

Original Research Article

Adherence to lifestyle interventions and its effect on metabolic and behavioral outcomes in type 2 diabetes mellitus cases

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ABSTRACT

Background: Type 2 diabetes mellitus (T2DM) is a major global health concern, often exacerbated by sedentary lifestyles and poor dietary habits. Lifestyle interventions, including dietary modifications, physical activity, and behavioral changes, are essential for managing T2DM. However, adherence to these interventions is a significant challenge.

Methods: This cross-sectional observational study was conducted over six months, from July to December 2023, in Rajapur Upazila of Jhalokathi district and Bhandaria Upazila of Pirojpur district under the guidance of the Department of Biomedical Engineering and Public Health, World University of Bangladesh. This study evaluated the effectiveness of a structured non-pharmacological lifestyle intervention on metabolic parameters in individuals with T2DM. The primary outcomes measured were HbA1c, fasting blood glucose, and body mass index (BMI).

Results: Of 150 patients, 124 (82.67%) were uncontrolled (FBS>6.4), and 26 (17.33%) were controlled (FBS <6.4). Most patients (77.33%) had a BMI of 20-29, with a mean BMI of 22.46 ± 3.39 ($p < 0.001$). Hypertension was present in 39 (26%) patients. In group A1 (<50 years, non-pharmacological intervention), post-intervention results showed FBS 6.32 ± 0.72 mmol/l ($p < 0.001$), HbA1c $6.72 \pm 0.41\%$ ($p < 0.001$). In group A2 (>50 years, combined intervention), FBS decreased to 6.47 ± 1.00 mmol/l ($p < 0.001$) and HbA1c to $6.86 \pm 0.56\%$ ($p = 0.004$).

Conclusions: Non-pharmacological interventions focusing on lifestyle changes can result in meaningful improvements in metabolic control for individuals with T2DM. Enhancing adherence remains a key challenge for maximizing long-term benefits.

Keywords: Adherence, Body mass index, Fasting blood glucose, HbA1c reduction, Lifestyle intervention, Type 2 diabetes mellitus

INTRODUCTION

Type 2 diabetes mellitus (T2DM) is a chronic metabolic disorder characterized by insulin resistance and relative insulin deficiency, contributing to hyperglycemia and a myriad of complications.^{1,2} It is a significant public health challenge, affecting over 500 million individuals globally, with prevalence rates projected to rise sharply in the coming decades.³ In Bangladesh, the burden of T2DM has been increasing due to rapid urbanization, sedentary

lifestyles, and unhealthy dietary practices. Addressing this epidemic requires more than pharmacological interventions; adherence to lifestyle interventions plays a pivotal role in preventing complications and improving overall health outcomes.⁴

Lifestyle interventions, including dietary modifications, regular physical activity, stress management, and cessation of harmful habits like smoking, are essential components of diabetes management.⁵ These non-

pharmacological measures aim to improve glycemic control, reduce cardiovascular risk, and enhance the quality of life.⁶ However, adherence to these interventions often remains suboptimal due to various factors such as limited knowledge, socioeconomic barriers, and cultural norms.⁷ In resource-constrained settings like Bangladesh, where healthcare access and awareness are limited, understanding the extent of adherence to lifestyle interventions and their impact is critical for designing effective community-based strategies.⁸

The metabolic outcomes of T2DM, such as glycemic control and lipid profile, are strongly influenced by lifestyle behaviors.⁴ Regular physical activity improves insulin sensitivity and glycemic regulation, while a balanced diet helps maintain optimal glucose levels.⁹ Similarly, avoiding tobacco use and managing stress can mitigate the risk of complications like cardiovascular disease, neuropathy, and nephropathy.¹⁰ Beyond metabolic effects, lifestyle adherence also significantly influences behavioral outcomes, including patient engagement, mental well-being, and self-management capabilities.¹¹ Thus, understanding how lifestyle adherence shapes both metabolic and behavioral dimensions is essential for a holistic approach to diabetes care.¹²

In Bangladesh, where the healthcare infrastructure often struggles to meet the demands of chronic disease management, community-based approaches are increasingly being recognized as effective strategies for promoting lifestyle modifications. However, the success of these initiatives depends on a thorough understanding of the barriers and facilitators of adherence.^{10,13} Factors such as educational attainment, income level, family support, and cultural perceptions of health and disease often play a crucial role.⁷ Furthermore, healthcare providers' ability to deliver tailored, culturally sensitive advice significantly impacts patient adherence.¹⁴

The objective of this study was to assess the impact of lifestyle interventions on metabolic and behavioral outcomes in individuals with type 2 diabetes mellitus, focusing on identifying effective strategies for diabetes management in the study population.

METHODS

This cross-sectional observational study was conducted over six months, from July to December 2023, in Rajapur Upazila of Jhalokathi district and Bhandaria Upazila of Pirojpur district under the guidance of the Department of Biomedical Engineering and Public Health, World University of Bangladesh. A total of 150 individuals with type 2 diabetes mellitus, aged between 20 and 90 years, were included. Participants were selected using a simple random sampling technique from healthcare centers, and eligibility was determined based on predefined inclusion and exclusion criteria. Individuals with type 2 diabetes mellitus who were willing to participate in a lifestyle

intervention program were included, while non-diabetic individuals and diabetic patients unable to adhere to the lifestyle intervention program were excluded. Data collection focused on demographic and socio-economic variables, as well as factors influencing lifestyle behaviors such as dietary habits, physical activity, smoking, and stress levels. Additionally, laboratory test results, including fasting blood sugar (FBS), postprandial blood sugar, HbA1c, and serum creatinine levels, were used to assess metabolic outcomes. Behavioral outcomes were evaluated through lifestyle changes pre- and post-intervention.

The study protocol included the administration of non-pharmacological interventions such as dietary counseling, walking routines, and stress management techniques, either alone or in combination with medication, depending on the participant group. Data collection followed a structured format to ensure completeness and accuracy, with all records verified and consolidated into a master sheet for analysis. Statistical analysis was performed using SPSS software, employing both descriptive and inferential methods to explore relationships between variables. Ethical approval was obtained from the Research Ethical Committee of the World University of Bangladesh, ensuring adherence to ethical principles. Participants provided written informed consent before participation, and confidentiality of data was maintained throughout the study. Continuous monitoring and quality assurance measures were implemented to enhance the reliability of data, with regular auditing of collected information.

RESULTS

Table 1 shows the diabetes prevalence of our study patients. Majority 124 (82.67%) patients were uncontrolled (FBS >6.4) compared to 26 (17.33%) were controlled (FBS <6.4).

Table 1: Prevalence of diabetes of our study patients (n=150).

Diabetes	N	Percentage
Controlled	26	17.33
Uncontrolled	124	82.67
Total	150	100

In table 2 we found majority 98 (65.33%) patients were female and 52 (34.67%) patients were male with a ratio 1.9:1.

Table 2: Gender distribution of our study patients (n=150).

Gender	N	Percentage
Female	98	65.33
Male	52	34.67
Total	150	100

Table 3: Distribution of our study patients by BMI and comorbidities (n=150).

BMI	N	Percentage	P value
10-19	28	18.67	<0.001 ^s
20-29	116	77.33	
≥30	6	4.00	
Mean±SD	22.46±3.39		
Min-Max	14.37-35.41		
DM	150	100	
HTN	39	26.00	

s-significant

Table 3 shows the distribution of our study patients by BMI and comorbidities. The majority 116 (77.33%) patients BMI were 20-29, then 28 (18.67%) were between 10-19 and 6 (4.00%) were ≥30. BMI Mean±SD were 22.46±3.39 ($p<0.001^s$). 39 (26.00%) patients had HTN, respectively.

Table 4: Distribution of our study patients by economic status (n=150).

Economic status	N	Percentage
Lower class	28	18.67
Lower middle class	111	74.00
Middle class	9	6.00
Upper middle class	2	1.33
Total	150	100

Table 4 shows the distribution of our study patients by economic status. The majority 111 (74.00%) patients were from lower middle class, then 28 (18.67%) were from lower class, 9 (6.00%) were from middle class and 2 (1.33%) were from upper middle class, respectively.

Table 5: Comparison of lifestyle behaviour between pre intervention and post intervention in our study patients (n=150).

Lifestyle	Pre intervention (n=150) (%)	Post intervention (n=150) (%)
Dietary habit	0 (0.00)	130 (86.67)
Walking	0 (0.00)	120 (80.00)
Exercise	0 (0.00)	13 (8.67)
Smoking	9 (6.00)	7 (4.67)
Alcohol	0 (0.00)	0 (0.00)

Table 5 shows comparison of lifestyle behavior between pre intervention and post intervention in our study patients. Nine (6.00%) patients had smoking habit in pre intervention, then 130 (86.67%) got dietary habit, 120 (80.00%) got walking habit, 13 (8.67%) started exercise and 7 (4.67%) had smoking in post intervention.

Table 6 shows comparison of laboratory test for group A1 (<50 years) and B1 (>50 years) between pre intervention and post intervention given only non-pharmacological intervention and no medicine. Pre intervention FBS Mean±SD were 8.57±2.55 mmol/l compared to 6.32±0.72 mmol/l in post intervention ($p = <0.001^s$), then 2HABF were 12.00±2.78 mmol/l compared to 8.85±1.10 mmol/l ($p<0.001^s$), HBA1C were 7.58±1.15% compared to 6.72±0.41% ($p<0.001^s$) and S. Creatinine were 1.04±0.12 mg/dl in pre intervention compared to 1.07±0.11 mg/dl in post intervention ($p=0.196^{ns}$).

Table 6: Comparison of laboratory test for group A1 (<50 years) and B1 (>50 years) given only non-pharmacological intervention and no medicine (n=50).

Test name	Pre intervention (n=50)	Post intervention (n=50)	P value
FBS	8.57±2.55	6.32±0.72	<0.001 ^s
2HABF	12.00±2.78	8.85±1.10	<0.001 ^s
HBA1C	7.58±1.15	6.72±0.41	<0.001 ^s
S. creatinine	1.04±0.12	1.07±0.11	0.196 ^{ns}

s-significant, ns-non-significant

Table 7 shows comparison of laboratory test for group A2 (<50 years) and B2 (>50 years) between pre intervention and post intervention given both non pharmacological and medicine. Pre intervention FBS Mean±SD were 9.07±3.31 mmol/l compared to post intervention 6.47±1.00 mmol/l ($p\leq 0.001^s$), then 2HABF were 12.62±3.45 mmol/l compared to 9.06±1.43 mmol/l ($p\leq 0.001^s$), HBA1C were 7.56±1.59% compared to 6.86±0.56% ($p=0.004^s$) and S. creatinine were 1.08±0.18 mg/dl in pre intervention compared to 1.07±0.12 mg/dl in post intervention ($p=0.745^{ns}$).

Table 7: Comparison of laboratory test for group A2 (<50 yrs) and B2 (>50 yrs) given both non pharmacological and medicine (n=50).

Test name	Pre intervention (n=50)	Post intervention (n=50)	P value
FBS	9.07±3.31	6.47±1.00	<0.001 ^s
2HABF	12.62±3.45	9.06±1.43	<0.001 ^s
HBA1C	7.56±1.59	6.86±0.56	0.004 ^s
S. creatinine	1.08±0.18	1.07±0.12	0.745 ^{ns}

s-significant, ns-non-significant

DISCUSSION

The findings of our study align with previous research by Fappa et al, who also observed that a significant proportion of patients with type 2 diabetes mellitus struggle to maintain glycemic control despite intervention efforts.¹⁵ In our study, the majority of the population (82.67%) had uncontrolled diabetes, a finding consistent

with those of Gregg et al, where high rates of uncontrolled diabetes were noted, particularly among individuals from lower socioeconomic backgrounds.¹⁶

Our study demonstrated that 17.33% of patients had controlled diabetes (FBS <6.4 mmol/l), which is comparable to the results of Chen et al, who found that a similar proportion of patients achieved glycemic control following targeted lifestyle interventions.¹⁷ This emphasizes the importance of reinforcing diabetes education and adherence strategies.

The higher prevalence of T2DM among female patients (65.33%) is consistent with findings by Seib et al, who identified a gender disparity in diabetes prevalence.¹⁸ This could be due to a combination of biological and socio-cultural factors, as suggested by Sayon-Orea et al, who proposed that women in rural settings may have limited access to healthcare resources, leading to a higher diabetes burden.¹⁹

Our study revealed that the majority of patients (77.33%) had a BMI between 20-29, which is similar to the results by Magkos et al who reported a high prevalence of diabetes among individuals with normal to overweight BMIs.²⁰ Furthermore, hypertension was common (26.00%) among our participants, reinforcing the findings of Dunkley et al, who also highlighted the association between diabetes and hypertension in their cohort.²¹

The socioeconomic distribution of our study participants (74.00% from lower-middle class) mirrors the findings of Waugh et al, who noted that economic barriers are a major factor contributing to poor diabetes management.²² These socioeconomic challenges hinder access to proper medical care, diet, and exercise resources, which could be addressed through targeted public health initiatives.

Our study observed a substantial improvement in lifestyle behaviors post-intervention, particularly in dietary habits (86.67%) and walking (80%). These findings are in agreement with those of Pillay et al, who demonstrated that lifestyle modifications, including diet and physical activity, can significantly improve metabolic parameters in T2DM patients.²³ However, the limited participation in exercise (8.67%) and the persistence of smoking (4.67%) suggest ongoing barriers to comprehensive lifestyle changes, as previously reported by Kim et al.²⁴

Significant improvements in laboratory test results, such as FBS, 2HABF, and HbA1c, were observed in both groups (non-pharmacological intervention alone and combined with pharmacological treatment). These results support the findings of Balducci et al, who also reported marked improvements in glycemic control following lifestyle interventions.²⁵ However, the small change in serum creatinine levels ($p=0.745$) suggests that while lifestyle and pharmacological interventions benefit

glucose control, they may have a lesser impact on renal function in the short term, as noted by Nerat et al.²⁶

Despite improvements, challenges in adhering to lifestyle changes persist. Similar to the study by Vermeire et al, the low uptake of exercise and continued smoking habits among some participants reflect the difficulty in achieving long-term behavioral change.²⁷ The role of socioeconomic factors, such as financial constraints and limited access to exercise facilities, may contribute to these challenges, as highlighted by Orchard et al.³

The results of our study, in conjunction with the findings of Garcia-Molina et al, underline the importance of community-based interventions that incorporate diabetes education, lifestyle changes, and regular monitoring.⁸ Additionally, our results suggest that healthcare systems should focus on making lifestyle modifications more accessible and effective, particularly for individuals from lower socioeconomic backgrounds.

One limitation of this study is the relatively small sample size, which may limit the generalizability of the results. Additionally, the study was conducted in a specific geographic area, potentially reducing its applicability to broader populations. The reliance on self-reported data for lifestyle habits such as diet and physical activity could also introduce recall bias. Furthermore, the short duration of the study may not capture the long-term effects of lifestyle interventions.

CONCLUSION

This study demonstrates that non-pharmacological interventions, particularly lifestyle changes, significantly improve metabolic parameters in patients with Type 2 Diabetes Mellitus. While challenges in adherence remain, the findings emphasize the importance of community-based strategies and ongoing support for managing diabetes, particularly in low-resource settings. Further research with larger sample sizes and longer follow-up is needed to confirm the sustainability of these interventions.

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