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REVIEW

The effects of CrossFit® training in adults with obese or overweight: A systematic review of randomized controlled trials

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KEYWORDS
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Abstract This systematic review and meta-analysis aimed to examine and critically analyze evidence on the effects of CrossFit® in individuals with overweight or obesity. A search was conducted in four databases (Scopus, WOS, SPORTDiscus, and MEDLINE/PubMed) covering publications from their inception to November 2024. Ten RCTs were analyzed. CrossFit® groups showed significant reductions in weight [six studies; $n = 161$; Hedges' g: −0.76 (95%CI: −1.51, −0.02); $p = 0.008$] and body mass index (BMI) [five studies; $n = 61$; Hedges' g: −0.71 (95%CI: −1.45, 0.02); $p = 0.007$]. However, changes in weight [six studies; $n = 320$; 93% men; Hedges' g: 1.55 (95%CI: −0.66, 3.76); $p = 0.071$] and BMI [five studies; $n = 120$; Hedges' g: 1.24 (95%CI: −0.81, 3.29); $p = 0.094$] were not significantly different compared to control groups. CrossFit® is a feasible option for improving body composition, metabolic health, and cardiorespiratory fitness in this population. However, its impact on blood pressure is inconclusive, and its effects on weight and BMI are comparable to traditional exercise modalities.

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PALABRAS CLAVE
Composición corporal;
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Entrenamiento de alta intensidad;
Lípidos

Los efectos del entrenamiento de CrossFit® en adultos con obesidad o sobrepeso: una revisión sistemática de ensayos controlados aleatorizados

Resumen Esta revisión sistemática y metaanálisis tuvo como objetivo examinar y analizar críticamente la evidencia sobre los efectos del CrossFit® en las personas con sobrepeso u obesidad. Se realizó una búsqueda en 4 bases de datos (Scopus, WOS, SPORTDiscus y MEDLINE/PubMed), que abarcó publicaciones desde su inicio hasta noviembre de 2024. Se analizaron 10 ensayos controlados aleatorizados. Los grupos de CrossFit® mostraron reducciones significativas en el peso (6 estudios; n = 161; g de Hedges: −0,76 [IC 95%: −1,51; −0,02; p = 0,008) y el índice de masa corporal (IMC) (5 estudios; n = 61; g de Hedges: −0,71 [IC 95%: −1,45; 0,02]; p = 0,007). Sin embargo, los cambios en el peso (6 estudios; n = 320; 93% varones; g de Hedges: 1,55 [IC 95%: −0,66; 3,76]; p = 0,071) y el IMC (5 estudios; n = 120; g de Hedges: 1,24 [IC 95%: −0,81; 3,29]; p = 0,094) no fueron significativamente diferentes en comparación con los grupos control. El CrossFit® es una opción viable para mejorar la composición corporal, la salud metabólica y la aptitud cardiorrespiratoria en esta población. Sin embargo, su impacto en la presión arterial es inconcluso, y sus efectos en el peso y el IMC son comparables a las modalidades de ejercicio tradicionales.

Introduction

Regular physical exercise is regarded as one of the most effective adjunct therapies for enhancing metabolic health in individuals with overweight/obesity.[1] Early exercise prescriptions for this population were based on classic exercise physiology studies, which recommended long-duration, continuous, moderate-intensity activities to optimally stimulate adipose tissue metabolism for muscle fuel.[2] Under this approach, aerobic exercises became the primary recommendation. However, the potential risk of muscle mass loss during weight loss programs prompted the consideration of strength training as an alternative.[3] In addition to preventing muscle loss, strength training increases resting metabolic rate, creating the calorie deficit needed for weight loss.[4]

Despite the promising benefits of aerobic and strength exercises for weight loss, both require a significant time investment, which can discourage participation. As a result, research shifted toward exploring shorter, higher-intensity workouts with rest intervals, sparking growing interest in a new exercise modality, high-intensity interval training (HIIT). The HIIT protocol is based on the Tabata method, which allegedly promotes weight loss by performing brief, supramaximal 20-second intervals within a 4-min exercise bout.[5] Findings from several systematic have reported that HIIT is more effective and time-efficient than classical exercise training programs for managing metabolic health in people with obesity.[6–8] However, reports on levels of affective response and enjoyment in HIIT among people with overweight/obesity are inconsistent, with some studies suggesting that the high exercise intensity required by HIIT could jeopardize motivation to engage in its practice,[9] while results on long-term adherence remain under-researched.[10,11]

In this context, CrossFit® one of the fastest-growing high-intensity functional training (HIFT) modes among the global fitness trends, emerges as an interesting alternative. CrossFit® aims to optimize physical fitness through high-intensity exercises that are performed quickly and repetitively, with little to no rest between sets, by incorporating gymnastics movements, weightlifting, and cardiovascular activities.[12] Although CrossFit®, like HIIT, involves high-intensity effort, its adherence rates may be higher. A key difference is that CrossFit® fosters a strong sense of community, satisfaction, and motivation, which enhances participant commitment.[13]

Findings on CrossFit®'s impact on weight management are mixed. A meta-analysis by Claudino et al., [12] of four studies found no significant effect on body composition. In contrast, other authors have reported that CrossFit®, effectively stimulates fat loss.[14,15] However, none of these studies specifically focused on individuals with overweight or obesity.

In this context, health practitioners need the best available scientific evidence on the efficacy of CrossFit® as a weight management strategy before recommending it to individuals with overweight or obesity. This can be accomplished through systematic reviews that synthesize and critically evaluate existing research on the topic. To the best of the authors' knowledge, no such study has been conducted to date. Therefore, the purpose of this systematic review and meta-analysis aimed to examine and critically analyze the available scientific evidence regarding the effects of CrossFit® on individuals with overweight or obesity.

Table 1 Search strategy and inclusion/exclusion criteria based on PICO (Population, Intervention, Comparison and Outcome).

Databases	Search terms	PICO	Inclusion criteria	Exclusion criteria
MEDLINE/PubMed Web of Science SPORTDiscus Scopus	(''CrossFit'' OR ''High-Intensity Functional Training'' OR ''High Intensity Power Training'' OR ''Crosstraining'' OR ''Cross Training'') AND (''Obesity'' OR ''Overweight'' OR ''Obese'')	Population	Adults with obese or overweight	Participants without obese or overweight. Studies that included mixed samples, unless separate data were available specifically for the adults with obese or overweight.
		Intervention	CrossFit® program	Studies that implemented interventions based on a single exercise training session. Studies that were not clearly identified as CrossFit® interventions
		Comparison	Control group or other structured interventions	No comparison between structured interventions or control condition with pre/post-results.
		Outcome	Quantitative measures	They lacked data regarding the effects of exercise intervention.

Material and methods

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.[16]

Search strategy

A systematic search was conducted in four electronic databases (Scopus, Web of Science, SPORTDiscus and MEDLINE/PubMed) covering the period from their inception until November 2024 (see, Table 1). Additionally, a manual search was also conducted in the PEDro database with terms ''CrossFit'', ''Obesity'', ''Overweight'' and ''Obese''. Finally, the first 100 references from Google Scholar were reviewed.

Eligibility criteria

Eligible studies for inclusion in this review were randomized controlled trials (RCTs) that provided information on the effects of CrossFit® intervention in adults with overweight or obesity, as defined by a Body Mass Index (BMI) of $\geq$25 kg/m^2.[17,18] Research articles were included or excluded using criteria defined with the Population, Intervention, Comparison and Outcome (PICO) criteria (Table 1). To be considered for the first screening, the studies had to be published or in-press in peer-reviewed journals (i.e., abstracts published in conference proceedings, books, theses, and dissertations were not considered), and have an abstract available for screening.

Study selection

The Rayyan software (QCRI, Qatar) was used to remove duplicate references before screening.[19] Both authors independently assessed the titles and abstracts of the identified studies to evaluate their eligibility. Following this initial review, the selected studies were examined by both reviewers to confirm inclusion. Any discrepancies were resolved through discussion and consensus. Full-text versions of potentially relevant studies were then obtained. Additionally, the reference lists of the included articles and citations found in Google Scholar were reviewed to identify any further studies that could be incorporated into the review.

Data extraction

A single researcher extracted data from the original reports, including details on the country, year of the study, sample characteristics, intervention characteristics, outcome measurements, main results, adverse events, and dropouts. All outcomes reported by the included studies have been extracted (see Table 2) and can be categorized into anthropometric measures, cardiometabolic health, cardiorespiratory fitness, and blood markers. Table 2 presents the number of participants at the start of each intervention, while the final sample represents those who completed the interventions (i.e., excluding dropouts that occurred during the interventions). The extracted data were then cross-verified by a second investigator.

Table 2 Descriptive characteristics of the included studies.

First author (year), country	Sample	Intervention	Outcomes	Results	Dropouts and adverse events
Saedi et al. (2024) **Country:** Iran	**Participants (*n*, sex):** 100M **Final sample (*n*, sex):** 68M **Age, years (mean; SD):** 27.6 ± 8.4 **BMI, kg/m^2 (mean; SD):** 32.6 ± 2.6	**Duration:** 12-week **Frequency:** 3 days/week **Volume:** 60 min/session **Intensity:** Severe intensity **EG1:** CrossFit® **Activities:** 10–15 min of stretching and warm up, 10–20 min of instruction and practicing techniques and movements, and 5–30 min for the workout of the day that was performed at relative individual levels of ability and fitness. **EG2:** CrossFit® + supplement **Activities:** Supplement of spinach-derived thylakoid extract and perform the EG1 program. **CON1:** Supplement group Activities: Supplement of spinach-derived thylakoid extract. The administered dose was 5 grams daily, consumed 30 minutes before lunch for 12 weeks. **CON2:** Control group **Activities:** Instructed to maintain their current lifestyles.	**Anthropomorphic measures:** • Weight (kg) • BMI (kg/m^2) • Body fat (%) • FFM (kg) **Cardiorespiratory fitness:** • HR • VO_2peak (ml kg^{-1} min^{-1}) **Blood markers:** • CTRP-12 (pg/ml) • Furin (ng/ml) • KLF-15 (ng/ml) **Cardiometabolic health:** • BP • HDL (mg/dl) • LDL (mg/dl) • TG (mg/dl) • TC (mg/dl)	**Intra-group ($p < 0.05$)** ↓ Weight and BMI in *EG1*, *EG2* and *CON1* ↑ VO_2peak and HDL in EG1 and EG2 ↑ FFM, KLF-15 and CTRP-12 in *EG1*, *EG2* and *CON1* ↓ Body fat, LDL, TC, TG and Furin in *EG1*, *EG2* and *CON1* **Inter-group ($p < 0.05$)** *EG1*, *EG2* and *CON1* > KLF-12, CTRP-12 and FFM compared to *CON2* *EG1*, *EG2* and *CON1* < Furin, Weight, BMI and Body fat compared to *CON2* *EG1* and *EG2* > HDL compared to *CON1* and *CON2* *EG1* and *EG2* < LDL, TC and TG compared to *CON1* and *CON2* *EG1* and *EG2* > KLF-15 and CTRP-12 compared to *CON2* *EG1* and *EG2* < Furin compared to *CON2* *EG2* > KLF-15 compared to *CON1* *EG2* < Furin compared to *CON1* *EG1* < Furin compared to *CON1* *CON1* < Furin compared to *CON2* *CON1* > CTRP-12 compared to *CON2*	**Dropouts:** NR **Adverse events:** NR

Table 2 (*Continued*)

First author (year), country	Sample	Intervention	Outcomes	Results	Dropouts and adverse events
Moqaddam et al. (2024) **Country:** Iran	**Participants (*n*, sex):** 68M **Final sample (*n*, sex):** 44M **Age, years (mean; SD):** 27.6 ± 8.4 **BMI, kg/m² (mean; SD):** 33.6 ± 1.4 kg/m²	**Duration:** 12-week **Frequency:** 3 days/week **Volume:** 60 min/session **Intensity:** High intensity **EG1:** CrossFit® **Activities:** 10–15 min of stretching and warm up, and 5–30 min for the workout of the day; bodyweight movements and aerobic workouts. **EG2:** CrossFit® + supplement **Activities:** Supplement of astaxanthin and perform the EG1 program. **CON1:** Supplement group **Activities:** Supplement of astaxanthin. The administered dose was 20 mg/day with breakfast for 12 weeks. **CON2:** Control group **Activities:** Instructed to maintain their current lifestyles	**Blood markers:** • TGF-β (mg/dl) • Decorin (mg/dl) • Myostatin (mg/dl) • Follistatin (mg/dl) • Activin A (mg/dl)	**Intra-group ($p < 0.05$)** ↑ Decorin and Follistatin in *EG1, EG2* and *CON1* ↑ Activin A in *CON2* ↓ Activin A in *EG1* and *EG2* ↓ Follistatin in *CON2* ↓ Myostatin and TGF-β in *EG1, EG2* and *CON1* ↑ TGF-β in *CON2* **Inter-group ($p < 0.05$)** *EG1, EG2* and *CON1* > Decorin, Follistain and TGF-β compared to *CON2* *EG1* > Decorin compared to *CON2* *EG2* > Decorin and TGF-β compared to *EG1* and *CON1* *EG1, EG2* and *CON1* < Activin A and Myostatin compared to *CON2* *EG1* and *EG2* < Activin A compared to *CON1* *EG1* and *EG2* > Follistain compared to *CON1* *EG2* > Follistain compared to *EG1* *EG2* < Myostatin compared to *EG1* and *CON1*	**Dropouts:** 24 participants from different groups withdrew from the study for employment related difficulties **Adverse events:** NR
Zhang & Jiang (2023) **Country:** China	**Participants (*n*, sex):** 200 F **Final sample (*n*, sex):** 200F **Age, *years* (mean; SD):** 19–22 years **BMI, *kg/m²* (mean; SD):** NR	**Duration:** 8-week **Frequency:** NR **Volume:** NR **Intensity:** NR **EG:** CrossFit® **Activities:** NR **CON:** General aerobic training **Activities:** NR	**Anthropomorphic measures:** • Weight (kg) • WHR (%) • Arm circumference (cm) • Thigh circumference (cm) • Fat (kg) • Body fat (%) • FFM (kg) • Trunk fat (lean body weight, body fat, abdominal lean weight, abdominal fat) (kg) • Limb fat (upper limb lean weight, upper limb fat, lower limb lean weight, lower limb fat) (kg)	**Intra-group ($p < 0.05$)** ↓ Weight, WHR, Arm circumference, Thigh circumference, Body fat, Trunk fat (body fat), Trunk fat (abdominal fat), Limb fat (upper limb fat) and Limb fat (lower limb fat) in *EG* and *CON* ↓ Fat, FFM, Trunk fat (lean body weight), Trunk fat (abdominal lean weight), Limb fat (upper limb lean weight) and Limb fat (lower limb lean weight) in *EG* **Inter-group ($p < 0.05$)** – NR	**Dropouts:** NR **Adverse events:** NR

Table 2 (*Continued*)

First author (year), country	Sample	Intervention	Outcomes	Results	Dropouts and adverse events
Supriya et al. (2023) **Country:** Iran	**Participants (*n*, sex):** 68M **Final sample (*n*, sex):** 44 M **Age, *years* (mean; SD):** 27.0 ± 8.0 **BMI, *kg/m²* (mean; SD):** 33.6 ± 1.4	**Duration:** 12-week **Frequency:** 3 days/week **Volume:** 60 min/session **Intensity:** Vigorous **EG1:** CrossFit® **Activities:** 10–15 min of stretching and warm up, 10–20 min of instruction and practicing techniques and movements, and 5–30 min for the workout of the day that was performed at relative individual levels of ability and fitness. **EG2:** CrossFit® + Supplement **Activities:** Supplement of astaxanthin and perform the EG1 program. **CON1:** Supplement group **Activities:** Supplement of astaxanthin. The administered dose was 20 g daily, with breakfast for 12 weeks. **CON2:** Control group **Activities:** Instructed to maintain their current lifestyles	**Anthropomorphic measures:** • Weight (kg) • BMI (kg/m²) **Blood markers:** • Resistin (ng/ml) • Leptin (ng/ml) • Adiponectin (μg/ml) • Visfatin (ng/ml) • Vaspin (ng/ml) • Retinol-binding protein 4 (ng/ml) • Apelin (ng/ml) • Ometin-1 (ng/ml) • Chemerin (ng/ml) • Semaphorin3c (ng/ml)	**Intra-group ($p < 0.05$)** ↓ Body weight, BMI, Leptin, Resistin, Vaspin, Visfatin, Apelin, Retinol-binding protein 4, Chemerin and Semaphorin3c in *EG1*, *EG2* and *CON1* ↑ Adiponectin in *EG1* and *EG2* ↑ Omentin-1 in *EG1*, *EG2* and *CON1* **Inter-group ($p < 0.05$)** *EG1* and *EG2* < Body weight, Semaphorin3c compared to *CON2* *EG1*, *EG2* and *CON1* < BMI, Leptin, Vaspin Visfatin, Apelin, Retinol-binding protein 4 and Chemerin compared to *CON2* *EG2* < Body weight and BMI compared to *EG1* and *CON1* *EG2* > Adiponectin compared to *CON2* *EG1*, *EG2* and *CON1* > Omenti-1 compared to *CON2* *EG1* and *CON1* < Resistin compared to *CON2* *EG2* > Adiponectin compared to *EG1* *EG2* > Adiponectin compared to *CON1* *EG1* and *EG2* > Omenti-1 compared to *CON1* *EG2* < Visfatin, Apelin, Retinol-binding protein 4 and Semaphorin3c compared to *CON1*	**Dropouts:** 6 participants per group ($n = 24$) declined to participate due to medical, job or lack of interest reasons. **Adverse events:** No adverse events were reported from both training and supplementation procedures

Table 2 (*Continued*)

First author (year), country	Sample	Intervention	Outcomes	Results	Dropouts and adverse events
Saedi, Nouri-Habashi et al. (2023) **Country:** Iran	**Participants (*n*, sex):** 101 M **Final sample (*n*, sex):** 68 M **Age, *years* (mean; SD):** 27.6 ± 8.4 **BMI, *kg/m²* (mean; SD):** 33.6 ± 1.4	**Duration:** 12-week **Frequency:** 3 days/week **Volume:** 60 min/session **Intensity:** High-intensity **EG1:** CrossFit® **Activities:** **EG2:** CrossFit® + supplement **Activities:** Supplement of astaxanthin and perform the EG1 program. **CON1:** Supplement group **Activities:** Supplement of astaxanthin. The administered dose was 20 grams daily, with breakfast for 12 weeks. **CON2:** Control group **Activities:** NR	**Anthropomorphic measures:** • Weight (kg) • BMI (kg/m^2) • Body fat (%) • FFM (kg) **Cardiorespiratory fitness:** • HR • VO_2peak ($ml\,kg^{-1}\,min^{-1}$) **Blood markers:** • CTRP-9 (ng/ml) • CTRP-2 (ng/ml) • GDF-15 (pg/ml) • GDF-8 (pg/ml) **Cardiometabolic health:** • BP • Insulin (ng/ml) • Glucose (mmol/l) • HOMA-IR (mmol/l) • HDL (mg/dl) • LDL (mg/dl) • TG (mg/dl) • TC (mg/dl)	**Intra-group ($p < 0.05$)** ↓ Weight, Body fat, BMI, LDL, TC, TG, CTRP-9, CTRP-2 and GDF-8 in *EG1*, EG2 and *CON1* ↑ Body Fat in *CON2* ↑ FFM, VO_2peak and HDL in *EG1*, EG2 and *CON1* ↓ Insuline, Glucose and HOMA-IR in EG2 and *CON1* ↓ GDF-15 in *EG1* and *EG2* **Inter-group ($p < 0.05$)** *EG1*, *EG2* and *CON1* < Weight, Body fat, BMI, LDL, TC, CTRP-9, CTRP-2, and GDF-8 compared to *CON2* *EG1*, *EG2* and *CON1* > FFM compared to *CON2* *EG1* and *EG2* > VO_2peak, HDL compared to *CON2* *EG1* and *EG2* < TG compared to *CON2* *EG2* and *CON1* < Insuline, Glucose compared to *CON2* *EG2* < HOMA-IR compared to *CON2* *EG2* < Weight compared to *EG1* *EG2* < BMI, CTRP-9 and GDF-8 compared to *EG1* and *CON1* *EG2* < Body fat compared to *CON1* *EG1* and *EG2* > VO_2peak compared to *CON1* *EG1* and *EG2* < CTRP-2 compared to *CON1* *EG1* and *EG2* < GDF-15 compared to *CON1* and *CON2*	**Dropouts:** 8 participants from different groups withdrew from the study for medical reasons, employment related difficulties or lack of interest in continued participation **Adverse events:** NR

Table 2 (*Continued*)

First author (year), country	Sample	Intervention	Outcomes	Results	Dropouts and adverse events
Saeidi, Saei, et al. (2023) **Country:** Iran	**Participants (*n*, sex):** 68 M **Final sample (*n*, sex):** 60 M **Age, *years* (mean; SD):** 27.6 ± 8.4 **BMI, *kg/m*^{2} (mean; SD):** 32.6 ± 2.6	**Duration:** 12-week **Frequency:** 3 days/week **Volume:** 60 min/session **Intensity:** Vigorous **EG1:** CrossFit® **Activities:** 10–15 min of stretching and warm up, 10–20 min of instruction and practicing techniques and movements, and 5–30 min for the workout of the day that was performed at relative individual levels of ability and fitness **EG2:** CrossFit® + Supplement **Activities:** Supplement of spinach-derived thylakoid extract and perform the EG1 program. **CON1:** Supplement group **Activities:** Supplement of spinach-derived thylakoid extract. The administered dose was 5 grams daily, consumed 30 minutes before lunch for 12 weeks. **CON2:** Control group **Activities:** Instructed to maintain their current lifestyles	**Anthropomorphic measures:** • Weight (kg) • BMI (kg/m^2) • Body fat (%) • FFM (kg) **Cardiorespiratory fitness:** • VO_2peak (ml kg^{-1} min^{-1}) **Blood markers:** • Adiponectin (μg/ml) • Leptin (ng/ml) • Resistin (ng/ml) • Omentin (ng/ml) • Vaspin (ng/ml) • Visfatin (ng/ml) • Apelin (ng/ml) • Retinol-binding protein 4 (ng/ml) • Chemerin (ng/ml) • Semaphorin3c (ng/ml) **Cardiometabolic health:** • HOMA-IR • Insulin (ng/ml) • Glucose (mg/dl)	Intra-group ($p < 0.05$) ↓ HOMA-IR, Insulin, Glucose, Weight, BMI, Body fat, Leptin, Resistin, Vaspin, Visfatin, Apelin, Retinol-binding protein 4, Chemerin and Semaphorin3c in *EG1*, *EG2* and *CON1* ↑ FFM, Adiponectin and Omentin in *EG1*, *EG2* and *CON1* Inter-group ($p < 0.05$) *EG1*, *EG2* and *CON1* < HOMA-IR, Insulin, Glucose, Weight, Body fat, Leptin, Resistin, Vaspin, Visfatin, Apelin, Retinol-binding protein 4, Chemerin and Semaphorin3c compared to *CON2* *EG1*, *EG2* and *CON1* > FFM, Adiponectin and Omentin compared to *CON2* *EG1* and *EG2* < BMI compared to *CON2* *EG1* and *EG2* > VO_2peak compared to *CON2*	Dropouts: 8 participants from different groups withdrew from the study for medical reasons, employment related difficulties or lack of interest in continued participation. Adverse events: NR

Table 2 (*Continued*)

First author (year), country	Sample	Intervention	Outcomes	Results	Dropouts and adverse events
Dehghanzadeh-Suraki et al. (2021) **Country:** Iran	**Participants (*n*, sex):** 26 M **Final sample (*n*, sex):** 26 M **Age, *years* (mean; SD):** 21.6 ± 1.6 **BMI, *kg/m²* (mean; SD):** 27.8 ± 3.17	**Duration:** 4-week **Frequency:** 5 days/week **Volume:** 120 min **Intensity:** Maximum effort/RPE 17.5 **EG:** CrossFit® **Activities:** Standardized warm-up (5 min continuous cycling on unloaded cycle and 5 min dynamic stretching). The work of the day was designed based on ''for time'' or ''time trial''. 10 min cool down on unloaded cycle at low intensity and static stretching **CON:** NR **Activities:** NR	**Anthropomorphic measures:** • Body fat (%) • Fat mass (kg) • FFM (kg) • Visceral adiposity index • WHR (cm) • WC (cm) • HC (cm) • Thigh cir (cm) • Weight (kg) • BMI (kg/m^2) **Cardiorespiratory fitness:** • VO_2max ($ml\,kg^{-1}\,min^{-1}$) • HR • Power peak P/BW • Average P/BW **Cardiometabolic health:** • SBP • DBP • TG (mg/dl) • HDL (mg/dl) • LDL (mg/dl) • vLDL (mg/dl) • LDL/HDL	**Intra-group ($p < 0.05$)** ↓ Weight, BMI, Visceral adiposity index, WC, HC, Fat mass, SBP, DBP, HR, TG, LDL, vLDL and LDL/HDL in *EG* ↑ FFM, VO_2max, P/BW and Avg P/BW in *EG* **Inter-group ($p < 0.05$)** *EG* < Weight, BMI, Fat mass, DBP, HR, TG, LDL and LDL/HDL compared to *CON* *EG* > FFM, VO_2max, P/BW and Avg P/BW compared to *CON*	**Dropouts:** NR **Adverse events:** NR

Table 2 (*Continued*)

First author (year), country	Sample	Intervention	Outcomes	Results	Dropouts and adverse events
Sarani (2020) **Country:** Iran	**Participants (*n*, sex):** 20 M **Final sample (*n*, sex):** 20 M **Age, *years* (mean; SD):** 25.0 ± 2.9 **BMI, *kg/m²* (mean; SD):** 28.4 ± 1.4	**Duration:** 12-week **Frequency:** 5 days/week **Volume:** 45–60 min/session **Intensity:** Vigorous **EG:** CrossFit® **Activities:** 10–15 min of stretching and warm up, 10–20 min of instruction and practicing techniques and movements, 5–30 min for the workout of the day that was performed at relative individual levels of ability and fitness. **CON:** NR **Activities:** NR	**Anthropomorphic measures:** • Weight (kg) • BMI (kg/m^2) • WC (cm) • HR (cm) • WHR (cm) • Body fat (%) **Cardiorespiratory fitness:** • VO_2max ($ml\,kg^{-1}\,min^{-1}$) **Cardiometabolic health:** • Glucose (mg/dl) • TC (mg/dl) • TG (mg/dl) • LDL (mg/dl) • HDL (mg/dl)	**Intra-group ($p < 0.05$)** ↓ Weight, BMI and Body fat in *EG* ↑ VO_2max in *EG* **Inter-group ($p < 0.05$)** *EG* < Weight, BMI, Body fat, Glucose, TC, TG and LDL compared to *CON* *EG* > VO_2max and HDL compared to *CON*	**Dropouts:** NR **Adverse events:** NR
Feito et al. (2019) **Country:** USA	**Participants (*n*, sex):** 23 (13F, 10M) **Final sample (*n*, sex):** 18 (12F, 6M) **Age, *years* (mean; SD):** 26.8 ± 5.5 **BMI, *kg/m²* (mean; SD):** 30.5 ± 2.9	**Duration:** 8-week **Frequency:** 3 days/week **Volume:** 60 min/session **Intensity:** Vigorous **EG:** CrossFit® **Activities:** 10–15 min of stretching and warm up, 10–20 min of instruction and practicing techniques and movements, 5–30 min for the workout of the day that was performed at relative individual levels of ability and fitness. **CON:** Aerobic and resistance training **Activities:** 2 days/week of 50 min aerobic exercise on the machines (40–50% HRR for weeks 1–4 and 50–60% HRR for weeks 5–8) and 20 min full-body resistance training with individualized workout plan, and 1 day/week 50 min of aerobic training. 3 days/week 3 sets of 15 crunches. The sessions were supervised.	**Anthropomorphic measures:** • Weight (kg) • BMI (kg/m^2) • Body fat (%) • FFM (kg) • Fat mass (kg) • WC (cm) **Cardiorespiratory fitness:** • Resting heart rate (HRR) **Cardiometabolic health:** • Plasma glucose (mg/dl) • Glucose AUC	**Intra-group ($p < 0.05$)** ↑ FFM in *EG* **Inter-group ($p < 0.05$)** – NR	**Dropouts:** 2 participants from CON withdrew from the study for scheduling issues and not providing reasons. 3 participants dropped out EG for scheduling issues, having a lower body injury and groin muscle and not providing reasons. **Adverse events:** NR

Table 2 (*Continued*)

First author (year), country	Sample	Intervention	Outcomes	Results	Dropouts and adverse events
Heinrich et al. (2014) **Country:** USA	**Participants (*n*, sex):** 23 (13F, 10M) **Final sample (n, sex):** 18 **Age, *years* (mean; SD):** 26.8 ± 5.9 **BMI, *kg/m*^{2} (mean; SD):** 31.1 ± 3.5	**Duration:** 8-week **Frequency:** 3 days/week **Volume:** 60 min/session **Intensity:** High-intensity **EG:** CrossFit® **Activities:** 10–15 min of stretching and warm up, 10–20 min of instruction and practicing techniques and movements, 5–30 min for the workout of the day that was performed at relative individual levels of ability and fitness, and 5 min for cool-down and stretching **CON:** Aerobic and resistance training **Activities:** warmed up using aerobic exercise machines (time not recorded). 3 days/week 50 min of aerobic exercise on the machines (40–50% HRR for weeks 1–4 and 50–60% HRR for weeks 5–8). 2 days/week 20 min full-body resistance exercises. 3 days/week 3 sets of 15 crunches.	**Anthropomorphic measures:** • Weight (kg) • BMI (kg/m^2) • Body fat (%)	**Intra-group ($p < 0.05$)** **Inter-group ($p < 0.05$)**	**Dropouts:** 2 participants from CON withdrew from the study for scheduling issues and not providing reasons. 3 participants dropped out EG for scheduling issues, having a pulled groin muscle and not providing reasons **Adverse events:** NR

>: Greater; <: Lower; ↑: Increment; ↓: Decrement; BMI: body mass index; CON: control group; EG: experimental group; F: female; HOMA: Homeostasis Model Assessment of Insulin Resistance; M: male; VO_2peak: peak oxygen uptake; TG: triglycerides; TC: cholesterol; FFM: fat free mass; BP: blood pressure; SBP: systolic blood pressure; DBP: diastolic blood pressure; HR: heath rate; WHR: waist to hip ratio; WC: waist circumference; HC: hip circumference.

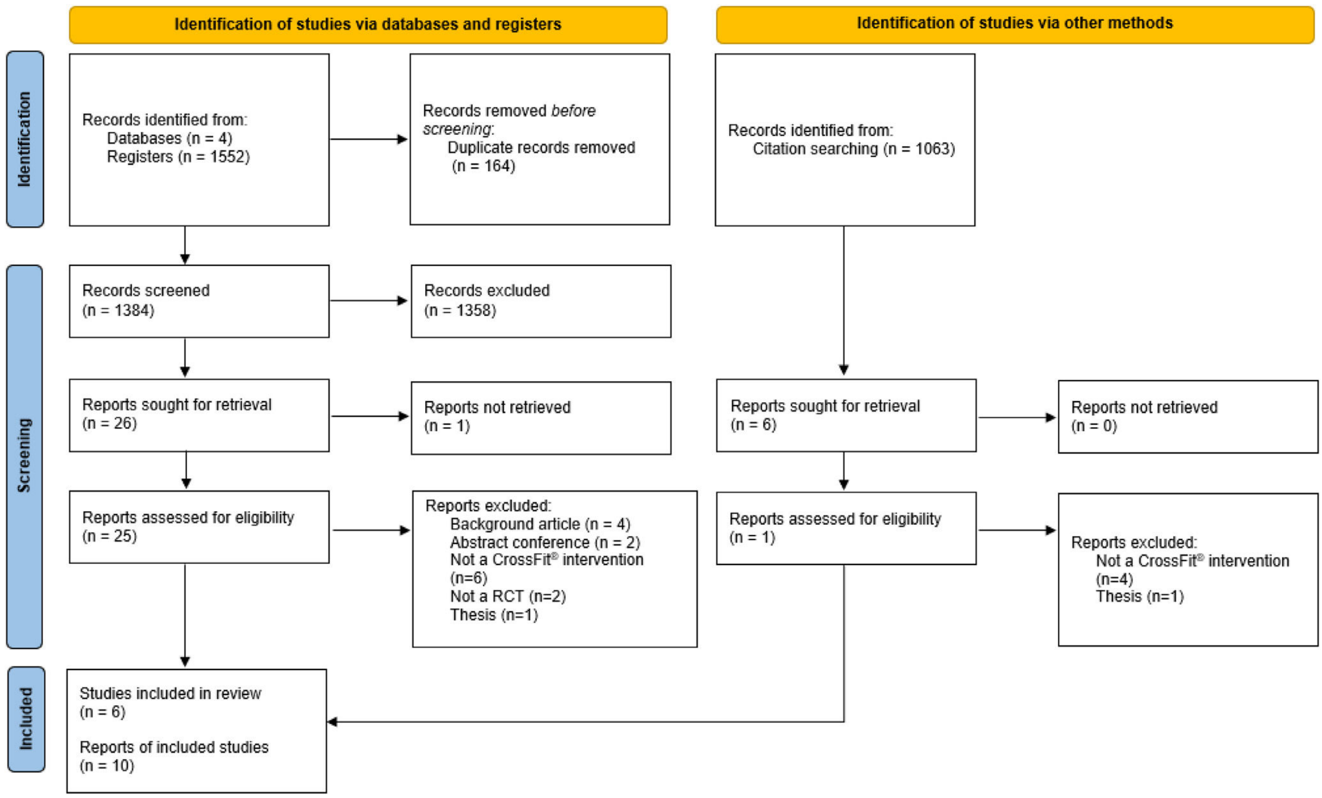


Figure 1 PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) study flow diagram.

Quality appraisal

The methodological quality of each RCTs was retrieved from the Physiotherapy Evidence Database (PEDro). The quality of the studies were categorized according to the following cut-off points: excellent (9–10), good (6–8), fair (4–5), and poor (<3).[20]

Statistical analysis

We could obtain data only to perform a meta-analysis on the effect of CrossFit® on weight and BMI. First, we analyzed the pre–post change for the CrossFit® groups and then we compared also the change in the CrossFit® groups versus control. The calculations were made with Meta-Essentials Workbooks,[21] using the Hedges' g to calculate the effect size, and a random effects model for all analysis to account for the sources of heterogeneity among different studies, using the inverse variance method.

The I^2 was applied to assess statistical heterogeneity and inconsistency. An I^2 value of 0% indicates no observed heterogeneity, and higher values indicate greater heterogeneity. In addition to 95% confidence intervals (CI), we calculated the prediction intervals to express both the magnitude and consistency of the effects.

Results

Study selection

We obtained 1552 records from the database search. After excluding duplicates, we screened the titles and abstracts of 1384 records, and subsequently, 26 articles were retrieved for the full-text assessment. Finally, 10 RCTs met the inclusion criteria and were included in the systematic review. Three sets of studies [22–28] shared the same sample and methodological design, resulting in a total of six studies included in the review (Fig. 1).

Design and samples

The reviewed studies included a total sample size of 697 participants, with individual study sizes ranging from 20[29] to 200[30] individuals. Participant ages varied, with the youngest mean age being 19 years [30] and the oldest mean age being 27.6 years.[22–25] All participants were classified as overweight or obese and were physically inactive.

Only two studies included mixed-gender samples,[27,28] while the remaining investigations focused exclusively on men, except for Zhang & Jiang,[30] who included only women in their research. All the studies were published between 2014 and 2024. Table 2 provides a detailed summary of the primary characteristics of the selected investigations.

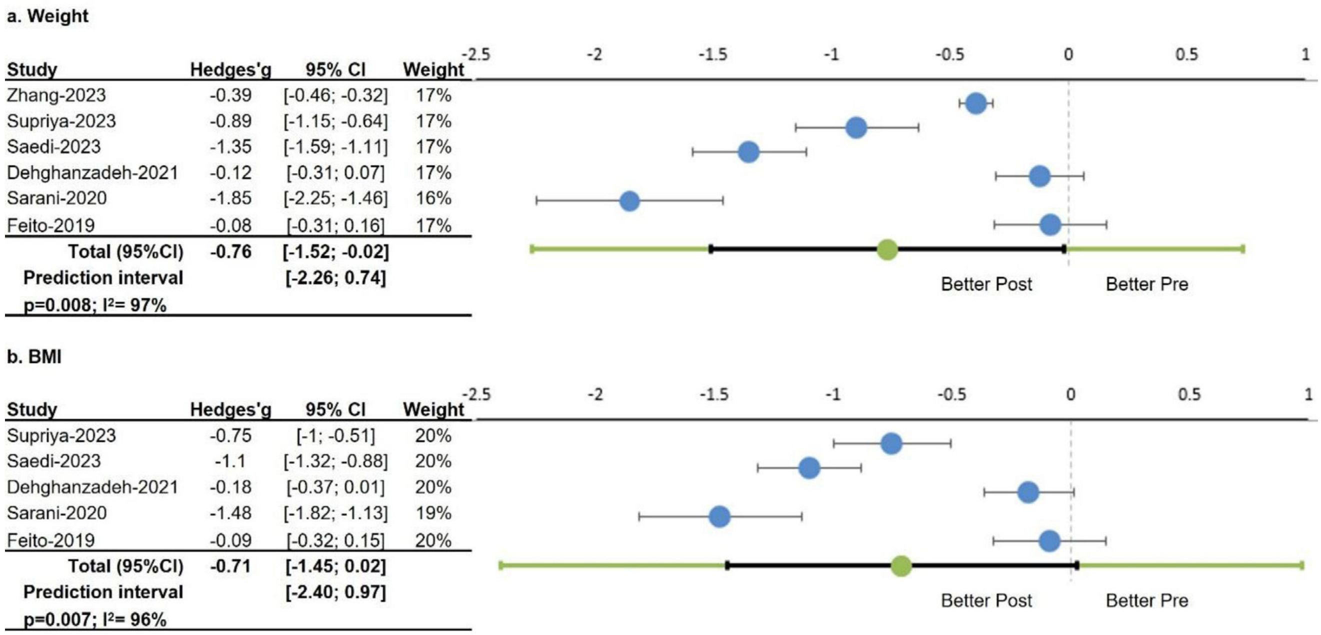


Figure 2 Forest plot for the change in (a) weight and (b) BMI after CrossFit® training. Random effect model, inverse variance.

Interventions characteristics

All CrossFit® interventions across the reviewed investigations were supervised, with the exception of the studies conducted by Zhang & Jiang[30] and Sarani.[29] The duration of the exercise programs varied significantly; 12 weeks in six studies,[22–26,29] 8 weeks in three studies,[27,28,30] and 4 weeks in one study.[31] The reported frequency of sessions was 3 days per week in most studies, except for Dehghanzadeh Suraki et al.,[31] and Sarani,[29] who implemented a higher frequency of 5 days per week. Session durations ranged from 45 min to 120 min. In this regard, Zhang & Jiang [30] did not provide details regarding training load or session structure.

Exercise intensity was controlled in four studies either by means of heart rate monitor,[22–24] or rate or perceived exertion scale.[31] The remaining studies did not specify how exercise intensity was monitored.

Five studies examined the effects of CrossFit® compared to supplements, a combination of both, or maintaining an unchanged lifestyle,[22–26] while three investigations proposed aerobic and resistance training as an intervention for the control groups.[27,28,30] The remaining two studies did not specify the activities undertaken by the control group.[29,31]

Main outcomes

Anthropomorphic measures

A total of nine studies were considered to analyze the effects of CrossFit® on anthropometric measures,[22–24,26–31] with eight of them reporting significant within-group differences, primarily in reductions in body weight, body fat percentage, and BMI, as well as increases in fat-free mass.[22–24,26–31]

The pooled data from the studies comparing pre- and post-intervention measurements within the CrossFit® groups indicated a significant trend toward reductions in weight [six investigations; $n = 161$; Hedges' g: −0.76 (95% CI −1.51; −0.02); $p = 0.008$], and BMI levels [five investigations; $n = 61$; Hedges' g: −0.71 (95% CI −1.45; 0.02); $p = 0.007$]. Heterogeneity was very high for both weight ($I^2 = 97\%$) and BMI ($I^2 = 96\%$) (Fig. 2).

Four investigations examined the effects of CrossFit® programs compared to maintaining an unchanged lifestyle, supplementation alone, or a combination of CrossFit® and supplementation. In all cases, the between-group differences showed that any intervention was superior to maintaining an unchanged lifestyle.[22–24,26] Additionally, two studies indicated that combining CrossFit® with supplementation was more effective for reducing body weight and BMI than participating in CrossFit® alone.[24,26]

CrossFit® was also more effective than an unchanged lifestyle for achieving reductions in body weight, BMI, and fat, as well as increases in lean mass.[29,31] In contrast, its practice did not show to be much more efficient than aerobic and resistance training for any of the anthropometric variables.[27,28,30]

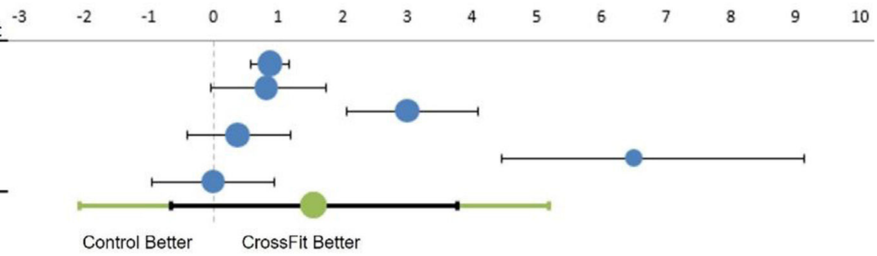
The pooled analysis of the data revealed that changes observed in the CrossFit® groups were not significantly different from those reported in the control or comparison groups for either body weigh [six studies; $n = 320$; 93% men; Hedges' g: 1.55 (95% CI −0.66; 3,76); $p = 0.071$] or BMI levels [five studies; $n = 120$; Hedges' g: 1.24 (95% CI −0.81; 3.29); $p = 0.094$]. Heterogeneity was very high for both weight ($I^2 = 90\%$) and BMI ($I^2 = 83\%$) (Fig. 3).

Cardiometabolic health

Six studies aimed to identify the association between CrossFit® practice and changes in various cardiometabolic health markers.[22–24,27,29,31] Three of them reported significant intra-group improvements, including decreases in triglycerides, LDL, VLDL, HDL/LDL ratio, and total cholesterol,[22,24,31] as well as increases in HDL.[22,24]

a. Weight

Study	Hedges'g	95% CI	Weight
Zhang-2023	0.88	[0.59; 1.17]	20%
Supriya-2023	0.82	[-0.04; 1.75]	18%
Saedi-2023	3	[2.07; 4.08]	17%
Dehghanzadeh-2021	0.38	[-0.4; 1.18]	18%
Sarani-2020	6.5	[4.45; 9.13]	10%
Feito-2019	0	[-0.95; 0.95]	17%
Total (95%CI)	**1.55**	**[-0.66; 3.76]**	
Prediction interval		**[-2.07; 5.18]**	
p=0.071; I²= 90%			



b. BMI

Study	Hedges'g	95% CI	Weight
Supriya-2023	0.97	[0.1; 1.91]	21%
Saedi-2023	0.95	[0.25; 1.69]	22%
Dehghanzadeh-2021	0.52	[-0.26; 1.34]	22%
Sarani-2020	4.79	[3.17; 6.82]	14%
Feito-2019	0.15	[-0.8; 1.11]	21%
Total (95%CI)	**1.24**	**[-0.81; 3.29]**	
Prediction interval		**[-2.20; 4.68]**	
p=0.094; I²= 83%			

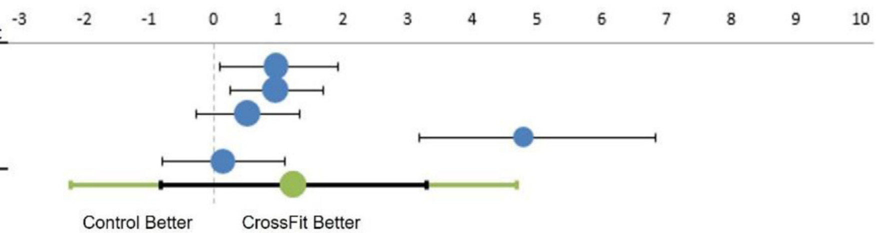


Figure 3 Forest plot for the comparison between CrossFit® or control groups in (a) weight and (b) BMI. Random effect model, inverse variance.

Two interventions focused on the effect of CrossFit® on reductions in insulin, HOMA-IR, and glucose levels. Saeidi, Saei et al., [23] reported significant changes following its practice, while Saeidi, Nouri-Habashi et al., [24] observed similar reductions in groups that received astaxanthin supplements, regardless of their participation in CrossFit® programs. However, combining CrossFit® with supplementation appeared to be more effective for controlling insulin, HOMA-IR, and glucose levels.[24] Out of the three investigations that included blood pressure as an outcome,[23,24,31] only Dehghanzadeh Suraki et al., [31] reported significant intragroup changes.

Regarding inter-group comparisons, significant improvements in cholesterol markers, triglycerides, blood glucose levels and diastolic blood pressure were observed among CrossFit® practitioners, in comparison with those who either received supplementation [22] or maintained their usual life style.[22–24] The comparative analysis of studies involving supplementation also revealed that any intervention was more effective than maintaining an unchanged lifestyle.[22–24] According to the findings of Saeidi et al., [22], participation in CrossFit® programs, regardless of supplementation, was found to be more effective in improving cholesterol parameters.

Cardiorespiratory fitness

Six studies provided information on the effects of CrossFit® on cardiorespiratory fitness, including heart rate, $VO2_{max}$, $VO2_{peak}$, peak power-to-bodyweight ratio (P/BW), and/or average power-to-bodyweight ratio (avg P/BW).[22–24,27,29,31]

Four studies reported positive effects of CrossFit® on increasing $VO2_{max}$, $VO2_{peak}$, P/BW, and avg P/BW, as well as a reduction in heart rate.[22,24,29,31] When analyzing between-group differences, three of these studies showed significant improvements in comparison to the control groups, including increases in $VO2_{max}$, $VO2_{peak}$, P/BW, and avg P/BW.[24,29,31]

Blood markers

The effects of CrossFit® on blood markers (adipokines, growth and differentiation factors, enzymes) was analyzed in five studies, all of which reported positive intra-group and inter-group effects.[22–26] Notably, combining CrossFit® with supplementation led to higher improvements than performing CrossFit® alone.[24–26]

Dropouts and adverse events

A total of 74 dropouts were reported across the six studies that provided this information.[23–28] Of these, 10 occurred in groups participating in CrossFit® alone,[26–28] and 6 in groups combining CrossFit® with supplementation programs.[26] The main reasons for dropouts included health issues, scheduling conflicts, work-related challenges, or lack of interest. Additionally, the study by Heinrich et al., [28] indicated that participants in CrossFit® programs demonstrated higher adherence compared to those in aerobic and resistance training programs. No adverse effects were reported in any of the studies.

Methodological quality

The methodological quality of the included studies, assessed using the PEDro scale, was fair with all but one research receiving 5 out 10 points (Electronic Supplementary Material Table S1). The main limitations were the lack of concealed allocation, blinding of subjects, therapists, and assessors, and the absence of intention-to-treat analysis. Despite these limitations, most studies demonstrated adequate follow-up, baseline comparability, between-group comparisons, and provided point estimates (treatment effect sizes) along with measures of variability such as standard deviations or confidence intervals.

Discussion

The purpose of this research was to examine and critically analyze the existing scientific evidence on the efficacy of CrossFit® in individuals with overweight or obesity, aiming to provide up-to-date and high-quality information regarding its utility as a prescribed exercise modality for this population. We identified considerable RCTs, though they exhibited high heterogeneity and were predominantly of fair methodological quality. Despite these limitations, several findings merit discussion, as they provide valuable insights into the potential of CrossFit® for managing overweight and obesity.

There is a recognized need for updated practice recommendations on exercise in the management of overweight and obesity in adults.[3] The findings of this review address this need by providing evidence that supports the inclusion of CrossFit® as a viable exercise modality. Specifically, the performed meta-analysis on intra-group changes indicated that CrossFit® can be recommended for managing body weight and BMI levels.

The results also demonstrated that combining CrossFit® with supplementation yielded superior improvements in anthropometric outcomes. This aligns with prior evidence suggesting that HIIT, when paired with dietary supplementation, can enhance the benefits of the exercise regimen.[32] In contrast, CrossFit® showed similar effects to aerobic training alone or combined with resistance training in improving anthropometric outcomes, aligning with previous findings. For instance, it is considered that combining aerobic and resistance training exerts superior benefits compared to any single exercise modality in reducing anthropometric markers such as abdominal adiposity in individuals with overweight or obesity.[33] Similarly, meta-analytic evidence has confirmed no significant differences between aerobic and high-intensity interval exercise in terms of weight, fat, and visceral adipose tissue loss within this population,[34] while other authors have suggested that aerobic exercise lead to greater reductions in body fat levels.[35] Notably, the inter-group meta-analysis revealed no significant superiority of CrossFit® compared to control or comparison groups for managing body weight and BMI.

Scientific evidence has consistently demonstrated that exercise exerts a significant impact on intermediate disease markers in populations with overweight or obesity, including triglycerides, LDL, HDL, HOMA-IR, insulin, systolic blood pressure, and diastolic blood pressure.[36] The findings of this review partially support this notion. CrossFit® appeared to be effective in improving HOMA-IR and insulin levels. In addition, the reviewed studies reported significant improvements in triglycerides and cholesterol following its practice. These results reinforce the idea that high exercise intensity is an effective strategy for improving metabolic health in individuals with overweight or obesity.[1]

However, the impact of CrossFit® on blood pressure levels is less conclusive, with only one out of three studies reporting intra-group beneficial effects. This finding is somewhat unexpected, as exercise, particularly high-intensity training, has been consistently shown to significantly improve blood pressure in this population.[37] In this regard, it is noteworthy that CrossFit® demonstrated effectiveness in reducing blood pressure among individuals with overweight but not in those with severe obesity. This distinction underscores the importance of considering baseline characteristics, such as body composition, when prescribing CrossFit® for managing blood pressure.

Cardiorespiratory fitness is a critical determinant of overall health and serves as a robust predictor of future cardiovascular disease risk.[38] Accordingly, individuals with overweight or obesity should prioritize achieving optimal CRF levels to mitigate morbidity and mortality risks.[39] Designing personalized exercise programs tailored to improve CRF in this population is therefore essential for effective intervention and long-term health benefits.[40] According to a comprehensive network meta-analysis of available data on exercise interventions for individuals with obesity, identifying the most effective single exercise modality for CRF remains challenging. However, combining high-intensity aerobic exercise with high-load resistance training seems to yield the greatest improvements in CRF.[33] This idea is in accordance with the findings of this research, since CrossFit® led to significant improvements on a number of CRF markers, including $VO2_{max}$, which is considered the gold standard measure. Specifically, the significant impact of CrossFit on heart rate and maximal oxygen consumption is noteworthy, as obesity is a known risk factor for cardiovascular and respiratory complications.[41] These benefits make CrossFit® a viable intervention for managing cardiovascular and respiratory health in individuals with overweight/obesity.

Obesity is characterized by the excessive accumulation of adipose tissue, particularly white adipose tissue, which secretes a variety of bioactive polypeptides known as adipokines. In the obese state, these adipokines are integral to the development and progression of obesity-related metabolic disorders.[42] In this sense, adipokines are now considered an important target for exercise training prescription among individuals with overweight/obesity. Consequently, adipokines are now recognized as a significant target for exercise training prescriptions in individuals with overweight or obesity, given their potential to modulate inflammation and improve metabolic health.[43]

However, the efficacy of exercise training on adipokine levels in this population remains an intriguing and debated topic.[44] The findings of this review contribute to addressing this scientific gap, as all the analyzed studies concluded that CrossFit® was effective in modulating adipokine concentrations. The obtained results also confirmed a greater effect when CrossFit® was combined with supplementation. This aligns with previous findings that emphasize the enhanced efficacy of combining dietary interventions with exercise in improving this critical marker of health.[45]

According to the reviewed investigations, CrossFit® proved to be a feasible exercise training modality for individuals with overweight or obesity, as evidenced by good adherence levels and the absence of reported adverse effects or health issues related to its practice. This is particularly noteworthy given the well-documented incidence of sport injuries and health issues, such as urinary incontinence, associated with CrossFit®, where BMI is considered a significant risk factor for both.[46,47]

This seems to be the very first systematic review and meta-analysis exploring the effects of CrossFit® in individuals with overweight/obesity. The obtained results contribute to the scientific understanding of CrossFit®'s efficacy, support evidence-based practice, and enhance the overall quality of care for this population. Specifically, CrossFit can be prescribed for weight management, maintaining physical fitness, and preserving metabolic health, thereby helping to prevent obesity-related comorbidities. However, its effects are not superior to those of other, more extensively studied exercise modalities, and its benefits are maximized when combined with supplementation. Nevertheless, the recommendation to prescribe CrossFit is based on studies with methodological limitations, conducted primarily in young, healthy male populations, which limits its broader applicability.

In addition, there are a number of limitations that should be acknowledged. Firstly, only one meta-analysis could be conducted due to the limited number of studies on various variables, combined with the fact that three investigations utilized the same sample. Secondly, a lack of studies directly comparing CrossFit® to other exercise programs hindered the ability to comprehensively evaluate its relative efficacy. Thirdly, none of the reviewed investigations included a follow-up phase, leaving the question of whether the effects of CrossFit® are sustained over the long term unresolved. Lastly, the exclusion of gray literature may have restricted the scope of studies identified, potentially omitting relevant data.

Conclusion

CrossFit® is a feasible exercise modality that can be recommended for managing body composition and metabolic health, as well as improving cardiorespiratory fitness in individuals with overweight or obesity. However, its impact on blood pressure remains inconclusive. Preliminary evidence suggests that the efficacy of CrossFit® for controlling body weight and BMI is not superior to that of traditional aerobic or resistance exercise modalities. Further studies with larger sample sizes and the inclusion of active comparison groups are needed to confirm these findings.

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Conflict of interests

The authors declare that there is no conflict-of-interest.

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Not necessary of the included studies.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.semerg.2025.102512.

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