



Combined dietary and exercise interventions for body composition and metabolic outcomes in adults with overweight or obesity: a systematic review

Intervensi gabungan pola makan dan latihan fisik terhadap komposisi tubuh dan luaran metabolik pada orang dewasa dengan kelebihan berat badan atau obesitas: tinjauan sistematis

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Article History:

Received: June 10, 2026; Revised: July 20, 2026; Accepted: August 05, 2026; Published: September 15, 2026.

Publisher:



Politeknik Kesehatan Aceh
Kementerian Kesehatan RI

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Abstract

Obesity is a global public health crisis with a rising prevalence in Southeast Asia and substantial consequences for adult health and cardiometabolic risk. This systematic review aimed to evaluate the effectiveness of combined dietary and physical activity interventions on body composition and metabolic biomarkers in adults with overweight or obesity. Following the PRISMA 2020 guidelines, a comprehensive literature search was conducted across PubMed, Cochrane Library, EBSCOhost, and MDPI for peer-reviewed studies published between 2020 and 2025, focusing on randomized controlled trials or quasi-experimental designs. Nine RCTs (2022-2025) were included, which generally reported reductions in BMI and body fat percentage. Favorable changes have been reported across several combined dietary and physical activity approaches. Positive changes in metabolic health, including reduced fasting glucose levels and improved lipid profiles, have also been reported. Interventions showed flexible delivery, including online programs that are feasible in Southeast Asian contexts. These findings suggest that combined dietary and physical activity interventions may improve selected body composition and metabolic outcomes; however, direct evidence from occupational settings remains limited. Future research should assess long-term adherence, sustainability, and context-specific implementation, particularly in under-represented populations.

Keywords: Body composition, cardiometabolic risk, diet therapy, exercise, obesity

Abstrak

Obesitas merupakan krisis kesehatan masyarakat global dengan prevalensi yang meningkat di Asia Tenggara, dengan dampak yang besar terhadap kesehatan orang dewasa dan risiko kardiometabolik. Tinjauan sistematis ini bertujuan untuk mengevaluasi efektivitas intervensi gabungan diet dan aktivitas fisik terhadap komposisi tubuh dan biomarker metabolik pada orang dewasa dengan kelebihan berat badan atau obesitas. Mengikuti pedoman PRISMA 2020, pencarian literatur komprehensif dilakukan di PubMed, Cochrane Library, EBSCOhost, dan MDPI untuk studi yang ditinjau sejawat yang diterbitkan antara tahun 2020 dan 2025, dengan fokus pada uji coba terkontrol secara acak atau desain kuasi-eksperimental. Sembilan RCT (2022-2025) dimasukkan, yang secara konsisten menunjukkan penurunan pada indeks massa tubuh (IMT) dan persentase lemak tubuh. Perubahan yang menguntungkan dilaporkan pada beberapa pendekatan gabungan pola makan dan aktivitas fisik. Perubahan positif dalam kesehatan metabolik,

termasuk penurunan glukosa puasa dan perbaikan profil lipid, juga dilaporkan. Intervensi menggunakan metode pelaksanaan yang beragam dan fleksibel, termasuk program daring yang layak untuk konteks Asia Tenggara. Temuan ini menunjukkan bahwa intervensi gabungan pola makan dan aktivitas fisik dapat memperbaiki luaran komposisi tubuh dan metabolik tertentu; namun, bukti langsung dari lingkungan kerja masih terbatas. Penelitian selanjutnya perlu menilai kepatuhan, keberlanjutan jangka panjang, serta implementasi yang sesuai konteks pada populasi yang masih kurang terwakili.

Kata Kunci: Komposisi tubuh, latihan fisik, obesitas, risiko kardiometabolik, terapi diet

Introduction

Obesity is a major global public health challenge and a leading contributor to noncommunicable diseases (NCDs). According to the World Health Organization (WHO), more than 2.5 billion adults were overweight in 2022, including nearly 890 million with obesity, representing more than a twofold increase since 1990 (WHO, 2024). Excess body weight is strongly associated with cardiovascular disease, type 2 diabetes mellitus, several types of cancer, and premature mortality, imposing substantial clinical and economic burdens worldwide (Alsudairy et al., 2021).

The prevalence of overweight and obesity continues to increase in many regions, including Southeast Asia. In Indonesia, adult obesity has reached 23.4%, whereas abdominal obesity affects more than half of the adult population (Tee & Voon, 2024). Similar upward trends have been reported in other ASEAN countries, highlighting obesity as an important regional public health concern (Osornprasop et al., 2019). Although these data demonstrate the growing burden of obesity in Southeast Asia, evidence regarding the effectiveness of lifestyle interventions in this region remains relatively limited compared to that from Europe, Australia, and North America.

Lifestyle modifications remain the cornerstone of obesity management. Dietary approaches, including energy restriction, low-carbohydrate diets, high-protein diets, Mediterranean dietary patterns, and time-restricted eating, have consistently demonstrated favorable effects on body weight and metabolic health. Likewise, structured physical activity, such as aerobic exercise, resistance training, and high-intensity interval training, improves body composition, physical function, and cardiometabolic outcomes (Hsu et

al., 2019; Nitschke et al., 2022). Because diet and exercise target complementary physiological mechanisms, combining these interventions may produce greater improvements than either strategy alone (Babu et al., 2021; Ramírez-Vélez et al., 2020).

Although numerous randomized controlled trials have evaluated combined dietary and exercise interventions, considerable heterogeneity exists in dietary strategies, exercise modalities, intervention duration, participant characteristics, and outcome measures. Furthermore, relatively few studies have been conducted on Southeast Asian populations, limiting the applicability of existing evidence to this region. Therefore, a systematic synthesis of recent randomized controlled trials is needed to summarize the available evidence and identify the current knowledge gaps.

This systematic review aimed to evaluate the effectiveness of combined dietary and physical activity interventions in improving body composition and metabolic outcomes in adults with overweight or obesity. The review was conducted using the PICOS framework, in which the population comprised adults aged ≥ 18 years with overweight or obesity; the intervention consisted of combined dietary and physical activity programs; the comparator included usual care, single-component interventions, or other lifestyle interventions; and the primary outcomes included changes in body mass index (BMI), body fat, body composition, fasting blood glucose, lipid profile, and other metabolic biomarkers. By synthesizing evidence from randomized controlled trials, this review provides an updated overview of the effectiveness of combined lifestyle interventions, while highlighting the need for further studies in underrepresented populations, including those in Southeast Asia.

Methods

This systematic review was conducted and reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 statement (Page et al., 2021). This review aimed to synthesize evidence on the effectiveness of combined dietary and physical activity interventions in improving body composition and metabolic outcomes among adults with overweight or obesity. The review protocol was not prospectively registered in an international registry (e.g., PROSPERO), and no published protocols were available. Therefore, no protocol deviations were observed.

A comprehensive literature search was conducted in PubMed, the Cochrane Library, and EBSCOhost, with an additional search of the MDPI publishing platform. The final literature search will be performed on March 31, 2025. Studies published in English between January 2022 and March 2025 were considered to be eligible. Search terms were developed using Medical Subject Headings (MeSH) and free-text keywords related to obesity, dietary interventions, physical activity, and metabolic outcomes of interest. The primary Boolean search strategy was as follows: ("obesity" OR "overweight") AND ("diet" OR "diet therapy" OR "dietary intervention" OR "weight loss") AND ("exercise" OR "physical activity" OR "training") AND ("body mass index" OR "BMI" OR "body composition" OR "body fat" OR "blood glucose" OR "lipid profile" OR "metabolic biomarkers")

Database-specific search strategies, field tags, applied filters, and search syntax are listed in Supplementary Table S1.

Eligibility criteria were established according to the PICOS framework. The population consisted of adults aged 18 years or older with overweight (BMI 25.0–29.9 kg/m²) or obesity (BMI ≥30.0 kg/m²). Studies including mixed populations were eligible only when data for adults with overweight or obesity were reported separately or when most participants met these criteria. The intervention comprised a combined dietary and physical activity program. Eligible comparators included usual care, no intervention, dietary intervention alone, exercise intervention alone, and other lifestyle interventions. The primary outcomes were

changes in the body mass index (BMI), body weight, body fat percentage, visceral fat, waist circumference, lean body mass, and fat-free mass. Secondary outcomes included fasting blood glucose, lipid profiles, insulin sensitivity, adipokines, and other metabolic biomarkers. Studies with intervention durations of at least six weeks were eligible. Only randomized controlled trials (RCTs) were included in the final analysis. Although quasi-experimental studies were considered during protocol development, none fulfilled the eligibility criteria after the full-text assessment.

Study selection, data extraction, and risk of bias assessment were independently performed by two reviewers. Disagreements were resolved through discussion until a consensus was reached. Data extracted from each study included the author, publication year, country, participant characteristics, sample size, intervention and comparator, intervention duration, outcome measures, and reported effect estimates, including mean differences, percentage changes, confidence intervals, and p-values, where available. References were managed using Mendeley Reference Manager. The methodological quality of the included studies was assessed using the Cochrane Risk of Bias 2 (RoB 2) tool (Sterne et al., 2019). Because substantial heterogeneity was identified across dietary interventions, exercise modalities, intervention duration, participant characteristics, and outcome measures, statistical pooling was deemed inappropriate. Therefore, the findings were synthesized using narrative synthesis.

As this review analyzed data from previously published studies and did not involve the direct participation of human subjects, ethical approval was not required.

Result and Discussion

Study Selection

A total of 4,215 records were identified from four databases: PubMed (1,312), Cochrane Library (1,959), EBSCOhost (938), and an additional search of the MDPI publishing platform (6). After removing 31 duplicates, 4,184 titles were screened. Following the abstract and full-text screening, nine studies met the inclusion criteria. The complete study

selection process is outlined in the PRISMA 2020 Flow Diagram (Figure 1).

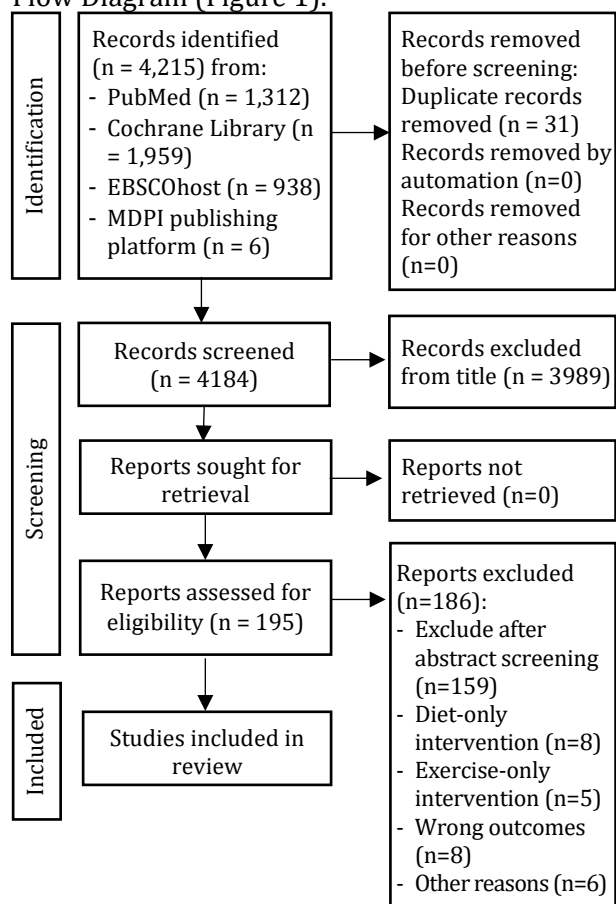


Figure 1. PRISMA 2020 flow diagram of the study selection process (Page et al., 2021).

Characteristics of Included Studies

Nine randomized controlled trials published between 2022 and 2025 were included in this review, involving adult participants with overweight or obesity from Spain, Saudi Arabia, Australia, Thailand, China, and Poland. The sample sizes ranged from 34 to 1,521 participants, with intervention durations varying from 6 weeks to 3 years.

The dietary interventions included energy-restricted Mediterranean diets, low-carbohydrate diets, intermittent energy restriction, time-restricted eating, hypocaloric diets, and high-protein, low-glycemic index diets. The exercise interventions consisted of aerobic, resistance, circuit, and sprint interval training, online exercise programs, and combined aerobic-resistance exercise. The comparator groups received usual care, dietary advice alone, exercise alone, or standard physical activity recommendations.

Overall, the included studies evaluated changes in body composition, including body weight, body mass index (BMI), body fat percentage, visceral fat, waist circumference, lean body mass, and fat-free mass (FFM). Several studies have assessed metabolic outcomes, such as fasting blood glucose, lipid profile, insulin sensitivity, adipokines, and cardiometabolic biomarkers.

Risk of Bias Assessment

The methodological quality of the included studies was assessed using the Cochrane Risk of Bias 2 (RoB 2) tool, which evaluates five domains: (1) bias arising from the randomization process, (2) bias due to deviations from the intended interventions, (3) bias due to missing outcome data, (4) bias in the measurement of outcomes, and (5) bias in the selection of the reported results.

Overall, the methodological quality of the included studies was acceptable. Most trials demonstrated a low risk of bias in the domains of randomization, outcome measurement, and selection of reported results. Some concerns were identified regarding deviations from the intended interventions because participant blinding was generally not feasible in lifestyle intervention studies involving dietary modifications and exercise programs. A small number of studies also reported participant attrition, resulting in concerns related to missing outcome data. Nevertheless, these limitations are unlikely to have substantially influenced the overall findings, and no study was judged to have a high overall risk of bias.

Overall, the quality of the included studies was sufficient to support their inclusion in the qualitative synthesis. Table 3 summarizes the detailed Risk of Bias assessment for each included study.

Effects on Body Composition

Body composition outcomes were the most consistently reported endpoints across the included studies, encompassing changes in body weight, body mass index (BMI), fat mass, lean body mass, waist circumference, and visceral adiposity. Overall, interventions combining intermittent fasting (IF) with structured exercise, particularly resistance training, sprint interval training, or high-intensity interval training (HIIT), demonstrated greater improvements in body composition than either intervention alone.

A reduction in body weight was observed in almost all the intervention groups involving intermittent fasting. Among the included studies, the greatest weight loss was reported when IF was combined with exercise training. For example, Cooke et al. (2022) found that both the IF and IF plus sprint interval training (IF/SIT) groups experienced significantly greater reductions in body weight than those in the sprint interval training group alone after 16 weeks (Cooke et al., 2022). Similarly, Cui et al. (2025) reported significant reductions in body weight in the time-restricted eating (TRE) and TRE combined with resistance training (TRE+RT) groups, with the combined intervention producing the largest decrease (-2.9 ± 1.7 kg) (Cui et al., 2025). Mesinovic et al. (2025) also demonstrated comparable reductions in total body mass following both high-intensity resistance and impact training (HiRIT) and aerobic training, although HiRIT produced greater improvements in physical function than aerobic training (Mesinovic et al., 2025). In contrast, interventions consisting of exercise alone generally resulted in smaller or non-significant changes in body weight.

Consistent improvements were also observed in the body mass index (BMI). Significant decreases in BMI were reported in studies combining intermittent fasting with structured exercise, including those by Cooke et al. (2022), Wichansawakun et al. (2025), Cui et al. (2025), and Suder et al. (2024) (Cooke et al., 2022; Cui et al., 2025; Suder et al., 2024a; Wichansawakun et al., 2025). In particular, Suder et al. (2024) found that only the exercise combined with dietary intervention group demonstrated a significant reduction in BMI after six weeks, whereas exercise alone did not significantly change the BMI. Similarly, Wichansawakun et al. (2025) reported significant within-group reductions in BMI in both intervention groups over 12 weeks, although no significant differences were observed between the groups at study completion (Wichansawakun et al., 2025).

Fat mass is one of the most responsive indicators of combined lifestyle interventions. Five studies consistently demonstrated significant reductions in total fat mass following interventions that incorporated both dietary restriction and exercise. Cooke et al. (2022) observed greater reductions in fat mass in both

fasting groups than in the sprint interval training group alone (Cooke et al., 2022). Cui et al. (2025) reported the largest decrease in fat mass in the TRE+RT group (-3.2 ± 1.6 kg), exceeding the reductions achieved with TRE or resistance training alone (Cui et al., 2025). Likewise, Suder et al. (2024) showed significant decreases in body fat and abdominal fat exclusively in the exercise-diet group, whereas exercise alone produced minimal changes (Suder et al., 2024a). Mesinovic et al. (2025) further demonstrated substantial reductions in fat mass and visceral fat in both exercise interventions, indicating that structured exercise remains effective for adiposity reduction, although the preservation of functional capacity favors resistance-based training (Mesinovic et al., 2025).

Changes in lean body mass (LBM) or fat-free mass (FFM) were inconsistent across studies. Most interventions maintained lean muscle mass despite reductions in body weight and fat mass. Cooke et al. (2022) reported temporary reductions in lean body mass during the early phase of intermittent fasting; however, no significant between-group differences were observed after 16 weeks (Cooke et al., 2022). Cui et al. (2025) demonstrated that resistance training effectively preserves fat-free mass, particularly when combined with time-restricted eating, whereas time-restricted eating alone reduces fat-free mass (Cui et al., 2025). Similarly, Mesinovic et al. (2025) observed a smaller decline in appendicular lean mass in the HiRIT group compared that to in the aerobic training group, suggesting that resistance exercise may attenuate muscle loss during weight reduction (Mesinovic et al., 2025). Conversely, Wichansawakun et al. (2025) and Suder et al. (2024) reported no significant changes in skeletal muscle mass or fat-free mass between the intervention groups (Suder et al., 2024a; Wichansawakun et al., 2025).

Several studies have also assessed central adiposity, including waist circumference and visceral fat. Significant reductions in waist circumference were consistently observed in interventions that combined dietary restriction with exercise. Cui et al. (2025) reported greater reductions in waist circumference in the TRE+RT group than in the control group, whereas Suder et al. (2024) found significant decreases only in the exercise-diet intervention group (Cui et al., 2025; Suder et al., 2024b).

Cooke et al. (2022) demonstrated reductions in waist circumference following intermittent fasting interventions, whereas Wichansawakun et al. (2025) observed significant within-group decreases in both intervention groups over 12 weeks (Cooke et al., 2022; Wichansawakun et al., 2025). Additionally, reductions in visceral adipose tissue or abdominal fat were reported by Cooke et al. (2022), Suder et al. (2024), and Mesinovic et al. (2025), indicating improvements in central fat distribution (Cooke et al., 2022; Mesinovic et al., 2025; Suder et al., 2024b).

Overall, the evidence consistently indicates that combining intermittent fasting with structured exercise provides superior improvements in body composition, particularly in reducing body weight, BMI, total fat mass, waist circumference, and visceral adiposity, whereas resistance-based exercise appears to better preserve lean body mass than dietary intervention alone. Across the included randomized controlled trials, combined interventions produced the most consistent and clinically meaningful improvements in body composition outcomes.

Effects on Metabolic Outcomes

Metabolic outcomes were evaluated in most of the included studies and primarily comprised markers of glucose metabolism, lipid profiles, insulin sensitivity, and cardiovascular parameters. Overall, improvements in metabolic health were less consistent than the changes in body composition.

Nevertheless, interventions combining intermittent fasting with structured exercise generally demonstrate more favorable metabolic adaptations than dietary or exercise interventions alone.

Glucose Metabolism

Markers of glucose metabolism, including fasting blood glucose, glycated hemoglobin (HbA1c), glucose tolerance, and insulin resistance, have been assessed in several studies. Overall, fasting glucose levels remained relatively stable across the intervention groups, with no significant between-group differences reported in most trials. Cooke et al. (2022) found no significant changes in fasting glucose, HbA1c, or HOMA-IR after 16 weeks of sprint interval training (SIT), intermittent fasting (IF), or combined IF/SIT (Cooke et al., 2022). Similarly, Wichansawakun et al. (2025) reported no significant changes in

fasting blood glucose or HbA1c after 12 weeks of intervention, despite significant reductions in body weight and adiposity (Wichansawakun et al., 2025).

Comparable findings were observed by Suder et al. (2024), who found no significant changes in fasting glucose concentrations among the control, exercise-only, or exercise-plus-diet groups after six weeks (Suder et al., 2024b). However, fasting insulin concentrations decreased significantly in the exercise group, suggesting a modest improvement in insulin regulation despite unchanged glucose levels. In contrast, Cooke et al. (2022) reported a significant reduction in the glucose tolerance area under the curve (AUC) in the combined IF/SIT group, indicating improved postprandial glucose handling despite stable fasting glucose concentrations (Cooke et al., 2022). These findings suggest that combined dietary and exercise interventions may exert greater effects on glucose regulation during dynamic metabolic testing than fasting glycemic indices alone.

Lipid Profile

Changes in lipid profiles, including total cholesterol, triglycerides, low-density lipoprotein cholesterol (LDL-C), and high-density lipoprotein cholesterol (HDL-C), were reported in six of the included studies. Overall, lipid responses varied among the studies, although several interventions improved selected lipid parameters.

Cooke et al. (2022) observed no significant changes in total cholesterol, triglycerides, or HDL-C across the intervention groups; however, the combined IF/SIT intervention produced a significant reduction in LDL cholesterol after 16 weeks (Cooke et al., 2022). Wichansawakun et al. (2025) similarly reported no significant changes in total cholesterol, LDL-C, or HDL-C between the intervention groups, although triglyceride concentrations were significantly lower in the study group than in the control group at the end of the intervention (Wichansawakun et al., 2025).

Suder et al. (2024) reported significant reductions in LDL cholesterol exclusively in the exercise plus diet group, whereas HDL cholesterol remained unchanged across all groups. Likewise, fasting triglyceride and total cholesterol levels showed minimal changes following the intervention (Suder et al., 2024b). Overall, these findings indicate that combined dietary restriction and exercise may improve

specific components of the lipid profile, particularly LDL cholesterol and triglycerides, whereas changes in HDL cholesterol and total cholesterol levels appear less consistent.

Biomarkers Related to Metabolic Health

Several studies have investigated additional biomarkers associated with metabolic regulation and adipose tissue function. Wichansawakun et al. (2025) evaluated circulating vitamin D concentrations and liver enzymes, including aspartate aminotransferase (AST) and alanine aminotransferase (ALT). Vitamin D concentration remained unchanged throughout the intervention. Significant reductions in AST and ALT levels were observed only in the control group, whereas no significant between-group differences were identified (Wichansawakun et al., 2025).

Suder et al. (2024) assessed adipokines, including irisin and omentin, as biomarkers of metabolic adaptation in pigs. Irisin concentrations decreased significantly in the exercise-plus-diet group over six weeks, whereas omentin concentrations remained unchanged across all intervention groups (Suder et al., 2024b). Correlation analyses further demonstrated associations between irisin, LDL cholesterol, insulin, body composition variables, and selected dietary components, suggesting potential interactions between adipokines, lipid metabolism, and changes in body composition. However, these biomarkers did not consistently translate into significant clinical differences between the intervention groups.

Blood Pressure and Cardiovascular Indicators

Cardiovascular risk markers have been evaluated in several studies. Cui et al. (2025) reported no significant changes in systolic blood pressure among the intervention groups following time-restricted eating (TRE),

resistance training (RT), or combined TRE+RT (Cui et al., 2025). However, significant reductions in diastolic blood pressure were observed in both resistance training groups. The heart rate remained unchanged throughout the intervention.

Similarly, Cooke et al. (2022) found no significant effects of intermittent fasting, sprint interval training, or their combination on peripheral blood pressure, central blood pressure, or pulse wave velocity after 16 weeks (Cooke et al., 2022). These findings indicate that although combined lifestyle interventions substantially improved body composition, short-term effects on blood pressure and vascular function were limited in generally healthy adults with overweight or obesity.

Overall, the included randomized controlled trials demonstrated that metabolic improvements were generally more modest and variable than body composition changes. Combined intermittent fasting and structured exercise consistently improved selected metabolic markers, including LDL cholesterol, triglycerides, fasting insulin, and glucose tolerance, whereas fasting glucose, HbA1c, HDL cholesterol, and total cholesterol levels remained largely unchanged across most studies. Biomarkers related to adipose tissue function and inflammation also showed inconsistent responses, reflecting complex physiological adaptations to combined dietary and exercise interventions. Nevertheless, interventions integrating intermittent fasting with structured exercise appear to provide the most comprehensive improvements across multiple metabolic outcomes compared with either intervention alone (Cooke et al., 2022; Cui et al., 2025; Suder et al., 2024b; Wichansawakun et al., 2025).

Table 1. Characteristics of studies included in the systematic review

Study	Country	Participants	Intervention	Comparator	Duration	Outcomes	Main Findings
(Konieczna et al., 2023)	Spain	1,521 adults (55–75 years) with overweight/obesity and metabolic syndrome	Energy-reduced Mediterranean diet + physical activity promotion	Usual care with ad libitum Mediterranean diet	3 years	Total mass, visceral fat, lean mass	The combined intervention significantly reduced total and visceral fat and attenuated the loss of lean mass compared with the control group.
(Prats-Armon et al., 2024)	Spain	Adults with obesity (BMI 30–40)	Physical activity prescription + healthy diet + Positive Mental	Usual care	9 months	Body fat, body composition, cholesterol, physical	Significant improvements in physical activity, dietary adherence, body fat reduction,

Study	Country	Participants	Intervention	Comparator	Duration	Outcomes	Main Findings
			Health intervention			activity, Mediterranean diet adherence	and cholesterol levels were observed in the intervention group.
(Seyam et al., 2022)	Saudi Arabia	70 adults with mild to moderate obesity	Circuit training + low-carbohydrate diet	Circuit training only	60 days	Body weight, BMI, waist circumference, body fat, VO ₂ max, lipid profile	Combined intervention produced greater improvements in body composition, exercise capacity, and cardiometabolic indices than exercise alone did.
(Suder et al., 2024a)	Poland	44 men with abdominal obesity	Aerobic-resistance exercise + high-protein, low-glycemic index diet	Exercise and no intervention	6 weeks	Body composition, leptin, asprosin, insulin resistance, total cholesterol	Combined diet and exercise resulted in greater reductions in body fat, leptin, and total cholesterol and greater improvements in fat-free mass than exercise alone.
(Cooke et al., 2022)	Australia	34 adults with overweight/obesity	Intermittent energy restriction + sprint interval training	Intermittent fasting alone or sprint interval training alone	16 weeks	Body composition, cardiometabolic biomarkers, VO ₂ peak	Energy restriction improves body composition, whereas exercise primarily improves cardiorespiratory fitness. The combined intervention showed no additional body composition benefits compared to the diet alone.
(Wichansa et al., 2025)	Thailand	54 adults with obesity	Dietary advice + exercise program	Dietary advice + printed exercise guidance	12 weeks	Body weight, fat mass, waist circumference, physical activity	Both groups experienced significant weight loss, with no significant between-group differences observed. The online exercise group showed greater engagement in physical activities.
(Cui et al., 2025)	China	54 young adults with overweight/obesity	Time-restricted eating (TRE) + resistance training	Control, TRE alone, or resistance training alone	8 weeks	Body weight, BMI, fat mass, fat-free mass, blood pressure, mood, sleep quality	Combined TRE and resistance training resulted in greater fat loss, preservation of lean mass, and improved sleep quality than single interventions.
(Suder et al., 2024b)	Poland	44 men with abdominal obesity	Aerobic-resistance exercise + ad libitum high-protein, low-glycemic index diet	Exercise and no intervention	6 weeks	Body composition, irisin, omentin, glucose, insulin, lipid profile	Combined intervention significantly improved body composition and metabolic biomarkers, particularly irisin and LDL cholesterol, compared to exercise alone.
(Mesinovic et al., 2025)	Australia	60 older adults (≥60 years) with	Hypocaloric diet + high-intensity	Hypocaloric diet + aerobic training	12 weeks	Physical function, body	Both groups achieved similar weight and fat loss, whereas HiRIT

Study	Country	Participants	Intervention	Comparator	Duration	Outcomes	Main Findings
		obesity	resistance and impact training (HiRIT)			composition, lean mass, visceral fat	resulted in greater improvements in physical function and better preservation of lean muscle mass.

BMI: Body Mass Index; VO₂max: Maximal Oxygen Uptake; VO₂peak: Peak Oxygen Uptake; TRE: Time-Restricted Eating; HiRIT: High-Intensity Resistance and Impact Training; LDL: Low-Density Lipoprotein Cholesterol; HDL: High-Density Lipoprotein Cholesterol; HbA1c: Glycated Hemoglobin; HOMA-IR: Homeostatic Model Assessment of Insulin Resistance; FFM: Fat-Free Mass; PA: Physical Activity; PMH: Positive Mental Health.

Tabel 2. Summary of intervention effects on body composition and metabolic outcomes

Study	Comparator	Body Weight	BMI	Fat Mass	Lean Mass	Glucose	Lipid Profile	Biomarkers	Overall Effect
(Konieczna et al., 2023)	Ad libitum Mediterranean diet	Weight loss intervention achieved significant improvements in body composition; exact body-weight change not reported	Baseline BMI 32.5 kg/m ² ; post-intervention BMI change not reported	↓ Total fat mass (−1.39 kg Year 1; −0.76 kg Year 3, $p<0.001$)	↑ Lean mass % (+0.88% Year 1; +0.34% Year 3, $p<0.001$)	NR	NR	↓ Visceral fat (−126 g Year 1; −70.4 g Year 3, $p<0.001$)	Significant improvement in body composition after combined Mediterranean diet and physical activity intervention.
(Prats-Armon et al., 2024)	Standard care (usual lifestyle advice)	↓ −5.92 kg ($p<0.001$)	↓ −2.24 kg/m ² ($p<0.001$)	↓ Body fat −2.50 kg and body fat percentage −0.95% ($p<0.001$)	↑ Muscle mass +1.09 kg and muscle percentage +2.28% ($p=0.010$; $p<0.001$)	No significant change (−2.25 mg/dL; $p=0.112$)	↓ Total cholesterol (−11.52 mg/dL; $p=0.028$); ↑ HDL (+7.20 mg/dL; $p=0.003$); ↓ Triglycerides (−20.87 mg/dL; $p=0.033$); LDL not significant ($p=0.157$)	No obesity-specific biomarkers assessed	Combined physical activity, dietary counseling, and positive mental health interventions significantly improved body composition and several cardiometabolic risk factors, although fasting glucose and LDL cholesterol levels did not change significantly.
(Seyam et al., 2022)	Conventional weight-loss program	↓ Weight from 109.9±11.2 to 96.6±14.4 kg vs 111.1±9.7 to 106.1±9.6 kg; between-group difference significant ($p=0.044$)	↓ BMI from 35.4±2.5 to 32.1±2.2 kg/m ² vs 34.9±3.1 to 33.3±3.2 kg/m ² ; between-group difference significant ($p=0.015$)	↓ Body fat % from 27.7±1.5 to 23.9±2.3 % vs 27.6±1.6 to 25.2±1.5 %; greater reduction in intervention group ($p=0.025$)	NR	NR	↑ HDL (+5.7%, $p<0.001$); ↓ LDL (−3.8%, $p=0.013$); ↓ triglycerides (−8.0%, $p<0.001$), and ↓ total cholesterol (−4.2%, $p=0.001$) in intervention group; lipid improvements were not significant in the comparator group	↑ VO ₂ max (30.3→33.6 mL/kg/min, $p=0.028$); ↓ waist circumference (−4.7 cm, $p=0.001$); ↓ waist-to-hip ratio ($p=0.002$)	Combined dietary and exercise interventions produced greater improvements in body weight, BMI, body fat, HDL, and cardiorespiratory fitness than the comparator program.
(Suder et al., 2022)	Control	↓ Body weight	NR	↓ Body fat	↑ Fat-free mass	↑ Insulin sensitivity	↓ Total cholesterol	↓ Leptin	Combined

Study	Comparator	Body Weight	BMI	Fat Mass	Lean Mass	Glucose	Lipid Profile	Biomarkers	Overall Effect
al, 2024a)	group (with exercise-only group as additional comparator)	weight from 105.6±10.3 to 101.7±10.3 kg after 6 weeks in the exercise-diet group (interaction p<0.001)		from 35.1±3.9 % to 31.1±4.1 % (p<0.001); ↓ android fat from 44.1±4.7 % to 38.1±5.7 % (p<0.001)	mass from 66.1±3.9 % to 69.0±3.7 % (p<0.001)	sensitivity (QUICKI 0.33→0.34, p=0.02)	cholesterol from 5.2±0.9 to 4.6±0.7 mmol/L (interaction p<0.001)	(6.4→3.4 ng/mL, p<0.001); ↓ Asprosin (50.4→42.3 ng/mL, p=0.01)	exercise and dietary intervention produced the greatest improvements in body composition, adipokine profile, insulin sensitivity, and total cholesterol compared with exercise alone and the control group.
(Cooke et al, 2022)	Sprint Interval Training (SIT) vs Intermittent Fasting (IF) vs IF + SIT	Significant reductions in body weight were observed only in the IF and IF+SIT groups over 16 weeks (p<0.05), whereas the SIT-only group showed no significant weight loss.	BMI decreased in parallel with body weight in the fasting groups, whereas minimal changes were observed with SIT alone.	Fat mass decreased significantly in the IF and IF+SIT groups compared with that in the SIT group. Visceral adipose tissue decreased significantly only in the IF+SIT group, with a trend toward a reduction in the IF group.	Lean body mass did not differ significantly at the end of the intervention period. However, lean mass loss was observed in both fasting groups at week 8, with no significant between-group differences at week 16.	Fasting glucose, HbA1c, and HOMA-IR levels remained unchanged across all groups. However, glucose tolerance (AUC) improved significantly only in the IF+SIT group (p<0.05).	The total cholesterol, triglyceride, and HDL cholesterol levels did not change significantly. A significant reduction in LDL cholesterol was observed only in the IF+SIT group (p<0.01).	No circulating inflammatory or hormonal biomarkers were evaluated. Cardiorespiratory fitness (VO ₂ peak) increased significantly in the SIT and IF+SIT groups, with the greatest improvement observed in the latter. Blood pressure and arterial stiffness remained unchanged in both groups.	Combining intermittent fasting with sprint interval training produces the greatest overall benefits, including reductions in body weight, fat mass, visceral adipose tissue, LDL cholesterol, and glucose tolerance, while simultaneously improving aerobic fitness. Intermittent fasting alone effectively reduced body weight and fat mass, whereas sprint interval training alone primarily enhanced cardiorespiratory fitness without substantial metabolic or body composition changes in the participants.
(Wichans awakun et al, 2025)	Standard weight-loss program (control)	↓ Weight in both groups (Study: 106.54→104.59 kg, p=0.004; Control: 103.31→101.30 kg, p=0.015); no significant between-	↓ BMI in both groups (Study: 38.80→38.1 1 kg/m ² , p=0.003; Control: 38.44→37.6 4 kg/m ² , p=0.012); between-group	↓ Fat mass in both groups (Study: 47.92→46.32 kg, p=0.005; Control: 46.03→41.76 kg, p=0.040); skeletal	Skeletal muscle mass maintained in both groups (NS)	Fasting blood glucose showed no significant change in either group	Triglycerides decreased more in the intervention group, with a significant between-group difference at 12 weeks (p=0.004); total	Liver enzymes (AST and ALT) improved only in the control group; HbA1c and vitamin D showed no significant	Both interventions produced modest reductions in body weight, BMI, waist circumference, and fat mass; however, the intervention provided

Study	Comparator	Body Weight	BMI	Fat Mass	Lean Mass	Glucose	Lipid Profile	Biomarkers	Overall Effect
		group difference (p=0.581)	difference not significant (p=0.804)	muscle mass maintained; between-group difference not significant			cholesterol, LDL, and HDL showed no significant between-group differences	changes	additional benefits for triglyceride reduction, while most metabolic outcomes were comparable between the groups.
(Cui et al., 2025)	Control, time-restricted eating (TRE), and resistance training (RT)	↓ Body weight in TRE+RT (74.2→71.2 kg; -2.9 kg, p<0.01), greater reduction than RT and control; TRE alone also reduced weight (-2.6 kg)	↓ BMI in TRE+RT (26.8→25.7 kg/m ² ; -1.0 kg/m ² , p<0.01), significantly greater reduction than RT and control; similar reduction with TRE	↓ Fat mass in TRE+RT (-3.2 kg, p<0.01), the greatest reduction among all groups; RT alone also reduced fat mass (-1.1 kg)	Lean mass preserved in TRE+RT (+0.2 kg), whereas TRE alone reduced fat-free mass (-2.3 kg); RT alone increased fat-free mass (+1.6 kg)	NR	NR	↓ Waist circumference (-4.0 cm) and hip circumference (-4.6 cm); no significant changes in blood pressure or heart rate beyond modest within-group improvements	Combining time-restricted eating with resistance training produced the greatest improvements in body weight, BMI, fat mass, and waist circumference while preserving lean mass, indicating superior body composition benefits compared with either intervention alone.
(Suder et al., 2024b)	Control (CG) vs Exercise (EG) vs Exercise + Diet (EDG)	No significant changes in body weight were observed in either the control or exercise groups. The exercise plus diet group (EDG) demonstrated the greatest improvement in body composition, with significant reductions in BMI, waist circumference, body fat, and abdominal fat after 6 weeks (p<0.01).	BMI decreased significantly only in the EDG (32.1→30.8 kg/m ² ; p<0.01), whereas no significant changes were observed in the control or exercise-only groups.	Body and abdominal fat decreased significantly only in the EDG (BF: 36.0→31.7 kg; ABD: 16.1→12.3 kg; p<0.01). Exercise alone did not produce significant reductions in body weight.	The fat-free mass (FFM) remained stable across all groups, indicating the preservation of lean mass throughout the intervention.	Fasting glucose levels did not change significantly in any group. Insulin levels decreased significantly only in the exercise group (EG), while the EDG showed a non-significant downward trend.	LDL cholesterol decreased significantly only in the EDG (p<0.01), whereas HDL cholesterol levels remained unchanged across all groups.	Irisin levels decreased significantly in the EDG, whereas omentin concentrations did not change significantly. Correlation analyses revealed significant associations between irisin, omentin, and LDL-C, body composition, and dietary components, particularly in the combined exercise and diet groups.	Combined exercise and dietary interventions produced the greatest improvements in body composition and metabolic health compared with exercise alone or the control group. Dietary modification plays a key role in reducing adiposity and LDL cholesterol levels while preserving lean body mass.
(Mesinovic et al., 2025)	Aerobic Training (AT) vs High-	Both intervention groups achieved	The baseline mean BMI of the	Fat mass decreased substantially in both	Both groups experienced	Not reported.	Not reported.	No circulating metabolic biomarkers	Both exercise modalities effectively reduced body

Study	Comparator	Body Weight	BMI	Fat Mass	Lean Mass	Glucose	Lipid Profile	Biomarkers	Overall Effect
Intensity Resistance and Impact Training (HiRIT)	similar and significant reductions in body weight after the intervention (HiRIT: -5.1 kg vs AT: -4.9 kg).	participants was 32.9 ± 4.1 kg/m ² . Both interventions reduced body weight, suggesting improvements in BMI, although post-intervention BMI values were not reported in this study.	groups (HiRIT: -3.6 kg vs. AT: -3.3 kg), with comparable reduction in visceral fat (HiRIT: -32.1 cm ² vs. AT: -31.4 cm ²).	reduction in appendicular lean mass; however, the loss was smaller in the HiRIT group (-0.8 kg) than in the aerobic training group (-1.2 kg), indicating better preservation of lean mass.				were assessed. Functional outcomes improved, with HiRIT producing greater gains in gait speed, handgrip strength, and Short Physical Performance Battery (SPPB) scores than aerobic training did.	weight and fat mass. However, high-intensity resistance and impact training (HiRIT) provided superior improvements in physical function while better preserving lean mass, suggesting that it may be a more effective strategy than aerobic training alone in older adults with obesity.

BMI: Body Mass Index; CG: Control Group; EG: Exercise Group; EDG: Exercise plus Diet Group; AT: Aerobic Training; HiRIT: High-Intensity Resistance and Impact Training; SIT: Sprint Interval Training; IF: Intermittent Fasting; TRE: Time-Restricted Eating; RT: Resistance Training; VO₂max: Maximal Oxygen Uptake; VO₂peak: Peak Oxygen Uptake; HDL: High-Density Lipoprotein Cholesterol; LDL: Low-Density Lipoprotein Cholesterol; HbA1c: Glycated Hemoglobin; HOMA-IR: Homeostatic Model Assessment of Insulin Resistance; AUC: Area Under the Curve; QUICKI: Quantitative Insulin Sensitivity Check Index; AST: Aspartate Aminotransferase; ALT: Alanine Aminotransferase; FFM: Fat-Free Mass; SPPB: Short Physical Performance Battery; NS: Not Significant; NR: Not Reported.

Tabel 3. Risk of bias assessment of included studies

Study	Randomization Process	Deviations from Intended Intervention	Missing Outcome Data	Measurement of Outcome	Selection of Reported Result	Overall Risk
(Konieczna et al., 2023)	Low	Low	Some concerns	Low	Some concerns	Some concerns
(Prats-Arimon et al., 2024)	Some concerns	Low	Some concerns	Low	Some concerns	Some concerns
(Seyam et al., 2022)	Some concerns	Low	Low	Low	Some concerns	Some concerns
(Suder et al., 2024a)	Low	Low	Low	Low	Some concerns	Some concerns
(Cooke et al., 2022)	Low	Low	Some concerns	Low	Some concerns	Some concerns
(Wichansawakun et al., 2025)	Some concerns	Some concerns	Low	Low	Some concerns	Some concerns
(Cui et al., 2025)	Low	Low	Low	Low	Some concerns	Some concerns
(Suder et al., 2024b)	Low	Low	Low	Low	Some concerns	Some concerns
(Mesinovic et al., 2025)	Low	Some concerns	Low	Low	Some concerns	Some concerns

The present review demonstrates that combined dietary modification and physical activity consistently produce greater improvements in body composition than either strategy alone. Across the included studies, interventions combining dietary restriction or dietary counseling with structured exercise resulted in greater reductions in body weight,

BMI, fat mass, visceral adiposity, and waist circumference while generally preserving the lean body mass. These findings indicate that integrating nutritional and exercise interventions provides complementary physiological effects that optimize changes in body composition in adults who are overweight or obese.

Weight reduction was one of the most consistent findings in the included studies. Significant decreases in body weight have been observed following combined interventions in Mediterranean diet-based lifestyle programs (Konieczna et al., 2023), multidisciplinary behavioral interventions (Prats-Armon et al., 2024), low-carbohydrate diet combined with circuit training (Seyam et al., 2022), intermittent fasting combined with sprint interval training (Cooke et al., 2022), time-restricted eating combined with resistance training (Cui et al., 2025), and exercise combined with dietary modification (Suder et al., 2024a, 2024b). Although Wichansawakun et al. (2025) reported comparable weight loss between the intervention and control groups, both groups received dietary advice, suggesting that nutritional counseling alone may substantially contribute to weight reduction (Wichansawakun et al., 2025). Similarly, Mesinovic et al. (2025) demonstrated comparable weight loss between aerobic training and high-intensity resistance and impact training (HiRIT), likely because both exercise modalities were accompanied by a hypocaloric diet (Mesinovic et al., 2025). Collectively, these findings suggest that dietary energy restriction is the principal determinant of body weight reduction, whereas exercise enhances the effectiveness and sustainability of weight management.

The superior reduction in adiposity observed with the combined interventions is physiologically plausible. Dietary energy restriction induces a negative energy balance, leading to increased mobilization of stored triglycerides from adipose tissue, whereas exercise increases total daily energy expenditure and stimulates fatty acid oxidation. When implemented simultaneously, these mechanisms promote greater fat store depletion than either intervention alone. This synergistic effect was particularly evident in studies that reported significant reductions in total body fat, visceral fat, abdominal fat, and android fat (Cui et al., 2025; Konieczna et al., 2023; Seyam et al., 2022; Suder et al., 2024a, 2024b). Visceral adipose tissue is metabolically active and strongly associated with insulin resistance, systemic inflammation, dyslipidemia, and cardiovascular disease; therefore, reductions in this fat depot are considered clinically meaningful beyond simple weight loss alone.

An important observation from the present review is the preservation of lean body mass in interventions incorporating resistance exercise. Weight loss achieved through dietary restriction alone frequently results in concomitant reductions in skeletal muscle mass, which may decrease the resting metabolic rate and increase the likelihood of long-term weight regain. In contrast, resistance-based interventions stimulate muscle protein synthesis through activation of the mammalian target of rapamycin (mTOR) signaling pathway while attenuating muscle protein breakdown, thereby helping to preserve fat-free mass during caloric restriction. This pattern was consistently demonstrated by Cui et al. (2025), who reported the preservation of lean mass only in the time-restricted eating plus resistance training group, whereas time-restricted eating alone reduced fat-free mass (Cui et al., 2025). Likewise, Mesinovic et al. (2025) observed smaller reductions in appendicular lean mass following HiRIT than aerobic training, despite similar weight loss, indicating that resistance exercise provides an anabolic stimulus capable of mitigating muscle loss during energy restriction (Mesinovic et al., 2025). Similar improvements in fat-free mass were reported by Suder et al. (2024a), further supporting the importance of incorporating resistance exercise into obesity management programs (Suder et al., 2024a).

Several studies have also highlighted that exercise modality influences the quality of body composition changes. Aerobic exercise effectively increases energy expenditure and contributes to fat oxidation, whereas resistance training primarily preserves skeletal muscle while simultaneously reducing body fat. High-intensity interval-based exercise and resistance training appear particularly advantageous because they combine improvements in aerobic fitness with favorable changes in body composition. Cooke et al. (2022) demonstrated that sprint interval training primarily enhances cardiorespiratory fitness, whereas meaningful reductions in body weight and fat mass require concomitant intermittent fasting (Cooke et al., 2022). Similarly, Cui et al. (2025) showed that resistance training alone improved lean mass but produced smaller reductions in body fat when combined with time-restricted eating (Cui et al., 2025). These findings suggest that exercise alone may improve physical fitness, but dietary

modification is necessary to maximize reductions in adiposity.

Interestingly, although body weight reductions were relatively similar across several interventions, the magnitude of improvement in body composition often differed substantially between studies. This finding emphasizes that body weight alone inadequately reflects changes in metabolic health because reductions in fat mass accompanied by the preservation of lean mass represent a more favorable clinical outcome than the equivalent weight loss resulting from muscle depletion. For example, Konieczna et al. (2023) demonstrated the attenuation of lean-mass loss despite prolonged weight reduction over three years (Konieczna et al., 2023), while Mesinovic et al. (2025) reported superior preservation of appendicular lean mass in participants undertaking resistance and impact training (Mesinovic et al., 2025). Consequently, body composition assessment should complement body weight measurements when evaluating obesity interventions.

The findings of this review are consistent with current obesity management guidelines, which recommend combining individualized dietary therapy with structured physical activity rather than implementing either intervention in isolation alone. Recent evidence indicates that caloric restriction primarily drives weight loss, whereas exercise preserves lean mass, improves physical function, enhances metabolic flexibility, and facilitates the long-term maintenance of reduced body weight. Therefore, the synergistic interaction between these interventions provides benefits that extend beyond simple reductions in body weight.

However, several sources of heterogeneity should be acknowledged. Considerable variation exists across studies regarding dietary approaches, including Mediterranean diets, intermittent fasting, time-restricted eating, hypocaloric diets, and low-carbohydrate diets. Exercise interventions also differed substantially in modality, intensity, frequency, and duration, ranging from circuit training and sprint interval training to resistance training, combined aerobic-resistance exercise, and high-intensity resistance training. The intervention duration varied from six weeks to three years, and participant characteristics ranged from young adults with overweight to older adults with obesity. These methodological differences may partly explain the variability in effect sizes

observed across studies and limit the direct comparison of intervention efficacy.

Overall, the available evidence indicates that combined dietary modification and structured exercise consistently produce superior improvements in body composition compared with single-component interventions alone. The greatest benefits are observed when diet-induced energy restriction is paired with resistance or combined aerobic-resistance exercise, resulting in significant reductions in body weight, adiposity, and visceral fat while minimizing the loss of lean body mass. These findings support the current recommendations advocating for integrated lifestyle interventions as the cornerstone of obesity management.

Conclusion

This systematic review suggests that combining dietary modification with structured physical activity may provide greater improvements in body composition than either intervention alone in adults with overweight or obesity. Across the included studies, combined interventions were generally associated with reductions in body weight, body mass index, fat mass, visceral adiposity, and waist circumference, whereas resistance-based exercise appeared to help preserve lean body mass during weight loss. Improvements in several metabolic outcomes, including lipid profiles and insulin sensitivity, have also been reported in some studies, although these findings were less consistent across interventions and populations.

The magnitude of the observed effects varied according to dietary strategy, exercise modality, intervention duration, and participant characteristics, indicating substantial heterogeneity among studies. Therefore, the available evidence should be interpreted with caution, and direct comparisons between interventions are limited. Future well-designed randomized controlled trials with standardized intervention protocols and longer follow-up periods are needed to clarify the relative contributions of different dietary and exercise approaches and to evaluate the sustainability of their effects on body composition and metabolic health.

Acknowledgements

The authors would like to express their sincere gratitude to the Department of Nutrition Science, Faculty of Health Sciences, Universitas Brawijaya, for providing academic support and research facilities during the completion of this study. The authors also acknowledge the valuable contributions of the lecturers and reviewers who provided constructive feedback on this manuscript.

References

- Alsudairy, N. M., Alsadhan, A. I., Alghaith, B. K., Merdad, F. J., Althawab, B. A., Al Bossier, A. S., Al-Aqeel, S. A., Al-Harbi, A. S., Alshammari, R. S., Albalawi, A. K., & Aldandan, S. J. (2021). Updated modalities for management of obesity. *International Journal of Community Medicine and Public Health*, 8(6), 3156–3162. <https://doi.org/10.18203/2394-6040.ijcmph20211905>
- Babu, A. F., Csader, S., Lok, J., Gómez-Gallego, C., Hanhineva, K., El-Nezami, H., & Schwab, U. (2021). Positive effects of exercise intervention without weight loss and dietary changes in NAFLD-related clinical parameters: A systematic review and meta-analysis. *Nutrients*, 13(9), Article 3135. <https://doi.org/10.3390/nu13093135>
- Cooke, M. B., Deasy, W., Ritenis, E. J., Wilson, R. A., & Stathis, C. G. (2022). Effects of intermittent energy restriction alone and in combination with sprint interval training on body composition and cardiometabolic biomarkers in individuals with overweight and obesity. *International Journal of Environmental Research and Public Health*, 19(13), Article 7969. <https://doi.org/10.3390/ijerph19137969>
- Cui, T., Sun, Y., Ye, W., Liu, Y., & Korivi, M. (2025). Efficacy of time restricted eating and resistance training on body composition and mood profiles among young adults with overweight/obesity: A randomized controlled trial. *Journal of the International Society of Sports Nutrition*, 22(1), Article 2481127. <https://doi.org/10.1080/15502783.2025.2481127>
- Hsu, K. J., Liao, C. D., Tsai, M. W., & Chen, C. N. (2019). Effects of exercise and nutritional intervention on body composition, metabolic health, and physical performance in adults with sarcopenic obesity: A meta-analysis. *Nutrients*, 11(9), Article 2163. <https://doi.org/10.3390/nu11092163>
- Konieczna, J., Ruiz-Canela, M., Galmes-Panades, A. M., Abete, I., Babio, N., Fiol, M., Martín-Sánchez, V., Estruch, R., Vidal, J., Buil-Cosiales, P., García-Gavilán, J. F., Moñino, M., Marcos-Delgado, A., Casas, R., Olbeyra, R., Fitó, M., Hu, F. B., Martínez-Gonzalez, M. Á., Martínez, J. A., . . . Salas-Salvadó, J. (2023). An energy-reduced Mediterranean diet, physical activity, and body composition: An interim subgroup analysis of the PREDIMED-Plus randomized clinical trial. *JAMA Network Open*, 6(10), Article e2337994. <https://doi.org/10.1001/jamanetworkopen.2023.37994>
- Mbuya, N. V., Osornprasop, S., & David, C. (2019). *Addressing the double burden of malnutrition in ASEAN*. World Bank. <https://doi.org/10.1596/33142>
- Mesinovic, J., Gandham, A., Cervo, M. M., Jansons, P., Glavas, C., Braude, M., Rodriguez, J. P., De Courten, B., Zengin, A., Beck, B. R., Ebeling, P. R., & Scott, D. (2025). Resistance and impact training during weight loss improves physical function and body composition in older adults with obesity. *Journal of Cachexia, Sarcopenia and Muscle*, 16(2), Article e13789. <https://doi.org/10.1002/jcsm.13789>
- Nitschke, E., Gottesman, K., Hamlett, P., Mattar, L., Robinson, J., Tovar, A., & Rozga, M. (2022). Impact of nutrition and physical activity interventions provided by nutrition and exercise practitioners for the adult general population: A systematic review and meta-analysis. *Nutrients*, 14(9), Article 1729. <https://doi.org/10.3390/nu14091729>
- Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M.

- M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., . . . Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ*, 372, Article n71. <https://doi.org/10.1136/bmj.n71>
- Prats-Arimon, M., Puig-Llobet, M., Barceló-Peiró, O., Ribot-Domènech, I., Vilalta-Sererols, C., Fontecha-Valero, B., Heras-Ojeda, M., Agüera, Z., Lluch-Canut, T., Moreno-Poyato, A., & Moreno-Arroyo, M. C. (2024). An interdisciplinary intervention based on prescription of physical activity, diet, and positive mental health to promote a healthy lifestyle in patients with obesity: A randomized control trial. *Nutrients*, 16(16), Article 2776. <https://doi.org/10.3390/nu16162776>
- Ramírez-Vélez, R., Izquierdo, M., Castro-Astudillo, K., Medrano-Mena, C., Monroy-Díaz, A. L., Castellanos-Vega, R. D. P., Triana-Reina, H. R., & Correa-Rodríguez, M. (2020). Weight loss after 12 weeks of exercise and/or nutritional guidance is not obligatory for induced changes in local fat/lean mass indexes in adults with excess adiposity. *Nutrients*, 12(8), Article 2231. <https://doi.org/10.3390/nu12082231>
- Seyam, M. K., Alqahtani, M., Sirajudeen, M. S., Muthusamy, H., Kashoo, F. Z., & Salah, M. M. (2022). Effect of circuit training with a low-carbohydrate diet on body composition, cardiometabolic indices, and exercise capacity in adults with mild to moderate obesity in Saudi Arabia: A randomized control trial. *Medicine*, 101(33), Article e30054. <https://doi.org/10.1097/MD.00000000000030054>
- Sterne, J. A. C., Savović, J., Page, M. J., Elbers, R. G., Blencowe, N. S., Boutron, I., Cates, C. J., Cheng, H.-Y., Corbett, M. S., Eldridge, S. M., Emberson, J. R., Hernán, M. A., Hopewell, S., Hróbjartsson, A., Junqueira, D. R., Jüni, P., Kirkham, J. J., Lasserson, T., Li, T., . . . Higgins, J. P. T. (2019). RoB 2: A revised tool for assessing risk of bias in randomised trials. *BMJ*, 366, Article l4898. <https://doi.org/10.1136/bmj.l4898>
- Suder, A., Makiel, K., Targosz, A., Kosowski, P., & Malina, R. M. (2024a). Effects of exercise and dietary interventions on asprosin, leptin, and lipid metabolism in males with abdominal obesity: A randomized controlled trial. *Scientific Reports*, 14(1), Article 28109. <https://doi.org/10.1038/s41598-024-79853-7>
- Suder, A., Makiel, K., Targosz, A., Kosowski, P., & Malina, R. M. (2024b). Positive effects of aerobic-resistance exercise and an ad libitum high-protein, low-glycemic-index diet on irisin, omentin, and dyslipidemia in men with abdominal obesity: A randomized controlled trial. *Nutrients*, 16(20), Article 3480. <https://doi.org/10.3390/nu16203480>
- Tee, E. S., & Voon, S. H. (2024). Combating obesity in Southeast Asian countries: Current status and the way forward. *Global Health Journal*, 8(3), 147–151. <https://doi.org/10.1016/j.glohj.2024.08.006>
- Wichansawakun, S., Srikhajonjit, W., Srichan, C., & Tonglim, J. (2025). Efficacy of an online exercise program to improve weight management outcomes in individuals with obesity: A randomised trial. *Clinical Nutrition ESPEN*, 66, 202–207. <https://doi.org/10.1016/j.clnesp.2025.01.039>
- World Health Organization. (2025, December 8). *Obesity and overweight*. <https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight>