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Impact of Combined Stress Relieving Technique and Circuit Training on Glycemic Control, Physical and Psychological Well-Being in Diabetic Patients

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ABSTRACT

Introduction: Diabetes mellitus (DM) is a chronic metabolic disorder characterized by persistent hyperglycemia due to insulin dysfunction, leading to severe systemic and psychological complications.This study evaluated the impact of a combined stress relieved techniques(SRT) and circuit training program on glycemic control, physical endurance, and psychological well-being in type 2 diabetic patients.

Methods and Materials: An experimental study was conducted on 68 participants aged 40–50 years with type 2 DM for over five years. Participants were randomized into two groups: Group A (control, n=34), advised to follow standard care with regular medications and diet, and Group B (experimental, n=34), engaged in an 5-week circuit training and SRT program. Pre- and post-intervention assessments included fasting and postprandial blood glucose levels, 6-minute walk test (6MWT), and Perceived Stress Scale (PSS). Statistical analysis was performed using paired and unpaired tests, with $p < 0.001$ considered Extremely significant.

Results: Group B showed significantly greater improvements compared to Group A in all parameters. Fasting glucose decreased from 155.82 ± 4.39 to 114.94 ± 7.29 in Group B ($p < 0.0001$), while Group A showed a modest reduction ($p = 0.0214$). Group B demonstrated substantial gains in 6MWT (292.23 ± 11.21 to 408.23 ± 11.21, $p < 0.0001$) and marked reductions in PSS scores (33.22 ± 3.73 to 20.05 ± 4.23, $p < 0.0001$).

Conclusion: The integration of circuit training with SRT offers a holistic approach to diabetes care, addressing both physical and psychological aspects, resulting in superior glycemic control, improved functional capacity, and reduced stress.

Keywords: *Diabetes mellitus, stress relieving technique, circuit training, glycemic control, physical fitness, stress management, holistic intervention.*

1. INTRODUCTION

Diabetes mellitus (DM) is a chronic metabolic disorder caused by insufficient insulin secretion or the body's reduced ability to utilize insulin effectively. This results in elevated blood glucose levels, which, if unmanaged, lead to severe health complications. The International Diabetes Federation (IDF) reported over 537 million adults with diabetes in 2021, with projections reaching 783 million by 2045[1]. India, at the center of this epidemic, had over 77 million cases in 2021, a figure expected to escalate to 134 million by 2045, earning it the title of the "diabetes capital of the world"[2]. Diabetes impacts multiple organ systems, leading to vascular complications such as heart disease, stroke, retinopathy, nephropathy, and neuropathy[3]. It also affects musculoskeletal health, causing joint stiffness, reduced muscle strength, and diabetic arthropathy, which hinder mobility and increase the risk of falls[4]. Chronic hyperglycemia induces oxidative stress and inflammation, further exacerbating these impairments[5].

The psychological burden of diabetes, including stress, anxiety, and depression, adds another layer of complexity. Stress activates the hypothalamic-pituitary-adrenal (HPA) axis, increasing cortisol levels, which contributes to hyperglycemia and insulin resistance[6]. Depression often leads to poor self-care practices, such as irregular medication use, unhealthy diets, and lack of exercise, worsening glycemic control[7]. In India, studies show that up to 30% of diabetic patients experience significant psychological stress, emphasizing the urgent need to integrate mental health interventions into diabetes care[8].

Physical activity is a cornerstone of diabetes management, offering improved glycemic control, better cardiovascular health, and enhanced overall fitness[9]. Regular exercise increases insulin sensitivity by facilitating glucose uptake in skeletal muscles[10]. Among the various exercise modalities, circuit training—combining aerobic and resistance exercises in a structured sequence—stands out as an effective option. It improves strength, endurance, flexibility, and balance while being time-efficient for individuals with busy lifestyles[11]. Studies have shown that circuit training helps regulate blood sugar, reduce body fat, and improve muscle strength and overall fitness in diabetic patients[12]. Beyond physical benefits, exercise also addresses mental health by reducing cortisol, increasing endorphins, and improving sleep quality[13][14]. Group-based exercise programs, like circuit training classes, provide the added benefit of social interaction, alleviating feelings of isolation and enhancing motivation[15].

Stress-relieving techniques (SRT), derived from practices like meditation and yoga, address the psychological challenges associated with diabetes. These techniques help reduce HPA axis activation, lower cortisol levels, and promote emotional balance and overall well-being[16][17]. SRT has also been shown to improve adherence to self-care behaviors such as regular physical activity, healthy eating, and medication compliance, which are essential for diabetes management[18]. Integrating circuit training with SRT offers a holistic approach to diabetes care, addressing both the physical and psychological challenges of the disease. Circuit training enhances metabolic health by improving muscle strength and cardiovascular fitness, while SRT reduces stress and improves mental well-being. Evidence suggests that combining exercise and stress management yields superior outcomes, including better glycemic control, reduced complications, and enhanced overall quality of life[19][20].Despite the potential of this integrative approach, research on the combined effects of SRT and circuit training remains limited, particularly in India. High levels of stress and anxiety among Indian diabetic patients further highlight the importance of incorporating psychological care into standard treatment protocols. This study aims to evaluate the impact of a combined circuit training and stress-relieving program on glycemic control, physical health, and psychological well-being in diabetic patients.

2. METHODOLOGY

The type of study was a Experimental study. Its study design was a pre-test and post- test measurements.68 Participants were selected in simple random sampling method. Again, from these 68 participants, 34 participants were selected to be in group A(Controlled group) and another 34 participants were selected under Group B(experimental Group) via Computed Randomization technique. This study was conducted in Krishna Vishwa Vidyapeeth, deemed to be university, Karad, Maharashtra. The duration of the study was 3 months. The study was started once the ethical committee approved the study.

Respondents were informed about the study and provided with the procedures before giving their informed consent. All participants voluntarily took part, and their privacy was upheld throughout the study

Sample size $n=Z^2 pq/L^2= 68$

Where,

Z = type 1 error with 5% level of significance =1.96

p = Anxiety in diabetic patients = 27.6%%

q = 100 – 27.6 = 72.4%

L = 15 (permissible limit of error)

n = 34.11 = 34

Taking prevalence p=27.4% , according to a study from India . [21],

Subjects were selected according to the inclusion and exclusion criteria. The inclusion criteria consisted of Males and female diagnosed with diabetes mellitus type2 in the past 5 years. Age group between 40-50, HbA1c should be between 6 to 8,A note from the physician that the participants are fit to undergo circuit training. With no severe mobility impairments, Willing participants , Participants should be on a stable medication regimen for at least 3 months prior to the study, without any changes in diabetes medication during the study period.

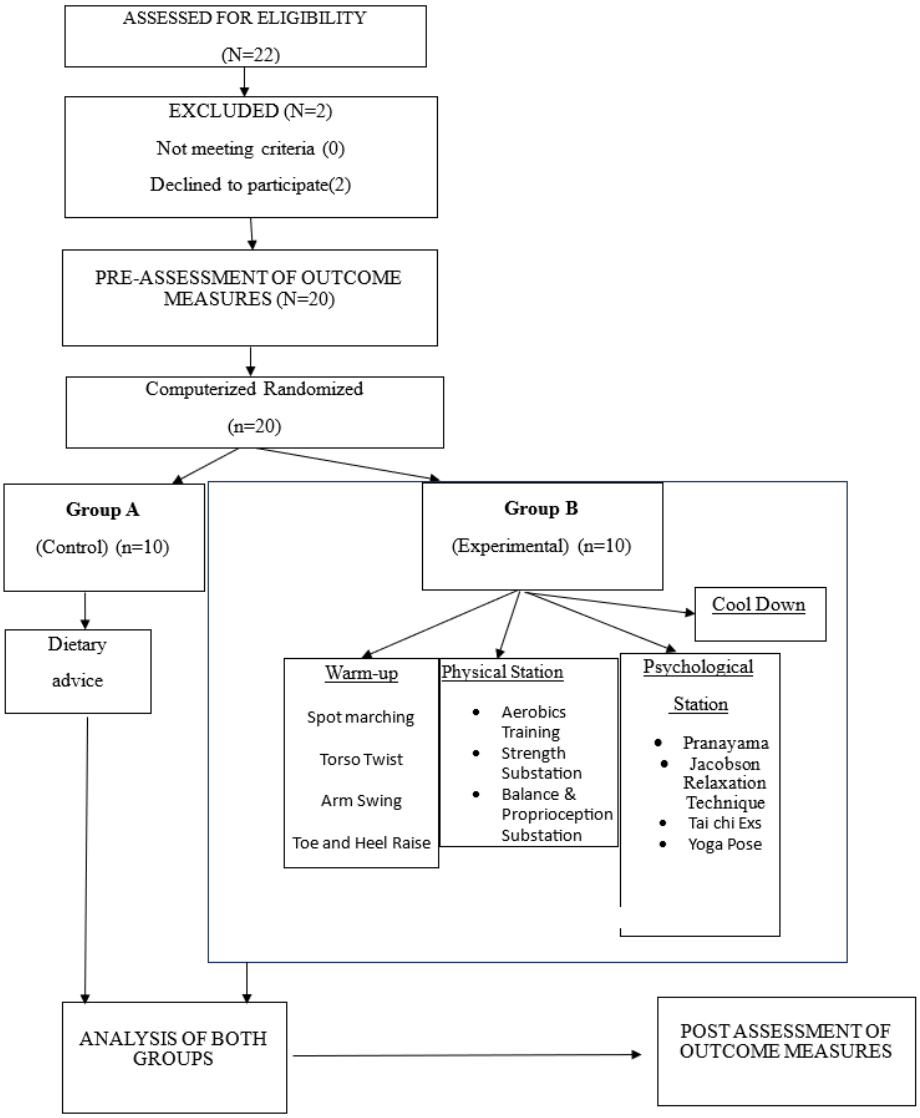
and the exclusion criteria was Severe Diabetes Complications, Uncontrolled Hypertension, Recent Surgery or Major Illness, Psychiatric Disorders, Pregnancy.

Before obtaining their consent, participants were given sufficient information about the study. Subject signed an informed consent form.

With their full agreement, 68 patients were recruited. The participants were from a village area near Karad city.

Two groups were selected. And the participants were distributed according to computer randomization method. 34 participants were allotted in Group A(controlled group) and another 34 participants were allotted in Group B(experimental group). Participants from group A was advised to take regular medications and follow the regular diet. And the group B

participants were advised to participant in circuit training for 5 weeks . Before and after the training pre and post assessment was taken for both the groups. To check blood glucose level, fasting and postprandial blood glucose level were taken. For checking the physical well-being, 6 minute walk test was used. And to assess the psychological well being, perceived stress scale was used.



Flowchart 1. Overview of methodology

Picture1 lateral pulls *Picture 2 (treadmill)* *Picture 3(leg press)*

Picture 4 (balasana)

Picture 5 (Adho Mukha svanasana

Interpretation

Table 1. Fasting values of pre and post intervention

Metric	Pre (Mean and SD)	Post	p-Value
Group A	155.82± 5.396	146.29±14.196	0.0214 (Considered Significant)
Group B	155.82 ± 4.39	114.94 ± 7.299	<0.0001(Extremely Significant)

The fasting glucose levels showed significant improvement in both Group A and Group B following the intervention, as analyzed using the Wilcoxon Matched-Pair Test. Group A demonstrated a reduction in fasting glucose from 155.82 ± 5.396 to 146.29 ± 14.196, with a p-value of 0.0214, indicating statistical significance. In contrast, Group B exhibited a more substantial decrease from 155.82 ± 4.39 to 114.94 ± 7.299, with a highly significant p-value of <0.0001. These results highlight that the improvement in Group B was more pronounced.

Table 2. Postprandial values of pre and post intervention

Metric	Pre	Post	p-Value
Group A	239.55± 5.165	230.97±6.188	<0.0213 (Considered Significant)
Group B	240.11 ± 6.91	196.14 ± 11.016	<0.0001 (Extremely Significant)

The postprandial blood glucose values showed significant changes in both Group A and Group B following the intervention, as analyzed using the Wilcoxon Matched-Pair Test. Group A demonstrated an increase in postprandial values, rising from 239.55 ± 5.165 to 239.97 ± 6.188, with a p-value of <0.0213, indicating significant change. Conversely, Group B exhibited a substantial reduction in postprandial values, decreasing from 240.11 ± 6.91 to 196.14 ± 11.016, with a p-value of <0.0001, highlighting an extremely significant improvement. These results suggest that while Group A experienced slight improvement in postprandial glucose, Group B achieved a notable improvement, possibly due to a more tailored or intensive intervention strategy.

Table 1. 6MWT values of pre and post intervention

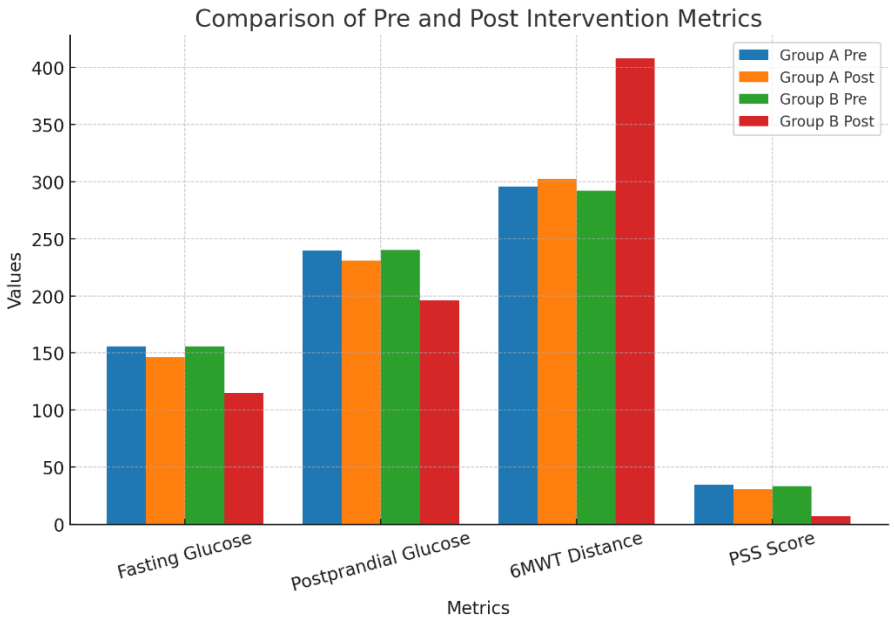
Metric	Pre	Post	t-Value	p-Value
Group A	296.02± 7.36	302.35±8.37	3.308	0.0015(Very Significant)
Group B	292.23 ± 11.206	408.23 ± 11.206	29.43	<0.0001(Extremely Significant)

The 6-minute walk test (6MWT) values demonstrated significant improvements in both Group A and Group B following the intervention, as analyzed using the paired t-test. Group A showed a slight increase in 6MWT values, improving from 296.02 ± 7.36 to 302.35 ± 8.37, with a t-value of 3.308 and a p-value of 0.0015, indicating a very significant change. In contrast, Group B exhibited a dramatic improvement, with 6MWT values increasing from 292.23 ± 11.206 to 408.23 ± 11.206. The corresponding t-value of 29.43 and the extremely significant p-value of <0.0001 highlight the substantial effect of the intervention.

Table 4. PSS values of pre and post intervention

Metric	Pre	Post	p-Value
Group A	34.61± 2.76	30.41±2.5	<0.014(Less Significant)
Group B	33.22 ± 3.73	20.05 ± 4.23	<0.0001(Extremely Significant)

In Group A, analyzed using the paired t-test, PSS values decreased from 34.61 ± 2.76 to 30.41±2.5,with the p-value of 0.014 (less significant), indicating a significant but less pronounced improvement. In contrast, Group B, analyzed using the Wilcoxon Matched-Pair Test, exhibited a more dramatic reduction in PSS values, dropping from 33.22 ± 3.73 to 20.05 ± 4.23, an extremely significant p-value of <0.0001.



Graph 5. Comparisom of pre and post intervention metric

The graph illustrates the effects of the intervention on fasting glucose, postprandial glucose, 6MWT distance, and PSS scores in Groups A and B. Group B demonstrated a more significant reduction in blood glucose levels (both fasting and postprandial) compared to Group A, with an extremely significant p-value ($p < 0.0001$). Additionally, the 6MWT distance increased dramatically in Group B, indicating improved physical endurance, whereas Group A showed only a slight improvement. In terms of stress levels, Group B exhibited a substantial decrease in PSS scores, while Group A had a moderate reduction. Overall, the intervention was more effective in Group B, suggesting it led to greater physiological and psychological benefits.

3. DISCUSSION

This study investigated the impact of combined stress-relieving techniques and circuit training on glycemic control, physical function, and psychological well-being in diabetic patients, revealing significant improvements across all parameters. Group B, which received the combined intervention, exhibited superior outcomes compared to Group A. Fasting and postprandial glucose levels improved significantly in both groups, but the reductions were more pronounced in Group B, reflecting the synergistic effects of circuit training and stress-relieving techniques. Chronic stress elevates cortisol levels, impairing insulin action and promoting hyperglycemia. The inclusion of stress-relieving techniques in Group B helped mitigate these effects by lowering cortisol levels, enhancing insulin sensitivity, and improving glucose uptake. Physical endurance, assessed through the 6-minute walk test (6MWT), also improved significantly in Group B, demonstrating the benefits of circuit training in enhancing aerobic capacity, muscular strength, and overall functional fitness. Psychological well-being, measured using the Perceived Stress Scale (PSS), showed greater improvement in Group B, emphasizing the role of stress-relieving techniques in reducing perceived stress. These techniques likely improved neuroendocrine regulation, particularly by reducing hypothalamic-pituitary-adrenal (HPA) axis activation, while also promoting relaxation and emotional resilience.

The mechanisms underlying these improvements are rooted in the physiological and psychological effects of the interventions. Circuit training enhances glucose metabolism by activating GLUT-4 transporters in skeletal muscles, increasing glucose uptake, and improving mitochondrial efficiency, thereby facilitating glucose oxidation and storage. Stress-relieving techniques further support glycemic control by reducing cortisol levels, which are known to impair glucose metabolism by promoting hepatic gluconeogenesis and reducing peripheral glucose utilization. These combined effects create a physiological state that supports better blood sugar regulation. Physical improvements stemmed from the structured nature of circuit training, which includes aerobic and resistance components that enhance cardiovascular endurance, muscle strength, and neuromuscular coordination. Stress-relieving techniques complemented these benefits by reducing muscle tension, promoting better sleep quality, and facilitating recovery. Psychological well-being was positively impacted through reduced perceived stress and anxiety. Mindfulness-based practices decreased amygdala hyperactivity and enhanced prefrontal cortex regulation, fostering emotional stability and resilience. Endorphin release during physical activity further contributed to mood improvement and supported adherence to self-care behaviors, such as consistent exercise and medication compliance.

The results of this study align with and expand upon existing research in the field. Sharma et al. (2019) found that yoga significantly reduced fasting glucose levels and psychological stress in diabetic patients, consistent with the findings of the current study. However, their intervention did not address physical endurance or functional fitness, highlighting the added value of circuit training in this study[22]. Similarly, Johnson et al. (2020) demonstrated that circuit training improved 6MWT performance and glycemic control, but their study did not report psychological benefits, underscoring the advantage of including stress-relieving techniques for a more comprehensive intervention[23]. Gupta et al. (2021) focused on mindfulness-based stress reduction and observed significant reductions in perceived stress and improvements in glycemic control. However, their study did not report any changes in physical endurance, further supporting the superiority of combining stress-relieving techniques with circuit training to address both physical and psychological aspects of diabetes management[24].

The superior outcomes in Group B reflect the synergistic benefits of integrating physical activity with stress management. While exercise enhances glucose metabolism, improves physical fitness, and releases mood-enhancing endorphins, stress-relieving techniques address the detrimental effects of chronic stress on glucose regulation and psychological health. Together, these interventions create a holistic framework that addresses the multifaceted challenges faced by diabetic patients. By combining circuit training and stress-relieving techniques, this study highlights the potential of comprehensive approaches to improve glycemic control, physical function, and psychological well-being. The findings underscore the need for culturally tailored, integrative interventions in diabetes care and encourage future research to explore their long-term effects and mechanisms in diverse populations.

Future perspective of the study

Future research should focus on exploring the individual contributions of each component—stress management and circuit training—to better understand their distinct and combined effects on glycemic control, physical fitness, and psychological well-being. Integrating advanced biomarkers, such as HbA1c and inflammatory markers, could provide deeper insights into the physiological mechanisms underlying these improvements. Additionally, the impact of dietary patterns, sleep quality, and adherence to lifestyle modifications should be investigated to create a more holistic intervention model. Personalized

interventions tailored to the severity of diabetes, comorbidities, and individual stress levels could further enhance outcomes. Exploring the scalability of this approach in community-based and telemedicine settings could make it more accessible to a larger population, especially in resource-limited areas. Ultimately, this study provides a foundation for developing multi-disciplinary, patient-centered interventions aimed at improving the overall quality of life in diabetic patients.

4. LIMITATION OF THE STUDY

The limitations of this study include a relatively small sample size, which may restrict the generalizability of the findings to a broader population of diabetic patients. The study duration was short, limiting the ability to assess the long-term sustainability of the improvements in glycemic control, physical endurance, and psychological well-being. Another limitation was the reliance on self-reported data for stress levels, such as the Perceived Stress Scale (PSS), which may introduce response bias. Dietary habits, which could significantly influence glycemic control, were not closely monitored or standardized, potentially confounding the results. Future studies should address these limitations by incorporating a larger sample size, longer follow-up periods, and more rigorous control of dietary variables, along with isolating the effects of the individual components of the intervention.

5. CONCLUSION

The study highlights that combining circuit training with stress-relieving techniques effectively enhances physical fitness, glycemic control, and overall well-being in diabetic patients. This dual approach addresses both the physical and psychological dimensions of diabetes, underscoring the importance of incorporating holistic interventions in physiotherapy practice. The results emphasize the role of such integrated strategies in improving the quality of life and health outcomes for diabetic patients, with potential for broader clinical application.

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