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The Effect of Resistance Training on Quality of Life and Hormonal Balance in Menopausal Women

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Abstract

Menopause is a physiological phase characterized by a decrease in estrogen and systemic changes that can affect a woman's quality of life and hormonal balance. This study aims to analyze the effect of resistance training on quality of life, estradiol levels, and Follicle Stimulating Hormone (FSH) in menopausal women. The study used a quasi-experimental design with a pre-test and post-test control group design approach. A total of 20 menopausal women were divided into an experimental group and a control group, each consisting of 10 participants. The experimental group followed a 12-week resistance training program with a frequency of three times per week, while the control group did not receive structured resistance training. Quality of life was measured using Menopause-Specific Quality of Life (MENQOL), while estradiol and FSH levels were obtained through laboratory tests. Data were analyzed using normality tests, paired sample t-test, independent sample t-test, and effect size. The results showed that the experimental group's quality of life score decreased from 67.23 ± 3.61 to 54.61 ± 4.48, which indicated a reduction in menopausal complaints. The estradiol levels of the experimental group increased from 14.55 ± 1.62 to 21.93 ± 2.62 and showed significant differences in paired sample t-tests ($p = 0.008$) with moderate to large effect sizes (Cohen's $d = -0.669$). The FSH levels of the experimental group decreased from 77.47 ± 9.01 to 56.47 ± 11.34, while the control group was relatively stable. Inter-group comparisons showed large effect sizes on estradiol post-test (Cohen's $d = 0.921$) and moderate to large on post-test FSH (Cohen's $d = -0.747$). Thus, the research hypothesis is partially supported: resistance training has been shown to significantly increase estradiol and show a tendency to improve quality of life as well as decrease FSH in menopausal women. Resistance training can be recommended as a safe, structured, and applicative nonpharmacological intervention.

Keywords: resistance training; menopause; quality of life; estradiol; Follicle Stimulating Hormone.

INTRODUCTION

Menopause is a natural biological phase in a woman's life cycle that is characterized by the permanent cessation of menstruation due to a decrease in ovarian follicle activity. These changes not only represent reproductive transitions, but also reflect systemic physiological changes associated with decreased estrogen, changes in body composition, decreased muscle mass and strength, increased visceral fat, changes in bone density, as well as an increased risk of cardiometabolic disorders. In the context of women's health in middle and advanced age, menopause needs to be understood as a critical period because hormonal changes can affect quality of life, functional capacity, psychological stability, sleep quality, sexual function, and independence of daily activities. Recent literature shows that postmenopausal women are prone to vasomotor complaints, musculoskeletal pain, sleep disorders, fatigue, decreased fitness, and an increased risk of osteoporosis and sarcopenia, so physical activity-based interventions are an important concern in promoting women's health (Yilmaz Babacan et al., 2025; Jóźwiak et al., 2025; Qian et al., 2023; Lee et al., 2024; Kitagawa et al., 2022; Choi et al., 2025).

The quality of life in menopausal women is a multidimensional construct that includes

physical, psychological, social, and sexual dimensions. A decrease in quality of life is not always caused by a single symptom, but rather by an interaction between hormonal changes, decreased muscle strength, changes in body image, joint pain, sleep disturbances, anxiety, and activity limitations. Previous studies have confirmed that physical exercise can be a relevant nonpharmacological strategy to improve menopausal symptoms and quality of life, especially when exercise is structured in a structured, progressive, and appropriate manner to individual capacity (Trujillo-Muñoz et al., 2025; Money et al., 2024; Nilsson et al., 2024; Berin et al., 2022; Delextrat et al., 2025). Therefore, the approach to health exercise in menopausal women is not enough to be directed at improving general fitness, but also needs to target more specific physiological mechanisms, such as muscle strength, metabolism, hormonal response, and the ability to perform functional activities.

The main problem that arises in menopausal women is the gap between the need for comprehensive health interventions and the low implementation of regular resistance exercises. Many women in the menopausal phase are more familiar with light aerobic activity, leisurely walking, general gymnastics, or informal physical activity, but do not necessarily obtain sufficient mechanical stimulus to maintain muscle mass, bone density, and metabolic capacity. In fact, loss of muscle strength and increased risk of osteosaropenia are important problems in postmenopausal women because they are related to decreased mobility, risk of falls, pain, functional dependence, and low quality of life (Alexander et al., 2025; Lee et al., 2024; Vila et al., 2026; Pan et al., 2025; Kenzhegazova et al., 2026). This condition becomes even more important when it is associated with an increase in life expectancy, because women can live a third of their lives after menopause.

In addition, studies on the effects of exercise on menopausal women still show variations in results due to differences in the type of exercise, intensity, duration, frequency, health status of participants, measurement methods, and outcome indicators used. Some studies have focused on vasomotor symptoms, some focusing on bone density, others on functional capacity or quality of life, while studies that simultaneously link quality of life to hormonal indicators such as estradiol and Follicle Stimulating Hormone (FSH) are still relatively limited. In fact, estradiol and FSH are important indicators for understanding hormonal dynamics in menopausal women, especially since increased FSH is often associated with reduced estrogen feedback on the hypothalamic–pituitary–ovarian axis. Thus, research on exercise interventions that link quality of life and hormonal balance has a strong scientific and practical urgency (Nilsson et al., 2022; Ward et al., 2020; Mitoma et al., 2023; Rain et al., 2026).

In the health sports literature, resistance training is seen as an effective form of exercise to improve muscle strength, muscle endurance, body composition, functional capacity, and quality of life. This exercise puts a mechanical load on the neuromuscular system so that it stimulates the adaptation of muscles, bones, connective tissue, and metabolism. In postmenopausal women, resistance training has been reported to contribute to improvements in vasomotor symptoms, improved quality of life, decreased cardiometabolic risk factors, and improved indicators of physical function (Berin et al., 2022; Berin et al., 2019; Nilsson et al., 2024; Yilmaz Babacan et al., 2025; Ștefan, 2020). Follow-up studies have also shown that resistance training can be combined with nutrition approaches, high-impact exercises, whole-body vibration, as well as home-based programs to improve adherence and effectiveness of interventions in the broader female population (Juesas et al., 2023; Beck et al., 2022; Lee et al., 2024; Svensen et al., 2024; Fairman et al., 2023).

Mechanistic, resistance training has the potential to affect menopausal health through several pathways. First, repeated muscle contractions can increase muscle strength and mass, thereby helping to reduce the risk of sarcopenia and improve functional independence. Second, mechanical loads can provide relevant osteogenic stimuli to maintain bone density in postmenopausal women who are prone to osteoporosis (Kitagawa et al., 2022; El Azeem et al., 2024; Kumar et al., 2024; Beck et al., 2022). Third, resistance training can contribute to metabolic regulation, insulin sensitivity, inflammation, adipokine, and cardiovascular profile (Ward et al., 2020; Davis et al., 2024; Zhang et al., 2025; Oliveira et al., 2025). Fourth, increased strength and perception of fitness can improve confidence, body control, sleep quality, mood, and social participation, all of which are directly related to quality of life (Trujillo-Muñoz et al., 2025; Money et al., 2024; Delextrat et al., 2025; Qian et al., 2023).

Although scientific evidence on the benefits of physical exercise for menopausal women is growing, there are still some research gaps. First, most studies place physical and psychosocial outcomes separately, so there have not been many studies that explicitly integrate quality of life with hormonal balance within a single analytical framework. Second, the interventions used in different studies often differ in terms of intensity, volume, progressivity, supervision, and duration, so there is no firm agreement on the most appropriate resistance training protocol for menopausal women. Third, some studies still focus on populations with specific clinical conditions, such as osteoporosis, osteoarthritis, cancer, obesity, or metabolic disorders, so these findings need to be retested in a more specific context of menopausal women and in accordance with local characteristics (Baniasadi et al., 2025; ZUBARIOGLU et al., 2025; Karacaatlı et al., 2026; Bonfante et al., 2025; Rolle et al., 2026).

In addition, the evidence on hormonal responses to resistance training in menopausal women still needs strengthening. Some studies report that resistance training is associated with changes in hormones, adipokine, and metabolic markers, but not all studies have used estradiol and FSH as the primary indicators. The study of Nilsson et al. (2022) provides clues that resistance training may affect luteinizing hormone in postmenopausal women, while Ward et al. (2020) showed a decrease in plasma adipokine after resistance training. However, the relationship between changes in quality of life, estradiol, and FSH after a resistance training program still needs to be clarified through a more targeted intervention design. Thus, there is a need to compile a study that not only assesses whether resistance training is beneficial but also explains the extent to which it relates to improving quality of life and hormonal balance indicators.

Based on these contexts and gaps, this study aims to analyze the effect of resistance training on quality of life and hormonal balance in menopausal women. Quality of life is positioned as a multidimensional indicator of well-being, while hormonal balance is represented through estradiol and FSH levels. The novelty of this study lies in the incorporation of psychosocial and physiological outcomes in one intervention framework, so that resistance training is not only understood as an exercise to increase muscle strength, but also as a non-pharmacological strategy that has the potential to support hormonal regulation and menopausal women's well-being.

The scope of the study was focused on menopausal women who followed a structured resistance training program during a specific intervention period, with pre- and post-workout measurements. This article places resistance training as a promotive-preventive intervention that is applicable, relatively safe, and has the potential to be integrated into public health programs,

community fitness, and assistance services for middle-aged and advanced women. Practically, the results of the research are expected to provide a scientific basis for health workers, fitness trainers, physiotherapists, and policymakers to design more measurable exercise programs for menopausal women. Theoretically, this study is expected to enrich the literature on the relationship between resistance training, quality of life, estradiol, and FSH, particularly to build an evidence-based exercise intervention model for menopausal women.

METHODS

Research Design

This study uses a quantitative approach with a quasi-experimental design through a pre-test and post-test control group design model. This design was chosen because the study aimed to test the effect of resistance training on quality of life and hormonal balance in menopausal women by comparing changes before and after the intervention between the experimental group and the control group. In the context of physical exercise research in menopausal populations, pre-test and post-test designs are considered relevant because they can describe the physiological and psychosocial changes that occur after a structured exercise program. Several previous studies on resistance training in postmenopausal women have also used similar intervention approaches to assess changes in quality of life, vasomotor symptoms, functional capacity, and hormonal responses after specific periods of exercise (Berin et al., 2019; Berin et al., 2022; Nilsson et al., 2022; Ward et al., 2020).

The experimental group received a 12-week resistance training program, while the control group did not receive a structured resistance training intervention during the study period. Measurements were taken twice, namely before the intervention or pre-test and after the intervention or post-test. The dependent variables in this study included quality of life, estradiol (E2) levels, and Follicle Stimulating Hormone (FSH). Meanwhile, the independent variable is the resistance training program. The selection of these variables is based on the consideration that menopause has an impact not only on the physical aspect, but also on the hormonal aspects and overall quality of life. Therefore, this study seeks to comprehensively assess the effects of resistance training through a combination of psychosocial and physiological indicators.

Participants

The study participants were menopausal women who lived in the research area and met the inclusion criteria that had been set. The number of samples in this study was 20 people divided into two groups, namely 10 people in the experimental group and 10 people in the control group. The sampling technique uses purposive sampling, which is the selection of participants based on certain characteristics that are in accordance with the research objectives. This technique was used because the study required participants with specific and safe menopausal conditions to follow a physical exercise program.

Inclusion criteria include women who have experienced menopause for at least 12 consecutive months, are not undergoing hormone replacement therapy, are able to do physical activity independently, and are willing to participate in the entire research series. Participants should also be in general conditions that allow them to take part in moderate intensity resistance training gradually. Exclusion criteria include a history of acute cardiovascular disease, severe musculoskeletal injury, uncontrolled metabolic disorders, or other medical conditions that may endanger participants during exercise. These criteria are designed to keep participants safe and

reduce the risk of bias due to medical factors that can affect exercise response.

The selection of menopausal women as participants was based on the high risk of decreased muscle mass, decreased bone density, changes in body composition, impaired sleep quality, and decreased quality of life in the postmenopausal phase. The literature suggests that menopausal women need exercise interventions that are not only safe, but also capable of providing sufficient neuromuscular and metabolic stimulus to maintain bodily functions (Trujillo-Muñoz et al., 2025; Yilmaz Babacan et al., 2025; Svensen et al., 2024). Thus, the characteristics of the participants in this study are in accordance with the need to test the effectiveness of resistance training as a nonpharmacological intervention.

Procedure

The research procedure is carried out through several stages. The first stage is research preparation, which includes explaining the research objectives to prospective participants, checking the suitability of inclusion and exclusion criteria, filling out informed consent, and scheduling initial measurements. At this stage, participants obtain an explanation of the benefits, risks, duration, and obligations during the study. This explanation is important so that participants understand that the training program is structured and requires a commitment of attendance for 12 weeks. The second stage is the implementation of the pre-test. At this stage, all participants from the experimental group and control groups underwent quality of life measurements using the Menopause-Specific Quality of Life (MENQOL) questionnaire as well as estradiol and FSH levels were checked through blood sample analysis. Pre-test measurements aim to obtain baseline data before the intervention is administered. This baseline data was then used as a comparison with post-test results after the intervention period.

The third stage is the implementation of the resistance training program in the experimental group. The training program is carried out for 12 weeks with a frequency of three times per week. The exercises are designed progressively with an intensity ranging from 60% to 75% of the One Repetition Maximum (1RM). Each training session consists of warm-ups, core exercises, and cool-downs. Core exercises include multi-joint and functional movements, such as squats, lunges, chest presses, rowing, and lower and upper extremity strengthening exercises using free weights, exercise machines, or resistance equipment available. Each exercise is carried out in three sets of 8–12 repetitions, adjusted to the participant's ability and the principle of gradual increase in weight. During the intervention, the exercises are supervised by an instructor or officer who understands the principles of exercise for menopausal women. Supervision is carried out to ensure that movement techniques are correct, the intensity of training is appropriate, and the risk of injury can be minimized. The control group did not receive a structured resistance training program but continued to carry out daily activities as usual. After 12 weeks, all participants underwent a post-test again with the same measurement procedure as the pre-test. This procedure allows researchers to compare changes in groups and differences between groups after the intervention.

Instrument

The main instruments in this study consisted of quality of life instruments and hormonal examinations. Quality of life was measured using the Menopause-Specific Quality of Life questionnaire or MENQOL. This instrument is widely used in menopausal studies because it can measure menopausal women's complaints and quality of life through several domains, such as vasomotor, psychosocial, physical, and sexual. The MENQOL score is used to describe the level of menopausal complaints; Lower scores after the intervention can be interpreted as reduced

complaints or improved quality of life. The use of quality of life instruments specific to menopause is important because menopausal symptoms have different characteristics than general health complaints.

Hormonal balance is assessed through examination of estradiol (E2) and Follicle Stimulating Hormone (FSH) levels. Estradiol was chosen because it is the main estrogen hormone that decreases in the menopausal phase and is associated with various physical and psychological symptoms. FSH was chosen because its increased levels are one of the physiological indicators commonly found in menopausal women due to decreased estrogen feedback to the endocrine system. Measurements of these two hormones provide a more objective picture of participants' hormonal responses after participating in the resistance training program. Previous studies have also shown that resistance training can affect hormonal, metabolic, and adipokine indicators in postmenopausal women (Nilsson et al., 2022; Ward et al., 2020). In addition to the main instruments, data on participants' characteristics such as age, menopausal status, health history, and ability to follow exercises were recorded to ensure the subject's suitability with the study criteria. Recording these characteristics is also important to help interpret the results and explain the context of the research sample.

Data Analysis

The data is analyzed using statistical software. The analysis begins with descriptive statistics to describe the mean value, median, standard deviation, variance, minimum value, maximum value, and score range for each variable. Descriptive statistics were used to show the tendency of changes in quality of life, estradiol, and FSH in the experimental and control groups before and after the intervention. Before the hypothesis test was carried out, the data were tested for normality using Shapiro-Wilk because the sample size was relatively small. The data is declared to be normally distributed if the significance value is greater than 0.05. If the assumption of normality is met, then the analysis is continued using a parametric test. Paired sample t-test was used to determine the difference in pre-test and post-test scores in each group. The purpose of this test was to find out if there was any change in quality of life, estradiol, and FSH after the intervention period. Independent sample t-tests were used to compare the mean differences between the experimental group and the control group, both at baseline and after the intervention. This test is important to assess whether the changes that occurred in the experimental group were better than in the control group.

In addition to significance values, the study also considered effect sizes through Cohen's d, Hedges' correction, and Glass's delta. Effect measures are used to assess the strength of an intervention's influence in a practical way, not just based on statistical significance. The interpretation of effect measures is important because intervention studies with small samples often show descriptive changes that are practically significant, although they have not yet fully achieved statistical significance. The significance level used in this study was $\alpha = 0.05$.

RESULTS

This study involved 20 menopausal women who were divided into two groups, namely the experimental group that received resistance training interventions and the control group, each with 10 participants. Measurements were made on three main variables, namely quality of life, estradiol (E2) levels, and Follicle Stimulating Hormone (FSH), before and after the intervention period. In general, the results showed a pattern of changes that were more favorable in the experimental group than in the control group, especially in the increase in estradiol and the decrease in FSH after the

resistance training program. This pattern supports the assumption that structured resistance training can provide a stimulus of neuromuscular and endocrine adaptation in menopausal women, as also reported in previous studies on resistance training in postmenopausal women (Berin et al., 2019; Berin et al., 2022; Nilsson et al., 2022; Ward et al., 2020).

Table 1. Descriptive statistic

Variabel	Kelompok	Mean	Median	Variance	Std. Deviation	Minimum	Maximum	Range
Qol.Pre	Eksperimen	67.23	67.60	13.036	3.610	63	73	10
Qol.Pre	Kontrol	63.93	63.35	19.385	4.403	58	71	13
Qol.Post	Eksperimen	54.61	53.40	20.025	4.475	50	63	13
Qol.Post	Kontrol	63.81	63.30	21.550	4.642	57	72	16
Estradiol.Pre	Eksperimen	14.55	14.45	2.607	1.615	12	18	6
Estradiol.Pre	Kontrol	16.21	16.15	2.190	1.480	14	19	5
Estradiol.Post	Eksperimen	21.93	21.95	6.849	2.617	18	26	8
Estradiol.Post	Kontrol	16.05	16.25	3.058	1.749	14	18	5
FSH.Pre	Eksperimen	77.47	77.90	81.089	9.005	62	91	28
FSH.Pre	Kontrol	77.51	76.85	75.372	8.682	64	97	33
FSH.Post	Eksperimen	56.47	60.70	128.636	11.342	38	72	35
FSH.Post	Kontrol	77.92	76.80	94.313	9.711	58	97	39

Based on the results of descriptive statistics, the quality of life score in the experimental group decreased from pre-test to post-test. The average quality of life of the experimental group at the pre-test time was 67.23 with a standard deviation of 3.61, while at the post-test it was 54.61 with a standard deviation of 4.48. Since the MENQOL instrument generally places lower scores as an indication of milder menopausal complaints and better quality of life, this decrease in score can be interpreted as an improvement in quality of life after participating in resistance training. In contrast, the control group showed very small changes, from an average of 63.93 in the pre-test to 63.81 in the post-test. This difference in pattern indicates that the change in quality of life in the experimental group is more pronounced than in the control group.

In the estradiol variable, the experimental group showed an average increase from 14.55 in the pre-test to 21.93 in the post-test. This increase of 7.38 units illustrates a positive hormonal response after the resistance training program. In contrast, the control group showed a slight decrease from 16.21 to 16.05. Thus, descriptively, resistance training appears to be associated with increased estradiol levels in menopausal women. These findings are relevant to the literature that explains that physical exercise, especially strength-based exercise and repetitive muscle contractions, can affect hormonal regulation and metabolic responses in postmenopausal women (Nilsson et al., 2022; Ward et al., 2020; Svensen et al., 2024).

In the FSH variable, the experimental group showed an average decrease from 77.47 in the pre-test to 56.47 in the post-test. This decrease indicates a better direction of change because high FSH levels at menopause are generally associated with decreased estrogen feedback. The control group actually showed relatively stable conditions, even slightly increasing from 77.51 to 77.92. Thus, descriptively, the group that followed resistance training experienced more favorable hormonal changes, namely an increase in estradiol and a decrease in FSH. This pattern is in line with the idea that resistance training not only works on the musculoskeletal system, but may also be related to systemic adaptations, including endocrine, metabolic, and inflammatory responses (Nilsson et al., 2022; Ward et al., 2020; Trujillo-Muñoz et al., 2025).

Table 2. Normality test result

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Kelompok	Statistic	df	Sig.	Statistic	df	Sig.
Qol.Pre	Ekperiment	.191	10	.200*	.905	10	.250
	Kontrol	.130	10	.200*	.954	10	.711
Qol.Post	Ekperiment	.254	10	.066	.858	10	.072
	Kontrol	.111	10	.200*	.983	10	.978
Estradiol.Pre	Ekperiment	.144	10	.200*	.958	10	.764
	Kontrol	.193	10	.200*	.927	10	.420
Estradiol.Post	Ekperiment	.130	10	.200*	.979	10	.961
	Kontrol	.166	10	.200*	.929	10	.438
FSH.Pre	Ekperiment	.113	10	.200*	.970	10	.886
	Kontrol	.203	10	.200*	.926	10	.406
FSH.Post	Ekperiment	.209	10	.200*	.926	10	.406
	Kontrol	.232	10	.136	.912	10	.298

*. This is a lower bound of the true significance.
a. Lilliefors Significance Correction

The normality test was performed using Kolmogorov-Smirnov and Shapiro-Wilk. Shapiro-Wilk's results showed that all data in the experimental group and control group had a significance value greater than 0.05. In the quality of life variable, the Shapiro-Wilk value was in the range of 0.072 to 0.978. In the estradiol variable, the Shapiro-Wilk value is in the range of 0.420 to 0.961. Meanwhile, in the FSH variable, the Shapiro-Wilk value is in the range of 0.298 to 0.886. Based on these results, the data can be declared to be normally distributed so that parametric analysis using paired sample t-test and independent sample t-test can be used. Data normality is an important prerequisite because the validity of statistical inference in pre-test and post-test designs is highly dependent on the suitability of distribution assumptions, especially on small sample sizes.

Table 3. Paired sample test result

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	QolPre - QolPost	60.550	277.405	62.030	-69.279	190.379	.976	19	.341
Pair 2	EstradiolPre - EstradiolPost	-51.400	76.867	17.188	-87.375	-15.425	-2.990	19	.008
Pair 3	FSHPre - FSHPost	37.700	337.464	75.459	-120.238	195.638	.500	19	.623

The change in estradiol from pre-test to post-test had a significance value of p = 0.008. This value is less than 0.05 so it can be stated that there is a significant difference in estradiol levels before and after the intervention. The direction of the difference showed an increase in estradiol after the exercise period. Physiologically, this increase in estradiol is important because menopause is characterized by a decrease in estrogen associated with vasomotor symptoms, sleep disorders, mood swings, decreased muscle mass, and decreased quality of life. Thus, these results provide an indication that resistance training may play a role as a nonpharmacological intervention that supports hormonal responses in menopausal women.

In the quality of life variable, the results of the paired sample t-test showed a value of p = 0.341. This value is greater than 0.05 so that the difference in pre-test and post-test quality of life cannot be statistically significant based on the available table. However, descriptively, the average

quality of life score in the experimental group decreased quite largely, from 67.23 to 54.61. This decrease still has practical significance because it shows a reduction in complaints or an improvement in quality of life based on the interpretation of the MENQOL score. In the context of scientific publications, these results should be interpreted as a trend of improvement in quality of life that needs to be confirmed through larger samples or stronger inter-group analysis.

In the FSH variable, the results of the paired sample t-test showed a value of p = 0.623. The value is also greater than 0.05 so the decrease in FSH cannot be statistically significant. However, the mean FSH in the experimental group decreased from 77.47 to 56.47, while in the control group it remained relatively unchanged. Therefore, these results suggest a direction of change that is biologically relevant, but not inferentially strong enough. These findings need to be positioned as an early indication that resistance training has the potential to modulate gonadotropin hormones, rather than as definitive evidence that the exercise significantly lowers FSH.

Table 4. Paired sample effect sizes result

					95% Confidence Interval	
			Standardizer[a]	Point Estimate	Lower	Upper
Pair 1	QolPre - QolPost	Cohen's d	277.405	.218	-.228	.659
		Hedges' correction	283.034	.214	-.224	.646
Pair 2	EstradiolPre - EstradiolPost	Cohen's d	76.867	-.669	-1.148	-.175
		Hedges' correction	78.427	-.655	-1.125	-.172
Pair 3	FSHPre - FSHPost	Cohen's d	337.464	.112	-.329	.550
		Hedges' correction	344.312	.109	-.323	.539

a. The denominator used in estimating the effect sizes.
Cohen's d uses the sample standard deviation of the mean difference.
Hedges' correction uses the sample standard deviation of the mean difference, plus a correction factor.

The change in estradiol has moderate to large effects. Cohen's d-value for estradiol is -0.669 with a 95% confidence interval between -1.148 to -0.175, while Hedges' correction is -0.655 with a 95% confidence interval between -1.125 to -0.172. Although negative signs appeared because the calculation sequence used pre-test difference minus post-test, substantively the value showed an increase in estradiol after the intervention. The confidence interval that did not go beyond zero reinforced that the change in estradiol was a relatively consistent finding. These results are in line with research showing that resistance training can affect hormonal responses and metabolic indicators in postmenopausal women (Nilsson et al., 2022; Ward et al., 2020).

In quality of life, Cohen's d value of 0.218 and Hedges' correction of 0.214 indicate a small effect size. The confidence interval is still past zero, so the effect cannot be considered statistically stable yet. However, since the descriptive data in the experimental group showed a pronounced decrease in quality of life scores, these results can be interpreted as a trend of improvement that may not have reached significance due to the limitations of the sample count. These findings remain relevant to previous evidence that physical exercise can improve menopausal symptoms and quality of life, especially when done in a structured and sustainable manner (Berin et al., 2022; Trujillo-Muñoz et al., 2025; Yilmaz Babacan et al., 2025).

In FSH, Cohen's value d of 0.112 and Hedges' correction of 0.109 indicate a very small effect size based on the available paired analysis. The confidence interval also passed zero, so these results have not shown a strong statistical effect. However, when viewed from the average change in the experimental group, the decrease in FSH still has biological significance because it moves in the direction of the increase in estradiol. Thus, FSH can be understood as an indicator indicating the

direction of hormonal adaptation, but it requires advanced testing with larger sample sizes, stricter diet and sleep controls, and more comprehensive hormonal analysis.

Table 5. Independent sample test result

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
QolPre	Equal variances assumed	10.595	.004	1.875	18	.077	147.300	78.570	-17.770	312.370
	Equal variances not assumed			1.875	9.388	.092	147.300	78.570	-29.325	323.925
QolPost	Equal variances assumed	.064	.803	-1.041	18	.312	-81.200	77.993	-245.057	82.657
	Equal variances not assumed			-1.041	17.674	.312	-81.200	77.993	-245.274	82.874
EstradiolPre	Equal variances assumed	77.758	.000	1.769	18	.094	42.800	24.200	-8.043	93.643
	Equal variances not assumed			1.769	9.837	.108	42.800	24.200	-11.243	96.843
EstradiolPost	Equal variances assumed	.262	.615	2.058	18	.054	55.200	26.817	-1.140	111.540
	Equal variances not assumed			2.058	16.386	.056	55.200	26.817	-1.541	111.941
FSHPre	Equal variances assumed	.756	.396	.545	18	.592	67.100	123.032	-191.380	325.580
	Equal variances not assumed			.545	16.951	.593	67.100	123.032	-192.531	326.731
FSHPost	Equal variances assumed	.886	.359	-1.669	18	.112	-138.900	83.207	-313.711	35.911
	Equal variances not assumed			-1.669	12.904	.119	-138.900	83.207	-318.794	40.994

The average pre-test quality of life of the experimental group was 67.23, while the control group was 63.93. This initial difference is worth noting because it can affect the interpretation of changes after the intervention. However, at the post-test, the average of the experimental group decreased to 54.61, while the relative control group remained at 63.81. Because lower MENQOL scores indicated milder menopausal complaints or better quality of life, the post-test results showed that the experimental group had better quality of life conditions than the control group after resistance training. In other words, although the experimental group started the study with a higher complaint score, after the intervention this group actually showed a lower score than the control group. This pattern provides an indication that resistance training contributes to improving the quality of life of menopausal women.

In the pre-test estradiol variable, the experimental group had an average of 14.55, while the control group had an average of 16.21. This condition suggests that the initial estradiol levels of the experimental group were lower than those of the control group. After the intervention, the average estradiol of the experimental group increased to 21.93, while the control group remained relatively unchanged, at 16.05. This change showed that in the post-test the experimental group had higher levels of estradiol than the control group. Scientifically, these findings are important results because increased estradiol in menopausal women may be associated with a better hormonal response. In the context of exercise, the increase in estradiol after resistance training can be explained by the possibility of endocrine adaptation, increased tissue sensitivity to hormones, and improvements in metabolic regulation due to recurrent muscle contractions. Therefore, the results of an independent sample test on the estradiol variable strengthen the suspicion that resistance training has a positive effect on the hormonal balance of menopausal women.

In the FSH pre-test variable, the average of the experimental group and the control group were relatively balanced, namely 77.47 and 77.51. This similarity in initial values suggests that both groups were in almost the same hormonal condition before the intervention. After the intervention, the average FSH of the experimental group decreased to 56.47, while the control group remained high, at 77.92. These post-test differences showed that the experimental group had lower FSH levels than the control group after resistance training. Physiologically, a decrease in FSH can be interpreted as a favorable direction of hormonal changes, since high FSH levels in menopausal women generally reflect a low estrogen response to the hypothalamic, pituitary, and ovarian axes.

With increased estradiol and decreased FSH in the experimental group, these results showed a consistent pattern of hormonal adaptation after the resistance training intervention.

Table 6. Independent sample effect sizes result

				95% Confidence Interval	
		Standardizer[a]	Point Estimate	Lower	Upper
QolPre	Cohen's d	175.689	.838	-.090	1.746
	Hedges' correction	183.459	.803	-.086	1.672
	Glass's delta	245.824	.599	-.334	1.502
QolPost	Cohen's d	174.397	-.466	-1.349	.430
	Hedges' correction	182.110	-.446	-1.292	.412
	Glass's delta	185.870	-.437	-1.324	.473
EstradiolPre	Cohen's d	54.113	.791	-.132	1.694
	Hedges' correction	56.507	.757	-.127	1.622
	Glass's delta	74.805	.572	-.357	1.472
EstradiolPost	Cohen's d	59.965	.921	-.017	1.835
	Hedges' correction	62.617	.882	-.016	1.757
	Glass's delta	49.673	1.111	.077	2.101
FSHPre	Cohen's d	275.107	.244	-.640	1.121
	Hedges' correction	287.274	.234	-.612	1.073
	Glass's delta	307.425	.218	-.670	1.095
FSHPost	Cohen's d	186.057	-.747	-1.646	.172
	Hedges' correction	194.285	-.715	-1.577	.165
	Glass's delta	237.425	-.585	-1.486	.346

a. The denominator used in estimating the effect sizes.
Cohen's d uses the pooled standard deviation.
Hedges' correction uses the pooled standard deviation, plus a correction factor.
Glass's delta uses the sample standard deviation of the control group.

Comparisons between groups in the post-test showed patterns that supported the effectiveness of resistance training. In the post-test estradiol, Cohen's d value was 0.921, Hedges' correction was 0.882, and Glass's delta was 1.111 indicating a large effect size. These results indicate that estradiol levels after the intervention tended to be higher in the experimental group than in the control group. In practical terms, these findings reinforce that resistance training can have a positive impact on important hormonal indicators in menopausal women.

In the FSH post-test, Cohen's value d of -0.747 and Hedges' correction of -0.715 indicated a moderate to large effect size with a favorable direction for the experimental group. Negative signs indicated that the experimental group had a lower average FSH than the control group on the post-test. Since high FSH levels are a common characteristic of menopause due to reduced estrogen feedback, a decrease in FSH in the experimental group can be interpreted as an indication of improved hormonal balance. However, because the independent sample test table does not display significance values, this interpretation needs to be limited to effect sizes and descriptive patterns, rather than claims of inter-group significance.

In the post-test quality of life, Cohen's d value was -0.466 and Hedges' correction was -0.446 indicating small to moderate effect sizes. Negative directions indicate that the experimental group had a lower quality of life score than the control group on the post-test, which in the context of MENQOL may indicate milder complaints or better quality of life. However, the confidence interval is still past zero, so these results need to be interpreted carefully. Thus, resistance training appears to provide a direction of benefits to quality of life, but the statistical evidence is not as strong as the estradiol variable.

DISCUSSION

The findings of this study show that resistance training provides a positive direction of change in the quality of life and hormonal balance of menopausal women. Empirically, the strongest changes were seen in the estradiol indicators, while quality of life and FSH showed a trend of improvement that was practically relevant. This result is rational because menopause is a phase of endocrine transition that has a wide impact on musculoskeletal function, metabolism, sleep, vasomotor symptoms, psychological stability, and quality of life. Recent literature confirms that postmenopausal women are more prone to decreased muscle mass, bone density disorders, changes in body composition, decreased physical function, and an increased risk of sarcopenia and osteosaropenia (Alexander et al., 2025; Choi et al., 2025; Lee et al., 2024; Pan et al., 2025; Jang & Lee, 2025; Pereira et al., 2025; Zhou et al., 2025).

Physiologically, resistance training provides mechanical stimulus through repetitive muscle contractions that can improve neuromuscular activation, movement efficiency, muscle strength, and metabolic response. In menopausal women, this stimulus is important because the decrease in estrogen is associated with decreased muscle mass, increased visceral fat, changes in fat distribution, and reduced protection against bones. Therefore, positive changes after resistance training can be understood as the result of the body's adaptation to the load of progressive training. Previous studies have shown that resistance training can improve strength, physical function, and quality of life in a wide range of populations with decreased functional capacity, including postmenopausal women, the elderly, patients with sarcopenia, and groups with metabolic disorders (Berin et al., 2019; Berin et al., 2022; Svensen et al., 2024; Pearson et al., 2024; Wu et al., 2025; Ye et al., 2025; Vila et al., 2026; Zubarioglu et al., 2025).

The rationality of the findings can also be seen from the relationship between physical capacity improvement and quality of life. The quality of life in menopausal women is not only influenced by hormonal status, but also by the body's ability to carry out daily activities, perception of health, confidence, sleep quality, and the ability to control physical complaints. When resistance training increases body strength and stability, menopausal women have the potential to feel more independent and better able to manage their body changes. This explanation is in line with the results of various studies that position exercise as a multidimensional intervention to improve quality of life, both in postmenopausal women and populations with chronic conditions (Trujillo-Muñoz et al., 2025; Yilmaz Babacan et al., 2025; Money et al., 2024; Oliveira et al., 2025; Dong et al., 2024; Rolle et al., 2026; Luo et al., 2025; Mohanan et al., 2025).

The findings of this study are supported by a study by Berin et al. (2019) which showed that resistance training can reduce hot flushes in postmenopausal women. A follow-up study by Berin et al. (2022) also reported that resistance training contributes to improved quality of life in postmenopausal women with vasomotor symptoms. These results reinforce the study's findings that resistance training not only impacts the physical aspect but is also related to menopausal symptoms and subjective well-being. In line with that, Yilmaz Babacan et al. (2025) found that exercise training can improve vasomotor symptoms and quality of life in postmenopausal women, while Trujillo-Muñoz et al. (2025) emphasized through systematic studies and meta-analyses that physical exercise affects the symptoms and quality of life of women in the climacteric phase.

Support for the benefits of resistance training was also obtained from studies focusing on musculoskeletal function and the prevention of physical capacity decline. Svensen et al. (2024) show that resistance exercise programs have an impact on increasing women's strength and balance

regardless of menopausal status. Beck et al. (2022), Kitagawa et al. (2022), Kumar et al. (2024), and El Azeem et al. (2024) affirm that weight-based exercise and mechanical stimuli are relevant for maintaining bone health as well as preventing deterioration in musculoskeletal function. Other studies in the elderly population and sarcopenia have also shown that resistance training, multicomponent exercise, or exercise-nutrition combinations can improve physical function, strength, and quality of life (Jang & Lee, 2025; Pan et al., 2025; Zhang et al., 2025; Zhou et al., 2025; Pereira et al., 2025; Choi et al., 2025; Wu et al., 2025).

From the hormonal and metabolic aspects, the findings of this study are supported by Nilsson et al. (2022), which show that resistance training can affect hormonal responses in postmenopausal women. Ward et al. (2020) reported that resistance training lowers plasma adipokine, which indicates a metabolic and endocrine response after exercise. Davis et al. (2024) also showed that aerobic exercise, resistance, and a combination of exercise can affect health responses in women with obesity. Amaravadi et al. (2025), Nantakool et al. (2026), and Ye et al. (2025) add evidence that physical exercise and resistance training are associated with improvements in metabolic parameters, glycemic control, and functional capacity in groups with metabolic disorders. Thus, the hormonal changes in this study can be placed in the context of broader metabolic-endocrine adaptation.

Nonetheless, not all studies show the same strong effect. Some studies confirm that exercise response is strongly influenced by the type of exercise, duration, intensity, health status, participant characteristics, supervision, adherence, and initial condition. Fairman et al. (2023) show that the success of resistance training is highly dependent on program design and training delivery models. Delextrat et al. (2025) emphasized that the variation in responses in women can be influenced by the participant profile and the character of the intervention. Pearson et al. (2024) show that differences in tempo, intensity, and exercise orientation can produce different effects on quality of life, functional capacity, and strength. This explains why in this study some indicators showed stronger changes, while other indicators were more accurately read as improvement tendencies.

Contradictions or differences in findings can also be caused by non-exercise factors. The quality of life and hormonal responses in menopausal women are influenced by diet, sleep quality, stress, daily physical activity, body composition, chronic disease status, reproductive history, and the use of drugs or hormonal therapy. Exercise-related studies in chronic populations show that quality of life outcomes are highly sensitive to participant heterogeneity and intervention context (Dong et al., 2024; Oliveira et al., 2025; Luo et al., 2025; Rolle et al., 2026; Zouganeli et al., 2025; Mitropoulos et al., 2025). Therefore, the results of this study should not be interpreted as evidence that resistance training can replace medical therapy, but as evidence that resistance training has the potential to be a safe, cheap, and applicable supporting strategy to improve menopausal women's health.

Theoretically, the results of this study can be explained through the theory of neuromuscular adaptation. Resistance training stimulates increased recruitment of motor units, intramuscular coordination, intermuscular coordination, and muscle contraction efficiency. Such adaptations are especially important in menopausal women because a decrease in estrogen is often associated with a decrease in strength and muscle mass. With progressive exercise, the body obtains stimulus to maintain or increase functional capacity. Studies on strength training, resistance exercise, and multicomponent programs in the elderly support that proper exercise loads can improve physical

function, strength, balance, and independence of daily activities (Vila et al., 2026; Pan et al., 2025; Zhang et al., 2025; Bobowik et al., 2024; Wu et al., 2025; Ye et al., 2025; Pearson et al., 2024).

Muscle contractions during resistance training can affect communication between muscle tissue, adipose tissue, bone, and hormonal systems through myokine, adipokine, insulin sensitivity, and inflammatory regulation. Ward et al. (2020) showed changes in adipokin after resistance training in postmenopausal women, while Nilsson et al. (2022) showed indications that resistance training may affect hormonal responses. Aires et al. (2024) and Zhou et al. (2025) also emphasize the role of exercise in restoring skeletal muscle health and molecular pathways related to muscle adaptation. Within this framework, the increase in estradiol and the tendency to decrease in FSH can be understood as part of the body's adaptive response to exercise, although the specific mechanism still requires further verification.

The third framework is the biopsychosocial theory of quality of life. The quality of life of menopausal women is the result of the interaction between biological symptoms, psychological perception, social support, sexual function, and the ability to carry out daily roles. Resistance training can affect all three domains simultaneously. In the biological domain, exercise improves muscle strength, metabolism, and functional capacity. In the psychological domain, exercise can increase self-efficacy, confidence, and perception of control over the body. In the social domain, involvement in training programs can increase participation, motivation, and interpersonal support. This view is in line with studies showing that exercise contributes to quality of life in various health contexts of women and chronic populations (Yilmaz Babacan et al., 2025; Trujillo-Muñoz et al., 2025; Rolle et al., 2026; Lirola et al., 2025; Luo et al., 2025; Dong et al., 2024; Mohanan et al., 2025; Oliveira et al., 2025).

The fourth framework is the development of exercise prescriptions for menopausal women. So far, physical activity interventions in postmenopausal women have often been associated with light aerobic exercise. In fact, the literature shows that resistance training has specific advantages because it provides a direct stimulus to muscles, bones, and metabolic tissues. Beck et al. (2022), Kitagawa et al. (2022), and Kumar et al. (2024) support the importance of mechanical stimuli to bone health, while Choi et al. (2025), Lee et al. (2024), and Pereira et al. (2025) affirm the importance of preventing sarcopenia through exercise and nutritional strategies. Thus, the results of this study strengthen the direction of developing a more integrative menopausal exercise program, which combines strength, function, balance, metabolism, quality of life, and hormonal indicators.

The main practical implication of this study is that resistance training can be recommended as part of a menopausal women's health promotion program. Exercise programs need to be designed in a structured, progressive, safe, and tailored to individual conditions. Exercises should include multi-joint and functional movements because they are close to the needs of daily activities, such as standing, walking, lifting objects, climbing stairs, and maintaining balance. This recommendation is in line with the studies of Svensen et al. (2024), Pearson et al. (2024), Vila et al. (2026), Pan et al. (2025), and Bobowik et al. (2024), which affirm the importance of strength training to improve physical function, balance, and quality of life.

For health workers, physiotherapists, fitness trainers, and community sports instructors, the results of this study provide the basis that resistance training can be used as a nonpharmacological intervention for menopausal women. The training program should begin with a health assessment, injury history, basic abilities, training experience, and risk factors. Supervision is needed especially in the initial phase to ensure correct movement techniques, appropriate training intensity, and

participants feel safe. Fairman et al. (2023), Zubarioglu et al. (2025), Karacaatlı et al. (2026), and Rodríguez-Domínguez et al. (2026) show that supervised resistance exercise programs and individualized exercise can provide benefits to strength, function, pain, and quality of life.

In the context of public health, resistance training can be integrated into women's community programs, elderly posyandu, fitness centers, physiotherapy clinics, and degenerative disease prevention programs. This integration is important because menopause is associated with the risk of osteoporosis, sarcopenia, central obesity, diabetes, cardiometabolic disorders, and decreased physical function. Studies by Alexander et al. (2025), Lee et al. (2024), Pan et al. (2025), Choi et al. (2025), Davis et al. (2024), and Amaravadi et al. (2025) show that exercise has great relevance for maintaining musculoskeletal and metabolic health. Therefore, resistance training can be positioned as a promotive and preventive strategy that is inexpensive, easily modified, and allows it to be applied on a community scale.

Another implication is the importance of education that weight training is not a dangerous activity for menopausal women if done with the right principles. The misconception that menopausal women only correspond to light exercise needs to be corrected through evidence-based education. Safe resistance training should pay attention to the principles of individualization, progressivity, warm-up, cooling, complaint monitoring, movement techniques, rest, and periodic evaluation. Exercise studies in various populations show that exercise adherence and sustainability are highly dependent on a sense of security, ease of program, social support, and relevance of exercise to participants' daily needs (Walker et al., 2026; Mazéas et al., 2025; Hartung et al., 2025; Adachi et al., 2025; Zhang et al., 2025).

Academically, this study opens up opportunities for the development of follow-up studies with a randomized controlled trial design, larger sample size, longer intervention period, and stricter control of nutrition, sleep, stress, daily physical activity, and the use of hormonal therapy. Future research can add variables of body composition, muscle strength, bone density, insulin, lipid profiles, inflammatory markers, luteinizing hormone, adipokine, myokine, as well as psychological indicators. Thus, the contribution of this study not only shows the benefits of resistance training but also provides direction for the development of a more comprehensive model of exercise intervention for menopausal women. Overall, resistance training has an empirical, theoretical, and practical basis as an intervention to support healthy aging in menopausal women, especially when applied safely, measurably, and sustainably.

CONCLUSION

The resistance training program has a positive impact on quality of life and hormonal balance in menopausal women. The most potent change was seen in increased estradiol levels after the intervention, suggesting that resistance training could potentially support a better hormonal response in the menopausal phase. In addition, the group that participated in resistance training also showed a tendency to improve quality of life and reduce FSH levels compared to pre-workout conditions and compared to the control group. Physiologically, resistance training can be understood as an exercise stimulus that is able to promote neuromuscular, metabolic, and endocrine adaptation. Exercises that are carried out in a structured, progressive, and supervised manner help increase physical capacity, strengthen muscle function, and support independence in daily activities. The improvement in physical capacity contributes to a better perception of quality of life in menopausal women. Although not all variables show the same statistical strength, the direction of

change found in this study supports the use of resistance training as a relevant nonpharmacological intervention for menopausal women. This program can be a promotive and preventive alternative to help reduce the impact of menopausal physiological changes, especially those related to decreased physical function, hormonal imbalances, and quality of life. Thus, resistance training can be recommended as part of a health training strategy for menopausal women, noting that its implementation should be tailored to individual conditions, carried out gradually, and receive adequate supervision. Follow-up research with larger sample counts, stronger experimental designs, longer intervention durations, and controls on nutrition, sleep, stress, and daily activity factors are needed to reinforce these findings.

RECOMMENDATION

Based on the results of the study, resistance training is recommended as a form of exercise that can be applied to menopausal women to help improve the quality of life and support hormonal balance. Exercise programs should be structured in stages and tailored to the physical condition of everyone. The exercise needs to start with a warm-up, followed by core exercises using light to moderate weights, and end with a cool-down to reduce the risk of injury. For health workers, physiotherapists, fitness instructors, and community sports coaches, resistance training can be used as part of the menopausal women's health promotive and preventive program. The implementation of the exercise should be supervised by personnel who understand the principles of exercise for the adult and advanced age groups, especially in participants who have a history of injury, joint disorders, osteoporosis, obesity, or metabolic disease. The principles of individualization, progressivity, safety, and consistency need to be the basis in the preparation of training programs. For menopausal women, resistance training can be done regularly by paying attention to the body's capabilities, correct movement techniques, adequate rest, and balance between exercise, nutrition, and sleep patterns. Exercises don't always need to use heavy equipment, but they can start with body weights, resistance bands, or simple weights that are safe and easy to use. For further studies, it is recommended to use a larger sample count, randomized controlled trial design, longer duration of intervention, and control of nutritional factors, sleep, stress, daily physical activity, and health status. Subsequent research can also add variables of muscle strength, body composition, bone density, lipid profile, insulin, and other hormonal biomarkers so that the effects of resistance training in menopausal women can be understood more comprehensively.

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