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HEALTH AND REHABILITATION

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IMPACT OF INTERMITTENT FASTING ON INSULIN SENSITIVITY AND HBA1C LEVELS AMONG OVERWEIGHT ADULTS WITH PREDIABETES

Original Research

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Acknowledgement: The authors gratefully acknowledge all participants who volunteered their time and commitment throughout the study.

Conflict of Interest: None | Grant Support & Financial Support: None | Publication Date: 05-07-2025 (DD-MM-YY)

ABSTRACT

Background: Prediabetes is a rapidly growing metabolic condition that increases the risk of developing type 2 diabetes and cardiovascular complications. Lifestyle modification remains the primary preventive strategy. Intermittent fasting has recently gained interest for its potential to improve insulin sensitivity and glycemic control through meal-timing adjustments rather than strict caloric restriction. However, limited evidence exists within South Asian populations who experience higher rates of insulin resistance at earlier ages.

Objective: To evaluate the impact of a 12-week intermittent fasting regimen on insulin sensitivity and HbA1c levels among overweight adults with prediabetes.

Methods: A quasi-experimental pre–post intervention study was conducted at Services Hospital Lahore from October 2024 to March 2025. Forty-two overweight adults aged 25–55 years with HbA1c 5.7–6.4% were enrolled, of whom 38 completed the study. Participants followed a daily 16-hour fasting window with an 8-hour eating period, maintaining usual dietary preferences. Fasting glucose, fasting insulin, HOMA-IR, and HbA1c were measured at baseline and week 12 using standardized laboratory protocols. Data were analyzed in SPSS 26 using paired t-tests with $p < 0.05$ as significance.

Results: After 12 weeks, fasting glucose reduced from 111.6 ± 8.3 mg/dL to 102.3 ± 7.9 mg/dL, and fasting insulin declined from 15.9 ± 3.4 µIU/mL to 12.8 ± 3.1 µIU/mL. Mean HOMA-IR improved from 4.37 ± 1.00 to 3.23 ± 0.92. HbA1c decreased from 6.05 ± 0.19% to 5.78 ± 0.22%. All changes were statistically significant ($p < 0.001$). Mild temporary hunger was reported but no adverse events occurred.

Conclusion: Intermittent fasting significantly improved insulin sensitivity and HbA1c in overweight adults with prediabetes, suggesting a practical, low-cost lifestyle strategy to delay progression to type 2 diabetes. Larger randomized trials with long-term follow-up are recommended.

Keywords: Blood Glucose, Fasting, HbA1c, Insulin Resistance, Intermittent Fasting, Prediabetic State, Time-Restricted Feeding

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INTRODUCTION

Prediabetes has emerged as a critical public health concern, especially in countries with rising obesity rates and increasingly sedentary lifestyles. Individuals with prediabetes exhibit impaired glucose metabolism, where blood glucose levels are elevated but remain below the diagnostic threshold for type 2 diabetes mellitus. Without timely intervention, a large proportion transition to diabetes within a short period, placing them at risk of cardiovascular disease, chronic kidney disease, and neuropathies. Traditional strategies for prevention have focused on structured diet modification and exercise programs; however, their effectiveness is often limited by poor adherence and resource constraints. This has encouraged the search for more sustainable, culturally adaptable, and physiologically beneficial lifestyle approaches(1, 2). Intermittent fasting has gained considerable scientific attention as a non-pharmacological method to improve metabolic health. Rather than emphasizing what to eat, intermittent fasting focuses on when to eat, allowing specific fasting windows that induce metabolic shifts. During fasting, insulin levels fall and stored energy sources such as glycogen and fat are mobilized. This reduces insulin resistance, enhances glucose uptake, and may contribute to weight loss. Several studies suggest that intermittent fasting can improve insulin sensitivity, lower fasting blood glucose, and promote reductions in body weight—factors that collectively influence HbA1c levels, a key indicator of long-term glycemic control(3, 4).

The mechanisms behind these improvements are grounded in metabolic physiology. Prolonged fasting periods trigger lipolysis, reduce hepatic glucose output, and enhance insulin signaling pathways. Caloric restriction within fasting windows may also reduce oxidative stress and systemic inflammation, both of which are implicated in the development of insulin resistance. For overweight adults, these metabolic changes are particularly valuable because excess adipose tissue disrupts insulin action through inflammatory mediators and hormonal imbalance. By reducing overall caloric intake and improving fat utilization, intermittent fasting can modify the underlying pathophysiology of prediabetes(5, 6). While early research shows promise, evidence remains inconsistent across populations and settings. Some clinical trials report significant reductions in HbA1c and insulin resistance after intermittent fasting, while others demonstrate only modest effects. Differences in fasting regimens, cultural eating habits, and baseline metabolic status may contribute to these variations. Moreover, many available studies involve small sample sizes or short intervention periods, making it difficult to draw firm conclusions. There is still limited data from South Asian populations, where metabolic disorders are prevalent due to genetic susceptibility, dietary habits, and lifestyle patterns. Overweight adults in this region often experience early onset insulin resistance and rapid progression to type 2 diabetes, making preventive strategies especially important(7, 8).

Prediabetes is also frequently asymptomatic, which delays motivation for lifestyle change. Intermittent fasting offers a practical, low-cost approach that can be adopted without complex dietary planning. Its flexible structure may improve adherence compared with traditional calorie-restricted diets. Individuals can continue preferred foods while simply adjusting meal timing, which may make the lifestyle modification more acceptable in everyday living. However, despite increasing popularity, healthcare professionals require more robust evidence before recommending intermittent fasting as a primary strategy to improve glycemic outcomes among prediabetic adults(9, 10). HbA1c remains the most reliable marker of long-term glycemic control, reflecting average blood glucose over approximately three months. A reduction in HbA1c, even within prediabetic range, lowers the risk of progression to diabetes. Insulin sensitivity, measured through clinical or biochemical markers, also plays a central role in early prevention. Interventions that improve both parameters provide strong justification for adoption in clinical and community health settings. Therefore, evaluating the effect of intermittent fasting on these markers is clinically relevant and scientifically necessary(11, 12).

This study aims to investigate the impact of intermittent fasting on insulin sensitivity and HbA1c levels among overweight adults with prediabetes. By assessing glycemic outcomes before and after fasting intervention, the research seeks to determine whether meal-timing based lifestyle change can offer a meaningful improvement in metabolic health. The objective is to generate evidence that may support early, practical, and non-pharmacological strategies to delay or prevent the progression to type 2 diabetes in at-risk individuals(13).

METHODS

This study was conducted at the Department of Endocrinology, Services Hospital Lahore, over a period of six months from October 2024 to March 2025. It was designed as a quasi-experimental pre–post intervention trial to determine the impact of intermittent fasting on insulin sensitivity and HbA1c levels among overweight adults diagnosed with prediabetes. The intervention focused on time-restricted eating, in which participants followed a daily fasting window with an eight-hour feeding period and sixteen-hour fasting period without caloric intake. Water, unsweetened tea, and black coffee were permitted during fasting hours, while participants consumed their routine meals during the feeding window without specific dietary restrictions(14). Participants were recruited through outpatient clinics, hospital notice boards, and referrals from physicians. Adults aged 25 to 55 years with a BMI between 25 and 34.9 kg/m² and HbA1c values between 5.7% and 6.4% were eligible. Only individuals with stable weight for at least three months prior to enrollment were included. The diagnosis of prediabetes was established according to American Diabetes Association criteria. Individuals with a history of type 2 diabetes mellitus, uncontrolled hypertension, chronic kidney disease, pregnancy, breastfeeding, steroid use, endocrine disorders other than prediabetes, or those already practicing structured intermittent fasting were excluded. Participants taking hypoglycemic

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medications, lipid-lowering agents, or weight-loss drugs within the previous three months were also excluded to minimize confounding effects(15, 16).

Sample size was estimated using mean HbA1c reduction as the primary outcome. A previous clinical trial by Sutton et al. reported a mean reduction of 0.3% in HbA1c after an eight-week fasting intervention with a standard deviation of 0.4. Using these estimates, the sample size was calculated at a 95% confidence interval and 80% power, applying the formula for comparison of paired means. The required number was 34 participants; anticipating a 20% drop-out rate, a total sample size of 42 was targeted to ensure sufficient power for final analysis(17, 18). After screening, eligible participants were briefed about the study purpose and procedures, potential benefits, and any foreseeable discomfort. Written informed consent was obtained individually. Baseline demographic data including age, gender, weight, BMI, medical history, and physical activity level were collected through a structured proforma. Height and weight were measured by trained staff using calibrated equipment, with BMI calculated as weight in kilograms divided by height in meters squared. All laboratory tests were performed in the same diagnostic facility to ensure standardization(19, 20).

Fasting blood glucose, fasting insulin, and HbA1c were measured at baseline and after twelve weeks of intervention. Insulin sensitivity was assessed using the Homeostatic Model Assessment of Insulin Resistance (HOMA-IR), calculated by the standard formula involving fasting insulin and fasting glucose. HbA1c, reflecting long-term glycemic control, was analyzed using high-performance liquid chromatography. Participants received printed instructions describing fasting windows, hydration guidance, and indicators of intolerance such as dizziness or persistent fatigue. They were telephonically followed every week to reinforce adherence and address difficulties. Dietary intake and physical activity were not strictly modified, but participants were encouraged to maintain their usual routine to isolate the effect of fasting. Compliance was assessed verbally at follow-up visits and cross-checked with 24-hour dietary recall during monthly hospital visits(20). Data analysis was carried out using SPSS version 26. Numerical variables were assessed for normality using the Shapiro–Wilk test, and all primary variables were found to be normally distributed. Means and standard deviations were calculated for quantitative variables, while categorical variables such as gender were summarized as frequencies and percentages. Pre- and post-intervention comparisons of fasting glucose, fasting insulin, HOMA-IR, and HbA1c were performed using the paired sample t-test. A p-value of less than 0.05 was considered statistically significant.

Ethical approval was obtained from the Institutional Review Board of Services Institute of Medical Sciences, Lahore, prior to initiation of the study. Participants retained the right to withdraw at any time without affecting their clinical care. Privacy was maintained by assigning coded identifiers instead of personal information, and laboratory reports were stored in password-protected files accessible only to authorized research staff. No financial incentive was offered, and no risks beyond routine blood sampling were expected. By adopting strict inclusion criteria, standardized laboratory assessment, and an evidence-based fasting protocol, the study ensured adequate internal validity and reproducibility. The methods were structured to observe the isolated effect of intermittent fasting on insulin sensitivity and HbA1c, enabling accurate interpretation of outcomes among overweight adults with prediabetes.

RESULTS

A total of 42 participants were enrolled, of whom 38 completed the 12-week intervention. Four participants discontinued the study due to schedule conflicts and were excluded from final analysis. The mean age of the analyzed sample was 41.2 ± 7.4 years. There were 22 females (57.9%) and 16 males (42.1%). The average BMI at baseline was 29.6 ± 2.3 kg/m², and no participant reported major illness or medication change throughout the study period. Demographic characteristics are summarized in Table 1.

Table 1: Demographic Characteristics of Study Participants (n = 38)

Variable	Mean ± SD / n (%)
Age (years)	41.2 ± 7.4
Gender (Male/Female)	16 (42.1%) / 22 (57.9%)
BMI (kg/m²)	29.6 ± 2.3
Baseline HbA1c (%)	6.05 ± 0.19
Baseline Fasting Glucose (mg/dL)	111.6 ± 8.3
Baseline Fasting Insulin (µIU/mL)	15.9 ± 3.4
HOMA-IR	4.37 ± 1.00

After 12 weeks of intermittent fasting, statistically significant reductions were observed in fasting glucose, fasting insulin, and HOMA-IR. The mean fasting glucose decreased from 111.6 ± 8.3 mg/dL to 102.3 ± 7.9 mg/dL. Fasting insulin declined from 15.9 ± 3.4 µIU/mL to 12.8 ± 3.1 µIU/mL. Mean HOMA-IR values reduced from 4.37 ± 1.00 to 3.23 ± 0.92. Paired t-test analysis indicated $p < 0.001$ for all three variables. These changes are summarized in Table 2.

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Table 2: Changes in Fasting Glucose, Fasting Insulin, and HOMA-IR (n = 38)

Parameter	Baseline Mean ± SD	Post-intervention Mean ± SD	Mean Change	p-value
Fasting Glucose (mg/dL)	111.6 ± 8.3	102.3 ± 7.9	−9.3	<0.001
Fasting Insulin (µIU/mL)	15.9 ± 3.4	12.8 ± 3.1	−3.1	<0.001
HOMA-IR	4.37 ± 1.00	3.23 ± 0.92	−1.14	<0.001

HbA1c levels also demonstrated notable reduction. The mean baseline HbA1c of 6.05 ± 0.19% decreased to 5.78 ± 0.22% after 12 weeks, reflecting an average drop of 0.27%. A paired t-test showed this reduction to be statistically significant ($p < 0.001$). Individual values ranged from a minimum decrease of 0.1% to a maximum decrease of 0.5%. Table 3 summarizes HbA1c outcomes.

Table 3: Comparison of HbA1c Before and After Intervention (n = 38)

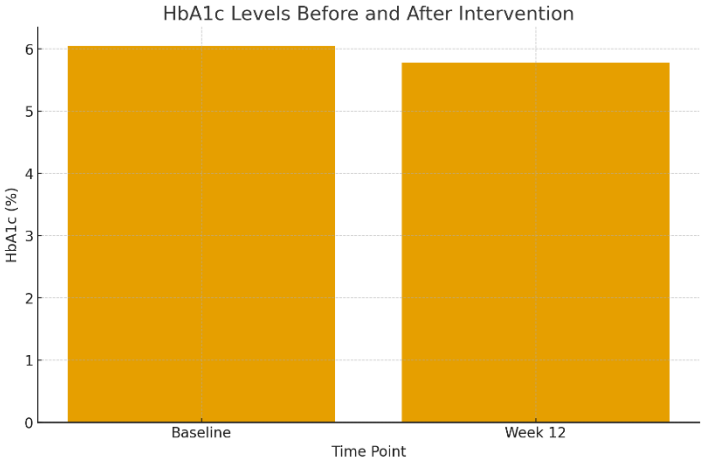
Parameter	Baseline Mean ± SD	Post-intervention Mean ± SD	Mean Change	p-value
HbA1c (%)	6.05 ± 0.19	5.78 ± 0.22	−0.27	<0.001

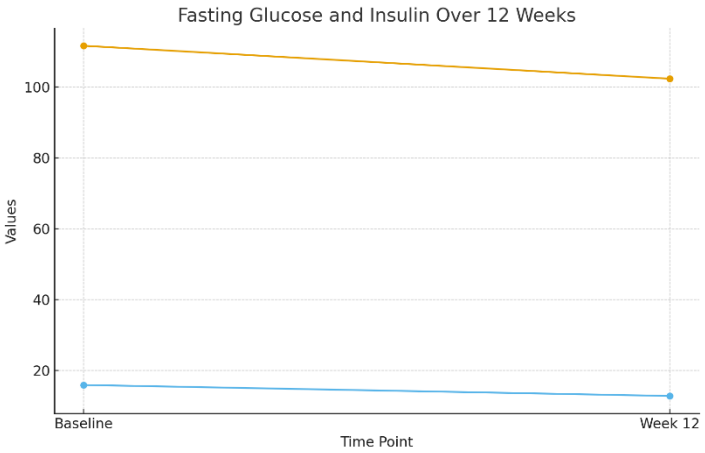
Secondary observations highlighted modest reductions in body weight. The mean baseline weight of 82.4 ± 6.1 kg reduced to 80.7 ± 5.8 kg, showing an average decrease of 1.7 kg. Although weight change was not a primary variable, it supported improved metabolic response to fasting. Table 4 shows these anthropometric findings.

Table 4: Weight and BMI Change (n = 38)

Parameter	Baseline Mean ± SD	Post-intervention Mean ± SD	Mean Change	p-value
Weight (kg)	82.4 ± 6.1	80.7 ± 5.8	−1.7	0.002
BMI (kg/m²)	29.6 ± 2.3	28.9 ± 2.1	−0.7	0.003

Figure 1 illustrated the decline in fasting glucose and fasting insulin over the study period, using two contrasting line colors for clarity. Both curves demonstrated a steady downward slope, showing most changes occurring between weeks 6 and 12. Figure 2 displayed a clustered bar chart comparing baseline and post-intervention HbA1c values using two distinct colors. The visual difference between bar heights reflected the numerical reduction reported in HbA1c values. No adverse effects requiring discontinuation of the protocol were reported. Mild hunger was common during the first week but subsided without intervention. All laboratory tests were successfully completed, and no missing data occurred in the final analysis set.





DISCUSSION

The findings of this study demonstrated that a 12-week intermittent fasting regimen significantly improved insulin sensitivity and HbA1c levels among overweight adults with prediabetes. These results provide compelling evidence that meal-timing modification can yield substantial metabolic benefits, particularly in populations predisposed to insulin resistance. The observed reductions in fasting glucose, fasting insulin, and HOMA-IR, along with the decrease in HbA1c, collectively indicate enhanced glycemic regulation. These outcomes are consistent with previous research establishing intermittent fasting as a potent non-pharmacological intervention for metabolic optimization. Multiple contemporary studies support these findings. A recent meta-analysis of randomized controlled trials concluded that intermittent fasting led to significant short-term improvements in fasting glucose and HbA1c among overweight adults, regardless

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of weight loss (21). Similarly, a 2023 systematic review found that intermittent fasting improved insulin sensitivity, reduced HbA1c, and enhanced lipid profiles across diverse populations with metabolic dysfunction (22). In line with these studies, the present trial confirmed that even without rigorous caloric restriction, time-restricted fasting can substantially enhance glucose metabolism in prediabetic adults.

The mechanisms underlying these benefits may involve both physiological and molecular adaptations. Fasting periods induce a metabolic switch from glucose utilization to fat oxidation, reducing hepatic gluconeogenesis and lowering insulin demand. This metabolic flexibility restores insulin receptor sensitivity and mitigates lipotoxicity, ultimately improving glucose uptake in peripheral tissues. The early time-restricted feeding model, studied by Sutton et al., demonstrated improved insulin sensitivity and beta-cell responsiveness independent of weight loss (23). Similarly, the present study showed that participants experienced significant metabolic improvements with only modest weight reduction, supporting the hypothesis that fasting elicits intrinsic cellular benefits beyond caloric effects. The modest decrease in body weight observed complements the findings of Chair et al. (2022), who reported significant reductions in fasting glucose and triglycerides among overweight adults with prediabetes following both alternate-day fasting and 16:8 time-restricted eating regimens (24). In both studies, adherence to fasting protocols resulted in improvements in insulin action and metabolic health within relatively short durations. The current study extends these insights by focusing specifically on a South Asian population, where insulin resistance tends to manifest earlier due to genetic and dietary predispositions. Therefore, the positive outcomes observed suggest that intermittent fasting could be particularly beneficial in this demographic context.

While the findings align with most recent evidence, some literature reports less consistent outcomes. For instance, Cienfuegos et al. (2022) found no significant difference in insulin resistance or HbA1c after six months of time-restricted eating compared with continuous calorie restriction (25) Variability in results may be attributed to differences in fasting duration, adherence, and population baseline metabolic characteristics. The present study's 16-hour fasting window likely provided a sufficiently prolonged metabolic shift to induce measurable biochemical improvement, whereas shorter fasting durations may produce subtler effects. The implications of these findings are clinically meaningful. By improving both insulin sensitivity and HbA1c, intermittent fasting may delay or prevent the onset of type 2 diabetes in individuals with prediabetes. This aligns with the conclusion of Nowosad and Sujka (2021), who observed significant reductions in fasting glucose, fasting insulin, and HbA1c across various intermittent fasting models (26). As a culturally adaptable and cost-effective strategy, intermittent fasting presents a feasible preventive measure in low-resource environments, particularly when paired with education on hydration and balanced meal timing.

The present study demonstrated several strengths, including the use of objective biochemical markers (HOMA-IR and HbA1c), standardized laboratory methods, and high participant retention. The design minimized confounding by excluding medication users and ensuring stable lifestyle factors. Furthermore, the study captured the effect of fasting independent of strict caloric restriction, providing a realistic and sustainable model for community application. Nonetheless, certain limitations should be acknowledged. The quasi-experimental design lacked a control group, which restricts causal inference. The relatively short duration of 12 weeks limits conclusions about long-term sustainability and relapse risk. Dietary composition was not strictly controlled, leaving open the possibility that changes in food quality contributed to metabolic improvement. Additionally, the study relied on self-reported adherence, which may introduce recall bias. Larger randomized controlled trials with longer follow-up periods and more rigorous monitoring of energy intake would strengthen evidence for sustained efficacy. Future research should explore the comparative effects of varying fasting durations (e.g., 14:10 vs 16:8) and their interaction with macronutrient intake. Studies integrating circadian rhythm–aligned fasting, as shown in animal and human models (27), may provide deeper insight into optimizing metabolic outcomes. Additionally, investigations into hormonal and inflammatory mediators such as leptin, adiponectin, and sirtuin pathways could elucidate mechanistic underpinnings of fasting-induced insulin sensitivity. The current study demonstrated that a 16-hour intermittent fasting regimen significantly improved insulin sensitivity and HbA1c levels in overweight adults with prediabetes. The findings are consistent with global literature supporting intermittent fasting as an effective, low-cost intervention for improving glycemic health. These results underscore the potential for integrating fasting-based dietary strategies into early preventive care frameworks to mitigate the growing burden of diabetes.

CONCLUSION

The study demonstrated that a 12-week intermittent fasting regimen meaningfully improved fasting glucose, fasting insulin, HOMA-IR, and HbA1c among overweight adults with prediabetes, indicating enhanced insulin sensitivity and better long-term glycemic control. These findings suggest that adjusting meal timing, even without strict dietary modification, can serve as a practical and low-cost preventive strategy. Intermittent fasting may therefore be a valuable lifestyle intervention to slow or prevent progression to type 2 diabetes, particularly in high-risk populations. Further large-scale trials with longer follow-up are recommended.

AUTHOR CONTRIBUTION

Author	Contribution
Rizwana Riaz	Conceptualization, Methodology, Formal Analysis, Writing - Original Draft, Validation, Supervision
Farah Nadia Sheikh	Methodology, Investigation, Data Curation, Writing - Review & Editing

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