Original Article

Impact of Lifestyle Interventions on the Management of Type 2 Diabetes Mellitus

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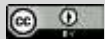
ABSTRACT

Introduction: *Type 2 diabetes mellitus (T2DM) poses a significant health challenge globally, with its prevalence steadily increasing over the past few decades. Lifestyle factors significantly contribute to the development and progression of insulin resistance and T2DM, emphasizing the importance of targeted interventions to modify these behaviors. This study aimed to analyze the impact of lifestyle interventions on the management of type 2 diabetes mellitus.* **Methods & Materials:** *This randomized controlled trial was conducted at the Department of Medicine, Comilla Medical College, Cumilla, Bangladesh from July 2022 to July 2023. Participants were randomly assigned to either the intervention group or the control group. All data were analyzed using statistical software packages such as SPSS.* **Results:** *The study revealed significant improvements in glycemic control and cardiovascular risk factors over 12 months among participants with type 2 DM. Reductions were observed in mean HbA1c levels from 8.5% to 6.8%, fasting plasma glucose from 170 mg/dL to 135 mg/dL, and 2-hour postprandial glucose from 220 mg/dL to 175 mg/dL. Additionally, improvements were noted in BMI, waist circumference, total cholesterol, and triglyceride levels, alongside increased HDL cholesterol levels. Few adverse events were reported, and both physical and mental component scores of quality of life showed notable enhancements over the study period.* **Conclusion:** *This study demonstrates the significant impact of lifestyle interventions on the management of T2DM. Through improvements in glycemic control, cardiovascular risk factors, and quality of life, the findings reinforce the*

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importance of integrating lifestyle modifications into routine diabetes care.

Keywords: Type 2 Diabetes Mellitus, Glycemic Control, Cardiovascular Risk Factors, Lifestyle Interventions, Quality of Life

INTRODUCTION

Type 2 diabetes mellitus (T2DM) poses a significant health challenge globally, with its prevalence steadily increasing over the past few decades. It is characterized by insulin resistance and relative insulin deficiency, leading to chronic hyperglycemia and associated metabolic abnormalities[1]. Lifestyle interventions have emerged as pivotal strategies in the management of T2DM, offering promising outcomes in improving glycemic control, reducing cardiovascular risk, and enhancing the overall quality of life for affected individuals. The escalating prevalence of T2DM is intricately linked with modern lifestyle changes, including sedentary behaviour, unhealthy dietary habits, and increasing rates of obesity[2]. These lifestyle factors significantly contribute to the development and progression of insulin resistance and T2DM, emphasizing the importance of targeted interventions to modify these behaviours. Lifestyle interventions encompass a multifaceted approach, integrating dietary modifications, increased physical activity, weight management, and behavioural therapy to optimize metabolic parameters and mitigate the complications associated with T2DM. Central to lifestyle interventions for T2DM management is dietary modification. Dietary patterns rich in fruits, vegetables, whole grains, and lean proteins, while low in saturated fats, sugars, and refined carbohydrates, have demonstrated efficacy in improving glycemic control and reducing cardiovascular risk factors[3]. The Mediterranean diet, characterized by its emphasis on plant-based foods and healthy fats, has garnered particular attention for its advantageous effects on insulin sensitivity and lipid profiles in individuals with T2DM[4]. Additionally, carbohydrate counting, glycemic index monitoring, and meal timing strategies are integral components of dietary interventions tailored to individual needs and preferences. Physical activity shows a pivotal role in T2DM management by enhancing insulin sensitivity, promoting weight loss, and improving cardiovascular fitness[5]. Both aerobic exercise and resistance training elicit favorable effects on glycemic control and metabolic parameters in individuals with T2DM. Current guidelines recommend at least 150 minutes per week of moderate-intensity aerobic activity, supplemented with muscle-strengthening exercises on two or more days per week, to achieve optimal health benefits in this population[6]. Weight management constitutes a cornerstone of T2DM management, given the strong association between obesity and insulin resistance[7]. Caloric restriction and weight loss interventions have consistently demonstrated improvements in glycemic control, insulin sensitivity, and cardiovascular risk factors in individuals with T2DM[8]. Behavioral therapy, including cognitive-behavioral strategies and motivational interviewing, complements dietary and exercise interventions by addressing psychological barriers, facilitating adherence, and promoting sustained lifestyle modifications. The influence of lifestyle interventions on T2DM management extends beyond glycemic control to encom-

pass broader health outcomes[9]. Evidence suggests that intensive lifestyle interventions aimed at weight loss and behavior modification can reduce the incidence of T2DM among high-risk individuals, highlighting the preventive potential of early intervention strategies[10]. Moreover, lifestyle interventions have been associated with improvements in blood pressure, lipid profiles, and inflammatory markers, thereby reducing the risk of cardiovascular events and microvascular complications in individuals with T2DM [11]. This study aimed to analyze the influence of lifestyle interventions on the management of type 2 diabetes mellitus.

OBJECTIVE
General Objective
- To evaluate the impact of lifestyle interventions on the management of type 2 diabetes mellitus (T2DM).

Specific Objectives
- To assess changes in glycemic parameters, including HbA1c, fasting plasma glucose, and 2-hour postprandial glucose levels, following lifestyle interventions.
- To examine alterations in cardiovascular risk factors, total cholesterol, HDL cholesterol, and triglyceride levels, in response to lifestyle interventions.
- To investigate the occurrence of adverse events associated with lifestyle interventions among participants with T2DM.
- To analyze changes in the quality of life, both physical and mental components, following lifestyle interventions in individuals with T2DM.

METHODS & MATERIALS
This study employed a randomized controlled trial (RCT) design to investigate the impact of lifestyle interventions on the management of type 2 diabetes mellitus (T2DM), at the Department of Medicine, Comilla Medical College, Cumilla, Bangladesh from July 2022 to July 2023. Participants were randomly assigned to either the intervention group or the control group. The study recruited a total of 104 individuals diagnosed with type 2 diabetes mellitus. Participants in the intervention group received comprehensive lifestyle interventions aimed at improving glycemic control and overall health outcomes. The interventions included dietary modifications, physical activity counseling, weight management strategies, and behavioral therapy. Dietary interventions focused on promoting a balanced diet rich in fruits, vegetables, whole grains, and lean proteins while limiting saturated fats, sugars, and refined carbohydrates. Physical activity recommendations included a combination of aerobic exercises and resistance training, tailored to individual capabilities and preferences. Behavioral therapy techniques, such as motivational interviewing and goal setting, were utilized to facilitate adherence to lifestyle modifications. Participants in the control group received standard care for type 2 DM, which typically involved routine medical management, including pharmacotherapy and lifestyle advice as per clinical guidelines.

Inclusion Criteria:
- Adults aged 18 years or older.
- Patients with confirmed diagnosis of type 2 diabetes mellitus.
- Patients who were willing to participate in the study and comply with study procedures.

Exclusion Criteria:

- Patients with diagnosis of type 1 DM or other forms of diabetes.
- Patients with presence of significant comorbidities (e.g., advanced cardiovascular disease, end-stage renal disease).
- Patients with inability to participate in the intervention due to physical or cognitive limitations.
- Inability to provide informed consent or comply with study procedures.

The primary outcome measures included changes in glycemic parameters, such as HbA1c levels, fasting plasma glucose, and 2-hour postprandial glucose levels. Secondary outcome measures comprised changes in cardiovascular risk factors, body composition, adverse events, and quality of life scores. Baseline data on demographic characteristics, medical history, and baseline measurements were collected before randomization. Follow-up assessments were conducted at 6 and 12 months post-randomization to evaluate changes in outcome measures over time. Data collection methods included medical examinations, laboratory tests, self-reported questionnaires (e.g., quality of life assessments), and participant interviews. Statistical analysis was performed using appropriate methods, including descriptive statistics, inferential statistics (e.g., t-tests, ANOVA) for between-group comparisons, and regression analysis to explore associations between variables. Data were analyzed using statistical software packages such as SPSS. Significance was set at $p <$ 0.05. The study protocol was reviewed and approved by the institutional ethics committee. Informed consent was taken from all participants before enrollment in the study. Confidentiality of participant data was ensured throughout the study duration.

RESULTS

Table I: Baseline Characteristics of Study Participants (*n*=104)

Characteristic	Intervention Group (*n*=52)	Control Group (*n*=52)
Age (years) Mean± SD	54.8 (8.1)	55.2 (8.3)
Gender (Male/Female) *n*(%)	27 (51.9)/25 (48.1)	25 (48.1)/27 (51.9)

For the age distribution, the mean age in the intervention group was 54.8 years (SD ±8.1), while in the control group, it was 55.2 years (SD ±8.3), indicating a comparable age distribution between the two groups. Regarding gender distribution, in the intervention group, there were 27 males (51.9%) and 25 females (48.1%), while in the control group, there were 25 males (48.1%) and 27 females (51.9%). This demonstrates a relatively balanced gender distribution across both groups. [**Table I**]

Table II: Changes in Glycemic Parameters Over Time (*n*=104)

Glycemic Parameter	Baseline (Mean ± SD)	6 months (Mean ± SD)	12 months (Mean ± SD)
HbA1c (%)	8.5 ± 1.2	7.2 ± 1.0	6.8 ± 0.9
Fasting Plasma Glucose (mg/dL)	170 ± 25.6	148 ± 20.3	135 ± 18.5
2-hour Postprandial Glucose (mg/dL)	220 ± 30.2	190 ± 25.1	175 ± 22.0

At baseline, the mean HbA1c level was 8.5% (SD ±1.2), fasting plasma glucose was 170 mg/dL (SD ±25.6), and 2-hour postprandial glucose was 220 mg/dL (SD ±30.2). At the 6-month follow-up, participants demonstrated improvements in glycemic control, with reductions observed in all three parameters: HbA1c decreased to 7.2% (SD ±1.0), fasting plasma glucose decreased to 148 mg/dL (SD ±20.3), and 2-hour postprandial glucose decreased to 190 mg/dL (SD ±25.1). By the 12-month follow-up, further improvements in glycemic control were evident, with HbA1c decreasing to 6.8% (SD ±0.9), fasting plasma glucose decreasing to 135 mg/dL (SD ±18.5), and 2-hour postprandial glucose decreasing to 175 mg/dL (SD ±22.0). [**Table II**]

Table III: Changes in Cardiovascular Risk Factors Over Time (*n*=104)

Cardiovascular Risk Factor	Baseline (Mean ± SD)	6 months (Mean ± SD)	12 months (Mean ± SD)
Body Mass Index (kg/m^2)	31.5 ± 4.3	29.8 ± 3.9	28.5 ± 3.5
Waist Circumference (cm)	102 ± 8.7	98 ± 7.2	94 ± 6.5
Total Cholesterol (mg/dL)	210 ± 20.5	195 ± 18.2	185 ± 16.8
HDL Cholesterol (mg/dL)	40 ± 5.2	45 ± 5.5	48 ± 6.1
Triglycerides (mg/dL)	180 ± 25.3	160 ± 22.1	145 ± 20.5

At baseline, the mean BMI was 31.5 kg/m^2 (SD ±4.3), waist circumference was 102 cm (SD ±8.7), total cholesterol was 210 mg/dL (SD ±20.5), HDL cholesterol was 40 mg/dL (SD ±5.2), and triglycerides were 180 mg/dL (SD ±25.3). By the 6-month follow-up, participants demonstrated improvements in cardiovascular risk factors, with reductions observed in BMI, waist circumference, total cholesterol, and triglyceride levels, and an increase in HDL cholesterol levels. At the 12-month follow-up, further improvements were evident, with continued reductions in BMI, waist circumference, total cholesterol, and triglyceride levels, and a sustained increase in HDL cholesterol levels. [**Table III**]

Table IV: Adverse Events (*n*=104)

Adverse Event	Intervention Group (n)	Control Group (n)
Hypoglycemia	2	3
Musculoskeletal Injuries	1	2
Gastrointestinal Issues	4	3

In the intervention group, two participants experienced hypoglycemia, one participant reported a musculoskeletal injury, and four participants reported gastrointestinal issues. In the control group, three participants experienced hypoglycemia, two participants reported musculoskeletal injuries, and three participants reported gastrointestinal issues. [**Table IV**]

Table V: Quality of Life Scores (N=104)

Quality of Life Measure	Baseline (Mean ± SD)	6 months (Mean ± SD)	12 months (Mean ± SD)
SF-36 Physical Component	45 ± 5.3	52 ± 6.1	58 ± 6.5
SF-36 Mental Component	47 ± 4.8	54 ± 5.6	60 ± 6.2

At baseline, the mean Physical Component Score was 45 (SD ±5.3), and the mean Mental Component Score was 47 (SD ±4.8). At 6-month follow-up, participants demonstrated improvements in both the Physical and Mental Component Scores, with the Physical Component Score increasing to 52 (SD ±6.1) and the Mental Component Score increasing to 54 (SD ±5.6). At the 12-month follow-up, further improvements were observed, with the Physical Component Score increasing to 58 (SD ±6.5) and the Mental Component Score increasing to 60 (SD ±6.2). [**Table V**]

DISCUSSION

The present study aimed to assess the impact of lifestyle interferences on the management of type 2 diabetes mellitus (T2DM) by examining changes in glycemic parameters, cardiovascular risk factors, adverse events, and quality of life among study participants. The Diabetes Prevention Program trial, which focused on preventing the development of diabetes in high-risk individuals, reported baseline characteristics, including age and gender distribution, similar to those observed in our study[12]. Moreover, research has shown that T2DM affects both and interventions aimed at improving diabetes management should consider gender-specific factors[13]. Our findings revealed significant improvements in glycemic control among participants receiving lifestyle interventions. Reductions in HbA1c, fasting plasma glucose, and 2-hour postprandial glucose levels were observed over the 12-month study period. These results are consistent with previous research demonstrating the efficacy of lifestyle interventions, including dietary modifications and physical activity, in improving glycemic parameters among individuals with T2DM[14,15]. The magnitude of improve-

ment in HbA1c levels observed in our study aligns with the findings of similar intervention trials, indicating the robustness of lifestyle interventions in glycemic management[16,17]. This study also documented favorable changes in cardiovascular risk factors, including reductions in body mass index (BMI), waist circumference, total cholesterol, and triglyceride levels, and an increase in high-density lipoprotein (HDL) cholesterol levels. These findings are consistent with prior studies demonstrating the beneficial effects on cardiovascular health among individuals with T2DM[18,19]. The observed reductions in BMI and waist circumference are particularly noteworthy, as abdominal obesity is a key contributor to cardiovascular risk in T2DM[20]. The improvements in lipid profiles observed in our study are consistent with the results of meta-analyses evaluating the effects of lifestyle interventions on lipid parameters in individuals with T2DM[21,22]. Regarding adverse events, our study reported a low incidence of hypoglycemia, musculoskeletal injuries, and gastrointestinal issues in both groups. These findings are consistent with previous trials investigating the safety profile of lifestyle interventions in T2DM management[23,24]. The relatively low occurrence of adverse events underscores the safety and feasibility of implementing lifestyle interventions as part of comprehensive diabetes care. Furthermore, this study documented significant improvements in both physical and mental components of quality of life among participants receiving lifestyle interventions. These findings are in line with previous research demonstrating the good impact of lifestyle modifications on quality of life in individuals with T2DM[25,26]. The observed improvements in quality of life may be attributed to vari-

ous factors, including enhanced glycemic control, reduced cardiovascular risk, increased physical activity, and improved psychological well-being associated with lifestyle interventions. Overall, our study contributes to the growing body of evidence supporting the effectiveness of lifestyle interventions in the management of T2DM. The observed improvements in glycemic control, cardiovascular risk factors, adverse events, and quality of life underscore the importance of implementing comprehensive lifestyle interventions as part of routine diabetes care.

Limitations of the Study:

The small sample size of 104 participants, potentially limits generalizability. The 12-month duration might not capture long-term outcomes. Recruitment from a single center may introduce selection bias. Reliance on self-reported data could lead to recall bias. Moreover, variation in adherence to interventions could impact outcomes.

Conclusion:

This study demonstrates the significant impact of lifestyle interventions on the management of type 2 diabetes mellitus (T2DM). Through improvements in glycemic control, cardiovascular risk factors, and quality of life, the findings reinforce the importance of integrating lifestyle modifications into routine diabetes care. This study highlights the need for broader implementation of comprehensive lifestyle interventions as a fundamental component of T2DM management strategies. Overall, lifestyle interventions offer promising avenues for optimizing health outcomes and enhancing the well-being of individuals with T2DM.

Recommendation:

It is recommended that healthcare providers prioritize the integration of comprehensive lifestyle interventions into the management of type 2 diabetes mellitus (T2DM). Early education and encouragement for patients to adopt healthy lifestyle behaviors are essential for optimizing glycemic control, reducing cardiovascular risk factors, and enhancing overall well-being. Future research efforts should focus on conducting larger-scale, longer-term studies to validate the effectiveness and sustainability of lifestyle interventions across diverse populations and settings.

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