Jurnal Kesehatan Vokasional, Vol. 10 No. 2 (Mei 2025)
ISSN 2541-0644 (print), ISSN 2599-3275 (online)
DOI https://doi.org/10.22146/jkesvo.106152

JKesV
JURNAL KESEHATAN VOKASIONAL

Multicomponent Exercise Module: Guidelines for Improving Frailty, Hemodynamic Parameters, and Balance in Older Adults

Modul Latihan Multikomponen: Panduan Memperbaiki Keringkihan, Parameter Hemodinamik, dan Keseimbangan pada Lansia

Andreany Kusumowardani[1]✉, R.A. Tuty Kuswardhani[2], I Made Muliarta[3], Luh Putu Ratna Sundari[3]

[1]Doctoral Program in Medical Sciences, Faculty of Medicine, Udayana University, Indonesia
[2]Postgraduate Program, Udayana University, Indonesia
[3]Department of Physiology, Faculty of Medicine, Udayana University, Indonesia

ABSTRACT

Background: One in five older adults in Indonesia experiences frailty. Multicomponent exercise is one of the recommended strategies for managing frailty in older populations. However, its implementation can be challenging without a clearly defined program guide. In this study, a Multicomponent Exercise Program module was developed and implemented as an exercise guide, but its effectiveness in improving physical performance among frail elderly has not yet been established.

Objective: The study aimed to determine the effectiveness of the MEP in the module in improving frailty, hemodynamic parameters, and balance in pre-frail and frail older adults.

Methods: Quasi-experimental method was used in the study involving 17 participants (73.47 + 8.43 years). The MEP was conducted 3 times per week for 12 weeks, consisted of flexibility, balance, aerobic, and strength training. Categorical data were analyzed using McNemar's test while analysis of continuous data using paired t-test or Wilcoxon Signed Rank, $\alpha = 0.05$.

Results: The MEP decreased frailty scores, systolic, diastolic blood pressure, and mean arterial pressure ($p < 0.000$), and improved balance ($p = 0.023$) in older adults. Furthermore, the program reduced the frailty status, as evidenced by 41.18% of frail participants becoming pre-frail and 5.88% participants shifting from pre-frail to robust.

Conclusion: The MEP in the module was effective in improving frailty, hemodynamic parameters, and balance in older adults. However, these findings need to be confirmed in studies with larger sample sizes and more rigorous research designs.

Keywords: multi component exercise; elderly; frailty; hemodynamics; balance

ABSTRAK

Latar Belakang: *Satu di antara lima lansia di Indonesia mengalami keringkihan. Latihan multikomponen merupakan salah satu strategi yang direkomendasikan dalam manajemen keringkihan. pada lansia. Namun, latihan ini sulit diimplementasikan tanpa panduan program yang jelas. Dalam penelitian ini telah disusun dan dipraktikkan suatu panduan latihan berupa modul Program Latihan Multikomponen, tetapi efektivitasnya untuk memperbaiki performa fisik lansia ringkih belum diketahui.*

Tujuan: *Penelitian ini bertujuan untuk mengevaluasi efektivitas PLM dalam modul untuk memperbaiki keringkihan, parameter hemodinamik, serta keseimbangan pada lansia pre-ringkih dan ringkih.*

Metode: *Kuasi eksperimental dengan melibatkan 17 sampel (73,47 ± 8,43 tahun). Intervensi PLM dilakukan 3 kali per minggu selama 12 minggu, terdiri dari latihan fleksibilitas, keseimbangan, aerobik, dan kekuatan. Data kategori dianalisis dengan uji McNemar sedangkan data kontinyu dengan uji t berpasangan atau Wilcoxon Signed Rank,* $\alpha = 0{,}05$.

Hasil: *PLM menurunkan skor keringkihan, tekanan darah sistolik, diastolik, dan tekanan arteri rata-rata* ($p < 0{,}001$)*, serta meningkatkan keseimbangan* ($p = 0{,}023$) *pada lansia. Pelatihan tersebut juga memperbaiki status keringkihan lansia, terbukti sebanyak 41,18% sampel ringkih menjadi pre-ringkih, dan 5,88% beralih dari pre-ringkih menjadi kokoh.*

Kesimpulan: *PLM dalam modul tersebut efektif untuk memperbaiki keringkihan, parameter hemodinamik, serta keseimbangan pada lansia. Namun hal ini perlu dikonfirmasi dengan sampel yang lebih besar dan desain penelitian yang lebih baik.*

Kata Kunci: *latihan multikomponen; lansia; keringkihan; hemodinamik; keseimbangan*

✉ Corresponding author: andrenathandre@gmail.com

Submitted 21 April 2025 **Revised** 07 May 2025 **Accepted** 26 May 2025

https://jurnal.ugm.ac.id/jkesvo
Published online May 31, 2025

Copyright © 2025 THE AUTHOR(S). This article distributed under a Creative Commons Attribution-ShareAlike 4.0 International license.
https://creativecommons.org/licenses/by-sa/4.0/

INTRODUCTION

The global population of older adults continues to rise. The WHO predicts that by 2050, individuals aged 60 years and older will comprise 22% of the total population, nearly double the proportion recorded in 2015 which was only 12% (World Health Organization, 2024). An ageing population has occurred in Indonesia since 2020, where the number of older adults has exceeded 10% of the entire population, reaching 10.7%. In fact, it is projected that by 2045 the number of elderly in Indonesia will reach almost one-fifth of the total population (Badan Pusat Statistik, 2021).

The increase in the older adult population may lead to various challenges, as aging is typically associated with a decline in physiological function, rendering older individuals more vulnerable to diseases and health-related issues. One of the most commonly encountered health problems in this age group is frailty. Globally, the prevalence of frailty among older adults is estimated to range from 3.5% to 27.3% (Sciacchitano *et al.*, 2024). A multicenter study conducted in 2020 concluded that one in five older adults in Indonesia experiences frailty, with a prevalence of 66.2% for pre-frail and 18.7% for frail individuals (Setiati *et al.*, 2021. Given its substantial prevalence, frailty is considered one of the most serious public health challenges of the current century (Doody *et al.*, 2023).

Frailty is a distinct health condition associated with the aging process, characterized by the gradual depletion of intrinsic physiological reserves across multiple body systems (Boone, 2023). While the decline in physiological function due to cellular wear and tear is a normal aspect of aging, frailty represents an extreme outcome of this process, marked by an accelerated deterioration and the progressive failure of homeostatic responses (Clegg *et al.*, 2013; Doody *et al.*, 2023).

Fried et al. identified frailty based on five phenotypes: weight loss (more than 5% over the past year), fatigue, muscle weakness, slow walking, and low physical activity. These frailty phenotypes serves as independent predictors of fall incidents, reduced mobility and self-care capacity, disability, hospitalization, and mortality (Fried *et al.*, 2001).

Frailty is also associated with multimorbidity resulting from the dysregulation of multiple physiological systems due to aging (Perazza, Brown-Borg and Thompson., 2022), including the cardiovascular system. Age-related decline in cardiovascular function contributes to the onset of frailty (Angulo *et al.*, 2020) and increases the risk of cardiovascular disease. High blood pressure is the strongest risk factor and has a high prevalence of cardiovascular disease (Fuchs and Whelton, 2020).

Various studies have demonstrated the benefits of physical exercise on frailty (Dent *et al.*, 2023) and cardiovascular disease (Benton, 2015). Physical activity and exercise is an appropriate intervention model to improve frailty since it targets on multiple body systems, including skeletal muscle, cardiovascular, endocrine system, and inflammatory response (Doody *et al.*, 2023). Physical exercise should be prescribed to prevent frailty and pre-frailty, reduce frailty status, and prevent adverse effects of frailty (Ricci and Cunha, 2020).

The recommended form of physical exercise for frail elderly is a multicomponent physical activity program. Even for those in a pre-frail stage, such programs are essential as a preventive measure to delay or prevent the progression to frailty (Dent *et al.*, 2019).

A Multicomponent Exercise Program (MEP) is a program that combines endurance, coordination, strength, balance, and flexibility exercises in one training session, potentially impacting multiple components of functional performance (Tarazona-Santabalbina *et al.*, 2016; Gonçalves *et al.*, 2019). The combination of various types of exercises within a single session may help improve frailty, as each component targets specific aspects of the frailty.

Several previous studies have demonstrated the effectiveness of MEP in improving frailty (Castell *et al.*, 2019; Sadjapong *et al.*, 2020; Brañas *et al.*, 2024). However, the MEPs used in these studies vary widely and therefore cannot serve as standardized references. This variability arises because MEPs are not fixed protocols; rather, they must be tailored to individual needs. Careful consideration of exercise type, intensity, and appropriate movement selection is crucial, especially since the target population comprises older adults who may have experienced physical and/or cognitive decline. Proper exercise dosage and movement design can optimize benefits for frail older adults while minimizing the risks associated with physical activity. Consequently, a structured and needs-based MEP guide would be highly valuable for implementing such programs. Unfortunately, to the best of our knowledge, no such guide currently exists within geriatric services in Indonesia.

In this study, we have designed a MEP that is structured in the form of an exercise module. The module has been piloted in a preliminary study and was found to be safe and well-tolerated by the elderly. However, the effectiveness of the MEP contained in the module in improving frailty and physical performance among the older adults has not yet been established. Therefore, this study was conducted to evaluate whether the MEP in the module is effective for improving frailty and physical performance, including hemodynamic parameters and balance, in frail older adults.

MATERIALS AND METHODS

A. Research Design

The quasi-experimental method was used in this study, which was conducted from May to September 2024 at the Tresna Wredha Social Service Center (BPSTW) Abiyoso Yogyakarta. This study has been declared ethically feasible by the Health Research Ethics Commission of Dr. Moewardi Hospital with number: 1.200 / V / HREC / 2024.

B. Population and Sample

All elderly residents of BPSTW became the target population in this study, while elderly who met the inclusion criteria were recruited as research samples. The inclusion criteria set include: age at least 60 years, belonging to the pre-frail and frail categories based on examination with the Frailty Phenotype, having a cognitive score of> 17 based on examination with the Indonesian version of the Mini Mental Status Examination (MMSE) instrument, and willing to participate in the study. The exclusion criteria included: having a chronic disease that was not routinely controlled or whose symptoms increased with physical exercise, having more than 4 types of comorbidities, having severe visual, hearing, and/or movement impairments. Seventeen older adults volunteered for the study and signed the informed consent.

C. Data Retrieval Technique

The data obtained in the study were primary data derived from the results of interviews, examinations, and measurements. Data on participant characteristics including age, gender, weight and height, body mass index (BMI), cognitive scores, and comorbidities were obtained during sample selection. To maintain accuracy, data derived from individual reports were matched with administrative data at the institution.

D. Research Instrumens

The cognitive ability of the study sample was checked with the MMSE instrument. Cognitive examination was conducted to ensure that all samples had sufficient cognitive ability to understand the exercise instructions and could perform them correctly. Elderly who had a cognitive score of less than 17 were categorized as having severe cognitive impairment so they could not be included in the study.

Frailty was identified based on Fried's 5 phenotype criteria, using a modified Frailty Phenotype template from the CGA Toolkit Plus (Fried, 2014). The five phenotypes are: a). Weight Loss: > 5% or > 4.5 kilograms in the past year; b). Low Physical Activity: inability to perform previously manageable vigorous physical activities, based on individual report; c). Exhaustion: continuous fatigue for more than 2 days; d). Muscle Weakness: low grip strength based on gender criteria of < 29 kg for men and < 17 kg for women, measured using a dynamometer (Jamar Hydraulic Hand Dynamometer Model J00105, Lafayette Instrument, USA); e). Slow Walking: more than 7 seconds to walk a distance of 4.6 meters.

Older adults were eligible to participate in the study only if they exhibited 1–2 of these frailty phenotypes (classified as pre-frail) or 3–4 phenotypes (classified as frail). Participants with none of these phenotypes were categorized as robust, while those presenting all phenotypes were considered to have a disability. Frailty reversibility was defined as a change in status from frail to pre-frail or robust, or from pre-frail to robust. Frailty was assessed twice: at baseline (during participant selection) and at the end of the study (one day after the intervention period concluded).

Changes in hemodynamic parameters, such as systolic blood pressure (SBP), diastolic blood pressure (DBP), and heart rate (HR) were measured using a digital sphygmomanometer (Omron HEM-7130, Kyoto, Japan). Mean arterial pressure (MAP) was calculated by the formula (SBP+ (2 DBP))/3. Hemodynamic measurements were conducted during each intervention session—specifically at three time points: before the start of the exercise, mid-session, and after the session concluded. These measurements were intended to monitor exercise intensity and ensure that hemodynamic changes remained within safe limits for older adults.

Balance ability was assessed using the Tinetti Balance Test, which consists of 9 items with a maximum score of 16. Higher scores indicate better balance performance. Balance assessments were carried out twice: once on the day before the intervention began and once on the day after the intervention was completed.

E. Intervention

The MEP was designed based on exercise movements for seniors Lee, Jackson and Richardson, (2017) and the principles of exercise programs for older adults according to the American College of Sport Medicine (ACSM) (ACSM, 2018). The program includes flexibility, balance, aerobic, and resistance/strength training.

The exercises were conducted in group sessions. Each session lasted approximately 60 minutes and was held three times per week over a period of 12 weeks. Sessions were scheduled on non-consecutive days to allow rest intervals and to minimize the risk of muscle soreness resulting from the exercise. The sessions were led by a trained instructor, assisted by one support staff member.

To enhance muscle strength, resistance bands were used as external loads. Three types of resistance bands (Speeds Flexiband LX 024-19) with varying thicknesses were utilized: 0.4 mm (extra light), 0.5 mm (light), and 0.6 mm (medium). The exercise program began with the extra light band and progressed gradually to higher resistance levels.

During the exercise sessions, movement speed was regulated using a metronome to ensure consistency. Initially, a tempo of 50 beats per minute (bpm) was set and gradually increased to enhance exercise intensity.

All procedures and movements during the training sessions adhered to the guidelines outlined in the exercise module (Figure 1). This module included detailed instructions, frequency, and tempo for each movement, supplemented with illustrations of the starting and ending positions. The introduction section of the module provided information on equipment, space requirements, and special considerations to be addressed prior to starting the training. Additionally, the module included examples of progressive training and an appendix featuring the modified Borg Rating of Perceived Exertion (RPE) scale to assess levels of fatigue. Exercise intensity was monitored using this scale, with a target maximum rating of 3–4 (moderate fatigue) to ensure participant safety.

Blood pressure and heart rate were measured before starting the exercise. Older adults with a resting SBP > 200 mmHg or DBP > 110 mmHg were not recommended to participate in the training. These measurements were repeated during a break after 30 minutes of exercise and again upon completion of the session. Throughout the exercise, blood pressure was monitored to ensure it did not exceed 220/105 mmHg, in order to prevent exercise-related risks (Stathokostas and Jones, 2015).

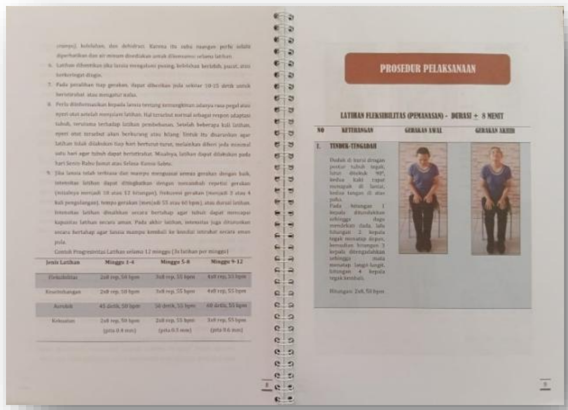

Figure 1. Exercise Program Module for the Elderly

The exercise session began with a warm-up consisting of flexibility exercises, involving dynamic stretching of the neck, shoulders, arms, waist, and legs in a seated position. This was followed by 15 minutes of balance training in a standing position, which included tiptoeing, various leg movements, trunk rotations, and tandem walking. Aerobic exercises were then performed in both standing and seated positions. Standing aerobic activities included marching in place, forward-backward stepping, and side-stepping. In the seated position, various arm and leg movements were performed, initially with duration of 45 seconds. The intensity of aerobic exercise was progressively increased from 40% of maximum heart rate (light intensity) to 60–70% (moderate intensity). Following the aerobic session, participants were given a rest break during which blood pressure and heart rate were measured. Upon completion of the measurements, the session continued with strength training targeting the chest, arms, back, and legs for 15 minutes. Exercise intensity was increased by using thicker resistance bands and by increasing the frequency and speed of movements. The session concluded with a 7-minute cool-down period consisting of static stretching. The full exercise program protocol is presented in Table 1.

Table 1. Multicomponent Exercise Program Protocol

No	Exercise Type	Description	Progressivity Wk 1-4	Wk 5-8	Wk 9-12
1.	Flexibility (warm up) (8 minutes)	Dynamic stretching : 1). neck, 2). shoulder, 3). arm, 4). body side, 5). waist, 6). elbow	2x8 reps, 50 bpm	3x8 reps, 55 bpm	4x8 reps, 60 bpm
2.	Balance (15 minutes)	1). tiptoe, 2). alternate foot lifitng, 3). side step, 4). weight transfers, 5). side swing, 6). alternate knee raises, 7). forward swing, 8). body rotation, 9). tandem walking	2x8 reps, 50 bpm	3x8 reps, 55 bpm	4x8 reps, 60 bpm
3.	Aerobic (15 minutes)	1). walk in place, 2). forward-backward walking, 3). sideways walking, 4). seated marching, 5). front span, 6), side span, 7). open legs, 8). arm swing, 9). mambo, 10). boxing	45 sec, 50 bpm	50 sec, 55 bpm	60 sec, 60 bpm
4.	Strength / Resistance (15 minutes)	1). chest press, 2). fly, 3). seated row, 4). rotator cuff curl, 5). biceps curl, 6). upright row, 7).triceps extension, 8). abdominal crunch, 9). lower back crunch, 10). marching hip flexor, 11). abductor curl, 12). leg press, 13). chair raise	2x8 reps, 50 bpm (0.4 mm)	2x8 reps, 55 bpm (0.5 mm)	3x8 reps, 60 bpm (0.6 mm)
5.	Flexibility (cool down) (7 minutes)	Static stretching : 1). waist, 2). shoulder, 3). neck, 4). chest, 5). thighs & calves, 6). lower back	2x8 reps, 50 bpm	3x8 reps, 55 bpm	4x8 reps, 60 bpm

*Wk = week, rep = repetitions, bpm = beats per minute, sec = seconds, mm = millimeter

F. Data Analysis Technique

All statistical analyses were performed using SPSS software version 25.0 (IBM Corp., Armonk, NY, USA). Data normality was assessed using the Shapiro-Wilk test, and homogeneity of variance was tested using Levene’s test. Categorical data were analyzed using the McNemar test, while continuous data were analyzed using either the paired t-test or the Wilcoxon Signed Rank test, with a significant level set at $\alpha = 0.05$.

RESULT AND DISCUSSION

A. Characteristics of the Participants

Data on the characteristics of participants are presented in Table 2. Based on the average age criterion, the participants fell within the category of older adults in the late elderly stage, specifically those aged 70–79 years (Badan Pusat Statistik, 2023). All participants exhibited frailty, classified as either pre-frail or frail. Setiati et al. identified age as a risk factor for frailty among older adults in

Indonesia, with age ≥ 70 years recognized as a prognostic factor that exacerbates frailty (Setiati *et al*., 2019). Aging is characterized by cellular damage that leads to a progressive and cumulative decline in physiological function and organ capacity, making individuals increasingly frail and vulnerable to disease as they grow older (Fragala, 2015).

Table 2. Characteristics of the participants

No.	Variables	Sample (n=17)
1	Age (yrs), mean+ SD	73.47+ 8.43
2	Gender, n (%):	
	a. Male	6 (35,29)
	b. Female	11 (64,71)
3	Morphology, average+ SD:	
	a. Body weight	49.82+ 13.87
	b. Height	151+ 12.88
	c. Body Mass Index	21.71+ 4.72
	d. Cognitive score, average+ SD	19+ 5.05
4	Comorbidites, n (%):	
	a. Hypertension	9 (52,94)
	b. Osteoporosis	1 (5,88)
	c. Arthritis	2 (11,76)
	d. Stroke	1 (5,88)
	e. Hypotension	2 (11,76)
	f. History of Falls	8 (47,06)

In this study, the majority of participants were female, as the residential facility was predominantly occupied by older women. This is consistent with national demographic data indicating that the proportion of older women in Indonesia is higher than that of men (52.82% vs. 47.72%) (BPS, 2023). Regarding comorbidities, 52.94% of the study participants had hypertension. This finding aligns with the 2023 Indonesian Health Survey, which reported a hypertension prevalence of 57.8% among individuals aged 65–74 years (Badan Kebijakan Pembangunan Kesehatan, 2023).

B. Changes in Fragility

A comparison of the data before and before and after the MEP intervention is presented in Table 3.

Frailty scores showed a significant reduction of 32.41%. This improvement was attributed to better outcomes in individual frailty phenotypes, which contributed to a lower overall frailty status. A total of 8 participants (47.06%) experienced frailty reversibility: 7 individuals (41.17%) transitioned from frail to pre-frail status, while 1 individual (5.88%) improved from pre-frail to robust.

Several previous studies have reported similar findings, showing a reduction in frailty status following multicomponent training interventions (Tarazona-Santabalbina et al., 2016; Sadjapong et al., 2020; Oh et al., 2021; Brañas et al., 2024). Reversibility of frailty may be due to improvements in physical performance components, such as strength and balance, leading to increased physical activity and improved frailty (Sadjapong et al., 2020). Multicomponent physical exercise exerts positive effects on various body systems involved in frailty phenotypes, including improvements in muscle weakness, low physical activity, motor slowness, and poor activity tolerance that contributes to fatigue (Aguirre and Villareal, 2015).

In this study, participants experienced an improvement in muscle strength post- intervention as indicated by a significant increase in grip strength scores. Although the improvement did not result in a change in the Muscle Weakness phenotype category, the increased grip strength may reflect a higher level of physical fitness (Kim et al., 2022). This was evidenced by a reduction in the phenotypes of Low Physical Activity and Exhaustion. Improved physical fitness contributes to reduced fatigue and enhanced ability to perform activities, all of which lead to an overall improvement in frailty scores.

An increase in muscle strength due to MEP intervention was also found in previous studies (Sadjapong et al., 2020; Brañas et al., 2024). This improvement may be attributed to the resistance training component included in the MEP, which can enhance anabolism and muscle protein synthesis, thereby increasing recruitment capacity, strength, and muscle power, as well as inducing muscle hypertrophy (Ricci and Cunha, 2020).

There was also a significant change in the Slow Walking phenotype after the intervention. The number of participants having this phenotype was reduced by 66.67% as 6 individuals had moved from the category of "slow walking" to "normal walking" after completing the MEP intervention. Although the improvement in walking speed score was not statistically significant, the change in this phenotype contributed to the reduction in overall frailty score.

In their systematic review, Giné-Garriga et al. concluded that physical exercise can improve walking speed in frail elderly. Furthermore, they noted that slowness is associated with reduced muscle strength and impaired balance (Giné-Garriga et al., 2014). In this study, the improvement in the Slow Walking phenotype appears to be linked to gain in muscle strength and balance resulting from the MEP exercise intervention.

Table 3. Comparison of Pre- and Post-Intervention Data

No	Variables	Pre-intervention	Post-intervention	Changes (%)	p value
1.	Frailty				
	Frailty score, mean ± SD	2,53 ± 0,51	1,71 ± 0,77	-32,41	0,000*
	Frailty phenotype, n (%):				
	a. Weight Loss	1 (5,88)	1 (5,88)	0	1
	b. Low Physical Activity	13 (76,47)	7 (41,17)	-46,15	0,031*
	c. Exhaustion	5 (29,41)	3 (17,65)	-40	0,5
	d. Muscle Weakness	15 (88,23)	15 (88,23)	0	1
	e. Slow Walking	9 (52,94)	3 (17,65)	-66,67	0,031*
	Handgrip score, mean ± SD	13,71 ± 7,47	15,59 ± 6,01	13,71	0,022*
	Walking speed score, mean ± SD	7,07 ± 1,61	6,65 ± 2,63	-5,94	0,196
	Frailty status, n (%):				
	a) Robust	0 (0)	1 (5,88)	100	1
	b) Pre-frail	8 (47,06)	14 (82,35)	75	0,07
	c) Frail	9 (52,94)	2 (11,76)	-77,78	0,016*
2.	Hemodynamic Parameters				
	Hemodynamic, mean ± SD:				
	a. SBP	132,09 ± 18,28	122,64 ± 17,51	-7,15	0,000*
	b. DBP	81,70 ± 11,73	74,45 ± 11,47	-8,87	0,000*
	c. MAP	98,50 ± 13,44	90,51 ± 12,95	-8,11	0,000*
	d. HR	77,39 ± 8,94	78,10 ± 8,59	0,91	0,723
3.	Balance				
	Balance, mean ± SD	14,71 ± 1,36	15,29 ± 1,31	3,94	0,023*

* = has significant difference, Statistical significance at $p < 0.05$ using paired t-test or Wilcoxon Signed Rank Test for continuous data and McNemar Test for categorical data, SD = Standard Deviation,
SBP = Systolic *Blood* Pressure, DBP = Diastolic Blood *Pressure,* MAP = *Mean* Arterial Pressure, HR = Heart Rate

C. Changes in Hemodynamic Parameters

Participants' baseline systolic and diastolic blood pressure levels fell within the prehypertension category according to the Joint National Committee on High Blood Pressure (JNC) VIII classification. Following the MEP, there was a significant reduction in SBP, DBP, and MAP. However, no significant change was observed in HR between pre- and post-intervention. These findings are consistent with a study by Gonçalves et al., which also reported reductions in SBP, DBP, and MAP, but no change in HR after a 26-week multicomponent exercise intervention (Gonçalves *et al.*, 2019). Notably, the reductions in SBP (−7.15%), DBP (−8.87%), and MAP (−8.11%) observed in the present study were greater than those reported by Gonçalves et al., which were −4.42%, −6.68%, and −5.17%, respectively. These significant changes in blood pressure are clinically relevant, as elevated blood pressure is causally linked to increased cardiovascular disease risk (Fuchs and Whelton, 2020).

A systematic review of 93 experimental studies concluded that endurance (aerobic) training, dynamic resistance training, and isometric resistance training reduce SBP and DBP (Cornelissen and Smart, 2013). The antihypertensive effects of exercise are thought to be mediated through increased baroreceptor sensitivity, decreased norepinephrine levels, improved insulin sensitivity, and changes in the expression of vasodilatory and vasoconstrictive factors (Ghadieh and Saab, 2015).

D. Changes to the Balance

Data regarding balance showed that there was a statistically significant improvement after the intervention ($p< 0.05$). This result is consistent with previous studies that MEP can improve the balance component (Gonçalves *et al.*, 2019; Sadjapong *et al.*, 2020). Decreases in static postural control and dynamic walking speed that occur due to aging, along with declines in vision, proprioceptive, vestibular sensory and motor functions, are common etiologies of balance decline in the elderly. This limitation in balance is associated with slower walking (Xie *et al.*, 2017) and increased risk of falls (Ricci and Cunha, 2020).

In this study, 47.06% of participants had a history of falls, including recurrent falls. The MEPs, which includes balance training, are particularly important for frail populations who are at high risk of falling (Ricci and Cunha, 2020). Studies have shown that MEP, which includes balance, functional and resistance training, has been shown to reduce the risk of falls by 34%, and 22% among older adults with a history of falls (Angulo *et al.*, 2020). The proprioceptive stimulation of joints during MEP enhances stability, leading to improvements in balance (Sadjapong *et al.*, 2020). Improved balance also contributes to increased walking speed and the ability to perform daily activities, thereby improving overall frailty scores.

CONCLUSION

The structured MEP, delivered through an easy-to-follow training module, has been shown to have a positive impact on frail older adults. Regular implementation of the program effectively reduced frailty scores, improved hemodynamic parameters, and enhanced balance in older individuals. In addition, the MEP module proved to be safe and feasible for older adults to use independently.

However, this study has several limitations, including a small sample size and the absence of a control group. Future research is encouraged to adopt more robust study designs with larger sample sizes. It is also recommended that future studies involve community-dwelling older adults—such as those participating in elderly community health posts (Posyandu Lansia)—to enhance the generalizability of the findings.

REFERENCES

Aguirre, L. E. & Villareal, D. T. (2015) 'Physical Exercise as Therapy for Frailty', *Nestle Nutr Inst Workshop Ser.*, 83(November), pp. 83–92. doi: 10.1159/000382065.

American College of Sport Medicine. (2018) *ACSM's Resources for the Exercise Physiologist -A Practical Guide for the Health Fitness Professional 2nd edn.* Edited by P. Magyari et al. Philadelphia: Wolters Kluwer.

Angulo, J., El Assar, M., Álvarez-Bustos, A., & Rodríguez-Mañas, L. (2020) 'Physical activity and exercise: Strategies to manage frailty', *Redox Biology*. Elsevier B.V., 35(January), p. 101513. doi: 10.1016/j.redox.2020.101513.

Badan Kebijakan Pembangunan Kesehatan (2023) *Survei Kesehatan Indonesia 2023 Dalam Angka*. Available at: https://www.badankebijakan.kemkes.go.id/ski-2023-dalam-angka/

Badan Pusat Statistik (2023) *Statistik Penduduk Lanjut Usia 2023*. Jakarta: Badan Pusat Statistik.

Benton, M. J. (2015) 'Benefits of Exercise for Older Adults', in Sullivan, G. M. and Pomidor, A. K. (eds) *Exercise for Aging Adults A Guide for Practitioners*. Cham: Springer International Publishing, pp. 13–25. doi: 10.1007/978-3-319-16095-5.

Boone, T. (2023) *Exercise Medicine for the Frailty Syndrome*. New York: Routledge. doi: 10.4324/9781003119920.

Brañas, F., Díaz-Álvarez, J., Fernández-Luna, J., Vásquez-Brolen, B.D., García-Molina, R., Moreno, E., Ryan, P., Martínez-Sanz, J., Luna, L., Martínez, M., Dronda, F., & Sánchez-Conde, M. (2024) 'A 12-week multicomponent exercise program enhances frailty by increasing robustness, improves physical performance, and preserves muscle mass in older adults with HIV: MOVIhNG study', *Frontiers in Public Health*, 12(April). doi: 10.3389/fpubh.2024.1373910.

Castell, M. V., Gutiérrez-Misis, A., Sánchez-Martínez, M., Prieto, M.A., Moreno, B., Nuñez, S., Triano, R., de Antonio, M.P., Mateo, C., Cano, M.D., Garrido, A., Julian, R., Polentinos, E., Rodriguez-Barrientos, R., Otero Puime, A., & MEFAP Group. (2019) 'Effectiveness of an intervention in multicomponent exercise in primary care to improve frailty parameters in patients over 70 years of age (MEFAP-project), a randomised clinical trial: Rationale and study design', *BMC Geriatrics*. BMC Geriatrics, 19(1), pp. 1–9. doi: 10.1186/s12877-018-1024-8.

Clegg, A., Young, J., Iliffe, S., Rikkert, M.O., & Rockwood, K. (2013) 'Frailty in Elderly People', *Lancet*, 381(9868), pp. 752–762. doi: 10.1016/S0140-6736(12)62167-9.

Cornelissen, V. A. & Smart, N. A. (2013) 'Exercise training for blood pressure: a systematic review and meta-analysis.', *Journal of the American Heart Association*, 2(1), pp. 1–9. doi: 10.1161/JAHA.112.004473.

Dent, E. Morley, J.E., Cruz-Jentoft, A.J., Woodhouse, L., Rodríguez-Mañas, L., Fried, L.P., Woo, J., Aprahamian, I., Sanford, A., Lundy, J. , Landi, F. , Beilby,J., Martin, F.C., Bauer, J.M., Ferrucci, L., Merchant, R.A., Dong, B., Arai. H, Hoogendijk, E.O, Won, C.W., Abbatecola, A., Cederholm, T, Strandberg,T., Gutiérrez Robledo, L.M., Flicker, L., Bhasin, S., Aubertin-Leheudre, M, Bischoff-Ferrari, H.A., Guralnik, J.M., Muscedere, J., Pahor, M., Ruiz, J.,Negm, A.M., Reginster, J.Y., Waters, D.L, & Vellas, B. (2019) 'Physical Frailty: ICFSR International Clinical Practice Guidelines for Identification and Management', *Journal of Nutrition, Health and Aging*, 23(9), pp. 771–787. doi: 10.1007/s12603-019-1273-z.

Dent, E., Daly, R. M., Hoogendijk, E. O., & Scott, D. (2023) 'Exercise to Prevent and Manage Frailty and Fragility Fractures', *Current Osteoporosis Reports*. Springer US, 21(2), pp. 205–215. doi: 10.1007/s11914-023-00777-8.

Doody, P., Lord, J. M., Greig, C. A., & Whittaker, A.C. (2023) 'Frailty: Pathophysiology, Theoretical and Operational Definition(s), Impact, Prevalence, Management and Prevention, in an Increasingly Economically Developed and Ageing World', *Gerontology*, 69(8), pp. 927–945. doi: 10.1159/000528561.

Fragala, M. S. (2015) 'The Physiology of Aging and Exercise', in Sullivan, G. M. and Pomidor, A. K. (eds) *Exercise for Aging Adults A Guide for Practitioners*. Cham: Springer International Publishing Switzerland, pp. 1–11.

Fried, L. (2014) 'Frailty Phenotype', *CGA Toolkit Plus*, pp. 1–3. Available at: www.cgakit.com.

Fried, L. P., Tangen, C.M., Walston, J., Newman, A.B., Hirsch, C., Gottdiener, J., Seeman, T., Tracy, R., Kop, W.J., Burke, G., & McBurnie, M.A. (2001) 'Cardiovascular Health Study Collaborative Research Group. Frailty in older adults: evidence for a phenotype.', *J Gerontol A Biol Sci Med Sci.*, 56(3), pp. M146-56. doi: 10.1093/gerona/56.3.m146.

Fuchs, F. D. & Whelton, P. K. (2020) 'High Blood Pressure and Cardiovascular Disease', *Hypertension*, 75(2), pp. 285–292. doi: 10.1161/HYPERTENSIONAHA.119.14240.

Ghadieh, A. S. & Saab, B. (2015) 'Evidence for exercise training in the management of hypertension in adults', *Canadian Family Physician*, 61(3), pp. 233–239.

Giné-Garriga, M., Roqué-Fíguls, M., Coll-Planas, L., Sitjà-Rabert, M., & Salvà, A. (2014) 'Physical exercise interventions for improving performance-based measures of physical function in community-dwelling, frail older adults: A systematic review and meta-analysis', *Archives of Physical Medicine and Rehabilitation*, 95(4). doi: 10.1016/j.apmr.2013.11.007.

Gonçalves, I. D. O., Bandeira, A.N., Coelho-Júnior, H.J., Aguiar, S.d.S, Camargo, S.M., Asano, R.Y., & Júnior, M.L.B (2019) 'Multicomponent exercise on physical function, cognition and hemodynamic parameters of community-dwelling older adults: A quasi-experimental study', *International Journal of Environmental Research and Public Health*, 16(12), pp. 1–14. doi: 10.3390/ijerph16122184.

Kim, S. H., Kim, T., Park, J.C., & Kim, Y.H. (2022) 'Usefulness of hand grip strength to estimate other physical fitness parameters in older adults', *Scientific Reports*. Nature Publishing Group UK, 12(1), pp. 6–13. doi: 10.1038/s41598-022-22477-6.

Lee, P. G., Jackson, E. A., & Richardson, C. R. (2017) 'Exercise prescriptions in older adults', *American Family Physician*, 95(7), pp. 425–432.

Oh, G., Lee, H., Park, C.M., Jung, H.W., Lee, E., Jang, I.Y., Guralnik, J.M., & Kim, D.H. (2021) 'Long-term effect of a 24-week multicomponent intervention on physical performance and frailty in community-dwelling older adults', *Age and Ageing*, 50(6), pp. 2157–2166. doi: 10.1093/ageing/afab149.

Perazza, L. R., Brown-Borg, H. M. , & Thompson, L. V. (2022) 'Physiological Systems in Promoting Frailty', *Comprehensive Physiology*, 12(3), pp. 3575–3620. doi: 10.1002/cphy.c210034.

Ricci, N. A., & Cunha, A. I. L. (2020) 'Physical Exercise for Frailty and Cardiovascular Diseases', in Veronese, N. (ed.) *Frailty and Cardiovascular Diseases Research into an Elderly Population*. Cham: Springer Nature Switzerland, pp. 115–129.

Sadjapong, U., Yodkeeree, S., Sungkarat, S., & Siviroj, P. (2020) 'Multicomponent exercise program reduces frailty and inflammatory biomarkers and improves physical performance in community-dwelling older adults: A randomized controlled trial', *International Journal of Environmental Research and Public Health*, 17(11). doi: 10.3390/ijerph17113760.

Sciacchitano, S., Carola, V., Nicolais, G., Sciacchitano, S., Napoli, C., Mancini, R., Rocco, M., & Coluzzi, F. (2024) 'To Be Frail or Not to Be Frail: This Is the Question—A Critical Narrative Review of Frailty', *Journal of Clinical Medicine*, 13(3). doi: 10.3390/jcm13030721.

Setiati, S., Soejono, C.H., Harimurti, K., Dwimartutie, N., Aryana, I.G.P.S, Sunarti, S., Budiningsih, F., Mulyana, R., Dwipa, L., Sudarso, A., Rensa, R., Istanti, R., Aswar, M.K., & Marsigit, J. (2021) 'Frailty and Its Assocaited Risk Factors: First Phase Analysis of Multicentre Indonesia Longitudinal Aging Study', *Front. Med*. 8:658580. doi: 10.3389/fmed.2021.658580.

Stathokostas, L., & Jones, G. (2015) 'Risks of Exercise for Older Adults', in Sullivan, G. M. and Pomidor, A. K. (eds) *Exercise for Aging Adults A Guide for Practitioners*. Heidelberg: Springer International Publishing, p. 163. doi: 10.1007/978-3-319-16095-5.

Tarazona-Santabalbina, F. J., Gómez-Cabrera, M.C., Pérez-Ros, P., Martínez-Arnau, F.M., Cabo, H., Tsaparas, K., Salvador-Pascual, A., Rodriguez-Mañas, L., & Viña, J. (2016) 'A Multicomponent Exercise Intervention that Reverses Frailty and Improves Cognition, Emotion, and Social Networking in the Community-Dwelling Frail Elderly: A Randomized Clinical Trial', *Journal of the American Medical Directors Association*. Elsevier Inc., 17(5), pp. 426–433. doi: 10.1016/j.jamda.2016.01.019.

World Health Organization (2024) *Ageing and Health*. Available at: https://www.who.int/news-room/fact-sheets/detail/ageing-and-health.

Xie, Y. J., Liu, E. Y., Anson, E. R., & Agrawal, Y. (2017) 'Age-related imbalance is associated with slower walking speed: analysis from the National Health and Nutrition Examination Survey', *J Geriatr Phys Ther*, 40(4), pp. 183–189. doi:

10.1519/JPT.0000000000000093.Age-related.