E-ISSN: 2790-6094
P-ISSN: 2957-4587

Journal Biological And Allied Health Sciences



# Impact of Endurance Exercise on Glycated Hemoglobin (HbA1c) Among Diabetic Patients

1. Muhammad Zayan[1], Alamgir Khan[2], Zafar Iqbal Butt[3], Mubeen Ahmed[4], Shahzadi Sanam Roohi Farooqi[5], Rana Waqas[6], Bilal Rasool[7], Sarmad Siddique[8], Zeliha Selamoglu[9]

**Original Article**

**ARTICLE INFORMATION**

**Corresponding Author:**

- **mubeenahmed958@gmail.com**

**Affiliations:**

1. Department of Sports Sciences and Physical Education, University of the Punjab, Lahore, Pakistan.
2. Department of Sports Sciences and Physical Education, University of the Punjab, Lahore, Pakistan.
3. Department of Sports Sciences and Physical Education, University of the Punjab, Lahore, Pakistan
4. Department of Sports Sciences and Physical Education, University of the Punjab, Lahore, Pakistan.
5. Riphah International University, Faisalabad Campus
6. Riphah International University, Faisalabad Campus
7. Department of Emerging Allied Health Technologies, Superior University, Lahore.
8. Department of Emerging Allied Health Technologies, Superior University, Lahore.
9. Prof Dr. Medical Biology Department, Nigde Omer Halisdemir University, Turkey.

**Keywords:** Endurance exercise, Hemoglobin Concentration, Diabetes, Complete blood count, HbA1c.

**ABSTRACT**

**Background:** Hemoglobin concentration is an important clinical parameter that reflects the oxygen-carrying capacity of the blood. Poor control of blood glucose levels in diabetic patients can lead to decreased haemoglobin concentration, which may result in complications such as anaemia and cardiovascular disease.

**Objective:** This study aimed to investigate the impact of a 8-week endurance exercise program on haemoglobin concentration among twenty diabetic patients.

**Methods & Material:** The study participants comprised diabetic patients registered to "Health Center Punjab University Lahore Pakistan. Complete Blood count (CBC & HbA1c) tests were performed to assess hemoglobin-RBCs among diabetic patients. A self-made exercise protocol was applied to subjects (Brisk Walk).5ml blood sample was collected from each subject before and after using the prescribed exercise protocol. Ethical approval was taken from the ethical review board Department of sports sciences & physical education, University of the Punjab, Quaid-i-Azam campus, Lahore. The collected data were tabulated and analyzed by using appropriate tools through SPSS.

**Result &Conclusion:** The mean and standard deviation of comparison between the pre-test and post-test was 0.740 ± 1.384, t-value was 2.390.df was 19, and P value was 0.027. Therefore, the study shows that brisk walking significantly affects glycosylated haemoglobin (HbA1C). Based on the analysis, the researcher concluded that exercises are vital in controlling haemoglobin concentration in diabetic patients.

**Introduction:**

Exercise is a well-established, affordable, and effective way to help manage diabetes, notably by improving insulin sensitivity in those with type 2 diabetes. However, the specific effects of endurance training on type 2 diabetes haven't been fully explored. A previous study investigated how endurance training affected body weight, glucose and insulin levels, lipid profiles, and HbA1c levels in rats with induced type 2 diabetes (using STZ) and a high-fat diet. HbA1c levels were used to monitor glucose control throughout the endurance training program [1].

The benefits of regular exercise for people with type 2 diabetes (T2DM) are well-established. This study explored the long-term impact of consistent exercise training on various health markers in these individuals. The results showed that long-term, regular physical activity led to improvements in blood sugar control, body composition, and cardiovascular fitness in T2DM patients. Furthermore, sustained physical activity helped prevent the decline in health indicators observed in the group that didn't exercise. [2].

Managing blood sugar, as measured by HbA1c levels, is crucial for treating type 2 diabetes (T2DM). Endurance training, especially high-volume or progressively intense programs, is a recognized and effective tool for diabetes management and can significantly lower HbA1c. However, some research studies indicate that while aerobic exercise improves cardiovascular fitness (VO2), it might also raise hemoglobin (Hb) levels compared to sedentary individuals. This leads to the hypothesis that HbA1c might underestimate the true reduction in blood sugar levels achieved through aerobic training. Essentially, because aerobic exercise can both lower blood sugar and raise Hb levels, the resulting HbA1c value might appear better than it actually is. This potential overestimation of blood sugar control raises concerns about relying solely on HbA1c in physically active individuals, particularly those in aerobic training programs. It highlights the need for a more complete evaluation of blood sugar control that considers multiple markers, not just HbA1c, in people who exercise regularly [3].

Type 2 diabetes (T2DM) is a growing global health problem, strongly associated with the obesity epidemic. Beyond genetics, environmental factors and unhealthy behaviors like high-carbohydrate diets and lack of exercise play a role in the development of T2DM. Structured exercise programs, including Moderate-Intensity Training (MIT) and High-Intensity Interval Training (HIIT), have emerged as potential strategies for managing T2DM, particularly by controlling HbA1c levels. This review aims to summarize the latest research on the effects of HIIT on HbA1c levels [4].

All types of exercise offer some benefit in lowering HbA1c (a key measure of blood glucose levels). These modest improvements are comparable to the effects seen with other diabetes treatments, such as dietary changes, medication, and

insulin therapy [5]. Global prevalence of diabetes is rising, reaching epidemic proportions. Type 2 diabetes, the most common form, accounts for 90-95% of all cases and is marked by problems with insulin secretion and/or action. This research aimed to assess and compare the impact of different aerobic exercise programs on blood sugar control in people with type 2 diabetes. [6].

This research examined how resistance exercise (RE) at varying intensities affects HbA1c, insulin, and blood glucose levels in people with type 2 diabetes (T2D). A meta-analysis was performed, including diabetes studies that compared an exercise group to a control group. The exercise programs were divided into low-to-moderate intensity and high-intensity groups. The meta-analysis suggests that high-intensity resistance exercise is more effective than low-to-moderate intensity exercise in improving HbA1c levels and insulin sensitivity in individuals with T2D [7].

Anemia, a significant hematological condition, is common in a variety of clinical settings and across many diseases, affecting roughly one-third of surgical patients before their operations. It's also prevalent in individuals with inflammatory bowel disease (IBD), liver disease (LD), and chronic heart failure (CHF). Anemia leads to increased fatigue, reduced functional capacity, worse surgical outcomes, and a poorer prognosis in conditions like CHF, cancer, and chronic obstructive pulmonary disease (COPD). In surgery, the decreased oxygen-carrying capacity of blood in anemic patients, and the resulting inadequate tissue perfusion, may contribute to increased vulnerability to negative outcomes after surgery [8].

Glycosylated hemoglobin (HbA1c) is the primary way we measure how well blood sugar has been controlled over the past three months. While it's generally accepted that aerobic exercise improves blood sugar control in type 2 diabetes by making the body more sensitive to insulin, another important, but often overlooked, aspect of diabetes is its negative impact on emotional well-being and the increased risk of depression. Because of this, physical activity is frequently recommended as a way to improve quality of life, prevent depression, lessen anxiety, and boost overall emotional well-being in people with diabetes [9].

While the COVID-19 pandemic has had a massive global impact, it's unclear if national states of emergency declared due to COVID-19 have had direct negative effects on HbA1c levels in people with type 2 diabetes. Diabetic patients were particularly affected by restricted access to outpatient clinics. Healthcare professionals specializing in diabetes were worried that blood sugar control in these patients would decline due to reduced physical activity, increased snacking, and significant psychological stress [10].

The literature review highlights the importance of adequate hemoglobin levels for overall health. It also reveals a connection between hemoglobin production and use, and exercise. Therefore, this research aims to explore and address the gaps in our current understanding of this relationship.

**Study Gap:**

Diabetes is a major health concern in Pakistan as well as in all around the World. Researchers around the globe analyzed the impact of different exercise protocols on hemoglobin among upon diabetic patients but there is not much work done on the humans with moderate intensity effects on glycosylated hemoglobin level among diabetes patients. In line of this research study, the researcher decided to conduct a research study under the title “Impact of endurance exercises upon hemoglobin concentration among diabetic patients”.

**Strength and Weakness of Study**

In this research study, the researcher has used quantitative research approach, showing its strength. In addition, based on anthropometric attributes such as age, gender and health status of the subjects have been recruited and examined, which proved the generalization of the study. Along these, there are some limitation of the study, such as the study was only carried out among male patients, only moderate intensity exercise was applied to the recruited subjects as a research intervention, small sample size, absence of control group. These limitations may provide new insight for researchers to carry out such studies with new anthropometric attributes of subjects and other natures of the exercise, on large sample and with control group.

**METHODOLOGY:**

This study investigated the impact of endurance exercise on hemoglobin levels in diabetic patients using a quantitative, pre-post intervention design. Diabetic patients registered at the Health Center of Punjab University, Lahore, Pakistan, formed the study population, from which 20 subjects was randomly selected as sample size by using G power statistics. Participants met pre-defined inclusion criteria (e.g., age, diabetes type, stable health) and were free of exclusion criteria (e.g., contraindications to exercise, severe anemia). Data collection involved pre- and post-intervention of Complete Blood Count (CBC) tests which measured hemoglobin levels, red blood cell counts, and other related parameters, as well as HbA1c tests to assess glycemic control. A self-designed, supervised brisk walking protocol with moderate intensity was implemented over two months (February 1st to April 1st, 2023). Each one-hour session included two intervals: 30 minutes of brisk walking followed by a 3-5 minute rest period, 5 days a week. The brisk walking intensity was moderate, allowing conversation but with noticeably heavier breathing. The researcher directly supervised all sessions, ensuring protocol adherence and participant safety. Ethical approval was obtained from the University of the Punjab's Ethical Review Board (D/272/SPS - 03-02-2023), and all participants provided informed consent. Data were analyzed using SPSS (version 26). Descriptive statistics summarized participant characteristics, while paired t-tests compared pre- and post-intervention hemoglobin levels and related parameters. Correlation analysis explored relationships between hemoglobin changes and other variables like HbA1c and exercise adherence.

E-ISSN: 2790-6094
P-ISSN: 2957-4587



**PESENTATION OF DATA**

**Table 1 Showing the Descriptive Analysis of Pre-Test**

| | N | Range | Minimum | Maximum | Mean | | Std. Deviation | Variance |
|---|---|---|---|---|---|---|---|---|
| | Statistic | Statistic | Statistic | Statistic | Statistic | Std. Error | Statistic | Statistic |
| Gender | 20 | 1.00 | 1.00 | 2.00 | 1.8500 | .08192 | .36635 | .134 |
| Age | 20 | 5.00 | 1.00 | 6.00 | 2.7000 | .37767 | 1.68897 | 2.853 |
| Pretest | 20 | 7.80 | 5.20 | 13.00 | 6.6600 | .41861 | 1.87207 | 3.505 |

The above table shows the descriptive analysis of the testing variable (demographic variable). The total number of respondents was 20. The mean and standard deviation of gender was 1.85 ± .3667. The variance was .134. Minimum range was 1.00; Maximum Range was 2.00. The mean and standard deviation in terms of age was 2.70 ± 1.688. The variance was 2.853.

**Table 2 Showing the Descriptive Analysis of Post-Test**

| | N | Range | Minimum | Maximum | Mean | | Std. Deviation | Variance |
|---|---|---|---|---|---|---|---|---|
| | Statistic | Statistic | Statistic | Statistic | Statistic | Std. Error | Statistic | Statistic |
| Gender | 20 | 1.00 | 1.00 | 2.00 | 1.8500 | .08192 | .36635 | .134 |
| Age | 20 | 5.00 | 1.00 | 6.00 | 2.7000 | .37767 | 1.68897 | 2.853 |
| Posttest | 20 | 2.80 | 5.30 | 8.10 | 5.9200 | .17254 | .77160 | .595 |

The above table shows the descriptive analysis of the testing variable (demographic variable). The total number of respondents was 20. The mean and standard deviation in term of gender was 1.85 ± .3667, variance was .134, minimum range was 1.00, and maximum range was 2.00. The mean and standard deviation in term of age was 2.70 ± 1.688. The variance was 2.853, minimum range was 1.00, and maximum range was 6.00

**Table.3 Compares Pre and Post-Test Results Regarding the Impact of Endurance Exercise On Haemoglobin Concentration Among Diabetic Patients After Applying Prescribed Exercise Protocols.**

| | | Paired Differences | | | | | T | df | Sig. (2-tailed) |
|---|---|---|---|---|---|---|---|---|---|
| | | Mean | Std. Deviation | Std. Error Mean | 95% Confidence Interval of the Difference | | | | |
| | | | | | Lower | Upper | | | |
| Pair 1 | Pretest – Posttest | .74000 | 1.38465 | .30962 | .09196 | 1.38804 | 2.390 | 19 | .027 |

The above table compares pre-test and post-test regarding the impact of endurance exercise on haemoglobin concentration among diabetic patients. The total number of respondents was 20. The mean and standard deviation of comparison between the pre-test and post-test was 0.740 ± 1.384, the t-value was 2.390, the degree of freedom was 19, and the significant level was 0.027. Therefore, the study shows brisk walking considerably affects glycosylated haemoglobin (HbA1C).

**DISCUSSION**

Hemoglobin, the protein in red blood cells responsible for oxygen transport throughout the body, can be influenced by regular endurance exercise like brisk walking. Such exercise improves cardiovascular health and boosts the blood's oxygen-carrying capacity, which can indirectly affect hemoglobin levels. Exercise training is a proven therapy for type 2 diabetes. Prior research has demonstrated the positive effects of personalized aerobic endurance exercise on insulin resistance and HbA1c (a key blood sugar marker) levels in women with type 2 diabetes. This emerging concept was supported by [11] which indicating that exercise is an effective interventional strategy to improve glycemic control in type 2 diabetes patients. While exercise training is beneficial for type 2 diabetes, the optimal exercise intensity for maximizing these benefits is still unclear. This study addresses this gap by evaluating the effectiveness of a long-term exercise program on both metabolic control and arterial stiffness in individuals with type 2 diabetes. Poor glucose control significantly increases the risk of vascular complications and cardiovascular death in these patients, making improvements in these areas crucial. In line with this concept, the study's finding conducted by [12] also supports the present study by concluding that there is a significant difference. Diabetic peripheral neuropathy (DPN) is a serious complication of type 2 diabetes (T2DM) and the leading cause of amputations in this population. It significantly impacts quality of life, with those suffering from diabetic foot ulcers reporting even lower quality of life compared to other T2DM patients and healthy individuals. High blood sugar (hyperglycemia) is the primary driver of DPN. The metabolic changes caused by hyperglycemia lead to the formation of advanced glycation end products (AGEs). Glycation, the non-enzymatic binding of glucose to proteins, begins with glucose forming a reversible compound called a Schiff base with a protein. The level of glucose in the blood plasma determines how much glycation occurs, with hyperglycemia and aging both contributing to the development of vascular disease in diabetes. The same finding was drawn by [13] Exercise is crucial for health, especially because older adults and those with type 2 diabetes (NIDDM) often have increased central body fat. While direct evidence is limited, existing data suggests that endurance exercise training could be very beneficial for elderly diabetic patients. The potential benefits go beyond just improving insulin and glucose levels; they also include reducing key risk factors for atherosclerosis. By following the recommendations outlined here, many elderly

individuals with diabetes can safely and effectively benefit from endurance training.

The study conducted by [14] showed that Regular exercise programs can significantly improve HbA1c levels and overall blood sugar control in people with type 2 diabetes. The same finding drawn by [15] is that Exercise is a cornerstone of type 2 diabetes treatments, recommended by most clinical guidelines. While a combination of aerobic and resistance training is often suggested, the specific benefits of each type of exercise, and how they interact, still need further investigation. Current research indicates that aerobic exercise, resistance training, and a combination of the two have similar effects on HbA1c levels. However, they each have distinct and independent effects on other important measures of cardio metabolic health.

## CONCLUSION

Endurance exercise, which involves repetitive movements of major muscle groups, offers many health benefits for people with diabetes. For example, brisk walking is a great way to get endurance exercise. Some of the benefits of aerobic exercise include better blood glucose control and improved cardiovascular health. Aerobic exercise can also have a positive impact on hemoglobin levels in people with diabetes. Hemoglobin is a protein found in red blood cells that helps carry oxygen throughout the body.

People with diabetes often have lower haemoglobin levels compared to those without diabetes, which can impact their overall health and well-being. The researcher concluded that walking at a brisk pace or moderate intensity is an aerobic exercise. Briskly walking can help you build stamina, burn excess calories and make your heart healthier. It can help the body to use insulin more effectively. In this research, endurance exercise has been found to impact haemoglobin concentration among diabetic patients positively. Regular endurance exercise (brisk walking) can increase the amount of oxygen the body receives, ultimately increasing haemoglobin concentration. This increase in haemoglobin concentration can help to improve overall health outcomes for diabetic patients, including better glucose control, reduced insulin resistance, and improved cardiovascular function. However, diabetic patients must consult their healthcare provider before engaging in any new exercise program to ensure safety and efficacy.

### Recommendations

The following recommendations can be made regarding the impact of endurance exercise on hemoglobin concentration among the diabetic patients:

- Regular exercise such as brisk walking, cycling, or swimming, should be performed regularly among diabetic patients to improve overall hemoglobin concentration levels. A minimum of 30 minutes, 3-5 times a week is recommended.
- Exercise plans should be individualized according to the patient's age, weight, physical abilities, and overall health status. Diabetic patients with other comorbidities should consult with their healthcare provider before initiating any exercise regimen.
- Diabetic patients should monitor their blood glucose levels before, during, and after exercising to avoid hypoglycemia or hyperglycemia and to control glucose levels in the target range.
- Diabetic patients should consume iron-rich foods, such as spinach, red meat, beans, and fortified cereals, to maintain a healthy hemoglobin level.
- Diabetic patients should stay hydrated before, during, and after exercise to prevent dehydration and maintain a healthy blood volume, which can affect hemoglobin concentration.
- Diabetic patients should incorporate resistance training, such as weight lifting or bodyweight exercises, to build muscle mass and improve hemoglobin concentration levels.
- Diabetic patients should consult with their healthcare providers before initiating an exercise plan to monitor any changes in hemoglobin levels and adjust any medications if necessary.

## REFRENCES

1. Heo M, Kim E. Effects of endurance training on lipid metabolism and glycosylated hemoglobin levels in streptozotocin-induced type 2 diabetic rats on a high-fat diet. Journal of physical therapy Science. 2013;25(8):989-92.
2. Najafipour F, Mobasseri M, Yavari A, Nadrian H, Aliasgarzadeh A, Abbasi NM, Niafar M, Gharamaleki JH, Sadra V. Effect of regular exercise training on changes in HbA1c, BMI and VO2max among patients with type 2 diabetes mellitus: an 8-year trial. BMJ Open Diabetes Research and Care. 2017 Nov 1;5(1):e000414.
3. Delevatti RS, Leonel LD, Wolin IA. Physical exercise and glycemic control: Is HbA1c the best marker for assessing the effects of aerobic training?. Medical Hypotheses. 2024 Jul 1;188:111379.
4. Pedrosa A, Furtado G, de Barros MP, Bachi AL, Ferreira JP, Sardão VA, Rama L, Teixeira A. The impact of moderate-to-high-intensity exercise protocols on glycated hemoglobin levels in type 2 diabetes patients. Diabetology. 2022 Dec 28;4(1):11-8.
5. Snowling NJ, Hopkins WG. Effects of different modes of exercise training on glucose control and risk factors for complications in type 2 diabetic patients: a meta-analysis. Diabetes care. 2006 Nov 1;29(11):2518-27.
6. Church TS, Blair SN, Cocreham S, Johannsen N, Johnson W, Kramer K, Mikus CR, Myers V, Nauta M, Rodarte RQ, Sparks L. Effects of aerobic and resistance training on hemoglobin A1c levels in patients with type 2 diabetes: a randomized controlled trial. Jama. 2010 Nov 24;304(20):2253-62.
7. Liu Y, Ye W, Chen Q, Zhang Y, Kuo CH, Korivi M. Resistance exercise intensity is correlated with attenuation of HbA1c and insulin in patients with type 2 diabetes: a systematic review and meta-analysis. International journal of environmental research and public health. 2019 Jan;16(1):140.
8. Otto JM. The importance of haemoglobin to physical function (Doctoral dissertation, UCL (University College London)).
9. Madden KM. Evidence for the benefit of exercise therapy in patients with type 2 diabetes. Diabetes, metabolic syndrome and obesity: targets and therapy. 2013 Jul 3:233-9.

10. Aso Y, Iijima T, Tomaru T, Jojima T, Usui I. No negative impact of a national state of emergency by COVID-19 outbreak on hemoglobin A1c levels in patients with type 2 diabetes living in semi-rural Japan. The American Journal of the Medical Sciences. 2021 Jul 1;362(1):104-5.
11. Ghaedi H, Takesh S, Banitalebi E. The effects of personalized sprint interval training and combined aerobic endurance and resistance training on insulin resistance and glycated hemoglobin in women with type 2 diabetes. Journal of Shahrekord University of Medical Sciences. 2020 Jun 29;22(3):113-20.
12. Loimaala A, Groundstroem K, Rinne M, Nenonen A, Huhtala H, Parkkari J, Vuori I. Effect of long-term endurance and strength training on metabolic control and arterial elasticity in patients with type 2 diabetes mellitus. The American journal of cardiology. 2009 Apr 1;103(7):972-7.
13. Vinik AI, Ullal J, Parson HK. Clinical diabetes, translating research into practice. Diabetic Neuropathy. 2006;1:129-35..
14. Yavari A, Hajiyev AM, Naghizadeh F. The effect of aerobic exercise on glycosylated hemoglobin values in type 2 diabetes patients. Journal of sports medicine and physical fitness. 2010 Dec 1;50(4):501.
15. Madden KM. Evidence for the benefit of exercise therapy in patients with type 2 diabetes. Diabetes, metabolic syndrome and obesity: targets and therapy. 2013 Jul 3:233-9.

**CONFLICT OF INTEREST**

Authors declared no conflict of interest, whether financial or otherwise, that could influence the integrity, objectivity, or validity of their research work.

**GRANT SUPPORT AND FINANCIAL DISCLOSURE**

Authors declared no specific grant for this research from any funding agency in the public, commercial or non-profit sectors

**DATA SHARING STATEMENT**

The data that support the findings of this study are available from the corresponding author upon reasonable request

This is an Open Access article distributed under the terms of the Creative Commons License Online Research Publications by authors is licensed under a Creative Commons Attribution-Non-commercial, No Derivatives 4.0 International License.

JBAHS web address: www.jbahs.pk
Email address: editor.jbajhs@superior.edu.pk