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Effect Of Exercise Therapy on Lipid Profile and Oxidative Stress Indicators in Patients with Type 2 Diabetes

Madeeha Jadoon[1], Shazia Zeb[2], Sajid Razaq[3], Munazza Khan[4], Muhammad Shoaib[5], Sara Mariyum[6]

Abstract

Objective: To measure change in lipid profile and levels of oxidative stress by performing exercise therapy in patients with type 2 diabetes.

Methods: This cross-sectional study was carried out from January 2022 to January 2023 at Hayatabad Medical Complex, Peshawar, and consisted of 35 patients with T2DM using non-probability consecutive sampling. Criteria for patient selection were a T2DM duration of at least one year and patients aged between 28-45 years with or without consent to enrol for the study. Information was gained through questionnaires, satisfaction surveys, physical assessments, and biochemical assays. Levels of lipid profiles and oxidative stress indicators were determined enzymatically from the sera obtained from the fasting blood samples and by ELISA kits.

Results: This study established that exercise therapy has a beneficial effect on the lipid status of patients with type 2 diabetes. Overall cholesterol and LDL-C concentration also decreased (p = 0. 023 and p = 0. 042, respectively) thereby lowering cardiovascular risk. LDL-C adiposity levels were reduced (p = 0. 378), but desirable cholesterol levels, HDL-C, improved (p = 0. 032). Additionally, oxidative stress indicators improved: Apropos to this, serum MDA, a marker of oxidative stress, significantly reduced (p = 0. 012). The total antioxidant capacity (TAC) and the antioxidants enzymes; superoxide dismutase (SOD), glutathione peroxidase (GPx), and catalase all increased (p = 0. 021, 0. 035, 0. 022 and 0. 015) and increased the body's ability to fight oxidative stress.

Conclusion: Exercise therapy significantly improves type 2 diabetes patients' oxidative stress indicators and lipid profiles. According to the data, there was a significant decrease in triglycerides, LDL-c, HDL-c, and total cholesterol following the exercise intervention. As a result, exercise is crucial for controlling dyslipidemia, a common problem in individuals with diabetes. The improvement in metabolic health can be attributed to the protective effects of exercise against oxidative stress, as seen by the decline in MDA levels and the rise in activity of antioxidant defence-related enzymes such as superoxide dismutase, glutathione peroxidase and catalase.

MeSH Keywords: Exercise Therapy, Type 2 Diabetes Mellitus, Oxidative Stress.

[1] Assistant Professor, Department of Biochemistry, Women Medical and Dental College, Abbottabad; [2] Additional Medical Superintendent, AMS, Holy Family Hospital, Rawalpindi; [3] Fellow Endocrinology, Hayatabad Medical Complex, Peshawar; [4] Associate Professor, Department of Physiology, Saidu Medical College, Swat, KPK; [5] Assistant Professor, Department of Biochemistry, Gajju Khan Medical College, Swabi; [6] Associate Professor, Department of Biochemistry, Swat Medical College, Swat, KPK.

Correspondence: Dr. Sajid Razaq, Fellow Endocrinology, Hayatabad Medical Complex, Peshawar. **Email:** dr.sajjid19922@gmail.com

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1. Introduction

T2DM is a chronic metabolic disease that affects the use of insulin by the body cells and the ability of the pancreas to secrete this hormone leading to high blood sugar.[1] T2DM has increased worldwide significantly; caused by poor diet intake, lack of regular physical exercise, and obesity.[2] It is not only a strong predictor of cardiovascular diseases (CVD) but also leads to several comorbidities including nephropathy, neuropathy, and retinopathy, and hence a major public health issue.[3]

Dyslipidemia is one of the most common complications of T2DM It is manifested by increased serum levels of total cholesterol LDC, triglycerides, and decreased levels of serum HDL cholesterol.[4] The disturbing lipid profile is also among the key factors in the development of atherosclerosis, which accordingly increases the morbidity and mortality from cardiovascular diseases in patients with diabetes mellitus.[5] This means that lipid profile management is an essential intervention in T2DM with emphasis being placed on reduction of LDL-C and elevation of HDL-C in a bid to offset cardiovascular risks.

Other factors such as oxidative stress contribute to the development of T2DM and its complications. It refers to the situation where there is an increase in the formation of these reactive formations called ROS and the body's ability to prevent the negative effects of these formations using antioxidants.[6] In individuals with T2DM, hyperglycemia is chronic and increases the rate of forming ROS, which in turn intensifies insulin resistance, affects endothelial cells and contributes to the development of diabetic

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complications. Indeed, it can be argued that the prevention of oxidative stress is critical for the control of T2DM and its outcomes for patients.[7]

Exercise therapy has now been recognized as one of the best non-pharmacological treatments for T2DM. Physical exercise is also documented to exert a positive influence on glycemic control, insulin sensitivity, and weight reduction.[8] Besides glucose metabolism, exercise also has a significant impact on lipidemia profile by decreasing triglyceride cholesterolemia, and LDL-C and enhancing the level of HDL-C. These changes in diabetic patient's status help in the prevention of cardiovascular diseases.[9]

Also, it was found that exercise reduces oxidative stress by upgrading the body's antioxidant defences.[10] It has been reported that moderate exercise enhances the levels of endogenous enzymatic antioxidants; superoxide dismutase (SOD), glutathione peroxidase (GPx), and catalase which are primary in scavenging ROS. These changes lower oxidation in T2DM patients which may improve the endothelial function, decrease inflammation, and subsequently reduce the likelihood of complications.[11]

Although exercise is known to have a positive impact on glycemic status, its influence on lipid profile and other markers of oxidative stress in T2DM has not been fully explained. The knowledge of these effects may be useful in determining the best exercise regimes for diabetic patients to improve the general treatment of the disease. The present investigation aims to measure changes in lipid profile and levels of oxidative stress by performing exercise therapy in patients with type 2 diabetes.

2. Materials & Methods

This cross-sectional study was done between January 2022 and January 2023, at Hayatabad Medical Complex, Peshawar. The present work focused on assessing the effects of exercise therapy on lipid profiles and markers of oxidative stress in people with T2DM. The sample size calculated through Open Epi software was 40. Five participants were dropped out and the study was conducted on 35 patients with diagnosed T2DM. The sampling method adopted was convenient sampling which entails selecting participants starting from a given point in the population until samples reach the researcher's desired number.

The investigation included individuals with T2DM who had been diabetic for a year or longer, were in the 28-42-year-old age range, and had agreed to give informed consent for involvement in the research. Patients suffering from chronic kidney disease, cardiovascular disease, or cancer, those using lipid-lowering or antioxidant agents, apart from diabetic agents, or patients who cannot exercise due to musculoskeletal or neurological diseases were excluded from the study.

This was accomplished using structured interviews and clinical assessment as well as laboratory investigations. To capture socio-demographic data (age, gender, BMI, smoking status), and clinical profile data (duration of diabetes, medication profile, and physical activity) a structured questionnaire was adopted. Patients were put on a supervised exercise program which is a mix of both aerobic and resistance training a minimum of three days a week in the course of the study. The exercise sessions were 60 minutes in duration and included a 10-minute warm-up session, 40 minutes of moderate exercise, and a 10-minute cool–down session.

All the subjects were fasted for 12 hours the night before venous blood samples were obtained. Enzymatic and colourimetric techniques were used to measure the lipid concentrations, which included triglycerides, LDL, HDL, and total cholesterol. Additionally, oxidative stress markers such as malondialdehyde (MDA), total antioxidant capacity (TAC), and antioxidant enzyme activities (catalase, glutathione peroxidase [GPx], and superoxide dismutase [SOD]) were measured in serum and blood specimens. Enzyme-linked immunosorbent Assay (ELISA) kits were utilised to determine these markers by the user manual.

The Statistical Package of Social Sciences (SPSS) version 26 was used to analyze the data. Descriptive statistics were used to analyze basic clinical and democratic data from study participants in primary investigations. When presenting quantitative data, the mean and standard deviation were used if the data had a normal distribution; otherwise, the median and interquartile ranges were used. Frequency and percentages were used when presenting qualitative data. The before and post-exercise results were compared using a paired t-test to examine the changes in the oxidative stress measure and lipid profile following exercise therapy. A p-value less than 0.05 was considered significant.

Each research participant provided written informed permission following the research's approval by the Hayatabad Medical Complex's ethical review board in Peshawar. The purpose of the research was explained to the subjects, and only those who volunteered to take part in it were enrolled. The research project complied with the Declaration of Helsinki's guiding principles,

protecting subjects' right to anonymity and their ability to leave the research project at any moment.

3. Results

According to the findings of this study, exercise therapy had a positive effect on the lipid profile of patients with type 2 diabetes. The study showed a significant decrease in total cholesterol (p = .023) and LDL-C (p = .042), which are both crucial indicators of cardiovascular health. Total cholesterol and LDL-C levels below that threshold pose a smaller risk for plaque formation in the arterial walls and, therefore, decrease the probability of a cardiovascular event, like a heart attack or stroke. Besides these reductions, over the 6 months, there was a significant rise in the level of high-density lipoprotein cholesterol HDL-C (P= 0. 032), which is advantageous because HDL-C is useful in cholesterol removal from the bloodstream and taken to the live where it is metabolized and excreted. Such a reduction in 'bad' cholesterol while at the same time increasing the 'good' cholesterol levels indicates the benefits of exercise, especially in treating lipid pathology among patients with type 2 diabetes. (Table 1) (Figure 1)

Table 1: Effect of Exercise Therapy on Lipid Profile in Patients with Type 2 Diabetes

Lipid Profile Parameter	Pre-Exercise (Mean ± SD)	Post-Exercise (Mean ± SD)	p-value
Total Cholesterol (mg/dL)	221.2 ± 32.2	196.4 ± 29.5	0.023
LDL-C (mg/dL)	136.3 ± 25.7	114.9 ± 22.8	0.042
HDL-C (mg/dL)	41.2 ± 7.1	49.2 ± 6.1	0.032
Triglycerides (mg/dL)	171.5 ± 39.1	146.3 ± 35.2	0.022

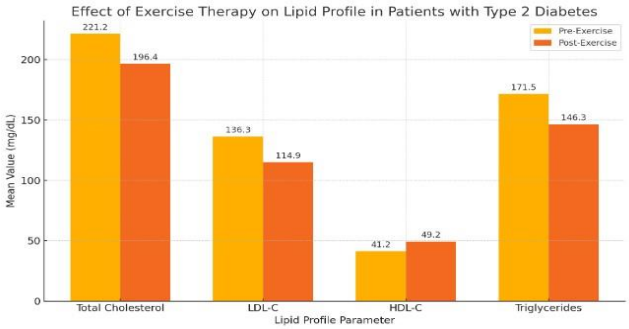

Figure 1: The bar chart compares the mean values (in mg/dL) of various lipid profile parameters before and after exercise therapy. Statistically significant differences are observed in all parameters, with p-values < 0.05, indicating the beneficial impact of exercise on lipid profiles in these patients

Another important observation made during the study is that increased exercise therapy beneficially affected oxidative stress. Reactive oxidative species (ROS) which also determine the extent of oxidation in cells, were reduced (p = 0.012). This was reduced by exercise indicating that exercise assisted in reducing the rate at which lipid peroxidation was taking place in the body which is important in the prevention of oxidative stress. Furthermore, the TAC was found to be enhanced (p= 0. 021), and other antioxidant enzyme activity including SOD (p = 0. 035), GPx (p = 0. 022), and catalase (p = 0. 015). These enzymes are very vital in defence against toxic free radicals and oxidation effects on the body. The improvement of these antioxidant defences suggests that exercise attenuates oxidative injury, and increases resistance to oxidative stress which is beneficial in controlling the effects of type 2 diabetes.

Table 2: Effect of Exercise Therapy on Oxidative Stress Indicators in Patients with Type

Oxidative Stress Indicator	Pre-Exercise (Mean ± SD)	Post-Exercise (Mean ± SD)	p-value
Malondialdehyde (MDA) (µmol/L)	4.6 ± 0.9	3.3 ± 0.7	0.012
Total Antioxidant Capacity (TAC) (%)	53.3 ± 10.6	69.9 ± 12.1	0.021
Superoxide Dismutase (SOD) (U/mL)	121.3 ± 16.4	147.8 ± 20.4	0.035
Glutathione Peroxidase (GPx) (U/mL)	106.5± 14.8	127.4 ± 15.9	0.022
Catalase (U/mL)	91.5 ± 12.3	111.7 ± 13.9	0.015

4. Discussion

According to the study's findings, exercise therapy helped type 2 diabetic patients experience more positive changes in their oxidative stress levels and lipid profiles. The present discourse situates these findings with prior scholarly works that have examined analogous research enquiries. Following exercise therapy, there was a decrease in total cholesterol, LDLC, and triglycerides, as well as an increase in HDL-C, which is consistent with other previous studies. Aerobic exercise significantly reduced patients' LDL-C levels and increased their HDL-C levels, as demonstrated by Silva et al., 2020.[12] Similarly, a study conducted in 2019 by Chung Sheng et al. found that aerobic and resistance training improved lipid profile, with positive changes in triglyceride and total cholesterol levels and negative changes in these levels.[13]

Furthermore, the study conducted by Edward BJ et al., 2020 also corroborates these findings highest level of improvements in lipid parameters was noted to be in the group who exercised more frequently and to a greater intensity.[14] This is supported by Stanton et al., 2022 which established that moderate to high-intensity exercises reduced total cholesterol and LDL-C and increased HDL-C.[15]

Also, exercise therapy was seen to significantly decrease the degrees of oxidative stress indices in the examined group. This decrease in MDA and the corresponding rise in SOD, catalase, and GPx are in concordance with literature reports of research investigating the effect of exercise on oxidative stress in type 2 diabetes patients. For instance, Ye et al., 2021 revealed that aerobic exercise lowered MDA which is a peroxidation lipid index and increased endogenous antioxidant activity.[16] Canal et al 2022 also observed the same results which indicated that resistance training had a positive effect on oxidative stress by decreasing oxidative stress and also increasing the antioxidant enzyme activity.[17]

In addition, the study carried out by Man AW et al. 2020 revealed that oxidative stress markers were significantly improved with both exercises, especially when accompanied by diet in type 2 diabetic patients.[18] These findings regarding the combined impact of exercise and nutrition on oxidative stress indicators are consistent with the study by Sharifi et al., 2020, who also discovered that major exercise interventions resulted in substantial changes in oxidative stress.[6]

The findings regarding exercise and its consequences on lipid profiles as well as oxidative stress in diabetic patients are well established. Many exercise studies published by Legaard et al., 2022 show that long-term exercise interventions over a few months have had permanent changes in the lipid profile and oxidative stress. The illustrated improvements in cardiovascular risk show that implementing a regular exercise regime could be beneficial for a proper diabetes management plan.[19]

5. Conclusion

In this study, it is established that exercise therapy has a marked favourable impact on lipid profile and biomarkers of oxidation in patients with type II diabetes. The changes in total cholesterol, LDL-C, HDL-C, and triglycerides all demonstrated significant reduction after the intervention, this established the importance of exercise in the control of dyslipidemia which remained one of the complications associated with diabetes. Also, a decrease in MDA concentration with a simultaneous increase in the level of small molecules of antioxidant enzymes, SOD, GPx, and catalase, testifies to the ability of training to lessen oxidative burden and to control metabolic processes.

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M.J, S.R, M.S - Conception of study
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M.J, M.K, M.S - Critical Review

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