

Effect of Leisure Walking on Biochemical Parameters in Patients with Type II Diabetes Mellitus

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ABSTRACT

OBJECTIVE: To evaluate the impact of a leisure walking program on biochemical and hematological parameters of Type 2 Diabetes mellitus patients in Hyderabad, Sindh.

METHODOLOGY: This quasi-experimental, single-group, longitudinal study was conducted from September 2023 to August 2025 using convenience sampling. 40 individuals (male and female) aged 30 to 60 years with only Type 2 Diabetes mellitus (T2DM) participated in the study and were exposed to a supervised home-based walking program for 9 months. The intervention consisted of moderate-intensity aerobic exercise (50-70% of maximal heart rate), performed by walking at 3- 4 mph for over 15 minutes a day, 7 days a week, excluding warm-up and cool-down. Assessment has been carried out at 4 time points (baseline, 3, 6, and 9 months) for biochemical parameters (HbA1c, FBS, RBS, T.G, total lipids, cholesterol, HDL, LDL) and hematological parameters (hematocrit, Hemoglobin, platelet count, WBC, ESR). Repeated-measures ANOVA, paired t-tests, Friedman, and Wilcoxon signed-rank tests have been used to analyze data in the R programming environment. 4.4.1 and Python version. 3.12.

RESULTS: There have been pronounced changes in glycemic control. Total cholesterol, TG, LDL and VLDL decreased, whereas HDL and Hemoglobin increased remarkably after 9 months of walking. ESR also decreased, indicating reduced inflammation.

CONCLUSION: A structured, moderate-intensity walking program has been shown to have a significant positive effect on biochemical and hematological parameters of T2DM patients. Walking is a useful, low-cost adjunct in scarce-resource environments.

KEYWORDS: Type II Diabetes Mellitus, Walking Program, Glycemic Control, Lipid Profile, Hematological Parameters, HbA1c.

INTRODUCTION

Type II Diabetes Mellitus (T2DM) is a chronic metabolic disease, manifested by insulin resistance and progressive dysfunction of beta cells leading to chronic hyperglycemia and long-term complications of multiple organ systems¹. The disease is a major cause of morbidity and mortality worldwide, being linked with microvascular (retinopathy, nephropathy, neuropathy) and macrovascular complications (cardiovascular disease and stroke)². The prevalence of T2DM worldwide has risen dramatically over the last few decades, driven by demographic transitions, dietary changes, urbanization, and sedentary lifestyles³. Approximately 537 million adults are currently living with diabetes globally, and projections estimate an increase in this figure to 783 million by 2045². Irony is that the burden is disproportionately concentrated in low- and middle-income countries, where lack of preventive services and delayed diagnoses compound morbidity and mortality³. In Pakistan, the diabetes epidemic is a critical public

health issue. National Diabetes Survey of Pakistan (2016-17) reported that 26.3 million adults have diabetes, with a substantial proportion remaining undiagnosed⁴. Recent analyses report a national prevalence of 11.77%, with higher rates among urban males. While in Sindh province, prevalence is reported to be as high as 16.2% in males and 11.7% in females⁵. Poor glycemic control is common in Pakistan, with reviews showing that patients do not attain glycemic goals and are at high risk of complications, i.e. nephropathy, retinopathy and other microvascular pathologies⁶. Given its multifactorial etiology, management of T2DM should be based on a comprehensive approach combining pharmacological and lifestyle interventions. Physical activity plays a central role, with strong evidence that regular aerobic exercise improves insulin sensitivity, promotes glycemic control, and produces favorable changes in lipid metabolism and body composition⁷. Walking, in particular, is an effective intervention in resource-limited settings, is culturally acceptable, and is scalable⁸. Meta-analyses and systematic reviews have confirmed significant reductions in HbA1c, BMI, and blood pressure in patients with T2DM following walking interventions⁹⁻¹¹. Therefore, it is necessary to assess the efficacy of walking as a feasible, less resource-intensive, non-pharmacologic approach to improve glycemic control and biochemical and hematological parameters in diabetic patients.

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doi: 10.22442/jlumhs.2026.01424

Received: 02-12-2025 Revised: 30-03-2026

Accepted: 06-04-2026 Online First: 13-05-2026



METHODOLOGY

Study Design

We conducted a quasi-experimental, single-group, longitudinal pre-post intervention study from September 2023 to August 2025. The study included 40 subjects (male and female, aged 30-60 years, with T2DM only), while participants with other disorders were excluded. Subjects were from various parts of Hyderabad, Sindh, and were recruited through convenience sampling. The Ethical Committee, Institute of Biochemistry, University of Sindh, Jamshoro, approved the study vide Reference No. IOB/329/2023, dated 31-05-2023. Informed consent was obtained from all participants. Statistical analysis used repeated-measures comparisons. The study included repeated measures meant to measure the impacts of a structured walking program on the biochemical and hematological measures in patients of T2DM.

Laboratory Parameters

Biochemical parameters included Triglycerides (T.G), Total Lipid, Cholesterol, High-density lipoprotein (HDL), Low-density lipoprotein (LDL), Fasting Blood Sugar (FBS), Random Blood Sugar (RBS) and Glycated Hemoglobin (HbA1c). Hematological parameters, including Hematocrit, Platelet Count, White Blood Cells (WBC), Hemoglobin, and Erythrocyte Sedimentation Rate (ESR). We assessed measurements at four stages: baseline (before walking) and after 3, 6, and 9 months. Comparisons were drawn between these time periods. We minimized inter-individual variation by using each participant as their own control.

Intervention: Walking Program

All participants were engaged in a moderate-intensity walk session (monitored home-based) for 15 minutes every morning for seven days a week with a 5-10 minute warm-up and a 5-minute cool-down. The desired intensity was 50-70 percent of the maximal heart rate (in most cases walk@3-4mph, and fit individuals did brisk walk @4-5mph). Heart rate monitors and perceived exertion instructions were provided to help participants reach the target intensity.

Specimen Collection and Laboratory Procedures

Gel (serum) and EDTA tubes were used to collect venous blood samples from the trained phlebotomists using aseptic procedures. Samples underwent routine testing: EDTA samples and complete blood count (CBC) were analyzed on an XN-350 automated haematology analyzer, which provided six-part differentials and CBC indices. Serum samples: We centrifuged the samples and used them for biochemical tests, including HbA1c, FBS, RBS, and lipid profile. We performed analysis on the Roche Cobas C111 analyzer using photometric and enzymatic methods. Calibration and quality control: Standard operating procedures were used, including the use of manufacturer-supplied calibrators and running of daily quality control with normal and

pathological controls. Results were reviewed before reporting.

Statistical analysis

Data analysis was performed using R version 4.4.1 and Python 3.12. Normality of continuous variables was evaluated by the Shapiro-Wilk test, which was justified by the visualization of histograms and Q-Q plots. Based on the results, variables were categorized as either parametric or nonparametric¹². Descriptive statistics of both groups were computed, and boxplots of the distributions were drawn. In dependent-samples designs, a paired t-test was used to compare two time points when data were normally distributed^{13,14}, and a repeated-measures ANOVA was used to compare when data had more than three time points^{13,15}. For nonparametric data, the Wilcoxon signed-rank test was applied to two dependent samples^{13,16}, and the Friedman test was applied when there were three or more dependent samples¹³. We compared baseline (before the walking program) with 3, 6, and 9 months. A p-value of below 0.05 was considered statistically significant.

RESULTS

Descriptive Statistics

As shown in **Tables 1a & 1b**, Normal descriptive statistics for T.G, hematocrit, platelet count, and WBC count: There was a normal distribution of T.G, hematocrit, platelet count, and WBC count over the period of study, as shown by p-values (<0.05). During the first month before the walking intervention (Month 1) to Month 3, 6, and 9 after walking, the mean of T.G increased gradually and steadily, indicating that levels of T.G of both mean and median type showed the same pattern, which was a gradual decrease, with the variability remaining comparatively constant, indicating a similar effect on all participants. Hematocrit increased gradually over the same period, as shown by rising mean and median values and uniform dispersion, indicating improved red blood cell concentration across all groups. There was a slight downward movement in platelet counts, with slight changes in mean and median values and constant variability, which is an indication of a small but steady decline. The number of WBCs shows a progressive decrease over time, as indicated by a decreasing central tendency and relatively constant dispersion, suggesting a consistent drop in the level of immune cells among subjects. Comprehensively, these results suggest that walking produced a pattern of consistent physiological alterations throughout the course of the study, directional tendencies in lipid profile, hematological measures, and the number of immune cells, and mostly similar responses among the groups. Non-normal descriptive: HbA1c, FBS, RBS, total lipids, total cholesterol, HDL cholesterol, LDL cholesterol, Hemoglobin, and ESR were non-normally distributed across the study period, as reflected in p-values < 0.05. After the walking intervention, HbA1c, FBS, and RBS showed a clear, consistent downward

trend at 3, 6, and 9 months after baseline, while median values decreased over time, demonstrating improved glycemic control. Total lipid and total cholesterol levels also decreased steadily during the study period, whereas HDL cholesterol increased steadily, indicating a positive change in the lipid profile. LDL cholesterol gradually decreased, supporting a positive effect on cardiovascular risk factors. The level of Hemoglobin slightly improved over time, providing evidence of a slight improvement in red blood cells. ESR continued to decrease, indicating a decrease of systemic inflammation. Overall, these variables showed central tendency values moving in the expected direction, and dispersion was relatively steady, indicating that the walking intervention produced similar physiological responses across participants and positive effects of glycemic control, lipid metabolism, haematological parameters, and inflammation.

Table Ia: Descriptive statistics and normality assessment (Shapiro–Wilk test)

Normal Variable	Mean±SD	p-value
T.G (<150mg/dl) *Baseline	296±20.07	0.305
After 3 months	285.6±19.22	0.203
After 6 months	271.87±17.74	0.155
After 9 months	254.25±18.45	0.334
HEMATOCRIT (36-50%) *Baseline	38.94±4.0	0.384
After 3 months	41.10±3.91	0.600
After 6 months	42.77±4.02	0.231
After 9 months	44.65±4.05	0.344
PLAT COUNT (150-450 10 ⁹ /L)*Baseline	401.47±52.06	0.705
After 3 months	390.9±51.79	0.785
After 6 months	381.65±51.80	0.767
After 9 months	378.35±49.48	0.554
WBC (4.5-11.0 10 ⁹ /L) *Baseline	13.09±1.107	0.135
After 3 months	12.68±1.107	0.058
After 6 months	12.105±1.118	0.178
After 9 months	11.55±1.135	0.052

Note: Normal variables: variables following a normal distribution (Shapiro–Wilk test).

**Baseline; before start of walk program*

Boxplots of Normally Distributed Variables

Figure 1: Boxplots of normally distributed variables showed significant temporal changes between baseline and follow-ups (3, 6, and 9 months), which were confirmed using repeated-measures ANOVA ($p < 0.001$ for all variables). At baseline, T.G was high, and median values decreased progressively with diminished variability at 9 months, indicating steady improvement of lipid metabolism. The values of hematocrit demonstrated a consistent upward trend with the follow-up period, indicating an increase in oxygen-carrying capacity and hematological state; however, the interquartile ranges have been relatively

Table Ib: Descriptive statistics and normality assessment (Shapiro–Wilk test)

Non-normal Variable	Mean	p-value
HbA1c (<5.7%) *Baseline	11.24±1.44	0.045
After 3 months	10.14±1.36	0.003
After 6 months	9.36±1.186	0.000
After 9 months	8.40±1.190	0.000
FBS (77-99mg/dl) *Baseline	164±15.56	0.008
After 3 months	160.47±13.90	0.040
After 6 months	156.82±13.89	0.027
After 9 months	152.77±13.85	0.029
RBS (<140 smg/dl) *Baseline	365.12±31.11	0.002
After 3 months	360.15±30.50	0.002
After 6 months	355.55±31.00	0.002
After 9 months	347.87±30.18	0.010
TOTAL LIPID (<200 mg/dl) *Baseline	919.12±37.88	0.015
After 3 months	913.07±34.62	0.006
After 6 months	882.5±31.94	0.044
After 9 months	862.25±32.30	0.014
CHOLESTROL (<200 mg/dl) *Baseline	341.4±39.29	0.000
After 3 months	352.02±26.93	0.000
After 6 months	318.87±26.59	0.031
After 9 months	236.95±29.73	0.029
HDL (35-60 mg/dl) *Baseline	23.6±5.18	0.000
After 3 months	27.95±4.88	0.001
After 6 months	32.17±4.44	0.000
After 9 months	37.87±4.11	0.032
LDL (<100mg/dl) *Baseline	158.63±16.46	0.000
After 3 months	152.9±16.33	0.000
After 6 months	144.63±18.17	0.023
After 9 months	132.49±16.92	0.028
HEMOGLOBIN (13-16g/dl) *Baseline	10.16±0.65	0.008
After 3 months	10.4±0.63	0.015
After 6 months	10.59±0.63	0.021
After 9 months	10.86±0.59	0.018
ESR (<20mm/hr) *Baseline	55.27±14.89	0.048
After 3 months	52.37±14.20	0.021
After 6 months	49.65±14.13	0.006
After 9 months	45.97±13.38	0.003

Note: Non-normal variables: variables not following a normal distribution

**Baseline; before start of walk program*

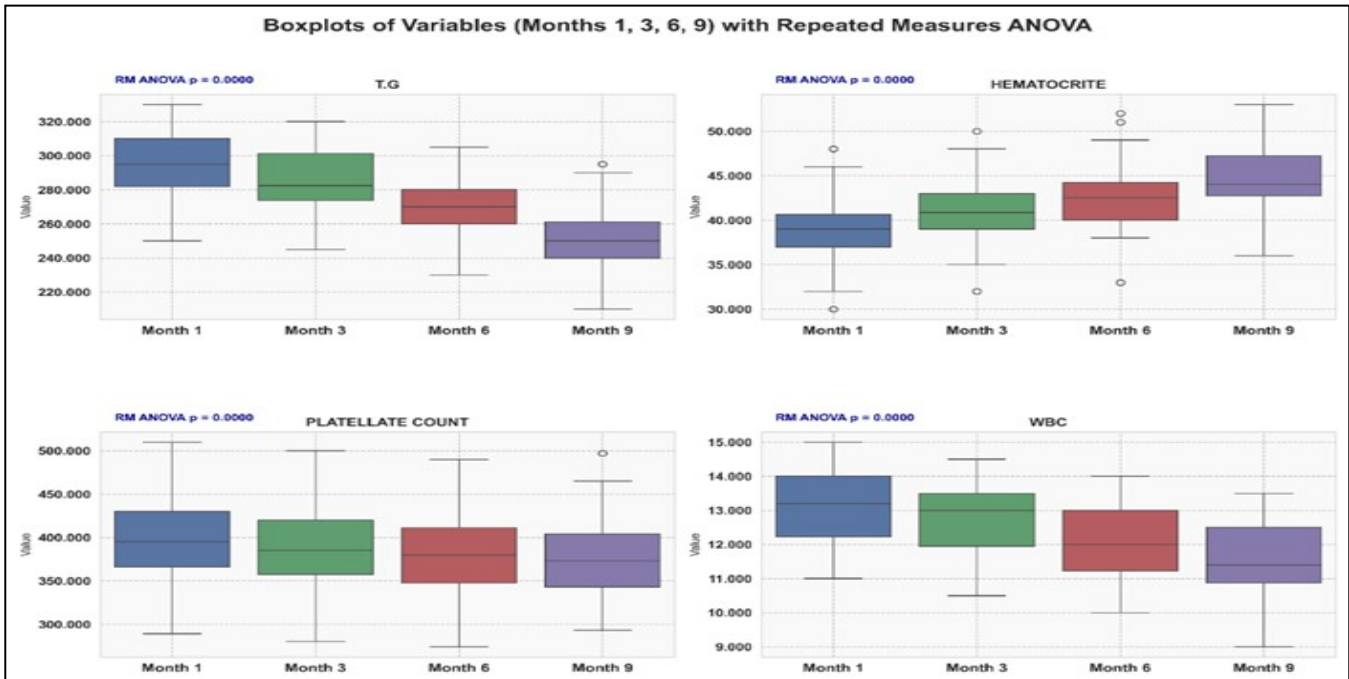


Figure 1: Boxplots of normally distributed variables analyzed with repeated-measures ANOVA

narrow, which can be ascribed to personal variation. The platelet count was relatively high at baseline, increased between 6 and 9 months, and then stabilized. This trend indicated an initial rise in platelet activity, which did not increase further. Similarly, the number of WBC progressively decreased from baseline to 9 months, reflecting a decline in systemic immune and inflammatory responses. Taken together, the changes in central tendency and variability, supported by highly significant ANOVA results, highlight the positive influence of walking on lipid, hematological, and immunological values over time.

Boxplots of Non-Normally Distributed Variables

Figure 2 Shows that boxplot analysis revealed significant improvements in glycemic, lipid, hematological, and inflammatory parameters after the walking intervention, as confirmed by the Friedman test ($p < 0.001$ of all parameters). Baseline-elevated HbA1c and RBS exhibited progressive changes with a negative median and a reduced interquartile range at 3, 6 and 9 months, which demonstrated long- and short-term glycemic control improvements. The lipid parameters had a positive trend. Total lipids and LDL showed an identical reduction in the median of total lipids and LDL, with decreased variation. At the same time, HDL increased from a low baseline, indicating improved cardioprotective lipid fractions, coupled with a very slight increase in dispersion among respondents. Total cholesterol (TC) also showed a general downward trend of total cholesterol (TC). The median did not change significantly between baseline and three months. Still, distinct downward changes were observed between three and six months and

were sustained until nine months, so the most significant changes occurred after the first three months of intervention. Hemoglobin increased slowly, indicating improved hematological status. Still, ESR, which was initially high, showed a downward trend and decreased variability, indicating reduced systemic inflammation. Overall, the boxplots show consistent, clinically significant benefits of regular walking, and the Friedman analysis supports the statistical validity and highlights the strength of the temporal changes.

Tests Interpretation of Normally Distributed Variables

In **Table II**, T.G indicates a steady and significant decrease during the intervention period. The repeated-measures ANOVA shows the existence of an overall effect ($F=178.823$, $p<0.05$); paired t-tests show a significant decrease from baseline at 3, 6, and 9 months (all $p<0.05$). The hematocrit (HCT) gradually increased throughout the course of the study. Repeated-measures ANOVA showed that the overall effect was significant ($F=215.270$, $p<0.05$), and the gain was significant of each follow-up interval on a paired t-test (all $p<0.05$). The overall change in the platelet count (PLT) was significant ($F=25.450$, $p<0.05$). Paired t-tests showed significant differences between baseline and three months and between three and six months (both $p<0.05$). There was no significant difference after six and nine months ($p=0.412$). WBC showed a significant, steady positive trend ($F=620.956$, $p<0.05$). Paired t-tests showed a significant change at baseline and three months, three to six months, and six-9 months (all $p<0.05$).

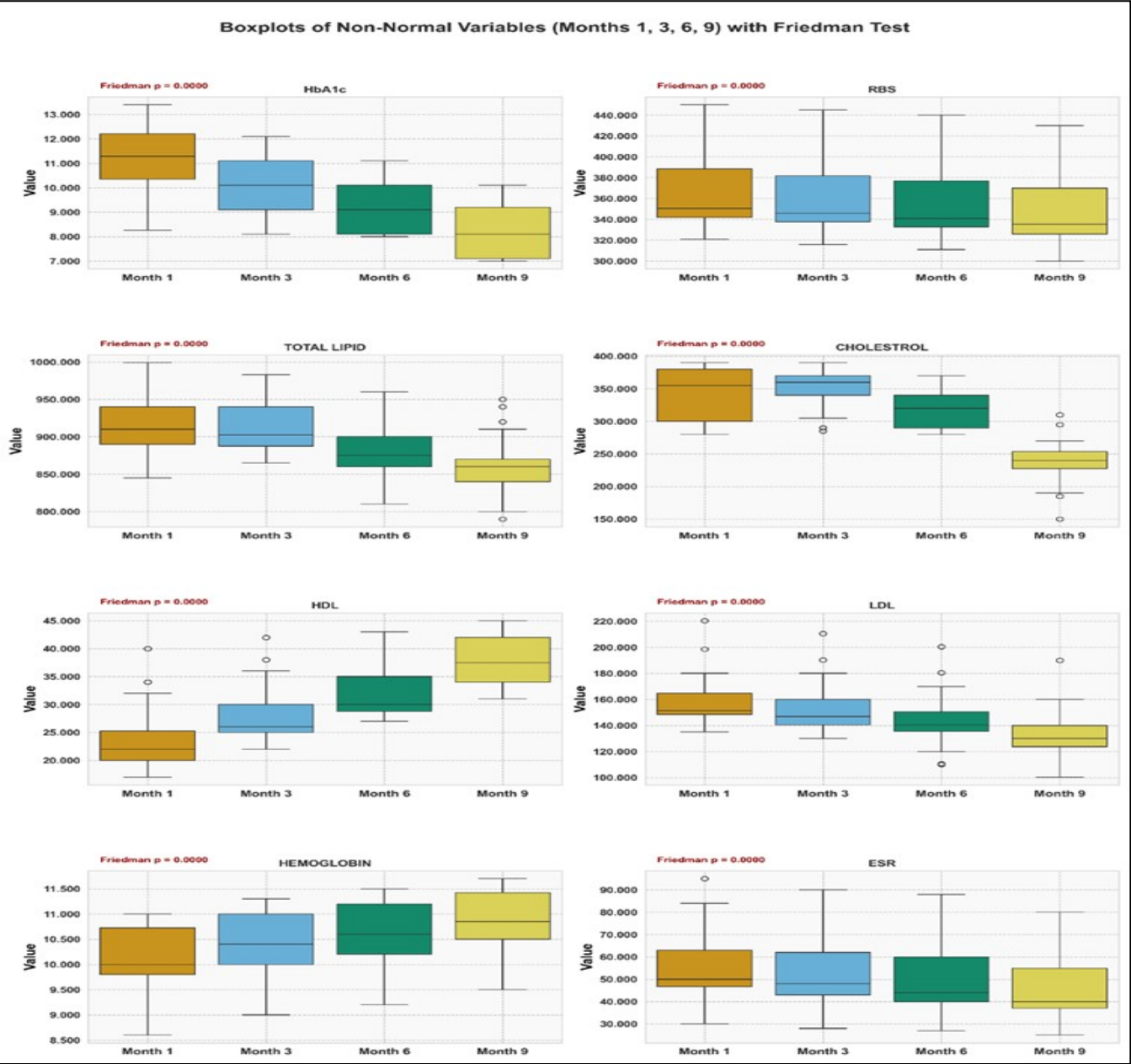


Figure 2: Boxplots of non-normally distributed variables analyzed with the Friedman Test

Table II: Analysis of normally distributed variables using paired t-test and repeated-measures ANOVA

Variables		T.G (mg/dl)				HEMATOCRIT (%)			
Test	RM ANOVA	Paired T-Test			RM ANOVA	Paired T-Test			
		1 vs 3	3 vs 6	6 vs 9		1 vs 3	3 vs 6	6 vs 9	
Statistic	178.823	6.657	8.103	10.265	215.27	-8.547	-14.601	-13.437	
p-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
Variables		PLATELLATE COUNT(10 ⁹ /L)				WBC(10 ⁹ /L)			
Test	RM ANOVA	Paired T-Test			RM ANOVA	Paired T-Test			
		1 vs 3	3 vs 6	6 vs 9		1 vs 3	3 vs 6	6 vs 9	
Statistic	25.450	13.757	20.313	0.830	620.956	15.576	14.633	15.832	
p-value	0.000	0.000	0.000	0.412	0.000	0.000	0.000	0.000	

Test Results (Non-Normally Distributed Variables)

Table III: HbA1c decreased significantly during the intervention period. The Friedman test showed an overall effect ($\chi^2=115.52$, $p<0.05$). Wilcoxon signed-rank tests showed significant reductions from baseline to three months, three to six months, and six to nine months (all $p < 0.05$). RBS also reduced significantly over time. The Friedman test showed a highly significant change ($\chi^2 = 116.76$, $p < 0.05$). Wilcoxon pairwise comparisons of the Wilcoxon test showed significant differences between baseline and three months ($p < 0.05$), three months and six months ($p < 0.05$), and six months and nine months ($p < 0.05$). Total lipids (TL) decreased progressively over the 9-month intervention, with a significant overall effect ($\chi^2 = 113.88$, $p < 0.05$). Wilcoxon tests were used to ensure that stepwise reductions were significant (all p -values < 0.05). A significant overall decrease in total cholesterol (TC) was observed ($\chi^2=92.59$, $p<0.05$). But no difference was noted between baseline and 3 months ($p=0.54$). Significant changes were observed at three to six months and six to nine months (both $p<0.05$). The level of HDL was significantly elevated during the intervention ($\chi^2=120$, $p<0.05$). Wilcoxon tests showed that increases at three, six, and nine months were highly significant compared with baseline (all $p < 0.05$). LDL decreased significantly and consistently ($\chi^2 = 107.58$, $p < 0.05$). Significant differences between baseline and three months, three and six months, and six and 9 months were observed using pairwise Wilcoxon tests (all $p<0.05$). Hemoglobin (Hb) values increased gradually throughout the study period. Friedman test results

showed an overall significant effect ($\chi^2=120$, $p<0.05$), and Wilcoxon tests showed significant gains at all follow-up intervals (all $p<0.05$). ESR decreased significantly over the course of the intervention ($\chi^2=116.49$, $p<0.05$). Wilcoxon tests showed significant reductions between the three-month, six-month, and nine-month time points (all $p<0.05$).

DISCUSSION

This research revealed that a systematic walking intervention of nine months led to statistically significant and clinically meaningful changes in the biochemical and hematological indicators in patients of T2DM. Consistency of positive changes was reported in both parametric (repeated-measures ANOVA, paired t-tests) and nonparametric analyses (Friedman and Wilcoxon signed-rank tests), which highlight the strength of the results. Glycemic Parameters: Glycemic control significantly improved, as shown by a steady decrease in HbA1c ($\chi^2=115.52$, $P<0.05$) and RBS ($\chi^2=116.76$, $P<0.05$) at all times. HbA1c is an indicator of long-term glycemic control, and a gradual decrease of the parameter indicates a long-term positive outcome of walking in enhancing insulin sensitivity and peripheral uptake of glucose⁷. Enhancements in RBS also represent the acute exercise effect on glycemic balance. These results are corroborated by previous evidence that aerobic exercises, such as walking, lower HbA1c by a significant margin in T2DM patients in Pakistan⁹. Of relevance to a population health approach, these figures are very worrying in Pakistan, where an astounding number of individuals with T2DM are not

Table III: Analysis of non-normally distributed variables using the Wilcoxon signed-rank test and the Friedman test

Variable	HbA1c (%)				RBS (mg/dl)			
	Wilcoxon			Friedman Test	Wilcoxon			Friedman Test
Test	1 vs 3	3 vs 6	6 vs 9		1 vs 3	3 vs 6	6 vs 9	
Statistic	0.000	0.00	0.00	115.51	8.000	0.000	1.000	116.76
p-value	0.000	0.00	0.00	0.000	0.000	0.000	0.000	0.000
Variable	TOTAL LIPID (mg/dl)				CHOLESTEROL (mg/dl)			
	Wilcoxon			Friedman Test	Wilcoxon			Friedman Test
Test	1 vs 3	3 vs 6	6 vs 9		1 vs 3	3 vs 6	6 vs 9	
Statistic	193.0	0.00	0.00	113.88	365.00	0.000	1.000	92.592
p-value	0.003	0.00	0.00	0.000	0.543	0.000	0.000	0.000
Variable	HDL (mg/dl)				LDL (mg/dl)			
	Wilcoxon			Friedman Test	Wilcoxon			Friedman Test
Test	1 vs 3	3 vs 6	6 vs 9		1 vs 3	3 vs 6	6 vs 9	
Statistic	0.000	0.00	0.00	120.00	5.00	40.00	0.000	107.578
p-value	0.000	0.00	0.00	0.000	0.00	0.00	0.000	0.000
Variable	HEMOGLOBIN (g/dl)				ESR(mm/hr)			
	Wilcoxon			Friedman Test	Wilcoxon			Friedman Test
Test	1 vs 3	3 vs 6	6 vs 9		1 vs 3	3 vs 6	6 vs 9	
Statistic	0.000	0.00	0.00	120.00	29.500	0.000	0.000	116.49
p-value	0.000	0.00	0.00	0.000	0.000	0.000	0.000	0.000

adequately controlled⁶. Community-based walking interventions can help stabilize the burden of uncontrolled diabetes and its complications. **Lipid Profile:** The lipid profile showed significant changes. The T.G ($F=178.823$, $p<0.05$), total lipids ($\chi^2=113.88$, $p<0.05$), and LDL cholesterol ($\chi^2=107.58$, $p<0.05$) significantly decreased, whereas the HDL cholesterol significantly increased ($\chi^2=120$, $p=0.05$). Lipid benefits were not observed until 6 months ($\chi^2=92.59$, $p<0.05$), suggesting that the benefits of long-term intervention may take time to show benefits. The findings are consistent with previous findings that exercise improves lipid metabolism by increasing fatty acid oxidation and the activities of lipoprotein enzymes^{8,17,18}. Since dyslipidemia is a significant risk factor in cardiovascular conditions of diabetic populations, identified changes have high clinical value, especially in low-resource settings, where the availability of lipid-lowering medications is scarce². **Hematological Parameters:** The walking program significantly affected haematological indicators. The rate of increase in hematocrit ($F=215.270$, $p<0.05$) was accompanied by gains in Hemoglobin ($\chi^2=120$, $p<0.05$), which is consistent with stimulation of erythropoiesis and an increase in oxygen-carrying capacity, as a result of exercise¹⁹. The number of platelets increased in the first six months ($F=25.450$, $p<0.05$) and then levelled off ($p=0.412$), reflecting an early adaptive mechanism and then homeostasis. WBC count showed a steady increase ($F=620.956$, $p<0.05$), consistent with exercise-induced leukocytosis, typically viewed as the mobilization of immune cells rather than pathologic inflammation^{19,20}. These hematologic changes could enhance tissue oxygenation and the immune response, which are essential of alleviating diabetes-associated complications. **Inflammatory Marker:** The large decrease in ESR ($\chi^2=116.49$, $p<0.05$) suggests anti-inflammatory effects of walking. The decrease in ESR thus indicated that walking is more than a metabolic intervention; it is an anti-inflammatory intervention in the management of diabetes.

Statistical and Public Health Significance: The statistical integrity of the results, based on the finding of consistent significance of the results of various tests ($p<0.05$), indicates that the effects of the interventions were not due of chance. In medicine, the risk of micro- and macrovascular complications (retinopathy, nephropathy, neuropathy, stroke, and myocardial infarction) is reduced by improving glycemic, lipid, hematological, and inflammatory parameters¹. The health impacts are significant to the population, since Pakistan has one of the highest burdens of diabetes in the world^{4,5}. Walking is a more affordable and culturally accessible intervention that can be expanded through community health programs, workplace health programs, and gender-sensitive campaigns, making it an effective alternative in resource-limited settings.

CONCLUSION

This research indicates that a well-designed walking program of 9 months has significant and progressive improvement in key bio-parameters. HbA1c, FBS, and RBS decreased significantly, indicating meaningful improvement in glycemic control. Initial analysis of the Walking Group also showed positive results in Lipid Profile parameters, including significant reductions in Total Cholesterol, Triglycerides, and LDL, and a marked increase in HDL. Haematological parameters also improved, with a steady rise in Hemoglobin and a decrease in ESR, reflecting reduced systemic inflammation over time. Overall, the structured walking intervention is an effective, low-cost, and sustainable non-pharmacological strategy for meaningful health improvements in patients with Type II Diabetes Mellitus, particularly in resource-limited settings.

Disclaimer: This work is from the PhD thesis of Ms. Mahak Memon (1st Author of this article)

Ethical Permission: Institute of Biochemistry, University of Sindh, Jamshoro, Pakistan, IRB approval letter No. IOB/329/2023.

Conflict of interest: There is no conflict of interest between the authors.

Financial Disclosure / Grant Approval: No funding agency was involved in this research.

Data Sharing Statement: The corresponding Author can provide the data proving the findings of this study on request. Privacy or ethical restrictions bound us from sharing the data publicly.

AUTHOR CONTRIBUTION

Memon M: Data collection, Literature search, Analysis and interpretation

Shah A: Study Design, Drafting, Data Interpretation.

Memon FN: Literature search, Data collection

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