



Meta-Analysis

Efficacy of Different Modes of Intermittent Fasting for Decreasing Visceral and Subcutaneous Fat in Adults With Overweight and Obesity: A Systematic Review and Network Meta-analysis

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Context: Intermittent fasting (IF) is a popular dietary strategy for the management of obesity and reducing visceral adipose tissue (VAT) and subcutaneous adipose tissue (SAT). However, the comparative efficacy of different IF modalities remains uncertain.

Objective: To evaluate the efficacy of IF interventions for reducing VAT and SAT in adults with overweight and obesity.

Data Sources: PubMed, Web of Science, and Scopus were searched from inception to July 2025 using key words related to fasting protocols and adipose tissue. Eligible studies were randomized trials of IF, including time-restricted eating (TRE), alternate-day fasting (ADF), or the 5:2 diet compared with controls (CON) or continuous caloric restriction (CR). Outcomes included changes in VAT and/or SAT in individuals with body mass index (BMI) ≥ 25 kg/m².

Data Extraction: Two independent reviewers extracted data, with disagreements resolved by consensus.

Data Analysis: Twenty-four studies ($n = 1930$; ages 22–69 years; BMI : 27–40 kg/m²) were included, with 24 contributing to VAT and 8 to SAT analyses. Compared with CON, the 5:2 diet (standardized mean difference [SMD]: -0.54) and TRE (SMD: -0.44) led to greater reductions in VAT, whereas neither ADF nor CR had significantly larger effects. Compared with CR, TRE demonstrated a small reduction in VAT (SMD: -0.21); however, the difference was not statistically significant. Compared with CON, the 5:2 diet (SMD: -0.45) and TRE (SMD: -0.37)

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led to larger reductions in SAT, but ADF and CR did not lead to differential effects. No IF modality demonstrated superiority over CR for SAT.

Conclusion: Compared with CON, specific IF modalities—particularly the 5:2 diet and TRE—produce greater reductions in VAT and SAT. However, advantages over CR are limited, with only TRE approaching greater VAT reduction and no IF modality outperforming CR for SAT. IF may serve as an alternative to CR within a broader lifestyle approach, with adherence likely driving effectiveness.

Systematic Review Registration: PROSPERO registration no. CRD420251145598.

Key words: time-restricted eating, alternate-day fasting, the 5:2 diet, abdominal fat, obesity.

INTRODUCTION

In 2022, the World Health Organization estimated that over 2.5 billion adults worldwide (~43%) were overweight, including 890 million with obesity, highlighting the emergence of obesity as a global epidemic.¹ The prevalence of obesity has more than doubled since 1990 and continues to increase across high- and low-income regions.^{2,3} Excess adiposity drives insulin resistance, type 2 diabetes, cardiovascular diseases, and other noncommunicable diseases, imposing an escalating health and economic burden.^{4,5} Visceral adipose tissue (VAT), located within the abdominal cavity (eg, omental and mesenteric fat), and subcutaneous adipose tissue (SAT), located beneath the skin, are metabolically distinct.⁶ Although both depots contribute to overall fat mass, VAT and SAT differ markedly, both physiologically and with respect to downstream effects on disease risk.⁶ Visceral adipose tissue typically comprises only approximately 5%–20% of total fat, whereas SAT accounts for the bulk of adipose tissue.⁷ Visceral adipose tissue is more cellular, vascularized, and immune cell-infiltrated with a proinflammatory phenotype than SAT, which exhibits lower immune cell density and a comparatively lower proinflammatory profile.^{6,8} Functionally, VAT adipocytes show greater insulin resistance and adrenergic sensitivity than SAT, releasing more free fatty acids and proinflammatory cytokines during lipolysis.⁹ After adjusting for body mass index (BMI) or waist circumference (WC), VAT still predicts dyslipidemia, insulin resistance, and hypertension.¹⁰ In contrast, SAT expansion (particularly in the gluteofemoral regions) is comparatively benign or even protective against cardiovascular and metabolic diseases. Accordingly, visceral obesity is recognized as the more pathogenic fat depot, driving much of the cardiometabolic risk associated with excess weight.^{5,11}

Continuous energy restriction (caloric restriction [CR]) remains the standard dietary approach for weight loss and fat reduction,¹² but sustained adherence is often poor.¹³ In

practice, daily CR (defined as a ~500–750 kcal/day deficit or ~30% below baseline energy needs) typically yields only modest weight loss (~5–10% at 1 year) and adherence tends to decline substantially within the first 1–4 months to over 1 year.¹⁴ As an alternative strategy, there has been growing interest in intermittent fasting (IF), which involves a dietary regimen periodically limiting energy intake over defined windows. Intermittent fasting has become increasingly popular,¹⁵ due, in part, because it is easier for some individuals to selectively restrict intake on only certain days or hours rather than daily.^{16,17} In several randomized trials and meta-analyses, IF regimens have produced weight-loss outcomes comparable to CR,¹⁸ with some studies reporting slightly greater short-term reductions in body weight or fat mass in IF groups.¹⁹ However, these differences are generally small and not consistently sustained over the long term, suggesting that overall energy deficit and adherence—rather than the fasting pattern itself—are the primary determinants of weight-loss success. Adherence also varies substantially among IF regimens. For instance, alternate-day fasting (ADF) often shows higher dropout rates compared with daily CR,²⁰ whereas the 5:2 regimen (2 restricted days per week) is generally well tolerated but may show declining adherence over time.²¹ Time-restricted eating (TRE) appears to produce weight-loss and metabolic outcomes similar to CR, although the studies are limited and long-term compliance remains uncertain.^{22,23} Conversely, emerging 4:3 protocols (3 fasting days per week) may support adherence in some individuals but require further study.²⁴ Collectively, these data suggest that, while IF can offer a feasible alternative to CR, sustained adherence—rather than the fasting pattern itself—likely determines long-term success in reducing weight, total fat, and VAT. Beyond weight loss, IF is recognized for potential metabolic benefits, including improved insulin sensitivity, lipid profiles, and blood pressure.^{15,25,26}

Among several IF regimens that have been studied, the best known are ADF, the 5:2 diet, and TRE. In ADF,

individuals alternate between “fast” days and “feast” days of ad libitum eating.^{27,28} Variations include zero-calorie ADF and modified ADF (allowing 20%–30% of energy on fast days).²⁷ In the 5:2 diet, people eat normally for 5 days each week and consume very few calories on 2 (consecutive or nonconsecutive) “fasting” days.^{19,28} Time-restricted eating confines daily intake to a consistent eating window within each 24-hour period (typically, 4–12 hours), followed by fasting for the remaining hours (~12–20 hours).¹⁴ All of these IF patterns create an intermittent energy deficit, but they have different biological and behavioral features.

Despite extensive investigation, findings across clinical trials and meta-analyses are mixed, with some showing comparable effects of IF modes and CR on total weight loss, while others report differing impacts on fat and lean mass components.^{18,29} Many trials have focused on overall weight or BMI changes, but have not reported the separate effects on VAT and SAT, with few comparisons between different modes of IF.^{20,30} Some systematic reviews report that IF diets cause weight and fat loss that are similar to conventional CR,^{17,19,31} whereas others suggest that IF is more efficient than CR in reducing weight and body fat.^{32,33} Data on depot-specific fat reduction are limited as most trials do not image VAT or SAT, and thus evidence on IF patterns that preferentially mobilize either depot is limited.

Notably, to our knowledge, no prior study has systematically compared multiple IF modes against each other and against conventional CR with respect to reductions in VAT and SAT mass. To address this gap, we conducted a network meta-analysis of randomized controlled trials in adults with overweight or obesity. We aimed to synthesize all available evidence on IF interventions; rank ADF, 5:2, TRE, and CR for efficacy in reducing VAT and SAT; and thereby provide novel insights into depot-specific fat loss. To our knowledge, this is the first analysis to integrate comparative data across IF modalities for targeted adipose tissue outcomes, and thus aims to contribute to clinical recommendations on the most effective IF modes for VAT reduction.

METHODS

This systematic review and network meta-analysis was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Guideline and the Cochrane Handbook for Systematic Reviews of Interventions. This systematic review was prospectively registered in the International Prospective Register of Systematic Reviews (PROSPERO ID: CRD420251145598).

Search Strategy

A systematic and comprehensive search was conducted in PubMed, Scopus, and Web of Science to identify articles published from inception to July 2025. The search was conducted using 2 groups of key words including (“time-restricted feeding” OR “time restricted feeding” OR “time-restricted eating” OR “time restricted eating” OR “time-restricted diet” OR “time restricted diet” OR “time-restricted fasting” OR “time restricted fasting” OR “intermittent fasting” OR “intermittent energy restriction” OR “alternate fasting” OR “periodic fasting” OR “reduced meal frequency” OR “alternate-day fasting” OR “alternate day fasting” OR “fasting diet” OR “TRF” OR “TRE” OR “ADF” OR “5:2 diet” OR “4:3 diet”) AND (“Subcutaneous fat” OR “visceral fat” OR “subcutaneous adipose tissue” OR “visceral adipose tissue” OR “abdominal fat” OR “abdominal adipose tissue” OR “Intra-Abdominal Fat” OR “visceral adiposity” OR “visceral lipids” OR “VAT” OR “ectopic fat” OR “ectopic adipose tissue” OR “adipose tissue”). Additional details of our search strategy for each database are provided in [Table S1](#). In addition, the reference lists of the included studies, previously published meta-analyses, and citations within eligible articles in Google Scholar were manually screened.

Study Selection and Eligibility Criteria

All retrieved studies from the database searches were imported into EndNote version 21 (Clarivate, Philadelphia, PA, USA) for screening. After removing duplicate records, the titles and abstracts of all remaining studies were screened, and then potentially eligible studies underwent full-text screening against our a priori inclusion and exclusion criteria. The screening process was independently conducted by 2 authors (M.H.S. and F. G.) and any disagreements were resolved by discussion with another author (M.K.). Peer-reviewed and English-language published studies were included in the reviews if they met the following criteria based on the PICOS framework—Population: studies including adults 18 years and older with a BMI of 25 kg/m² or higher, regardless of biological sex and health status; Intervention: studies including any mode of IF including TRE, ADF, modified ADF (mADF), or the 5:2 diet, with intervention durations of 2 weeks or more; Comparator: studies including a control (CON) or continuous CR group; Outcomes: studies reporting measurements of visceral and/or subcutaneous fat content; Study design: randomized controlled or clinical trials. TRE was defined as interventions restricting daily energy intake to a consistent eating window within each 24-hour cycle (typically, 4–12 hours), without prescribed caloric targets, with fasting occurring

during the remaining hours. Studies were classified as TRE when fasting was implemented daily rather than on alternating or weekly restricted days. Only 1 included study used a 4:3 fasting protocol, which was therefore classified under the ADF/mADF group based on its shared fasting-day structure. In addition, no restrictions were applied to the measurement methods used for the outcomes, and therefore, various methods such as bioelectrical impedance analysis (BIA), magnetic resonance imaging (MRI), or computed tomography (CT) were included. Exclusion criteria were as follows: nonoriginal studies, nonrandomized trials, non-English-language studies, non-peer-reviewed studies, studies involving children or adolescents, studies combining IF with exercise training, and duplicate publications from the same study.

Data Extraction and Synthesis

Data were extracted from each study by 2 independent authors (M.H.S. and F.G.). Data extracted included information on the study characteristics including first author name, publication year, and study design; participant characteristics including sample size, biological sex, age, BMI, health status; intervention characteristics including IF modes, durations, and protocols; comparator characteristics including CON or CR, durations, and protocols; and outcomes of interest and measurement methods. Furthermore, to perform statistical analyses, means and SDs of change scores (postintervention minus preintervention values) were extracted or were calculated from pre- and postintervention values using the formula recommended by the Cochrane Handbook. When required, these data were calculated from SEs, medians, and IQRs or 95% CIs,^{34–36} or were extracted from figures using GetData Graph Digitizer software (S. Fedorov, Russia). In addition, the corresponding authors of studies published within the past 5 years were contacted to obtain missing data.

Quality Assessment

The overall quality of included studies was determined using the Physiotherapy Evidence Database (PEDro) risk-of-bias scale, a valid tool for randomized trials,³⁷ and was assessed independently by 2 authors (A.H.M. and M.H.S.), with any disagreements resolved by discussion with a third author (M.K.). This scale consists of 11 items; however, 2 items (blinding of participants and blinding of all therapists who administered therapy) were not included in the overall score, as dietary interventions such as IF cannot be blinded due to the nature of the interventions. Study quality was therefore rated on a scale from 0 to 9,

with higher scores indicating better methodological quality (Table S2).

Statistical Analyses

We used the netmeta package in the statistical software R (version 4.4.1; R Foundation for Statistical Computing, Vienna, Austria) to investigate the effect of the various modes of IF compared with CON and CR on VAT and SAT outcomes. Standardized mean differences (SMDs) and 95% CIs were used to calculate the effect sizes using the mean changes and their SDs, along with sample sizes. The SMDs were selected due to the heterogeneity of measurement units among included studies. Effect sizes were computed using random-effects models due to the methodological heterogeneity among included studies. Forest plots and league tables were generated using direct and indirect comparisons to present effect sizes. In addition, P-scores were calculated to rank the interventions, with higher scores indicating greater likelihood of efficacy. In order to assess heterogeneity, I^2 statistics, tau-squared (τ^2), and Q statistics were calculated. In order to assess the inconsistency assumption, global consistency was evaluated using the assumption of a full design-by-treatment interaction random-effects model, with $P > .05$ indicating nonsignificant inconsistency. In addition, local consistency was evaluated using node-splitting models that compared the results of direct and indirect comparisons, with $P > .05$ indicating nonsignificant inconsistency. Furthermore, in order to assess publication bias, Egger's tests were used, with $P < .05$ indicating significant publication bias. Additionally, 95% prediction intervals (PIs) were calculated for each intervention compared with CON to reflect the expected range of effects in future studies, taking into account between-study heterogeneity. Several subgroup analyses were conducted according to age (younger: < 50 years; older: ≥ 50 years), BMI (without obesity: < 30 kg/m²; with obesity: ≥ 30 kg/m²), intervention durations (short-term: < 6 months; longer-term: ≥ 6 months), and validity of the measurement method (valid including dual-energy X-ray absorptiometry [DXA], MRI, and CT, and less valid including BIA).

RESULTS

Study Characteristics

From 1057 records initially identified, 693 remained after removing duplicates and 119 studies remained after screening the titles and abstracts. Of these, 95 were excluded for the reasons presented in Figure 1, and finally, 24 studies were included in the review and analyses.^{16,20,23,38–58} All included studies were randomized controlled or clinical trials, with a total of 1930 adults, aged 22 to 69 years, with BMIs ranging from 27 to 40 kg/m². All participants had

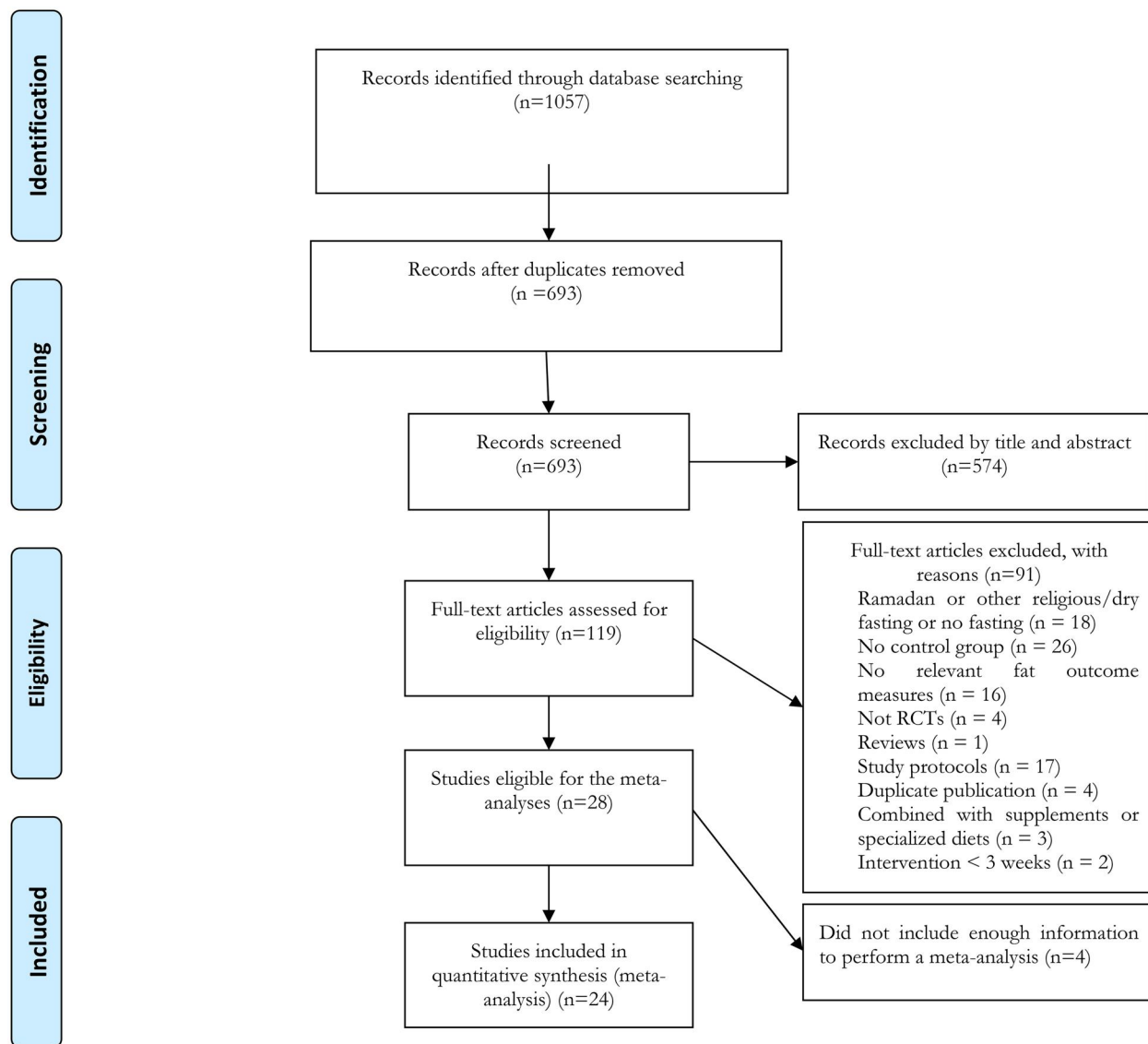


Figure 1. Flow Diagram of the Systematic Literature Search

Abbreviation: RCT, randomized controlled trial. From: Moher D, Liberati A, Tetzlaff J, Altman DG; The PRISMA Group. Preferred Reporting Items for Systematic Reviews and Meta-Analyses: the PRISMA statement. *PLoS Med.* 2009;6(7): e1000097.

overweight or obesity, with health statuses varying from healthy to having chronic diseases such as type 2 diabetes. Intervention durations ranged from 1 to 12 months. Studies included different modes of IF, with TRE, ADF, and the 5:2 diet being the most common approaches. Comprehensive details of the included studies, participants, and intervention characteristics are summarized in [Table 1](#). The overall methodological quality of the included studies ranged from 5 to 9 ([Table S2](#)).

Network Meta-analysis

Visceral Fat. A total of 24 studies, involving 38 pairwise comparisons, 5 treatment arms, and 9 study designs, were

included in the network meta-analysis ([Figure 2](#)). Compared with CON, TRE (SMD: -0.44 ; 95% CI: -0.67 to -0.20 ; $P = .001$) and the 5:2 diet (SMD: -0.54 ; 95% CI: -0.98 to -0.09 ; $P = .01$) led to significantly larger reductions in VAT, while neither ADF (SMD: -0.21 ; 95% CI: -0.75 to 0.31 ; $P = .42$) nor CR (SMD: -0.23 ; 95% CI: -0.49 to 0.03 ; $P = .08$) led to significant changes ([Figure 3](#)). Compared with CR, TRE led to larger decreases in VAT that were borderline statistically significant (SMD: -0.21 ; 95% CI: -0.45 to 0.03 ; $P = .08$) ([Table S3](#)). Based on P-score rankings, the 5:2 diet (0.85) was ranked as having the highest probability of being the most effective intervention, followed by TRE (0.77), ADF (0.41), and CR (0.40) ([Figure 3](#)). Based on

Table 1. Participant and Intervention Characteristics

No.	Source, Year	Participant characteristics				Intervention characteristics				Outcomes	
		Sample size, n (sex)	Health status	Age, y	BMI, kg/m ²	Physical activity level (baseline and during intervention)	IF mode, duration	IF protocol	CON or CR protocol	Measurement method, unit	Change in VAT and SAT from baseline, %
1	Abu Salma et al, 2024 ⁴¹	86 (F)	PCOS	IF: 34.5 ± 7.2 CR: 36.5 ± 11.2	IF: 34.6 ± 5.7 CR: 32.1 ± 5.3	Sedentary (assumed); activity factor 1.2	TRE (18:6), 6 mo	18:6 TRE on nonconsecutive days up to 3 times per week, combined with calorie-restricted diet	CR: calorie-restricted diet	VAT (BIA)	IF: -22.7 CR: -5.8
2	Cai et al, 2022 ⁴⁷	36 (F & M)	Overweight & obesity	IF: 45.30 ± 9.6 CR: 43.2 ± 10.4	24–35	ND	5:2 diet, 3 mo	5 d of habitual eating for feeding days and 2 d energy-restriction diet including 500–600 kcal/d	CR: daily calorie-restricted diet with 30%–50% energy reduction while meeting basic nutritional needs	VAT (BIA)	IF: -3.5 CR: -3.1
3	Carter et al, 2018 ⁴⁰	97 (F & M)	T2D	IF: 61.0 ± 9.0 CR: 61.0 ± 9.2	IF: 37.0 ± 5.8 CR: 37.0 ± 5.7	Exploratory, daily step count measured; no structured exercise intervention	5:2 diet, 12 mo	5 d of habitual eating for feeding days and 2 consecutive days energy-restriction diet including 500–600 kcal/d	CR: continuous energy restriction diet including 1200–1500 kcal/d	VAT (DXA)	IF: -9 CR: -8
4	Chow et al, 2020 ⁵⁵	20 (F & M)	Obesity	IF: 46.5 ± 12.4 CON: 44.2 ± 12.3	IF: 33.8 ± 7.6 CR: 34.4 ± 7.8	Habitual physical activity; unchanged; no structured exercise	TRE (16:8), 12 wk	16:8 TRE (self-selected) with ad libitum intake	CON: maintain habitual dietary pattern	VAT (DXA)	IF: -11.1 CR: 0
5	Cienfuegos et al, 2020 ⁴⁴	49 (F & M)	Obesity	IF ₁ : 49.0 ± 8.0 IF ₂ : 46.0 ± 13.0 CON: 45.0 ± 7.4	IF ₁ : 36.0 ± 4.0 IF ₂ : 37.1 ± 4.3 CON: 36.0 ± 3.7	Habitual physical activity; unchanged; no structured exercise	TRE (IF ₁ , 20:4; IF ₂ , 18:6), 8 wk	20:4 TRE (ad libitum) feeding from 3:00 PM to 7:00 PM with a 20-h fasting window from 7:00 PM to 3:00 PM 18:6 TRE (ad libitum) feeding from 1:00 PM to 7:00 PM with an 18-h fasting window from 7:00 PM to 1:00 PM	CON: maintain habitual physical activity and dietary pattern	VAT (DXA)	IF ₁ : -12.9 CON: -1.8
6	Domaszewski et al, 2023 ³⁸	108 (F & M)	Overweight	IF: 68.9 ± 3.3 CON: 68.8 ± 3.4	IF: 28.2 ± 3.1 CON: 27.5 ± 2.9	Habitual physical activity; unchanged; no structured exercise	TRE (16:8), 6 wk	16:8 TRE (no calorie-containing food or drinks from 8:00 PM to 12:00 PM)	CON: maintain habitual dietary pattern	VAT (BIA)	IF: -7 CON: -3.3

(continued)

Table 1. Continued

No.	Source, year	Participant characteristics				Intervention characteristics				Outcomes	
		Sample size, n (sex)	Health status	Age, y	BMI, kg/m ²	Physical activity level (baseline and during intervention)	IF mode, duration	IF protocol	CON or CR protocol	Measurement method, unit	Change in VAT and SAT from baseline, %
7	Dote-Montero et al, 2025 ⁴⁵	197 (F & M)	Obesity	IF ₁ : 47.2 ± 6.2 IF ₂ : 48.0 ± 6.9 IF ₃ : 45.2 ± 5.8 CON: 46.0 ± 6.0	IF ₁ : 33.8 ± 3.3 IF ₂ : 32.4 ± 3.4 IF ₃ : 32.4 ± 3.3 CON: 33.4 ± 3.7	Habitual physical activity; unchanged; no structured exercise	TRE (16:8), 12 wk	16:8 TRE (ad libitum feeding from 7:00 AM to 3:00 PM combined with MedDiet education) 16:8 TRE (ad libitum feeding from 12:00 PM to 8:00 PM combined with MedDiet education) 16:8 TRE (ad libitum feeding in a self-chosen 8-h window combined with MedDiet)	CON: usual care with MedDiet education	VAT (DXA)	IF ₁ : -8.8 IF ₂ : -10 IF ₃ : -7.5 CON: -4.4
8	Ezpeleta et al, 2023 ³⁹	40 (F & M)	NAFLD	IF: 44.0 ± 16.0 CON: 44.0 ± 12.0	IF: 36.0 ± 8.0 CON: 37.0 ± 5.0	Habitual physical activity maintained; no structured exercise	ADF, 3 mo	Consumed 600 kcal (2500 kJ) as dinner on fast days (between 5:00 and 8:00 PM) and ate ad libitum on alternating feast days	CON: maintained their habitual diet and physical activity patterns throughout the study without any dietary or exercise intervention	VAT (DXA)	IF: -13.1 CON: -1.2
9	Guevara-Cruz et al, 2024 ⁵¹	33 (F & M)	Obesity	IF: 32.5 ± 12.3 CR: 37.2 ± 10.9 CON: 41.0 ± 9.6	IF: 33.7 ± 3.1 CR: 36.6 ± 4.7 CON: 35.6 ± 3.9	ND	TRE (16:8), 1 mo	16:8 TRE (with same macronutrient distribution including 500-kcal energy deficit)	CR: caloric restriction with 500 kcal deficit; macronutrient distribution: 25%–35% protein, 45%–55% carbohydrate, 20%–30% fat CON: maintain habitual dietary pattern	VAT (BIA)	IF: -4.9 CR: -2.6 CON: -1.3
10	Haganes et al, 2022 ⁵⁴	66 (F)	Obesity	IF: 36.2 ± 5.9 CON: 36.4 ± 6.2	IF: 31.8 ± 3.3 CON: 33.1 ± 4.2	Maintain their habitual physical activity; no structured exercise	TRE (14:10), 7 wk	≤10-h self-selected TRE (ad libitum feeding during the eating window with fasting outside the window	CON: maintained their habitual diet and physical activity patterns without intervention	VAT (DXA)	IF: -4 CON: -2.8

(continued)

Table 1. Continued

No.	Source, year	Participant characteristics				Intervention characteristics				Outcomes	
		Sample size, n (sex)	Health status	Age, y	BMI, kg/m ²	Physical activity level (baseline and during intervention)	IF mode, duration	IF protocol	CON or CR protocol	Measurement method, unit	Change in VAT and SAT from baseline, %
11	Hopp et al, 2022 ⁵⁸	24 (F & M)	Autosomal dominant polycystic kidney disease	IF: 46.0 ± 6.0 CR: 47.0 ± 12.0	IF: 34.8 ± 5.1 CR: 34.6 ± 5.1	Maintain habitual physical activity; no structured exercise	ADF, 12 mo	Consumed 20% of their baseline energy needs on fast days (4 d of a habitual diet for feeding days and 3 consecutive days of reduced energy intake)	CR: daily calorie restriction of ~34% of estimated energy requirements	VAT and SAT (MRI)	VAT IF: -10.8 CR: -15.2 SAT IF: -9.3 CR: -7.9
12	Jamshed et al, 2022 ⁴³	90 (F & M)	Obesity	IF: 43.0 ± 10.0 CR: 43.0 ± 11.0	IF: 40.1 ± 6.6 CR: 39.2 ± 6.8	Advised to exercise 75-150 min/wk depending on baseline activity; no between-group differences	TRE (16:8), 14 wk	16:8 TRE (from 7:00 AM to 3:00 PM with energy restriction)	CR: ≥ 12-h eating window with energy restriction	VAT (DXA)	ND
13	Lin et al, 2023 ⁵⁶	77 (F & M)	Obesity	IF: 44.0 ± 12.0 CR: 44.0 ± 9.0 CON: 44.0 ± 13.0	IF: 37.0 ± 6.0 CR: 37.0 ± 5.0 CON: 38.0 ± 5.0	Maintain habitual physical activity; no structured exercise	TRE (16:8), 12 mo	16:8 TRE (ad libitum feeding between 12:00 PM and 8:00 PM with fasting from 8:00 PM to 12:00 PM; no calorie counting; allowed water and energy-free drinks during fasting)	CR: 25% daily calorie restriction with individualized meal plans and calorie counting CON: maintain habitual dietary pattern	VAT (DXA)	IF: -8.7 CR: -7.5 CON: -1.7
14	Lin et al, 2022 ⁴²	63 (F)	Overweight	IF: 50.1 ± 7.5 CR: 54.2 ± 7.9	IF: 25.9 ± 3.7 CR: 25.7 ± 3.8	Light exercise (<60 min/wk of moderate exercise) at baseline; 8 30-min exercise sessions during intervention	TRE (16:8), 8 wk	16:8 TRE (ad libitum feeding from 10:00 AM to 6:00 PM or from 12:00 PM to 8:00 PM, with fasting from 6:00 PM to 10:00 AM or from 8:00 PM to 12:00 PM	CR: traditional weight-loss diet with 3 meals per day, without time restriction	VAT (BIA)	IF: -11.1 CR: -10.3
15	Lindqvist 2023 ⁵²	42 (F & M)	NAFLD	IF: 57.0 ± 10.0 CON: 58.0 ± 7.0	IF: 32.2 ± 2.6 CON: 33.0 ± 5.2	Instructed to maintain habitual physical activity; unchanged during intervention; no between-group differences	5-2 diet, 12 wk	5 d of habitual eating for feeding days and 2 nonconsecutive days of energy-restriction diet including 500-600 kcal/d (ad libitum eating other 5 d; average 1600 kcal/d [women], 1900 kcal/d [men])	CON: standard care with individualized healthy diet advice	VAT and SAT (MRI)	VAT IF: -19 CON: -4.3 SAT IF: -13.1 CON: -4.7

(continued)

Table 1. Continued

No.	Source, year	Participant characteristics				Intervention characteristics				Outcomes	
		Sample size, n (sex)	Health status	Age, y	BMI, kg/m ²	Physical activity level (baseline and during intervention)	IF mode, duration	IF protocol	CON or CR protocol	Measurement method, unit	Change in VAT and SAT from baseline, %
16	Liu et al, 2022 ¹⁶	139 (F & M)	Obesity	IF: 31.6 ± 9.3 CR: 32.2 ± 8.8	IF: 31.8 ± 2.9 CR: 31.1 ± 2.6	Instructed to maintain usual physical activity; similar between groups	TRE (16:8), 12 mo	16:8 TRE including 1200–1800 kcal/d calorie-restricted diet consumed between 8:00 AM and 4:00 PM	CR: calorie-restricted diet including 1200–1800 kcal/d	VAT and SAT (DXA)	VAT IF: -21.2 CR: -16.9 SAT IF: -17 CR: -12.2 VAT IF: -0.4 CON: 1.4 SAT IF: -2 CON: -0.6 IF: -5.4 CR: -4.1 CON: 3.5
17	Lowe et al, 2020 ⁴⁹	46 (F & M)	Obesity	IF: 46.8 ± 10.8 CON: 46.1 ± 10.3	IF: 32.9 ± 4.9 CON: 32.6 ± 3.4	No physical activity intervention prescribed	TRE (16:8), 12 wk	16:8 TRE (ad libitum feeding from 12:00 PM to 8:00 PM with fasting between 8:00 PM and 12:00 PM)	CON: maintain habitual dietary pattern	VAT and SAT (DXA)	VAT IF: -0.4 CON: 1.4 SAT IF: -2 CON: -0.6 IF: -5.4 CR: -4.1 CON: 3.5
18	Oldenburg et al, 2025 ⁵⁷	88 (F & M)	Obesity	IF: 44.0 ± 11.5 CR: 42.2 ± 9.6 CON: 43.4 ± 10.7	IF: 35.8 ± 5.7 CR: 36.5 ± 5.5 CON: 36.4 ± 4.1	Changes in actigraphy-measured physical activity distribution did not differ among interventions	TRE (16:8), 12 wk	16:8 TRE (8-h self-selected eating window, ad libitum feeding)	CR: consume 85% of daily maintenance calories CON: maintain habitual dietary pattern	VAT (DXA)	VAT IF: -8.4 CR: -7.2 CON: -3.2
19	Pavlou et al, 2023 ²³	69 (F & M)	T2D	IF: 56.0 ± 13.0 CR: 55.0 ± 13.0 CON: 54.0 ± 10.0	IF: 39.0 ± 9.0 CR: 38.0 ± 5.0 CON: 39.0 ± 7.0	Physical activity unchanged; participants instructed to maintain usual habits; no between-group differences	TRE (16:8), 6 mo	16:8 TRE (ad libitum feeding from 12:00 PM to 8:00 PM with fasting between 8:00 PM and 12:00 PM)	CR: energy intake reduction by 25% of their baseline energy needs every day CON: maintain habitual dietary pattern	VAT (DXA)	VAT IF: -8.4 CR: -7.2 CON: -3.2
20	Schübel et al, 2018 ⁴⁶	150 (F & M)	Obesity	IF: 49.4 ± 9.0 CR: 50.5 ± 8.0 CON: 50.7 ± 7.1	IF: 32.0 ± 3.8 CR: 31.2 ± 4.0 CON: 31.1 ± 3.6	Advised to maintain habitual physical activity levels throughout the study	5:2 diet, 12 wk	5 d of habitual eating for feeding days and 2 nonconsecutive days with a 75% energy deficit	CR: daily energy deficit of 20% CON: maintain habitual dietary pattern	VAT and SAT (MRI)	VAT IF: -21.3 CR: -16.1 CON: -9.2 SAT IF: -16.3 CR: -11.7 CON: -7.6 ND
21	Teong et al, 2023 ⁵⁰	183 (F & M)	Prediabetes	IF: 57.0 ± 10.0 CR: 58.0 ± 10.0 CON: 59.0 ± 11.0	IF: 34.7 ± 4.6 CR: 35.0 ± 4.6 CON: 33.8 ± 4.9	Instructed to maintain their usual physical activity levels throughout the trial; no between-group differences	TRE (20:4), 6 mo	20:4 TRE (30% energy requirements between 08:00 and 12:00 h followed by a 20-h fasting period on 3 nonconsecutive days per week, and ad libitum eating on other days)	CR: 70% of energy requirements daily CON: maintain habitual dietary pattern	VAT (DXA)	VAT IF: -21.3 CR: -16.1 CON: -9.2 SAT IF: -16.3 CR: -11.7 CON: -7.6 ND

(continued)

Table 1. Continued

No.	Source, year	Participant characteristics				Intervention characteristics				Outcomes	
		Sample size, n (sex)	Health status	Age, y	BMI, kg/m ²	Physical activity level (baseline and during intervention)	IF mode, duration	IF protocol	CON or CR protocol	Measurement method, unit	Change in VAT and SAT from baseline, %
22	Trepanowski et al, 2018 ²⁰	79 (F & M)	Obesity	IF: 46.0 ± 10.0 CR: 44.0 ± 10.8 CON: 44.0 ± 10.0	IF: 34.0 ± 5.0 CR: 35.0 ± 5.4 CON: 34.0 ± 5.0	Participants instructed to maintain usual physical activity; no change during trial	ADF, 24 wk	25% energy lunch on fast days, 125% energy on feast days (weight loss); 50% fast days, 150% feast days (maintenance)	CR: 75% of energy daily (weight loss); 100% of energy daily (maintenance) CON: maintain habitual dietary pattern	VAT and SAT (DXA)	VAT IF: -15.7 CR: -13.0 CON: -9.0 SAT IF: 3.7 CR: 3.9 CON: 2.6
23	Wei et al, 2023 ⁴⁸	88 (F & M)	Obesity & NAFLD	IF: 32.3 ± 10.5 CR: 31.7 ± 8.3	IF: 32.2 ± 3.4 CR: 32.2 ± 3.2	Participants were instructed not to change their physical activity habits throughout the trial; similar between groups	TRE (16:8), 12 mo	16:8 TRE (eating between 8:00 AM and 4:00 PM, including 1500 to 1800 kcal/d for men and 1200 to 1500 kcal/d for women)	CR: habitual meal timing, with 1500 to 1800 kcal/d for men and 1200 to 1500 kcal/d for women CON: maintain habitual physical activity pattern	VAT and SAT (DXA)	VAT IF: -28.1 CR: -23.3 SAT IF: -18.4 CR: -15.8
24	Zhang et al, 2022 ⁵³	60 (F & M)	Overweight	IF ₁ : 23.8 ± 0.6 IF ₂ : 23.2 ± 0.5 CON: 22.1 ± 0.4	IF ₁ : 27.1 ± 0.7 IF ₂ : 28.5 ± 0.8 CON: 27.8 ± 0.8	Maintain habitual physical activity; no between-group differences	TRE (18:6), 8 wk	18:6 TRE (ad libitum feeding from 7:00 AM to 1:00 PM with fasting between 1:00 PM and 7:00 AM) 18:6 TRE (ad libitum feeding from 12:00 PM to 6:00 PM with fasting between 6:00 PM and 12:00 PM)	CON: maintain habitual physical activity and dietary pattern CON: maintain habitual physical activity and dietary pattern	VAT (BIA)	IF ₁ : -11 CON: -2.7

Abbreviations: ADF, alternate-day fasting; BIA, bioelectrical impedance analysis; BMI, body mass index; CON, control; CR, calorie restriction; CT, computed tomography; DXA, dual-energy X-ray absorptiometry; F, female; IF, intermittent fasting; M, male; MedDiet, Mediterranean diet; MRI, magnetic resonance imaging; NAFLD, nonalcoholic fatty liver disease; ND, not defined; PCOS, polycystic ovarian syndrome; SAT, subcutaneous adipose tissue; T2D, type 2 diabetes; TRE, time-restricted eating; VAT, visceral adipose tissue.

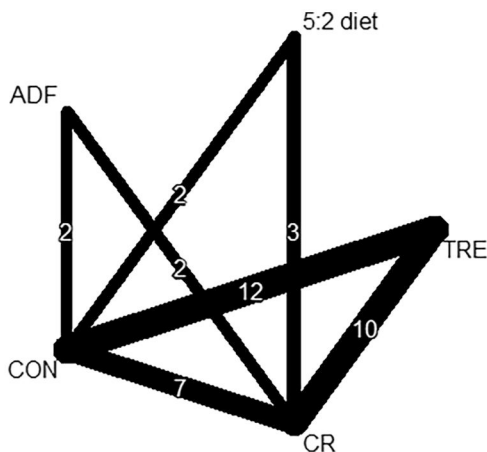


Figure 2. Network Geometric Map of Studies Investigating the Effect of IF Modes on Visceral Fat. Numbers on the connecting lines indicate the number of available comparisons between studies for each treatment contrast.

Abbreviations: ADF, alternate-day fasting; CON, control; CR, caloric restriction; IF, intermittent fasting; TRE, time-restricted eating; 5:2 diet, 2 restricted days per week.

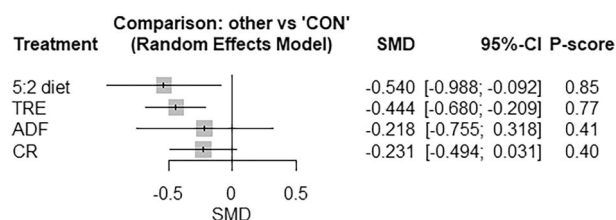


Figure 3. Forest Plot of the Network Meta-analyses on Visceral Fat

Data are reported as SMDs (95% confidence limits). Abbreviations: ADF, alternate-day fasting; CON, control; CR, caloric restriction; SMD, standardized mean difference; TRE, time-restricted eating; 5:2 diet, 2 restricted days per week.

heterogeneity assessment, there was moderate heterogeneity among the included studies ($\tau^2 = 0.1255$; $\tau = 0.3543$; $I^2 = 66.6\%$ [95% CI: 50.4%; 77.5%]). Neither the global (full design-by-treatment interaction random-effects model) ($Q = 7.79$, $df = 7$, $P = .45$) (Table S4) nor the local (node-splitting) method detected significant inconsistency (Table S5). Based on Egger's test results, there was no significant publication bias ($P = .21$) (Figure S1). In addition, the 95% PIs were wide, ranging from -1.17 to 0.28 for TRE, -1.36 to 0.28 for the 5:2 diet, -1.09 to 0.65 for ADF, and -0.97 to 0.51 for CR.

Subcutaneous Fat. A total of 8 studies, involving 12 pairwise comparisons, 5 treatment arms, and 6 study designs, were included in the network meta-analysis (Figure 4). The 5:2 diet (SMD: -0.45 ; 95% CI: -0.82 to -0.08 ;

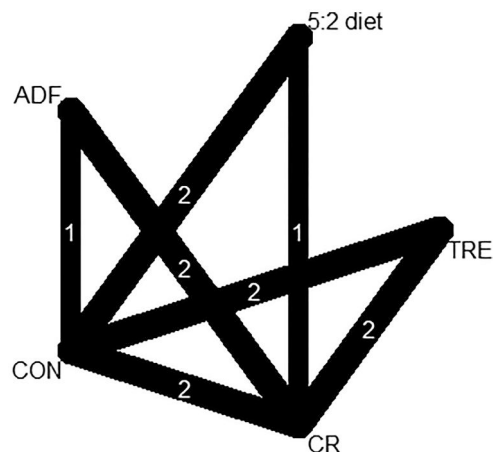


Figure 4. Network Geometric Map of Studies Investigating the Effect of IF Modes on Subcutaneous Fat

Abbreviations: ADF, alternate-day fasting; CON, control; CR, caloric restriction; IF, intermittent fasting; TRE, time-restricted eating; 5:2 diet, 2 restricted days per week.

$P = .01$) and TRE (SMD: -0.37 ; 95% CI: -0.65 to -0.09 ; $P = .008$) reduced SAT significantly more than CON, a response not found with ADF (SMD: -0.05 ; 95% CI: -0.53 to 0.43 ; $P = .84$) or CR (SMD: -0.26 ; 95% CI: -0.54 to 0.02 ; $P = .06$) (Figure 5). Compared with CR, none of the IF interventions had larger effects (Table S6). Based on P-score rankings, the 5:2 diet (0.85) had the highest probability of being the most effective intervention, followed by TRE (0.76), CR (0.54), and ADF (0.24) (Figure 5). Heterogeneity was low between studies ($\tau^2 = 0.0167$; $\tau = 0.1292$; $I^2 = 23.1\%$ [95% CI: 0.0%; 65.9%]). Neither global (full design-by-treatment interaction random-effects model) ($Q = 6.59$, $df = 4$, $P = .15$) (Table S4) nor local (node-splitting) methods detected any significant inconsistencies (Table S7). Based on Egger's test results, there was no significant publication bias ($P = .38$) (Figure S2).

Subgroup Analyses

Visceral Fat. The network geometry from the subgroup analyses indicated that, compared with CON, TRE led to larger reductions in VAT in both younger (SMD: -0.42 ; $P = .007$) and older (SMD: -0.38 ; $P = .04$) adults, in individuals with obesity (SMD: -0.38 ; $P = .003$), in those with both short-term (SMD: -0.36 ; $P = .004$) and longer-term (SMD: -0.58 ; $P = .03$) interventions, and with valid measurement methods (SMD: -0.32 ; $P = .001$). The 5:2 diet led to larger reductions in VAT in older adults (SMD: -0.62 ; $P = .004$), in individuals with obesity (SMD: -0.53 ; $P = .03$), in those with short-term interventions (SMD: -0.64 ; $P = .006$), and with valid measurement methods (SMD: -0.44 ; $P = .001$).

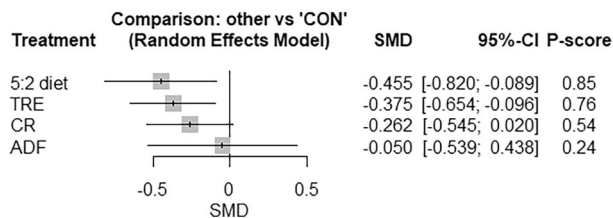


Figure 5. Forest Plot of the Network Meta-analyses on Subcutaneous Fat

Data are reported as SMD (95% confidence limits). Abbreviations: ADF, alternate-day fasting; CON, control; CR, caloric restriction; SMD, standardized mean difference; TRE, time-restricted eating; 5:2 diet, 2 restricted days per week.

Compared with CON, CR led to significantly larger reductions in VAT in older adults (SMD: -0.40 ; $P = .02$) and with valid measurement methods (SMD: -0.26 ; $P = .001$). Subgroup analyses could not be conducted for SAT due to the small number of studies available.

DISCUSSION

In the current systematic review and network meta-analysis, results indicated that IF markedly affects adipose tissue depots, but the magnitude of these effects varies by fasting protocol. Compared with CON, the 5:2 diet and TRE produced significantly larger reductions in VAT, whereas ADF and daily CR showed smaller, nonsignificant effects. The P-score rankings confirmed that the 5:2 diet followed by TRE were the probable most effective modalities for VAT reduction. For SAT, the 5:2 diet and TRE led to significantly larger decreases when compared with CON, a response not found with ADF and CR. Heterogeneity was moderate for the VAT analysis but low for SAT, and we found no evidence of inconsistency or publication bias.

Our results are mainly in agreement with prior observations. Across meta-analyses, IF and CR have produced comparable reductions in body weight, fat mass, and VAT.³¹ Importantly, our network meta-analysis distinguishes between the efficacy of each regimen, emphasizing the superiority of the 5:2 diet and TRE in promoting reductions in VAT.⁵⁹ Although the 5:2 diet and TRE ranked highest for both VAT and SAT according to P-scores, these rankings should be interpreted with caution due to moderate heterogeneity and the inherent limitations of relative ranking metrics. In agreement with the current results, Bahadoran et al⁵⁹ noted that TRE trials achieved 11%–27% VAT loss in adults with overweight and obesity and improvements in adipose tissue health. Furthermore, our finding that ADF did not outperform CR for reducing VAT is consistent with other long-term

trials.²⁰ This finding challenges earlier suggestions that ADF would uniquely mobilize VAT more strongly.²⁰ Mechanistically, the intense energy deficits achieved when adhering to ADF should trigger a potent lipolytic response in visceral adipocytes,⁶⁰ but our analysis suggests this theoretical advantage may not translate into substantially greater VAT loss.

Our results were mixed for SAT, with the 5:2 diet and TRE showing evidence for reducing SAT more than CON but not compared with CR, although data on depot-specific effects remain limited. Because only a small number of studies contributed to the SAT analysis ($n = 8$), these findings should be considered preliminary and interpreted with caution. The apparent larger reduction in SAT observed with the 5:2 diet and TRE, as compared with CON, may reflect a potential benefit of more calorie-intensive IF regimens, although the limited number of studies reduces confidence in this estimate. This pattern may reflect differences in adherence, total weight loss, and energy deficits among protocols. However, the smaller number of trials assessing SAT compared with VAT likely reduced statistical power for this outcome, and thus these findings should be interpreted cautiously. Future studies with balanced imaging data for both fat depots are needed to clarify whether the apparent differences between VAT and SAT responses represent true physiological effects or simply differences in sample size and study coverage. In practice, IF regimens often lead to reductions in WC and truncal fat in participants with overweight.^{61,62} For instance, WC has been shown to decrease by 3 to 8 cm in IF studies longer than 4 weeks, a magnitude that is comparable to that achieved with CR and slightly greater than reductions commonly observed with exercise-only interventions.^{63,64} However, because most included trials were short-term (≤ 12 weeks), the durability of visceral fat reduction and long-term adherence to IF remain uncertain. Our findings also suggest that subcutaneous fat may be less responsive to IF modalities unless energy restriction is substantial. Our network meta-analysis indicates that both IF and CR reduce adiposity, while the 5:2 diet and TRE are more effective for lowering VAT, with daily CR alone having the lowest probability of being effective for reducing VAT compared with IF modalities.

We also explored whether the effects of the intervention varied by participant or study characteristics and observed a moderating effect of age that may reflect baseline adipose depot differences (older individuals with obesity have higher visceral stores) or behavioral factors (eg, adherence). These observations should, however, be interpreted cautiously, as the number of studies in each stratum was limited and subgroup tests can be underpowered for determining true effects.

Intermittent fasting may promote the loss of VAT through several interrelated pathways, including endocrine responses to fasting, such as reduced insulin and elevated counterregulatory hormones, including glucagon, catecholamines, and cortisol that shift metabolism from glucose toward fatty acid and ketone utilization.^{15,65} The following mechanisms are proposed explanations based on prior experimental and clinical literature and should be considered as hypotheses rather than direct evidence derived from the present meta-analysis. Visceral adipocytes may have high lipolytic activity and are particularly sensitive to fasting-induced, counterregulatory hormone surges, which can accelerate VAT mobilization.^{20,65} Notably, even modest energy deficits tend to preferentially deplete abdominal/visceral fat,⁶⁵ and by limiting energy intake to the active phase of the day, TRE aligns nutrient availability with clock-regulated metabolic processes in adipose tissue and other peripheral organs.⁶⁶ This circadian alignment may improve the timing and amplitude of hormonal signals (eg, insulin and leptin)⁶⁶ and enhance lipolytic and lipid-cycling pathways in adipocytes, accelerating adipose tissue turnover and favorable remodeling.^{67–69} Clinical and preclinical studies report that IF regimens may reduce adipocyte hypertrophy and attenuate adipose tissue inflammation across both VAT and SAT, thus improving metabolic function.^{59,70,71} In addition to changes in fat mass, IF may influence adipose tissue function through modulation of adipocytokines. Adipose tissue acts as an endocrine organ that secretes signaling molecules such as adiponectin, leptin, resistin, and proinflammatory cytokines (eg, tumor necrosis factor- α [TNF- α] and interleukin-6 [IL-6]), which regulate insulin sensitivity, lipid metabolism, and systemic inflammation.⁷² Intermittent fasting interventions have been associated with increased adiponectin concentrations and reduced leptin and inflammatory cytokines, reflecting improved adipocyte metabolic activity and reduced adipose tissue inflammation.⁷³ These endocrine adaptations may contribute to improved insulin sensitivity and metabolic regulation beyond the magnitude of fat loss itself and have also been reported in clinical populations characterized by adipose dysfunction, such as women with polycystic ovary syndrome.⁷⁴ Collectively, these findings suggest that IF-induced improvements in metabolic health may partly arise from qualitative changes in adipose tissue signaling in addition to reductions in adipose mass. Mechanistically, fasting and IF regimens may activate cellular energy sensors (notably, AMP-activated protein kinase [AMPK] and sirtuins [SIRT1/SIRT3]), as well as mitochondrial action through peroxisome proliferator-activated receptor γ coactivator-1 α (PGC-1 α), and stimulate autophagy while reducing proinflammatory signaling in adipocytes, processes that together reduce adipocyte hypertrophy and

local inflammation across depots.^{75,76} Intermittent fasting may also influence metabolic responses through alterations in gut microbiota composition and microbial metabolites, although such outcomes were not consistently reported across the included trials and were therefore beyond the scope of the present analysis.⁷⁷ Overall, IF may elicit depot-specific metabolic adaptations that favor VAT catabolism and improved adipose tissue health.^{15,59}

A critical caveat to our study findings is that many included trials did not match total energy restriction across study arms, with IF often resulting in a larger net energy deficit and/or better short-term adherence than comparator arms. In addition, the magnitude and timing of energy restriction varied considerably across studies. Absolute caloric deficit and cumulative weight loss determine regional fat loss, which means that depot-specific differences may reflect differential energy deficits, follow-up durations, or adherence rather than intrinsic biological effects of fasting.⁷⁸ It should be noted that several included trials did not match total energy intake between intervention and comparator arms, and therefore observed differences in VAT and SAT reductions may partly reflect variations in caloric deficit rather than the intrinsic effects of the fasting regimen. Adherence assessment also differed across fasting modalities. Most studies evaluated adherence using self-reported dietary records, fasting logs, or compliance with prescribed eating windows, while some incorporated attendance records or digital monitoring of eating periods. Time-restricted eating protocols generally required participants to maintain a daily eating window, which may support more consistent routine-based adherence, whereas ADF and 5:2 regimens required intermittent large energy-restriction days that may be more difficult to sustain over time. Consequently, apparent differences in fat loss between fasting protocols may partially reflect differences in sustained behavioral compliance rather than solely physiological effects. Future trials should report standardized adherence metrics and examine whether depot-specific fat loss persists after accounting for adherence levels. Comparisons that do not control for net caloric intake are susceptible to confounding factors, and another potential source of variability is physical activity. Most included trials did not strictly control or objectively monitor habitual activity levels, and changes in daily movement or structured exercise could independently influence visceral and subcutaneous fat loss. Because energy expenditure contributes to net energy balance, differences in physical activity between or within study arms may partly explain variations in adipose tissue reduction attributed to dietary interventions. Future trials should incorporate standardized monitoring of physical activity to better isolate fasting-specific effects. In

addition, we reported PIs (%) to illustrate the expected range of effects in future studies and to account for between-study heterogeneity, providing a more clinically relevant interpretation of the results. Meta-regression or stratified analyses that adjust for measured energy deficit, weight change, and study duration are therefore essential to distinguish regimen-specific from calorie-driven and weight-loss effects. We therefore recommend interpreting apparent regimen advantages with caution and treating them as hypothesis-generating until confirmed by trials that directly match energy deficit or include prespecified caloric equivalence in study groups. In addition, subgroup analyses based on measurement method validity (BIA vs gold-standard methods) demonstrated consistent reductions in VAT and SAT across measurement methods. This suggests that the observed effects are unlikely to be explained by measurement inaccuracies and supports the robustness of our findings despite heterogeneity in adiposity assessment techniques.

Strengths and Limitations

In the current systematic review and network meta-analysis, we conducted a comprehensive literature search and applied network meta-analysis to compare multiple fasting modes simultaneously, using SMDs to integrate heterogeneous measures of VAT and SAT. We found no significant inconsistency, and small-study bias was not evident. Nonetheless, there are some limitations that require consideration. Many included trials were of relatively short duration (often ≤ 12 weeks). This factor likely contributed to the moderate heterogeneity observed for VAT outcomes. Moreover, study quality varied, and although we only included randomized trials, several had incomplete blinding or high attrition, which may bias the estimates of depot-specific adipose tissue loss. Our analysis focused on adults with overweight or obesity, so applicability to normal-weight or very-high-risk patients is uncertain. Sex-specific effects could not be examined because most included trials reported pooled results without sex-disaggregated outcomes, limiting interpretation of potential differences in fasting responses between men and women. Also, the relatively small number of studies for SAT (and for certain IF modes) means that these results, in particular, should be interpreted with caution. Finally, network meta-analysis assumes that indirect comparisons are valid, which seems plausible here, although unmeasured differences in some study protocols, such as total caloric deficit targets and physical activity energy expenditure, could bias the relative rankings. Additionally, PIs were wider than the corresponding CIs and, in some cases, included the null value, indicating variability in effect magnitudes across studies and

suggesting that treatment benefits may differ across populations and settings.

Future Research Directions

Future trials are needed to confirm our findings, with longer-term randomized controlled trials (>6 – 12 months) to assess sustainability and magnitude of VAT reduction and to evaluate IF protocol adherence and weight regain, as short-term studies may misclassify depot changes. Studies should also use precise imaging (MRI/CT) for fat quantification and distribution to avoid reliance on proxies such as WC. Although the network analyses provide comparative estimates, definitive confirmation of the rankings of IF modes requires randomized trials that directly compare specific regimens. More mechanistic research is needed to incorporate biomarkers and multi-omics, such as measuring free fatty acids, adipokines, and gut microbiome changes that could elucidate how fasting modulates metabolism. Advanced methods such as frequent serial imaging and metabolomics could reveal molecular pathways linking fasting to reductions in VAT. Examining interactions with exercise or dietary composition (eg, protein intake) is also important. Finally, stratified studies are needed to determine whether certain populations (eg, individuals with metabolic syndrome, older adults, or women vs men) derive greater benefits from specific IF modes.

CONCLUSION

In adults with overweight or obesity, the 5:2 diet and TRE can effectively reduce VAT and SAT when compared with CON. In comparison, ADF and CR were not more effective than CON for reducing either fat depot. These findings have potential clinical implications, since reducing visceral fat is critical to lowering cardiometabolic risk.⁷⁹ However, given the variability across studies, these findings should not be interpreted as showing definitive superiority of a single protocol. Instead, some regimens of IF may be considered as an alternative to CR within a broader lifestyle approach, with regimen selection guided primarily by feasibility and long-term adherence to achieve meaningful reductions in visceral fat and cardiometabolic risk.

Author Contributions. M.K., M.E.S., S.K.R., H.Ra., and G.M.T. conceptualized and designed the protocol. M.K., M.H.S., A.H.M., F.G., and H.Ro. carried out the screenings and reviews and the analysis of the articles. M.K., K.O., and H.Ra. drafted the manuscript, and M.E.S., S.K.R., and G.M.T. revised the manuscript. All authors read and approved the final manuscript.

Supplementary Material

Supplementary Material is available at *Nutrition Reviews* online.

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Conflicts of Interest

G.M.T. is an inventor on the international patent “Compositions and methods of use of beta-hydroxy beta-methylbutyrate (HMB) associated with intermittent fasting.” The other authors declare no conflicts of interest.

Data Availability

All data generated or analyzed for this study are contained within this published article or are available from the corresponding author upon reasonable request.

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