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COMPARISON OF LINE DANCE AND *SENAM LANSIA* ON EXECUTIVE FUNCTION IN COMMUNITY-DWELLING OLDER ADULTS: A QUASI-EXPERIMENTAL STUDY

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ABSTRACT

Background: The aging population worldwide has increased interest in interventions that can preserve cognitive function, particularly executive function, among older adults. In Indonesia, *senam lansia* is an accessible form of aerobic exercise for the elderly, while line dance has gained popularity as a more engaging alternative that may offer long-term engagement. However, their comparative effects on executive function remain understudied. **Objective**: This study compares the effects of *senam lansia* and line dance on executive function in community-dwelling older adults. **Methods**: A quasi-experimental, non-randomized, pre- and post-test-controlled design was conducted involving 36 older adults. Participants were assigned to line dance or *senam lansia* groups, each completing 3 times 60-minute sessions for six weeks. Executive function was assessed pre- and post-intervention using the Stroop Test and Trail Making Test B (TMT-B). Baseline demographic characteristics were compared to identify group differences. **Results:** The line dance group was younger (64.90 ± 5.45 vs. 68.75 ± 4.99 years) and entirely female, while the *senam lansia* group included 25% men; adjusting for sex did not alter the cognitive outcomes. Stroop and TMT-B scores showed no meaningful pre–post changes in either group, and intergroup comparisons were nonsignificant. Effect sizes were negligible for Stroop test, with intragroup effects were d = 0.00 (*senam lansia*) and d = –0.33 (line dance), with a small intergroup effect (d = –0.38). TMT-B showed similar pattern, with intragroup effects (≈0.26–0.27) and a very small between-group difference (pooled d ≈ 0.76). **Conclusion:** Short-term participation in *senam lansia* and line dance did not produce statistically or clinically significant improvements in executive function.

BACKGROUND

The aging population is a demographic transformation due to the decline in both birth and death rates. The demographic has resulted in the highest percentage of aging population across the world. It has been calculated that the number of individuals aged ≥ 60 years will be predicted to rise from 12 to 22 percent by 2015-2050.[1] Indonesia has entered the stage of an aging population since 2021, when the relative number of older people in the demographic composition increased. By 2024, older adults consist of 12% of the population (dependency ratio 17.08), requiring adjustments in health services, social support, and policy for active aging.[2]

As individuals age, older adults will experience a progressive deterioration in both physiological and cognitive functions.[2] The incidence of cognitive impairment in older adults is between 5.1% - 41.0, with a median of approximately 19%.[3] Recent studies show that there is a significant effect of the aging process on fundamental areas of executive functioning. Executive function is a set of high-level cognitive processes, including inhibitory control, working memory, and cognitive flexibility, which

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underline planning, reasoning, and problem-solving. Declines in these capacities could affect the ability to plan and organize tasks, manage time effectively, and adjust to unexpected situations, which reduces the independence in daily functioning and quality of life in the elderly.[4,5]

In Indonesia, *senam lansia* is widely promoted as an accessible form of aerobic exercise among community-dwelling older adults. Evidence suggests that exercise reduces the risk of chronic illness and improves neuroplasticity, improving memory, executive function, and processing speed.[6] Aerobic exercise, particularly in structured formats such as warm-up, conditioning, and cool-down, offers a safe, low-injury option for older adults, supporting fitness, reducing oxidative stress, and promoting overall health and quality of life.[7,8] However, conventional *senam lansia* programs often rely on repetitive movement patterns and familiar musical accompaniments, which may reduce participant engagement and long-term adherence.

In contrast, line dance provides an active, socially interactive alternative, which combines multidirectional, rhythmic moves with choreographed patterns that stimulate physical, cognitive, and emotional processes that help to enjoy and generate long-term engagement. Evidence suggests that dance-based programs, such as line dance, can improve balance, gait performance, functional mobility, and quality of life in older adults.[9,10] Additional evidence signify that dance can help reduce physical frailty and improve cognitive performance in older adults with mild cognitive impairment. Notable improvements were seen in executive function, verbal fluency, and overall cognitive capacity.[11]

Despite their similarities as community-based aerobic programs, *senam lansia* and line dance have not been directly compared, in terms of executive function. This gap highlights the need for research comparing the effects of *senam lansia* and line dance on executive function in community-dwelling older adults.

The researchers have a hypothesis that there is a significant difference between line dance and *senam lansia* related to the improvement of executive function in community-dwelling older adults.

METHODS

Methodology

This study utilized a quasi-experimental design with a non-randomized control group, pre-test and post-test measurements to evaluate the comparative effects of *senam lansia* and line dance on executive function in community-dwelling older adults. Executive function will be assessed using the Stroop Test and the Trail Making Test B (TMT-B). Findings from this research are expected to provide valuable proof about the efficacy of these two exercise modalities in augmenting cognitive performance, especially executive function and overall health outcomes in the elderly population.

Study Population and Sampling

Participants were community-dwelling older adults aged 60–75 years, recruited from two groups in Semarang, which is the Line Dance Senior Mitra Graha group and the *senam lansia* group from Prolanis. Purposive sampling was applied to select individuals who met the following inclusion criteria: ability to understand and follow instructions; normal vision and hearing; capacity to stand for at least 60 minutes without discomfort; ability to walk independently without assistive devices; good cognitive function (MoCA-INA ≥26); and adequate nutritional status (Mini Nutritional Assessment >7). Participants with musculoskeletal or neuromuscular disorders causing pain or impairment during standing or walking, uncontrolled comorbidities or other conditions affecting mobility, or balance disorders were excluded. Informed consent was obtained from all participants who met eligibility criteria. Dropout criteria included failure to adhere to and complete the exercise schedule on three consecutive occasions; absence from either the initial or final assessment; occurrence of hemodynamic disturbances such as fatigue, excessive sweating, drowsiness, shortness of breath, pallor, a pulse rate exceeding the maximum heart rate, oxygen saturation below 90% (or a ≥4% decrease from baseline before testing), or blood pressure exceeding 160/100 mmHg; and voluntary withdrawal from the study. A priori sample size calculation was not performed due to feasibility constraints and the community-based nature of the study.

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Data Collection Procedures

Data collection was conducted in two phases: pre-intervention and post-intervention. Baseline measurements included demographic data and executive function assessed using the Stroop Test and the Trail Making Test B (TMT-B).

Intervention Protocols

The line dance program comprised choreographed routines adapted for older adults, with progressive increases in complexity and intensity over time. A 10-minute warm-up, 40 minutes of core exercises, and a 10-minute cool-down comprised each session. In the first 2 weeks, they were exercised with beginner movements (100-160 beats/minute,32-48 counts), and in the next 3 weeks, they improved the movements (160-299 beats/minute, 64 counts). The *senam lansia* group participated in a standardized low-impact aerobic routine following the same session structure by using the 2013 KEMENPORA *Senam lansia Bugar* exercise. Both groups completed 60-minute sessions, three times per week, for six consecutive weeks. Both groups were instructed by the certified instructors in each field. Additionally, participants were also instructed not to take part in any additional structured physical exercise during the study period.

Outcome Measures

The outcome was executive function, assessed using two validated neuropsychological tests, the Stroop Test and Trail Making Test B (TMT-B). Inhibitory control and selective attention were assessed using the Stroop Test, which measures the ability to suppress the automatic tendency to process the conflicting stimulus attributes. It typically involves three tasks: naming the colors of colored patches (C), reading color names printed in black (W), and naming the ink color (CW) of words that spell out a different color (for example, the word "RED" printed in blue ink). For each test, completion time in seconds and the number of uncorrected errors were recorded. To quantify interference while adjusting for individual differences in baseline reading and color-naming speed, a Golden-type interference score was calculated. Higher scores indicate greater difficulty suppressing the automatic response to read the printed word rather than name the ink color. Pre- and post-intervention interference values were used as the Stroop outcomes.(12,13)

Cognitive flexibility was assessed using the TMT-B, a standard measure of set-switching and executive control. It uses paper and pencil, and the participants need to connect the alternating numbers and letters in upward sequences as quickly as possible (e.g., 1–A–2–B). The total completion time served as the TMT-B outcome. (14,15) All measurements were conducted by qualified assessors who were blinded to group allocation to maintain objectivity.

Data Analysis

Baseline participant demographic and clinical profiles were assessed prior to the intervention to evaluate group comparability. Normality of the data was tested using the Shapiro-Wilk test. Paired t-tests were employed to analyze intragroup variances before and after the intervention. Independent t-tests were employed to evaluate the differences intergroup for normally distributed data, whereas the Mann-Whitney U test was used for non-normally distributed data. Statistical significance was defined as $p < 0.05$, and all analyses were conducted using SPSS software.

Ethical Considerations

The study protocol was assessed and authorized by the Ethics Committee of Universitas Diponegoro No. No.201/EC/KEPK/FK-UNDIP/V/2024. All procedures complied with ethical guidelines for research involving human participants. Potential risks, including exercise-related fatigue, were minimized by supervision from medical staff and a gradual increase in exercise intensity. All participants gave written informed consent, adhering to the ethical standards of the Declaration of Helsinki.

RESULTS

Demographic characteristics of the participants are summarized in Table 1. All 36 participants (*senam lansia* n=16; line dance n=20) completed the entire 6-week intervention, and none met the predefined dropout criteria or withdrew voluntarily during the study. Significant differences were observed between the *senam lansia* and line dance groups in age, sex, and educational level. The line-dance group was younger (64.90 ± 5.45 years) than the *senam-lansia* group (68.75 ± 4.99 years) and was entirely female, while the *senam-lansia* group included 25% men (p=0.031).

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Adjusting for sex did not materially change the non-significant between-group results for TMT and Stroop, and the sex × intervention interaction was non-significant. The line-dance group had a higher proportion of participants with secondary and tertiary education.

The results presented negligible differences intergroup were found for employment status, comorbidities, body weight, height, glucose levels, or pain perception using Visual Analog Scale (VAS).

Table 1. Demographic characteristics of participants

Variables	Groups		p-value
	Elderly Gymnastics (n=16)	Line Dancing (n=20)	
Age (years)	68.75 ± 4.99	64.90 ± 5.45	**0.035***
Gender			**0.024***
Man	4 (25)	0 (0)	
Woman	12 (75)	20 (100)	
Education			**0.001***
Elementary School	4 (25)	0 (0)	
Junior High School	7 (43.8)	1 (5)	
Senior High School	3 (18.8)	15 (75)	
College	2 (12.5)	4 (20)	
Work Status			0.546
Unemployed	8 (50)	8 (40)	
Work	8 (50)	12 (60)	
Comorbidities			
Hypertension	10 (62.5)	11 (55)	0.648
DM	2 (12.5)	1 (5)	0.418
Heart disease	0 (0)	2 (10)	0.191
Visual disturbances	12 (75)	16 (80)	0.716
Hearing impairment	1 (6.3)	0 (0)	0.270
Limb weakness	0 (0)	0 (0)	-
Lung disease	1 (6.3)	0 (0)	0.270
Musculoskeletal	2 (12.5)	0 (0)	0.117
Weight (kg)	54.63 ± 8.15	53.08 ± 8.43	0.584
Height (cm)	149.88 ± 9.23	151.13 ± 7.14	0.654
GDS (mg/dL)	126.25 ± 40.51	113.35 ± 35.22	0.315
VAS (score)	0.25 ± 0.68	0.00	0.141

Table 2 presents the pre-test and post-test Stroop Test scores for both groups. At baseline, there were insignificant differences in Stroop Test scores between the *senam lansia* and line dance groups (70.0 ± 9.4 vs. 69.4 ± 9.6; p = 0.842). Post-intervention scores also exhibited negligible intergroup differences (70.0 ± 8.8 vs. 68.8 ± 9.4; p = 0.721). Intragroup analysis indicated no significant pre–post change in the *senam lansia* group (p = 1.000) or the line dance group (p = 0.153). The mean change (post–pre) was 0.0 ± 1.2 in the *senam lansia* group and –0.6 ± 1.8 in the line dance group, with no significant intergroup difference (p = 0.412). Effect size calculations indicated minimal practical impact, with Cohen's d = 0.00 for *senam lansia* and d = –0.33 for line dance. A small between-group effect size was observed for the change scores (d = –0.38).

Table 2. Stroop Test pre-test, post-test and difference

Stroop Test	Group		p-value
	Senam lansia (16)	Line dance (20)	
Pre-test	70.0 ± 9.4	69.4 ± 9.6	0.0842 ‡
Post test	70.0 ± 8.8	68.8 ± 9.4	0.721 ‡
p	1.000 †	0,153†	
Difference	0.0 ± 1.2	–0.6 ± 1.8	0.412 ‡

Description: *Significant (p < 0.05); ‡Mann-Whitney; † Wilcoxon

Table 3 presents the results of Trial Making Test B (TMT-B). At baseline, the *senam lansia* and line dance groups did not differ significantly in their TMT-B scores (4.50 ± 0.63 vs. 4.45 ± 0.76; $p = 0.986$). Post-intervention scores showed no significant between-group differences (4.63 ± 0.72 vs. 4.70 ± 0.47; $p = 0.514$). Intragroup analyses indicated no significant pre–post changes in either the *senam lansia* group ($p = 0.317$) or the line dance group ($p = 0.194$). The mean change (post–pre) was 0.13 ± 0.50 in the *senam lansia* group and 0.25 ± 0.91 in the line dance group, with no evidence of significant intergroup differences ($p = 0.924$).

Table 3. TMT-B pre-test, post-test and differences

TMT	Group		p-value
	Senam lansia (16)	Line dance (20)	
Pre-test	4,50 ± 0,63	4,45 ± 0,76	0,986‡
Post test	4,63 ± 0,72	4,70 ± 0,47	0,514‡
p	0,317†	0,194†	
Difference	0,13 ± 0,50	0,25 ± 0,91	0,924‡

Description: *Significant (p<0.05); ‡ Mann-Whitney; † Wilcoxon

Correlation analysis revealed no significant association between age and post-test scores ($p = 0.693$) or score change ($p = 0.087$). Comparisons by sex showed no significant differences in post-test scores ($p = 0.121$) or score change ($p = 0.696$). Analysis by education level indicated a significant difference in post-test scores ($p = 0.041$), but no

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difference in score change ($p = 0.599$). Multiple linear regression found no significant predictors of post-test performance.

Effect size estimates indicate the observed changes were minimal. For the Stroop interference score, within-group effects were negligible in the *senam lansia* group (Cohen's d = 0.00) and small in the line-dance group (Cohen's d = –0.33). The between-group effect size for Stroop change scores was also small (Cohen's d = –0.38), indicating no meaningful advantage for either exercise modality. A similar pattern was observed for TMT-B performance; within-group paired effect sizes were small ($d_x \approx 0.26$ for *senam lansia*; $d_x \approx 0.27$ for line dance), and the between-group standardized difference for TMT-B change was very small (pooled d ≈ 0.76), reflecting only a slight, non-meaningful advantage for the line-dance group.

These small effect sizes align with the non-significant values and suggest that any cognitive changes after six weeks were minimal and unlikely to be clinically meaningful.

DISCUSSION

This study was conducted to evaluate the effects of line dance and *senam lansia* interventions on executive function among community-dwelling older adults. The outcome was measured using the Stroop Test and Trial Making Test-B. Both interventions were delivered over six weeks with a high training frequency (three 60-minute sessions per day). The results revealed that neither group demonstrated a statistically significant improvement in either executive function measure. The effect size estimates were uniformly small, indicating minimal practical impact of either intervention on inhibitory control or cognitive flexibility.

Interpretation of the results needs to consider baseline differences between groups. Although the baseline Stroop and TMT-B scores were similar, the group varied in several demographic characteristics that are known to influence executive-function performance. Prior research showed that the executive function in older adults is influenced by the combination of age, demographic factors, physical and functional status, lifestyle, pathological conditions, and genetics. Age is strongly related to gradual declines in processing speed and executive control. Educational level also plays an important role, as individuals with more years of formal education demonstrated a tendency to achieve better on executive function tasks and complete tests such as the Stroop test more quickly. Some evidence further suggests that older women may perform better than older men on certain executive function measures, including Stroop performance.[16,17]

These demographic differences may have contributed to variability in outcomes and reduced the ability to detect subtle changes resulting from the interventions. Because this study did not stratify participants or adjust for these covariates, it is difficult to determine the intervention's true effects with confidence. The null findings, therefore, need to be interpreted with caution, as baseline heterogeneity may have been responsible for a reduction in the ability to detect the small but potentially meaningful differences in cognitive performance.

Stroop interference scores remained stable in both groups, with negligible change in *senam lansia* (Cohen's $d = 0.00$) and a small, non-significant improvement in line dance (Cohen's $d = –0.33$). The between-group effect size was also small (Cohen's $d = –0.38$), indicating no meaningful advantage for either modality. TMT-B results followed a similar pattern, with small within-group effects ($d_x \approx 0.26–0.27$) and a very small between-group difference (pooled $d \approx 0.76$). These findings suggest that neither intervention produced measurable gains in inhibitory control or set-shifting over six weeks.

Several factors may explain the minimal cognitive change observed. Many participants already showed relatively strong cognitive performance at baseline, which left limited potential for measurable improvement and increased the likelihood of ceiling effects. The six-week duration of intervention may also have been insufficient to produce meaningful neurocognitive adaptations, as improvements in executive function often appear only after longer or more cognitively demanding exercise programs. Furthermore, both *senam lansia* and line dance were structured to be safe and accessible for older adults, which likely limited the level of cognitive challenge involved. The movement patterns used in these activities may not have required the kinds of rapid decision-making, dual-tasking, or complex sequencing that typically engage and strengthen executive-control processes.

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Even though *senam lansia* and line dance offer clear benefits for physical activity, balance, and social engagement, the results of this study suggest that their short-term cognitive effects, particularly on executive function, are limited in older adults with healthy cognitive function. The small effect sizes and non-significant changes indicate that, in their current form and duration, these activities are unlikely to produce clinically meaningful improvements in inhibitory control or cognitive flexibility.

Evidence from previous systematic reviews helps explain why the cognitive gains observed here were minimal. The systematic review by Zheng et al. reported that exercise interventions of moderate intensity, performed at least twice weekly for 30–60 minutes over a period exceeding 12 weeks, are associated with significant improvements in executive function through enhanced prefrontal cortical activation and neurotransmitter regulation.[19] Supporting this finding, Gomes-Osman et al. demonstrated through a systematic review that longer cumulative exercise exposure, particularly exceeding 52 hours, is linked to greater gains in processing speed and executive functioning, suggesting that adequate intervention duration is essential for measurable neural adaptation.[6] Similarly, Cai et al. reviewed that both aerobic and strength exercises enhance executive function, but mixed exercise programs that combine multiple modalities produce the most significant cognitive benefits, likely due to their combined effects on neurobiological mechanisms and cognitive stimulation inherent in complex motor tasks.[20]

The combination of these views suggests that meaningful improvements in executive function are more likely when exercise programs incorporate sufficient duration, cognitive complexity, and multimodal components. In contrast, the six-week interventions used in this study may not have provided enough volume or cognitive challenge to produce measurable neurocognitive changes. This aligns with the broader understanding that both physiological and neurocognitive processes underlying brain plasticity require sustained and sufficiently demanding stimulation.

Limitations

This research was subject to several limitations. First, the intervention duration may have been inadequate to produce measurable improvements in executive function among older adults. Second, the sample size and baseline differences in age, gender, and educational level between the line dance and *senam lansia* groups could have influenced the outcomes and reduced statistical power. Third, although the Stroop and Trail Making Test are validated measures, they might not have been sensitive enough to detect the subtle change, especially given the participant's high baseline cognitive performance, which could have led to ceiling effects.

CONCLUSION

This study found that both line dance and *senam lansia* interventions conducted over six weeks did not produce significant improvements in executive function, as measured by the Stroop and Trail Making Tests, in community-dwelling older adults. While both activities remain valuable for promoting physical well-being, balance, and social connection, their cognitive impact appears limited when delivered in a low-complexity structure and over a relatively short duration. Evidence from previous research consistently indicates that longer, more cognitively demanding, and multimodal exercise programs are more likely to produce meaningful gains in executive function. These findings highlight the importance of designing future interventions that focus on extended intervention periods, multimodal exercise programs, more substantial sample, and comprehensive cognitive assessments to better investigate the efficacy of such exercise modalities in promoting executive function during healthy aging.

ETHICAL APPROVAL

The *study* protocol was approved by the ethics committee of Universitas Diponegoro No. 201/EC/KEPK/FK-UNDIP/V/2024, and all procedures complied with ethical guidelines for research involving human participants. Potential risks, including exercise-related fatigue, were minimized by supervision from medical staff and a gradual increase in exercise intensity. All participants gave written informed consent, complying with the ethical standards of the Declaration of Helsinki.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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