

Table 2. Critical Appraisal of Studies Using the Centre for Evidence-Based Medicine (CEBM) Framework

Author, year	Randomized	Selection Bias	Equal Treatment	Loss to follow-up	Blind Measuring
Tarazona-Santabalbina, 2016[13]	Yes	No	Yes	Yes	No
Romero-García, 2021[14]	No	No	Yes	Yes	No
Courel-Ibáñez, 2022[15]	Yes	No	Yes	Yes	No
Cadore, 2014[16]	Yes	No	Yes	Yes	No
Sedaghati, 2022[17]	Yes	No	Yes	No	No
Casas-Herrero, 2022[18]	Yes	No	Yes	Yes	Yes
Yu, 2020[19]	Yes	No	Yes	Yes	No
Sunde, 2020[20]	Yes	No	Yes	Yes	No
Zhuang, 2014[21]	Yes	No	Yes	Yes	No
Chang, 2023[22]	Yes	No	Yes	Yes	No

DISCUSSION

Exercise plays a significant role in preventing falls among older people and is recommended in evidence-based guidelines. Exercise covers a wide range of physical tasks (balance, strength, flexibility, etc.) delivered in many formats, some of which result in bigger reductions in falls than others. Systematic reviews clearly indicate that fall-prevention programs that include walking as a single modality are inferior to those combining strength and balance exercises, with such interventions being linked to higher fall and osteoporotic fracture rates in individuals at risk. Similar to aerobic and resistance training, there is evidence that balance and flexibility training induce specific adaptations in these health-related physical fitness components. Improvement in balance is linked to reduced falls and fall-related injuries, as well as improved functional mobility.[23,24] A multicomponent exercise program (MEP) is a combined program of endurance, strength, coordination, balance, and flexibility exercises that can affect a range of functional performance measures.[13] The goal of this systematic review was to investigate the effects of multicomponent training on functional performance and fall risk in older adults, as assessed by the SPPB, TUG, and BBS tests. The goal of this systematic review was to investigate the effects of multicomponent training on functional performance and fall risk in older adults, as assessed by the SPPB, TUG, and BBS tests. The results showed that the multicomponent training benefited all the outcomes investigated; in fact, most showed significant effects on functional improvement, balance, and reduced risk of falling in the elderly.

It was verified that most studies evaluating the effect of multicomponent training on balance and functionality used the TUG test, as reported in 6 of the 10 articles. Multicomponent exercise programs not only focus on the development of a single objective but also work on all of them simultaneously, thereby magnifying gains in strength, resistance, flexibility, and cardiovascular health, recognizing that all of these are necessary qualities for performing these tests. This means that the positive effect of exercise on functional capacity is more evident when multiple physical components are included. The substantial reduction in fall risk after the intervention aligns with the studies included in our systematic review, showing that a

multicomponent exercise program is the best option to improve balance, muscle strength, and functional mobility in elderly adults, thereby reducing their risk of falling.[14]

A study provided new information about the protective short- and long-term benefits of exercise after different periods of inactivity in older nursing home residents with sarcopenia. The main results of the study suggest that benefits from both short (4-week) and long (24-week) VIVIFRAIL multicomponent exercise programs persist and are maintained in older adults, resulting in better conditioning relative to baseline after 6-14 weeks of inactivity.[25] Another study also investigated the effects of the VIVIFRAIL multicomponent intervention on functional capacity in the elderly with mild cognitive impairment. The results showed a significant impact on the SPPB. In addition to functional gains, their findings indicate that the VIVIFRAIL exercise program promotes mood, mental function, and muscle function after 3 months of intervention compared with usual clinical care.[18] The study suggests that the VIVIFRAIL multicomponent exercise program may help mitigate the trajectory of frailty and disability in community-dwelling older adults with mild cognitive impairment and/or mild dementia, and it also appears to benefit mood, mental function, and muscle function, which are key components of intrinsic capacity.[18] Another study aimed to evaluate the impact of multicomponent functional training (MCFT) with postural correction on functional balance and the risk of falling among elderly nursing home residents with a history of falls. The results showed a significant difference between the pre- and post-test (P = 0.001) for the effects of MCFT on BBS, TUG, TUG-D, and SPPB.[17]

On the other hand, a study that aimed to evaluate the effects of a multicomponent high-intensity exercise program on physical function did not show significant increases in Berg Balance Scale and SPPB scores. This may be attributed to a ceiling effect, as 22.7% of participants in the intervention group achieved the highest possible score on both tests. Even though the between-group difference in change in SPPB score was also not statistically significant, a change of 0.8 points can be considered clinically meaningful. However, improvements in functional capacity, as measured by the MWT, and in physical HRQOL were observed. Further, a multicomponent high-intensity exercise program can be considered safe for this population since no serious adverse events occurred.[20]

Chang et al. studied the effects of multicomponent exercise during the COVID-19 pandemic. Previous studies have suggested that exercise interventions featuring sessions of at least 60 minutes, 2-3 times per week, and lasting at least three months can improve physical performance. However, due to the pandemic, they were only able to provide one group exercise session per week, and the remaining exercise time had to be set aside by participants themselves. Self-management behaviors thus became particularly important in this study. To encourage such behaviors, they used the following four methods: (1) taught simple multicomponent exercise skills that could easily be done at home; (2) encouraged participants to remember every action performed; (3) provided a notebook and asked participants to record their exercise behaviors, using a checklist to allow for low literacy or poor eyesight; and (4) used messenger applications to upload exercise videos and send reminders to exercise every week. The intervention effectively improved physical activity levels, physical performance, and prefrailty rates in community-dwelling older adults during the COVID-19 pandemic.[22]

Although this review provides valuable insights into the effectiveness of multicomponent exercise programs, several limitations should be considered. First, there is considerable variability in the design and implementation of the included studies, such as differences in exercise intensity, duration, and frequency, which may affect the

generalizability of the findings. Additionally, many studies included in this review did not report long-term follow-up data, which limits our understanding of the sustained effects of these programs. Furthermore, some studies lacked clear blinding and randomization procedures, which could introduce bias into the results. Future research should focus on optimizing multicomponent exercise programs by identifying the most effective combination of exercise modalities to reduce fall risk and improve balance in older adults. It would also be beneficial to explore the long-term effects of these interventions, particularly in frail populations, to understand the lasting impact of exercise on fall risk reduction. Additionally, studies with more rigorous designs, including proper blinding and randomization, as well as larger sample sizes, are needed to provide more robust evidence on the benefits of multicomponent exercise for the elderly. Finally, research exploring the potential benefits of multicomponent exercise programs in individuals with cognitive impairments, such as dementia, could further enhance our understanding of their broader applicability.

CONCLUSION

Multicomponent exercise programs, involving strength, balance, aerobic, and stretching exercises performed at least twice a week for a minimum of 8 weeks, are highly beneficial for improving functional capacity and reducing fall risk in older adults. These programs offer a comprehensive approach to frailty prevention and fall risk mitigation, making them a valuable strategy for maintaining and enhancing the health of older populations.

Declaration by Authors

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