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Review

Time-restricted eating increases hunger in adults with overweight and obesity: A systematic review and meta-analysis of randomized controlled studies

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ABSTRACT

Time-Restricted Eating (TRE) is an intermittent fasting approach that holds promise in managing obesity and appears to influence hunger. We hypothesized that the effects of TRE would be due to a lower caloric intake imposed, as with any other type of dietary intervention. However, it remains unclear whether these effects are attributed to the chrononutrition protocol itself or the caloric restriction resulting from the intervention. Our primary aim was to examine the impact of TRE on hunger compared to isocaloric strategies in adults with overweight or obesity. We conducted a systematic review of randomized clinical trials, with inclusion criteria comprising adults aged 18 years and older with overweight/obesity. A literature search was conducted from the earliest available article up to January 2025, with no restrictions on time, region, or language. The search encompassed major electronic databases, including CENTRAL, MEDLINE, LILACS, EMBASE, Google Scholar, and OpenGrey. Of the 14 studies included, four met the eligibility criteria for the primary meta-analysis, which evaluated hunger in 323 participants. The findings revealed that TRE resulted in an increase in hunger (MD 2.05, 95% CI 1.46, 2.64; $I^2 = 0\%$) compared to the isocaloric control group. In conclusion, the TRE protocol was associated with elevated hunger compared to isocaloric strategies, which may warrant further investigation into its long-term feasibility in weight loss programs.

Abbreviations: ADF, alternate day fasting; CI, confidence interval; CR, caloric restriction; eTRE, early time-restricted eating; GRADE, grading recommendation assessment, development and evaluation; HDL-C, high-density lipoproteins cholesterol; HOMA-IR, homeostasis model assessment-estimated insulin resistance; IF, intermittent fasting; LDL-C, low-density lipoproteins cholesterol; PRISMA, preferred reporting items for systematic reviews and meta-analyses; PSQI, Pittsburgh sleep quality index; RCTs, randomized clinical trials; TFEQ, three-factor eating questionnaire; TRE, time-restricted eating; TRF, time-restricted feeding; VAS, visual analogue scale.

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1. Introduction

Obesity stands as the most significant global public health challenge [1]. According to the World Health Organization [2], over 1 billion individuals worldwide are affected by obesity, including 650 million adults, 340 million adolescents, and 39 million children. Projections indicate that approximately 167 million adults and children will be affected by excess weight by 2025 [3–5]. Among the various strategies aimed at managing obesity, intermittent fasting, a dietary approach that involves restricting the eating window to 4 to 10 hours and fasting for 14 to 20 hours a day has gained attention [6–9]. In this method, calorie counting is not required during the eating window, but individuals are encouraged to consume water and calorie-free beverages during the fasting period [10].

Time-Restricted Feeding (TRF) and Time-Restricted Eating (TRE) are specific forms of intermittent fasting showing promise in managing obesity in animal and human studies, respectively [11]. TRE involves limiting daily caloric intake to a defined time window, typically ranging from 4 to 12 hours, with fasting periods lasting between 12 and 20 hours [7]. The duration of the eating window in TRE protocols varies, but common regimens include 12/12-hour, 10/14-hour, 8/16-hour, 6/18-hour, and 4/20-hour cycles, where the first number represents the eating window and the second represents the fasting duration [6,8]. These fasting periods differentiate TRE from conventional calorie restriction (CR) by structuring energy intake within a specific time frame, rather than focusing on overall calorie reduction [9,10]. The rationale behind the benefits of TRE lies in the intricate interplay between circadian rhythms, nutrition, and energy metabolism, suggesting that improvements in body composition and obesity-related conditions can occur without necessarily restricting overall calorie intake [6,12]. However, there are substantial gaps in understanding whether these benefits arise due to the involuntary caloric restriction from the shortened eating window, improvements in metabolic function linked to circadian rhythms, or a combination of both. One major limitation in the current literature is the lack of energy intake assessments in most randomized clinical trials (RCT) investigating TRE [9,13–16].

Despite being a promising chrononutrition strategy, studies exploring the effectiveness of TRE during weight loss interventions have yielded divergent results and have also investigated potential adverse effects [13,14,17], including its impact on subjective perceptions related to food intake [16,18–20]. Several studies [20–32] have raised questions about whether adherence to TRE might be influenced by subjective perceptions such as hunger, stress, mood swings, fatigue, depression, fullness, satiety, and satisfaction, factors that could either hinder or facilitate the implementation of the TRE protocol. Tacad, Tovar [33] demonstrated the physiological mechanisms involved in hunger and satiety hormones in response to caloric restriction (CR) and TRE during fasting, revealing a decrease in ghrelin while orexin remains unchanged, suggesting a reduction in hunger and satiety signals during the fasting period of TRE. However, there are still substantial gaps and contradictions concerning the potential effects of TRE on subjective perceptions related to food intake.

To comprehensively understand the effects of TRE as a chrononutrition strategy on subjective dietary perceptions and metabolic responses in adults with obesity or overweight, it is crucial to compare this protocol with other dietary strategies that provide equivalent energy intake. This comparative approach allows the differentiation of TRE effects from those of conventional CR. Our hypothesis is that TRE increases hunger due to the prolonged fasting period compared to the isocaloric control group. Therefore, our primary objective was to conduct a systematic review of RCT to examine the effects of TRE, compared to other isocaloric dietary strategies, on hunger and other subjective perceptions related to food intake in adults with obesity or overweight. Additionally, we assessed the effects of TRE on body weight and modifications in metabolic parameters (lipid and glucose profile, changes in body composition, percentage of body fat, and percentage of lean mass) as secondary outcomes.

2. Methods and materials

This systematic review was registered in the PROSPERO database under the registration number CRD 42021279863. The review was reported following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) [34] guidelines and followed the recommendations outlined in the Cochrane Handbook for Systematic Reviews of Interventions [35].

2.1. *Literature search*

A systematic literature search was conducted from the earliest available article up to January 2025 with no restrictions on time, region, or language. The search encompassed the main available electronic databases, including CENTRAL (via Cochrane Library), MEDLINE (via PubMed), LILACS (via Virtual Health Library—VHL), and EMBASE (via Elsevier). Additionally, studies registered in gray literature were sought using OpenGrey (http:/www.opengrey.eu) and Google Scholar. We also manually searched the reference lists of the included studies without limitations on date or status (abstracts, full text, or ongoing studies). The search terms comprised a combination of relevant keywords, such as “Overweight’’[Mesh]; “Obesity’’[Mesh]; “Obesity, Morbid’’[Mesh]; “Obesity Management’’[Mesh]; “Fasting’’[Mesh]; Circadian Rhythm“[Mesh”]; Weight Loss"[Mesh]; “Body Fat Distribution”[Mesh]; “Hunger’’[Mesh]; “Appetite"[Mesh]; “Appetite Regulation’’[Mesh]; “Fatigue’’[Mesh]; “adverse effects’’ [Subheading]. The complete search strategy is available in Supplement 1.

2.2. *Inclusion and exclusion criteria*

The present study employed the PICO strategy (Population; Intervention; Comparison/Control; Outcome) to establish the search strategy and selection criteria (Table 1). Inclusion criteria for this review were adult participants aged 18 years and older, with overweight or obesity defined as BMI $\geq$25 kg/m^2 and BMI $\geq$ 30 kg/m^2, respectively. Studies had to evaluated at least one association between subjective perceptions

Table 1 – Description of the PICO acronym and study designs utilized in this systematic review

Population	Adults with obesity or overweight, aging more than 18 years old.
Intervention	Fasting (time-restricted eating/feeding) for any time.
Comparison/control	Other isocaloric dietary strategies at any time.
Outcome	Subjective perceptions included hunger, satiety, appetite, fatigue, irritability, binge eating, mood changes, headache, gastrointestinal symptoms, constipation, nausea, or changes in sleep pattern.
Secondary outcome	Body weight, fat percentage, lean body mass; glycemic alterations; lipid profile.
Study design	Randomized clinical trials.

(such as hunger, satiety, fatigue, irritability, appetite, binge eating, mood swings, headache, and gastrointestinal symptoms) and intermittent fasting, TRE or TRF in comparison to other isocaloric dietary strategies among individuals. The energy intake between the control and experimental groups had to be isocaloric, either as part of the predesigned experimental strategy or as an outcome that emerged after the study, even though it was not initially planned. The main reviewer requested missing or incomplete data from the authors of the studies via email. Only RCTs were included in this review, excluding studies with animals and participants with diseases that could affect the outcome.

2.3. Data extraction and quality assessment

The screening process for the studies was performed using the Rayyan software [36] according to predefined inclusion and exclusion criteria. Two authors (A.D.S and K.C.G) independently and blindly conducted the screening process. While reading the full texts, the authors (A.D.S. and K.C.G.) strictly followed the inclusion criteria. In cases of disagreement, a third author (C.A.C) was consulted to resolve the disagreements in both processes.

Relevant data from each included study were extracted according to the adapted Data Collection Form—Cochrane [35] model by the researchers (A.D.S and K.C.G.) and tabulated as described in Table 2 : study authorship, country of origin, study design, study population, and type of study. We use the Recommendation Assessment, Development and Evaluation (GRADE pro GDT) [37] methodology to assess the overall certainty of the evidence. This approach considers study design, risk of bias, inconsistency, indirectness, imprecision, effect estimate precision, and the possibility of publication bias. The overall certainty of the evidence ranged from “high,” indicating a high degree of certainty that the estimated effect reflects the truth, to “very low," indicating substantial uncertainty about the estimated effect. We also evaluated intervention type, comparator/control, follow-up period, and primary outcomes.

2.4. Risk of bias (quality) assessment

The Cochrane Risk of Bias Tool [35] for RCTs was used to evaluate the risk of bias in each included study. The risk of bias instrument assessed selection bias, performance bias, detection bias, attrition bias, reporting bias, and other biases that do not fall into these categories.

The following domains were assessed: random sequence generation, allocation concealment, blinding of participants and personnel, blinding of outcome assessment, incomplete outcome data, selective reporting, and other biases. A single criterion was assigned for each domain: low risk, uncertain risk, or high risk, as independently judged by the authors (A.D.S and K.C.G). Disagreements were resolved by the third author (C.A.C).

2.5. Data synthesis

Meta-analysis was conducted using Review Manager [38] for outcomes observed in included studies. Data on variables of interest were reported as means and standard deviations. Studies that reported the intervention, comparison/control, and outcome of interest were included in the meta-analysis, incorporating mean differences and standard errors, along with a 95% confidence interval (CI) for continuous outcomes. Heterogeneity was considered significant when $I^2 > 50\%$. We used the random-effects model, considering that the included studies have some differences in methodology and populations.

3. Results

A total of 15,860 studies were retrieved from all databases (Fig. 1), after removing duplicates ($n = 1299$), 14,561 remained. These 14,561 articles were eligible for title and abstract reading, leading to 133 being eligible for full-text reading. However, 119 studies were excluded as they were not related to the research question or did not meet the inclusion criteria. Exclusion reasons were as follows: 23 studies were not randomized; 17 performed different interventions; 38 did not use an isocaloric strategy in the comparator group; two studies were previously included in another article; six studies were preprints; two studies were protocol studies; three studies were included the same participants as another included study; nine studies had a different population of interest; and 19 did not assess the primary outcome (subjective perceptions). Thus, 14 studies [17,20,22–27,29–32,39,40] were carefully selected and included. The meta-analysis regarding hunger included four specific studies [22,23,27,30]. Ten studies [20,24–26,28,29,31,32,39,41] evaluated other subjective perceptions such as fullness, satisfaction/satiety, sleep quality, but due to the limited number of studies for each outcome, the analyses were not shown in a forest plot. The secondary outcomes (body weight, body fat percentage, glucose and lipid profiles)

Table 2 – Summary of randomized clinical trials that evaluated time-restricted eating vs isocaloric diets (intervention) on subjective food perceptions (outcome)

Author, country, study design	Population	Intervention and comparator (follow-up time)	Outcomes/research tools
CAI et al. [35] CHINA RCT	Adults with DHGNA Age: 18-65 years N 271 (ADF *n* 95; TRF *n* 97; Control group *n* 79) BMI > 24 kg/m^2	TRF subjects were provided with meals within an 8-h window and asked to refrain from consumption of all food or beverages that included energy for the remaining 16 h. Control group: consumed 80% of their energy needs every day without any recommendations for or restrictions on their usual lifestyle patterns. (12 wk). NI	Hunger - Fullness Satisfaction (Analogic visual scale)
COUTINHO, et al. [36] NORWAY RCT	Adults with obesity Age: 18-65 years N 35 (IER *n* 18; CER *n* 17) BMI: 30-40 kg/m^2	IER: underwent 3 nonconsecutive days of partial fasting per week. During 3 d, participants followed VLCD: 550 and 660 kcal/day for women and men, respectively). CER: followed a low-calorie diet (LCD) using conventional food every day. In both groups, the participants were encouraged to consume at least 2.5 L of noncaloric liquids/day. (13 wks)7 NI	Subjective feelings of appetite (Analogic visual scale)
DOTE-MONTERO et al. [37] SPAIN RCT	Adults with overweigh/obesity N 22 BMI: NI	e-TRE: eating window was 7.9 ± 0.5 h. First meal within the first 2 h after waking up. late-TRE: The mean intervention eating window was 7.1 ± 0.5 h. First meal 5-7 h after waking up TRE: self-selected time (04 wks) NI	Depression, headache, nausea, acidity, diarrhea, thirstiness, hunger, cravings, tiredness, stress, irritability, anxiety eating. (Validated Questionnaires)
FAGUNDES et al. [38] BRAZIL RCT	Adults with overweigh/obesity Age: 18 to 59 y N 36 (TRE: 24; NE: 12) BMI: >25 kg/m^2	TRE: 8-h eating window and 16 h of fasting every day. One subgroup consumed their first meal at 08:00 h and last meal at 16:00 h, and the other subgroup consumed their first meal at 12:00 h and last meal at 20:00 h Control Group: no time restriction (8 wks) NI	Depression Anxiety Stress (Validated Questionnaires)
HANICK et al. [39] USA RCT	Adults with obesity Age: 25-75 years N 90 BMI: 30-60 kg/m^2	TRE (8 h eating window: 7am-3pm) Control Group: ≥ 12 h eating window (14 wks) NI	Appetite Eating behaviors (Validated Questionnaires)
IRANI *et.al.* [41] IRAN RCT	Adults with overweigh/obesity N 57 BMI: >25 kg/m2	TRF subjects consumed all meals within an 8-hour window and were instructed to abstain from any food or energy-containing beverages for the remaining 16 h. Control group: Participants consumed 80% of their daily energy needs without any specific recommendations or restrictions regarding their usual lifestyle patterns. (8 wks). NI	Hunger: TFEQ-r18 Stress Emotional eating (Validated Questionnaires)
JAMSHED, STEGER, BRYAN, et al. [18] USA RCT	Adults with obesity Age: 25-75 years N 90 (Control+ER: 45; eTRE+ER: 45) BMI: > 30 kg/m^2	Control ±ER group: (8-h our eating window between 7:00 and 15:00) eTRE±ER group: eating schedule (a self-selected ≥ 12-hour window) (14 wks) Adjustment covariates: adjustment for race, sex, and age	Mood Satisfaction (Validated Questionnaires) Likert Scale

(*continued on next page*)

Table 2 (*continued*)

Author, country, study design	Population	Intervention and comparator (follow-up time)	Outcomes/research tools
KOTARSKY et al. [27] USA RCT	Adults with overweight/obesity Age: 35-60 years *N* 21 (NE 10; TRE: 11) BMI: 25-34.9 kg/m^2	TRE: consume all their calories between 12:00 p.m. and 8:00 p.m. each day vs NE: no time restriction (08 wks) NI	Adherence Morning headaches
PUREZA et al. [40] BRAZIL RCT	Women adults with obesity living in social vulnerability Age: 19 - 44 years *N* 58 (HD + TRF *n* 35; HD *n* 27) BMI: 32.25- 34.9 kg/m^2	HD ±TRF: to eat only during a 12-h period and fasted during the other 12 h, from the time of the last meal. HD: Composed of a diet with the same energy restriction as the TRF group but without TRF (81 d) NI	Hunger Adherence (Analogic visual scale)
STEGER et al. [25] USA RCT	Adults with obesity Age: 25-75 years *N* 59 (CON+ER *n* 30, eTRE+ER *n* 29) BMI: 30.0-60 kg/m^2	eTRE: Participants were randomized either to eat within na 8-hour window between 7:00 am and 3:00 pm Control group: Eat over a self-selected period ≥ 12 hous for at least 6d/wk for 14 wks. (14 wks) Adjustment covariates: between-group analyses were adjusted for age, race (black vs non-Black), and sex (male vs female).	Appetite Eating behaviors (Validated Questionnaires)
STEGER et al. [43] USA RCT	Adults with obesity Age: 25-75 years *N* 36 (CON+ER *n* 21, eTRE+ER *n* 15) BMI: 30.0-60 kg/m^2	eTRE: within within na 8-hours window between 07:00 and 15:00 Control group: Eating schedule with involved eating over a self-seleted ≥ 12-hour period. (14 wks) Adjustment covariates: between-group analyses were adjusted for age, race (black vs non-Black), and sex (male vs female).	Appetite—Analog Scales Eating behaviors Mood Sleep (Validated Questionnaires)
THOMAS et al. [41] USA RCT	Adults with obesity Age: 18-55 years *N* 85 (DCR *n* 42, eTRE + DCR *n* 43) BMI: 27-45 kg/m^2	DCR: were not given any specific instruction regarding timing of food intake. E-TER±DCR: were instructed to eat only during a window of 10 h, starting within 3 h of waking. (39 wk). NI	Appetite (VAS) Eating behaviors (Validated Questionnaires)
TINSLEY et al. [29] USA RCT	Women adults Age: 18-30 years *N* 40 (TRF+HMB *n* 13; CD *n* 14; TRF *n* 13) BMI: NI	CD: instructed to consume breakfast as soon as possible after waking and to continue to eat at self-selected intervals throughout the remainder of the day. TRF: consume all calories between 1200 and 2000 h each day. (08 wk). NI	Emotional eating Mood and Feelings Uncontrolled Eating (Validated Questionnaires)
WEI et al. [42] CHINA RCT	Adults with DHGNA Age: 18-65 years *N* 88 (TRE *n* 45; DCR *n* 43) BMI: 32.25- 34.9 kg/m^2	TRE: Participants were instructed to consume the prescribed calories from 8:00 am to 4:00 pm every day. DCR: had no eating time restriction during the 12-month study period. (12 mo). NI	Adherence Quality of life Depressive symptoms Sleep quality (Validated Questionnaires)

Abbreviations: ADF, alternate day fasting; BMI, body mass index; CD, control diet; CER, continue energy restriction; DHGNA, nonalcoholic fatty liver disease; HD, hypoenergetic diet; HMB, β-hydroxyβ-methyl butyrate; IER, intermittent energy restriction; N, sample number; NE, normal eating; NI, no information; RCT, randomized clinical trial; TRE, time-restricted eating; e-TRE, early time-restricted eating; late-TRE, late time-restricted eating; TRF, time-restricted feeding; VLDC, very low caloric diet.

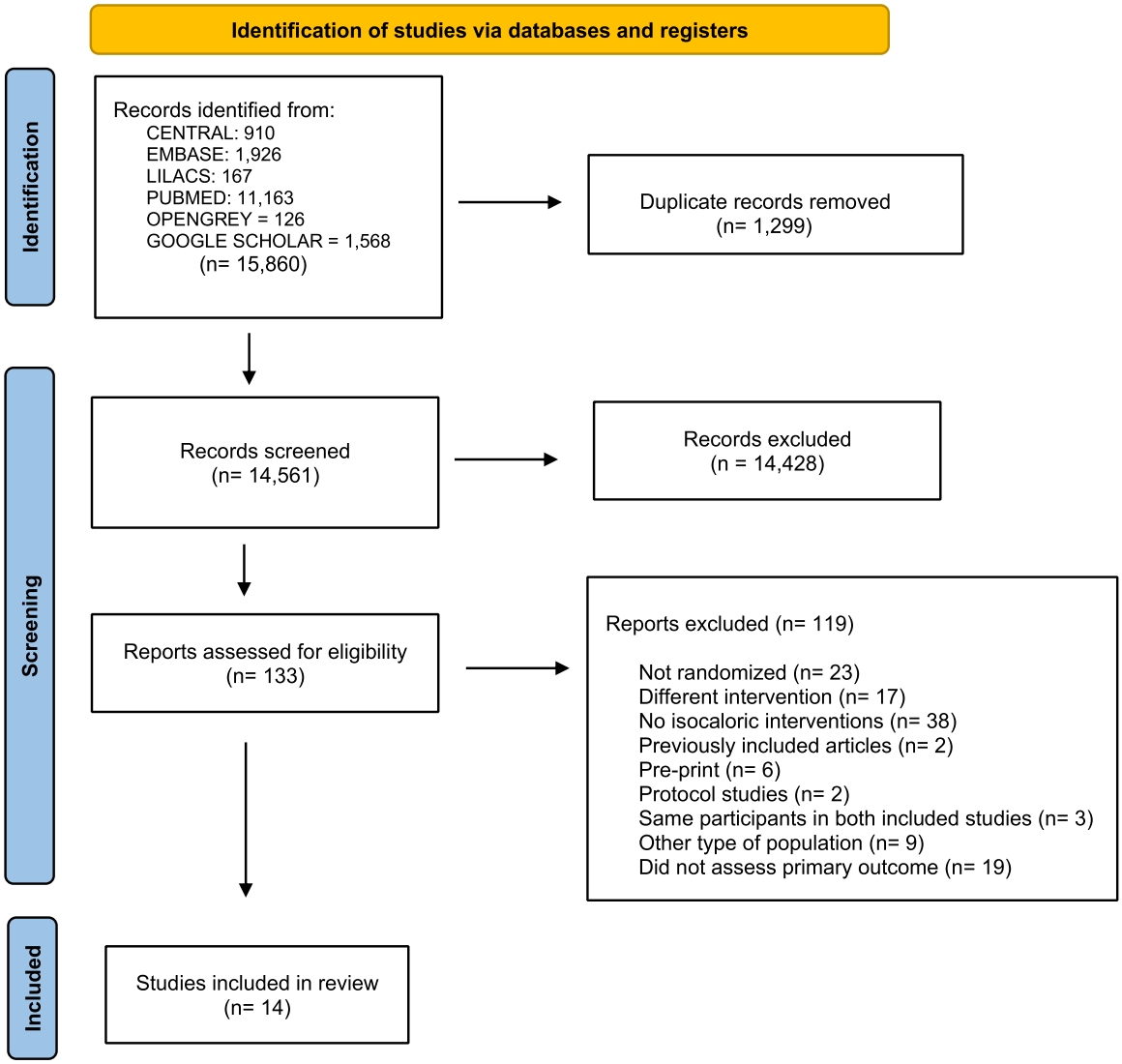

Fig. 1 – Prisma—Flow diagram of the literature search process for new systematics reviews.

were composed of eight studies [20,22,23,26,27,30,31,41] and were presented in a meta-analysis. For all included studies, a qualitative analysis was conducted for outcomes that could not be analyzed in the meta-analysis.

The trials were conducted worldwide between 2018 and 2025. Seven studies were carried out in the United States, two in China, one in Iran, one in Spain, two in Brazil, and one in Norway. In total, participants were recruited across the quantitatively analyzed studies, and outcomes were observed for periods ranging from four weeks to 12 months. The main characteristics of the included studies are described in Table 2.

Although the interventions in the included studies were referred to by different names (e.g., alternate-day fasting or intermittent fasting), we considered TRE as the period of the fasting window ≥12 hours, aligning with the findings in TRE studies [7,20,27–30,32,39,41,42]. All these studies used an isocaloric control group for comparison. However, it was not possible to include data in the meta-analysis from two studies [24,39], as only the abstracts were accessible.

The main subjective perceptions' outcomes found in the studies were: hunger, desire to eat, the amount of food eaten, fullness, satiety, satisfaction when eating, depression, headache, nausea, gastric acidity, diarrhea, sadness, craving, stress, irritability, anxious eating, appetite, difficulties in adherence, eating behavior, mood, morning headache, difficulty sleeping, emotional eating, feelings, mood and uncontrollable eating. Most studies used validated visual analog scales (VAS) or questionnaires to analyze subjective perceptions, as shown in Table 2.

Complete data for performing the meta-analysis of hunger were available in four studies [22,23,27,30] Fullness was assessed in two studies [22,23] one study [31] assessed the desire to eat, the amount of food eaten, and compulsive or uncontrollable eating. Four studies [28,29,31,41] evaluated appetite and eating behavior involving aspects of emotional eating triggered by external cues or restrained eating, including binge eating behaviors, which were assessed using the Dutch Eating Behavior Questionnaire [39]. Four studies [20,22,28,29] as-

sessed satisfaction and improvements in symptoms of fatigue or inertia, tiredness, and exhaustion, which were measured using a visual analog scale or a validated questionnaire (Profile of Moods States-Short Form), respectively. Depression, anxiety, and stress were evaluated in three studies [24,25,40] Two studies [24,26] evaluated headaches or morning headaches. Steger, Jamshed [28] evaluated aspects related to sleep duration, latency, and efficiency. Other perceptions such as nausea, acidity, diarrhea, desires, and tiredness were evaluated in a single study [24]. In this review, we highlight the performance of some meta-analyses, whose results were not represented graphically due to the small number of articles included. Instead, their results are presented individually by study.

3.1. *Risk of bias assessment*

3.1.1. *Random sequence generation*

Nine studies [20,22,23,25,29–32,41] provided data on the randomization process and were considered "low risk." However, five studies [24,26–28,39] did not provide details of the randomization process for obtaining the "uncertain risk" classification.

3.1.2. *Allocation concealment*

Regarding allocation concealment, nine studies [20,23,25, 27,29–32,41] were assessed as having a "low risk'' of bias, while another five studies [22,24,26,28,39] were classified as having an "unclear risk'' because they did not specify how randomization was conducted or failed to provide specific details on the masking methods. The authors only briefly mentioned some of these aspects.

3.2. *Blinding*

3.2.1. *Performance bias (participants and personnel)*

Regarding blinding performance bias, six studies [20,22,24,25,28,39] were classified as having an "unclear risk" bias. Cai, Qin [22] used a stratified random sample to group participants, while Hanick, Jamshed [39] did not specify how randomization was performed, and four articles did not mention masking [20,24,25,28]. Seven studies [23,26,27,29–32,41] were deemed as "high risk" because the authors declared that it was not possible to mask in the protocol, or due to resource availability and study timing, masking was not feasible.

3.2.2. *Detection bias (outcome assessment)*

Blinding of outcome assessment was deemed an "unclear risk" in ten studies [20,22–25,29,31,32,39]. This was mainly due to the absence of related information in the studies. Four studies [26,27,30,41] were classified as having a "high risk" of bias being affected by resource availability, study timing, and owing to the nature of the intervention, respectively.

3.2.3. *Incomplete outcome data*

Ten studies [20,22,24,26,27,30–32,41] were classified as "low risk." Three studies [25,28,29] were considered "high risk" due to the number of losses of study participants (>15%). Only one study Hanick, Jamshed [39] was considered to have "unclear risk" because the authors did not mention any losses.

3.2.4. *Selective reporting*

11 studies [20,22,23,25,26,28–32,41] were classified as "low risk" of bias because they fulfilled what was described in the protocol. Three studies [24,27,39] were deemed as "unclear risk" due to the unavailability of the protocol.

3.2.5. *Other bias*

Two studies [28,31] obtained a "high risk" in this criterion. Tinsley, Moore [31] due to the use of the instrument (Short Mood and Feelings Questionnaire) [43] to assess depression in adult women. This questionnaire was developed to screen for depression in child psychiatric epidemiological studies [28] Steger, Jamshed [29] due to flaws in participant adherence metrics, as well as the number of lost surveys. The other studies [20,22–27,29,30,32,39,41] were classified as "low risk''. A summary of the risk of bias assessment for each included study is provided in Supplement 2.

3.3. *Data synthesis*

3.3.1. *Primary outcome—hunger*

Fig. 2 presents a meta-analysis of the mean difference in hunger between the TRE and isocaloric control groups. Hunger were reported by six studies [22,23,27,28,30,32]. However, four studies [22,23,27,30] provided compatible data for inclusion in the meta-analysis. With a total of 323 participants, the analysis indicated that the perception of hunger was reported to be higher in the TRE group compared to the isocaloric group (MD 2.05, 95% CI 1.46-2.64; $I^2 = 0\%$).

Steger et al., 2023 conducted an RCT comparing eTRE with CR versus the control group. Their findings suggested that the eTRE group did not affect the frequencies of varying degrees of hunger or average hunger (-7 ± 6 mm; $P = .24$). The effectiveness of suppressing hunger during the fasting period was assessed using the VAS [44], with the control group demonstrating higher scores (24 ± 9 mm; $P = .008$). In a separate study on adult's nonalcoholic liver disease [32] investigated eTRE versus a control group. Their results indicated no significant differences in hunger between the eTRE group and the control group. Irani et al. (2024) conducted an RCT to compare the effects of TRE with those of a control group following CR. Their findings indicated no statistically significant differences in hunger level scores between the two groups after eight weeks.

3.3.2. *Primary outcomes—other subjective perceptions related to food intake*

A meta-analysis for the following outcomes (satiety/satisfaction, sleep duration; latency or efficiency, emotional eating, mood and feelings, uncontrolled eating, mood, fatigue/inertia, anger/hostility, depression and perceived stress, appetite fluctuations, stomach discomfort, constipation, dyspepsia, dizziness) was not conducted due to either a limited number of studies or the absence of available/compatible data in the studies for performing the analysis. For this reason, the data from these studies will be presented qualitatively.

Fullness was assessed in two studies [22,23] and the results favored the TRE group over the isocaloric control group (MD 0.99, 95% CI 0.69, 1.29; $I^2 = 0\%$) (data not shown). Desire to eat

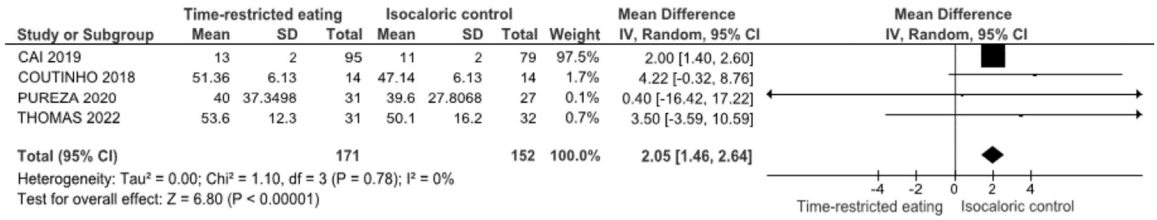

Fig. 2 – Forest plots of continuous data on hunger perception from studies on time-restricted eating and isocaloric diets. CI, confidence interval.

indicate how much the individual would like to eat and the desire to eat itself and were assessed in two studies [23,30] The results showed no significant differences between the intervention and control group (MD 6.16, −6.47, 18.79; $I^2 = 88\%$) (data not shown).

Regarding postmeal satiety/satisfaction, the combined findings from the studies by Cai, Qin [22] and Thomas, Zaman [30] suggest that the TRE group experienced significantly greater satisfaction compared to the isocaloric control group (MD 3.96, 95% CI 2.60, 5.32, $I^2 = 0\%$) (data not shown). Jamshed, Steger [20] assessed satisfaction with the eating window and observed similar results in satisfaction between the control and intervention (−0.3; 95% CI, −0.8 to 0.2; $P = 18$).

Two studies [31,32] assessed sleep quality using the Pittsburgh Sleep Quality Index (PSQI), revealing that the isocaloric control group exhibited better sleep quality compared to the TRE group (MD 0.27, 95% CI 0.05, 0.49, $I^2 = 31\%$) (data not shown). However, Steger, Jamshed [28] showed decreased sleep duration by (30 ± 13 minutes; $P = .03$), increased sleep latency by (7 ± 3 minutes; $P = .04$), and reduced sleep efficiency by (2% ± 1%; $P = .04$) in TRE+ER group relative to CON+ER.

In a study by Tinsley, Moore [31], mood and feelings, and uncontrolled eating were evaluated using the Mood and Feelings Questionnaire. The results indicated no significant differences between the groups in their responses to the questionnaire [45]. Emotional eating was observed in the RCT conducted by Tinsley, Moore [31] and Irani, Abiri [41], with analyses derived from the Three-Factor Eating Questionnaire [45]. Between the TRE and control groups, no statistically significant differences in emotional eating were identified. Steger, Jamshed [28] observed that patients who adhered to eTRE showed improvements in mood (−2.4 ± 0.9; $P = .009$), including fatigue/inertia (−0.6 ± 0.3; $P = .045$), anger/hostility (−0.4 ± 0.2; $P = .03$) compared to the control group.

Depression and perceived stress were assessed in a single study conducted by Fagundes, Tibaes [25]. They employed the Beck Depression Inventory [46] and Beck Anxiety Inventory [43] to measure these variables and your findings showed no significant changes in the scores of these variables between control and intervention groups.

Dote-Montero, Sevilla-Lorente [24] evaluated three types of TRE protocols (early-TRE, late-TRE, and TRE with a window self-selected by the participants). Among the perceptions assessed, their results suggest that early-TRE seems to be less viable and accepted relative to others, but it also seems to improve depression.

Appetite was assessed in four studies [28–30,39] using questionnaires. Hanick, Jamshed [39] found appetite was reduced in TRE, but in other studies [28–30] no statistically significant differences were found between groups. Regarding eating behaviors, four studies [28–30,39] found no significant differences between the TRE and control groups.

Wei, Lin [32], in a comparative study between the eTRE and CR, identified mild adverse events, including appetite fluctuations, stomach discomfort, constipation, dyspepsia, hunger, dizziness, and fatigue. However, no significant differences were observed in these manifestations between the groups. Taken together, these results indicate that the eTRE intervention appears to be neutral regarding such perceptions when contrasted with other isocaloric dietary strategies.

3.3.3. *Secondary outcomes—anthropometric parameters*

As shown in Fig. 3A, six studies [20,22,23,26,30,31] evaluated the relationship between body weight and TRE compared to another isocaloric protocol involving 320 participants. There was no statistically significant difference in postintervention body weight compared to the control group (MD 0.93, 95% CI −1.58, 3.44; $I^2 = 9\%$). Body fat percentage was assessed in five studies [23,26,27,30,31] and the results showed no statistically significant difference between groups (MD −0.37, 95% CI −2.28, 1.54; $I^2 = 0\%$).

Fig. 3B shows the lipid and glucose profile assessment between TRE and an isocaloric protocol. Three studies [20,26,31] including 58 subjects, assessed plasma cholesterol concentrations, and no statistically significant difference was observed between the groups (MD 5.67 mmol/L, 95% CI −3.22, 14.56; I^2 0%). Likewise, plasma triglyceride concentrations were assessed in two studies [20,31] and the analysis showed no statistically significant association between groups (MD 6.93 mmol/L, 95% CI −29.76, 43.61; $I^2 = 0\%$). Similarly, plasma Low-Density Lipoproteins Cholesterol (LDL-C) concentrations, were assessed in two studies [20,31] totaling 37 subjects, and no statistical significance was found between TRE and control groups (MD −2.19 mmol/L, 95% CI −19.01, 14.64; $I^2 = 0\%$). Fasting glucose parameters were assessed in three studies [20,27,31] with a total of 95 subjects, and the analysis showed no statistically significant difference between groups (MD 0.42, 95% CI −4.20, 5.04; $I^2 = 0\%$).

In Fig. 3C, three studies [20,26,31] assessed the plasma High-Density Lipoproteins Cholesterol (HDL-C) concentrations in TRE interventions compared to an isocaloric dietary protocol including 58 subjects. No statistically significant association was found between the groups (MD −1.20 mmol/L, 95% CI −4.12, 1.73; $I^2 = 0\%$).

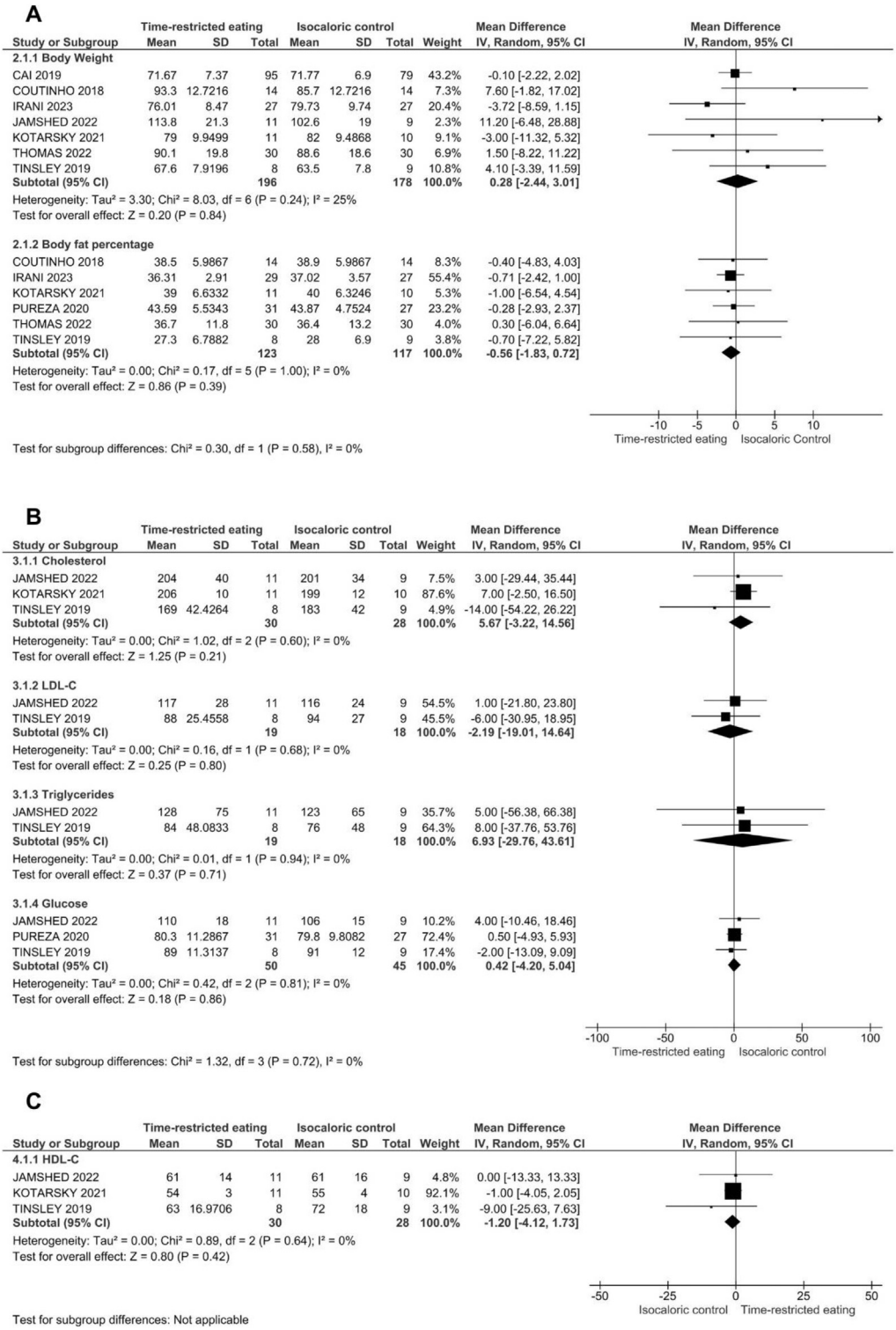

Fig. 3 – Forest plots of the effects of time-restricted eating vs isocaloric diet on secondary outcomes: body composition (A) and metabolic parameters (B and C). CI, Confidence Interval.

3.3.4. *Sensitivity analysis and quality of evidence*

A sensitivity analysis was performed excluding studies identified as having a high risk of bias for the outcome of interest (random sequence generation, allocation concealment, incomplete outcome data, selecting reporting other bias). Owing to the nature of the intervention, it was not possible to be double-blind or placebo-controlled. Three studies [25,28,29] were excluded due to bias in incomplete outcome data, while another two studies [24,39] were removed from the analyses due to bias in selecting reporting, and one study [31] was ex-

cluded due to other biases. No studies were excluded for perceptions of hunger, satiety, amount of food consumed, and fullness. Studies featuring incomplete outcome data, selection bias, reporting biases, or other biases were not identified in the primary meta-analysis analyses, consequently, their results are presented qualitatively. Similarly, concerning secondary outcomes such as body weight, body fat percentage, plasma cholesterol, LDL-C, triglycerides, glucose, and HDL-C concentrations, no studies were excluded, as the mentioned articles were not identified in the primary analyses.

Regarding the association between TRE and isocaloric control on hunger, as evaluated using GRADEpro GDT [37], a noteworthy concern arises regarding the serious risk of bias across three key domains: detection bias, performance bias, and incomplete outcome data as shown in Supplement 3. Additionally, there was a strong suspicion of publication bias. The determination of outcomes may have been premature, particularly because of the limited number of studies investigating the impact of TRE on hunger levels. Thus, it is possible to conclude that the level of evidence in this analysis was considered low, which means that additional studies are necessary in this domain.

4. Discussion

This systematic review of RCT assessed the effects of TRE compared to other isocaloric dietary interventions on hunger in adults with overweight and obesity. Our results suggest that TRE increases hunger, supporting the hypothesis that this effect is independent of caloric intake, as both the experimental and control groups adhered to isocaloric strategies. In addition, several subjective perceptions evaluated in the qualitative analysis—such as satisfaction, fullness, desire to eat, the amount of food eaten, depression, anxiety, emotional eating, mood and feelings, uncontrolled eating, sleep quality, and perceived stress—seemed to be neutral and inconclusive due to the limited number of studies included in this review when comparing TRE and control groups.

Our findings reveal somewhat contradictory effects on food perceptions following TRE. Compared to isocaloric controls, this chrononutrition strategy increased hunger, a perception that can precede and drive food intake in people with overweight and obesity, but, in turn, changed food perceptions that may control food intake over time, i.e., it provided more fullness. We believe that the results are primarily influenced by hunger, possibly linked to the extended fasting intervals. Fasting is well-documented to induce orexigenic endocrine changes, such as increased ghrelin secretion [47,48]. On the other hand, it has already been suggested that the freedom to eat without counting calories and without restrictions on quantity during the eating window proposed by TRE may lead to greater satisfaction and fullness than an isocaloric fractional diet. Our findings offer new insights into the paradoxical effects of TRE on food perceptions, highlighting its dual role in both stimulating hunger and enhancing fullness. This novel perspective underscores the complexity of TRE as a chrononutrition strategy and its potential implications for appetite regulation in individuals with overweight and obesity.

Several studies [7,13,17,49,50] have highlighted that an advantage of IF is that it does not impose limitations on the quantity and quality of food, but emphasizes the restriction of the time of food intake, naturally regulating caloric intake and providing a natural caloric ingestion that providing physiological and metabolic adjustments that promote synchronization between internal clock and food cues. However, this study prevents us from drawing definitive conclusions on the subject due to the limited number of included studies regarding these outcomes. Thus, studies testing different IF protocols must incorporate perceptions related to food intake as part of the analyzed variables, as well as monitor the caloric intake of interventions.

It is important to highlight that studies with TRE show results that, to some extent, corroborate the findings of the present study. Tacad, Tovar [33] in an RCT observed that the TRF group exhibited distinct effects on appetite compared to the CR group, suggesting a potential reduction in hunger in the TRF group relative to the CR group.

Moreover, Ravussin, Beyl [15] observed an increase in satiety and a decrease in desire to eat in a crossover trial with adults with obesity in the TRE group, which supports our findings. Conversely, another study by Gill and Panda [13] observed a decrease in hunger among individuals practicing TRF after 16 weeks. Similarly, Ravussin, Beyl [15] found in a crossover randomized study that early TRE (eating from 8 am to 2 pm) decreased morning plasma ghrelin concentrations (hunger hormone) and minimized diurnal oscillations in hunger perceptions while establishing a consistent 24-hour satiety compared to the control group (eating from 8 am to 8 pm). These studies suggested that prolonged fasting could reduce overeating throughout the day, promoting weight loss, which contrasts with our findings. However, it is worth noting that studies that assessed these variables in TRE and other forms of intermittent fasting intervention compared to other isocaloric interventions are scarce in the literature, limiting a more in-depth discussion.

Notably, few studies [23–25,28,31,39,41] have investigated changes in depression, anxiety, emotional and uncontrolled eating, amount of food eaten, desire to eat, or perceived stress in the context of TRE. Emotional eating is defined as the inability to resist emotional cues that stimulate food consumption, while uncontrolled eating refers to the tendency to overeat due to a loss of control over intake, often accompanied by subjective sensations of hunger [45]. Tinsley, Moore [31], and Irani, Abiri [41] assessed emotional eating using the Three-Factor Eating Questionnaire (TFEQ) [45] and found no statistically significant differences between the TRE and control groups. Similarly, Tinsley and Moore evaluated uncontrolled eating in these groups using the same questionnaire [45] and reported no significant differences. In our current review, we found two studies [25,28] that provided data for depression, anxiety, and perceived stress. Steger, Jamshed [28] observed a decrease in depression scores, and improvements in general mood in the TRE+ER group compared to the control group. However, these same parameters did not show significant differences between the TRE and control groups in the study by Fagundes, Tibaes [25]. In a nonrandomized study on the subject, Haines [51] demonstrated a significant decrease in mood scores accompanied by increased irritability and agi-

tation over the course of the study. In contrast, mood disturbance scores, including fatigue-inertia, vigor-activity, and depression-melancholy, were lower in the TRE group compared to the control group [20]. Some studies [16,18] that evaluated mood states reported similar results when comparing TRE with a control group. In a recent systematic review by Fernandez-Rodriguez, Martinez-Vizcaino [18] which compared IF with a control group in randomized and nonrandomized studies, IF had a moderate but positive effect on depression scores compared to control groups. However, IF did not significantly alter anxiety among participants. Therefore, future studies evaluating TRE under isocaloric conditions are necessary to obtain more reliable results regarding depression, anxiety, or perceived stress variables.

Our findings showed no statistical differences between the intervention and control groups for body weight and body composition (Fig. 3A). Considering that changes in subjective perceptions of food intake can influence variations in body weight, our results regarding hunger as a primary outcome do not align with the lack of change observed in the participants' body weight in the analysis of secondary outcomes. Importantly, the isocaloric strategy implemented in the protocols of the articles included in our review may explain the absence of differences in the weight changes and other anthropometric variables between the TRE and control groups.

In this review, the analyses of the glucose and lipid profiles demonstrated a similar effect between TRE and the control group (Fig. 3B and C), which may be because both groups were isocaloric and aimed at weight management. A recent systematic review [52] of randomized clinical trials that did not use isocaloric comparative conditions showed that overweight individuals had a reduction in fasting blood glucose and HOMA-IR associated with TRE intervention. Future studies and systematic reviews with larger sample sizes should investigate whether these results can be confirmed.

The greatest strength of this review is the inclusion of only RCT and studies that used isocaloric comparative interventions. This is a key differentiating factor, as both groups consumed the same caloric intake, effectively isolating the effect of TRE and any potential circadian benefits. This approach allows for a clearer assessment of whether TRE is merely another method to induce a caloric deficit or if it provides metabolic advantages beyond CR alone. However, these strengths also resulted in the inclusion of a limited number of studies, as many of the studies conducted so far have not been RCT and, more importantly, have not assessed or reported participants' caloric intake. Consequently, the limited number of available studies for some primary outcomes restricts our ability to draw definitive conclusions about the potential effects of TRE on other food-related perceptions investigated in the studies. Additionally, the small number of included studies prevented us from analyzing the effects of different eating window protocols on primary outcomes. Another limitation of this meta-analysis is that adherence to the interventions in the included studies was not assessed, which may have influenced the interpretation of the reported effects of TRE on hunger. Finally, additional RCT on this topic should assess energy intake to strengthen the available evidence and provide more robust conclusions.

5. Conclusion

Our findings suggest that TRE increased hunger compared to the control group. The TRE group exhibited greater fullness compared to the isocaloric control group. Subjective perceptions evaluated in the qualitative analysis—such as satisfaction, desire to eat, the amount of food eaten, anxiety, emotional eating, mood and feelings, and uncontrolled eating) seems to be neutral between the TRE and control groups. However, it is crucial to note that the certainty of the evidence, particularly regarding the association between TRE and hunger, was considered low. Confidence in the estimated effect is limited due to the small number of studies assessing subjective perceptions related to food intake in RCTs using TRE. This limitation does not offer strong clinical evidence supporting the notion that TRE could significantly enhance adherence to obesity treatment. To establish more robust conclusions, further studies on this topic are necessary. This would contribute to validating the potential of TRE as a feasible strategy for managing obesity.

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Author declarations

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.nutres.2025.04.003.

CRediT authorship contribution statement

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REFERENCES

[1] Hall JE, do Carmo JM, da Silva AA, Wang Z, Hall ME. Obesity-induced hypertension: interaction of neurohumoral and renal mechanisms. Circ Res 2015;116:991–1006. doi:10.1161/CIRCRESAHA.116.305697.

[2] WHO. World Health Organization. Obesity. https://www.who.int/health-topics/obesity#tab=tab_1/; 2023 [accessed March 9, 2023].

[3] BRAZIL. Ministério da SaúdePromoção da saúde e da alimentação adequada e saudável. Excesso de peso e obesidade 2020. https://www.gov.br/saude/pt-br/composicao/saps/promocao-da-saude [accessed February 5, 2020].
[4] OPAS. Organização Pan-Americana da Saúde. Dia mundial da obesidade 2022: acelerar ação para acabar com a obesidade. https://www.paho.org/pt/noticias/4-3-2022-dia-mundial-da-obesidade-2022-acelerar-acao-para-acabar-com-obesidade; 2022 [accessed February 14, 2022].
[5] ABESOAssociação Brasileira para o Estudo de Obesidade e Síndrome Metabólica. Mapa da Obesidade 2023. https://abeso.org.br/obesidade-e-sindrome-metabolica/mapa-da-obesidade/ [accessed February 14, 2023].
[6] Chow LS, Manoogian ENC, Alvear A, Fleischer JG, Thor H, Dietsche K, et al. Time-restricted eating effects on body composition and metabolic measures in humans who are overweight: a feasibility study. Obesity (Silver Spring) 2020;28:860–9. doi:10.1002/oby.22756.
[7] Cienfuegos S, Gabel K, Kalam F, Ezpeleta M, Wiseman E, Pavlou V, et al. Effects of 4- and 6-h time-restricted feeding on weight and cardiometabolic health: a randomized controlled trial in adults with obesity. Cell Metab 2020;32:366–78 .e3. doi:10.1016/j.cmet.2020.06.018.
[8] Tinsley GM, Forsse JS, Butler NK, Paoli A, Bane AA, La Bounty PM, et al. Time-restricted feeding in young men performing resistance training: a randomized controlled trial. Eur J Sport Sci 2017;17:200–7. doi:10.1080/17461391.2016.1223173.
[9] Wilkinson MJ, Manoogian ENC, Zadourian A, Lo H, Fakhouri S, Shoghi A, et al. Ten-hour time-restricted eating reduces weight, blood pressure, and atherogenic lipids in patients with metabolic syndrome. Cell Metab 2020;31:92–104.e5. doi:10.1016/j.cmet.2019.11.004.
[10] Varady KA, Cienfuegos S, Ezpeleta M, Gabel K. Clinical application of intermittent fasting for weight loss: progress and future directions. Nat Rev Endocrinol 2022;18:309–21. doi:10.1038/s41574-022-00638-x.
[11] Longo VD, Panda S. Fasting, circadian rhythms, and time-restricted feeding in healthy lifespan. Cell Metab 2016;23:1048–59. doi:10.1016/j.cmet.2016.06.001.
[12] Li MD. Clock-modulated checkpoints in time-restricted eating. Trends Mol Med 2022;28:25–35. doi:10.1016/j.molmed.2021.10.006.
[13] Gill S, Panda S. A smartphone app reveals erratic diurnal eating patterns in humans that can be modulated for health benefits. Cell Metab 2015;22:789–98. doi:10.1016/j.cmet.2015.09.005.
[14] Kim H, Jang BJ, Jung AR, Kim J, Ju HJ, Kim YI. The impact of time-restricted diet on sleep and metabolism in obese volunteers. Medicina (Kaunas) 2020;56. doi:10.3390/medicina56100540.
[15] Ravussin E, Beyl RA, Poggiogalle E, Hsia DS, Peterson CM. Early time-restricted feeding reduces appetite and increases fat oxidation but does not affect energy expenditure in humans. Obesity (Silver Spring) 2019;27:1244–54. doi:10.1002/oby.22518.
[16] Teong XT, Hutchison AT, Liu B, Wittert GA, Lange K, Banks S, et al. Eight weeks of intermittent fasting versus calorie restriction does not alter eating behaviors, mood, sleep quality, quality of life and cognitive performance in women with overweight. Nutr Res 2021;92:32–9. doi:10.1016/j.nutres.2021.06.006.
[17] Gabel K, Hoddy KK, Haggerty N, Song J, Kroeger CM, Trepanowski JF, et al. Effects of 8-hour time restricted feeding on body weight and metabolic disease risk factors in obese adults: a pilot study. Nutr Healthy Aging 2018;4:345–53. doi:10.3233/NHA-170036.
[18] Fernandez-Rodriguez R, Martinez-Vizcaino V, Mesas AE, Notario-Pacheco B, Medrano M, Heilbronn LK. Does intermittent fasting impact mental disorders? A systematic review with meta-analysis. Crit Rev Food Sci Nutr 2023;63:11169–84. doi:10.1080/10408398.2022.2088687.
[19] Jamshed H, Beyl RA, Della Manna DL, Yang ES, Ravussin E, Peterson CM. Early time-restricted feeding improves 24-hour glucose levels and affects markers of the circadian clock, aging, and autophagy in humans. Nutrients 2019;11. doi:10.3390/nu11061234.
[20] Jamshed H, Steger FL, Bryan DR, Richman JS, Warriner AH, Hanick CJ, et al. Effectiveness of early time-restricted eating for weight loss, fat loss, and cardiometabolic health in adults with obesity: a randomized clinical trial. JAMA Intern Med 2022;182:953–62. doi:10.1001/jamainternmed.2022.3050.
[21] Beaulieu K, Casanova N, Oustric P, Turicchi J, Gibbons C, Hopkins M, et al. Matched weight loss through intermittent or continuous energy restriction does not lead to compensatory increases in appetite and eating behavior in a randomized controlled trial in women with overweight and obesity. J Nutr 2020;150:623–33. doi:10.1093/jn/nxz296.
[22] Cai H, Qin YL, Shi ZY, Chen JH, Zeng MJ, Zhou W, et al. Effects of alternate-day fasting on body weight and dyslipidaemia in patients with non-alcoholic fatty liver disease: a randomised controlled trial. BMC Gastroenterol 2019;19:219. doi:10.1186/s12876-019-1132-8.
[23] Coutinho SR, Halset EH, Gasbakk S, Rehfeld JF, Kulseng B, Truby H, et al. Compensatory mechanisms activated with intermittent energy restriction: a randomized control trial. Clin Nutr 2018;37:815–23. doi:10.1016/j.clnu.2017.04.002.
[24] Dote-Montero M, Sevilla-Lorente R, Merchan-Ramirez E, Nuñez-Lopez JC, Mochón-Benguigui S, Jurado-Fasoli L, et al. Feasibility of three different 8h time-restricted eating schedules over 4 weeks in Spanish adults with overweight/obesity: a pilot randomized controlled trial. Curr Dev Nutr 2021;5:466. doi:10.1093/cdn/nzab039_002.
[25] Fagundes GBP, Tibaes JRB, Silva ML, Braga MM, Silveira ALM, Teixeira AL, et al. Metabolic and behavioral effects of time-restricted eating in women with overweight or obesity: preliminary findings from a randomized study. Nutrition 2023;107:111909. doi:10.1016/j.nut.2022.111909.
[26] Kotarsky CJ, Johnson NR, Mahoney SJ, Mitchell SL, Schimek RL, Stastny SN, et al. Time-restricted eating and concurrent exercise training reduces fat mass and increases lean mass in overweight and obese adults. Physiol Rep 2021;9:e14868. doi:10.14814/phy2.14868.
[27] Pureza I, Melo ISV, Macena ML, Praxedes DRS, Vasconcelos LGL, Silva-Junior AE, et al. Acute effects of time-restricted feeding in low-income women with obesity placed on hypoenergetic diets: randomized trial. Nutrition 2020;77:110796. doi:10.1016/j.nut.2020.110796.
[28] Steger FL, Jamshed H, Bryan DR, Richman JS, Warriner AH, Hanick CJ, et al. Early time-restricted eating affects weight, metabolic health, mood, and sleep in adherent completers: a secondary analysis. Obesity (Silver Spring) 2023;31(Suppl 1):96–107. doi:10.1002/oby.23614.
[29] Steger FL, Jamshed H, Martin CK, Richman JS, Bryan DR, Hanick CJ, et al. Impact of early time-restricted eating on diet quality, meal frequency, appetite, and eating behaviors: a randomized trial. Obesity (Silver Spring) 2023;31(Suppl 1):127–38. doi:10.1002/oby.23642.
[30] Thomas EA, Zaman A, Sloggett KJ, Steinke S, Grau L, Catenacci VA, et al. Early time-restricted eating compared with daily caloric restriction: a randomized trial in adults with obesity. Obesity (Silver Spring) 2022;30:1027–38. doi:10.1002/oby.23420.
[31] Tinsley GM, Moore ML, Graybeal AJ, Paoli A, Kim Y, Gonzales JU, et al. Time-restricted feeding plus resistance

training in active females: a randomized trial. Am J Clin Nutr 2019;110:628–40. doi:10.1093/ajcn/nqz126.
[32] Wei X, Lin B, Huang Y, Yang S, Huang C, Shi L, et al. Effects of time-restricted eating on nonalcoholic fatty liver disease: the TREATY-FLD randomized clinical trial. JAMA Netw Open 2023;6:e233513. doi:10.1001/jamanetworkopen.2023.3513.
[33] Tacad DKM, Tovar AP, Richardson CE, Horn WF, Krishnan GP, Keim NL, et al. Satiety associated with calorie restriction and time-restricted feeding: peripheral hormones. Adv Nutr 2022;13:792–820. doi:10.1093/advances/nmac014.
[34] Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The Prisma 2020 statement: an updated guideline for reporting systematic reviews. Syst Rev 2021;10:89. doi:10.1186/s13643-021-01626-4.
[35] Higgins JPT, Chandler J, Cumpston M, Li T, Page MJ, Welch. *Cochrane Handbook for Systematic Reviews of Interventions Version 6.4*. Cochrane; 2023 www.training.cochrane.org/handbook [accessed May 1, 2025].
[36] Ouzzani M, Hammady H, Fedorowicz Z, Elmagarmid A. Rayyan-a web and mobile app for systematic reviews. Syst Rev 2016;5:210. doi:10.1186/s13643-016-0384-4.
[37] Guyatt GH, Oxman AD, Vist GE, Kunz R, Falck-Ytter Y, Alonso-Coello P, et al. Grade: an emerging consensus on rating quality of evidence and strength of recommendations. BMJ 2008;336:924–6. doi:10.1136/bmj.39489.470347.AD.
[38] Cochrane Collaboration Review Manager (RevMan) Web. London, UK: Cochrane; 2020 https://revman.cochrane.org/ [accessed May 1, 2025].
[39] Hanick C, Jamshed H, Bryan D, Steger F, Richman J, Warriner A, et al. Effects of time-restricted eating on appetite, eating behaviors, and physical activity in adults. Obesity 2020;28:40–187. doi:10.1002/oby.23063.
[40] Steger FL, Jamshed H, Bryan DR, Richman JS, Warriner AH, Hanick CJ, et al. Early time-restricted eating affects weight, metabolic health, mood, and sleep in adherent completers: a secondary analysis. Obesity 2023;31:96–107. doi:10.1002/oby.23614.
[41] Irani H, Abiri B, Khodami B, Yari Z, Lafzi Ghazi M, Hosseinzadeh N, et al. Effect of time restricted feeding on anthropometric measures, eating behavior, stress, serum levels of BDNF and LBP in overweight/obese women with food addiction: a randomized clinical trial. Nutr Neurosci 2024;27:577–89. doi:10.1080/1028415X.2023.2234704.
[42] Gabel K, Hoddy KK, Varady KA. Safety of 8-h time restricted feeding in adults with obesity. Appl Physiol Nutr Metab 2019;44:107–9. doi:10.1139/apnm-2018-0389.
[43] Beck AT, Epstein N, Brown G, Steer RA. An inventory for measuring clinical anxiety: psychometric properties. J Consult Clin Psychol 1988;56:893–7. doi:10.1037//0022-006x.56.6.893.
[44] Stubbs RJ, Hughes DA, Johnstone AM, Rowley E, Reid C, Elia M, et al. The use of visual analogue scales to assess motivation to eat in human subjects: a review of their reliability and validity with an evaluation of new hand-held computerized systems for temporal tracking of appetite ratings. Br J Nutr 2000;84:405–15. doi:10.1017/s0007114500001719.
[45] de Lauzon B, Romon M, Deschamps V, Lafay L, Borys JM, Karlsson J, et al. The three-factor eating Questionnaire-R18 is able to distinguish among different eating patterns in a general population. J Nutr 2004;134:2372–80. doi:10.1093/jn/134.9.2372.
[46] Beck AT, Ward CH, Mendelson M, Mock J, Erbaugh J. An inventory for measuring depression. Arch Gen Psychiatry 1961;4:561–71. doi:10.1001/archpsyc.1961.01710120031004.
[47] Abizaid A, Horvath TL. Ghrelin and the central regulation of feeding and energy balance. Indian J of Endocrinol and Metab 2012;16:S617–SS26. doi:10.4103/2230-8210.105580.
[48] Alzoghaibi MA, Pandi-Perumal SR, Sharif MM, BaHammam AS. Diurnal intermittent fasting during Ramadan: the effects on leptin and ghrelin levels. PLoS One 2014;9:e92214. doi:10.1371/journal.pone.0092214.
[49] Garaulet M, Gomez-Abellan P, Alburquerque-Bejar JJ, Lee YC, Ordovas JM, Scheer FA. Timing of food intake predicts weight loss effectiveness. Int J Obes (Lond) 2013;37:604–11. doi:10.1038/ijo.2012.229.
[50] Jakubowicz D, Barnea M, Wainstein J, Froy O. Effects of caloric intake timing on insulin resistance and hyperandrogenism in lean women with polycystic ovary syndrome. Clin Sci (Lond) 2013;125:423–32. doi:10.1042/CS20130071.
[51] Haines RE. The Effect of Time-Restricted Feeding on Body Weight, Energy, The Effect of Time-Restricted Feeding on Body Weight, Energy, Mood, Sleep, and Hunger Levels of Adults on Social Media. Louisiana Tech University. 2020; https://digitalcommons.latech.edu/theses. [accessed April 29, 2025].
[52] Pureza I, Macena ML, da Silva AE Junior, Praxedes DRS, Vasconcelos LGL, et al. Effect of early time-restricted feeding on the metabolic profile of adults with excess weight: a systematic review with meta-analysis. Clin Nutr 2021;40:1788–99. doi:10.1016/j.clnu.2020.10.031.