SAR Journal of Anatomy and Physiology

Abbreviated Key Title: *SAR J Anat Physiol*
Home page: https://sarpublication.com/journal/sarjap/home
DOI: https://doi.org/10.36346/sarjap.2026.v07i04.001

OPEN ACCESS

ISSN 2707-7713 (P)
ISSN 2709-6874 (O)

Original Research Article

Effect of a Moderate Intensity Aerobic Training Program with Elliptical Machine on Some Hormonal and Physical Indicators and Body Composition in Post-Menopausal Women with Insulin Resistance (Aged 45-50)

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Article History: | Received: 15.08.2026 | Accepted: 20.10.2026 | Published: 24.10.2026 |

Abstract: This study aimed to investigate the effect of an 12-week moderate-intensity aerobic training programme using elliptical machine on insulin resistance, body composition, cardiorespiratory endurance and some metabolic and hormonal parameters in postmenopausal women (45 to 50 years old). A single-group design with pre- and post-test measurements was used by the researcher in their experimental technique. A purposive sampling method was used in the study, and the sample size was 15 women in the first sample and 10 women in the last after applying the exclusion, and inclusion criteria. The elliptical training programme that the participants completed had 44 sessions over the course of 12 weeks. Based on the Karvonen formula, we decided to aim for between 40% and 55% of HRR, and work in 20- to 30-minute blocks, gradually increasing to 1 hour. Adiponectin, fasting insulin, fasting glucose, HOMA-IR, weight, BMI, hip circumference, waist-to-hip ratio, percentage of body fat, mass of fat, and mass free of fat, and distance covered in a 6-minute walk test (6MWT), which was used to assess cardiorespiratory endurance, were measured. These findings demonstrated statistically significant increases in adiponectin (73.81%), decreases in fasting insulin (22.75%), fasting glucose (12.41%), and HOMA-IR (32.34%) from pre- to post-measures. Fats mass (18.51%), body fat percentage (13.91%), waist circumference (4.56%), hip circumference (3.74%) and body mass index (5.32%) all showed significant decreases whereas fat-free mass (2.83%) showed a significant increase. The WHR showed a slight decrease (-0.87%), but remained fairly stable. This improvement was even greater for the 6-minute walk distance (17.31%). The findings indicate that an aerobic exercise program using an elliptical machine enhanced metabolic parameters, body composition and cardiorespiratory capacity during the moderate intensity exercise program.

Keywords: Elliptical, Aerobic Exercise, Insulin Resistance, Adiponectin, Postmenopausal Women, Body Composition.

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INTRODUCTION

Obesity, diabetes, cancer, sleep apnea, among other health and metabolic diseases is on the rise because of sedentary lifestyles and less exercise. This is particularly true for conditions where insulin resistance of the tissues and alterations in body composition are associated with obesity. Frequent exercise promotes good body composition, efficient systems and regulates glucose and lipid metabolism. Since hormonal and physiological changes impact fat distribution, body composition, and metabolic responses throughout postmenopausal women, these factors take on added importance during this time. Exercising regularly during this time can improve many aspects of body composition, according to research (Khalafi *et al*., 2023). These include a reduction in fat mass, BFP and waist circumference and an increase in lean body mass. Adipokine Adiponectin is a key marker in metabolic regulation and it is involved in the regulation of glucose and lipid metabolism, as well as insulin sensitivity of tissues. Metabolic diseases and insulin resistance have

been associated with low levels of adiponectin, and exercise has been shown to have the capacity to change this marker and other pathways involved in insulin sensitivity (Consitt *et al*., 2018). There is strong evidence from systematic studies that aerobic exercise improves metabolic and functional health, including a number of cardiac and metabolic markers in postmenopausal women (Huynh *et al*., 2024). Furthermore, there are benefits that come from physical activity for insulin sensitivity and glucose utilisation control in muscles and other tissues (Bird & Hawley, 2017). The elliptical trainer is one type of aerobic training exercise that allows for simultaneous upper and lower body movement, and can be performed with other progressive aerobic training techniques. Women who participated in an 12-week elliptical training programme had higher levels of cardiorespiratory fitness and specific physiological parameters after the exercise programme (Egaña and Donne, 2004). Therefore, the aim of this study was to collect practical data on the physiological reaction to moderate intensity aerobic training by investigating the effects of 12 weeks training on insulin resistance in postmenopausal women aged 45-50 and several hormonal, metabolic, morphological and physical indicators.

Research Problem

During and after menopause, there are common changes in body composition including metabolic changes, redistribution of fat, and more. The changes reflect the need to have exercise and health programs to be based on regular physical activity to aid this population. The effects of exercise on insulin sensitivity and body composition in postmenopausal women have been the subject of many research. These findings, however, have been inconsistent because of variations in the number of samples, the form of training used, training intensity, training duration, and variables measured. Exercise programmes have been demonstrated to enhance insulin sensitivity markers in postmenopausal women (Bueno-Notivol *et al*., 2017; Khalafi *et al*., 2023) and exercise programmes have been demonstrated to enhance body composition markers (Skelton *et al*., 2018; Elka *et al*., 2019; Fard *et al*., 2020). To evaluate the impact of a training programme, however, not only insulin, glucose and HOMA-IR, but also adiponectin, an important marker of metabolic regulation and insulin sensitivity, must be measured. Based on this, the effect of a 12-week moderate intensity aerobic training using elliptical machine on insulin resistance in postmenopausal women (45-50 years) and on their body composition, cardiorespiratory endurance and some metabolic and hormonal markers will be explored.

Research Objectives

To Accomplish the Study Objective(s) to

Develop a moderate intensity elliptical aerobic exercise program for postmenopausal women who are insulin resistant (age 45-50). Discover the change in insulin resistance, fasting glucose and adiponectin following the training programme and how this relates to HOMA-IR. Discover the changes in weight, BMI, hip size, waist size, ratio of the waist to the hip, percentage of body fat, mass of the fat and mass free from fat after beginning the training programme. Know the impact of the training programme on the ability to walk for 6 minutes without stopping (cardiorespiratory endurance).

Claims for the Study

A statistically significant difference favours the post-test when comparing the pre-test and post-test hormones and metabolism. When comparing pre- and post-test results on the morphological and body composition variables evaluated, there are statistically significant differences between pre- and post-test results, the post-test having statistically significantly higher scores. With regards to the cardiorespiratory endurance, there are statistically significant differences between pre-test and post-test scores, and the post-test scores are higher.

Areas of Study

The sample of the study consists of postmenopausal women who are insulin-resistant (between the age of 45-50 years.). The temporal scope is the 12-week training period (both the pre- and post-test phases). The Fitness Home Centre for Fitness is the training site for the Fitness programme and is where all measurement will be taken.

Approach to Research

The researcher employed one group as designs with pre and post-test measurements. The study's objectives and the design necessitated the use of such a study to determine if a postmenopausal women with insulin resistance would benefit from an elliptical training programme which incorporated moderate intensity aerobic training. This design involves measuring and assessing the sample participants before the training programme, after the programme ends, measuring and assessing again to see how much of a change there was in the study variables, and finally comparing the two sets of data.

The Data is Collected From Study Participants

The research population consisted of post menopausal women who had insulin resistance and were within the age range of the study and were eligible to participate in the training programme. Researchers utilised a purposive sampling technique to pick their study participants. Volunteers who responded to the study announcement and members and customers of the "Fitness Home" facility were recruited. The initial group of women consisted of 15 women. A medical examination and cross-check of the inclusion/exclusion lists were performed on five individuals, who were judged to be unsuitable and did not participate in the study. The resulting experimental group comprised 10

women who were measured prior to the study, during the training programme and following that.

When picking a sample, the following is important to consider.

These Criteria Were Used in Selecting the People to Be Included in the Sample:

1. Young adulthood (45–50 years old).
2. The subject be in the postmenopausal period.
3. Laboratory tests must confirm insulin resistance.
4. Participants must be able to perform aerobic exercises on an elliptical trainer.
5. The research period, the volunteer can't be a regular part of any other fitness programme.

Attendees also underwent health checkup by Dr. Wasan Khairallah Yassin from Maysan Hospital to ensure their healthiness to participate in the course too. The nature and procedure of the study were explained to the participants and agreement was obtained from them. The study received the proper ethical approval prior to procedures.

Criteria to Exclude Study Subjects

For the Present Study the Following Were Excluded:

1. The menopause has not been confirmed using the accepted criteria.
2. Laboratory studies were unable to confirm insulin resistance.
3. Due to a health or medical condition, I am not able to join the programme as I cannot do aerobic exercises.
4. Engaging in another exercise training programme on a regular basis in a way that could impact the study's findings.
5. Not complying with the requirements of the training programme/measuring procedures.
6. Missing data from either the pre- or post-test.

Any other medical problem noticed by the specialist or doctor that may pose a threat to the participant's safety or the integrity of the data. Homogeneity of Study Population:

In order to have homogeneity of the sample members before the experimental programme was implemented, arithmetic means, standard deviations and skewness coefficients were calculated for the demographic, morphological, physical and metabolic characteristics as recorded in table (1).

Table 1: The arithmetic means, standard deviations and skewness of the variables studied were computed before implementation of the programme

Skewness	Standard Deviation	Arithmetic Mean	Unit of Measurement	Variable
0.10	2.13	47.10	Year	Age
0.12	3.43	159.20	Cm	Height
-0.15	4.53	82.60	Kg	Body weight
0.55	1.42	32.59	kg/m²	Body Mass Index (BMI)
-0.06	3.05	94.20	Cm	Waist circumference
-0.18	3.09	109.70	Cm	Hip circumference
-1.01	0.010	0.859	Ratio	Waist-to-hip ratio
-0.21	2.77	38.10	%	Body fat percentage
0.53	15.73	454.20	m	-6minute walk distance
0.88	1.32	4.20	µg/ml	Adiponectin
-0.35	1.66	18.90	µIU/ml	Fasting insulin
0.35	1.66	120.10	mg/dl	Fasting glucose
-0.10	0.54	5.61	Index	HOMA-IR

Based on the values of the skewness coefficient, the variables to be studied are not significantly different from a normal distribution, so the parametric statistical tests which are suitable for the characteristics of the data should be used.

Research Equipment, Tools, and Methods

Most importantly, the researcher used a range of instruments, techniques and tools that were suitable to the nature of the study variables and procedures, such as:

1. The InBody 270, a body composition analyser that measures both weight and percentage of fat in the body.
2. Elliptical trainer (to perform the exercise programme).
3. A height-measuring stadiometer.
4. A tape measure which is flexible enough to measure hip and waist circumference.
5. Reminder device (for the 6 minute walk test).
6. A pathway or appropriate location (to carry out the six-minute walk test).
7. Equipment and materials needed to collect blood samples.
8. Laboratory kits to measure glucose, insulin and adiponectin.
9. Data and finding forms.
10. Data processing equipment such as statistical computing and electronic calculator.

Analysing Factors and Using Measurements

The following variables were measured or calculated: hormonal, metabolic, physical and body composition.

First: Starting with: Measuring Height

The height of the individuals involved in the study was measured using stadiometer. The person took the standing posture which was usually used on the device's platform, with their feet flat on the ground, back straight and head held horizontally. Then it was inserted into the head in centimetres as the movable headpiece of the device was pushed down until it touched the top of the head.

Second: Subsequently: Mass

The InBody 270 equipment was used to measure the subject's weight in kg. A pre- and post-measurement setting was administered to all members of the sample and was as uniform as possible.

Thirdly: The percentage of Body Fat

The body fat percentage (PBF) was directly assessed by the InBody 270 Body Composition Analyser using Direct Segmental Multi-Frequency Bioelectrical Impedance Analysis (DSM-BIA) technology. The researcher took the percentage value displayed in the report for the body composition analysis at the pre- and post-measure, and measurements were conducted following the operating procedures of the device. For this reason the body fat % in this research is considered an independent variable and it has not been calculated based on the height or weight but has been measured directly on the device.

Fourth: Fat Mass

The InBody 270 device measured the amount of body fat and total body weight, and these measurements were then The body fat mass is equal to the body weight (kg) times the body fat percentage in the above equation. Fat mass is therefore a numerical representation of a person's body weight + their body fat percentage.

Fifth: Numerical Fat Content:

The following equation was used to determine Fat-Free Mass (FFM) by removing fat mass from body weight:

Fat-Free Mass is the difference between Body weight and Fat mass and is a value which is calculated as a result of computation and not an objective measurement that is recorded by the device.

Sixth: BMI

The following formula was used to calculate a person's Body Mass Index (BMI):
BMI – Body Weight (kg) / Height squared (m2). The result was given in units of kg/m².

Seven: Waist Size

Waist circumference was measured in centimetres with a flexible tape measure, under standardised conditions, for all subjects in the study.

Eight: Hip Size

Hip circumference was measured at the appropriate point using a flexible measuring tape in centimetres. This made the measurement the same for the pre- and post-test.

Nine: Hip-to-Waist Ratio

To calculate the ratio of waist circumference (WHR), the following formula was used: waist circumference/hip circumference. Waist-hip ratio equals the product of the three circumference measurements – waist, hips.

Short-Term Mobility Evaluation

Functional Cardiorespiratory Endurance capacity was assessed by Six-Minute Walk Test (6MWT). The subject was asked to walk along a test track for a period of 6 minutes and the distance walked over this period was measured. The result of the test was not converted to an expected oxygen consumption value, but was reported in metres and the distance covered in 6 minutes was used to indicate capability for functional endurance.

Analysis of Hormones and Metabolites Hormone and Metabolic Analysis

First: Adiponectin

The levels of serum adiponectin were determined by following the instructions provided by the assay kit's manufacturer for the (ELISA) technique.

Second: Fasting Insulin

The data were expressed in μIU/mL and were determined in the fasting blood insulin obtained following an overnight fast according to normal laboratory procedures.

The fasting blood glucose (FBG) was measured by a conventional laboratory technique and the results were interpreted in mg/dL.

The Insulin Resistance Index (HOMA-IR) is the fourth indicator.The fourth indicator is HOMA-IR (Insulin Resistance Index).

Fasting insulin and glucose levels were used to determine the HOMA-IR assessment. If glucose is reported in mmol/l, the formula to find the index is:
HOMA-IR (Homeostatic Model Assessment-Insulin Resistance) = Fasting Insulin (μIU/mL) x Fasting Glucose (mmol/L) / 22.5.

In this study, the results for glucose were reported in mg/dl, which was divided by 18 or the equivalent equation, before calculating the index.

HOMA-IR is an approximation to insulin resistance using fasting glucose and insulin levels.

****Pilot Study****

Before the main experiment, a pilot study was carried out to ensure the measurement procedures and tests were valid, to evaluate the appropriateness of the tools and equipment used, and to spot any problems that could arise during testing, measurement, and the training program's implementation. To make sure the methods were clear and feasible for the study sample, the pilot study was also conducted.

Pre-intervention Tests and Measurements

The sample of individuals was administered a set of pre-intervention assessments before the training programme started. Evaluation included body composition factors, anthropometric measures and the six minute walk test. Blood samples were collected for the measurement of adiponectin, fasting insulin and fasting glucose, in addition to the measurement of the HOMA-IR score. The researcher did his utmost to standardize as much as possible the time for the measurements, the way the blood sample was taken and the laboratory conditions.

****Training Program****

We devised a 12-week, 44-session aerobic exercise programme that made use of the elliptical machine.

The program has the following structure:
There will be a total of 12 training sessions (3 sessions per week) in Weeks 1-4.
There will be 32 sessions of learning (4 sessions per week) for weeks 5-12.

A total of 44 training sessions.

Gradually adjusting the intensity of training to match the various stages of the programme was done using the Heart Rate Reserve (HRR) approach, which is based on the Karvonen formula. Training Intensity Assessment.

A method called Heart Rate Reserve (HRR) was used to determine the intensity of training. It was based on the following equation:
HRR = HRmax − HRrest
The target heart rate was then calculated using the equation:
Target HR = HRrest + (HRR × intensity)

Training Intensity Ranged as Follows:

- 40–45% HRR during weeks 1–4.
- 45–50% HRR during weeks 5–8.
- 50–55% HRR during weeks 9–12.

****Training Session Components****

Each training session consisted of three main parts:

1. Warm-up.
2. Main session (using the elliptical machine).
3. Cool-down.

During weeks 1-4, each training session lasted 40 minutes; weeks 5-8, 45 minutes; and weeks 9-12, 50 minutes.
The duration of the main session on the elliptical machine was:

- 20 minutes in the first phase.
- 25 minutes in the second phase.
- 30 minutes in the third phase.

****Training Program Organization****

To ensure a progressive increase in training load throughout the programme, the programme was implemented in a progressive manner with regard to training intensity, primary session duration and weekly training sessions.

****Controlling Program Conditions****

Consistency in the conditions of the programme and tests was ensured by the researcher. All non-compliant and/or missing participant data was noted and compliance with training sessions and measurement instructions was monitored. Post mortem evaluations and exams. After the 12-week training programme ended, researchers measured and tested participants again using the same instruments and protocols as before to see how much of a difference the programme had on the study variables.

Data Analysis Techniques

The data was then analysed statistically using SPSS Version 26 software, which included the following methods:

1. Arithmetic mean.
2. Standard deviation.
3. Skewness coefficient.
4. Paired-samples t-test (to compare pre- and post-measurements).
5. Percentage of change.

The Percentage of Change Was Calculated using the Following Formula:

Percentage of Change (%) = [(Post-measurement Value − Pre-measurement Value) ÷ Pre-measurement Value] × 100.

To find out how significant the changes were between the pre- and post-measurements, a p-value of less than or equal to 0.05 was used.

Students should be able to analyze and discuss the results.
To begin with, some findings on morphological factors and body compositio have been observed as follows:

Table 2: Arithmetic mean, percentage of change, t value and significance level for morphological characteristics and body composition

Variable %	p	t	Post-test Mean ± SD	Pre-test Mean ± SD	Variable

−5.33%	<0.001	11.85	78.20 ± 3.85	82.60 ± 4.53	Weight (kg)
−5.32%	<0.001	12.00	30.85 ± 1.15	32.59 ± 1.42	BMI (kg/m²)
−4.56%	<0.001	20.15	89.90 ± 3.57	94.20 ± 3.05	Waist circumference (cm)
−3.74%	<0.001	5.94	105.60 ± 1.84	109.70 ± 3.09	Hip circumference (cm)
−0.87%	0.334	1.02	0.851 ± 0.025	0.859 ± 0.010	WHR
−13.91%	<0.001	12.53	32.80 ± 3.33	38.10 ± 2.77	Body fat percentage(%)
−18.51%	<0.001	15.71	25.73 ± 3.58	31.58 ± 3.96	Fat mass (kg)
+2.83%	0.008	−3.41	52.47 ± 1.94	51.02 ± 0.94	Fat-free mass (kg)

DISCUSSION OF RESULTS

The body composition indicators and morphological indicators were greatly reduced in most cases as indicated in Table (2). The largest drop in mass was fat mass (-18.51%) and body fat percentage (-13.91%). Other body measurements (including weight, BMI, waist and hip circumference) declined, with fat-free mass showing a significant increase. The researcher attributed these changes to the regular 12-week moderate intensity elliptical aerobic exercise, greater energy use and improved energy use during exercise. Additionally, elliptical training makes sure that a lot of muscles are worked out all during the workout since it uses both the upper and lower limbs. Decreases in fat mass, waist circumference and body fat percentage are due to physiological adaptations that occur as a result of the prolonged aerobic training and increased energy expenditure during the programme. This finding is consistent with the systematic reviews of postmenopausal exercise training, which have proven that exercise training produces positive changes in various body composition measures such as loss of fat mass, fat percent, and waist circumference (Khalafi *et al*., 2023; Huynh *et al.,* 2024). The discrepancy between the two measures indicates that the fat-free mass was increased by 2.83% following the weight loss; this could be due to adaptations induced by regular physical exercise, and/or loss of fat-free tissue. There was no significant difference between the two measures found with a shift of -0.87% in the waist to hip ratio (WHR). It was very little change in the overall ratio because the decrease in waist circumference and hip circumference were not very different statistically throughout the programme.

However, the results indicated that there were no significant changes in the waist-to-hip ratio, but there was a significant increase in various indicators of body composition, including fat mass, body fat percentage, weight and waist circumference, as well as an increase in fat-free mass, following the moderate-intensity aerobic training programme with the elliptical machine.

Last, the results related to the physical and functional properties are:

Table 3: The means, standard deviations, computed t-values, significance levels, and percentage change of physical and functional variables were calculated

Variable %	p	t	Post-test Mean ± SD	Pre-test Mean ± SD	Variable
+17.31%	<0.001	−9.53	532.80 ± 36.06	454.20 ± 15.73	-6minute walk (m)

Table (3) indicates that there was a significant improvement in the distance walked in 6-minutes from baseline (454.20 ± 15.73 metres) to post-intervention (532.80 ± 36.06 metres), which corresponds to 17.31% increase after the intervention, suggesting improvement in functional capacity for aerobic exertion. The researcher attributed this increase to physiological adaptations resulting from a prolonged period of training at moderate intensity using elliptical aerobic exercise, and also to progressive increases in training load over the duration of the main phase of training and number of training sessions. This is consistent with Malandish *et al*., (2022) who determined that moderate aerobic exercise was beneficial to some measure of cardiorespiratory fitness in overweight and obese postmenopausal women. This finding is in line with systematic evaluations that have shown that exercise training improves cardiorespiratory fitness in postmenopausal women (Huynh *et al*., 2024; Khalafi *et al*., 2023). Furthermore, aerobic exercise also activates the cardiovascular and respiratory systems as well as the working muscles, providing for extended physical exertion, a possible reason for being able to walk longer and faster after exercising. In the participants who took part in the moderate-intensity aerobic training programme using an elliptical machine, there was an improvement in cardiorespiratory endurance measured by the 6-minute walk distance.

Table 4: Means, standard deviations, t-values, p-values and percent change for hormonal and metabolic variables

Variable %	p	t	Post-test Mean ± SD	Pre-test Mean ± SD	Variable
+73.81%	<0.001	−13.29	7.30 ± 1.42	4.20 ± 1.32	Adiponectin
−22.75%	<0.001	7.98	14.60 ± 1.71	18.90 ± 1.66	Fasting insulin (µIU/ml)
−12.41%	<0.001	11.21	105.20 ± 4.76	120.10 ± 1.66	Fasting glucose (mg/dl)
−32.34%	<0.001	11.26	3.79 ± 0.49	5.61 ± 0.54	HOMA-IR

nt and fasting glucose levels decreased by -12.41 percent, as shown in Table 4. Adiponectin got increased by 73.81%. These were in addition to measures of insulin resistance, which dropped by 32.34%, and for which there were statistically significant differences from pre-to-post intervention for all variables. Participants in the study showed improvements in a number of metabolic parameters, the researcher believes are attributable to training-induced adaptations resulting from changes in body composition. The increases in adiponectin levels in the participants after the program might reflect metabolic changes in the participants. Adiponectin is one of the primary adipokines involved in the regulation of glucose and lipid metabolism, and insulin sensitivity of tissues. Results like these are in line with what Consitt *et al.,* (2018) found: that older women's adiponectin responses can be impacted by 12 weeks of endurance training. Aerobic exercise can help to lower fasting insulin and glucose levels with a number of beneficial effects, such as improved glucose regulation, increased glucose utilization by the working muscles, and prolonged training induced tissue insulin sensitivity. Insulin sensitivity and glucose utilisation management are both enhanced by frequent physical exercise, according to Bird and Hawley (2017). The decrease in fasting insulin and glucose, the two variables used in the calculation of insulin resistance index (HOMA-IR), can explain the decrease of 32.34% in the insulin resistance index. This data matches to those found by Bueno-Notivol *et al.,* (2017). They examined the extensive literature and carried out a meta-analysis that showed a decrease in insulin and HOMA-IR in women who trained for 3–4 months as postmenopausal women. Interestingly, these metabolic changes were accompanied by enhancements in some body composition parameters such as weight, body fat percentage and fat mass. These alterations probably helped bring about the observed improvements in metabolic indicators, in addition to the direct impacts of exercise. Recent assessments have found that aerobic activity offers several metabolic and cardiac benefits to postmenopausal women (Huynh *et al*., 2024). The decrease in metabolic markers (fasting insulin, fasting glucose and HOMA-IR) along with the increase in adiponectin in the study participants would exhibit an integrated pattern of changes in their metabolic markers following the programme. Although the results presented should be interpreted with caution because of the design and sample size of this study, the results indicate that greater improvements in insulin sensitivity markers occurred with elliptical aerobic training throughout this programme at a moderate intensity.

CONCLUSIONS

The following are the conclusions drawn by the researcher in relation to the research objectives, methodologies used in the field, and the statistical results:

1. The 12-week moderate intensity aerobic exercise programme on an elliptical trainer resulted in a significant increase in adiponectin (73.81 percentage points).
2. A steep drop in fasting insulin levels (-22.75%) and glucose levels (-12.41%) was linked to the programme.
3. The insulin resistance index (HOMA-IR) substantially decreased by -32.34% together with the reduction in fasting insulin and glucose.
4. Those who participated in the programme saw notable drops in their body weight (-5.33%), BMI (-5.32%), waist (-4.56%), and hip (-3.74%).
5. The lean body mass increased by 2.83%, body fat percentage decreased by 13.91%, and fat mass decreased by 18.51%.
6. The WHR had the least change (percentage change of -0.87%) when compared with the other indicators of body composition.
7. The 6 minute walk test (6MWT) showed an improvement in walking distance of 17.31% indicating improved functional capacity for aerobic exercise and cardiorespiratory endurance.
8. During the trial period, participants who performed a moderate-intensity aerobic training programme using an elliptical machine improved on various metabolic, morphological and functional markers.

Recommendations:

The following are the researcher's recommendations based on the study's findings:

1. Following menopause, exercise programmes for women should incorporate elliptical aerobics, taking into account individual characteristics and health status.
2. Adopting a progressive method of aerobic exercise in terms of intensity, length and frequency, and using the present programme as a training model which can be adapted to the special characteristics of target groups.
3. Training studies undertaken in individuals with insulin resistance related diseases should continue to monitor metabolic markers, such as fasting glucose, insulin level, HOMA-IR, in concert with healthcare providers.
4. Body weight should not be the only parameter used to study the effect of aerobic programmes on postmenopausal women and, instead, body composition and functional and metabolic parameters should be measured.
5. Looking at the effects of HIIT vs. continuous aerobic training on adiponectin, insulin, HOMA-IR, and body composition in postmenopausal women in future studies.

6. Unfortunately, future studies on aerobic training and these variables should be larger and have control group experimental designs to further verify the effect of aerobic training.
7. Examine the effects of elliptical training on metabolic markers and other adipokines (resistin and leptin) and the relationship between these markers and body composition.
8. Consider the specific needs of various groups when designing training programmes, such as: men, type 2 diabetes, metabolic risk factors.

REFERENCES

- Bird, S. R., & Hawley, J. A. (2017). Update on the effects of physical activity on insulin sensitivity in humans. BMJ Open Sport & Exercise Medicine, 2(1), e000143. https://doi.org/10.1136/bmjsem-2016-000143
- Bueno-Notivol, J., Calvo-Latorre, J., Alonso-Ventura, V., Pasupuleti, V., Hernández, A. V., & Pérez-López, F. R. (2017). Effect of programmed exercise on insulin sensitivity in postmenopausal women: A systematic review and meta-analysis of randomized controlled trials. Menopause, 24(12), 1404–1413. https://doi.org/10.1097/GME.0000000000000936
- Consitt, L. A., Saxena, G., & Schaefer, M. (2018). Sex-dependent reductions in high molecular weight adiponectin during acute hyperinsulinemia are prevented with endurance training in older females. Clinical Endocrinology, 88(5), 673–682. https://doi.org/10.1111/cen.13563
- Egaña, M., & Donne, B. (2004). Physiological changes following a 12 week gym based stair-climbing, elliptical trainer and treadmill running program in females. The Journal of Sports Medicine and Physical Fitness, 44(2), 141–146.
- Huynh, E., Wiley, E., Noguchi, K. S., Fang, H., Beauchamp, M. K., MacDonald, M. J., & Tang, A. (2024). The effects of aerobic exercise on cardiometabolic health in postmenopausal females: A systematic review and meta-analysis of randomized controlled trials. Women's Health, 20, 17455057241290889. https://doi.org/10.1177/17455057241290889
- Khalafi, M., Habibi Maleki, A., Sakhaei, M. H., Rosenkranz, S. K., Pourvaghar, M. J., Ehsanifar, M., Bayat, H., Korivi, M., & Liu, Y. (2023). The effects of exercise training on body composition in postmenopausal women: A systematic review and meta-analysis. Frontiers in Endocrinology, 14, 1183765. https://doi.org/10.3389/fendo.2023.1183765
- Khalafi, M., Sakhaei, M. H., Habibi Maleki, A., Rosenkranz, S. K., Pourvaghar, M. J., Fang, Y., & Korivi, M. (2023). Influence of exercise type and duration on cardiorespiratory fitness and muscular strength in post-menopausal women: A systematic review and meta-analysis. Frontiers in Cardiovascular Medicine, 10, 1190187. https://doi.org/10.3389/fcvm.2023.1190187
- Malandish, A., Rahmati-Yamchi, M., et al. (2022). The effect of moderate intensity aerobic exercise on cardiovascular function, cardiorespiratory fitness and estrogen receptor alpha gene in overweight/obese postmenopausal women: A randomized controlled trial. Journal of Molecular and Cellular Cardiology Plus, 2, 100026. https://doi.org/10.1016/j.jmccpl.2022.100026.