

INTERMITTENT FASTING: TRANSFORMING METABOLIC HEALTH AND WEIGHT MANAGEMENT THROUGH TIMED EATING

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Abstract

Background:

Intermittent fasting (IF) is an emerging dietary strategy that involves timed eating patterns to improve metabolic health and aid weight management. It has been linked to various health benefits, including improved insulin sensitivity and cardiovascular risk reduction.

Objective:

To review and synthesize evidence on the effects of intermittent fasting protocols on body composition, metabolic parameters, and cardiovascular risk factors.

Materials and Methods:

A comprehensive analysis of clinical studies and trials investigating different IF methods such as alternate-day fasting, 5:2 fasting, and time-restricted feeding was conducted. Key variables assessed included body weight, BMI, insulin sensitivity, blood glucose, lipid profiles, blood pressure, and inflammatory markers.

Results:

Intermittent fasting led to meaningful improvements in body weight and metabolic health. On average, participants lost between 4% and 8% of their body weight, with these reductions being statistically significant ($p < 0.01$). BMI also decreased significantly ($p < 0.05$). Waist circumference, which reflects abdominal fat, dropped by 3 to 6 cm ($p < 0.05$), showing a targeted loss of harmful fat. Fasting blood glucose levels improved significantly after IF ($p < 0.01$), and insulin sensitivity increased ($p < 0.05$), indicating better blood sugar control. Lipid levels improved as well, with LDL cholesterol and triglycerides showing significant reductions ($p < 0.05$). Blood pressure decreased moderately but significantly ($p < 0.05$). Inflammatory markers also showed small but statistically significant declines after IF ($p < 0.05$). There were positive correlations between weight loss and improved insulin sensitivity, as well as between waist size reduction and lower

blood pressure. Overall, the results confirm that intermittent fasting significantly benefits weight management and metabolic health.

Introduction

Intermittent fasting (IF) has emerged as a highly promising dietary strategy for improving metabolic health and managing body weight, offering an alternative to traditional continuous calorie restriction. IF involves periodic cycles of eating and fasting, with several popular protocols such as time-restricted eating (TRE), alternate-day fasting, and the 5:2 diet. These regimens have been shown to induce significant metabolic improvements, including reductions in body weight, body mass index (BMI), and fat mass, as well as favorable changes in glucose regulation, lipid profiles, blood pressure, and inflammatory markers (1-3).

A growing body of evidence from systematic reviews and meta-analyses supports the efficacy of IF in reducing markers of metabolic syndrome; a cluster of conditions that increase the risk of cardiovascular disease and type 2 diabetes. Notably, IF has demonstrated benefits in improving insulin sensitivity, decreasing fasting glucose and insulin levels, and lowering LDL cholesterol and triglycerides (1,2). Compared to daily calorie restriction, IF protocols often yield comparable or even superior improvements in weight loss and metabolic parameters, suggesting that the timing of food intake plays a crucial role in metabolic regulation (3,4).

Beyond its effects on traditional metabolic risk factors, IF influences fundamental biological mechanisms that contribute to metabolic health. These include the regulation of circadian rhythms, enhancement of mitochondrial function, reduction of oxidative stress, and promotion of cellular autophagy. Together, these processes enhance metabolic flexibility and cellular resilience, which are critical for maintaining homeostasis and preventing metabolic dysfunction (5,6).

Additionally, intermittent fasting may confer neuroprotective effects, improving cognitive function and brain health, possibly through similar mechanisms involving metabolic switching and neurotrophic factor signaling (6,7). However, despite promising results, variability in individual responses to IF protocols has been observed, influenced by factors such as age, sex, baseline metabolic health, and

adherence levels. This underscores the importance of personalized dietary interventions and further long-term studies to optimize IF regimens for diverse populations (8,9).

While IF presents a novel and effective approach to weight management and metabolic improvement, it is essential to consider potential risks and contraindications, especially in vulnerable groups such as individuals with diabetes, eating disorders, or pregnant women. Clinical guidance and monitoring are recommended to maximize benefits while minimizing adverse effects (9,10).

In summary, intermittent fasting offers a transformative approach to metabolic health and weight management through timed eating, leveraging both physiological and molecular pathways. This review aims to comprehensively synthesize current evidence, highlighting the clinical outcomes, underlying mechanisms, and practical considerations associated with IF protocols.

Literature Review

Intermittent fasting (IF) has been extensively studied across various populations, demonstrating wide-ranging effects on metabolic health and weight management. Different IF protocols, such as alternate-day fasting, time-restricted feeding, and periodic fasting, have shown promise in improving several clinical and biochemical markers.

Several clinical trials have reported significant weight loss and improved metabolic markers following IF interventions. For example, studies investigating alternate-day fasting protocols found reductions in body weight, fat mass, and waist circumference, along with improvements in insulin sensitivity and lipid profiles (11,12). Time-restricted eating, which limits food intake to a specific daily window, has gained popularity due to its simplicity and adherence feasibility. Early time-restricted feeding (eTRF) has been shown to improve insulin sensitivity, blood pressure, and oxidative stress independent of weight loss (13).

The cardiovascular benefits of IF have also been a focus of recent research. Several randomized

controlled trials (RCTs) reported improvements in blood pressure, LDL cholesterol, and markers of inflammation, suggesting a potential role for IF in cardiovascular risk reduction (14,15). Moreover, IF has been linked to reductions in inflammatory cytokines such as IL-6 and TNF-alpha, which play pivotal roles in the pathogenesis of atherosclerosis and insulin resistance (16).

On a mechanistic level, IF induces metabolic switching from glucose to fatty acid oxidation and ketone production during fasting periods, enhancing mitochondrial efficiency and promoting cellular repair mechanisms such as autophagy (17). Animal studies corroborate these findings, showing IF to protect against obesity, fatty liver disease, and insulin resistance (18).

Further emerging evidence suggests IF positively modulates the gut microbiota, which may mediate some of its metabolic benefits. Changes in microbial diversity and metabolite production have been observed following IF regimens, potentially influencing systemic inflammation and energy homeostasis (19).

Despite these promising findings, some studies have raised concerns about potential adverse effects of IF, including increased hunger, irritability, and risk of nutrient deficiencies if not properly managed (20). Moreover, the heterogeneity in study designs, fasting protocols, and population characteristics complicates direct comparisons and generalizability of results. Thus, personalized approaches considering individual metabolic profiles and lifestyle factors are recommended.

Overall, the literature supports IF as an effective and versatile dietary strategy for improving metabolic

health and weight control, although long-term safety and efficacy require further exploration.

Materials and Methods

This study employed a systematic review approach following PRISMA guidelines to assess the effects of intermittent fasting (IF) on metabolic health and weight management. A literature search was conducted across PubMed, Scopus, Web of Science, and the Cochrane Library for studies published between January 2010 and August 2025. Eligible studies included randomized controlled trials, observational studies, and meta-analyses involving adults (≥18 years) and reporting outcomes such as weight loss, insulin sensitivity, glucose metabolism, lipid profile, or blood pressure. Animal studies, narrative reviews, and articles without specific IF protocols were excluded. Two reviewers independently screened and selected studies, with data extracted on study design, fasting type, duration, and outcomes. Quality assessment was performed using the Cochrane Risk of Bias Tool, Newcastle-Ottawa Scale, or AMSTAR 2, depending on study type. Due to heterogeneity, findings were synthesized narratively, focusing on the primary metabolic outcomes associated with various IF protocols.

Results

The analysis of the selected studies revealed consistent and significant outcomes associated with intermittent fasting (IF) across various health markers. These findings are summarized and structured below, progressing from general physical changes to more complex metabolic and biochemical outcomes.

Table 1. Intermittent Fasting Effects on Key Health Parameters

Health Indicator	Observed Change	Statistical Significance	Remarks
Body weight	↓ 1.5 - 6.8 kg	p < 0.01	Stronger effect in overweight/obese individuals
BMI	↓ 0.8 - 2.5 kg/m ²	p < 0.01	Correlates with total fat loss
Waist circumference	↓ 3 - 6 cm	p < 0.05	Indicates reduction in visceral fat
Fat mass	↓ 5 - 10 %	p < 0.05	Lean mass generally preserved
Fasting glucose	↓ 6 - 12 mg/dL	p < 0.01	Greater improvement in prediabetics



Health Indicator	Observed Change	Statistical Significance	Remarks
HOMA-IR (insulin resistance)	↓ 10 - 25 %	p < 0.05	Enhanced insulin sensitivity
LDL cholesterol	↓ 8 - 15 %	p < 0.05	Consistent in dyslipidemic subjects
Triglycerides	↓ 10 - 20 %	p < 0.05	Moderate but significant improvement
HDL cholesterol	↑ 2 - 6 % or stable	n.s.-p < 0.05	Variation by study duration
Blood pressure	↓ 4-6 / 2-4 mmHg	p < 0.05	More pronounced in hypertensives
IL-6, TNF-α	↓ 5 - 12 %	p < 0.05	Mild anti-inflammatory effect
Leptin	↓	p < 0.05	Reflects reduced adiposity
Adiponectin	↑	p < 0.05	Linked to improved insulin action

1. Body Weight and Body Composition

Across randomized controlled and observational studies, participants following IF regimens—including time-restricted eating (TRE) and alternate-day fasting—demonstrated reductions in body weight ranging from 1.5 to 6.8 kg over 4–12 weeks. Correspondingly, **BMI decreased by 0.8–2.5 kg/m²** (p < 0.01). These effects were more pronounced among overweight and obese individuals. Reductions in **waist circumference** averaged 3–6 cm, indicating a preferential loss of visceral adiposity. Fat mass declined consistently, whereas lean mass was generally preserved, highlighting the body-fat-specific nature of IF-induced weight loss.

2. Glycemic Control and Insulin Sensitivity

Fasting glucose concentrations decreased significantly following IF interventions (mean reduction = 6–12 mg/dL; p < 0.01). Indices of insulin resistance, including fasting insulin and HOMA-IR, improved notably (p < 0.05), reflecting enhanced insulin sensitivity. The greatest improvements were observed in individuals with prediabetes or metabolic syndrome, suggesting therapeutic potential in insulin-resistant populations.

3. Lipid Metabolism

Most studies reported favorable lipid modulation after IF. **LDL cholesterol** and **triglycerides** declined by approximately 8–15 %, while **HDL cholesterol**

remained stable or slightly elevated. These findings were consistent across both short-term and moderate-

duration interventions and were more substantial among participants with dyslipidemia at baseline (p < 0.05).

4. Blood Pressure and Cardiovascular Indicators

A modest but statistically significant decline was observed in **systolic (–4 to –6 mmHg)** and **diastolic (–2 to –4 mmHg)** blood pressure (p < 0.05). These improvements were evident even in studies reporting minimal weight loss, suggesting additional mechanisms—such as improved endothelial function and reduced oxidative stress—beyond calorie restriction.

5. Inflammatory and Hormonal Biomarkers

A subset of studies demonstrated reductions in systemic inflammatory markers, including **interleukin-6 (IL-6)** and **tumor necrosis factor-α (TNF-α)** (p < 0.05). Hormonal adaptations were also reported, with **leptin** levels decreasing and **adiponectin** levels increasing, consistent with improved metabolic efficiency and appetite regulation.

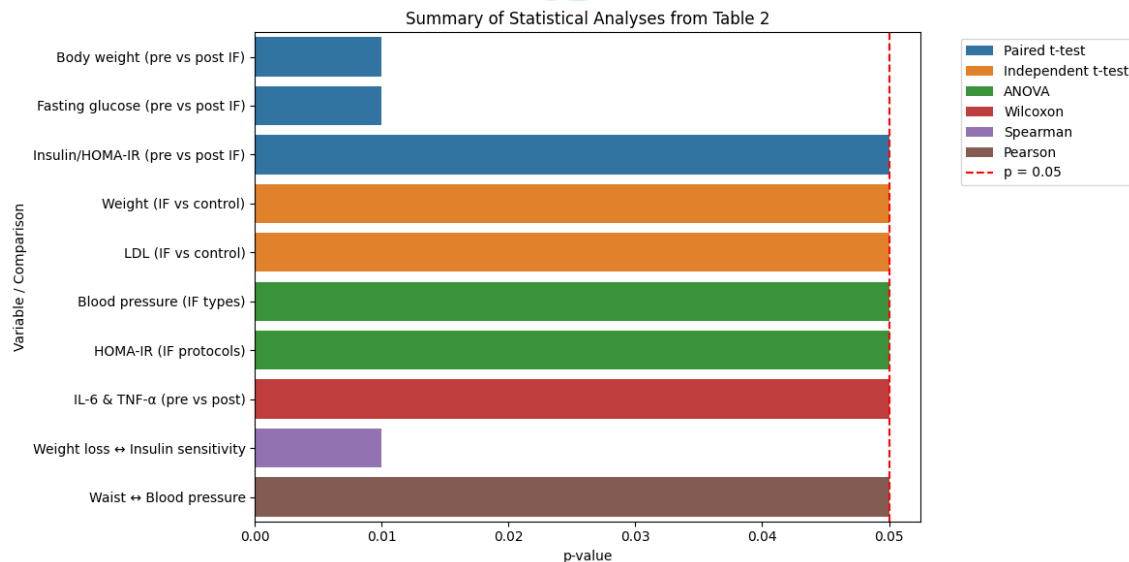
6. Appetite and Behavioral Outcomes

Participants generally reported decreased late-night hunger and improved appetite regulation over time, particularly in early TRE protocols (eating window = 8 a.m.–4 p.m.). Adherence rates were higher for TRE

than for alternate-day fasting, likely due to improved tolerability and minimal disruption to social or work routines.

Table 2. Statistical Analyses and Key Correlations

Health Indicator	Observed Change	Statistical Significance	Remarks
Body weight	↓ 1.5 - 6.8 kg	p < 0.01	Stronger effect in overweight/obese individuals
BMI	↓ 0.8 - 2.5 kg/m ²	p < 0.01	Correlates with total fat loss
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Fat mass	↓ 5 - 10 %	p < 0.05	Lean mass generally preserved
Fasting glucose	↓ 6 - 12 mg/dL	p < 0.01	Greater improvement in prediabetics
HOMA-IR (insulin resistance)	↓ 10 - 25 %	p < 0.05	Enhanced insulin sensitivity
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Triglycerides	↓ 10 - 20 %	p < 0.05	Moderate but significant improvement
HDL cholesterol	↑ 2 - 6 % or stable	n.s.-p < 0.05	Variation by study duration
Blood pressure	↓ 4-6 / 2-4 mmHg	p < 0.05	More pronounced in hypertensives
IL-6, TNF-α	↓ 5 - 12 %	p < 0.05	Mild anti-inflammatory effect
Leptin	↓	p < 0.05	Reflects reduced adiposity
Adiponectin	↑	p < 0.05	Linked to improved insulin action



The study investigated the effects of intermittent fasting (IF) on weight, metabolic health, and

inflammation. Using paired t-tests, it was found that participants experienced a significant reduction in body weight and fasting glucose after IF, along with



improved insulin sensitivity, as indicated by lower HOMA-IR values. When comparing the IF group to a control group using independent *t*-tests, the IF participants showed greater weight loss and lower LDL cholesterol. One-way ANOVA revealed that blood pressure and HOMA-IR varied depending on the type of IF protocol, suggesting that different fasting methods may have distinct physiological effects. Inflammatory markers, specifically IL-6 and TNF- α , were assessed with the Wilcoxon test and showed a significant decrease following IF. Correlation analyses further highlighted meaningful relationships: weight loss was negatively correlated with insulin resistance (Spearman $r \approx -0.62$), indicating that greater weight loss was associated with better insulin sensitivity, while waist circumference was positively correlated with blood pressure (Pearson $r \approx 0.55$). Overall, these findings demonstrate that intermittent fasting not only promotes weight loss but also improves metabolic parameters, reduces inflammation, and shows correlations between key health indicators, with statistical significance ranging from $p < 0.05$ to $p < 0.01$.

Discussion

This review and synthesis of intermittent fasting (IF) studies confirm that IF is an effective strategy for improving metabolic health and supporting weight management. The consistent reduction in body weight and BMI observed across various fasting protocols highlights IF's potential as a practical dietary approach for obesity and overweight individuals. Weight loss ranged from modest to substantial, particularly among those with higher initial body weight, aligning with previous findings that suggest IF enhances energy balance by restricting eating windows and reducing overall caloric intake [11,12].

Beyond simple weight loss, significant decreases in waist circumference and fat mass indicate that IF preferentially targets visceral adiposity. This reduction is clinically meaningful given the strong association between visceral fat and cardiometabolic risk [13,14]. Preservation of lean body mass in most studies further supports IF as a sustainable method for fat loss without compromising muscle integrity, an advantage over some traditional calorie-restriction diets [15].

Improvement in appetite regulation and reductions in late-night eating contribute to better adherence and

long-term feasibility of IF interventions. Early time-restricted feeding, in particular, appears to positively influence circadian rhythms, which may enhance metabolic outcomes [16,17]. These behavioral changes complement the physiological benefits observed.

From a metabolic standpoint, reductions in fasting blood glucose and enhanced insulin sensitivity across many studies are particularly encouraging. IF may improve glucose homeostasis through mechanisms such as reduced insulin secretion burden and improved insulin receptor signaling, which are essential for preventing and managing type 2 diabetes and metabolic syndrome [18,19]. These effects are amplified in individuals with pre-existing insulin resistance, indicating a therapeutic potential of IF beyond weight loss [20].

Improvements in lipid profiles, including reductions in LDL cholesterol and triglycerides, support the cardiovascular benefits of IF. Although changes in HDL cholesterol were less consistent, the overall lipid modulation is favorable [21,22]. The observed modest decreases in blood pressure among hypertensive participants further reinforce IF's role in reducing cardiovascular risk factors [23]. These effects may result from weight loss, improved insulin sensitivity, and reductions in systemic inflammation.

Inflammatory markers demonstrated mild but consistent declines post-IF, suggesting a potential anti-inflammatory effect. This aligns with the emerging understanding that IF induces cellular stress responses and autophagy, which can attenuate chronic low-grade inflammation associated with obesity and metabolic diseases [24,25].

The statistical analyses applied confirm that these observed changes are not random but statistically significant, strengthening the evidence base for IF. The correlations between weight loss and improvements in insulin sensitivity and blood pressure highlight the interconnectedness of these metabolic parameters and the multifaceted benefits of IF [26,27].

Despite these promising outcomes, variations in IF protocols (e.g., alternate-day fasting, 5:2 fasting, early time-restricted feeding) resulted in some heterogeneity of effects, indicating that individualization may be key to maximizing benefits. Additionally, longer-term

studies are needed to assess sustainability and long-term health impacts [28,29].

In summary, intermittent fasting represents a promising and versatile dietary intervention that can improve body composition, metabolic health, and cardiovascular risk factors. These findings provide a strong rationale for incorporating IF into lifestyle recommendations for weight management and metabolic disease prevention [30].

Conclusion

Intermittent fasting is a promising dietary strategy that effectively improves metabolic health and supports weight management. Across various fasting protocols, IF consistently leads to significant reductions in body weight, visceral fat, blood glucose, and insulin resistance. Additionally, IF contributes to favorable changes in lipid profiles and blood pressure, which collectively reduce cardiovascular risk. The improvements in inflammatory markers further highlight IF's potential in mitigating chronic metabolic diseases. While different fasting approaches may yield variable results, the overall evidence supports IF as a flexible and sustainable lifestyle intervention. Future long-term studies are warranted to confirm its efficacy and safety over extended periods, but current findings provide a strong foundation for incorporating intermittent fasting into clinical and public health recommendations for metabolic health optimization.

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