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Intermittent fasting as a treatment for obesity in young people: a scoping review

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Intermittent fasting focuses on the timing of eating rather than diet quality or energy intake, with evidence supporting its effects on weight loss and improvements in cardiometabolic outcomes in adults with obesity. However, there is limited evidence for its feasibility and efficacy in young people. To address this, a scoping review was conducted to examine intermittent fasting regimens in individuals aged 10 to 25 for the treatment of obesity focusing on methodology, intervention parameters, outcomes, adherence, feasibility, and efficacy. Due to the paucity of evidence in this age group, to adequately assess feasibility and adherence, all published studies of intermittent fasting in this age category, regardless of weight status and treatment intention, were included in the review. The review included 34 studies (28 interventional studies and 6 observational studies) with 893 participants aged 12 to 25. Interventions varied with 9 studies in cohorts with obesity utilizing intermittent fasting as an obesity treatment. Thirteen studies utilized 8-h time-restricted eating. Primary outcomes included cardiometabolic risk factors (7/28), anthropometric measurements (7/28), body composition (5/28), muscular performance (4/28), feasibility (1/28), and others (4/28). All 9 studies conducted in young people with obesity reported some degree of weight loss, although the comparator groups varied significantly. This review underscores the various utilizations of intermittent fasting in this age group and highlights its potential in treating obesity. However, the findings emphasize the need for rigorous studies with standardized frameworks for feasibility to ensure comparability and determine intermittent fasting's practicality in this age group depending on the treatment outcome of interest.

The global prevalence of overweight and obesity in children and adolescents aged 5–19 surged from 8% in 1990 to 20% in 2022, affecting both genders similarly[1]. The obesity epidemic impacts both developed and developing countries[2]. In the US, class I obesity increased from 16% to 21% in youth ages 12 to 19 years of age from 1999 to 2018, while severe obesity (classes II and III) rose from 5% to 8%[3]. This is concerning as obesity has been linked to comorbidities including type 2 diabetes, sleep apnea, and metabolic dysfunction associated steatotic liver disease[4–6]. In January 2023, the American Academy of Pediatrics issued new clinical practice guidelines for treating obesity in young people. The American Academy of Pediatrics' guidelines recommend prompt, multifaceted intervention strategies, including intensive health and behavioral lifestyle interventions, obesity pharmacotherapy, and bariatric surgery[6].

Adherence to treatment recommendations is possibly the strongest predictor of weight loss[7–10], and the best strategy for a given individual is the one they are willing and able to practice and sustain. Therefore, there is a critical need to diversify interventions to ensure young people can identify the strategies that work for them based on personal preference, developmental and social stage, and obesity phenotype. Intensive family-based health and behavioral interventions are the cornerstone of pediatric obesity treatment[6]. However, these interventions can only be effective in improving long-term health outcomes if they are delivered and received as intended. While family-based interventions work for some youth and their families who are able and willing to engage and adhere to all the required treatment recommendations, a meaningful proportion disengage prematurely[6,10,11]. For many adolescent and emerging adults, a family-based approach that relies on involvement of caregivers may not best fit the needs and new autonomous roles of this age group. Furthermore, modifications in the home food environment and complex behavior changes may not be practical or sustainable during this developmental period[6]. Developing and testing novel intervention approaches can diversify our treatment toolkit to help a greater segment of young people to achieve their health goals[12–15].

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Dietary regimens focusing on *when* food is consumed, rather than on the quality or quantity of food consumed[16,17] have gained popularity in the last decade. Intermittent fasting involves altering the timing and duration of eating and fasting periods[18]. Common intermittent fasting regimens include the 5:2 diet (eating ad libitum 5 days per week and fasting for two non-consecutive 24-h periods), alternate-day fasting (typically involves alternating a day of eating ad libitum with a fast day), time-restricted eating (fasting for a specified period of time each day), and religious fasting[19,20]. Intermittent fasting interventions emerged from findings indicating that, while diet quality and exercise are beneficial for health, the timing of eating may independently predict health outcomes and disease risks[21]. Spreading eating events across the day (i.e., >14 h eating window) and late-night eating have been linked to poor cardiometabolic health in adults[17,22–24]. By contrast, well-timed eating and fasting, such as eating earlier in the day and fasting in the evening and night, has been shown to induce weight loss, enhance insulin sensitivity, improved sleep quality, and decrease inflammation[20,24–32]. In adults, time-restricted eating studies indicate that shortening the eating period can lead to a 10-25% reduction in energy consumption, even without intentional caloric restriction[25–28]. In addition, cycling between periods of fasting and eating has also been linked to reduced markers related to aging, diabetes, autoimmune diseases, cardiovascular health, neurodegenerative conditions, and cancer[33–35]. Intermittent fasting has also been shown to modulate inflammatory responses and reduce oxidative stress[24,28,30–32]. Given the role of inflammation and oxidative stress in accelerating aging, exploring this effect from an early stage in life is compelling.

Intermittent fasting might be appealing to adolescents and emerging adults in allowing more freedom around food choices and because of its simplicity[17,24]. Yet, studies of intermittent fasting have mainly focused on adults over the age of 30, and research in youth is still in its early stages[36,37]. Since 2019, over 50 reviews have summarized the effectiveness of intermittent fasting in adults[22,38–90], with no comparable published summary among adolescents and emerging adults[36,37]. This scoping review seeks to address this gap by examining all published intermittent fasting studies involving adolescents and emerging adults, irrespective of whether the intervention was specifically intended for the treatment of obesity. Given the limited research in this age group, our focus extends beyond assessing the efficacy of intermittent fasting for weight loss to include feasibility and adherence. Specific considerations were given to: (1) methodology; (2) intervention parameters including eating timing, duration, and additional components; (3) adherence monitoring; (4) feasibility assessment; (5) primary and secondary outcomes captured; (6) potential iatrogenic effects; and (7) effects on anthropometric, metabolic outcomes, and markers of biological aging. This comprehensive approach aims to inform future trials by highlighting gaps in knowledge and evaluating whether intermittent fasting has been sufficiently studied in terms of feasibility and adherence.

Methods

PRISMA-ScR framework

A PRISMA-ScR scoping review was conducted. Consistent with the PRISMA framework[91,92] the following steps were executed: (1) identify the research question by clarifying and linking the purpose and research question; (2) identify relevant studies by balancing feasibility with breadth and comprehensiveness; (3) select studies using an iterative team approach to study selection and data extraction; (4) chart the data incorporating numerical summary and qualitative thematic analysis; and (5) collate, summarize and report the results, including the implications for practice and research.

Identifying the initial research questions

The focus of the review was to investigate intermittent fasting interventions that included adolescent and emerging adults. To ensure that a wide range of relevant studies was captured, the following two-part research question was crafted to guide the search[93]: In intermittent fasting interventions that include adolescents and emerging adults: 1) What were the intervention parameters, adherence monitoring approaches and fidelity measures employed, and primary and secondary outcomes captured, and 2) What is the reported feasibility and efficacy?

A structured search was applied utilizing the PubMed bibliographic database. The first author (JAB) created the initial PubMed search strategy using a combination of Medical Subject Headings and keywords for intermittent fasting, health effects, and youth. The search was restricted to studies published since 2000, on humans, who are adolescents or young adults, and written in English. Intermittent fasting included time-restricted eating, intermittent energy restriction, and alternate day fasting interventions. Team members (JAB, SJS, and APV) reviewed the strategy and preliminary results to modify and improve the search strategy. With the team's approval, JAB customized the search using controlled vocabulary and keywords in the database listed above. The search strategy included the following terms: ((“intermittent fasting”[MeSH Terms] OR (“intermittent”[All Fields] AND “fasting”[All Fields]) OR “intermittent fasting”[All Fields] OR (“intermittent fasting”[MeSH Terms] OR (“intermittent”[All Fields] AND “fasting”[All Fields]) OR “intermittent fasting”[All Fields] OR (“time”[All Fields] AND “restricted”[All Fields] AND “eating”[All Fields]) OR “time restricted eating”[All Fields]) OR (“intermittent fasting”[MeSH Terms] OR (“intermittent”[All Fields] AND “fasting”[All Fields]) OR “intermittent fasting”[All Fields] OR (“time”[All Fields] AND “restricted”[All Fields] AND “feeding”[All Fields]) OR “time restricted feeding”[All Fields]) OR ((“alternance”[All Fields] OR “alternances”[All Fields] OR “alternant”[All Fields] OR “alternants”[All Fields] OR “alternate”[All Fields] OR “alternated”[All Fields] OR “alternately”[All Fields] OR “alternates”[All Fields] OR “alternating”[All Fields] OR “alternation”[All Fields] OR “alternations”[All Fields] OR “alternative”[All Fields] OR “alternatively”[All Fields] OR “alternatives”[All Fields]) AND “day”[All Fields] AND (“fasted”[All Fields] OR “fasting”[MeSH Terms] OR “fasting”[All Fields] OR “fastings”[All Fields] OR “fasts”[All Fields])) OR ((“intermittant”[All Fields] OR “intermittence”[All Fields] OR “intermittencies”[All Fields] OR “intermittency”[All Fields] OR “intermittent”[All Fields] OR “intermittently”[All Fields]) AND (“energie”[All Fields] OR “energies”[All Fields] OR “energy”[All Fields]) AND (“restrict”[All Fields] OR “restricted”[All Fields] OR “restricting”[All Fields] OR “restriction”[All Fields] OR “restrictions”[All Fields] OR “restrictive”[All Fields] OR “restrictiveness”[All Fields] OR “restricts”[All Fields]))) AND (“weight s”[All Fields] OR “weighted”[All Fields] OR “weighting”[All Fields] OR “weightings”[All Fields] OR “weights and measures”[MeSH Terms] OR (“weights”[All Fields] AND “measures”[All Fields]) OR “weights and measures”[All Fields] OR “weight”[All Fields] OR “body weight”[MeSH Terms] OR (“body”[All Fields] AND “weight”[All Fields]) OR “body weight”[All Fields] OR “weights”[All Fields] OR (“metabolic”[All Fields] OR “metabolical”[All Fields] OR “metabolically”[All Fields] OR “metabolics”[All Fields] OR “metabolism”[MeSH Terms] OR “metabolism”[All Fields] OR “metabolisms”[All Fields] OR “metabolism”[MeSH Subheading] OR “metabolities”[All Fields] OR “metabolization”[All Fields] OR “metabolize”[All Fields] OR “metabolized”[All Fields] OR “metabolizer”[All Fields] OR “metabolizers”[All Fields] OR “metabolizes”[All Fields] OR “metabolizing”[All Fields]) OR (“metabolic”[All Fields] OR “metabolical”[All Fields] OR “metabolically”[All Fields] OR “metabolics”[All Fields] OR “metabolism”[MeSH Terms] OR “metabolism”[All Fields] OR “metabolisms”[All Fields] OR “metabolism”[MeSH Subheading] OR “metabolities”[All Fields] OR “metabolization”[All Fields] OR “metabolize”[All Fields] OR “metabolized”[All Fields] OR “metabolizer”[All Fields] OR “metabolizers”[All Fields] OR “metabolizes”[All Fields] OR “metabolizing”[All Fields]) OR (“body composition”[MeSH Terms] OR (“body”[All Fields] AND “composition”[All Fields]) OR “body composition”[All Fields]) OR (“aging”[MeSH Terms] OR “aging”[All Fields] OR “ageing”[All Fields]) OR (“inflammation”[MeSH Terms] OR “inflammation”[All Fields] OR “inflammations”[All Fields] OR “inflammation s”[All Fields]) OR (“inflammatories”[All Fields] OR “inflammatory”[All Fields]) OR (“oxidative stress”[MeSH Terms] OR (“oxidative”[All Fields] AND “stress”[All Fields]) OR “oxidative stress”[All Fields])) AND (“adolescent”[MeSH Terms] OR “adolescent”[All Fields] OR “youth”[All Fields]

OR "youths"[All Fields] OR "youth s"[All Fields] OR ("young adult"[MeSH Terms] OR ("young"[All Fields] AND "adult"[All Fields]) OR "young adult"[All Fields]) OR ("adolescences"[All Fields] OR "adolescency"[All Fields] OR "adolescent"[MeSH Terms] OR "adolescent"[All Fields] OR "adolescence"[All Fields] OR "adolescents"[All Fields] OR "adolescent s"[All Fields]))) AND ((y_10[Filter]) AND (humans[Filter]) AND (english[Filter]) AND (adolescent[Filter] OR youngadult[Filter])). All resulting citations were exported into a Mendeley library, and duplicates were removed. No additional efforts were conducted to seek out gray literature, including other study registries, websites, or conference proceedings. On November 4, 2024, the search was repeated in the bibliographic database to identify any more recent studies.

Study selection

Titles and abstracts were first screened, and then eligible full-text articles were screened by one author (JAB) (title abstracts: n = 241, full-text n = 92). For the initial screening of abstracts, the inclusion criteria were as follows: (1) articles are in English; (2) included participants with age equal to or less than 25 years old; (3) report of a primary or second outcome that relates to a change in weight (body mass index, Body mass index z-score, weight in excess of the 95th percentile, percent weight change), a change in metabolic markers (body composition, glycemic biomarkers, or lipid profiles), or a change in biological aging markers (inflammatory markers and oxidative stress). There was only one exclusion criterion. Studies on Ramadan intermittent fasting were excluded due to its unique cultural and ceremonial context, which entails significant alterations in eating habits, sleep cycles, and often leads to increased consumption of high-sugar and high-fat foods, rendering its effects incomparable to other forms of health-promoting fasting[18]. No exclusion criteria were applied to sample size or location. To assess the scope of ongoing and unpublished research in this emerging field, we also conducted a search of ClinicalTrials.gov using the following terms: "Intermittent Fasting OR Time Restricted Eating OR Time Restricted Feeding OR Alternate Day Fasting OR Intermittent Energy Restriction OR Time Limited Eating OR Time Limited Feeding" combined with "Adolescent OR Young Adult OR Emerging Adult." This search yielded 231 studies, with statuses as follows: 112 completed, 58 recruiting, 23 unknown, 14 not yet recruiting, 10 active but not recruiting, and the remainder either enrolling by invitation, suspended, terminated, or withdrawn. During subsequent full-text screening, two independent reviewers ensured the following criteria were met for all retrieved studies: (1) publication included full text and (2) publications were peer-reviewed.

Data charting

Data extraction was completed for eligible articles in relation to the study population, intervention details and study outcomes, using a standardized form, which was based on data extraction forms used in previous scoping reviews by the authors (APV). One reviewer (JAB) developed a data-charting form to determine which variables to extract and charted the data. Then, two reviewers discussed the results, and continuously updated the data-charting form. The data extracted included sample descriptions, methodology, outcome measures, assessments, and results of interventional studies. Next, one extractor reviewed all the articles and formed the table (JAB). An additional team member double-checked the extracted data and helped revise the table (APV). Data tables facilitated analysis. Participant characteristics across trial studies, interventions, measures, and results are summarized in Tables 1 and 2.

The Synthesis Without Meta-analysis guidelines nine-item checklist was adapted for this scoping review to promote transparency in reporting of the quantitative effects of intermittent fasting in the study cohort of interest[94]. 1) Studies were grouped for synthesis according to their study design and primary outcome measure. 2) Table 1 was created to highlight the primary and secondary outcomes as described by the authors. Table 2 was designed to emphasize the five primary standardized metrics of interest for this scoping review as it relates to use of an intermittent fasting approach in young people which include: 1) feasibility/acceptability; 2) adherence; 3) weight outcome (for studies that included youth with obesity); 4) metabolic markers; and 5) biological aging markers. 3) Given the heterogeneity in outcome measures captured and reported, no transformational methods were used to synthesize the effects for each outcome to undertake a meta-analysis of effect estimate. Alternatively, the data was utilized to explore the landscape of intermittent fasting in this age cohort and identify approaches that had been utilized to date. 4) The studies are ordered chronologically in descending order in Table 1 and Table 2 by those that included an intermittent fasting intervention for the treatment of obesity presented first as the most aligned with the primary aim of the scoping review. 5) To investigate the heterogeneity of the reported effects, the primary and secondary outcomes of each study were outlined and compared to determine the difference in metrics utilized, in the definitions, and measures assessed to capture the effect of intermittent fasting on various metabolic parameters in this age group. 6) The certainty of evidence was assessed with the criteria of credibility assessment tool. 7) The data are presented in both text and table format with studies ordered chronologically and with those that include cohorts with obesity for which intermittent fasting was used and an obesity treatment ordered first.

Ethical considerations

Ethical approval was not sought for this review as it relies on already published work. Additionally, this review was not registered in PROSPERO, the international database for systematic reviews in health and social care, due to the fact that scoping reviews do not fulfill the registration requirements (https://www.crd.york.ac.uk/prospero/#aboutpage).

Analytic analysis

For each interventional study on the health effects of intermittent fasting, the following data were abstracted: number of participants, ages of participants, study design, intermittent fasting regimen, additional intervention components, adherence monitoring method, feasibility assessment, primary and secondary outcome measures. To evaluate the acceptability and feasibility of healthcare interventions, a generic, theoretically grounded questionnaire was previously developed around the constructs of the Theoretical Framework of Acceptability[95]. This tool was designed to measure seven specific elements related to feasibility: affective attitude, burden, ethicality, intervention coherence, opportunity costs, perceived effectiveness, and self-efficacy. This versatile questionnaire can be customized to analyze the acceptability of various healthcare interventions across diverse settings. Studies were evaluated on whether they measured acceptability and feasibility consistent with the Theoretical Framework of Acceptability. The other included studies were analyzed conceptually, without charting of specific data.

Results

Upon removal of duplicates, 238 titles and abstracts were screened for eligibility. A total of 92 underwent full-text review. Of those, 34 studies met the pre-specified inclusion criteria. A PRISMA flow diagram detailing the database searches, the number of abstracts screened, and the full texts retrieved is illustrated in Fig. 1. The study designs and methodologies of the included studies are cataloged in Fig. 2. Descriptive details of included studies are summarized in Table 1.

All studies were published between 2013 and 2024. Twelve studies were conducted in the United States, four in China, three in the United Kingdom, three in Australia, two in South Korea, two in Brazil, one in Italy, one in France, one in Canada, one in Spain, one in Mexico, one in Denmark, one in Portugal, and one in Malaysia. Of these studies, 28 were interventional studies, nine of which were conducted in cohorts living with obesity for which intermittent fasting was utilized as an obesity treatment. Fifteen were randomized controlled trials, eight cross-over trials, and five one-arm design. Table 1 summarizes the key characteristics of the 28 interventional studies that included efficacy data, emphasizing intervention components, execution, feasibility measures, adherence monitoring, and primary and secondary outcomes. The remaining six studies were cross-sectional studies

Table 1 | Overview of intermittent fasting studies among adolescents and young adults that included efficacy data cataloged by study characteristics, study design, and outcomes

Reference (location, year)	Study Design	Participants (sample size; age=mean (SD); % F or M; baseline weight status)	Intervention	Eating window	Multi-component	Duration (days)	Primary Outcome	Secondary Outcome
121 (Australia, 2024)	RCT	*N* = 141; median age=14.8(IQR: 12.9-17.9); 50.4% males; %Body mass $index_{p95}$ = 130(15)	Arm 1: intermittent energy restriction (IER) 3 days/week and healthy eating 4 days/week Arm 2: continuous energy restriction (CER) daily		Energy restriction	364	Body weight (significant weight loss in both groups)	Body composition and cardiometabolic outcomes
97 (US, 2023)	RCT	*N* = 27 with type 2 diabetes; mean age=16.5(1.7); 63% females; %Body mass $index_{p95}$ = 128.5(28.7)	Arm 1: 8 h late time-restricted eating (12:00 – 20:00) Control: 12+ h eating	Late	+continuous glucose monitoring Isocaloric	84	Feasibility	Weight loss (significant within group), body composition, glycemic control, physical activity, dietary intake, and sleep
110 (China, 2023)	RCT	*N* = 77; college students; 100% females; mean age= 25 (4); mean BMI = 24 (2) kg/m^2	Arm 1: 8 h time-restricted eating Arm 2: Exercise Arm 3: 8 h time-restricted eating + Exercise Control	Late	Resistance training	56	Body weight (significant weight loss within group)	Body composition and lipid levels
111 (South Korea, 2023)	Uncontrolled trial	*N* = 34; healthy young adults; 64.7% females; mean age= 23.4 (2.9); mean BMI = 24 (2) kg/m^2	Arm 1: 8 h time-restricted eating + snack packages with 20 g protein/day	Self-selected		24	Body composition Weight (significant weight loss within group)	Cardiometabolic outcomes
103 (China, 2022)	RCT	*N* = 60; mean age= 23(0.5); 55% males; mean Weight=80(3.5) kg; mean BMI = 27.8(0.8) kg/m^2	Arm 1: 6 h etime-restricted eating (7:00 a.m.–1:00 p.m) Arm 2: 6 h ltime-restricted eating (12:00 p.m.-6:00 p.m.) Control (ad libitum)	Early vs. Late		56	Body weight (significant weight loss between time-restricted eating and control) and cardiometabolic outcomes	Compliance and feasibility
36 (US, 2021)	RCT	*N* = 45; age = 16.4(1.3); 64% females; median weight = 101.4 (87.9–123.8) kg; mean BMI z-score= 2.3(0.5)	Arm 1: 8 h time-restricted eating + continuous glucose monitoring Arm 2: 8 h time-restricted eating + blinded continuous glucose monitoring Control: 12+ h eating + blinded continuous glucose monitoring	Self-selected eating window	+continuous glucose monitoring Low carbohydrate and added sugar	84	Feasibility of time-restricted eating	weight loss (significant within all groups), dietary intake and quality, physical activity, eating behaviors and practices, and quality of life
37 (Australia, 2019)	Uncontrolled trial	*N* = 30; mean age= 15.1(1.4); 83% females; median BMI = 34.9 (27.7–52.4) kg/m^2	intermittent energy restriction: VLED 600–700 kcal/d for 3 d/wk and Prescribed healthy eating plan 4 d/wk	alternate day fasting	Energy Restriction	84	Body weight (significant weight loss within group)	Body composition, cardiometabolic outcomes, vascular structure, eating behaviors, and quality of life
114 (US, 2019)	Uncontrolled trial	*N* = 21; 76.2% females; mean age=16.2 (1.4); mean BMI = 41.9 (6.2) kg/m^2	Arm 1: Protein-sparing modified fast: 1200–1800 calories, 40–60 g of carbohydrate/day and 1.2–1.5 g protein/ kg of ideal body weight	Protein-sparing modified fastMF	Energy restriction	365	Body weight (significant weight loss within group)	BMI and psychosocial HRQOL
98 (Canada, 2017)	Uncontrolled trial	*N* = 22; 100% females; mean age = 21.3(1.2); mean Weight= 65.1(12.5) kg	Arm 1: 8 h time-restricted eating between 12 and 8 pm	Late		56	Body weight (significant weight loss within group)	Adherence, hunger, satisfaction, and fullness

Table 1 (continued) | Overview of intermittent fasting studies among adolescents and young adults that included efficacy data cataloged by study characteristics, study design, and outcomes

Reference (location, year)	Study Design	Participants (sample size; age=mean (SD); % F or M; baseline weight status)	Intervention	Eating window	Multi-component	Duration (days)	Primary Outcome	Secondary Outcome
107 (China, 2022)	RCT (Crossover study)	N = 12; healthy volunteers; 58% females; mean age=24 (2.3); mean BMI = 21.9 (1.71) kg/m^2	Arm 1: 5.5 time-restricted eating Control: 11 h eating control	Late	Isocaloric	14	Energy balance	Blood glucose and physiological markers
108 (Portugal, 2021)	RCT (Crossover study)	N = 12; healthy students; 100% males; mean age= 22.4 (2.8); mean BMI = 24.2 (2) kg/m^2	Arm 1: 8 h time-restricted eating between 1 and 9 pm Control: Non-time-restricted eating control (usual diet w/o time restriction)	Late	Isocaloric	56	Wingate anaerobic test performance	Body composition
102 (South Korea, 2021)	Uncontrolled trial	N = 33; mean age=22.5 (2.8); 76% females; mean BMI = 22.7(2.7) kg/m^2	Arm 1: 8 h time-restricted eating	Self-selected		24	Body composition and cardiometabolic outcomes	Meal patterns, sleep, and physiological factors
104 (US, 2020)	RCT	N = 22; age = 22(2.5); 100% males; mean Weight=90.3(24) kg; mean BMI = 28.5(8.3) kg/m^2	Arm 1: 8 h time-restricted eating (ad libitum) Arm 2: 8 h time-restricted eating (isocaloric)			28	Cardiometabolic health markers and antioxidant status	Caloric intake
105 (Italy, 2020)	RCT	N = 16 cyclists; 100% males; mean age= 19.3(0.1); mean Weight= 69.66 (6.11); mean BMI = 22.16 (1.74)	Arm 1: 8 h time-restricted eating (10–11 am to 6–7 pm) Control: Normal Diet (ND) (7 am to 9 pm)	Late		24	Body weight, body composition, and peak power output	Blood biomarkers
101 (China, 2020)	RCT	N = 80 active females; 100% males; mean age= 22.1 (2.1); mean Weight=76 kg; mean BMI = 25.14	Arm 1: 8 h time-restricted eating from 19:30 to 03:30 Control: Non-time-restricted eating	Late		24	Cardiometabolic outcomes and circadian rhythm	Microbial diversity
112 (US, 2020)	RCT	N = 26; recreationally active males; 100% males; mean age = ~22.7; mean weight = ~ 82.65 kg	Arm 1: 8 h time-restricted eating with 25% calorie deficit Control: normal diet with 25% calorie deficit		Energy restriction Resistance training	24	Body composition	Muscle performance, resting energy expenditure, and blood biomarkers
116 (Australia, 2020)	RCT (Crossover study)	N = 24; healthy lean; 50% females; mean age= 23(2.6); mean BMI = 22.1 (2.5) kg/m^2	Arm 1: 12 h overnight fast Arm 2: 14 h overnight fast Arm 3: 16 h overnight fast			9	Postprandial glycemia and insulinemia	Energy intake at subsequent meal
120 (UK, 2019)	RCT (Crossover study)	N = 12; healthy males; 100% males; mean age= 25(3); mean BMI = 26 (4) kg/m^2	Arm 1: FASTED AM-brisk walking Arm 2: FED AM-brisk walking Arm 3: FASTED PM-brisk walking Arm 4: FED PM-brisk walking	Early vs. Late	brisk walking	4	Gastric emptying	Metabolic responses and appetite
100 (US, 2019)	RCT	N = 40 active females; 100% females; mean age= 22.1(2.6); mean Weight=63.9(7.8) kg	Arm 1: 8 h time-restricted eating between 12 and 8 pm + resistance training Arm 2: 8 h time-restricted eating between 12–8 pm and resistance training Control: diet and resistance training	Late	β-hydroxy β-methylbutyratemeasurement Resistance training	56	Body composition	Muscular performance and physiological outcomes
118 (UK, 2019)	RCT (Crossover study)	N = 8; active males; 100% males; mean age= 25 (2); mean Weight= 74.6 (5.2) kg	Arm 1: fasted state cycling Control: fed state cycling (consumed a carbohydrate-		cycling	2	Skeletal muscle signaling responses	Substrate Availability and Utilization

Table 1 (continued) | Overview of intermittent fasting studies among adolescents and young adults that included efficacy data cataloged by study characteristics, study design, and outcomes

Reference (location, year)	Study Design	Participants (sample size; age=mean (SD); % F or M; baseline weight status)	Intervention	Eating window	Multi-component	Duration (days)	Primary Outcome	Secondary Outcome
			rich mixed-macronutrient breakfast 2 h before exercise)					
117 (France, 2018)	RCT (Crossover study)	$N = 12$; young males; 100% males; mean age= 21(0.5); mean BMI = 22.5 (1.7) kg/m^2	Arm 1: Energy restriction condition (Def-EI) involving a 24-h fast. Arm 2: Exercise condition (Def-EX) with energy depletion matched to the energy restriction condition through exercise. Control: no energy depletion		Energy restriction and exercise	6	Appetite and energy intake responses	Macronutrient intake and food reward
109 (UK, 2018)	RCT	$N = 14$; lean men; 100% males; mean age = 25 (4); mean BMI = 24 (2) kg/m^2	Arm 1: Energy Restriction (ER): 24-h 25% calories based on estimated needs Control: Energy Balanced (EB): 24-h 100% % calories based on estimated needs	alternate day fasting	Energy Restriction	2	Glycemic control	Body mass
119 (Malaysia, 2018)	RCT	$N = 20$; college students; 100% males; mean age= 20.5(1); mean Weight= 67 (4.5) kg	Arm 1: IF (four meals) Control: five meals		Calorie restriction and high-intensity exercise	10	Wingate Anaerobic Power and High-Intensity Time-to-Exhaustion (HIT) Cycling Performance	Physiological Measures
113 (Denmark, 2017)	RCT	$N = 20$; healthy lean subjects; 100% males; mean age = 23.5 (2.8); mean weight = 78.7 (8.5) kg	Arm 1: Alternate Day Calorie Arm 2: Restriction (ADCR): bed rest with 25% of total energy requirements every other day and 175% of total energy requirements every other day Control: bed rest with three daily isoenergetic meals	alternate day fasting		8	Insulin resistance	Cognitive function, body composition, and physical capacity
99 (US, 2017)	RCT	$N = 18$ active males; 100% males; mean age=22.45(3.25); mean Weight=83.2(16.3) kg	Arm 1: 4 h time-restricted eating anytime between 4 pm–12 a.m. for 4 days/week + resistance training on the other 3 days of the week Control ND + resistance training 3 days/week	Late	Resistance Training	56	Body composition	Dietary intake
96 (US, 2016)	RCT (Crossover study)	$N = 21$; young adults; 71% males; mean age= 21(3); mean BMI = 25(3) kg/m^2	Arm 1: short-term energy deprivation (ED) Control: energy balance (EB)		Energy restriction	4	Insulin, Acyl Ghrelin, and Leptin	Appetite and energy intake
106 (US, 2015)	RCT (Crossover study)	$N = 17$; healthy participants; mean age= 24; mean BMI = ~ 24 kg/m^2	Arm 1: IF only (IF) Arm 2: IF with antioxidant supplementation (IFAO)		Isocaloric	70	Gene expression	Oxidative stress
115 (US, 2013)	RCT	$N = 29$; 41.4% females; mean age = 22 (3.34); mean BMI = 41.9 (6.2) kg/m^2	Arm 1: 8 h time-restricted eating Control: eating an 810–860 kcal meal 4–5 h before each study visit	Late		5	Muscle damage indicators	Inflammation and oxidative stress markers

Table 2 | Overview of intermittent fasting studies among adolescents and young adults that included efficacy data cataloged by results reported

Reference	Feasibility/Acceptability	Adherence	Weight outcome	Metabolic markers	Biological markers
121	Not specifically measured in this study.	Not specifically measured in this study.	↓ BMIz, BMI, and %BMI_{p95} at week 52 in both groups (IER and CER)	↓ Blood pressure percentiles, TC, triglycerides, and fasting plasma insulin in both groups ↓ number of participants with insulin resistance in both groups at week 16, and only in the CER group at week 52	N/A
97	HOW: participant satisfaction Satisfaction surveys showed that ltime-restricted eating was viewed favorably by most participants.	HOW: recording the time, they started and finished eating daily, the number of days they adhered to their prescribed eating schedule, and barriers to adherence RESULTS: Adherence to the ltime-restricted eating protocol was high, with mean compliant days = 6.2 d/week, 3/27 adolescents reported barriers to implementing their assigned eating window into their daily schedule, including conflict with work or sleep schedule, social commitments, and explaining eating patterns to family	↓ %BMI_{p95} at week 12 by: −3.4% in the ltime-restricted eating group and −2.8% in the control ↓ %BMIp95 at week 12 by 5% in: 46% of the ltime-restricted eating and 21% in control	↓ HbA1C in both groups ↑C-peptide in ltime-restricted eating ↓ALT in ltime-restricted eating	N/A
110	The study did not specifically measure feasibility.	Dietary adherence was not evaluated. Minor adverse reactions were reported, including lack of concentration, dizziness, tiredness, thirst, irritability, leg pain, and back pain.	↓ body weight and lean body mass in time-restricted eating, time-restricted eating+Exercise, and Exercise groups compared to baseline ↓ body weight in time-restricted eating and time-restricted eating +Exercise groups compared to control ↓ BMI in time-restricted eating, time-restricted eating+Exercise, and Exercise groups compared to control	↑ fat% in Exercise and time-restricted eating +Exercise groups compared to baseline ↓ lean body mass in time-restricted eating, time-restricted eating+Exercise, and Exercise groups compared to control ↑ fat% in Exercise and time-restricted eating +Exercise groups compared to time-restricted eating group ↑ TC in time-restricted eating, time-restricted eating+Exercise, and Exercise groups after study period	N/A
111	The study did not specifically measure feasibility.	only one participant lost to follow-up Participants maintained their self-selected eating windows, and adherence was monitored through daily dietary records and sleep logs	↓ body weight and BMI only in the early time-restricted eating group compared to baseline ↓ waist circumference in all participants	↓ fat mass and fat mass% only in the early time-restricted eating group compared to baseline ↓ fasting BG, HOMA-IR, insulin, TG, and HDL in the early time-restricted eating group compared to baseline ↑ LDL HDL in the early time-restricted eating group compared to baseline ↓ TG in the late time-restricted eating group compared to baseline	N/A
103	Not specifically measured in this study.	Both etime-restricted eating and ltime-restricted eating groups were able to adhere to their respective eating windows throughout the 8-week intervention. However, adherence gradually decreased over time.	↓ weight and BMI in etime-restricted eating and ltime-restricted eating compared to control ↓ waist circumfrance in etime-restricted eating compared to control	↓ fat mass in etime-restricted eating and ltime-restricted eating compared to control ↓ fat-free mass in etime-restricted eating compared to control, and in ltime-restricted eating compared to etime-restricted eating ↓ fat mass% in ltime-restricted eating compared to control ↓ visceral fat in etime-restricted eating and ltime-restricted eating compared to control ↓ mean BG in etime-restricted eating compared to control ↑ mean BG in ltime-restricted eating compared to etime-restricted eating ↓ C-peptide, insulin resistance(HOMA-IR & fasting insulin), and SBP in etime-restricted eating compared to control ↓ leptin in etime-restricted eating and ltime-restricted eating compared to control ↑ LDL in etime-restricted eating and ltime-restricted eating compared to control	↑ superoxide dismutase in etime-restricted eating compared to ltime-restricted eating and control
36	Satisfaction Questionnaire, and exit Interview: 90% reported that the study was worthwhile, 95% reported that they would recommend it to others, 15% reported barriers to implementing their assigned eating window, mean score of how	HOW: Adolescents were asked to record the time they started and finished eating daily, the number of days they adhered to their prescribed eating schedule, and barriers to adherence. RESULTS: Mean number of time-restricted eating compliant days =	↓ ≥5% weight loss: -in 31% of time-restricted eating +continuous glucose monitoring -in 26% of time-restricted eating +blinded continuous glucose	N/A	N/A

Table 2 (continued) | Overview of intermittent fasting studies among adolescents and young adults that included efficacy data cataloged by results reported

Reference	Feasibility/Acceptability	Adherence	Weight outcome	Metabolic markers	Biological markers
	helpful time-restricted eating was = 4/5, mean score of how enjoyable time-restricted eating was = 4/5	5.2 d/week, 15% reported barriers to implementing their assigned eating window including conflict with work or sleep schedule, social commitments, and explaining eating patterns to family.	monitoring -in 13% of the control group		
37	Participants rated the intermittent energy restriction diet as easy and pleasant to follow (mean ± SD on a Likert scale from −4 to +4: +2.1 ± 1.2 for ease, +1.9 ± 1.2 for pleasantness). At 12 weeks, 23 participants chose to continue with intermittent energy restriction, and at 26 weeks, 19 participants remained on the VLED.	Participants maintained adherence to the VLED on prescribed days, with reported energy intake closely aligning with the prescribed 2500–2900 kJ/day	Compared to baseline: ↓ BMI %95th ↓ BMI z-score ↓ waist-to-height ratio	No changes	N/A
114	Not specifically measured or reported.	Adherence was measured based on participants' dietary recalls and categorized as "adherent" or "non-adherent." At 3 months, adherence was higher among participants who attended clinic visits (58.3%). Adherence dropped significantly by 6 months (37.5%).	↓ weight after 6 months (−4.7(6.6) kg; $p = 0.04$) but nonsignificant after 12 months (−1.3(10.6) kg; $p = 0.35$)	N/A	N/A
98	Self-reported measures of hunger, satisfaction, and fullness remained stable over the 4-week period (0: "Not hungry at all, completely empty, or not full at all" and 100: "Never been more hungry, cannot eat another bite, or totally full": Hunger: average 45 mm ($p = 0.877$) Satisfaction: average 51 mm ($p = 0.589$) Fullness: average 51 mm ($p = 0.812$)	HOW: Weekly emails were sent to participants reminding them to record their adherence, hunger, satisfaction, and fullness. Participants reported high adherence, maintaining the eating regimen for an average of more than 5.5 days per week with no significant variations across the weeks ($p = 0.902$)	↓ body weight with mean change of −0.6 kg	↓ fat mass in the subgroup performing resistance exercise, but this wasn't reported in the other subgroups (nonexercised, endurance-exercise, or endurance-resistance-exercise)	N/A
107	The study did not specifically measure feasibility.	The participants adhered strictly to the dietary intervention protocol, which involved consuming an isocaloric diet under rigorous control conditions. All food intake, physical activity, and other variables were meticulously monitored to ensure compliance with the intervention protocol.	N/A	↑ fecal energy loss and a (non-significant) trend in urine energy loss without energy expenditure alteration in time-restricted eating compared to control ↓ energy balance in time-restricted eating compared to control ↓ mean 24-h BG and heart rate in time-restricted eating compared to control	N/A
108	The study did not specifically measure feasibility.	Adherence to the dietary interventions was assessed through self-reported dietary records. Despite these measures, six participants were excluded for non-adherence.	No significant change	No significant change in body composition	N/A
102	Not specifically measured in this study.	Participants maintained an average of 2.8 eating occasions per day. Meal patterns showed consistent adherence, with participants consuming 39.2% of energy at lunch, 37.6% at dinner, and 18.5% via snacks. Despite high adherence, the weight gain group consumed significantly more saturated fat at dinner (6.0% of total energy, $p = 0.0241$) compared to the weight loss group (3.1% of total energy).	in total group and female subgroup but not male subgroup: ↓ mean weight ↓ mean BMI	↓ mean fat mass% in total group ↓ fasting insulin in the subgroup who lost weight ↓ HOMA-IR in the subgroup who lost weight ↑ LDL in total group and in the subgroup who lost weight ↓ HDL in the subgroup who lost weight	N/A
104	Not specifically measured in this study.	Participants adhered to the 16:8 time-restricted feeding protocol consistently, with an average eating window of 7.2 ± 0.7 h and an average fasting time of 16.7 ± 0.8 h	↓ body mass (kg) in both groups	↑ HDL in both LDL in ad libitum > isocaloric TC in ad libitum > isocaloric cortisol in ad libitum > isocaloric insulin in ad libitum > isocaloric RMR in ad libitum > isocaloric fat mass in ad libitum > isocaloric ↓ fat mass in both groups ↓ SBP in both groups ↓ DBP in both groups ↓ HR in both groups	↑ adiponectin in both CRP in ad libitum > isocaloric glutathione in ad libitum < isocaloric NOx in ad libitum > isocaloric
105	Not specifically measured in this study.	All participants followed their prescribed diet plans, which included regular meal timing, caloric intake, and macronutrient distribution.	↓ body weight of 2% in time-restricted eating compared to baseline	fat mass% of ND at week 4 > fat mass% of time-restricted eating at week 4 ↓ IGF-1 and testosterone free in time-restricted eating (but fat-free mass was maintained) ↓ cortisol in both groups	↑ adiponectin/fat mass in time-restricted eating compared to baseline ↓ leukocytes in ND ↓ neutrophils% in both groups ↑ lymphocytes in both groups ↓ neutrophil-to-lymphocytes ratio in

Table 2 (continued) | Overview of intermittent fasting studies among adolescents and young adults that included efficacy data cataloged by results reported

Reference	Feasibility/Acceptability	Adherence	Weight outcome	Metabolic markers	Biological markers
					time-restricted eating (inflammatory marker)
101	Not specifically measured in this study.	Not specifically measured in this study.	N/A	↓ TC and TAG in post time-restricted eating compared to pre-time-restricted eating and to non-time-restricted eating level. LDL remained the same ↑ HDL in post-time-restricted eating compared to non-time-restricted eating ↓ AST and ALT in post time-restricted eating compared to pre-time-restricted eating and non-time-restricted eating	serum IL-1B and TNF-a reduced in post-time-restricted eating but not statistically significant
112	HOW: The perceived recovery scale (PRS), daily analyses of life demand for athletes (DALDA), and visual analog scales (VAS) RESULTS: No significant differences between the groups were noted for emotional eating, uncontrolled eating, perceived recovery between training sessions, VAS (energy, desire to eat, fullness, hunger, and motivation to do physical tasks), or perceptions of daily life stressors	Participants reported dietary intake for three days each week using the MyFitnessPal application. A member of the research team checked food log compliance each week during resistance training sessions. Total calories, relative calories, carbohydrate (grams), fat (grams), and protein (grams) were collected from food logs. Average macronutrient and calorie intakes were compared between groups.	↓ body weight, fat mass, and fat mass% in both groups	↓ testosterone and REE in both groups ↑ plasma cortisol levels only in control	↓ adiponectin in both groups
116	Not specifically measured or reported.	Not specifically measured or reported.	N/A	↓ fasting BG and fasting insulin in all participants ↑ postprandial glycemic response in females with longer fasting periods ↓ HOMA-IR in females as fasting increased from 12 to 16 h	N/A
120	Not specifically measured or reported.	Not specifically measured or reported.	No significant differences in weight were reported.	No significant differences were reported for glucose concentrations. Significant trial effect for CHO oxidation, with higher rates in FED trials ($P = 0.001$).	N/A
100	HOW: questionnaires RESULTS: At 4 weeks, 84% of participants reported no side effects. At 8 weeks, 90% of participants reported no side effects. Reported side effcets included: •Suppressed appetite (TRF group: 1 participant) •Increased appetite with irritability (TRF group: 1 participant) •Morning fatigue (TRFHMB group: 1 participant) •Nausea (CD group: 1 participant) •Bloated stomach (CD and TRFHMB groups: 1 participant each) QUESTIONNAIRE RESPONSE: •Improvements in scores for the Mood and Feelings Questionnaire at W4 and W8 compared to baseline (W0) in all groups. •Reduction in the uncontrolled eating score of the Three Factor Eating Questionnaire across time in all groups. •Proportion of participants with regularly occurring menstrual cycles ranged from 69% to 79% across groups.	Compliance with the assigned eating schedule was ≥89% on average.	↑ weight in all groups	↑ fat-free mass and muscle thickness in all groups ↓ fat mass and fat mass% in time-restricted eating and time-restricted eating+ HMB groups but ↑ in control	N/A
118	Not specifically measured or reported.	Not specifically measured or reported.	N/A	No significant differences in weight were reported.	N/A
117	Not specifically measured or reported.	The study design involved healthy young males and the adherence to the protocol was ensured by the controlled laboratory settings and the randomization process. Participants adhered to the dietary restrictions or usual dietary habits as per the protocol.	N/A	N/A	N/A
109	The study did not specifically measure feasibility.	Adherence was assessed indirectly through controlled provision of meals and instructions for consumption. Compliance was ensured by providing all food and drink during the study period and instructing subjects to perform minimal activity.	↓ body weight in both groups but significantly to a greater extent after ER	↓ fasting BG after ER compared to EB ↓ fasting serum insulin and HOMA2-IR after ER compared to EB ↑ fasting NEFA after ER compared to compared to EB ↑ postprandial BG after ER compared to EB ↑ postprandial serum insulin after ER	N/A

Table 2 (continued) | Overview of intermittent fasting studies among adolescents and young adults that included efficacy data cataloged by results reported

Reference	Feasibility/Acceptability	Adherence	Weight outcome	Metabolic markers	Biological markers
				compared to EB ↑ postprandial NEFA after ER compared to EB	
119	Not specifically measured or reported.	Not specifically measured or reported.	No significant differences in weight were reported.	Significant effect of the fasting group on reducing triglycerides was reported ($p < 0.0001$).	N/A
113	Not specifically measured or reported.	The mean recorded daily energy intake was slightly lower than the estimated daily energy expenditure (7.4 kcal/day deficit, 95% CI: 2.1; 12.6, $P = 0.009$). The ADCR group managed to overeat every other day to compensate for the days of caloric restriction, ensuring overall energy balance.	↓ body weight among all participants compared to baseline	No positive effects were associated with ADCR on the negative health outcomes of bed rest. ↑ cortisol among all participants compared to baseline ↑ total cholesterol and LDL among all participants compared to baseline ↓ HDL among all participants compared to baseline	↑ TNF-a among all participants compared to baseline
99	reported Difficulty of TRF (VAS) 4 weeks: 3.6 ± 1.4 out of 10 8 weeks: 3.8 ± 2.2 out of 10 ($p = 0.86$)	Compliance Rates TRF Program: 95.9 ± 4.1% resistance training Programme (resistance training -ND): 92 ± 10% resistance training Programme (resistance training -TRF): 91 ± 8%	no significant change	no significant change in fat-free mass, fat mass, or fat mass%	N/A
96	Not specifically measured or reported.	21 out of 31 enrolled participants completed both ad libitum meal tests. Reasons for attrition included relocation, unrelated illness, esophageal reflux, nausea/vomiting, weakness and hunger, and inability to provide blood samples. Non-completers did not significantly differ from completers in age, sex, or BMI.	Participants experienced a significant reduction in body weight during energy deprivation ($p < 0.001$).	Fasting Glucose decreased significantly during ED but remained unchanged during EB ($p < 0.001$). Fasting Insulin decreased significantly during ED but remained unchanged during EB (0.01).	N/A
106	HOW: Dietary satisfaction survey RESULTS: A majority of participants expressed difficulty with finishing food on feasting days (76% agreed) and with eating so little on fasting days (65% agreed). Comparing fasting and feasting days, the majority of participants disagreed that feasting was more difficult than fasting (55% disagreed). Few participants rated the diet as improving quality of life overall (35% agreed). Importantly, a majority of participants rated the fasting days as making daily activities more difficult, but less than half rated the feasting days as making daily activities more difficult. Although participants would recommend the diet to a friend (71% agreed), most described the diet as more difficult than previously attempted diets (71% agreed), and only 18% would follow the diet if prescribed by a physician.	High compliance was noted, with participants consuming within 5% of the prescribed caloric intake on most pre-conditioning and fasting days. However, there was lower adherence on feasting days, with significant difficulty in consuming the full 175% of caloric intake.	The study aimed to maintain weight.	↓ plasma insulin in IF group (0.0023) but not the IFAO group (0.33)	(not significant but a trend) ↑ expression of *SIRT3* in the IF ($p = 0.0772$)
115	Not specifically measured or reported.	Participants adhered to the fasting and dietary restrictions, as verified by questionnaires.	N/A	N/A	↑ NO in fasting compared to control group ↓ TNF-a in fasting compared to control group

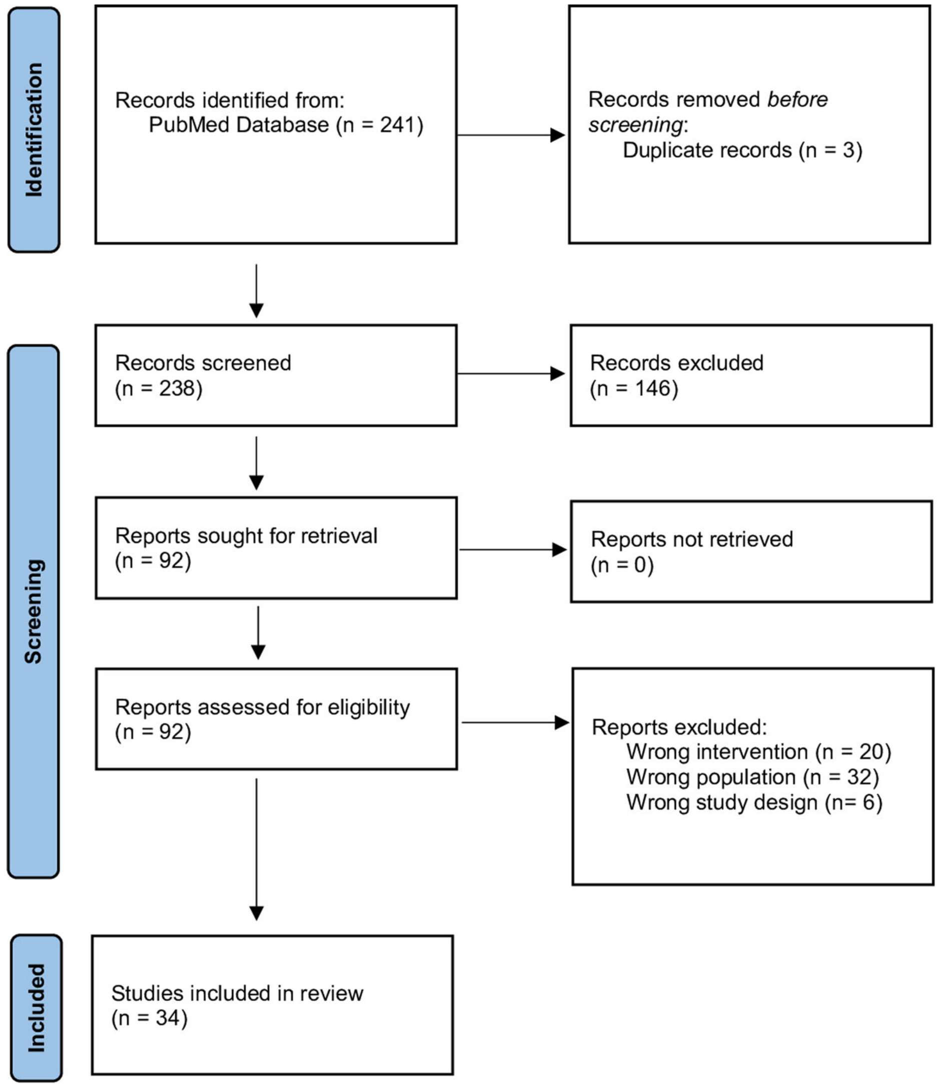


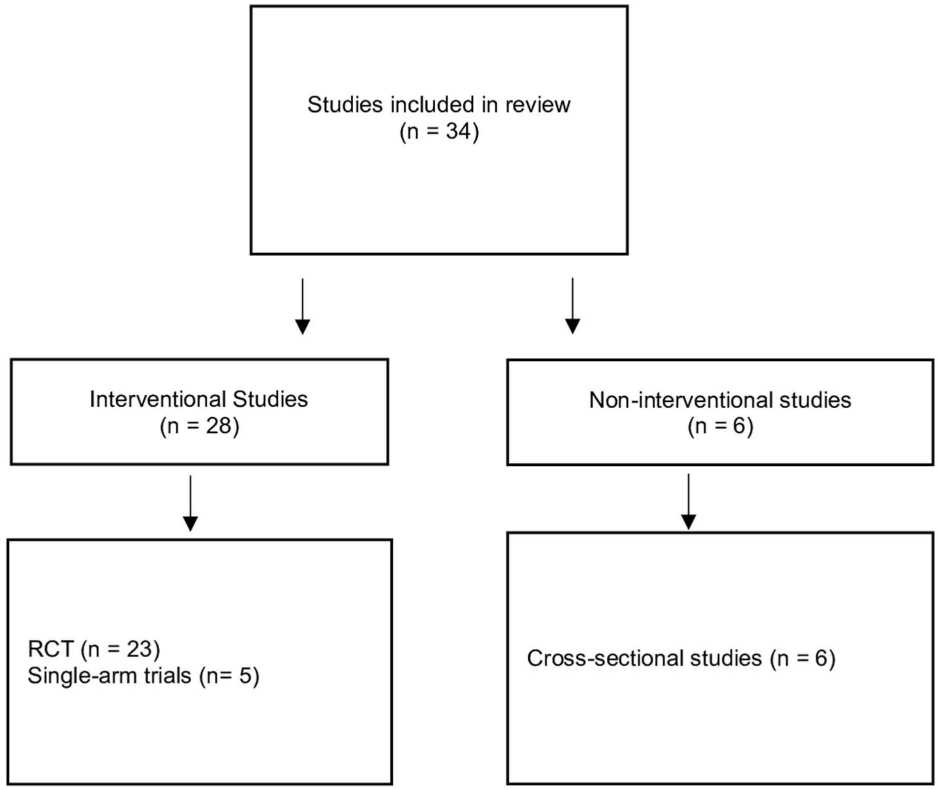
Fig. 1 | Scoping review flow diagram. The PRISMA flow diagram for new systematic reviews detailing the database searches, the number of abstracts screened, and the full texts retrieved.

focusing on discussing and evaluating the cardiometabolic effects, parental acceptability, and eating behaviors in adolescents and young adults, without involving the experimental manipulation of timing of eating.

The sample size of included interventional studies ranged from eight to 141 participants, ages 12–25 years old[36,37,96–120]. Of the interventional studies included, six focused on adolescents alone with a mean age of 15 and above up to 18 years, while 22 studies involved emerging adults with mean ages above 19 and below 25. Some studies included a majority of female participants (e.g., 64% in Vidmar et al.[36], while others only included male participants (e.g., 100% males in McAllister et al.[104] and Harder-Lauridsen et al.[104,113]. A few studies reported an approximately even sex distribution[103,116]. Participants' baseline weight status also varied widely, from those with a median or mean weight indicating overweight or obesity (e.g., median weight = 101.4 kg in Vidmar et al.[36] to those with participants in the normal weight range (e.g., mean Body mass index = 22.7 kg/m^2 in Park et al.[102]. Seventeen studies included participants with normal mean or median weight, while 11 studies involved participants with overweight or obesity. Regarding health status, most studies included generally healthy participants without significant comorbidities, chronic conditions, or medication use[98–100,102,105–113,116–119]. However, one study specifically included participants with type 2 diabetes[97].

Interventional studies focused on the efficacy or effectiveness of intermittent fasting interventions on exercise performance, body composition, body weight, metabolism, and/or biological aging markers, as summarized in Table 1[36,37,97–120]. Nine studies utilized intermittent fasting as an obesity treatment for cohorts of young people with obesity. The primary outcomes varied, which involved assessing the efficacy of various intermittent fasting interventions on body weight, body composition, cardiometabolic health markers, energy balance, and specific physiological responses such as glycemic control and muscle damage indicators. Secondary outcomes were also diverse and included assessments of dietary intake quality, physical activity, sleep patterns, eating behaviors, quality of life, glycemic control, blood biomarkers, microbial diversity, muscular performance, hunger, craving, mood, cognitive function, appetite, and energy intake responses. Most interventional studies involved interventions with short duration, spanning 4–12 weeks, which limits conclusions about long-term efficacy and safety. Among these studies, 23 were randomized controlled trials[36,97,99–101,103–105,109,110,112,113,115,121] and five were single-arm trials[37,98,102,111,114]. Thirteen studies utilized an 8-h time-restricted eating, where participants follow an 8-h eating window and a 16-h fasting period[36,97,98,100–102,104,105,108,110–112,115], and three tested other forms of intermittent fasting, including Alternate-Day Calorie Restriction[113], Intermittent Energy Restriction[121], and Protein-Sparing Modified Fast[114]. Other studies investigated different time-restricted eating windows or other intermittent fasting protocols. For instance, Zhang et al.[103] compared early (7:00 a.m.–1:00 p.m.) and late (12:00 p.m.–6:00 p.m.) 6-h time-restricted eating windows[103], and Bao et al.[107] tested the efficacy of a 5.5-h time-restricted eating window compared to an 11-h eating control group[107].

Fig. 2 | Methodologies of the Included Studies in the Scoping Review.



The intervention modalities varied across studies. Fifteen studies involved multimodal interventions combining time-restricted eating with various other health and behavioral lifestyles modalities including, continuous glucose monitoring, resistance training, energy restriction, low carbohydrate and added sugar diets, brisk walking, high-intensity exercise, antioxidant supplementation, and protein-sparing modified fasts. The specific details of the IF approach also varied by study. Only one study directly compared early and late time-restricted eating[103], whereas all others compared the IF approach to a control condition. In addition, the caloric requirements integrated into the IF approach varied across studies, with some implementing isocaloric conditions (maintaining the same caloric intake)[97,104], energy restriction (e.g., 25% calorie deficit, very low-calorie diets)[109], and intermittent fasting days such as alternate day fasting[37] and intermittent energy restriction[109]. Specific interventions like the protein-sparing modified fast had defined caloric intake ranges (1200–1800 calories with low carbohydrate and high protein)[114].

Table 2 presents an overview of the interventional studies, cataloged by the results reported. There was great heterogeneity in how feasibility was defined across various study designs. None of the studies utilized the seven Theoretical Framework of Acceptability components. A few of the individual components of the framework were captured: 6/28 affective attitude, 3/28 burden, 0/28 ethicality, 0/28 intervention coherence, 0/28 opportunity costs, 1/28 perceived effectiveness, and 0/28 self-efficacy.

Nine studies were conducted in cohorts of young people with obesity utilizing intermittent fasting as an obesity treatment[36,37,97,98,103,110,111,114,121]. Most of the remaining studies captured changes in weight as a secondary outcome despite the primary objective of the intervention not being weight change. There was a variety of weight status and body composition measures utilized across studies. The most commonly reported measures were the following: change in weight, pre and post weight, pre and post body mass index, and change in weight in excess of the 95th percentile. All nine studies that included young people with obesity reported significant improvement in at least one weight-related outcome following the intermittent fasting program compared to baseline[36,37,97,98,103,110,111,114,121], and only one study reported significant weight loss after following a 6-h time-restricted eating for 8 weeks compared to the control group (ad libitum diet)[103].

Overall, studies utilizing intermittent fasting interventions in adolescents and young adults have demonstrated variable effects on weight loss, influenced by factors such as intervention type, participant demographics, and additional lifestyle components. Vidmar et al.[36] conducted a randomized controlled trial with 45 adolescents (mean age = 16.4 years, 64% females) over duration of 84 days to examine the efficacy of late time-restricted eating in adolescents with obesity. All groups experienced weight loss, with 31% of the participants in the time-restricted eating plus continuous glucose monitoring group, 26% in the time-restricted eating with blinded continuous glucose monitoring group, and 13% in the control group losing ≥5% of their baseline weight. The study reported no significant difference in weight loss between groups ($p = 0.5$). Overall, there was a significant decrease in median weight, body mass index z-score, and weight in excess of the 95th percentile across all groups[36]. Hegedus et al.[97] reported a significant decrease in body mass index at the 95th percentile at week 12, with a 46% reduction observed in the late time-restricted eating group compared to 21% in the control group with an extended eating window[97]. Zhang et al.[103] observed decreases in weight and body mass index in both early and late time-restricted eating groups compared to controls[103]. In Moro et al.[105] study, the time-restricted eating group experienced a 2% weight change from baseline, while this was not the case for participants assigned to the control group[105]. Park et al.[102] documented significant weight loss among female participants, while no significant weight loss was observed among male participants[102]. In contrast, research examining the combination of time-restricted eating with resistance training offers a different perspective[99,100]. Tinsley et al.[100] investigated the effects of an 8-h time-restricted eating combined with β-hydroxy β-methylbutyrate supplementation and resistance training in active females, only to find an increase in body weight across all groups[100]. Similarly, a study by Tinsley et al.[99] on a 4-h time-restricted eating regimen coupled with resistance training in men reported no significant change in body weight[99], indicating that when combined with resistance training, time-restricted eating may not lead to weight loss, possibly due to increases in muscle mass or other physiological adaptations. This suggests that the efficacy of time-restricted eating on weight loss might be influenced by factors such as biological sex, baseline weight, and exercise regimens.

Regarding cardiometabolic outcomes, 19 studies reported one or more cardiometabolic outcomes. Several studies reported improvements in markers of glucose metabolism[97,102,103] For instance, Hegedus et al.[97]. found reductions in hemoglobin A1c and alterations in C-peptide levels in late time-restricted eating groups[97]. Kim and Song observed reductions in fasting blood glucose and improvements in HOMA-IR, indicating better glucose regulation and insulin sensitivity with early time-restricted eating[111]. Zhang et al.[103] highlighted a decrease in insulin resistance after a self-selected 8-h time-restricted eating[103]. One study also reported reductions in systolic and diastolic blood pressure following an 8-h time-restricted eating[104]. Conversely, two studies (one employing alternate day fasting and the other 4-h time-restricted eating)[37,99] observed no metabolic changes compared to baseline. Another study reported significant reductions in fasting insulin, acyl ghrelin, and leptin concentrations during short-term energy deprivation compared to energy balance. Postprandial hormone responses, including insulin, GLP-1, and PP, were elevated after energy deprivation, while acyl ghrelin was suppressed, indicating that altered sensitivity to appetite-mediating hormones may contribute to the adaptive response to negative energy balance[96]. Overall, these findings suggest that intermittent fasting can improve glucose metabolism and insulin sensitivity, though results may vary based on the specific fasting protocol and participant characteristics.

McAllister et al.[104] and Zhang et al.[103] noted decreases in body mass and fat mass in participants adhering to time-restricted eating, while preserving lean mass[103,104]. Additionally, time-restricted eating was associated with decreased liver enzymes aspartate aminotransferase and alanine transaminase in two studies[97,101]. McAllister et al.[104] reported increases in high-density lipoprotein and variations in low-density lipoprotein and total cholesterol depending on the type of time-restricted eating (ad libitum vs. isocaloric)[104]. Zeb et al.[101] found decreased total cholesterol and triglycerides, and an increase in high-density lipoprotein post-time-restricted eating[101] However, divergent effects on lipid profiles were observed as well, with increases in high-density lipoprotein[101,104] as well as in low-density lipoprotein[102,103]. These mixed results on lipid profiles indicate that intermittent fasting may have variable effects on lipid metabolism, potentially influenced by factors such as fasting duration, diet composition, and individual metabolic responses.

Only four studies measured markers associated with biological aging[101,103–105]. McAllister et al.[104] and Moro et al.[105] both reported an increase in adiponectin levels in participants following an 8-h time-restricted eating regimen, whether combined with an ad libitum diet or an isocaloric diet. Elevated adiponectin levels are inversely associated with obesity and oxidative stress and correspond to improved metabolism and resting energy expenditure[104,105]. Additionally, Moro et al.[105] observed a significant decrease in the neutrophil-to-lymphocyte ratio, an inflammatory marker, within the time-restricted eating groups compared to controls, indicating reduced inflammation[105]. Zeb et al.[101] observed reductions in serum IL-1B and TNF-a levels post-time-restricted eating, though these changes were not statistically significant, suggesting a potential trend towards reduced inflammation that warrants further investigation[101]. Zhang et al.[103] reported that superoxide dismutase, a crucial antioxidant defense in nearly all living cells exposed to oxygen, significantly increased in participants who engaged in early time-restricted eating compared to those in late time-restricted eating and control groups[103].

Most of the studies did not report serious adverse events or behavioral reactions. However, one study observed that while most participants did not experience adverse events[121], eight serious events occurred across six participants, with two possibly related to the intervention. Specifically, one participant in the continuous energy restriction group developed gallstones requiring cholecystectomy, and another in the intermittent energy restriction group developed atypical anorexia nervosa[121]. A few studies noted mild side effects such as dizziness and loss of concentration[100,110]. Additionally, some studies reported that only a few participants experienced conflicts with work or sleep schedules, social commitments, and explaining eating patterns to family[36,97]. Regarding behavioral reaction concerns, only one study, Thivel et al.[117], observed that when participants were allowed to eat freely after a period of 24 h of energy intake restriction, they consumed significantly more food during the test meal. This reaction did not occur when the energy depletion was caused by exercise[117].

All included observational studies were cross-sectional studies, and they varied in their focus. One study addressed parental interest in time-restricted eating, while others focused on intermittent fasting's effects on cardiometabolic markers and the associated concerns with intermittent fasting[122–127]. Tucker et al.[122] found that two-thirds of parents with children in pediatric weight management programs showed interest in time-restricted eating for ≤12 h per day, with interest waning for stricter limits of ≤10 or ≤8 h[122]. Observational research examining the relationships between the timing of eating, weight management outcomes, and cardiometabolic risk factors suggests there is no meaningful impact on body composition. However, there may be benefits to cardiometabolic health from adopting earlier and shorter eating windows[124–126]. Nevertheless, skipping breakfast was associated with increased cardiometabolic risk factors in adolescence, as observed in a cross-sectional survey study by de Souza et al.[123]. Another study reported that diets low in carbohydrates and those involving intermittent fasting were linked to increased disordered eating behaviors, including binge eating and food cravings. These findings suggest that such restrictive diets may heighten cognitive restraint, leading to an upsurge in food cravings. However, this study's reliance on a cross-sectional design and a web-recruited university sample, predominantly female, introduces potential biases[127].

Discussion

This scoping review catalogs published studies of intermittent fasting interventions in young people up to age 25. The review included 34 studies (9 randomized controlled trials in cohorts with obesity intended as a treatment approach) and revealed that there is great heterogeneity in study design, methodology, feasibility measures, adherence monitoring, and intervention components across studies of intermittent fasting in adolescents and young adults. The diversity of methodologies and outcomes makes it challenging to summarize the overall efficacy of intermittent fasting as a treatment option in youth with obesity[36,37,97–120]. While intermittent fasting interventions have the potential to be a feasible and acceptable treatment approach for young people with obesity, the current results highlight the need for rigorous studies to investigate feasibility of intermittent fasting utilizing standardized theoretical frameworks for acceptability[95]. This is crucial as an initial step when evaluating new interventions to allow for comparability across studies and cohorts[128,129]. As highlighted in the results; the majority of the studies included captured one to three of the seven recommended components associated with the acceptability framework[95]; however, none utilized all seven components in their entirety. In addition, the majority captured this data via self-report and open-ended questionnaire with very little qualitative data to drive conclusions regarding feasibility and acceptability of intermittent fasting interventions in this age group.

Furthermore, the intervention components investigated varied significantly. This was not only found among what form of intermittent fasting intervention was studied but what additional components of the intervention were included[36,37,97–120]. It very well may be that intermittent fasting based interventions can act as a synergistic intervention to other multi-component health and behavior approaches[37,99,100,109–112,114,117,119], but the studies cannot truly be compared for efficacy when the interventions are not similar in their components. Each intermittent fasting approach may be uniquely suited to a specific individual's preferences, life stage, and resources. Thus, large, well-designed feasibility and efficacy trials should be performed for each intermittent fasting approach compared to a control arm that is standardized across study designs to allow for comparability. In pediatric practice, investigators may consider utilizing a multidisciplinary, family-based intervention model given that is the most utilized health and behavioral lifestyle intervention implemented in this age group[6,10,11].

Time-restricted eating approaches were the most studied form of intermittent fasting used as an obesity treatment included in this review[36,97,98,101,102,104,105,108,110–112,115]. Even among time-restricted eating interventions, there remains significant opportunity for diversity in the approach, which affects the comparison of outcomes across studies[28,78,130]. Despite, studies utilizing different anthropometric measures those studies investigating the effects of time-restricted eating on weight reduction in young people showed similar results to previously published systematic reviews of time-restricted eating in adults with obesity. For example, at week 12 compared to baseline, Jebeiele et al. reported a within subjects' reduction in weight in excess of the 95th percentile of −5.6% ± 1.1 ($n = 30$)[37]; Hegedus et al. reported a with-in-subject reduction in weight in excess of the 95th percentile of −4.3% ± 5.76 ($n = 35$)[97]; and Vidmar et al. reported a with-in subject reduction in weight in excess of the 95th percentile of −3.4% ± 1.2 ($n = 13$)[36]. These findings are similar to outcomes reported with other healthy and behavioral lifestyle modification interventions such as very low-energy diet programs or multi-disciplinary family-based on intervention which often show a 3-5% body mass index reduction after program completion[131–133]. As shown in the results, the timing of the eating window varied by study design with the majority allowing for a participant-identified eating window followed by an afternoon/evening window. This variation in study design highlights a key aspect of intermittent fasting research: understanding the biological mechanisms that lead to improvements in weight and cardiometabolic health across all age groups living with obesity[24,57,134]. There remains debate as to which eating window is most preferred by participants as well as which eating window results in the greatest improvement in weight and cardiometabolic outcomes when adhered to well[97,124,126,135–137]. Further research is needed to understand both of these questions and understand the mechanisms underlying intermittent fasting interventions. Additionally, there is a need for a pragmatic approach to disseminate this type of intervention in real-life settings to optimize engagement and sustained efficacy[124].

Given that adherence to treatment recommendations is the strongest predictor of outcomes; rigorous adherence monitoring is needed in the assessment of novel intervention approaches to accurately assess efficacy[7–10]. There was great variety in the methods utilized to capture adherence to the intervention across studies[36,104,108], limiting comparability as well as the ability to assess how the dosage of the intervention received affected the primary outcome of interest. To advance the field of intermittent fasting interventions, it is crucial to determine the best practices for implementing and disseminating these interventions in pediatric cohorts[6,17,21]. Despite the limitations described above, the preliminary efficacy discussed in the reviewed articles exploring the effects of intermittent fasting on weight loss and cardiometabolic outcomes is consistent with findings reported in adult cohorts [24,33,35,69]. These few studies indicate that intermittent fasting, especially time-restricted eating, can significantly improve weight loss, body composition, and metabolic health, with potential benefits against metabolic syndrome and type 2 diabetes in adolescent and emerging adult cohorts[97,104,111]. However, due to heterogeneity in methodology and quality of the evidence, it is challenging to compare the efficacy across studies. Moreover, in adults intermittent fasting interventions have been shown to have positive effects across other clinical outcomes such as aging, oxidative stress, and inflammation[33,34,49,65]. The current results show the gap in mechanistic data that is available on how intermittent fasting interventions affect these other complex clinical outcomes that may have significant relevance to the long-term benefits for young adults[33,138,139].

Finally, this review draws attention to both the gaps in research regarding the use of intermittent fasting in adolescents and emerging adults and the opportunities. One review study evaluated the impact of the timing and composition of food intake, physical activity, sedentary time, and sleep on health outcomes in youth, suggesting that these factors independently predict health trajectories and disease risks. This underscores the need for a unifying framework that integrates time-based recommendations into current health guidelines for children and adolescents[21]. Expanding diverse nutrition interventions that are developmentally appropriate, practical, and easy to implement across communities and age groups is essential[4,6,17,21]. Intermittent fasting uniquely allows individuals to maintain control over their food choices within a specified eating window[17]. This flexibility in choosing foods, selecting an appropriate eating window, socializing during meals, and dining out without dietary restrictions distinguishes intermittent fasting as a dietary strategy that fosters sustainable behavioral change for an age group in which autonomy is expanding[21,36]. Given that adolescence is a period of growing independence, reflected in food choices and time management[140], further research is needed to understand adolescent and emerging adult eating patterns and frequencies and how those patterns may affect intervention implementation and dissemination. There does remain some concern among the pediatric community relating to the association between dietary restraint and eating disorder risk as well as inhibiting growth in youth participating in intermittent fasting[127,141]. This concern is certainly not isolated to intermittent fasting approaches and is something that the clinical and scientific are working to investigate closely as we thoughtfully treat young people living with obesity. In 2019, a systematic review and meta-analysis was conducted to evaluate the association between obesity treatment with a dietary component and eating disorder risk in children and adolescents[142]. The results demonstrated that professionally supervised dietary interventions are associated with improvements in other markers of eating disorder risk, in contrast to adolescents dieting on their own[142]. Similarly, Jebeile et al.[143] reported that intensive dietary interventions did not worsen mental health or eating behaviors in adolescents with obesity; instead, they observed improvements in symptoms of depression and disordered eating, alongside reductions in BMI and cardiometabolic parameters[143]. Many of the included trials examined in this review investigated the effect of intermittent fasting interventions on eating behaviors. Jebeile et al., Hegedus et al., and Vidmar et al. each captured and highlighted that in their pilot cohorts, there was no evidence of negative compensatory eating behaviors that occurred over the study period as the participants engaged in intermittent fasting approaches[36,37,97]. Despite limited data, in small sample sizes, the current published evidence suggests consistent with other literature in this area, that with proper guidance, youth with obesity, can adhere to intermittent fasting protocols safely without negative effects on eating behaviors[21,36,37,97,142]. Additional large trials of intermittent fasting in youth with obesity are needed to determine if intermittent fasting is an effective treatment strategy for weight reduction and cardiometabolic improvement in this age group. To date, the minimal evidence seems to support its feasibility and acceptability.

To our knowledge, this is the first review of intermittent fasting evidence among adolescents and young adults. The summary of available studies' methodology, intervention parameters, outcomes selected, feasibility, and efficacy fill an important gap in informing future research priorities. While comprehensive in its scope, the review also has several inherent limitations that could influence the interpretation and applicability of its findings. First, this review's ability to draw generalizable conclusions is challenged by the inherent heterogeneity in design, duration, sample size and characteristics, and methodologies. This variability hinders the broad-picture interpretation of intermittent fasting's efficacy. Particularly concerning is the lack of consistency in capturing intervention adherence. Dosage of the intervention is directly associated with efficacy and thus must be included to ensure efficacy accurately reflects the effect of the intervention. The short duration of many studies on intermittent fasting involving adolescents and emerging adults, limits the understanding of intermittent fasting's long-term effects on growth, development, and overall health in this demographic. Additionally, the potential for publication bias, where studies with positive or significant results are more likely to be published than those with negative or inconclusive findings, could inadvertently skew the review's findings in favor of intermittent fasting. The exclusion of gray literature and non-English texts may further introduce bias, potentially overlooking relevant findings not captured in the mainstream or English-speaking research community. Moreover, the review's approach did not extend to quantifying the quality of reporting or to an in-depth exploration of the methodological quality of the included studies, leaving a gap in our comprehension of the strength and reliability of the evidence base.

In conclusion, our scoping review of 34 studies on intermittent fasting among adolescents and emerging adults highlights significant variability in methodologies, intervention components, feasibility measures, and adherence monitoring, which complicates the assessment of studies' quality and comparability. Current findings from this scoping review are insufficient to make strong recommendations for or against intermittent fasting in adolescents and young adults. This review underscores the need for rigorous studies using standardized theoretical frameworks for acceptability and feasibility to enable comparability across studies and cohorts. This is crucial to determine the practicality and sustainability of intermittent fasting interventions in this age group before providing definitive guidance. Further research, especially long-term studies, is essential to better understand intermittent fasting's impact on youth, develop standardized methodologies, and ensure protocols that promote adherence and confirm clinical efficacy.

Data availability

No datasets were generated or analyzed during the current study.

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Author contributions

J.A.B. and A.P.V. conceptualized the study and led the overall project. J.A.B., A.P.V., and S.J.S. wrote the main manuscript text. J.A.B. designed the search strategy. J.A.B. prepared the tables and figures. J.A.B. and A.P.V. contributed to the data extraction and analysis. J.A.B. conducted the literature search, screened articles, and assisted in data extraction. All authors contributed to the interpretation of the data and reviewed and approved the final manuscript.

Competing interests

The authors declare no competing interests.

Additional information

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