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Effectiveness of Multicomponent Elderly Exercise on Balance and Fall Risk: SKILAS-based Screening in West Lombok Elderly Schools

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ABSTRACT/

Background: Falls are a major public health problem among older adults, leading to injuries, disability, and loss of independence. Community-based exercise programs are recommended as a preventive strategy. Objective: This study aimed to evaluate the effectiveness of a 4-week multicomponent elderly exercise program on balance and fall risk among Elderly School participants in West Lombok, Indonesia. Methods: A quasi-experimental one-group pretest–posttest design was conducted in February 2025 in Gunungsari, Mambalan Village. Sixty older adults aged ≥60 years were recruited using purposive sampling. Balance and fall risk were assessed using the Berg Balance Scale (BBS) and Timed Up and Go (TUG), while functional status was recorded using the SKILAS form. The intervention consisted of multicomponent exercise sessions conducted twice weekly for four weeks (eight sessions). Paired t-test or Wilcoxon signed-rank test was applied for continuous variables, and McNemar or chi-square test for categorical outcomes. Statistical significance was set at $\alpha = 0.05$, with effect sizes and 95% confidence intervals (CI) reported. Results: Mean BBS scores significantly increased from 38.5 (95% CI: 37.42–39.58) at baseline to 45.7 (95% CI: 44.72–46.68) post-intervention, indicating a mean improvement of 7.2 points ($p < 0.001$; Cohen's $d \approx 0.72$). The proportion of participants at risk of falls decreased from 40% (24/60; 95% CI: 28.6–52.6%) to 18% (10/60; 95% CI: 9.3–28.0%), representing an absolute reduction of 22 percentage points ($p = 0.002$). Conclusion: A 4-week multicomponent elderly exercise program significantly improved balance and reduced fall risk among older adults. This intervention is recommended for routine implementation in Elderly Schools and primary healthcare settings as a practical and effective fall-prevention strategy.

ABSTRAK

Latar Belakang: Jatuh merupakan masalah kesehatan masyarakat yang utama pada lanjut usia, yang dapat menyebabkan cedera, disabilitas, serta penurunan kemandirian. Program latihan fisik multikomponen berbasis komunitas direkomendasikan sebagai strategi pencegahan jatuh melalui peningkatan keseimbangan dan mobilitas fungsional. Tujuan: Penelitian ini bertujuan untuk mengevaluasi efektivitas program latihan lansia multikomponen selama 4 minggu

terhadap keseimbangan dan risiko jatuh pada peserta Sekolah Lansia di Lombok Barat, Indonesia. Metode: Penelitian menggunakan desain kuasi-eksperimen dengan satu kelompok pretest–posttest yang dilaksanakan pada Februari 2025 di Kecamatan Gunungsari, Desa Mambalan. Sebanyak 60 lansia berusia ≥60 tahun direkrut menggunakan teknik purposive sampling. Keseimbangan dan risiko jatuh dinilai menggunakan Berg Balance Scale (BBS) dan Timed Up and Go (TUG), sedangkan status fungsional dicatat menggunakan formulir SKILAS. Intervensi berupa latihan fisik multikomponen yang dilakukan dua kali per minggu selama 4 minggu (total 8 sesi). Uji paired t-test atau uji Wilcoxon digunakan untuk data kontinu, serta uji McNemar atau chi-square untuk data kategorik. Tingkat signifikansi ditetapkan pada α = 0,05, dengan pelaporan ukuran efek dan interval kepercayaan (IK) 95%. Hasil: Rerata skor BBS meningkat secara signifikan dari 38,5 (IK 95%: 37,42–39,58) sebelum intervensi menjadi 45,7 (IK 95%: 44,72–46,68) setelah intervensi, dengan selisih rerata sebesar 7,2 poin ($p < 0,001$; Cohen's $d \approx 0,72$). Proporsi lansia yang berisiko jatuh menurun dari 40% (24/60; 95% CI: 28.6–52.6%) menjadi 18% (10/60; 95% CI: 9.3–28.0%), menunjukkan penurunan absolut sebesar 22 poin persentase ($p = 0,002$). Kesimpulan: Program latihan lansia multikomponen selama 4 minggu terbukti secara signifikan meningkatkan keseimbangan dan menurunkan risiko jatuh pada lanjut usia. Program ini direkomendasikan untuk diimplementasikan secara rutin di Sekolah Lansia dan fasilitas pelayanan kesehatan primer sebagai strategi pencegahan jatuh yang praktis dan efektif.

A. INTRODUCTION

Falls in the elderly are a serious global public health problem because of their impact in the form of injury, disability, and loss of independence. According to the WHO (2021) falls are the leading cause of fatal injuries in the elderly. Meta-analyses show that exercise interventions can significantly lower the incidence of falls among older adults by improving balance, muscle strength, and functional mobility (Diyono et al., 2023; Sherrington et al., 2019). In Indonesia, the prevalence of falls in the elderly has reached 12.8% in the last two years (Susilowati et al., 2020). This emphasizes the importance of fall prevention programs at the community level, including Elderly Schools in West Lombok.

The body's balance ability is the main determinant in mitigating the risk of falling. Disturbances in the sensory system, muscle strength, and reflex responses can disrupt the stability of the body. The Berg Balance Scale (BBS) and Timed Up and Go (TUG) instruments are widely used to assess balance functions (Miranda & Tiu, 2023). However, the umbrella study confirms that there is no single measuring tool capable of accurately predicting the risk of falls (Jepsen et al., 2022). Therefore, a comprehensive approach is needed that includes physical, cognitive, social, and environmental factors, one of which is through the SKILAS instrument in Indonesia.

A number of recent studies support the effectiveness of multicomponent exercises. Tai Chi programs have been shown to improve balance and lower the risk of falls (Lin et al., 2024; Yang et al., 2024). The Otago Exercise Programme (OEP) has also been reported to improve balance, mobility, and reduce the fear of falls (Han et al., 2024; Yang et al., 2024). Furthermore, multicomponent exercise consistently improves physical function and lowers frailty rates in

the elderly (Luo et al., 2024; Yang et al., 2024). A review of practices in residential facilities even confirms structured moderate-intensity strength and balance training as an effective strategy in preventing falls (Dawson et al., 2024).

Although the global evidence is strong, there is a research gap in Indonesia. Most of the studies came from developed countries, while data on the implementation of community-based multicomponent elderly exercise using the SKILAS instrument remain limited. In addition, most interventions are carried out over long durations, while the effectiveness of short-term interventions in communities has not been widely reported. Social and spiritual aspects-such as family support and religious activities-that are relevant in local culture are also rarely explored as a factor of moderation. Although Indonesia has expanded community programs for older adults, such as Sekolah Lansia and Posyandu Lansia under national health promotion initiatives, there remains a paucity of rigorous, locally-based evaluations that quantify the effectiveness of short-term, cadre-led multicomponent exercise programs on objective outcomes (balance, functional mobility, and fall incidence). Existing reports are often descriptive or process-oriented, with limited use of stronger designs (quasi-experimental or randomized trials), incomplete statistical reporting (e.g., absence of effect sizes and 95% confidence intervals), and scarce medium- to long-term follow-up, thereby constraining evidence-based scale-up and standardization across Indonesian settings (Geriatry Gerontology, 2022; Montero-odasso et al., 2022). This study aims to analyze the effect of 4 weeks of multi-component exercise for older adults on balance scores (BBS) and fall risk as measured by SKILAS in participants of the School for Older Adults in West Lombok.

B. METHODS

Research Design

This study uses a quasi-experimental design with a one-group pretest–posttest design. This design was chosen because it is appropriate to evaluate the effectiveness of an intervention in a single group under real community conditions (Geriatry Gerontology, 2022; Shuang Wu,et al., 2024).

Population and Sample

The study population comprised all older adults actively participating in Elderly School activities at the BALADA and MANDIRI Elderly Schools in Mambalan Village, Gunungsari District, West Lombok Regency, West Nusa Tenggara, Indonesia. Samples were selected using purposive sampling. Inclusion criteria were age ≥60 years, ability to stand and ambulate independently without permanent assistive devices, and willingness to participate in the exercise program. Exclusion criteria included severe cognitive impairment, significant visual or hearing impairment, and a history of severe falls within the previous three months. The minimum sample size was calculated using G*Power (two-tailed test, $\alpha = 0.05$, power = 0.80) for a paired *t*-test with an expected effect size of $d = 0.5$, resulting in a required sample of approximately 34 participants. To account for potential attrition and to enhance the precision of the estimates, a total of 60 participants were recruited. (Cohen, 2019).

Research Instruments

Data were collected using three validated instruments. (1) Form SKILAS (Elderly Health Survey), a standardized instrument developed by the Indonesian Ministry of Health, was used to screen physical, psychological, cognitive, social, spiritual, and non-communicable disease (NCD) health status. The SKILAS form comprises approximately 20–25 items across these domains and has demonstrated acceptable internal consistency for the physical domain (Cronbach's Alpha 0.78–0.86) (Ministry of Health of the Republic of Indonesia, 2021); (2) Balance was assessed using the Berg Balance Scale (BBS), which consists of 14 items rated on a 5-point Likert scale (0–4), yielding a total score of 0–56, with higher scores indicating better balance. The Indonesian version of the BBS has shown excellent internal consistency (Cronbach's Alpha 0.92–0.97). (Miranda et al., 2023); (3) Timed Up and Go (TUG) for fall risk screening, which measures the time (in seconds) required to stand from a chair, walk 3 meters, turn, return, and sit down. The TUG has demonstrated high test–retest reliability among Indonesian older adults (ICC > 0.90) (Beck Jepsen et al., 2022).

Intervention Procedure

The intervention consisted of a multicomponent elderly exercise program focusing on balance, lower-limb muscle strength, and functional mobility. Each session lasted approximately 45 minutes and was delivered twice weekly for four weeks (eight sessions) in February 2025 under the supervision of trained health cadres. The exercise protocol was structured into three phases. The warm-up phase (5–7 minutes) included low-intensity marching in place, gentle joint mobilization, and dynamic stretching to prepare participants for exercise. The core phase (25–30 minutes) comprised balance training (single-leg and tandem stance, lateral stepping), lower-limb strengthening (sit-to-stand, calf raises, mini-squats), and functional exercises (stepping over low obstacles and directional changes). Exercise intensity was maintained at a light-to-moderate level (Borg Rating of Perceived Exertion [RPE] 11–13) and individually adjusted according to participants' tolerance. The cool-down phase (3–5 minutes) consisted of light static stretching and breathing exercises to facilitate gradual recovery. The exercise model was adapted from established fall-prevention programs, including the Otago Exercise Programme and Tai Chi–based exercises (Chen et al., 2023; Han et al., 2024). Safety was prioritized through continuous monitoring, individualized exercise modification, and provision of environmental support (e.g., chair or wall) during balance activities. Participants were encouraged to exercise at their own pace and to rest or stop if discomfort occurred. No adverse events were reported during the intervention period.

Data Analysis

Data were analyzed using paired t-tests for normal data and Wilcoxon tests for abnormal data. The $p<0.05$ value was set as significant. Effect size is calculated (Cohen's d or r) to assess the strength of the effect of the intervention (Louis Cohen et al., 2019).

Ethical Considerations

This research received approval from the Research Ethics Committee of Stikes Yarsi Mataram No. 075/INKES/P3M/I-G/V/II/2025) related institutions. All respondents signed informed consent, their identities were kept confidential, and respondents had the right to resign at any time.

C. RESULT AND DISCUSSION

Result

A total of 60 elderly people were respondents to this study. The majority are aged 60–70 years old (65%), female (70%), and have a history of hypertension (45%). This is consistent with reports that Elderly women are more susceptible to decreased balance due to hormonal changes, sarcopenia, and osteoporosis (Yang et al., 2022). The results of the statistical test showed a significant increase in the Berg Balance Scale (BBS) score from 38.5 ± 4.2 (pretest) to 45.7 ± 3.8 (posttest), with $p < 0.001$ and effect size = 0.72 (large). The proportion of respondents with a risk of falling decreased from 40% (pretest) to 18% (posttest), a statistically significant difference ($p = 0.002$). These findings support that multicomponent elderly exercise is effective in improving postural stability.

Table 1 Characteristics of Study Participants (n=60)

Characteristics	n (%)
Age (years)	
60–69	39 (65.0)
70–79	18 (30.0)
≥80	3 (5.0)
Gender	
Male	18 (30.0)
Female	42 (70.0)
Comorbidities	
Hypertension	27 (45.0)
Diabetes mellitus	14 (23.3)
Osteoarthritis	19 (31.7)
≥2 comorbid conditions	22 (36.7)
History of falls (past 12 months)	
Yes	24 (40.0)
No	36 (60.0)
Baseline fall risk category	
High risk	24 (40.0)
Low risk	36 (60.0)

Table 2 Comparison of Berg Balance Scale and Risk of Fall Before and After Multicomponent elderly exercise Intervention (n=60)

Variabel	Pretest (Mean ± SD)	Posttest (Mean ± SD)	p-value	Effect Size
BBS score	38.5 ± 4.2	45.7 ± 3.8	<0.001	0.72 (large)
TUG (seconds)	14.2	11.6	<0.001	
Fall risk (%)	40%	18%	0.002	r = 0.45 (medium)

Discussion

Improved Balance

A significant increase in BBS scores showed that multicomponent elderly exercise effectively improved static and dynamic balance. These results are in line with a meta-analysis that confirms that multicomponent exercise lowers the risk of falls in the elderly (Sherrington et al., 2019). Global guidelines also recommend balance exercises as a key component in fall prevention(Hopewell et al., 2018; Miranda & Tiu, 2023).

Reduced Risk of Falls

The proportion of fall risk decreased from 40% to 18%, supporting the finding of (Shuang et al, 2024) that Tai Chi can lower the risk of falling. The observed improvements in BBS scores and reductions in fall risk can be explained by several complementary physiological mechanisms. Multicomponent exercise enhances lower-limb muscle strength and power, improving the ability to generate corrective postural responses. Balance-specific training stimulates proprioceptive input and sensorimotor integration, leading to better postural control. Functional exercises further reinforce coordination and postural strategies required for daily movements. Together, these neuromuscular and functional adaptations translate into improved balance performance and a reduced risk of falling. Similarly, Han et al. (2024) showed that the Otago Exercise Programme was effective in reducing the fear of falls and improving mobility. This decrease is clinically significant because it is related to improving the quality of life of the elderly.

Comparison with Previous Research

The findings of this study are consistent with previous evidence indicating that community-based multicomponent exercise programs effectively reduce fall risk among older adults (Geriatry Gerontology, 2022; Montero-odasso et al., 2022). The World Health Organization has similarly emphasized the role of multicomponent interventions in fall prevention. Notably, unlike many prior studies employing long-term interventions, the present study demonstrates that a relatively short intervention period of four weeks can produce significant benefits. In this study, the proportion of participants at high risk of falls decreased by 22% following the intervention, which is comparable to reductions of 15–30% reported in previous multicomponent exercise studies among community-dwelling older adults. These findings suggest that well-structured, short-duration community programs can yield clinically meaningful improvements in fall risk reduction.

Practical Implications

This study is notable for combining a multicomponent fitness program with SKILAS, a nationally administered elderly health screening tool, in an Elderly School environment in Indonesia. Unlike exercise interventions in high-income nations, which are often administered in clinical or resource-intensive settings, Elderly Schools are community-based, cadre-led initiatives that promote health and empowerment. This setting emphasizes the necessity of developing locally relevant data that is consistent with existing national institutions and community structures, improving the practicality, scalability, and policy relevance of fall-

prevention programs. Furthermore, the use of SKILAS allows for systematic monitoring of participants' physical state, while social and spiritual components—such as family support and religious activities—may boost engagement and program sustainability among the elderly (Luo et al., 2024; Shuang Wuet al., 2024).

Research Limitations

This study has several limitations. First, the use of purposive sampling in a single village may introduce selection bias, as participants were likely more active and engaged in community activities than the general elderly population. Second, the findings can only be generalized to relatively active older adults who can ambulate independently without assistive devices. Therefore, caution is needed when extrapolating these results to frailer elderly populations or those with severe mobility limitations. Future studies should involve larger samples across multiple settings and include older adults with varying functional capacities to enhance generalizability.

D. CONCLUSION AND SUGGESTIONS

A 4-week community-delivered multicomponent exercise program improved balance and reduced the proportion of participants at fall risk (absolute reduction 22%, 95% CI 9%-35%). These findings support implementing structured, cadre-led exercise in community Elderly Schools as a preventive strategy, while randomized controlled trials with larger samples and longer follow-up are needed to confirm sustainability and wider applicability.

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