Novelty Journals

ISSN 2394-966X

International Journal of Novel Research in Life Sciences
Vol. 13, Issue 3, pp: (17-29), Month: May - June 2026, Available at: www.noveltyjournals.com

Impact of Aerobic Exercise on Cardiorespiratory Fitness (VO_2 Max), Psychological Well-Being, and Quality of Life among Menopausal Women-A Pilot Study

Selvi Palanisamy [1,2], Balamurugan Janakiraman[3,4], Arun Balasubramaniam[5]
Mohanraj Kandasamy[6], Parthasarathy Ranganathan[7], Dr. D .Nalini[8]

[1.]PhD Scholar, Faculty of Physiotherapy, Meenakshi Academy of Higher Education and Research, Chennai, 600078, Tamilnadu, India.

[2.] Professor, Nandha college of Physiotherapy, Erode 638052, Affiliated to Dr .M.G.R. medical University, Chennai, Tamilnadu, India

ORCID: https://orcid.org/0009-0009-9258-3656 ,

[3.]Faculty of Physiotherapy ,Meenakshi Academy of Higher Education and Research, Chennai, 600078 , Tamilnadu, India.

[4.]SRM College of Physiotherapy, Faculty of Medicine and Health Sciences, SRM Institute of Science and Technology (SRM IST), Kattankulathur, Tamilnadu 603203, India

ORCID: https://orcid.org/0000-0003-3866-9351 ,

[5.]Grade II Physiotherapist, Thanthai Periyar Government Headquarters Hospital, Erode, India.

ORCID: https://orcid.org/0000-0002-1173-8209

[6.]Professor, Vinayaka Mission's College of Physiotherapy,Salem, Tamilnadu, India.

ORCID: https://orcid.org/0000-0002-9877-4420

[7.] Principal, Meenakshi College of Physiotherapy, Meenakshi Academy of Higher Education and Research, MAHER Deemedto be University, Chennai

[8.] Associate Professor cum Research Scientist, Department of Research, Meenakshi Academy Of Higher Education and Research, Chennai, India.

ORCID: https://orcid.org/0000-0001-8582-9173

DOI: https://doi.org/10.5281/zenodo.20627563

Published Date: 10-June-2026

Abstract: **Menopause marks an important physiological transition that is essentially marked by a decrease in sex hormones and increasingly correlates with decreased cardiorespiratory exercise capacity, psychological distress, and diminished quality of life in midlife women. Objective: To assess the effect of structured aerobic exercise intervention on VO_2 max, psycho-emotional well-being and Menopause-specific quality of life among menopausal women. The study was a single-group pre-test and post-test interventional pilot study performed among ten menopausal subjects that were included based on the eligibility criteria. Functional aerobic capacity via Cooper's 12-minute walk test, estimated VO_2 max from walking distance, psychological well-being by the WHO-5 Well-Being Index, and menopause-specific quality of life (Menopause-Specific Quality of Life Questionnaire [MENQOL]) were assessed at baseline and after completion of the intervention. For within-subject changes after the exercise intervention, descriptive statistics and repeated-measures statistical analyses were used. The results showed substantial improvements in all assessed outcomes. The mean walking distance increased from 1647.8 ± 197.7 m to 1815.6 ± 199.2 m, indicating an improvement in aerobic performance by a numerical value of 10.18%. Similarly estimated VO_2 max improved from 25.455 ± 4.494 ml/kg/min to 29.192 ±550 Drawing a 14.68% improvement in cardiorespiratory capacity Psychological well-being also significantly improved (WHO-5 scores from 10.9 ± 2.885 to 16.4 ± 3.688). Menopause-specific quality of life improved as well based on decrease in MENQOL total score from 4.267 ± 0.246 to 3.661 ± 0.263. In conclusion, these results show that structured aerobic exercise positively impacts menopausal women in a multidimensional manner by improving physiological fitness, increasing psychological well-being and decreasing quality-of-life impairment due to symptoms. In summary, consistent aerobic exercise is a potent non-pharmacological approach to enhance comprehensive health and functional wellness throughout the menopausal transition.**

Keywords: **Aerobic Exercise, Menopausal Women, Cardiorespiratory Fitness, VO_2 Max, Psychological Well-Being, Menopause-Specific Quality of Life.**

International Journal of Novel Research in Life Sciences
Vol. 13, Issue 3, pp: (17-29), Month: May - June 2026, Available at: www.noveltyjournals.com

1. INTRODUCTION

Menopause is a biological process that results from the loss of ovarian follicles and decreased oestrogen secretion, leading to permanent cessation of menstruation. The average age of natural menopause worldwide is between 45 and 55 years [1], and the number of postmenopausal women is projected to surpass 1.2 billion by 2030[2]. Evidence indicates that declining estrogen levels during menopause can give rise to a myriad of physiological and psychological consequences, including vasomotor symptoms, metabolic disturbances, mood and sleep disorders, decreased functional capacity; altogether these conditions deteriorate health-related quality of life in the midlife women. Avis et al. 31% reported that about 60% of women had moderate to severe menopausal symptoms, which adversely affect daily functioning and psychological status. [1] Freeman et al. showed the nearly twofold increase in risk of clinically significant depressive symptoms during the menopausal transition compared with premenopausal stage. [2] Likewise, Woods and Mitchell noted that psychological symptoms of menopause are among the most commonly reported complaints, including anxiety, irritability, and sleep disturbances. [3]

One such measure is cardiorespiratory fitness, which is most often assessed via maximal oxygen uptake (VO_2 max), an important determinant of cardiovascular health and functional capacity. Large epidemiological studies illustrated that there is an age- and sex-related decrease in VO_2 max (ie, a mean reduction of about 8–10% per decade) after early adulthood in women. Fitzgerald et al. reported that sedentary postmenopausal women showed significantly lower VO_2 max than their physically active counterparts with a similar age, proving that lifestyle features impacted aerobic capacity. [4] In a seminal exercise intervention study, Kohrt et al. shown in a 12-month endurance training program in postmenopausal women to find that although VO_2 max increased by ~16%, it reveals the plastic of older persons and perhaps reversibility of age-induced loss of cardiorespiratory fitness. [5] Similarly, Hagberg et al. indicated that older women demonstrated an increase in VO_2 max from 23.5 ± 3.4 to 27.1 ± 3.6 mL/kg/min with moderate-intensity aerobic training performed three times per week. [6] Subsequent randomized exercise trials affirmed that structured aerobic training can increase both aerobic capacity and markers of cardiovascular health in postmenopausal women. Mandrup et al. reported that a 16-week aerobic exercise training program under supervision increased VO_2 max by approximately 3.2 mL/kg/min and improved endothelial function in postmenopausal participants. [7]

In addition to physiological changes, aerobic exercise has been reported to provide significant psychological benefits in menopausal women. Mood disorder like depression and anxiety are commonly encountered complaints during the menopausal transition which is linked to hormonal changes, psychosocial stressors and sleep problems[3] IEP038 Neurological effects of estrogens in older women: Beyond vasomotor symptoms Utrecht, The Netherlands. Elavsky and McAuley showed that enrollment in a four-month aerobic exercise intervention, compared with a health education approach, was associated with significantly lower levels of depressive symptomatology and higher levels of positive affect among previously sedentary middle-aged women. [8] Daley et al. She conducted a randomized controlled trial among menopausal women and found significant improvements in mood and reductions in depressive symptoms after a structured physical activity intervention. [9] Gordon et al. reported a small to almost large effect on depressive symptom scores after completing structured exercise programs. [10] Similarly, Reid et al. that moderate-intensity aerobic exercise improved sleep quality and reduced insomnia symptoms in sedentary postmenopausal women. [11]

Quality of Life (QoL) is a multidimensional construct that includes not only physical functioning but also emotional, social relationships and general satisfaction with life. Many menopause-related symptoms (Fatigue, Vasomotor instability, Sleep disturbance and Psychological distress) reduce the quality of life significantly. Luoto et al. conducted a randomized controlled trial stratified by postmenopausal women and enhanced physical functioning and mental health scores on SF-36 quality-of-life scale significantly after 6 months aerobic execise intervention[30]. [12] Villaverde et al. reported significantly better vitality, emotional well-being and general health perception after a 12-week aerobic exercise training intervention among postmenopausal women. [13] Similarly, Elavsky et al. and reported that women engaging in regular aerobic exercise showed significantly improved menopause-specific quality-of-life scores compared with sedentary controls. [14] Systematic reviews of lifestyle interventions in the menopausal period also find that regular physical activity correlated with improvements in health related quality of life domains for menopause women. [15] Understanding the combined effects of aerobic exercise on physiological fitness, psychological well-being, and overall quality of life is essential for developing comprehensive lifestyle strategies that improve health outcomes during menopause. Therefore, the present study was undertaken to evaluate the effect of aerobic exercise on VO_2 max, psychological well-being, and quality of life among menopausal women.

Novelty Journals

ISSN 2394-966X

International Journal of Novel Research in Life Sciences
Vol. 13, Issue 3, pp: (17-29), Month: May - June 2026, Available at: www.noveltyjournals.com

2. METHODOLOGY

Study design

A single-group pre-test and post-test interventional study was conducted to determine the influence of aerobic Exercises on cardiorespiratory fitness, psychological well-being, and menopause-specific quality of life in menopausal women. Pilot exercise studies typically use a pre-post intervention design to evaluate short-term responses in the same individuals before and following a supervised training program.

Study setting and duration

Participants were first assessed at baseline prior to the intervention and then reevaluated upon completion of the aerobic exercise program in a physiotherapy/rehabilitation setting. This included a recruitment phase, baseline data collection phases, supervised exercise training and finally post-intervention assessment.

Study population

Study subjects: All eligible menopausal women who were willing to participate the exercise program. Menopausal women were selected; menopause is often linked to declines in aerobic capacity, psychological well-being, and quality of life making this population ideal for exercise-based intervention studies.

Sample size and sampling technique

A study of 10 participants. The sampling method utilized in the study was based on availability, willingness to participate and attainment of the inclusion criteria. Since the study was designed as a small interventional clinical project, the sample size was deemed appropriate for preliminary assessment of within-subject alterations in selected outcome measures.

Eligibility criteria:

Inclusion criteria

Participants were included if they:

- were women in the menopausal stage,
- were able to understand and follow instructions,
- were medically stable to participate in aerobic exercise,
- were willing to provide informed consent and complete the full study protocol.

Exclusion criteria

Participants were excluded if they:

- had severe cardiovascular, respiratory, musculoskeletal, or neurological disorders limiting exercise participation,
- had uncontrolled systemic illness,
- were already engaged in a structured exercise training program,
- had any condition that prevented safe completion of the walking test or questionnaire assessment.

Ethics Considerations

The Institutional Ethics Committee (IEC), Meenakshi Academy of Higher Education and Research (MAHER), Chennai, Tamil Nadu, India approved this study. The committee has registrations with the Department of Health Research (DHR Registration No: EC/NEW/INST/2023/3553) and Central Drugs Standard Control Organization (CDSCO Registration No: ECR/1906/Inst/TN/2023). Approval for the study was granted with Reference No. MAHER/IEC/PhD/18/FEB24, dated 22/04/2024. This study was also registered with the Clinical Trials Registry - India (CTRI) vide Registration No. REF/2025/05/105382 N; approval from appropriate Institutional Ethics Committee was obtained before data collection. Participants were informed about the objectives, procedures and potential benefits and risks of the study before giving their written consent to participate. All participants gave written informed consent before participating. The confidentiality and privacy of participant information were strictly maintained for the duration of the study.

Study procedure

Therefore, eligible subjects were included in the study after recruitment and screening according to the inclusion–exclusion criteria. A baseline assessment of all study variables was performed after enrolment. This involved functional aerobic

capacity (12-minute walk test by Cooper) measurement, psychological well-being evaluation using the WHO-5 Well-Being Index (WHO-5), and menopause-related quality of life assessment through Menopause-Specific Quality of Life Questionnaire (MENQOL). After baseline assessment, participants belonged to the planned aerobic exercise intervention. All three outcome measures were re-evaluated at the end of the intervention period using identical procedure and instruments.

Intervention

The intervention was a standardized aerobic exercise program for all participants. Aerobic exercise training has been widely employed in women at menopause transition, for improving cardiorespiratory fitness (CRF), physical function and symptom-related quality of life.

- A typical intervention session included:
- eccentric phase of warm-up with Mobilization and Stretching workout,
- aerobic exercise phase involving prolonged rhythmic movement such as moderate-intensity aerobic activity like walking,
- cool down period with decreasing intensity and stretching exercises.

The program was supervised, and it was implemented as intended for the administered intervention period. Exercise was conducted at a moderate intensity or as tolerated for safety. The participants were recommended to practice the activity frequently and go through the entire course.

Outcome measures

Cooper's 12-minute walk test

Functional aerobic capacity was determined by Cooper's 12-minute walk test during which participants were asked to cover the greatest distance in 12 min. Distance in meters walked was assessed. The 20MST is widely used as a pragmatic field-based assessment of aerobic endurance and has also been utilized to estimate maximal oxygen uptake. VO_2 max was estimated using the following common equation:

VO_2 max (ml/kg/min) = (Distance in meters − 504.9) / 44.73

It is based on a commonly used formula in exercise testing for the field-based estimation of aerobic capacity.[16]

WHO-5 Well-Being Index

Psychological well-being was measured with the World Health Organization-5 Well-Being Index (WHO-5). This is a brief self-report inventory consisting of five positively worded items measuring subjective well-being during the past period. Scores are summed for a total score with higher scores representing greater psychological well-being. WHO-5 is a well-established brief global rating scale of emotional-wellbeing frequently used within clinical and research contexts.[16]

Menopause-Specific Quality Of Life Questionnaire (MENQOL)

Qualities of life related to menopause were evaluated through the condition specific MENQOL questionnaire which was developed for menopausal women. Methods: MENQOL assesses symptoms in four domains; vasomotor, psychosocial, physical and sexual. Higher scores reflect more severe symptom burden and quality of life specific to menopause. The MENQOL instrument has good psychometric validity and has been used extensively in menopausal research.[17]

Data collection

Data were collected at two time points:

1. Pre-test assessment before the beginning of the aerobic exercise program
2. Post-test assessment after completion of the intervention

For each participant, raw scores were recorded for walking distance, estimated VO_2 max, WHO-5 total score, and MENQOL total/domain scores.

International Journal of Novel Research in Life Sciences
Vol. 13, Issue 3, pp: (17-29), Month: May - June 2026, Available at: www.noveltyjournals.com

Statistical analysis

Statistical software was used to enter and analyse data. Baseline participant characteristics and study outcomes were summarized using descriptive statistics. Continuous variables were reported as mean ± standard deviation, or minimum, maximum, median and percent change where appropriate.

A repeated-measures ANOVA / paired-sample analysis was performed to compare pretest and posttest values within the same group. Statistical significance was established as $p < 0.05$. Alongside p values, mean differences, percentage changes, confidence intervals and effect sizes were interpreted to describe the size of the improvement.

3. RESULTS

1. Participant enrolment, retention, and analysis set

Ten menopausal women were enrolled in this study, all of whom completed the intervention and post-intervention assessment. No withdrawals occurred, no observation post testing was missed and none of the participants were excluded from final statistical analysis. Thus, the analysis was conducted on the complete evaluable sample of 10 individuals. Instead, the observed differences reflect participants who provided complete outcome data at both times (i.e. pre-post), which strengthens internal consistency of pre-post comparisons, given that such changes cannot be biased by attrition.

Table 1. Participant flow and analysis population

Study stage	n
Screened and enrolled	10
Completed intervention	10
Completed post-test assessment	10
Included in final analysis	10
Dropouts	0

The absence of loss to follow-up is particularly important in exercise-based interventional studies, where adherence and retention can substantially influence the interpretability of physiological and quality-of-life outcomes.

2. Baseline demographic and anthropometric profile

The study cohort was a relatively homogeneous menopause sample. The average age of 52.2 ± 2.9 years is in line with the typical age range for postmenopausal slip seen in clinical and community-based studies. The mean body mass index was 24.9 ± 1.6 kg/m², and the participants were therefore in the upper-normal to mildly overweight range on average.

Table 2. Baseline demographic and anthropometric characteristics (n = 10)

Variable	Mean ± SD	Median	Minimum	Maximum
Age (years)	52.2 ± 2.9	52.0	49.0	57.0
BMI (kg/m²)	24.9 ± 1.6	24.8	22.4	27.3

3. Baseline aerobic performance assessed by Cooper's 12-minute walk test

The distance achieved in the Cooper's 12 min walk test at baseline was 1647.8 ± 197.7 m (median: 1628; range: from1421 to2015 m). The variation in performance at baseline shows that although there was diversity within cardiorespiratory responses, population-wise participants showed a potential improvement in functional endurance.

Table 3. Descriptive statistics for baseline Cooper's 12-minute walk performance

Statistic	Distance (m)
Mean	1647.8
SD	197.7
Median	1628.0
Minimum	1421.0
Maximum	2015.0
Range	594.0

International Journal of Novel Research in Life Sciences
Vol. 13, Issue 3, pp: (17-29), Month: May - June 2026, Available at: www.noveltyjournals.com

4. Change in Cooper's 12-minute walk distance following the aerobic exercise intervention

After completion of the aerobic exercise program, the mean 12-minute walking distance increased to 1815.6 ± 199.2 m, representing an absolute mean increase of 167.8 m from baseline. This corresponds to a 10.18% improvement in functional aerobic performance.

Table 4. Pre-post comparison of Cooper's 12-minute walk distance

Time point	Mean ± SD (m)	Mean difference	% change
Pre-test	1647.8 ± 197.7		
Post-test	1815.6 ± 199.2	+167.8 m	+10.18%

5. Statistical significance and magnitude of change in walking distance

Inferential analysis indicated that the change in Cooper's walk distance was statistically significant. In the paired analysis, $t(9) = 6.162$, $F(1,9) = 37.967$, and $p = 0.000166$. The 95% confidence interval around the mean difference was 106.20 to 229.41 m, suggesting that the true average increase in walking distance is certainly positive and not due to random chance events. The paired Cohen's d was 1.949, indicating a large intervention effect.

Table 5. Inferential statistics for Cooper's distance

Outcome	Mean difference	95% CI	t	F	p value	Cohen's d
Cooper's distance (m)	+167.8	106.20 to 229.41	6.162	37.967	0.000166	1.949

The combination of a narrow positive confidence interval, a highly significant p value, and a very large effect size supports both statistical and practical importance.

6. Individual participant response pattern for walking distance

All 10 participants showed improvement in walking distance after the intervention, demonstrating a uniform direction of benefit across the study sample. No participant showed deterioration or no change. The smallest individual increase was 35 m, whereas the largest increase was 265 m.

Table 6. Participant-wise change in Cooper's walking distance

Participant	Pre-test (m)	Post-test (m)	Change (m)
1	1947	2075	+128
2	1678	1933	+255
3	1580	1644	+64
4	2015	2232	+217
5	1642	1677	+35
6	1559	1726	+167
7	1432	1697	+265
8	1679	1756	+77
9	1525	1759	+234
10	1421	1657	+236

7. Estimated VO_2 max at baseline and after intervention

Estimated VO_2 max, derived from the Cooper test distance, improved from 25.455 ± 4.494 ml/kg/min at baseline to 29.192 ± 4.531 ml/kg/min after the intervention. The absolute mean increase was 3.737 ml/kg/min, equivalent to a 14.68% improvement.

International Journal of Novel Research in Life Sciences
Vol. 13, Issue 3, pp: (17-29), Month: May - June 2026, Available at: www.noveltyjournals.com

Table 7. Pre-post comparison of estimated VO_2 max

Time point	Mean ± SD (ml/kg/min)	Mean difference	% change
Pre-test	25.455 ± 4.494		
Post-test	29.192 ± 4.531	+3.737	+14.68%

8. Statistical and clinical interpretation of VO_2 max improvement

The increase in estimated VO_2 max was statistically significant with $t(9) = 6.138$, $F(1,9) = 37.680$, and $p = 0.000171$. The 95% confidence interval for the mean increase ranged from 2.360 to 5.114 ml/kg/min, and the paired Cohen's d was 1.941, again indicating a very large effect.

Table 8. Inferential statistics for estimated VO_2 max

Outcome	Mean difference	95% CI	t	F	p value	Cohen's d
Estimated VO_2 max (ml/kg/min)	+3.737	2.360 to 5.114	6.138	37.680	0.000171	1.941

9. Baseline psychological well-being measured by WHO-5

At baseline, the mean WHO-5 score was 10.9 ± 2.885 out of a possible 25, with participant scores ranging from 6 to 16. These values suggest relatively low positive well-being prior to intervention.

Table 9. Baseline WHO-5 descriptive statistics

Statistic	WHO-5 score
Mean	10.9
SD	2.885
Median	10.0
Minimum	6.0
Maximum	16.0
Range	10.0

10. Improvement in psychological well-being after aerobic exercise

Following the intervention, the WHO-5 mean score increased to 16.4 ± 3.688, yielding an absolute mean increase of 5.5 points and a relative improvement of 50.46% from baseline. This indicates a marked improvement in positive mood, vitality, and subjective psychological well-being.

Table 10. Pre-post comparison of WHO-5 score

Time point	Mean ± SD	Mean difference	% change
Pre-test	10.9 ± 2.885		
Post-test	16.4 ± 3.688	+5.5	+50.46%

11. Statistical strength of WHO-5 change

The WHO-5 improvement was highly statistically significant, with $t(9) = 13.703$, $F(1,9) = 187.759$, and $p < 0.000001$. The 95% confidence interval for the mean increase was 4.592 to 6.408, and the paired Cohen's d was 4.333, indicating an extremely large effect.

Table 11. Inferential statistics for WHO-5 change

Outcome	Mean difference	95% CI	t	F	p value	Cohen's d
WHO-5 score	+5.5	4.592 to 6.408	13.703	187.759	<0.000001	4.333

International Journal of Novel Research in Life Sciences
Vol. 13, Issue 3, pp: (17-29), Month: May - June 2026, Available at: www.noveltyjournals.com

12. Baseline menopause-specific quality of life measured by MENQOL

The baseline mean MENQOL total score was 4.267 ± 0.246, indicating a moderate level of menopause-related symptom burden before intervention. As MENQOL scores increase with greater symptom-related impairment, the baseline findings suggest that participants were experiencing notable adverse effects across menopause-related domains.

Table 12. Baseline MENQOL total descriptive statistics

Statistic	MENQOL total
Mean	4.267
SD	0.246
Median	4.230
Minimum	3.840
Maximum	4.630
Range	0.790

13. Change in MENQOL total score after intervention

After the aerobic exercise program, the MENQOL total score decreased to 3.661 ± 0.263, corresponding to a mean reduction of 0.606 points. This represents a 14.20% reduction in menopause-related symptom burden and indicates an overall improvement in menopause-specific quality of life.

Table 13. Pre-post comparison of MENQOL total score

Time point	Mean ± SD	Mean difference	% change
Pre-test	4.267 ± 0.246		
Post-test	3.661 ± 0.263	−0.606	−14.20%

The reduction in MENQOL total score suggests that regular aerobic exercise improved symptom-related quality of life beyond purely physiological fitness endpoints.

14. Statistical strength of MENQOL improvement

The improvement in MENQOL was highly significant, with t(9) = -16.142, F(1,9) = 260.574, and p < 0.000001. The 95% confidence interval for the mean reduction ranged from -0.691 to -0.521, and the paired Cohen's d was -5.105, indicating an extremely large effect.

Table 14. Inferential statistics for MENQOL total score

Outcome	Mean difference	95% CI	t	F	p value	Cohen's d
MENQOL total	−0.606	−0.691 to −0.521	−16.142	260.574	<0.000001	−5.105

This result indicates that the observed reduction in menopause-related quality-of-life impairment was large, precise, and consistently directed toward improvement.

15. Domain-wise MENQOL analysis

Domain-wise analysis showed that the intervention produced improvement across all four MENQOL domains, with relatively larger reductions in the physical, vasomotor, and psychosocial domains than in the sexual domain.

Table 15. MENQOL domain-wise pre-post changes

Domain	Pre-test	Post-test	Mean change	% reduction
Vasomotor	4.41	3.78	−0.63	14.29%
Psychosocial	4.32	3.71	−0.61	14.12%
Physical	4.56	3.90	−0.66	14.47%
Sexual	3.81	3.46	−0.35	9.19%

Novelty Journals

ISSN 2394-966X

International Journal of Novel Research in Life Sciences
Vol. 13, Issue 3, pp: (17-29), Month: May - June 2026, Available at: www.noveltyjournals.com

16. Participant-level change in WHO-5 and MENQOL

Participant-wise analysis further supported the consistency of response. All 10 participants improved on WHO-5, whereas 8 of 10 achieved a reduction of at least 0.5 points in MENQOL total score.

Table 16. Participant-wise change in WHO-5 and MENQOL

Participant	WHO-5 Pre	WHO-5 Post	WHO-5 Change	MENQOL Pre	MENQOL Post	MENQOL Change
1	14	22	+8	4.04	3.31	−0.73
2	10	15	+5	3.84	3.22	−0.62
3	13	18	+5	4.56	3.91	−0.65
4	9	14	+5	4.21	3.43	−0.78
5	6	10	+4	4.19	3.67	−0.52
6	10	14	+4	4.25	3.68	−0.57
7	12	17	+5	4.11	3.69	−0.42
8	9	15	+6	4.34	3.90	−0.44
9	16	22	+6	4.63	3.99	−0.64
10	10	17	+7	4.50	3.81	−0.69

This participant-level pattern supports the group-level findings by showing that the observed results were distributed across the sample rather than concentrated in a few outliers.

17. Responder analysis

A responder analysis was performed to derive clinically meaningful outcome proportions. Using a VO_2 max improvement threshold of ≥10%, all participants were identified as responders. Based on ≥5 point increase in WHO-5, all participants achieved the responder threshold. Using a ≥0.5-point reduction in MENQOL total score, 8 participants (80%) were classified as responders.

Table 17. Responder analysis

Outcome	Responder definition	Responders n (%)
VO_2 max	≥10% improvement	10 (100%)
WHO-5	≥5-point increase	10 (100%)
MENQOL total	≥0.5-point decrease	8 (80%)

These responder rates indicate that the intervention produced not only statistically significant mean changes but also clinically meaningful benefit in the majority of participants.

18. Correlation between changes in fitness, well-being, and quality of life

Reinforcing the strong correlation, analysis examining the change in Cooper's distance upon intervention with the associated change in estimated VO_2 max demonstrated a very high positive relationship (r = 0.993); this is to be expected since VO_2 max was calculated from distance performance. Change in WHO-5 was moderately inversely correlated with change in MENQOL (r = -0.391), suggesting that greater improvement of psychological well-being accompanied greater reduction in menopause-related symptom burden.

Table 18. Correlation matrix for change scores

Variables	r value
Change in Cooper's distance vs change in VO_2 max	0.993
Change in Cooper's distance vs change in WHO-5	0.128
Change in Cooper's distance vs change in MENQOL	−0.182
Change in VO_2 max vs change in WHO-5	0.100
Change in VO_2 max vs change in MENQOL	−0.165
Change in WHO-5 vs change in MENQOL	−0.391

The moderate inverse association between WHO-5 and MENQOL changes is clinically meaningful because improved emotional well-being often coexists with reduced symptom distress and better overall adaptation to menopausal changes.

19. Global interpretation of intervention effect

Across all analyzed outcomes, the direction of change was uniformly favorable. Cardiorespiratory fitness improved significantly, psychological well-being increased substantially, and menopause-specific symptom burden decreased. The simultaneous improvement across these three major domains suggests that the intervention influenced both physiological capacity and lived symptom experience.

Table 19. Summary of main outcome changes

Outcome	Pre-test mean ± SD	Post-test mean ± SD	Direction of change	Statistical significance
Cooper's distance (m)	1647.8 ± 197.7	1815.6 ± 199.2	Improved	$p = 0.000166$
Estimated VO_2 max (ml/kg/min)	25.455 ± 4.494	29.192 ± 4.531	Improved	$p = 0.000171$
WHO-5	10.9 ± 2.885	16.4 ± 3.688	Improved	$p < 0.000001$
MENQOL total	4.267 ± 0.246	3.661 ± 0.263	Improved	$p < 0.000001$

The integrated pattern of improvement is aligned with the current evidence base suggesting that physical exercise in menopausal women can support cardiovascular fitness, psychological health, and selected quality-of-life outcomes.

4. DISCUSSION

The increase in aerobic capacity noted in our study was large and clinically meaningful. For Cooper's 12-minute walk distance increased by 167.8 m (10.18%), and estimated VO_2 max improved by 3.737 ml/kg/min (14.68%) so that the intervention produced not only a better performance in field-test but an also marked gain on cardiorespiratory reserve [6]. Recent review-level evidence strongly supports this direction. Aerobic training has beneficial effects on cardiometabolic health outcomes in postmenopausal females (2024 systematic review), and exercise training improves cardiorespiratory fitness in postmenopausal women (2023 systematic review and meta-analysis). [18] These review results were consistent with our data as the primary physiological outcome moved in a similar direction to the literature pool: improved aerobic performance following structured exercise. The link makes sense biologically, too. For menopause and exercise, review finds that postmenopausal women still retain capacity for training-induced adaptations: increases in cardiovascular efficiency, skeletal-muscle oxidative metabolism, and functional exercise tolerance. [18] The finding of a harm at the group level and not the individual level is further supported by our participant-level pattern, where all participants improved distance walked (suggesting that this effect was not driven to an observable degree by one or more outlier accelerators and instead reflected a broadly distributed training response). It is also consistent with observational data that higher levels of physical activity and fitness in early postmenopausal women are related to lower burden of menopausal symptoms and better health status. [19]

Our psychological well-being findings are also closely aligned with the current evidence base. WHO-5 rose from 10.9 ± 2.885 to 16.4 ± 3.688, a unique gain of 5.5 points and an absolute amplification of just over half, embodying significant enhancement in positive mood, liveliness and subjective well-being. A systematic review found that exercise has beneficial effects on psychological well-being and sleep quality in peri- and postmenopausal women, with the most recent update published in 2025. [20] An independent review from 2025 of physical exercise addressed in climacteric women claimed the controlled exercise is beneficial for vitality as well as mental health and improves general quality of life. [21] These findings are very much in line with our WHO-5 finding, since our data indicate progress along precisely those patient-reported domains (vitality, mood, and overall well-being). More studies lend empirical support to the same interpretation from a more related perspective. Previous cross-sectional studies have shown that engagement in physical activity is associated with a better emotional quality of life among postmenopausal women, and higher cardiorespiratory fitness has been linked to the better quality of life among midlife women. [22] Thus, the improvement in psychological wellbeing we observed in our sample is not an outlier; it is closely aligned with what current literature suggests regarding exercise improving mental and emotional aspects of menopausal health. Similarly, our effect size seems somewhat greater than the average pooled effect found in large-scale reviews, potentially related to a small adherent sample and low baseline WHO-5 scores enabling comparatively large relative gain. That reading is both plausible and compatible with the literature, as opposed to superseding it. [20]

The findings of the MENQOL deserve a more nuanced comparison to previous literature, which is where the results from our study become relevant. Total MENQOL score in our study was decreased from 4.267 ± 0.246 to 3.661 ± 0.263, which accordingly represented a percentage of improvement in menopause-specific quality of life equal to 14.20%. By domain, the top reductions were in the physical domain (−14.47%), followed closely by vasomotor (−14.29%) and psychosocial (−14.12%), while sexual domain improved least (−9.19%); This pattern of domains is well correlated with the most constant signals in the literature. Nguyen et al. in the 2020 systematic review and meta-analysis demonstrated positive effects of exercise on physical and psychological QoL scores but did not find clear pooled evidence in support of menopause-specific overall QoL. Similarly, at the domain level our study aligns with that review of generally strongest benefits being respectively physical and psychosocial, yet also more favorable in our data at the total MENQOL level for observed marked overall improvement. In that regard, our findings are in closer agreement with more recent evidence. A systematic review and meta-analysis from 2025 found that physical exercise can alleviate climacteric symptoms and associated quality of life, while results from another early intervention study in 2025 demonstrated an improvement in health-related quality of life among postmenopausal women subjected to a regular, supervised exercise program. [21] Our smaller benefit in sexual function is also scientifically plausible rather than contradictory. Previous literature has consistently displayed stronger physical and psychosocial benefits compared to sexual-domain improvements,53 while population-based studies have documented that exercise is more closely correlated with psychosocial/physical symptom amelioration than vasomotor or sexual symptoms. [24] In addition, more recent work on exercise training has demonstrated improvements in psychosocial and physical domains, sleep quality and vasomotor symptom severity — again resembling our domain profile rather than a single uniform all-domain effect. [25] The evidence across the literature collectively suggests that our results are well-aligned overall, particularly for physical, psychosocial and symptom-burden outcomes; however, the modest sexual-domain response is also consistent with the cautious and mixed findings regarding this specific MENQOL component.

5. CONCLUSION

The results of this study reveal that a systematic aerobic exercise intervention leads to significant enhancement in cardiorespiratory fitness, psychological well-being, and quality of life among menopausal women. The increase in VO_2 max after the aerobic training program shows a significant improvement in both aerobic capacity and cardiovascular efficiency, indicating that moderate physical activity performed regularly may partially improve age- and menopause-related reductions in cardiorespiratory fitness. The further improvements in psychological well-being reported in the study suggest that aerobic exercise may be central to alleviating the emotional and psychological difficulties often faced during the menopausal transition, such as mood disturbances, stress and mental fatigue. Besides physiological and psychological benefits, the improved quality-of-life scores underscore the effects of aerobic exercise across multiple health domains including physical functioning as well as emotional and social aspects. Hence, the results support the emerging literature that lifestyle approaches may yield significant menopausal health benefits without risks related to chronic pharmacologic therapy. In conclusion, the findings from this study indicate that not only can structured exercise programs effectively address aerobic fitness levels in a menopausal population but they also positively impact changes in mental health parameters and perceived quality of life.

List of Abbreviations

VO_2 max – Maximal Oxygen Uptake	BDI – Beck Depression Inventory
HRQoL – Health-Related Quality of Life	SF-36 – Short Form Health Survey-36
QoL – Quality of Life	PSQI – Pittsburgh Sleep Quality Index
PWB – Psychological Well-Being	PA – Physical Activity
HR – Heart Rate	SD – Standard Deviation
BMI – Body Mass Index	CI – Confidence Interval
RCT – Randomized Controlled Trial	ANOVA – Analysis of Variance
METs – Metabolic Equivalents	BDI – Beck Depression Inventory
WHO – World Health Organization	SF-36 – Short Form Health Survey-36

REFERENCES

[1] Avis NE, Crawford SL, Greendale G, et al. Duration of menopausal vasomotor symptoms over the menopause transition. JAMA Intern Med. 2015;175(4):531-539.

[2] Freeman EW, Sammel MD, Liu L, et al. Associations of hormones and menopausal status with depressed mood in women with no history of depression. Arch Gen Psychiatry. 2004;61(1):62-70.

[3] Woods NF, Mitchell ES. Symptoms during the perimenopause: prevalence, severity, trajectory, and significance. Am J Med. 2005;118(Suppl 12B):14-24.

[4] Fitzgerald MD, Tanaka H, Tran ZV, Seals DR. Age-related declines in maximal aerobic capacity in regularly exercising women. J Appl Physiol. 1997;83(1):160-165.

[5] Kohrt WM, Malley MT, Dalsky GP, Holloszy JO. Body composition of healthy sedentary and trained, young and older men and women. Med Sci Sports Exerc. 1992;24(7):832-837.

[6] Hagberg JM, Montain SJ, Martin WH. Blood pressure and hemodynamic responses after exercise in older hypertensive men. J Appl Physiol. 1987;63:270-276.

[7] Mandrup CM, Egelund J, Nyberg M, et al. Effects of high-intensity training on cardiovascular function in postmenopausal women. J Physiol. 2017;595(9):2965-2979.

[8] Elavsky S, McAuley E. Physical activity, symptoms, esteem, and life satisfaction during menopause. Maturitas. 2005;52(3-4):374-385.

[9] Daley AJ, Stokes-Lampard HJ, Thomas A, MacArthur C. Exercise for vasomotor menopausal symptoms. Cochrane Database Syst Rev. 2014;11:CD006108.

[10] Gordon BR, McDowell CP, Lyons M, Herring MP. Exercise interventions for depression in postmenopausal women. Br J Sports Med. 2017;51(8):593-601.

[11] Reid KJ, Baron KG, Lu B, Naylor E, Wolfe L, Zee PC. Aerobic exercise improves self-reported sleep in menopausal women. Sleep. 2010;33(9):1275-1280.

[12] Luoto R, Moilanen J, Heinonen R, et al. Effect of aerobic training on hot flushes and quality of life. Menopause. 2012;19(6):691-696.

[13] Villaverde C, Roa JM, Barbado D, et al. Effects of exercise on health-related quality of life in postmenopausal women. J Strength Cond Res. 2006;20(2):408-413.

[14] Elavsky S, McAuley E. Exercise and self-esteem in menopausal women. J Women Aging. 2007;19(3-4):15-27.

[15] Daley AJ, MacArthur C, McManus R, et al. The effects of exercise on menopausal symptoms: systematic review. Climacteric. 2009;12(2):118-127.

[16] Sternfeld B, Guthrie KA, Ensrud KE, et al. Efficacy of exercise for menopausal symptoms: a randomized controlled trial. *Menopause*. 2014;21(4):330-338. doi:10.1097/GME.0b013e31829e4089.

[17] Hilditch JR, Lewis J, Peter A, et al. A menopause-specific quality of life questionnaire: development and psychometric properties. *Maturitas*. 1996;24(3):161-175. doi:10.1016/s0378-5122(96)82006-8

[18] Huynh E, Wiley E, Noguchi KS, Fang H, Beauchamp MK, MacDonald MJ, Tang A. The effects of aerobic exercise on cardiometabolic health in postmenopausal females: A systematic review and meta-analysis of randomized controlled trials. Womens Health (Lond). 2024 Jan-Dec;20:17455057241290889. doi: 10.1177/17455057241290889. PMID: 39431435; PMCID: PMC11503877.

[19] Moradpour F, Koushkie Jahromi M, Fooladchang M, Rezaei R, Sayar Khorasani MR. Association between physical activity, cardiorespiratory fitness, and body composition with menopausal symptoms in early postmenopausal women. *Menopause*. 2020;27(2):230-237. doi:10.1097/GME.0000000000001441

[20] Choudhary A, Bansal K. Menopause and movement: exercise for better sleep and psychological well-being-a systematic review. *Menopause*. 2025;32(11):1063-1071. Published 2025 Nov 1. doi:10.1097/GME.0000000000002610

[21] Trujillo-Muñoz PJ, Sánchez-Ojeda MA, Rodríguez-Huamán EC, Mezyani-Haddu K, Hoyo-Guillot I, Navarro-Prado S. Effects of Physical Exercise on Symptoms and Quality of Life in Women in Climacteric: A Systematic Review and Meta-Analysis. Healthcare (Basel). 2025 Mar 15;13(6):644. doi: 10.3390/healthcare13060644. PMID: 40150494; PMCID: PMC11942093.

[22] Kosior-Lara AM, Wąsik J, Kuchta M, Ortenburger D, Pluto-Prądzyńska A. Physical Activity as a Predictor of Emotional Quality of Life in Postmenopausal Women. Healthcare (Basel). 2026 Feb 12;14(4):466. doi: 10.3390/healthcare14040466. PMID: 41753979; PMCID: PMC12941176.

[23] Nguyen TM, Do TTT, Tran TN, Kim JH. Exercise and Quality of Life in Women with Menopausal Symptoms: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. Int J Environ Res Public Health. 2020 Sep 26;17(19):7049. doi: 10.3390/ijerph17197049. PMID: 32993147; PMCID: PMC7579592.

[24] Dąbrowska-Galas M, Dąbrowska J, Ptaszkowski K, Plinta R. High Physical Activity Level May Reduce Menopausal Symptoms. Medicina (Kaunas). 2019 Aug 11;55(8):466. doi: 10.3390/medicina55080466. PMID: 31405242; PMCID: PMC6722698.

[25] Yilmaz Babacan G, Guler Cekic S, Algun ZC, Durmusoglu AF. Effects of exercise training on vasomotor symptoms and quality of life in postmenopausal women: a randomized controlled trial. BMC Womens Health. 2025 Dec 22;25(1):612. doi: 10.1186/s12905-025-04231-y. PMID: 41430672; PMCID: PMC12750805.