

EFFECT OF AEROBIC EXERCISE AND YOGA ON COGNITION, BLOOD GLUCOSE, AND QUALITY OF LIFE ASSOCIATED WITH BDNF ACTIVITY AMONGST TYPE 2 DIABETIC POPULATION

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Abstract :

Background: Type 2 diabetes mellitus (T2DM) is associated with metabolic dysfunction and may adversely affect cognitive function and quality of life. Brain-derived neurotrophic factor (BDNF) is implicated in neuronal survival, neuroplasticity, learning, and memory, and reduced BDNF levels have been reported in people with T2DM. Aerobic exercise and yoga are accessible non-pharmacological approaches that may benefit metabolic and cognitive health.

Aim: To study the effect of a four-week programme combining aerobic exercise and yoga on blood glucose, cognition, and quality of life in adults with T2DM, with the findings discussed in relation to the proposed role of BDNF.

Methods: Forty-six adults aged 35–56 years with clinically diagnosed T2DM and a Montreal Cognitive Assessment (MoCA) score below 26/30 participated in a pre–post experimental study. Participants received aerobic exercise on three days per week and yoga on alternate days for four weeks. Blood glucose, MoCA score, and quality of life were assessed before and after the intervention. Within-participant changes were analysed using the Wilcoxon signed-rank test.

Results: Mean blood glucose decreased from 153.02 ± 7.57 mg/dL to 137.30 ± 11.41 mg/dL, a mean reduction of 15.72 mg/dL. Mean MoCA score increased from 23.07 ± 1.70 to 25.22 ± 1.53 , while mean quality-of-life score increased from 60.54 ± 10.31 to 68.93 ± 9.68 . All three outcomes showed statistically significant pre–post improvement ($p < 0.001$), with reported effect sizes of 0.86, 0.83, and 0.87, respectively.

Conclusion: A four-week programme of aerobic exercise and yoga was associated with significant improvements in blood glucose, cognition, and quality of life in this sample of adults with T2DM. Because BDNF was not directly assayed, the present findings should be interpreted as being consistent with, rather than demonstrating, a BDNF-mediated mechanism. Larger controlled studies with direct measurement of BDNF and longer follow-up are warranted.

Keywords: Type 2 diabetes mellitus; aerobic exercise; yoga; cognition; Montreal Cognitive Assessment; blood glucose; quality of life; BDNF.

1. INTRODUCTION

Type 2 diabetes mellitus is a chronic metabolic disorder characterised by hyperglycaemia arising primarily from insulin resistance and inadequate insulin secretion. Persistent hyperglycaemia is associated with complications affecting the kidneys, eyes, nerves, and cardiovascular system and can adversely influence quality of life. Diabetes is also associated with alterations in central nervous system function and an increased risk of cognitive and neurological disorders.

BDNF is a neurotrophin involved in neuronal survival, synaptic plasticity, learning, and memory. It is expressed in the central nervous system and in several peripheral tissues, and BDNF is detectable in plasma and serum. Previous literature cited in the project has reported lower BDNF levels in people with T2DM and associations between BDNF, cognition, and metabolic health.

Physical activity is an important component of diabetes management. Aerobic exercise can improve insulin sensitivity and metabolic health and has been associated with beneficial effects on cognition. Yoga is a relatively low-cost mind–body intervention that may be suitable for individuals who find vigorous exercise difficult. Previous studies cited in the project have reported benefits of yoga for glycaemic control, quality of life, mood, and cognitive performance.

The project therefore examined whether a structured programme combining aerobic exercise and yoga could improve blood glucose, cognitive performance, and quality of life in adults with T2DM. The project also considered these outcomes in the context of the

proposed relationship between exercise, yoga, and BDNF. Importantly, serum BDNF itself was not measured in the present study; therefore, BDNF-related explanations remain mechanistic interpretations rather than directly tested outcomes.

II. AIM AND OBJECTIVES

Aim: This study aims To study the effect of exercise and yoga on cognition, blood glucose, and quality of life in adults with type 2 diabetes mellitus, with the findings considered in relation to BDNF activity.

Objectives:

- To study the effect of exercise and yoga on cognition using the Montreal Cognitive Assessment (MoCA).
- To study the effect of exercise and yoga on blood glucose level using a blood test.
- To study the effect of exercise and yoga on quality of life using a quality-of-life questionnaire.

III. MATERIALS AND METHODS

Study design and setting: The source project describes the study as a randomized clinical trial; however, the reported methodology consists of convenient sampling, allocation to a single intervention group, and pre- and post-intervention assessment. Accordingly, this manuscript describes the study conservatively as a pre–post experimental study. Data collection was undertaken over a six-month study period in the Miraj–Sangli region, with the project conducted through Miraj Medical Centre’s College of Physiotherapy, Wanless Hospital, Miraj.

Participants: A total of 46 participants completed the study. The inclusion criteria were both sexes, age 35–55 years, clinically diagnosed T2DM, diabetes duration of less than 10 years, stable anti-diabetic medication for at least three months, willingness to provide written informed consent, and MoCA score below 26/30. The recorded master chart contained participants aged 35–56 years.

Exclusion criteria: Severe diabetic complications that limited participation; recent cardiovascular events; cerebrovascular accident or stroke; audiovisual or motor-coordination impairment affecting cognitive testing; participation in another structured exercise or yoga programme; medication expected to influence BDNF levels, such as antidepressants; and neurological or psychiatric disorders. **Ethical considerations:** The source document states that institutional ethics committee clearance was obtained and that written informed consent was taken from participants. Participants were informed about the study procedure, potential fatigue or discomfort, confidentiality, voluntary participation, and the right to withdraw.

IV. INTERVENTION PROTOCOL

Aerobic exercise consisted of brisk walking for 40 minutes, three times per week on Monday, Wednesday, and Friday. Yoga was delivered on Tuesday, Thursday, and Saturday. The yoga session comprised prayer (3 minutes), Omkar recitation (3 minutes), pranayama (5 minutes), various asanas (30 minutes), and Shavasana (5 minutes). The intervention continued for four weeks, with exercise and yoga performed on alternate days.

Intervention component	Schedule	Dose
Brisk walking	Monday, Wednesday, Friday	40 min/session
Prayer	Tuesday, Thursday, Saturday	3 min
Omkar recitation	Tuesday, Thursday, Saturday	3 min
Pranayama	Tuesday, Thursday, Saturday	5 min
Various asanas	Tuesday, Thursday, Saturday	30 min
Shavasana	Tuesday, Thursday, Saturday	5 min

V. OUTCOME MEASURES

Blood glucose: Blood glucose was recorded before and after the intervention.

Cognition: Cognitive function was assessed using the Montreal Cognitive Assessment (MoCA), a 30-point screening tool. Participants with scores below 26/30 were eligible for the study.

Quality of life: Quality of life was assessed using the quality-of-life questionnaire documented in the project. The project used the Quality of Life Scale (QOLS) literature as a reference.

VI. STATISTICAL ANALYSIS

Data were entered into an Excel spreadsheet and analyzed using Python with the SciPy statistical package. Descriptive statistics were expressed as mean and standard deviation. Normality was examined using the Shapiro–Wilk test. Because the pre–post comparisons were paired and the MoCA scores did not meet the normality criterion, the Wilcoxon signed-rank test was used for within-group comparisons. A p value below 0.05 was considered statistically significant. The project reported standardized correlation-based effect sizes to describe the magnitude of change.

VII. RESULTS

Forty-six participants completed the study. There were 27 males (58.7%) and 19 females (41.3%). The mean age was 48.78 ± 5.77 years, with a recorded range of 35–56 years. The largest age category was 51–56 years (47.8%).

Characteristic		N	%		
Male		27	58.7		
Female		19	41.3		
Total		46	100.0		
Outcome	Pre-intervention Mean $\pm$ SD	Post-intervention Mean $\pm$ SD	Mean change	Reported effect size	p value
Blood glucose (mg/dL)	153.02 $\pm$ 7.57	137.30 $\pm$ 11.41	-15.72	0.86	<0.001
MoCA (0–30)	23.07 $\pm$ 1.70	25.22 $\pm$ 1.53	+2.15	0.83	<0.001
Quality of life	60.54 $\pm$ 10.31	68.93 $\pm$ 9.68	+8.39	0.87	<0.001

Blood glucose: Mean blood glucose decreased by 15.72 mg/dL from baseline to post-intervention. The project reported a Wilcoxon z value of 5.84 and $p = 0.001$, with an effect size of 0.86.

Cognition: Mean MoCA score increased by 2.15 points. The project reported a Wilcoxon z value of 5.620 and $p = 0.001$, with an effect size of 0.83.

Quality of life: Mean quality-of-life score increased by 8.39 points. The project reported a Wilcoxon z value of 5.915 and $p = 0.001$, with an effect size of 0.87.

VIII. DISCUSSION

The present study found significant pre–post improvements in all three measured outcomes following four weeks of aerobic exercise and yoga. Blood glucose decreased, while MoCA and quality-of-life scores increased. The direction of change was consistent across metabolic, cognitive, and functional domains.

The reduction in blood glucose is biologically plausible because regular aerobic exercise can increase glucose utilization and improve insulin sensitivity. Yoga may complement these effects through physical activity, relaxation, and behavioral mechanisms. The present findings are consistent with the project’s cited literature reporting beneficial effects of exercise and yoga on glycemic control in T2DM.

The improvement in MoCA score suggests better cognitive performance after the intervention. The project interprets this finding in relation to BDNF because exercise and yoga have been reported in the cited literature to influence BDNF and because BDNF has an established role in neuroplasticity and memory. However, the present study did not assay serum or plasma BDNF. Therefore, the observed cognitive improvement cannot be attributed directly to increased BDNF, and the BDNF pathway should be regarded as a plausible hypothesis for future research rather than a demonstrated mediator.

Quality of life improved by 8.39 points. This may reflect the combined physical and psychological benefits of regular exercise and yoga, including improved physical function, energy, mood, stress management, and perceived well-being. The finding is also consistent with the studies cited in the project that reported improved quality of life following yoga-based interventions in people with T2DM.

Taken together, the results suggest that a structured programme combining aerobic exercise and yoga may provide a practical adjunct to conventional diabetes management. Nevertheless, the absence of a control group, short intervention period, and lack of direct BDNF measurement limit causal and mechanistic interpretation.

IX. LIMITATIONS

1. The intervention period was short, and long-term effects were not assessed.
2. There was no post-intervention follow-up to determine whether improvements were sustained.
3. The sample included more males than females, which may limit generalizability across sexes.
4. The study used convenient sampling and a single intervention group, limiting causal inference.
5. BDNF was not directly measured; therefore, the relationship between the intervention and BDNF activity was inferred rather than experimentally established.

X. CONCLUSION

A four-week programme of aerobic exercise and yoga was associated with significant improvements in blood glucose, cognitive performance, and quality of life among adults with T2DM in this pre–post study. The magnitude of change and reported effect sizes suggest clinically relevant improvement across the measured domains. The findings support aerobic exercise and yoga as potentially useful, accessible adjuncts to diabetes management. Direct measurement of BDNF, inclusion of a control group, larger samples, and longer follow-up are required to establish the mechanisms and durability of these effects.

XI. FUTURE RECOMMENDATIONS

6. Conduct adequately powered randomized controlled trials with appropriate control groups.
7. Measure serum or plasma BDNF directly alongside cognitive and metabolic outcomes.
8. Include longer intervention and follow-up periods to evaluate sustainability.
9. Recruit participants from multiple centres and more diverse age and sex groups.

10. Compare the combined programme with aerobic exercise alone, yoga alone, and other established physiotherapy approaches.

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