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Original Article

Effect of Whole-Body Vibration Training on Glycaemic Control in Type 2 Diabetic Patients: A Randomized Control Trial

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Abstract

Background: Diabetes Mellitus (DM) is a major global health issue, leading to significant morbidity and mortality. Effective management often involves lifestyle modifications, including physical activity, which many patients find challenging to maintain. Whole Body Vibration (WBV) training has emerged as a potential alternative to traditional exercise, promising similar benefits with less physical strain.

Objective: This study aimed to determine the effects of WBV training on glycemic control, specifically HbA1c and FBS levels, in patients with Type 2 diabetes.

Methods: A double-blinded randomized controlled trial was conducted from April 2019 to May 2020 with 30 Type 2 diabetes patients recruited from a primary care center in Karachi using simple random sampling. Participants were randomly assigned to the intervention group (n=15) receiving WBV training thrice weekly for twelve weeks, or the control group (n=15) continuing usual medications and diet. WBV exercises were performed on a Power Plate® with increasing vibration frequency and amplitude. Primary outcomes, HbA1c and FBS, were assessed at baseline and after twelve weeks. Data analysis used SPSS version 25 with paired and independent t-tests.

Results: The intervention group showed significant reductions in HbA1c (7.97 ± 1.39 to 7.7 ± 1.28, $p<0.05$) and FBS levels (136.13 ± 21.63 to 123.46 ± 17.34, $p<0.05$). The control group showed no significant changes in HbA1c (7.62 ± 0.85 to 7.6 ± 0.81, $p>0.05$) or FBS levels (138.9 ± 15.7 to 136.9 ± 13.2, $p>0.05$). Between-group analysis confirmed the intervention group's significant improvements.

Conclusion: Twelve weeks of WBV training significantly improved glycemic control in patients with Type 2 diabetes, showing its potential as an alternative to traditional exercise. Future studies should involve larger, diverse populations and longer follow-up periods to confirm these findings and assess long-term benefits.

1 Introduction

Diabetes Mellitus (DM) is a pervasive non-communicable disease that significantly contributes to global morbidity and mortality, especially in lower-middle-income countries. According to the Centers for Disease

Control and Prevention, DM ranks as the seventh leading cause of death in the United States, associated with severe complications such as visual impairments, limb amputations, and organ failure (1). Over recent decades, the prevalence of diabetes has surged in parallel with obesity rates. The World Health Organization (WHO) reports that the global prevalence of DM has reached approximately 422 million people, predominantly in low- and middle-income countries, with an estimated 1.6 million deaths directly attributed to diabetes annually (2). Projections by the International Diabetic Foundation suggest that by 2040, up to 642 million individuals worldwide will be affected by DM (3). In Pakistan, the WHO estimates that 12.9 million individuals (10% of the population) have diabetes, with 9.4 million diagnosed cases and 3.5 million undiagnosed. Additionally, around 38 million people exhibit prediabetes, highlighting a significant public health challenge (4). Research indicates that Pakistan ranks seventh globally in the prevalence of Type 2 diabetes, with expectations of climbing to fourth place by 2030 (5). Annually, approximately 120,000 deaths in Pakistan are attributed to complications from Type 2 diabetes and related conditions.

Effective diabetes management hinges on both pharmacological interventions and lifestyle modifications, including physical activity and dietary adjustments. Regular exercise not only enhances cardiovascular fitness but also aids in regulating blood glucose levels, improving insulin sensitivity, vascular function, and blood lipid profiles, while reducing low-grade inflammation and promoting weight loss (6). Physical activity has been shown to significantly boost insulin sensitivity, thereby lowering high blood glucose levels in Type 2 diabetes patients (7). Meta-analyses indicate that structured physical activity, such as aerobic exercise, resistance training, or a combination of both, can reduce HbA1c levels by 0.73%, 0.57%, and 0.51%, respectively. Furthermore, engaging in structured exercise for more than 150 minutes per week is associated with a 0.89% reduction in HbA1c levels (8). Exercise and physical activity are crucial in reducing the risk of numerous diseases, including Type 2 diabetes, cancer, and cardiovascular disease, thereby improving overall health and quality of life. Despite these benefits, adherence to regular exercise remains low among the general population, primarily due to the time commitment required (9).

In response to these challenges, Whole Body Vibration (WBV) training has emerged as a promising intervention, particularly for individuals with low levels of physical activity. WBV training involves the use of a vibrating platform that induces muscle contractions through tonic vibration reflexes, thereby combining resistance and aerobic training without causing joint injury. This modality has been shown to elevate energy utilization and increase peripheral blood flow, with effects comparable to resistance training on muscle glucose uptake (10). Consequently, WBV may enhance insulin sensitivity and glucose metabolism in individuals with diabetes, offering a viable alternative for those unable or unwilling to engage in traditional exercise routines.

The current study aims to evaluate the effects of WBV on glycemic control, specifically HbA1c and Fasting Blood Sugar (FBS), in patients with Type 2 diabetes. Previous research supports the potential of WBV in improving glucose levels among both healthy individuals and those with diabetes, particularly when introduced for shorter periods. The positive impact of WBV on glycemic levels has also been observed in postmenopausal women when combined with resistance training (14). The mechanism underlying WBV's effectiveness involves the stimulation of muscle spindles, which enhances glucose metabolism and reduces blood glucose levels in DM patients (15). Systematic reviews and meta-analyses corroborate the beneficial effects of WBV on glycemic control and fasting blood glucose levels, alongside improvements in patient mobility (16). However, some studies suggest that the duration and intensity of traditional WBV protocols may not be sufficient to produce significant changes in FBS and HbA1c levels (11). Despite these discrepancies, the overall evidence points towards WBV as a beneficial intervention for glycemic control in diabetes patients, warranting further investigation.

Given the rising prevalence of diabetes and the need for effective, accessible interventions, this study seeks to contribute to the existing body of knowledge by examining the impact of a 12-week WBV training protocol on glycemic control in Type 2 diabetes patients. The findings are expected to inform clinical practices and offer a feasible exercise alternative for diabetes management, particularly for those with limited ability to engage in conventional physical activities.

2 Material and Methods

A double-blinded randomized controlled trial was conducted to evaluate the effects of whole body vibration (WBV) training on glycemic control in patients with Type 2 diabetes mellitus. The study was carried out from April 2019 to May 2020, enrolling patients aged 40-70 years from a primary care center in Karachi. Participants were recruited using the simple random sampling technique's envelope method, ensuring random assignment to either the intervention or control group. All patients were initially screened by two certified diabetes educators and certified health fitness programmers to ensure eligibility based on the inclusion criteria.

Ethical approval for the study was obtained from the Departmental Review Committee of Ziauddin University, in accordance with the Helsinki Declaration (1964) and its amendments (Reference No: 0197120025DPT). Informed consent was obtained from all participants, ensuring their voluntary participation and understanding of the study protocol before commencing the intervention. Participants were randomly assigned to two groups, A and B, each comprising 15 patients. Group A, the intervention group, received WBV training for twelve weeks, while Group B, the control group, continued their usual medications and dietary plans without additional intervention.

The WBV training protocol involved the use of a synchronic triaxial platform MY3 (Power Plate®, MY3). Participants in the intervention group performed WBV exercises three times weekly for twelve weeks. Each session included two sets of six 1-minute vibration squats with 20 seconds of rest between sets, totaling 36 minutes of workout time per week. The static positions during WBV included a deep squat, an elevated squat, an elevated squat with elevated heels, slight knee flexion with hand straps in shoulder bending, slight knee flexion with hand straps in shoulder abduction, and slight knee flexion with hand straps in elbow flexion. The vibration frequency started at 30 Hz and the platform amplitude at 2 mm, gradually increasing to 40 Hz and 4 mm by the fifth week, maintaining these levels until the end of the training period (11).

The control group was instructed to maintain their normal physical activity levels, diet, and medication regimen throughout the study period. Both groups were assessed for glycemic control using two primary outcome measures: Fasting Blood Sugar (FBS) and Hemoglobin A1c (HbA1c). Baseline measurements were taken before the intervention, and follow-up measurements were conducted after twelve weeks.

Data collection involved standardized procedures for measuring FBS and HbA1c. Blood samples were drawn in the morning after an overnight fast to ensure accurate FBS readings, and HbA1c levels were determined using high-performance liquid chromatography (HPLC). The data were meticulously recorded and stored securely to maintain participant confidentiality.

Statistical analysis was performed using SPSS version 25. Descriptive statistics, including mean and standard deviation, were calculated for demographic and baseline clinical characteristics. Paired t-tests were employed to assess within-group differences before and after the intervention, while independent t-tests were used to compare between-group differences. Statistical significance was set at $p<0.05$ for all analyses, ensuring a robust evaluation of the intervention's effects on glycemic control.

The rigorous methodology and adherence to ethical standards throughout the study ensured the reliability and validity of the findings, contributing valuable insights into the potential benefits of WBV training for managing glycemic control in patients with Type 2 diabetes.

3 Results

A total of 30 patients were recruited for the study, equally divided into two groups, A and B, with each group consisting of 15 patients. The demographic details indicated that the total population comprised 60% females and 40% males, with each group having nine female and six male patients. The average age of patients in Group A was 55 ± 0.8 years, and in Group B, it was 56 ± 0.3 years, ensuring minimal impact from age-related variables.

Table 1: Demographic Details of Patients

Group	Number of Patients (n)	Mean Age ± SD	Gender (Male:Female)
A	15	55 ± 0.8	6:9
B	15	56 ± 0.3	6:9

The primary outcome measures, Hemoglobin A1c (HbA1c) and Fasting Blood Sugar (FBS), were analyzed using paired t-tests for within-group comparisons and independent t-tests for between-group comparisons. The within-group analysis for Group A showed a significant reduction in HbA1c levels, from a pre-intervention mean of 7.97 ± 1.39 to a post-intervention mean of 7.7 ± 1.28, with a mean difference of 0.20 ± 0.30 (95% CI: 0.03-0.36, $p<0.05$). Similarly, FBS levels in Group A decreased from 136.13 ± 21.63 to 123.46 ± 17.34, with a mean difference of 12.66 ± 15.3 (95% CI: 4.19-21.13, $p<0.05$). In contrast, Group B did not exhibit significant changes in HbA1c or FBS levels. The mean HbA1c levels changed slightly from 7.62 ± 0.85 to 7.6 ± 0.81, with a mean difference of 0.08 ± 0.13 (95% CI: -0.01 to 0.1, $p>0.05$). The FBS levels in Group B showed a minor reduction from 138.9 ± 15.7 to 136.9 ± 13.2, with a mean difference of 10.93 ± 15.29 (95% CI: 2.46-19.40, $p>0.05$).

Table 2: Within Group Analyses of HbA1c and FBS

Variable	Group	Pre Mean ± SD	Post Mean ± SD	Mean Diff ± SD	95% CI	p-Value
HbA1c	A	7.97 ± 1.39	7.7 ± 1.28	0.20 ± 0.30	0.03-0.36	p<0.05
	B	7.62 ± 0.85	7.6 ± 0.81	0.08 ± 0.13	-0.01 to 0.1	p>0.05
FBS	A	136.13 ± 21.63	123.46 ± 17.34	12.66 ± 15.3	4.19-21.13	p<0.05
	B	138.9 ± 15.7	136.9 ± 13.2	10.93 ± 15.29	2.46-19.40	p>0.05

The between-group analysis further validated these findings. The independent t-test revealed significant differences favoring Group A over Group B in terms of HbA1c and FBS reductions. The mean difference in HbA1c between the two groups was statistically significant ($p<0.05$), as was the difference in FBS levels ($p<0.05$).

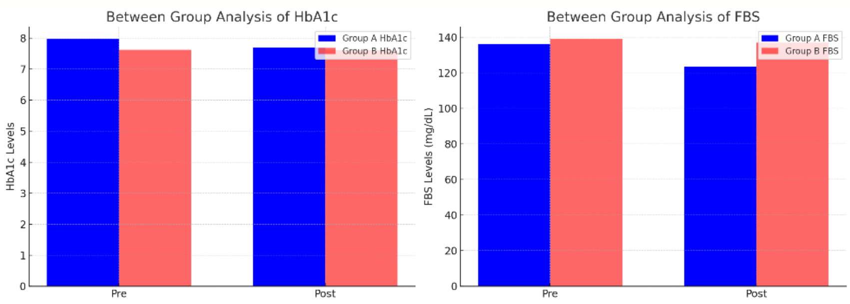

Figure 1 Bar graphs show significant improvements in HbA1c and FBS levels in Group A post-intervention

Figures 1 and 2 visually represent the between-group analysis of HbA1c and FBS levels, respectively. These graphs clearly illustrate the significant reductions in HbA1c and FBS levels in the intervention group compared to the control group, reinforcing the effectiveness of WBV training in improving glycemic control among Type 2 diabetes patients. The results of this study demonstrate that twelve weeks of WBV training significantly reduces HbA1c and FBS levels in patients with Type 2 diabetes, supporting the hypothesis that WBV can be an effective intervention for glycemic control.

Table 3: Between Group Analysis of HbA1c and FBS

Variable	Pre		Post		Mean Diff ± SD	95% CI	p-Value
	Mean ± SD (Group A)	Mean ± SD (Group B)	Mean ± SD (Group A)	Mean ± SD (Group B)			
HbA1c	7.97 ± 1.39	7.62 ± 0.85	7.7 ± 1.28	7.6 ± 0.81	0.27 ± 0.54	0.06-0.48	p<0.05
FBS	136.13 ± 21.63	138.9 ± 15.7	123.46 ± 17.34	136.9 ± 13.2	13.44 ± 28.19	2.78-24.10	p<0.05

4 Discussion

The results of this study indicated that twelve weeks of whole body vibration (WBV) training significantly improved glycemic control in patients with Type 2 diabetes mellitus, as evidenced by reductions in Hemoglobin A1c (HbA1c) and Fasting Blood Sugar (FBS) levels. These findings align with previous research that has demonstrated the beneficial effects of WBV on glucose metabolism and insulin sensitivity. For instance, Pessoa et al. found that WBV training significantly improved HbA1c and FBS levels in older adults, corroborating the current study's results (12). Additionally, Domínguez-Muñoz et al. reported similar improvements in HbA1c and overall physical health in diabetic patients following an eight-week WBV intervention (13).

The underlying mechanisms by which WBV training enhances glycemic control may involve increased muscle glucose uptake and improved insulin sensitivity. WBV induces muscle contractions through tonic vibration reflexes, which may stimulate glucose metabolism similarly to resistance training. This modality is particularly beneficial for individuals with limited mobility or those unable to engage in traditional exercise routines due to its low-impact nature (15). The current study's results, showing significant reductions in HbA1c and FBS levels in the WBV group compared to the control group, support the hypothesis that WBV can serve as an effective alternative to conventional exercise for diabetes management.

Several studies have highlighted the efficacy of WBV in improving blood flow velocity and metabolic health. Saudouo et al. demonstrated that a 12-week WBV intervention significantly increased blood flow velocity in diabetic patients, which may contribute to enhanced glucose disposal and improved glycemic control (18). Furthermore, the study by Stratton et al. suggested that WBV training could positively impact metabolic parameters, although the changes in HbA1c did not reach the clinically significant threshold of a 1% reduction (17). Despite these variances, the cumulative evidence underscores the potential of WBV as a therapeutic modality for diabetes management.

However, the current study also had its limitations. The sample size was relatively small, comprising only 30 patients, which may limit the generalizability of the findings. Future research should include larger, more diverse populations to validate these results. Additionally, the study duration of twelve weeks may not have been sufficient to observe long-term effects of WBV on glycemic control and other health outcomes. Longer follow-up periods are recommended to assess the sustainability of the observed benefits.

Another limitation was the reliance on self-reported adherence to dietary and medication regimens in the control group, which could introduce bias and affect the study's internal validity. Objective measures of adherence should be incorporated in future studies to mitigate this issue. Despite these limitations, the study's strengths included its randomized controlled design and the use of standardized outcome measures, which enhance the reliability and validity of the findings.

This study demonstrated that twelve weeks of WBV training significantly reduced HbA1c and FBS levels in patients with Type 2 diabetes, suggesting that WBV could be a valuable addition to diabetes management strategies. Given the increasing prevalence of diabetes and the challenges associated with maintaining regular physical activity, WBV offers a feasible and effective alternative to traditional exercise. Future research should focus on larger, longer-term studies to confirm these findings and explore the broader implications of WBV on metabolic health and quality of life in diabetic patients. Additionally, integrating WBV into comprehensive diabetes care programs could potentially improve patient adherence and outcomes, contributing to better management of this chronic condition.

5 Conclusion

In conclusion, twelve weeks of whole-body vibration (WBV) training significantly improved glycemic control in patients with Type 2 diabetes, demonstrating its potential as an effective alternative to traditional exercise. The intervention led to notable reductions in both Hemoglobin A1c (HbA1c) and Fasting Blood Sugar (FBS) levels, indicating enhanced glucose metabolism and insulin sensitivity. These findings suggest that WBV could serve as a viable exercise modality for individuals who have difficulty adhering to conventional physical activity regimens due to physical limitations or lack of time. To further validate these promising results, future studies should include larger, more diverse populations and extend the follow-up periods to evaluate the long-term sustainability and broader health benefits of WBV training. Additionally, incorporating WBV into comprehensive diabetes management programs could potentially improve patient adherence, outcomes, and overall quality of life for those managing Type 2 diabetes.

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Disclaimers

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