RESEARCH PAPER

EFFECT OF ECCENTRIC RESISTANCE TRAINING WITH AEROBIC EXERCISE ON LIPID PROFILE IN YOUNGER ADULTS

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Abstract
An altered lipid profile has been shown to play a significant role in metabolic and cardiovascular diseases. It has been demonstrated that regular engagement in structured exercise programs and physical activity improves lipid metabolism and lowers the risk of cardiovascular problems. Thus, the purpose of this study was to investigate how eccentric resistance training in conjunction with aerobic exercise affected the levels of triglycerides, total cholesterol, low-density lipoprotein, high-density lipoprotein, and very low-density lipoprotein in younger adults. Purposive sampling was used to identify 30 male volunteers between the ages of 20 and 30 for the experimental pre-test and post-test design of the study. The participants were evenly split and divided into the experimental and control groups randomly. Both groups had aerobic exercise for 6 weeks, with the experimental group also undergoing eccentric resistance training. The lipid profile parameters were calculated pre and post intervention. For statistical study, the paired t-test and independent t-test were employed, with $p < 0.05$ serving as the significance level. Following the intervention, the experimental group's levels of low-density lipoprotein (LDL), total cholesterol, and high-density lipoprotein (HDL) significantly improved. Triglyceride and VLDL levels, however, did not change in a statistically significant way. The results indicate that eccentric resistance training along with aerobic exercise can be beneficial strategy for the non-pharmacological approach to improve lipid profile and cardiovascular health in younger adults.
Keywords: Aerobic exercise; Eccentric resistance training; Lipid profile; HDL; LDL; Cardiovascular health.
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1. Introduction

Cardiovascular diseases and metabolic disorders are the major health issues of the population worldwide and are highly related to abnormal lipid profile, obesity, physical inactivity and sedentary lifestyle. Low-density lipoprotein (LDL), triglycerides, very low-density lipoprotein (VLDL), total cholesterol, and a drop in high-density lipoprotein (HDL) are considered significant cardiovascular risk factors that cause coronary artery disease and atherosclerosis. The rise in sedentary behaviors and physical inactivity has been a major driver of the rise in dyslipidemia and cardiovascular complications in adults (Bull et al., 2020; Katzmarzyk et al., 2019). Chronic disease also has been linked to physical inactivity, with metabolic adaptation and physiological function impaired (Booth et al., 2017). Exercise is crucial for maintaining cardiovascular health and promoting healthy lipid metabolism. To prevent and treat the influence of cardiovascular disease risk issues, exercise training has been highly recommended. Physical activity positively affects cardiorespiratory fitness, metabolic efficiency and lowers the risk of cardiovascular morbidity and mortality (Ross et al., 2016; Kokkinos et al., 2021). Exercise training has been shown to have a beneficial effect on lipid profile parameters, such as reducing total cholesterol, LDL and triglycerides and increasing HDL (Wood et al., 2023).

Aerobic activity has been recognized as one of the best forms of exercise for improving lipid metabolism and cardiovascular fitness. Aerobic training improves the use of oxygen, increases energy expenditure, and promotes lipid oxidation which allows for the enhancement of the health outcomes of the cardiovascular system. In adults, exercise interventions have also been linked to a decrease in cardiometabolic risk factors and metabolic function (Chatzi et al., 2026). Likewise, it has been reported that regular exercise decreases cardiovascular complications associated with obesity and improves the health status of cardiovascular health (Ortega et al., 2016; Lavie et al., 2019).

Resistance training also is becoming more relevant because of its muscle strength, functional and metabolic adaptations. Aerobic and resistance combined exercise training has been proven to have more beneficial cardiovascular effects than isolated exercise training (Schroeder et al., 2019). Eccentric resistance training has been a topic of interest among the various types of resistance training, as eccentric muscle actions produce more force with less metabolic and cardiopulmonary effort. This may be due to physiological traits that lead to better use of muscles and greater fat burning.

There are various studies showing the different modes of exercise give different effect on the parameters of lipid profile. It has been seen that exercise interventions are linked to an increase in HDL and LDL levels, and the extent of the increase is dependent on the intensity, duration, and type of exercise training intervention (Sousa et al., 2014). Aerobic exercise has also been shown to be a key element in non-pharmacological management strategies for metabolic syndrome and cardiovascular disease prevention (Fletcher et al., 2018). Additionally, exercise training has been linked with enhanced metabolic health and decreased cardiovascular risk in those who have metabolic dysfunction and are sedentary (Myers et al., 2019).

Few studies have explicitly observed the combined impact of aerobic exercise and eccentric resistance training on lipid profile markers in younger adults, despite the fact that numerous studies have documented the advantages of aerobic and resistance exercise on cardiovascular health. The majority of earlier studies have mostly concentrated on participants with metabolic problems, obese populations, or the elderly. Therefore, it is still necessary to investigate whether lipid profile variables in younger adults may be effectively improved by combining eccentric resistance training with aerobic exercise.

Therefore, the purpose of this study was to assess how eccentric resistance training and aerobic exercise affected the lipid profile in younger adults. The purpose of the study was to determine how resistance training and aerobic exercise affected the levels of triglycerides, total cholesterol, high-density lipoprotein, low-density lipoprotein, and very low-density lipoprotein. Additionally, following a 6-week intervention period, the study aimed to ascertain the impact of aerobic exercise independently on lipid profile and comparing it with the outcome of aerobic exercise in conjunction with eccentric resistance training.

2. Materials and Methods

2.1 Study Design and Participants

The impact of eccentric resistance training in conjunction with aerobic exercise on the profile of lipids in younger adults was evaluated using a pre- and post-test experimental study design. A total of thirty subjects who satisfied the inclusion and exclusion criteria were split equally into groups A (the experimental group) and B (the control group), each consisting of fifteen subjects, using the purposive sampling technique. For six weeks, each subject was examined.

2.2 Selection Criteria

Males between the ages of 20 and 30 who had total cholesterol levels under 250 mg/dl were included in the study. Participants with coronary artery disease, respiratory conditions, orthopaedic conditions, thyroid conditions, Type 1 or Type 2 diabetes, smoking, or alcohol consumption were excluded.

2.3 Intervention Protocol

Participants in Group B received aerobic exercise only, while those in Group A received aerobic exercise combined with eccentric resistance training. The intervention protocols were delivered for 6 weeks, 5 days per week for both intervention protocols.

2.3.1 Aerobic Exercise Training

There were three stages to the aerobic workout schedule: warm up, dynamic exercises and cool down. Warm-up consisted breathing exercises for 2 minutes, static exercises for 30 seconds twice for each of pectoralis major, triceps, hamstrings, calf muscles and quadriceps muscles, and slow walking for 3 minutes. The dynamic phase involved walking exercise at 60-80% target heart rate (THR) calculated using Karvonen formula:

$$THR = [(HR_{max} - HR_{rest}) \times (0.40\text{-}0.85)] + HR_{rest}$$

The aerobic exercise training was conducted 5 days a week. The participants carried out warm up, dynamic exercise and cool down for 10 minutes in each of the weeks 0-2. In weeks 2-4 the warm up and cool down time was still 10 minutes, and the time spent on dynamic exercise was raised to 20 minutes. For weeks 4-6, the warm up and cool down time was kept at 10 min, and the time spent on dynamic exercise was increased again to 30 min. Slow walking, breathing exercises, and ankle to toe exercises were performed for 5 minutes, 2 minutes, and 3 minutes, respectively, during the cool down period.

2.3.2 Eccentric Resistance Training

Group A also performed eccentric resistance training. Before the training protocol was initiated, 10 repetitions maximum (10RM) of each participant was determined. Ten repetitions of 50% of 10RM, ten repetitions of 33% of 10RM, and ten repetitions of 100% of 10RM were involved in the Delorme method. The eccentric resistance training program consisted of lowering the sandbag during biceps curl and raising the weight using both legs followed by lowering one leg. Participants were directed to do the eccentric biceps curl workout with the weight on one hand while comfortably seated. The opposite hand was used to support the hand during elbow flexion, and was removed during elbow extension.

This was repeated on the opposite upper limb. This exercise was repeated five times at first and then the number was gradually built up to 10 repetitions. In the lower limb activity, the participants were seated high and had weight attached to one leg. The opposite leg was used to support the leg during knee extension but no support was used during knee flexion. This was then repeated for the other lower leg. Initially the exercise was repeated 5 times and gradually increased to 10 repetitions.

2.4 Outcome Measures

Lipid profile indicators were evaluated, and a haematological study was carried out both before and after the intervention period. Triglycerides, VLDL, LDL, HDL, and total cholesterol were all assessed.

2.5 Statistical Analysis

Pre-test and post-test data were collected, and improvement differences were examined. For statistical analysis, the independent and paired t tests were employed. Pre-test and post-test values within groups were tested using paired t-test and differences between experimental and control groups were tested using independent t-test. A p value of < 0.05 was considered statistically significant.

3. Results

30 individuals participated in the study, and their responses were taken into account for statistical analysis. Group B received aerobic exercise alone, but Group A received both aerobic exercise and eccentric resistance training. Prior to and following the six-week intervention period, the lipid profile parameters total cholesterol, LDL, HDL, VLDL, and triglycerides were examined using paired and independent t-tests.

3.1 Effect of Intervention on Total Cholesterol

The impact of eccentric resistance training in conjunction with aerobic exercise on total cholesterol was examined using both paired and independent t-tests. The experimental and control groups' total cholesterol levels differed significantly following the intervention, according to a paired t-test analysis, although the control group's total cholesterol levels did not alter significantly following aerobic activity alone. There was no statistically significant variance between the control and the experimental groups in the pre-test evaluation, according to an independent t-test, which shows that there was no difference between the groups prior to intervention. Additionally, the post-test comparisons revealed no statistically significant differences between the groups. The total cholesterol levels in the experimental and control groups before and after the intervention are displayed in Table 1.

Table 1. Comparison of total cholesterol levels between experimental and control groups

Parameter	**Group**	**Pre-test (mg/dL)**	**Post-test (mg/dL)**	**t-value**	**p-value**
Total Cholesterol	Experimental	158.77	153.33	4.300	p < 0.05*
	Control	167.54	165.45	1.035	p > 0.05
Pre-test comparison	Experimental vs Control	158.83	158.0	0.082	p > 0.05
Post-test comparison	Experimental vs Control	153.35	167.54	1.55	p > 0.05

*Statistically significant

Table 1 illustrates that both groups experienced a reduction in total cholesterol following the intervention, with the experimental group experiencing a greater decline. However, there was no statistically significant difference in the post-test outcomes across the groups. The total cholesterol levels in the experimental and control groups before and after the intervention are represented graphically in Figure 1.

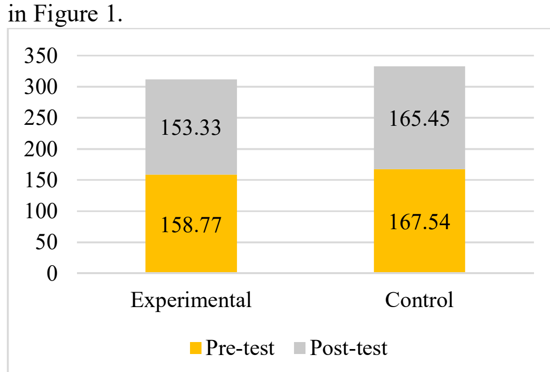

Figure 1. Comparison of Total Cholesterol Levels Before and After Intervention Between Experimental and Control Groups

Figure 1 illustrates the trend of reduction in total cholesterol levels following intervention, with comparatively greater decline observed in the experimental group.

3.2 Effect of Intervention on Low-Density Lipoprotein

The impact of the intervention on LDL was determined using paired t-test and independent t-test analysis. The experimental group saw a significant reduction in LDL levels at the conclusion of the intervention, whereas the control group did not exhibit a statistically significant decline. The independent t-test revealed a significant difference comparing the two groups, with the experimental group demonstrating more progress. The mean difference in LDL between the experimental and control groups before and after the intervention is displayed in Table 2.

Table 2. Comparison of LDL levels between experimental and control groups

Parameter	Group	Pre-test (mg/dL)	Post-test (mg/dL)	t-value	p-value
LDL	Experimental	94.83	85.27	4.846	$p < 0.05$*
	Control	102.71	99.11	0.597	$p > 0.05$
Pre-test comparison	Experimental vs Control	94.83	99.02	0.417	$p > 0.05$
Post-test comparison	Experimental vs Control	85.24	102.67	2.797	$p < 0.05$*

*Statistically significant

Table 2 demonstrates that following the intervention, the experimental group's LDL level significantly dropped. Although it was not statistically significant, the LDL level decreased in the control group as well. The experimental group made greater progress, according to a comparison of their post-test results. Figure 2 shows the LDL levels for the experimental and control groups both before and after the intervention.

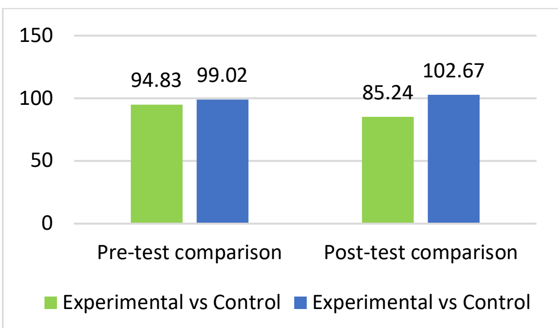

Figure 2. Pre-test and Post-test Comparison of LDL Levels Between Experimental and Control Groups

Figure 2 illustrates a marked decline in LDL levels in the experimental group compared with the control group following intervention.

3.3 Effect of Intervention on High-Density Lipoprotein

The effects of eccentric resistance training in conjunction with aerobic exercise on HDL levels were assessed using paired t-test and independent t-test. Following the intervention, the HDL levels of the experimental group significantly improved, whereas the control group did not exhibit any statistically significant change. In comparison to the control group's post-test results, the experimental group showed statistically significant improvement. The comparison of HDL levels across the experimental and control groups is displayed in Table 3 before and after.

Table 3. Comparison of HDL levels between experimental and control groups

Parameter	Group	Pre-test (mg/dL)	Post-test (mg/dL)	t-value	p-value
HDL	Experimental	48.45	53.24	2.43	$p < 0.05$*
	Control	31.19	32.64	1.964	$p > 0.05$
Pre-test comparison	Experimental vs Control	48.44	43.92	1.195	$p > 0.05$
Post-test comparison	Experimental vs Control	52.65	32.69	4.948	$p < 0.05$*

*Statistically significant

Table 3 shows that the level of HDL in the experimental group has increased significantly after intervention. There was some improvement in the control group, but not enough to be statistically significant. The experimental group showed significantly greater improvement in HDL levels when compared to the post-test scores of the other groups. Figure 3 shows that there was a difference in the graphic display of HDL levels before and after intervention between experimental and control groups.

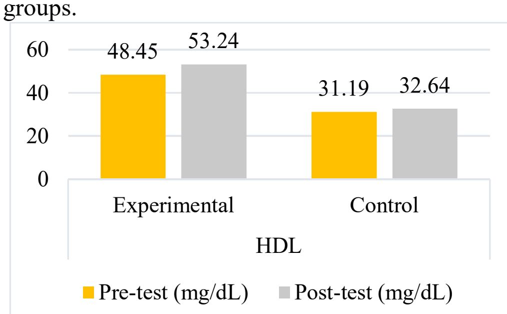

Figure 3. Comparison of HDL Levels Before and After Intervention Between Experimental and Control Groups

Figure 3 illustrates a greater increase in HDL levels in the experimental group following intervention compared with the control group.

3.4 Effect of Intervention on Very Low-Density Lipoprotein

The level of VLDL after Eccentric resistance training with aerobic exercises was analyzed by paired t test and independent t test analysis. There were no statistically significant changes in the VLDL level of either group after intervention. A pre-test comparison between groups was statistically significant but not a post-test comparison. VLDL concentration before and after the intervention is shown in Table 4.

Table 4. Comparison of VLDL levels between experimental and control groups

Parameter	Group	Pre-test (mg/dL)	Post-test (mg/dL)	t-value	p-value
VLDL	Experimental	16.28	14.42	1.02	p > 0.05
	Control	32.24	31.80	0.908	p > 0.05
Pre-test comparison	Experimental vs Control	16.28	31.80	4.594	p < 0.05*
Post-test comparison	Experimental vs Control	15.81	28.89	0.500	p > 0.05

*Statistically significant

Table 4 demonstrates that following the intervention period, there was no statistically significant difference in the two groups' VLDL levels. At the conclusion of the intervention period, there was a minor decrease in both groups, although the changes were not very substantial. Before and after intervention, VLDL levels are shown graphically as experimental and control groups in Figure 4.

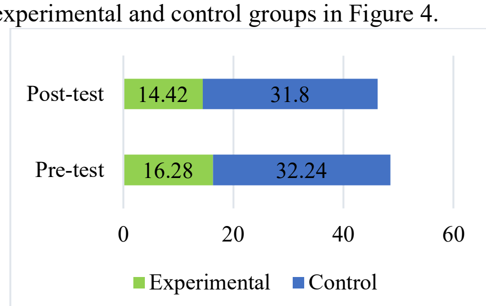

Figure 4. Comparison of VLDL Levels Before and After Intervention Between Experimental and Control Groups

Figure 4 illustrates only minor variation in VLDL levels following intervention in both groups.

3.5 Effect of Intervention on Triglyceride Levels

The paired t-test and independent t-test were used to examine the impact of eccentric resistance training combined with aerobic exercise on triglyceride levels. After the intervention, neither the experimental group nor the control group showed any statistically significant changes in triglyceride levels. Additionally, there was no statistically significant difference between the groups in the pre-test and post-test evaluations. Table 5 compares the triglyceride levels before and after the intervention for the experimental and control groups.

Table 5. Comparison of triglyceride levels between experimental and control groups

Parameter	Group	Pre-test (mg/dL)	Post-test (mg/dL)	t-value	p-value
Triglycerides	Experimental	72.89	72.79	0.29	p > 0.05
	Control	78.30	77.18	0.894	p > 0.05
Pre-test comparison	Experimental vs Control	75.046	78.22	0.652	p > 0.05
Post-test comparison	Experimental vs Control	75.82	74.65	0.186	p > 0.05

The above tables shows that there were no statistically significant differences in triglycerides after an intervention in either group. There was little difference in the triglycerides following the training protocol. The graph of level of triglyceride before and after intervention between experimental group and control group is presented in figure 5.

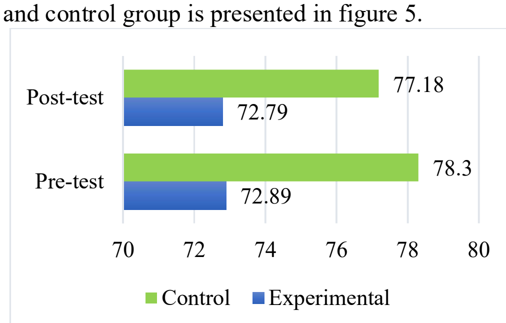

Figure 5. Comparison of Triglyceride Levels Before and After Intervention Between Experimental and Control Groups

Figure 5 illustrates minimal changes in triglyceride levels in both groups following intervention.

4. Discussion

This study observed the impact of eccentric resistance training and aerobic exercise on the parameters of young adults' lipid profiles. Results of the research showed that at the end of the six-week intervention period, LDL, the total cholesterol and HDL levels were significantly improved in the experimental group. VLDL and triglyceride levels, however, did not significantly improved. Comparatively lesser improvement of lipid profile parameters (control group) was observed with aerobic exercise alone.

The experimental group's lower total cholesterol suggests that the grouping of aerobic and eccentric resistance training may have beneficial results on lipid metabolism. It is well established that aerobic exercise can increase lipid oxidation and promote greater efficiency of the cardiovascular system, while eccentric resistance training increases the amount of muscular activity with less metabolic demands, which helps promote better lipid burning. The results of the current study are in line with the study conducted by Ghafari et al. (2020) and Kelley et al. (2012) who found that exercise interventions have significant effect on the lipid profile parameters in adults. Likewise, Smart et al. (2025) revealed that structured exercise interventions have positive results on blood lipid levels via metabolic adaptation and cardiovascular conditioning.

Additionally, the experimental group's LDL level significantly decreased. One of the main risk variables for heart disease is LDL and a reduction in LDL indicates a better state of cardiovascular disease. The results of the current study align with previous research, such as the CardioRACE trial by Lee et al. (2024), which also found that combined aerobic and resistance exercise training led to better cardiovascular risk reduction than either exercise type alone. Li et al., (2024) also reported that aerobic exercises also play an important role in reducing blood lipid levels and reducing LDL concentration in adults.

The greater raise in HDL concentration was also noted in experimental group, which further strengthens the lipid profile improvement by combined exercise training. HDL is protective against cardiovascular disease by promoting the reverse cholesterol transport. The positive effect of the exercise intervention on HDL levels could be related to the increase in the enzymatic activity of the lipids and the improvement in cardiovascular adaptation. These results are similar to those of Yun et al. (2023), who found that there is clear evidence of the impact of exercise modalities on HDL levels in older adults. Also, Wood et al. (2023) found aerobic exercise training to have a beneficial effect on lipid parameters, including HDL levels. In addition, Lin et al. (2026) found that the combined exercise modalities provided better metabolic and cardiovascular benefits by causing better physiological adaptations.

Triglyceride and VLDL levels did not significantly change in this investigation. There were some decreases observed in both groups but very small after the intervention period. This can be explained by the relatively short period of intervention, the small number of subjects and a normal level of triglycerides at baseline. Studies have also shown that short duration of exercise may not be enough to significantly change levels of triglycerides and VLDL. Sousa et al. (2014) found that exercise interventions resulted in better changes in selected lipid parameters, although the effect on triglycerides was relatively small. Similarly, Saatmann et al. (2022) found that after exercise training, triglyceride levels were found to differ based on the metabolic characteristics and cardiovascular risk factors.

The experimental group's higher improvement over the control group implies that eccentric resistance training could potentially increase the positive impact of aerobic exercise on lipid profile parameters. Eccentric contractions have been shown to generate more force with less energy expenditure that can lead to better metabolic efficiency and physiological adaptation. Overall, Swojnóg et al. (2026) highlighted that aerobic exercise, alongside other forms of physical activity, plays a crucial role in promoting metabolic and cardiovascular health outcomes as a non-pharmacological intervention.

The current study has many negative aspects. The results might not be versatile because there weren't many samples. Eccentric resistance training's long-term effects on lipid profiles were not evaluated during the six-week trial period. The study's findings cannot be extrapolated to other age groups or female participants because it only included male individuals between the ages of 20 and 30. There were also no dietary and lifestyle control measures during the intervention period, which could have impacted the results for the lipid profile. The number of participants and the length of the interventions should be increased in future to gain more insight into the long-term effects of eccentric resistance training combined with aerobic exercise on the lipid metabolism. Participants from various age groups and both genders being included may make the findings more generalizable. The impact of various exercise intensities, resistance training techniques, and nutritional treatments on lipid profile values and cardiovascular disease outcomes could possibly be the subject of future research.

5. Conclusion

The present study evaluated the impact of eccentric resistance training combined with aerobic exercise on lipid profile parameters in younger adults. Results showed that the total cholesterol, HDL and LDL significantly improved after 6 weeks of training when they were combined. However, VLDL and triglyceride levels did not change significantly after the intervention. Lipid profile measurements improved comparatively less in the aerobic exercise-only group. The findings of this research indicate that the inclusion of eccentric resistance training could also improve the positive effect of aerobic exercise on lipid metabolism and cardiovascular health. Combined exercise training shows a beneficial impact on cardiovascular risk-related factors in younger adults as evidenced by the improvement in LDL and HDL levels. The superior results in the experimental group suggest that the eccentric resistance exercise may be useful as an adjunct to aerobic exercise programs. Thus, the use of eccentric resistance training with aerobic exercise could be an alternative non-pharmacological intervention to improve lipid profile and cardiovascular health in younger adults. Future research with larger and longer intervention periods is recommended to confirm the long-term effectiveness of the intervention.

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