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Impact of a 12-Week Aerobic Exercise Intervention on Lipid Profile and Fasting Glucose in Obese Women: A Pre–Post Experimental Trial

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ABSTRACT: This study aimed to evaluate the effects of a 12-week moderate-intensity aerobic exercise intervention on blood lipid profiles and fasting blood glucose (FBG) levels in adult obese women. A single-group pre–post experimental trial was conducted among 40 sedentary obese women (BMI ≥ 30 kg/m², aged 30–38 years), selected through purposive sampling from a purposeful registry of office records/ data list which contains a total of 70 women and was utilized as a sampling frame. Participants engaged in supervised moderate-intensity aerobic exercise sessions (30 minutes, 3 times per week) for 12 weeks. Biochemical parameters including total cholesterol (TC), triglycerides (TG), low-density lipoprotein cholesterol (LDL-C), high-density lipoprotein cholesterol (HDL-C), and FBG were assessed at baseline and post-intervention using a calibrated biochemical analyzer at the International Clinical Laboratory. Statistical analysis was performed using paired-sample comparisons in SPSS Version 20. Following the 12-week intervention, significant improvements were observed in TC, LDL-C, HDL-C, and FBG ($p < 0.05$). However, changes in TG levels were not statistically significant ($p > 0.05$). The findings suggest meaningful cardio metabolic benefits associated with moderate-intensity aerobic exercise, particularly in lipid regulation and glycemic control. A structured 12-week program of moderate-intensity aerobic exercise effectively improves total cholesterol, HDL-C, LDL-C, and fasting blood glucose in obese adult women. While TG levels showed no significant change, the intervention demonstrates potential as a non-pharmacological strategy to mitigate cardio metabolic risk in this population.

Key words: Obesity, Aerobic exercise, Lipid profile, Fasting blood glucose

INTRODUCTION

Obesity is a chronic condition characterized by excessive accumulation of body fat that increases the risk of adverse health outcomes (Baldwin, 2010). In many settings, overweight and obesity are collectively classified as nutrition-related disorders driven largely by long-term energy imbalance and consequent fat accumulation (Komaroff, 2016). Over the past decades, obesity has emerged as a major challenge to chronic disease prevention across the life course worldwide (Hruby & Hu, 2015).

The condition is commonly assessed using body mass index (BMI), a pragmatic measure based on weight relative to height that is used to classify overweight and obesity in adults (Ellulu et al., 2014). Excess bodyweight is among the leading contributors to global disease burden, with about 1.1 billion adults and 10% of children currently classified as overweight or obese (Mohamed et al., 2022). Obesity is also a leading preventable cause of death, and its consequences include cardiovascular disease, type-2 diabetes, and several cancers (Ben-Noun, 2016). Consistent with regional evidence, the Southern Nations, Nationalities, and Peoples' Region (SNNPR)

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historically referred to as the "south region" before recent administrative changes has been reported to have comparatively lower life expectancy and higher total fertility rates than national averages (GBD 2019 Ethiopia Subnational-Level Disease Burden Initiative Collaborators, 2022).

Although obesity is often discussed as a problem of high-income countries, low- and middle-income settings, particularly urban areas in sub-Saharan Africa, are experiencing rising trends (Carroll & Dudfield, 2004; Warburton et al., 2006; Churilla & Zoeller, 2008; Sibhatu Biadgilign et al., 2018). For example, Ethiopian data from the 2011 Demographic and Health Survey indicated that overweight and obesity were more common in urban than rural areas, and studies from multiple Ethiopian cities have reported substantial proportions of adults living with excess weight (Mekonnen, Animaw, & Seyum, 2018). These patterns suggest that obesity-related risk is not only increasing but may be context-specific.

Adipose tissue plays an important role in energy homeostasis through adipocytes, and growing evidence indicates that the origin and development of adipocytes are critical to understanding metabolic disease mechanisms associated with obesity (Rutkowski et al., 2015). Despite extensive investment in weight-loss approaches, the pathogenesis of obesity remains incompletely understood, contributing to limited therapeutic effectiveness and persistent demand for interventions (Schwartz et al., 2017).

At a basic level, obesity is influenced by an imbalance between calorie intake and energy expenditure; however, obesity develops through complex biological and behavioral processes shaped by evolutionary physiology and modern environmental conditions (Schwartz et al., 2008). In this context, physical inactivity is an important modifiable risk factor, while appropriately prescribed exercise is widely recognized for its health benefits and relatively low disadvantages (Liikunta, 2008). Aerobic exercise, in particular, has been investigated for its preventive and therapeutic effects in obese populations, including improvements in cardiovascular risk factors and lipid profiles (Chaudhary et al., 2010; Lee & Heo, 2014).

Globally, overweight and obesity contribute substantially to mortality and disability, yet key knowledge gaps persist regarding determinants and effective interventions, including in Ethiopia. Specifically, evidence on structured aerobic exercise especially its effects on biochemical outcomes such as lipid fractions and fasting blood glucose among adult women with obesity remains limited. Given the growing burden of obesity and the need for practical, evidence-based strategies, this study evaluated the impact of a moderately rigorous aerobic exercise intervention on total cholesterol (TC), high-density lipoprotein (HDL), low-density lipoprotein (LDL), triglycerides (TG), fasting blood glucose (FBG), and associated risk assessment outcomes.

Methods

Study design:

This study employed an experimental design with a single-group, pre-post intervention structure, conducted at the institutional level (Single-arm trials refer to a design method in clinical research where only one experimental group is established, without the inclusion of a parallel control group (Non-Randomized, Intervention Only). It can be considered as an alternative when the design of an RCT is not feasible. This design was chosen to evaluate the effect of the intervention within a specific population group while acknowledging the limitations inherent in the absence of a control group.

Participants:

A total of 40 participants were recruited from a recorded data list of individuals who met all eligibility requirements through purposive sampling and included in the intervention cohort.

Important changes to methods after trial commencement, with reasons:

For the feasibility and the characteristics of the study design and the Objective Random Sampling was changed to Purposive Sampling.

Eligibility criteria for participants:

Inclusion criteria were as follows: women aged between 30 and 38 years, currently employed at Dilla University, classified as obese based on standard anthropometric measures, not engaged in any form of regular physical exercise prior to the study, and willing to provide informed consent for participation. Participants were recruited through institutional announcements and underwent screening to confirm eligibility before enrollment.

Study Setting:

Dilla (Amharic: ዲላ) is a market town and separate woreda in southern Ethiopia. The administrative center of the Gedeo Zone in the Southern Nations, Nationalities, and Peoples Region (SNNPR), it is located on the main road from Addis Ababa (on a distance of

298.98km) to Nairobi. Dilla has Aw (Arid warm) climate. It was part of Wenago woreda and is currently surrounded by Dila Zuria woreda. Dilla is the site of the Dilla College of Teachers' Education, which was founded in 1996 and was part of Debub University. The college become a full flagged University since 2007 and composed of more than 30 programs to Masters and bachelor's degree "The official website of Dilla University". A number of archeologically significant stelae fields are in the surrounding area, the most notable groups being those at Tutu Fella and Tutiti. Based on the 2007 Census conducted by the CSA, this town has a total population of 59,150, of whom 31,068 are men and 28,082 women. By 2012, the town has a total of 79,892 populations. Wikimedia Foundation, Inc. https://en.wikipedia.org/wiki/Dila,_ Ethiopia

Training Protocol:

An aerobic exercise intervention was implemented as part of this study, structured to promote moderate-intensity physical activity among the participants. Each session lasted for approximately 30 minutes and comprised a sequence of aerobic movements, including on-the-spot marching, marching with coordinated arm movements (raising and lowering), lateral movements (side-to-side), side-to-side movements with knee bends, side-step and kick, double side-step and kick, forward marching with arm swings, V-step movements, and zig-zag forward locomotion (Ross, et al. 2000).

To ensure participant safety and readiness, a 5-minute preparatory period preceded the exercise session. This was followed by a structured 5-minute warm-up phase to gradually elevate heart rate and prepare the musculoskeletal system for exercise (Irwin et al., 2003). At the conclusion of the aerobic session, a 5-minute cool-down period was included to facilitate recovery and minimize the risk of muscle soreness or cardiovascular strain. Additionally, a 10-minute period was allocated after each session for participant feedback and discussion, aimed at enhancing adherence and motivation. A 5-minute buffer was also incorporated to compensate for any unanticipated delays or interruptions during the session.

The intervention was conducted three times per week on non-consecutive days to allow for adequate recovery, in accordance with established exercise guidelines (Lee et al., 2012). The intensity of the aerobic exercises was set at 50–60% of the participants' maximum effort, corresponding to a moderate-intensity level appropriate for the age group under study (Church et al., 2007). The exercise protocol consisted of four sets of six repetitions, with 30-second rest intervals between exercises and 10-second rest intervals between sets to manage exertion and prevent fatigue (Slentz et al., 2004).

The design and execution of the intervention were developed in collaboration with certified fitness professionals from the Dilla University Community Gymnasium (DUCG), ensuring the scientific appropriateness and safety of the exercise regimen.

Exercise intensity was monitored using the L8-R8 Smart Heart Rate Wristband (Shenzhen L8star Technology Co., Ltd., China), which allowed for real-time tracking of heart rate to ensure adherence to the prescribed intensity range. Target heart rate zones were determined based on age-predicted maximum heart rate calculations, aligning with WHO guidelines for moderate-intensity physical activity. Participants maintained heart rates between 50 - 60 beats per minute, reflecting safe and effective exertion levels for this demographic cohort.

Data Collection:

This study employed a pre-test and post-test experimental design, with measurements taken at baseline and after a 12-week intervention period. Data collection focused on key biochemical markers, including fasting blood lipid profile and fasting blood glucose levels.

For the lipid profile analysis, participants were instructed to fast overnight and report to the testing site in the early morning. Upon arrival, participants were seated comfortably in a relaxed position, with the upper arm exposed and supported on a table to facilitate venipuncture. A trained laboratory technician collected approximately 5 mL of venous blood from the antecubital vein using standard aseptic techniques.

The collected samples were processed at the International Clinical Laboratory (ICL) in Hawassa center, where lipid parameters including total cholesterol, HDL-C, LDL-C, and triglycerides were analyzed using a calibrated, automated biochemical analyzer. The analyzer was interfaced with specialized software that automatically recorded, calculated, and printed the results to ensure data accuracy and consistency.

Fasting blood glucose levels were measured using the same venous blood sample. A glucometer (glucose meter) was used to assess serum glucose concentration. While glucometers typically analyze capillary blood via a finger-prick method, in this study, the glucose test was performed using the venous sample previously collected for lipid analysis, thereby minimizing participant discomfort and procedural redundancy.

To ensure measurement reliability and reduce potential error, all biochemical assessments were conducted by the same certified laboratory technician and repeated twice for verification purposes.

Any changes to trial outcomes after the trial commenced, with reasons:
Not Applicable

Sample size determination;

Sample Size Justification:

The sample size was determined based on the estimated effect size from previous studies assessing lipid and glycemic modulation through aerobic exercise. Assuming an effect size (Cohen's *f*) of 0.5 (medium), a significance level of 0.05, a power of 0.80, and Paired t-test (Pre-post/ baseline & week 12 measurements), the required sample size was calculated to be **34 participants** using G*Power 0.5 Accounting for a potential 10% attrition rate, the final sample size was set at **40 participants**.

Method used to generate the random allocation sequence:
N/A (Single-arm).

Blinding (masking) of participants, personnel, and outcome assessors:
N/A (Not Blinded)

Statistical analysis:

Statistical analysis was conducted using IBM SPSS Statistics version 20 (IBM Corp., Armonk, NY, USA). Descriptive statistics were employed to summarize participants' demographic characteristics, with categorical variables presented as frequencies and percentages.

For continuous variables that followed a normal distribution, independent sample *t*-tests were utilized to assess differences between groups (Ghanbari-Niaki, 2006; You & Nicklas, 2008; Kraus et al., 2002). In instances where the assumption of normality was violated, non-parametric alternatives specifically the Mann-Whitney U test were applied to compare group medians. The assessment of normality was carried out using visual methods, including histograms and standard Q-Q plots, as well as statistical testing via the Kolmogorov-Smirnov test.

To account for multiple comparisons in paired treatment conditions, post-hoc analyses were performed using Bonferroni-adjusted procedures. These included commonly used methods such as the Least Significant Difference (LSD) test, Duncan's multiple range tests, and Tukey's Honestly Significant Difference (HSD) test, depending on the nature of the data and research questions addressed.

This multi-faceted analytical approach ensured both robustness and statistical rigor in evaluating the effects of the intervention.

Other Information:

This single-arm interventional study was retrospectively registered on ClinicalTrials.gov under the Protocol Registration and Results System (PRS) with the trial registration number **NCT06986915** on **28 April 2025**. The registration occurred after the initiation of data collection due to administrative delays and initial unawareness of the requirement for prospective registration.

In accordance with the TREND (Transparent Reporting of Evaluations with Nonrandomized Designs) statement and the CONSORT (Consolidated Standards of Reporting Trials) guidelines, key elements relevant to trial design, methodology, and outcomes were incorporated into the ClinicalTrials.gov PRS submission. This ensures transparency, promotes reproducibility, and enhances the completeness of reporting for this non-randomized interventional study.

RESULTS

The effect of a 12-week moderate-intensity aerobic exercise intervention on selected biochemical markers was evaluated in obese adult women using **paired sample *t*-tests** to compare pre- and post-intervention values. The results are summarized in **Table 1**.

Table1. Paired sample t-test result of Biochemical Variables.

Pairs	Mean	Std. Deviation	std. Error Mean	t	df	Sig.
Total cholesterol level	24.825	18.00981	2.84760	8.718	39	0.000
High density Lipoprotein	-10.55	5.72870	.90579	-11.647	39	0.000
Low density Lipoprotein	19.925	49.751	7.866	2.533	39	0.015
Triglyceride	-3.72500	105.227	16.63785	-0.224	39	0.824
Fasting Blood glucose	15	13.437	2.124	7.06	39	0.000
Risk Assessment	0.93	1.74	0.275	3.382	39	0.002

Note: P value set as < 0.05

Total Cholesterol (TC)

A statistically significant reduction in total cholesterol was observed following the intervention. The mean difference was **-10.55 mg/dL** (SD = 5.73, SEM = 0.91), and the paired *t*-test yielded $t(39) = 8.718$, $\mathbf{p < 0.001}$. This indicates a significant improvement in total cholesterol levels attributable to the exercise regimen.

High-Density Lipoprotein (HDL)

HDL cholesterol levels significantly increased after the intervention. The mean difference was **+24.83 mg/dL** (SD = 49.75, SEM = 2.85), with a *t*-value of $t(39) = -11.647$, $\mathbf{p < 0.001}$. Despite the negative *t*-value, which reflects the direction of change, the result confirms a statistically significant elevation in HDL, a cardio-protective lipid marker.

Low-Density Lipoprotein (LDL)

The intervention also led to a significant decrease in LDL cholesterol levels. The mean difference was **–19.93 mg/dL** (SD = 18.01, SEM = 7.87), with $t(39) = 2.533$, $\mathbf{p = 0.015}$. This suggests a favorable shift in lipid profile, reducing a key risk factor for atherosclerosis and cardiovascular disease.

Fasting Blood Glucose (FBG)

There was a substantial and statistically significant reduction in fasting blood glucose levels post-intervention. The mean difference was **–15.00 mg/dL** (SD = 13.44, SEM = 2.12), with $t(39) = 7.060$, $\mathbf{p < 0.001}$. These findings indicate improved glycemic control, likely due to enhanced insulin sensitivity and glucose uptake resulting from consistent aerobic activity.

Triglycerides (TG)

In contrast to the above findings, triglyceride levels did not change significantly. The mean difference between baseline (**146.40 ± 78.57 mg/dL**) and post-intervention (**150.13 ± 75.98 mg/dL**) was **–3.73 mg/dL** (SD = 105.23, SEM = 16.64), with a *t*-value of $t(39) = -0.224$, $\mathbf{p = 0.824}$. This indicates that the aerobic exercise intervention had **no statistically significant effect** on triglyceride concentrations over the 12-week period.

Risk Assessment Score

The intervention also demonstrated a statistically significant reduction in the overall risk assessment score. The mean difference was **–0.93** (with corresponding $t(39) = 3.382$, $\mathbf{p = 0.002}$), suggesting that moderate-intensity aerobic exercise contributed to a measurable decrease in cumulative metabolic and cardiovascular risk.

Summary of Findings

The statistical analyses confirm that a structured 12-week program of moderate-intensity aerobic exercise leads to **significant improvements in key biochemical markers** among obese adult women. These include reductions in total cholesterol, LDL cholesterol, and fasting blood glucose, along with a significant increase in HDL cholesterol and a reduced risk assessment score. However, **no significant change was observed in triglyceride levels**, indicating that further investigation may be needed to determine the influence of exercise duration, intensity, or dietary factors on this specific lipid parameter.

Collectively, these findings support the role of moderate-intensity aerobic exercise as a **non-pharmacological strategy** for improving lipid metabolism and glycemic control, thereby potentially reducing the risk of obesity-related comorbidities such as cardiovascular disease and type 2 - diabetes.

Discussion:

Obesity, defined by excessive accumulation of body fat due to an imbalance between caloric intake and expenditure, continues to rise globally and remains a major public health concern, particularly in developed nations (Stephens, 2012). Its strong association with cardiovascular diseases (CVD), type 2 diabetes, and various metabolic disorders underscores the urgent need for effective, sustainable interventions.

While pharmacological and surgical treatments are available, their long-term efficacy, accessibility, and side-effect profiles remain limitations. In contrast, lifestyle modifications most notably structured aerobic exercise offer a practical, low-risk, and evidence-based approach for managing obesity and its comorbidities. Aerobic exercise, encompassing rhythmic, sustained physical activity that elevates heart rate and enhances oxygen consumption, has been consistently shown to improve cardiovascular and metabolic health (Delevatti et al., 2014; Wang & Xu, 2017).

Aerobic Exercise and Cardio metabolic Health

The present study's findings are consistent with existing literature demonstrating that structured aerobic exercise interventions contribute to reductions in both body weight and body fat. A growing body of literature affirms the preventive and therapeutic potential of aerobic exercise in obese populations. Chaudhary et al. (2010) reported that aerobic training outperformed conventional treatments in reducing cardiovascular risk, while Lee and Heo (2014) demonstrated significant reductions in total cholesterol (TC) and triglycerides (TG) following a 10-week aerobic exercise intervention combined with dietary modification.

Numerous studies have linked aerobic exercise with favorable changes in lipid profiles. Additionally, our findings align with a previous meta-analyses indicate that regular aerobic activity improves high-density lipoprotein cholesterol (HDL-C) while reducing low-density lipoprotein cholesterol (LDL-C), TG, and TC levels (Franczyk et al., 2023; Kelley et al., 2012). On the other hand low-to-moderate intensity exercise does not consistently reduce LDL-C, it remains beneficial for sedentary individuals by mitigating dyslipidemia risks (Albarrati et al., 2018). Similarly, Romero-Moraleda et al. (2013) found that both supervised and unsupervised exercise, when paired with a hypocaloric diet, led to significant lipid improvements—highlighting the importance of adherence over delivery mode.

Lipid Profile, Glycemic Control, and Body Composition

Moreover, aerobic exercise has demonstrated consistent effects on lipid metabolism. Kostrzewa-Nowak et al. (2015) observed improvements in TC, TG, HDL-C, and LDL-C among individuals with dyslipidemia following aerobic intervention. This is likely mediated through both aerobic and resistance training effectively improved TC, TG, and LDL-C, although changes in HDL-C were less consistent Buzdagli et al. (2022). However, Al-Mhanna et al. (2024) noted that combining aerobic training with dietary interventions and weight reduction significantly enhanced HDL-C levels.sd

In addition to lipid modulation, aerobic exercise positively affects glycemic control. Halbert et al. (1999) and Haiyan et al. (2011) found that moderate-intensity aerobic activity significantly reduced fasting glucose levels and improved insulin sensitivity. Sadeghi et al. (2019) further demonstrated reductions in insulin resistance and C-reactive protein (CRP) levels among obese women following aerobic intervention, even in the absence of changes in oxidized LDL. Similarly, Smart et al. (2025), Dogra et al. (2022), and Marandi et al. (2013) reported improvements in lipid profiles, body composition, and cardiovascular risk markers in overweight and obese females.

Exercise Intensity, Duration, and Modality

Our findings are further supported by previous studies indicating that the effectiveness of aerobic exercise is influenced by its intensity, frequency, and duration. Jayedi et al. (2024) concluded that while 30 minutes of weekly aerobic activity yields modest improvements, ≥150 minutes of moderate-to-vigorous activity per week leads to more substantial outcomes. Also, Janssen et al. (2002) and Hiklova & Gába (2019) emphasized the importance of tailoring exercise programs based on duration and type to optimize fat reduction. Again, Aghaei et al. (2018) found that eight weeks of aerobic training significantly reduced TC and LDL-C in overweight women, while Ross et al. (2000) and Jakicic et al. (2003) highlighted intensity as a key determinant in altering body composition.

Additionally, the previous studies indicating also higher-intensity aerobic exercise led to greater reductions in body weight, fat mass, and waist circumference, with Chiu et al. (2017) and Kim et al. (2019). Noting more pronounced changes in TG levels compared to LDL or HDL. These findings align with evidence from Kelley & Kelley (2007), Ismail et al. (2012), and Mann et al. (2014) showing reductions in visceral adiposity and improved lipid metabolism, thereby lowering CVD risk.

Combined and Alternative Training Approaches

Emerging evidence supports the synergistic effects of combined training modalities. Mengistu et al. (2025) documented improvements in fasting blood glucose, insulin resistance, blood pressure, and waist-to-hip ratio following an eight-month program involving aerobic, resistance, and concurrent exercises. Similarly, Amare et al. (2024) reported superior glycemic control and lipid profile enhancements with both aerobic and combined training. Zide et al. (2020) found that a 12-week Pilates program, when paired with a low-calorie diet, improved lipid parameters and body composition in postmenopausal women.

The present study's findings are consistent with existing literature demonstrating in a comprehensive meta-analysis by Silva et al. (2024), concluded that combined training not only enhances glucose metabolism but also reduces inflammation in sedentary adults. This is particularly relevant for populations without diabetes but with elevated cardiometabolic risk. Moreover, Jung et al. (2012) observed that moderate-intensity aerobic exercise led to significant reductions in total and visceral fat, whereas vigorous-intensity protocols improved muscle mass and insulin sensitivity, even in the absence of BMI changes. Boschetti et al. (2021) corroborated these findings, demonstrating that aerobic exercise at 60% of maximum velocity improved exercise tolerance and fasting glucose, even among individuals with severe obesity.

Synthesis and Implications

Collectively, the findings from prior studies align with the present research, reinforcing the role of aerobic and combined exercise interventions in improving lipid profiles, glycemic regulation, and body composition among overweight and obese individuals. The consistency of these outcomes across diverse populations and intervention types highlights aerobic exercise as a potent non-pharmacological strategy for mitigating cardio metabolic risk and enhancing overall health.

Future research should focus on refining exercise prescriptions by exploring optimal intensity thresholds, duration, and combinations with dietary or behavioral interventions. Furthermore, personalized approaches that consider individual variability in metabolic response, adherence capacity, and comorbidity profiles are essential for maximizing the clinical impact of exercise-based interventions.

Limitations of the Study

While this study offers valuable insights into the effects of aerobic exercise on lipid profiles and glycemic control in overweight and obese individuals, certain limitations should be considered when interpreting the findings.

One methodological consideration is the use of a single-group pre-post experimental design. Although this design allowed for practical implementation and facilitated within-subject comparisons, the absence of a control group limits the ability to establish definitive causal relationships. Without a comparator arm, it is challenging to fully isolate the intervention's effects from potential confounding factors such as maturation, lifestyle changes, or regression to the mean. Nevertheless, the observed statistically significant improvements across key biochemical markers provide a strong foundation for future controlled trials.

Additionally, while the study demonstrated meaningful changes in most lipid parameters and fasting glucose, triglyceride (TG) levels did not show a statistically significant reduction. This may be attributed to inter-individual metabolic variability or unmeasured factors such as dietary intake and physical activity outside the structured intervention. Although daily caloric intake and lifestyle behaviors were not systematically recorded, the consistency of improvements across other metabolic indicators suggests that the intervention had a genuine physiological impact.

The study also did not account for certain lifestyle-related variables—such as smoking status, alcohol consumption, sleep patterns, and psychological stress—which are known to influence metabolic health. While their exclusion may have introduced unmeasured variability, the homogeneity of the sample and the standardized exercise protocol helped mitigate some of these effects.

From a practical standpoint, several logistical factors shaped the scope of the study. The absence of external funding limited access to advanced biochemical assays and constrained the use of objective tools for monitoring dietary intake and exercise adherence. Despite these constraints, the study effectively utilized available resources to deliver a structured and supervised intervention, with outcomes supported by well-established clinical biomarkers.

Administrative challenges also arose during the research process, including the resignation of both the principal and co-advisors due to institutional and personal reasons. Although this led to temporary delays in protocol validation and manuscript development, the study was ultimately completed with academic rigor and adherence to ethical standards.

Strengths and Future Directions

Despite these limitations, the study contributes meaningful evidence to the growing literature on non-pharmacological interventions for metabolic health. Its design enabled real-world implementation, and its findings support the efficacy of moderate-intensity aerobic exercise in improving lipid profiles and glycemic markers. Future research should aim to incorporate randomized controlled designs, longer follow-up periods, and comprehensive lifestyle assessments to further elucidate the mechanisms underlying these improvements and enhance generalizability.

CONCLUSION

This study provides evidence that a 12-week program of moderate-intensity aerobic exercise is associated with statistically significant improvements in several key biochemical markers among obese adult women, including reductions in total cholesterol, LDL cholesterol, and fasting blood glucose, as well as an increase in HDL cholesterol. These changes suggest potential benefits for cardiovascular and metabolic health. However, the absence of a significant effect on triglyceride levels highlights the need for further investigation into the exercise dose–response relationship. It is possible that longer durations, higher intensities, or combined lifestyle interventions may be required to elicit favorable changes in all lipid components. Overall, these findings support the role of moderate-intensity aerobic exercise as a feasible and non-pharmacological strategy for improving selected cardio-metabolic risk factors in obese populations. Future research should aim to determine the most effective exercise parameters for optimizing lipid metabolism and reducing the burden of obesity-related diseases.

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