

## Changes in Resting Pulse Rate and Static Balance After Low-Impact Aerobic Exercise in Older Women

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### Abstract

**Background:** Aging is associated with changes in cardiovascular regulation and postural control that may contribute to functional decline and fall vulnerability. Low-impact aerobic exercise may provide an accessible form of physical activity for older adults; however, evidence describing concurrent changes in resting pulse rate and static balance remains limited.

**Objective:** To examine changes in resting pulse rate and static balance after a four-week low-impact aerobic exercise program in older women.

**Methods:** This pre-experimental one-group pretest-posttest study included 20 community-dwelling women aged 60 to 75 years recruited through purposive sampling in Badung Regency, Indonesia. Participants performed low-impact aerobic exercise three times weekly for four weeks, totaling 12 sessions of approximately 30 minutes. Resting pulse rate was measured using a Taff Omicron pulse oximeter, and static balance was assessed using the One Leg Stand Test. Paired data were reanalyzed to estimate mean differences, 95% confidence intervals (CIs), and standardized effect sizes.

**Results:** Mean resting pulse rate decreased from  $78.95 \pm 5.41$  to  $72.80 \pm 5.90$  beats/min, with a mean difference of 6.15 beats/min (95% CI 5.663 to 6.637;  $t[19] = 26.446$ ;  $p < 0.001$ ; Cohen's  $d_z = 5.91$ ). Static balance increased from  $5.15 \pm 2.09$  to  $7.41 \pm 2.11$  seconds, with a mean difference of 2.252 seconds (95% CI 1.744 to 2.760;  $t[19] = 9.283$ ;  $p < 0.001$ ; Cohen's  $d_z = 2.08$ ).

**Conclusion:** The program was followed by lower resting pulse rate and improved static balance. Controlled studies are needed to determine causal and clinical significance.

### Keywords

Aged; Exercise; Heart Rate; Postural Balance; Women

### Introduction

Population aging is accompanied by progressive changes in physiological reserve and physical function that may affect cardiovascular regulation, mobility, and postural control. These changes can increase vulnerability to functional limitations and falls, particularly when impairments occur simultaneously across multiple body systems. Regular physical activity is therefore considered an important component of healthy aging.<sup>1</sup> The World Health Organization recommends regular aerobic physical activity for older adults and emphasizes multicomponent activities incorporating balance, strength, and functional capacity to support the maintenance of physical function and reduce fall-related risk.<sup>2</sup>

Cardiovascular function undergoes several age-related changes that may influence the ability to respond to physiological demands. Resting pulse rate is a simple physiological indicator related to cardiac rhythm and autonomic regulation, although its interpretation should consider individual characteristics, medication use, physical fitness, and underlying health conditions.<sup>3</sup> Regular exercise has been associated with cardiovascular adaptations, but the magnitude and clinical relevance of changes in resting pulse rate may vary according to exercise modality, intensity, duration, baseline health status, and participant characteristics.<sup>4</sup> Consequently, a reduction in resting pulse rate should not automatically be interpreted as a clinically meaningful improvement without considering the broader physiological and clinical context.<sup>3</sup>

Age-related changes also affect the musculoskeletal and neuromotor systems responsible for maintaining postural stability. Alterations in muscle function, sensory integration, proprioception, and control of the center of mass may contribute to impaired balance and increased susceptibility to falls.<sup>1</sup> Exercise interventions have been associated with improvements in several balance-related outcomes among older adults, although the magnitude of these changes depends on intervention characteristics and the measurement methods used.<sup>1,5</sup> Evidence also suggests that sensorimotor, proprioceptive, and balance-oriented exercise may improve static and functional balance, including performance on single-leg stance assessments; however, the certainty and consistency of available evidence remain variable.<sup>5,6</sup> International guidelines similarly emphasize balance-challenging and functional exercise as important components of fall-prevention strategies for community-dwelling older adults.<sup>2</sup>

Low-impact aerobic exercise is a form of structured physical activity characterized by rhythmic and continuous movements while minimizing impact loading, particularly through the avoidance of jumping movements and the maintenance of relatively continuous contact with the supporting surface.<sup>7</sup> Such exercise may provide a practical option for older adults because repeated stepping, weight shifting, and coordinated upper- and lower-extremity movements can be performed within a relatively low-impact format. The program examined in the present study consisted of rhythmic aerobic movements performed three times weekly for four weeks. Although low-impact aerobic exercise may involve movement characteristics relevant to both cardiovascular activity and postural control, the physiological mechanisms underlying any observed changes cannot be established without direct mechanistic measurements.

Previous studies have reported changes in cardiovascular or balance-related outcomes following aerobic, multicomponent, or low-impact exercise interventions in older populations.<sup>4,5,7,8</sup> However, these outcomes have often been examined separately, and substantial differences exist in exercise protocols, intervention doses, participant characteristics, and outcome measures. This heterogeneity limits direct comparison across studies and makes it difficult to determine whether participation in a single low-impact aerobic exercise program is accompanied by concurrent changes in both cardiovascular and static balance outcomes.<sup>4,5,7,8</sup> In addition, evidence concerning exercise-related improvements in balance varies according to the type of exercise and the outcome assessment used.<sup>5</sup> Therefore, further investigation is warranted to describe changes in resting pulse rate and static balance following participation in a clearly defined exercise program within a specific older adult population.

The present study focused on community-dwelling older women in Banjar Badung Tengah, Ayunan Village, Badung Regency, Indonesia. This population was selected from the community available for recruitment and included women aged 60 to 75 years who met the study eligibility criteria. A preliminary assessment involving 10 older women in the community reported a mean pulse rate of 70 beats/min and a mean One Leg Stand Test performance of less than 5 seconds. These preliminary observations did not establish the presence of an intervention effect or clinical impairment but indicated the relevance of examining cardiovascular and balance-related outcomes within this population.

The research gap addressed by this study concerns the limited integrated evaluation of resting pulse rate and static balance following the same low-impact aerobic exercise program. Rather than considering the geographical setting as the primary source of novelty, the study contributes preliminary evidence by assessing outcomes from cardiovascular and functional domains concurrently within a single four-week exercise protocol. This approach allows the temporal patterns of both outcomes to be described in the same group of older women, although it does not establish the mechanisms responsible for those changes or confirm a causal relationship between the intervention and the observed outcomes.

Accordingly, this study aimed to examine changes in resting pulse rate and static balance before and after a four-week low-impact aerobic exercise program among older women in Banjar Badung Tengah, Ayunan Village, Badung Regency, Indonesia. Because the study used a pre-experimental one-group pretest-posttest design without a comparison group, the findings were intended to describe changes observed after participation in the program rather than establish a definitive causal effect.

## Methods

This pre-experimental study used a one-group pretest-posttest design to examine changes in resting pulse rate and static balance before and after participation in a low-impact aerobic exercise program. Outcome measurements were performed at two predefined time points: before the intervention as the pretest and after completion of the four-week program as the posttest. Because the study did not include randomization or a comparison group, the design was susceptible to threats to internal validity, including history, maturation, testing effects, regression to the mean, and uncontrolled confounding. Accordingly, the observed pretest-posttest differences were interpreted as changes occurring after participation in the program and not as definitive evidence of causality.

The study was conducted in Banjar Badung Tengah, Ayunan Village, Abiansemal District, Badung Regency, Indonesia, from April 19 to May 20, 2026. The documented sequence of activities consisted of preparation and participant selection according to the study criteria, informed consent, baseline assessment, delivery of low-impact aerobic exercise three times weekly for four weeks, and post-intervention assessment. Specific dates for recruitment, screening, baseline testing, individual exercise sessions, and posttest were not separately documented.

The study population consisted of 50 community-dwelling older women registered in the study setting. Twenty participants were selected through non-probability purposive sampling according to the study eligibility criteria. Eligible participants were women aged 60 to 75 years who resided in Banjar Badung Tengah and agreed to participate. The exclusion criteria included uncontrolled hypertension, heart disease, stroke, diabetes mellitus with complications, severe balance impairment, and recovery conditions such as fracture. The original documentation did not describe a standardized clinical procedure, medical-record review, or other formal method used to verify health status. In addition, no a priori sample size calculation or power analysis was documented to justify the selection of 20 participants. Therefore, the sample size was based on the documented study design and available eligible participants rather than a retrospectively constructed statistical justification. Purposive sampling and the absence of a documented sample size calculation were considered limitations of the study.

The intervention was conducted in Banjar Badung Tengah and consisted of low-impact aerobic exercise performed three times weekly for four weeks, resulting in 12 planned sessions. Each session lasted approximately 30 minutes and included warm-up, main exercise, and cool-down components. The exercise was characterized as low impact, with rhythmic movements performed without jumping and with an emphasis on relatively continuous contact with the supporting surface. The documented movement structure included 2 × 8 counts. The warm-up involved breathing exercises and gradual movements of the neck, shoulders, upper extremities, trunk, and lower extremities. The main component involved rhythmic stepping and coordinated upper- and lower-body movements, followed by lower-intensity movements during the cool-down.

The exercise program was adapted from materials described as originating from an official Ministry of Health source associated with Harapan Kita National Cardiovascular Center and from a video source documented in the study materials.<sup>9</sup> The intervention was accompanied by I Made Indra Sadhu Purwita, S.Kes., Ftr. However, the original study records did not document specific provider qualifications related to exercise instruction, the duration of each exercise component, target exercise intensity, progression between sessions, participant-level adherence, intervention fidelity, individual modifications, or adverse events. These elements were therefore not inferred or added retrospectively. Resting pulse rate was checked before and after exercise sessions for session monitoring, whereas the primary outcome was assessed during the formal pretest before the program and posttest after completion of the 12-session intervention.

Resting pulse rate was measured using a Taff Omicron pulse oximeter applied to the fingertip. During measurement, participants were instructed to remain relaxed and keep the measured finger still. The device displayed pulse rate as the number of pulses per minute. However, the documented protocol did not specify the participant's body position, duration of rest before measurement, duration of the reading, number of repeated measurements, or the rule used to determine the final recorded value. These undocumented details were not reconstructed retrospectively. The same documented measurement approach was used at pretest and posttest.

Static balance was assessed using the One Leg Stand Test (OLST). Participants performed the test barefoot, with their hands placed on their hips and their eyes open. The free leg was raised with the knee flexed to approximately 90°, and timing began when the foot left the floor. Timing was stopped when the raised foot touched the floor, the hands left the hips, or the trunk deviated by more than 45°. Participants performed three trials on each leg, with a maximum duration of 10 seconds per side, and the best

duration was recorded according to the documented protocol. However, the dataset contained only one static balance value for each participant and did not specify whether the analytical value represented a particular side or the best score across both sides. This limitation should be considered when interpreting and reproducing the assessment procedure. The validity and reliability sources reported in the study documentation should be retained only after final verification of their applicability to the exact OLST protocol used.<sup>6,10</sup> Similarly, the previously reported fall-risk categories should not be used unless their cut-off values and supporting source are confirmed to be appropriate for the study population and testing protocol.<sup>11</sup>

After providing written informed consent, participants underwent baseline assessment of resting pulse rate and static balance. They subsequently participated in the four-week exercise program. Posttest measurements were performed after completion of the program using the same documented outcome procedures. All 20 participants included in the final analysis had recorded pretest and posttest data. However, detailed recruitment information, including the number assessed for eligibility, excluded, declining participation, receiving the intervention, completing all 12 sessions, and withdrawing from the study, was not explicitly documented. Therefore, these numbers were not estimated or reconstructed.

Data were analyzed using paired observations from the 20 participants. The original study documentation stated that Statistical Package for the Social Sciences (SPSS) was used, although the software version was not recorded. The original analysis assessed normality separately for pretest and posttest values using the Shapiro-Wilk test. Reanalysis of the available paired data showed that the resting pulse rate difference scores were not normally distributed (Shapiro-Wilk  $p = 0.00485$ ), whereas the static balance difference scores were consistent with normality ( $p = 0.337$ ). Despite this finding, the original documented inferential analysis used paired-samples  $t$ -tests for both outcomes. To address the reviewer request for complete reporting, the paired data were additionally reanalyzed to calculate mean differences, 95% confidence intervals,  $t$  statistics, degrees of freedom, exact  $p$  values, and Cohen's  $d_z$  effect sizes. All 20 analyzed participants had both pretest and posttest observations available in the dataset; therefore, the reanalysis was based on complete paired data.

Potential confounding factors, including changes in habitual physical activity, medication use, health status, and participation in other structured exercise during the four-week study period, were not systematically documented. These variables were therefore not considered controlled and were treated as potential sources of confounding when interpreting the findings.

The study received ethical approval from Universitas Dhyana Pura, Ethical Clearance No. 001536/KEP Universitas Dhyana Pura/2026. Permission to conduct the study was obtained from the relevant local authorities, and all participants provided written informed consent before participation.

## Results

A total of 20 older women were included in the final analysis. The study population consisted of 50 older women from Banjar Badung Tengah; however, detailed information regarding the number of individuals assessed for eligibility, excluded, declining participation, receiving the intervention, completing all 12 exercise sessions, or withdrawing from the study was not explicitly documented. The available dataset confirmed that all 20 analyzed participants had complete pretest and posttest data for both resting pulse rate and static balance. Therefore, no participant was excluded from the final paired analysis because of missing outcome data. The available recruitment and attendance records did not support reconstruction of the remaining participant-flow categories, and these values were not estimated.

The analyzed sample consisted entirely of women aged 60 to 75 years. The distribution of participants across age categories is presented in Table 1 to describe the characteristics of the study sample. Participants aged 60 to 63 years and 72 to 75 years each represented 35.0% of the sample, whereas participants aged 64 to 67 years and 68 to 71 years each represented 15.0%.

**Table 1.** Participant Characteristics

| Characteristic | n (%)      |
|----------------|------------|
| Sex, women     | 20 (100.0) |
| Age, years     |            |
| 60–63          | 7 (35.0)   |
| 64–67          | 3 (15.0)   |
| 68–71          | 3 (15.0)   |
| 72–75          | 7 (35.0)   |
| Total          | 20 (100.0) |

The statistical analysis was based on paired observations from all 20 participants. The original analysis reported Shapiro-Wilk tests separately for pretest and posttest values, with  $p$  values of 0.782 and 0.753 for resting pulse rate and 0.247 and 0.090 for static balance, respectively. Because paired analysis is more directly concerned with the distribution of within-participant differences, the available paired data were subsequently reanalyzed. The resting pulse rate difference scores were not normally distributed according to the Shapiro-Wilk test ( $p = 0.00485$ ), whereas the static balance difference scores were consistent with normality ( $p = 0.337$ ). The original documented inferential analysis used paired-samples  $t$ -tests for both outcomes. Additional calculations from the available paired data were performed to obtain the mean difference, 95% confidence interval (CI),  $t$  statistic, degrees of freedom, exact  $p$  value, and Cohen's  $d_z$ .

The pretest and posttest values for both outcomes are summarized in Table 2. Resting pulse rate showed a lower mean value at posttest, whereas static balance demonstrated a higher mean duration after completion of the four-week exercise program. The additional statistical estimates provide information regarding the magnitude and precision of the observed within-participant changes.

**Table 2.** Changes in Resting Pulse Rate and Static Balance From Pretest to Posttest

| Outcome                       | Pretest Mean $\pm$ SD | Posttest Mean $\pm$ SD | Mean Difference <sup>†</sup> | 95% CI         | $t$ (df)    | $p$ value | Cohen's $d_z$ |
|-------------------------------|-----------------------|------------------------|------------------------------|----------------|-------------|-----------|---------------|
| Resting pulse rate, beats/min | 78.95 $\pm$ 5.41      | 72.80 $\pm$ 5.90       | 6.15                         | 5.663 to 6.637 | 26.446 (19) | < 0.001   | 5.91          |
| Static balance, seconds       | 5.15 $\pm$ 2.09       | 7.41 $\pm$ 2.11        | 2.252                        | 1.744 to 2.760 | 9.283 (19)  | < 0.001   | 2.08          |

SD, standard deviation; CI, confidence interval.

<sup>†</sup> Mean difference was calculated as pretest minus posttest for resting pulse rate and posttest minus pretest for static balance.

As shown in Table 2, mean resting pulse rate decreased from 78.95  $\pm$  5.41 beats/min at pretest to 72.80  $\pm$  5.90 beats/min at posttest. The mean reduction was 6.15 beats/min, with a 95% CI of 5.663 to 6.637. The paired comparison produced  $t(19) = 26.446$

and  $p < 0.001$ , with a Cohen's  $d_z$  of 5.91. Thus, resting pulse rate was lower at posttest among the analyzed participants. However, the statistical finding alone does not establish that the observed reduction represented a clinically meaningful improvement or that it was caused exclusively by the exercise program.

Static balance, assessed using the One Leg Stand Test, increased from  $5.15 \pm 2.09$  seconds at pretest to  $7.41 \pm 2.11$  seconds at posttest. The mean increase was 2.252 seconds, with a 95% CI of 1.744 to 2.760. The paired comparison showed  $t(19) = 9.283$  and  $p < 0.001$ , with a Cohen's  $d_z$  of 2.08. These results indicate that participants maintained the tested single-leg stance for a longer duration after completion of the four-week program.

The standardized effect sizes were calculated from the available paired data in response to the reviewer request and represent the standardized magnitude of the observed within-participant differences. Nevertheless, the results should be interpreted together with the study design and statistical assumptions. In particular, the resting pulse rate difference scores did not meet the Shapiro-Wilk normality criterion, while the original documented analysis applied a paired-samples  $t$ -test to both outcomes. Therefore, the inferential findings should be interpreted cautiously, and the statistical analysis should not be taken as evidence of a definitive causal effect.

The original manuscript also included categorical presentations of resting pulse rate and static balance. The resting pulse rate categories were not retained because all participants remained within the same reported category at both pretest and posttest, providing limited additional information beyond the continuous outcome analysis. Similarly, the previously reported fall-risk categories based on static balance were not retained because the applicability of the documented cut-off values to the exact One Leg Stand Test protocol and study population requires further verification.

Overall, statistically significant pretest-posttest differences were observed for both resting pulse rate and static balance among the 20 analyzed participants. Resting pulse rate was lower, and static balance performance was higher after completion of the four-week low-impact aerobic exercise program. However, because the study used a one-group pretest-posttest design without a comparison group and did not systematically monitor several potential confounding factors, the findings describe temporal changes observed within the study sample and cannot establish that the exercise intervention was the sole cause of those changes.

## Discussion

This study found statistically significant pretest-posttest differences in resting pulse rate and static balance among 20 older women who participated in a four-week low-impact aerobic exercise program. Mean resting pulse rate decreased by 6.15 beats/min, while mean static balance increased by 2.252 seconds. The standardized paired effect sizes were large, with Cohen's  $d_z$  values of 5.91 for resting pulse rate and 2.08 for static balance. However, these estimates should be interpreted cautiously because the study used a one-group pretest-posttest design, and the resting pulse rate difference scores did not satisfy the normality criterion based on the Shapiro-Wilk test. In addition, the absence of a comparison group prevents the observed changes from being attributed exclusively to the exercise program.

The lower resting pulse rate observed at posttest may be consistent with cardiovascular adaptations associated with repeated aerobic physical activity. Regular exercise has been associated with changes in cardiovascular regulation and autonomic function, although the magnitude of these adaptations may depend on baseline fitness, exercise intensity, training duration, health status, medication use, and adherence.<sup>4</sup> The present study cannot determine which physiological mechanisms contributed to the observed reduction because no measures of cardiorespiratory fitness, autonomic activity, stroke volume, or vascular function were obtained. Therefore, explanations involving improved cardiovascular efficiency or altered autonomic regulation remain biologically plausible interpretations rather than directly demonstrated mechanisms.

The finding should also be interpreted in relation to its potential clinical relevance. Both the pretest and posttest mean resting pulse rates were within the range generally regarded as resting values rather than indicating an overt abnormality in the study sample.<sup>3</sup> Consequently, a statistically significant reduction of 6.15 beats/min should not automatically be interpreted as a clinically meaningful improvement.<sup>12</sup> The study did not assess symptoms, cardiovascular fitness, medication changes, cardiac function, or clinical outcomes, and changes in these factors were not systematically monitored during the intervention period. The observed reduction therefore represents a measurable pretest-posttest change whose clinical significance remains uncertain.

The increase in static balance performance may be related to the movement characteristics of the low-impact aerobic program.<sup>8</sup> The intervention involved repeated stepping, coordinated upper- and lower-extremity movements, and shifts in body weight, all of which may provide repeated exposure to tasks relevant to postural control. Previous research has shown that structured exercise, particularly programs incorporating functional and balance-challenging activities, can improve balance-related outcomes in older adults.<sup>5</sup> Nevertheless, the present intervention was not designed primarily as a standardized balance-training program, and the study did not measure muscle strength, proprioception, sensory integration, gait, or dynamic balance. Accordingly, the mechanisms underlying the longer OLST duration cannot be determined from the available data.

The magnitude of the observed improvement in static balance should also be interpreted cautiously. Participants increased their mean OLST performance by 2.252 seconds, indicating a longer ability to maintain the tested single-leg stance at posttest. However, the clinical importance of this difference is uncertain because the study did not establish a minimal clinically important difference for the outcome. In addition, although the documented testing protocol involved three trials per leg, the available dataset contained only one balance value per participant and did not identify the side or summary rule used for the analytical value. This limitation affects the reproducibility of the outcome assessment and should be considered when comparing the present findings with studies using other single-leg stance protocols.

The findings are broadly consistent with evidence indicating that regular physical activity and structured exercise may support functional capacity and balance in older adults.<sup>2,5</sup> However, direct comparison with previous studies is limited by differences in participant characteristics, exercise modality, intensity, duration, supervision, and outcome measurement.<sup>4,5,7,8</sup> The present program was delivered three times weekly for four weeks, with approximately 30 minutes per session, but detailed information regarding exercise intensity, progression, adherence, intervention fidelity, and individual modifications was not systematically documented. These limitations make it difficult to determine the actual intervention dose received by each participant or to compare the program precisely with other exercise interventions.

The simultaneous assessment of resting pulse rate and static balance is a relevant feature of the present study because it provides information from cardiovascular and functional domains within the same participants and intervention period. However, concurrent changes in these outcomes should not be interpreted as evidence of coordinated physiological adaptations across multiple systems. The study did not include mechanistic or functional measures capable of establishing such relationships. The contribution

of the study is therefore primarily descriptive and preliminary, demonstrating that both outcomes changed over the same four-week period among the participating older women.

Several methodological limitations should be considered. First, the absence of a control group represents the principal limitation because history, maturation, regression to the mean, repeated testing, and other temporal influences cannot be separated from the potential contribution of the intervention. Second, the sample consisted of only 20 participants selected through purposive sampling from a single community, and no a priori sample size calculation was documented. These factors limit statistical precision and generalizability. Third, changes in habitual physical activity, medication use, health status, and participation in other structured exercise were not systematically monitored and may have acted as uncontrolled confounders.

Additional limitations concern intervention and outcome reporting. Detailed information regarding participant adherence, completion of all planned sessions, protocol fidelity, individual modifications, and adverse events was not available. The recruitment process also could not be fully reconstructed because the numbers assessed for eligibility, excluded, declining participation, and withdrawing were not documented. Furthermore, several technical details of resting pulse rate measurement, including body position, rest period, reading duration, repeated measurements, and the rule for determining the final value, were not recorded. These limitations reduce reproducibility and should be addressed in future studies.

The statistical findings also require careful interpretation. Although the paired reanalysis produced *p* values below 0.001 and large standardized effect sizes, statistical significance does not establish clinical importance or causality. Moreover, the resting pulse rate difference scores were non-normally distributed, whereas the original analysis used a paired-samples *t*-test. Future studies should prospectively specify the statistical analysis plan, assess assumptions using paired difference scores, and apply alternative or robust analytical approaches when assumptions are not satisfied. Complete reporting of the statistical software and version should also be ensured.

From a practical perspective, the findings suggest that low-impact aerobic exercise may be a potentially useful form of community-based physical activity for older women because it incorporates rhythmic movement and repeated weight shifting while minimizing jumping and impact loading. However, the present study did not evaluate safety systematically, compare the program with another intervention or usual activity, or assess clinically important outcomes such as falls, functional mobility, or long-term adherence. Therefore, the results should not be interpreted as evidence that the program is clinically effective, safe, or superior to other forms of exercise.

Future research should use adequately justified sample sizes and controlled study designs to distinguish intervention-related effects from temporal and contextual influences. Intervention reporting should follow established frameworks and include detailed information regarding exercise intensity, progression, provider qualifications, adherence, fidelity, modifications, and adverse events.<sup>13</sup> Future studies should also use standardized and clearly reproducible outcome protocols and evaluate broader outcomes, including dynamic balance, lower-extremity strength, functional mobility, physical activity, and prospective falls. Longer intervention and follow-up periods would further clarify whether the changes observed after short-term participation are maintained and whether they translate into clinically meaningful benefits.

Overall, the study observed a lower resting pulse rate and improved static balance after four weeks of low-impact aerobic exercise among the participating older women. These findings provide preliminary evidence of temporal changes in cardiovascular and functional outcomes within the study sample. Nevertheless, the methodological limitations and absence of a comparison group preclude a definitive causal interpretation, and the clinical significance of the observed changes remains to be established.

## Conclusion

This study observed significant pretest-posttest changes in resting pulse rate and static balance among 20 older women who participated in a four-week low-impact aerobic exercise program. After completing 12 exercise sessions, mean resting pulse rate decreased from 78.95 to 72.80 beats/min, whereas mean static balance increased from 5.15 to 7.41 seconds. These findings indicate that lower resting pulse rate and longer single-leg stance duration were observed after participation in the program.

However, the findings should be interpreted cautiously. The one-group pretest-posttest design, absence of a control group, small purposively selected sample, limited documentation of intervention adherence and fidelity, incomplete control of potential confounding factors, and several limitations in measurement reporting prevent definitive conclusions regarding causality or clinical effectiveness. In addition, the clinical significance of the observed changes was not established.

Therefore, the present findings provide preliminary evidence of temporal changes in cardiovascular and static balance outcomes following participation in low-impact aerobic exercise among the participating older women. Future research should use adequately powered controlled designs, standardized and reproducible measurement protocols, systematic monitoring of adherence and potential confounders, and longer follow-up periods to determine whether these observed changes are attributable to the intervention and translate into clinically meaningful benefits.

## Author Contribution

Theresia Yosefa Meo Oba: Conceptualization, Methodology, Investigation, Data Curation, Formal Analysis, Visualization, Writing Original Draft.

Agung Wahyu Permadi: Conceptualization, Methodology, Validation, Supervision, Writing Review and Editing.

Ni Putu Dwi Larashati: Methodology, Validation, Formal Analysis, Writing Review and Editing.

Luh Putu Ayu Vitalistyawati: Investigation, Data Curation, Visualization, Validation, Writing Review and Editing.

All authors have read and approved the final version of the manuscript.

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## Conflict of Interest Statement

The authors declare no conflict of interest.

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## Ethics Statement

This study received ethical approval from the Research Ethics Committee of Universitas Dhyana Pura, Indonesia, with Ethical Clearance No. 001536/KEP Universitas Dhyana Pura/2026. Permission to conduct the study was obtained from the Head of Ayunan Village and the Older Adult Community Leader of Ayunan Village. All participants received an explanation of the study procedures and provided written informed consent before data collection.

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