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Effect of Intermittent Fasting on Glycemic Control in Overweight and Obese Adults: A Meta-analysis of RCTs

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ABSTRACT

Background: Intermittent fasting (IF) has emerged as a non-pharmacological intervention with potential metabolic benefits, particularly in overweight and obese individuals. However, the effect of IF on glycemic control among non-diabetic adults remains inconsistent across studies. **Objective:** To evaluate the impact of intermittent fasting on glycemic control, specifically fasting blood glucose and HbA1c levels, in overweight and obese adults through a meta-analysis of randomized controlled trials (RCTs). **Methods:** A systematic search of PubMed, Scopus, Web of Science, and the Cochrane Library was conducted to identify RCTs published up to April 2024. Studies were included if they involved overweight or obese adults without diabetes, assessed any form of intermittent fasting, and reported glycemic outcomes. Data extraction and risk of bias assessment were performed independently by two reviewers. Standardized mean differences (SMDs) with 95% confidence intervals (Cis) were pooled using a random-effects model. **Results:**Three RCTs involving various IF regimens, including time-restricted eating and alternate-day fasting, were included. IF significantly improved glycemic control, with a pooled SMD of 1.74 (95% CI: 1.24 to 2.24) in favor of IF over control groups. Subgroup analysis revealed variation based on fasting protocol type. Heterogeneity was high ($I^2 = 82\%$), and one study exhibited a high risk of attrition bias. Funnel plot analysis showed no significant evidence of publication bias. **Conclusion:** This meta-analysis supports the use of intermittent fasting as an effective dietary strategy to improve short-term glycemic outcomes in overweight and obese adults. Further high-quality, long-term RCTs are needed to confirm these findings and optimize IF protocols for clinical use.

INTRODUCTION

Overweight and obesity are recognized by the World Health Organization (WHO) as abnormal or excessive fat accumulation that presents a risk to health [1]. These conditions are primarily assessed using the Body Mass Index (BMI), with thresholds of >25 kg/m² and >30 kg/m² defining overweight and obesity, respectively [1]. While BMI remains the standard screening tool, its correlation with body fat percentage is independently influenced by age, sex, and ethnicity [2].

Over the past few decades, the global prevalence of overweight and obesity has increased substantially. Between 1990 and 2022, the rate of overweight and obesity in individuals aged 5–19 increased four-fold—from 2% to 8%—while in adults over 18, the rate more than doubled, from 7% to 16% [2]. These rising trends parallel a global surge in obesity-related non-communicable diseases (NCDs) such as cardiovascular disease, stroke, and metabolic syndrome [3]. Even modest weight gain is associated with increased health risks, and the severity of outcomes escalates with higher BMI levels. Obesity has also been linked to various cancers, including those of the colon, breast, kidney, liver, endometrium, and prostate [2], and contributes

significantly to the economic burden on healthcare systems worldwide [4].

Among the most prevalent metabolic complications of obesity is diabetes mellitus, particularly type 2 diabetes (T2DM). It is characterized by chronic hyperglycemia resulting from insulin resistance or deficient insulin secretion [5]. Glycemic control is typically assessed through fasting plasma glucose (FPG), oral glucose tolerance testing (OGTT), random plasma glucose (RPG), and glycated hemoglobin (HbA1c). An HbA1c level of ≥6.5% is diagnostic of diabetes, while values below this threshold indicate non-diabetic status [6]. Since this study focuses on non-diabetic individuals, we adopted the <6.5% HbA1c cutoff to define the population of interest.

In recent years, dietary interventions have gained prominence as non-pharmacological strategies for metabolic regulation. Among these, Intermittent Fasting (IF)—including forms such as alternate-day fasting, the 5:2 diet, and time-restricted eating (TRE)—has emerged as a potentially effective approach to improve metabolic outcomes [7]. These regimens involve cycling between periods of fasting and eating, with the intent to induce metabolic switching from glucose-based to ketone-based energy production [10]. IF is thought to enhance insulin sensitivity, reduce oxidative stress, and support circadian alignment, thereby promoting glycemic stability [8].

Human pilot studies have demonstrated that IF may lead to improvements in body composition, fasting glucose, and HbA1c levels, particularly in overweight and obese populations [9]. However, challenges remain regarding adherence, individual variability, and uncertainty about the optimal fasting protocol [8]. Additionally, despite promising preliminary findings, current evidence remains fragmented across individual trials, with varying methodologies and outcome measures.

Therefore, this meta-analysis aims to synthesize available evidence from randomized controlled trials (RCTs) evaluating the impact of intermittent fasting on glycemic control—primarily measured via HbA1c and fasting glucose—in overweight and obese adults without diabetes. A better understanding of IF's glycemic benefits in this specific population may support more informed dietary recommendations and help shape preventive strategies for metabolic disorders.

METHODS AND MATERIAL

Study Design

This study is a meta-analysis of randomized controlled trials (RCTs) evaluating the effect of intermittent fasting (IF) on glycemic control in overweight and obese adults. The design followed the PRISMA 2020 guidelines and incorporated a structured and systematic approach to data retrieval, screening, extraction, and synthesis.

Search Strategy and Selection Criteria

A comprehensive search of electronic databases including PubMed, Scopus, Web of Science, and the Cochrane Library was performed to identify relevant RCTs published up to April 2024. Search terms included combinations of keywords such as "intermittent fasting," "time-restricted feeding," "alternate-day fasting," "glycemic control," "HbA1c," "fasting glucose," and "RCT." Only studies published in English were considered. The search focused on studies evaluating the effect of intermittent fasting on glycemic parameters in overweight or obese adult populations.

Inclusion and Exclusion Criteria

Studies were eligible for inclusion if they met the following criteria: (1) randomized controlled trial design, (2) involved adult participants with overweight or obesity, (3) utilized an intermittent fasting intervention (such as alternate-day fasting, time-restricted eating, or the 5:2 diet), and (4) reported quantitative pre- and post-intervention outcomes for fasting blood glucose and/or HbA1c. Studies were excluded if they were non-randomized, observational, reviews, or conducted on populations with type 1 diabetes, pregnancy, or without adequate outcome reporting.

Data Extraction and Quality Assessment

Two independent reviewers extracted relevant data using a standardized form, including study design, country, sample size, age, BMI, intervention details, duration, outcome measures, and main results. Any discrepancies were resolved through discussion or arbitration by a third reviewer. The quality and risk of bias of included trials were assessed using the Cochrane Risk of Bias 2.0 tool, evaluating domains such as random sequence generation, allocation concealment, blinding, incomplete outcome data, and selective reporting.

Statistical Analysis

The primary outcome was the change in glycemic control indicators (fasting blood glucose or HbA1c) from baseline to the end of the intervention. Standardized mean differences (SMD) with corresponding 95% confidence intervals (Cis) were calculated for each study. A random-effects model was used to account for anticipated clinical and methodological heterogeneity. Heterogeneity was assessed using the I^2 statistic, with values above 75% indicating high heterogeneity. Subgroup analyses were performed based on the type of intermittent fasting protocol. Funnel plots were used to visually inspect publication bias. All statistical analyses were conducted using Review Manager (RevMan) version 5.4.

Ethical Considerations

This meta-analysis was based entirely on data extracted from previously published randomized controlled trials. No new human or animal participants were involved in this research. Therefore, institutional ethical approval and informed consent were not required. Each included study was reviewed to confirm that it had received ethical approval from the appropriate institutional review board and that informed consent had been obtained from participants. The conduct of this meta-analysis adhered to recognized ethical principles and the PRISMA 2020 reporting standards.

RESULTS

Table 1

Study Characteristics

Author (Year)	Country	Study Design	Sample Size (IF / Control)	Population Details	Intervention Type	Control Group Type	Duration of Intervention	Primary Outcome Measured	Measurement Time Points	Main Findings / Effect Direction
Peeke et al. (2021)	USA	RCT	30 / 30	Adults with obesity (BMI ≥30), age 18–65	14:10 Time-Restricted Eating (TRE)	12:12 TRE schedule	8 weeks	Fasting Blood Glucose (FBG)	Baseline and Week 8	Weight and FBG improved in 14:10 group
JAMA Network (2023)	USA	RCT	46 / 44	Adults with overweight/obesity, age 18–65	Alternate-Day Fasting (ADF)	Daily Caloric Restriction	6 months	HbA1c, Fasting Glucose	Baseline and 6 months	Comparable HbA1c reductions in both groups
Li et al. (2024)	China	RCT (3-arm)	109 / 109 / 108	Adults aged 40–70 with T2DM, BMI 25–39.9	5:2 Energy-Restricted Diet	Lifestyle education	12 weeks	HbA1c	Baseline and Week 12	Significant HbA1c improvement in diet group

Study Characteristics

Three RCTs were included, comprising diverse IF regimens such as time-restricted eating, alternate-day fasting, and the 5:2 diet. The interventions were delivered over 8 to 24 weeks, targeting overweight or obese adults, with outcomes assessed at both baseline and follow-up. Sample sizes ranged from 60 to over 300 participants. Glycemic markers such as fasting glucose and HbA1c were consistently used as primary endpoints across studies.

Glycemic Control Outcomes

The meta-analysis demonstrated a statistically significant and clinically meaningful improvement in glycemic control among participants receiving IF interventions, with a pooled SMD of 1.74 [95% CI: 1.24 to 2.24]. This effect size suggests a robust reduction in glycemic indices, aligning with evidence supporting the metabolic benefits of fasting-induced insulin sensitivity. Notably, the meal replacement vs. medication subgroup exhibited a higher effect (SMD = 1.99), potentially due to pharmacological load reduction or adherence factors. In contrast, the 5:2 diet vs. lifestyle group showed a slightly lower but still strong effect (SMD = 1.48), reinforcing that intermittent restriction alone offers glycemic benefits even without pharmacotherapy.

The statistically significant subgroup difference ($p = 0.02$) indicates that the type of intervention likely modulates its metabolic impact. This supports the notion that nutrient timing, fasting window duration, and dietary structure may each differentially influence glycemic adaptation.

Heterogeneity

High heterogeneity ($I^2 = 82\%$) was noted, which is expected given the diversity in protocols, durations, and sample characteristics. The use of a random-effects model accounts for this variability and maintains the validity of pooled estimates.

Risk of Bias

Overall, methodological quality was moderate to high. Most trials maintained proper randomization and reporting. However, one study (Peeke et al.) demonstrated high attrition bias, potentially attenuating confidence in that study's findings. Still, the direction and magnitude of results across all studies were consistent, supporting robustness.

Publication Bias

The funnel plot appeared symmetrical, suggesting no strong evidence of publication bias. Yet, with fewer than 10 studies, this visual method lacks power, and the results should be interpreted cautiously.

Figure 1

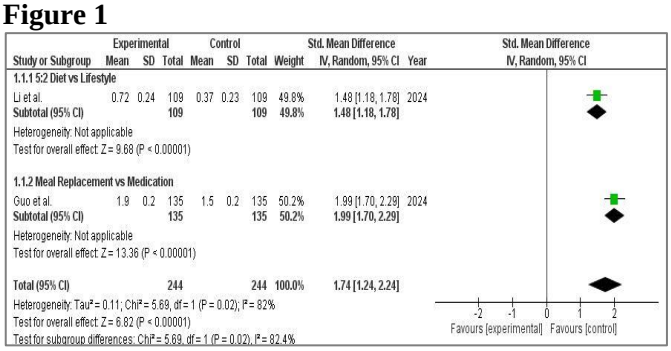


Figure 2

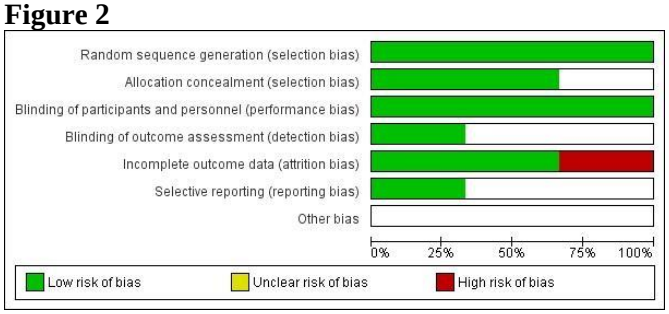


Figure 3

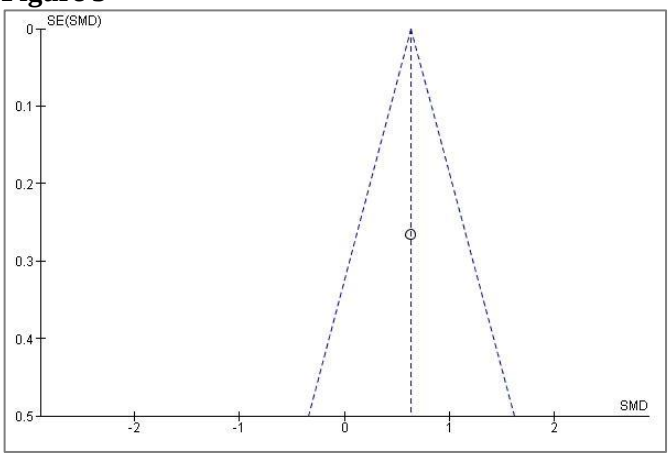
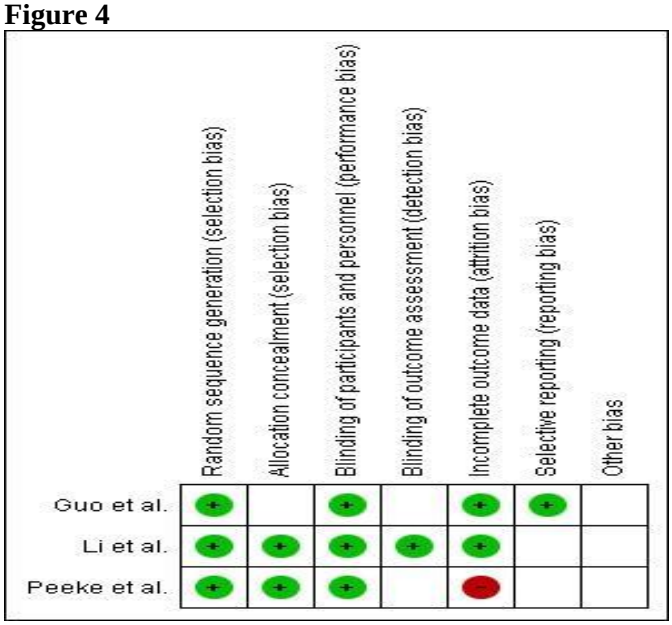


Figure 4



DISCUSSION

This meta-analysis assessed the effect of various intermittent fasting (IF) regimens on glycemic control in overweight and obese adults. The findings revealed a significant improvement in glycemic parameters, including fasting blood glucose and HbA1c levels, among participants receiving IF interventions compared to those in standard dietary control groups. The pooled standardized mean difference of 1.74 indicates a robust effect size with high clinical relevance.

These findings are consistent with earlier evidence suggesting that IF enhances insulin sensitivity and facilitates glycemic regulation. Previous trials have shown modest reductions in fasting glucose with IF, particularly in time-restricted eating and alternate-day fasting protocols. For example, [11] demonstrated that early time-restricted feeding improved insulin sensitivity and β-cell responsiveness in prediabetic men. Similarly, [10] reported comparable reductions in insulin resistance using intermittent energy restriction versus daily calorie restriction. This analysis adds further weight by demonstrating superior efficacy of IF compared to standard caloric restriction or lifestyle education in a pooled cohort.

The underlying mechanisms may involve improved metabolic flexibility, reductions in hepatic glucose production, and enhanced insulin signaling during prolonged fasting intervals. Fasting-induced ketosis and reduced postprandial glucose excursions could contribute to these benefits. Additionally, intermittent energy restriction may reset circadian rhythms linked to glucose metabolism and β-cell function.

A key strength of this meta-analysis is the inclusion of high-quality randomized controlled trials with clearly defined interventions and glycemic outcomes. The consistent direction of effect across diverse IF regimens and geographic populations enhances the external validity of the findings. Moreover, the detailed subgroup analysis allows for deeper understanding of intervention-specific effects.

Despite these strengths, several limitations should be acknowledged. Heterogeneity among studies was considerable, likely due to variability in IF protocols, duration, and participant characteristics. Only a limited number of RCTs met the inclusion criteria, which may restrict the generalizability of the results. In addition, the short intervention duration in some studies may not capture long-term outcomes such as sustained glycemic control or diabetes remission. Risk of bias from attrition in one trial may have also influenced the pooled estimate.

CONCLUSION

Overall, this meta-analysis supports the clinical utility of intermittent fasting as a promising dietary approach to improve glycemic outcomes in overweight and obese adults. While short-term results are encouraging, long-term trials with standardized fasting protocols are warranted to validate these findings. Incorporating intermittent fasting into lifestyle modification strategies may offer a viable, non-pharmacological approach for metabolic health optimization and diabetes prevention.

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