Original Article

Effects of Exercise Interventions for Type 2 Diabetes patients: a meta-analysis of randomized controlled trials

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ABSTRACT

Objective

To evaluate the effects of exercise interventions on HbA_{1C}, fasting blood glucose (FBG), lipid profiles, blood pressure, anthropometric components, insulin, Homeostasis Model Assessment for Insulin Resistance (HOMA-IR), and inflammatory markers among type 2 diabetes patients.

Methods

We conducted a meta-analysis of randomized control trials (RCTs). Seven electronic databases, namely CINAHL, the Cochrane Library, Embase, Ovid-Medline, PubMed, Scopus, and Web of Science were searched from inception to September 12, 2022 to identify RCTs assessing the effects of exercise for type 2 diabetes. Hedges' g and 95% confidence interval (CI) were calculated as the pooled estimates using a random-effects model, and a two-sided P of <0.05 was considered statistically significant. Moderator analyses were used to test the effect of potential moderators on trial effectiveness.

Results

In total, 126 RCTs involving 7155 people with type 2 diabetes were included. Exercise interventions significantly reduced the primary outcomes, HbA_{1C} and FBG, with a Hedges' g of -0.67 and -0.76 respectively. Significant effects on the secondary outcomes that included lipid profiles, blood pressure, anthropometric components, insulin, HOMA-IR, and inflammatory markers with Hedges' g values ranging from -0.26 to -0.78. Moderator analyses revealed that the effect size for FBG significantly different among the four intervention types, and there was a significant association between FBG's effect size and the percentage of men.

Conclusions

The results from this meta-analysis demonstrated the importance of exercise interventions on type 2 diabetes-related outcomes.

Keywords

Exercise; Aerobic exercise; Resistance exercise; Flexibility training; Type 2 diabetes; Meta-analysis

1. INTRODUCTION

Diabetes has become a significant health problem globally. Its prevalence is estimated at 9.3% in 2019 and is projected to rise to 10.2% and 10.9% by 2030 and 2045, respectively, worldwide.[1] Among the growing number of people with diabetes, type 2 diabetes is the most prevalent type. It is also a significant cause of blindness, kidney failure, heart attacks, stroke, and lower limb amputation.[2] Adults with type 2 diabetes are recommended to engage in moderate-to-vigorous aerobic exercise for 150 minutes or more per week, spreading over at least three days/week, with no more than two consecutive days without activity.[3]

Promoting exercise in type 2 diabetes patients offers numerous benefits, including increased insulin sensitivity, reduced HbA1C, and better cardiovascular risk management.[4] According to guidelines from the American College of Sports Medicine and the American Diabetes Association, recommended exercises include aerobic, resistance, combined aerobic and resistance, flexibility training, and others.[5] Aerobic exercise, involving large muscle groups, includes cycling, walking, and treadmill.[5,6] However, diabetes is linked to a 50-80% higher risk of disability, [7] and most patients are overweight,[8,9] have comorbidities, or limited

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mobility.[10] Consequently, achieving sufficient aerobic exercise can be challenging, making resistance and flexibility training more practical options. Resistance exercises enhance muscle strength, power, and endurance, while flexibility improves joint mobility.[5]

Dietary interventions combined with exercise interventions or exercise alone reduced fasting blood glucose (FBG), postprandial blood glucose, and HbA_{1C} in women with gestational diabetes.[11,12] However, results from several randomized controlled trial (RCT) studies and a meta-analysis did not support the notion of beneficial effects of exercise interventions for HbA_{1C}, homeostasis model assessment-insulin resistance (HOMA-IR) [13,14] and FBG [13,15,16,17] among patients with type 2 diabetes. Notably, the majority of the included studies in that meta-analysis were subject to such risk of bias as not employing allocation concealment, lack of blinded outcome assessment, and not using intention-to-treat analyses. Moreover, another meta-analysis showed that yoga interventions did not significantly decrease lipid profiles (total cholesterol, high-density lipoprotein cholesterol [HDL], low-density lipoprotein cholesterol [LDL], and triglyceride), BMI, blood pressure, waist-to-hip ratio (WHR), and waist circumference (WC) in patients with type 2 diabetes.[18] In contrast, a systematic review of the effect of high-intensity interval exercise on people with type 2 diabetes showed that 1) the majority of studies presented significant post-exercise differences in weight and BMI, 2) two studies illustrated significant post-exercise differences in systolic blood pressure (SBP), HDL, hip circumstance, and WC, and 3) only one study showed significant effects for total cholesterol, LDL, and triglycerides. [19]

To date, few systematic reviews and meta-analyses systematic reviews have examined the effects of exercise interventions in type 2 diabetes patients. Some have explored resistance [20] and aerobic exercises [21,22], but the most recent, conducted over ten years ago, covered all three types (aerobic, resistance, and combined) [23]. Additionally, inconsistencies exist in the literature. Thus, an updated review is needed to quantify the effects of exercise interventions in these patients.

We conducted a systematic review and meta-analysis of RCTs that assessed the effects of aerobic exercise, resistance exercise, flexibility training, combined aerobic and resistance exercise, and other types of training on HbA_{1C}, FBG, lipid profiles, blood pressure, anthropometric components, insulin, HOMA-IR, and inflammatory markers among patients with type 2 diabetes.

2. METHODS

2.1. Search Strategy and Eligibility Criteria

We conducted a systematic review and meta-analysis of RCTs. Searches were conducted in the following electronic databases: CINAHL, the Cochrane Library, Embase, Ovid-Medline, PubMed, Scopus, and Web of Science from inception to September 12, 2022, to identify relevant studies. Terms and keywords combination used in the searches for each database is described in Supplemental Table S2.

Study participants were adults who had received a diagnosis of type 2 diabetes or other chronic conditions with comorbid type 2 diabetes. To be included, articles must have been published in English and used an RCT design. We included all types of exercise intervention, including aerobic exercise, resistance exercise, flexibility training, and other types of training as a single or combined intervention. The comparison group is any type of control group that did not receive the exercise intervention. The primary outcomes were HbA_{1C} and FBG. The secondary outcomes were lipid profiles (total cholesterol, HDL, LDL, and triglycerides), SBP, diastolic blood pressure (DBP), anthropometric components (BMI, WC, and WHR), insulin, HOMA-IR, and inflammatory markers (tumor necrosis factor [TNF]-alpha, interleukin [IL]-6, C-reactive protein [CRP]).

2.2. Data Extraction and Quality Assessment

Two reviewers independently abstracted data necessary for calculating the effect sizes and the following study characteristics from the included trials: first author's name, publication year, country, clinical setting, mean age, % male, type of intervention, intervention duration, mode of delivery, and control group type. Any disagreements were addressed through discussion to reach a consensus. A third reviewer was consulted for adjudication if a consensus was not reached. Additionally, we contacted the authors of primary reports to request any unpublished data.

The two reviewers independently assessed the methodological quality of the included trials by using the RoB 2.0: A revised Cochrane risk of bias tool for randomized trials.[24] Each domain was judged to be at high, low risk or with some concerns. Discrepancies in the judgements were resolved through discussion and consultation with the third reviewer.

2.3. Statistical Analysis

All statistical analyses were performed using Comprehensive Meta-Analysis 2.0 (CMA 2.0, Biostat Inc., Englewood, New Jersey, USA). The mean change in outcomes from baseline to posttest was calculated, and the differences between the intervention and control groups were estimated. Hedges' g and 95% confidence interval (CI) were calculated as the pooled estimates using a random-effects model, and a two-sided p-value of <0.05 was considered statistically significant. Considering the differences in participants' characteristics, study design, and interventions among studies,[25] we selected a random effects model to pool the effects. The effect size was interpreted as small (0.2), medium (0.5), large (0.8), and very large (1.2). [26]

Heterogeneity was estimated using Cochran's Q test and I^2 statistics. The statistical significance of heterogeneity was set at $p < 0.05$, and I^2 was interpreted as low (<25%, moderate (50%) and high (>75%).[27] We conducted a sensitivity analysis by repeated analyses, removing studies one by one to determine those that cause the variability. Moderator analyses were conducted according to the type of setting, type of intervention, and intervention duration to explore possible sources of heterogeneity in the effect sizes. A meta-regression analysis with mean age and percentage of males as independent variables and heterogeneous outcomes as dependent variables was also performed. Publication bias was assessed using the Egger's regression with a p < 0.10, indicating significant publication bias. The trim and fill analysis was conducted when significant publication bias existed and the number of included studies.[28]

3. RESULTS

3.1. Search results.

A total of 3734 English publications were identified in the initial search. After excluding duplicates and screening the titles and abstracts for eligibility, 217 full-text articles were retrieved for further assessment. In total, 126 studies that met the eligibility criteria were included in the analysis. Figure 1 illustrates the selection process.

3.2. Study Characteristics

This meta-analysis included a total of 126 RCTs involving 7155 participants. These trials were conducted in 37 countries and published between 2002 and 2022. Sixteen studies did not report the mean age of the participants. In 110 studies involving 6102 participants, the mean age ranged from 21.3 to 73.3 years. The percentage of males ranged from 0.0% to 100%. Sixteen studies were conducted in Iran, Fifteen in Australia, ten in the United States, seven each in Denmark and Japan, six in Brazil, five each in Canada, India, Italy, and four each in China, Turkey, Nigeria, and United Kingdom, three each in the Netherlands, Korea, Austria, two each in Thailand, Indonesia, Portugal, Pakistan, and Greece, and one each in Saudi Arabia, Finland, Norway, Siri Lanka, Latvia, Switzerland, Mozambique, Belgium, Taiwan, Cuba, Sweden, Denmark, Mexico, Germany, and France. The duration of intervention ranged from 1 week to 14 months. Most of the studies delivered the exercise intervention in a face-to-face mode. Fifty-four studies implemented an aerobic exercise program, 26 studies conducted a resistance exercise program, 28 studies implemented a combined program of aerobic and resistance exercise, and eight studies assessed other types of training (i.e., Taichi, Yoga, Taichi Qigong, Pilates exercise, Hatha Yoga). The characteristics of all the included studies are presented in Table 1.

3.3. Quality Assessment

The quality of studies was assessed using ROB 2.0. Regarding the overall quality of studies, most studies (68.25%) exhibited high risk, 18.25% of the studies were judged to be some concern, and 13.49% was considered low risk (Supplemental Figure S4).

3.4. Effects of Exercise Interventions on the Primary Outcomes

The pooled results for all outcomes are presented in Table 1. The forest plots for all outcomes are presented in Supplemental Figure S3.

HbA_{1C}

Eighty-nine studies with a total of 5540 participants were included for the analysis of HbA_{1C}. The pooled between-group mean difference of HbA_{1C} was -0.46 (95% CI = -0.55 to -0.38, p < 0.001). The pooled effect size was -0.67 (95% CI = -0.78 to -0.56, p <0.001), indicating a medium effect. These studies had considerable heterogeneity (I^2 = 76.19%, p <0.001). The results of Egger's test indicated possible publication bias (p <0.001). The results remained largely unaltered after the trim and fill analysis.

FBG

The effect of exercise interventions on FBG was evaluated in 93 studies, and the pooled effect was statistically significant with an effect size of -0.76 (95% CI = -0.92 to -0.60, p <0.001), indicating a medium effect. These studies were highly heterogenous (I^2 = 86.07%, p <0.001). Publication bias was identified by the Egger regression analysis (p = 0.0001). The trim and fill analysis did not alter the results.

3.5. Exercise Intervention on the Secondary Outcomes

Lipid Profiles

The pooled effect size for the 56 studies on total cholesterol was -0.78 (95% CI = -1.03 to -0.53, p <0.001), indicating a medium effect. These studies were highly heterogenous (I^2 = 89.85%, p <0.001). The results of Egger's test indicated publication bias (p = 0.0003). The trim and fill analysis did not substantially alter the results.

The pooled effect size for the 65 studies on HDL was -0.41 (95% CI = -0.47 to -0.35, p <0.001), indicating a medium effect. The studies had considerable heterogeneity (I^2 = 73.71%, p <0.001). Publication bias was identified by the Egger regression analysis (p = 0.020). After adjustment using the trim and fill method, the results revealed a smaller but statistically significant effect size (Hedges' g = -0.49, 95% CI = -0.63 to -0.36).

The pooled effect size for the 64 studies on LDL was -0.65 (95% CI = -0.83 to -0.471, p <0.001), indicating a medium effect. These studies were highly heterogenous (I^2 = 85.18%, p <0.001). Egger's test revealed possible publication bias (p = 0.0003). The trim and fill analysis did not substantially alter in the effect size.

The pooled effect size for the 65 studies on triglyceride was -0.66 (95% CI = -0.81 to -0.50, p <0.001), indicating a medium effect. These studies were highly heterogenous (I^2 = 79.15%, p <0.001). Publication bias was identified by the Egger regression analysis (p <0.001). The results remained largely unaltered after the trim and fill analysis.

Blood Pressure

The overall effect size for the 56 studies on SBP was -0.49 (95% CI = -0.61 to -0.38, p <0.001), indicating a medium effect. The studies had moderate heterogenous (I^2 = 55.97%, p <0.001). The results of Egger's test indicated that publication bias was likely (p = 0.001). The trim and fill analysis did not substantially alter the effect size.

The overall effect size for the 54 studies on DBP was -0.52 (95% CI = -0.66 to -0.38, p <0.001), indicating a medium effect. Moderate heterogeneity between studies were observed (I^2 = 72.415, p <0.001). The results of Egger's test indicated publication bias (p = 0.001). The results remained largely unaltered after the trim and fill analysis.

Anthropometric components

The effect size for the 78 studies on BMI was -0.32 (95% CI = -0.41 to -0.24, p <0.001), indicating a small effect. Moderate heterogeneity between studies were identified (I^2 = 44.61%, p <0.001). The results of Egger's test indicated publication bias (p = 0.012). The trim and fill analysis did not substantially alter the effect size.

The overall effect size for the 41 studies on WC was -0.49 (95% CI = -0.64 to -0.35, p <0.001), indicating a small effect. These studies had considerable heterogeneity (I^2 = 66.56%, p <0.001). The results of Egger's test indicated that publication bias was unlikely (p = 0.13).

The pooled effect for the 16 studies on WHR was -0.26 (95% CI = -0.44 to -0.09, p = 0.003), indicating a small effect. No significant heterogeneity was observed (I^2 = 25.34%, p = 0.170). Publication bias was identified by the Egger regression analysis (p = 0.014). The trim and fill analysis results revealed a smaller but statistically significant effect size (Hedges' g = -0.24, 95% CI = -0.39 to -0.10).

Insulin

The overall effect size for the 33 studies on insulin was -0.78 (95% CI = -1.01 to -0.55, p <0.001), indicating a medium effect. These studies had considerable heterogeneity (I^2 = 81.52%, p <0.001). The results of Egger's test indicated that there might exist publication bias (p = 0.001). After adjustment using the trim and fill method, the results revealed a smaller and statistically significant effect size (Hedges' g = -0.21, 95% CI = -0.29 to -0.13).

HOMA-IR

The overall effect size for the 36 studies on HOMA-IR was -0.78 (95% CI = -0.99 to -0.57, p <0.001), indicating a medium effect. The studies had high heterogeneity (I^2 = 80.10%, p <0.001). The results of Egger's test indicated that publication bias was likely (p = 0.001). After adjustment using the trim and fill method, the results revealed a larger and statistically significant effect size (Hedges' g = -0.52, 95% CI = -0.66 to -0.38)

Inflammatory markers

The nine studies on TNF-alpha had a pooled effect size of 0.56 (95% CI = 0.27 to 0.84, p <0.001), indicating a medium effect. The studies had substantial heterogeneity (I^2 = 61.30%, p = 0.001). The results of Egger's test indicated that publication bias was unlikely (p = 0.170).

The pooled effect size for the ten studies assessing IL-6 was -0.60 (CI = 0.13 to 1.06, p <0.001), indicating a medium effect. These studies had considerable heterogeneity (I^2 = 84.35%, p <0.001). The results of Egger's test indicated possible publication bias (p = 0.07). After adjustment using the trim and fill method, the results revealed a smaller but statistically significant effect size (Hedges' g = -0.37, 95% CI = 0.20 to 0.55).

The pooled effect size for the 15 studies on CRP wad -0.60 (CI = -0.53 to -0.29, p = 0.012), indicating a moderate effect. No significant heterogeneity was observed (I^2 = 6.01%, p = 0.39). The results of Egger's test indicated that publication bias was unlikely (p = 0.43).

3.6. Moderator Analyses

Moderate to high heterogeneity were noted between the included studies for HbA_{1C}, FBG, total cholesterol, HDL, LDL, triglyceride, BMI, SBP, DBP, HOMA-IR, WC, insulin, TNF-alpha, and IL-6. However, we did not conduct a moderator analyses for TNF-alpha due to a small number of trials. Meta-regression analysis results (Table 2) revealed a significant association between the effect size of FBG, HDL, LDL, WC, and insulin, and the percentage of male. Age was significantly associated with the effect size of BMI but not with other outcomes. Although sub-group analyses of different types of intervention revealed no significant difference, the combination of aerobic exercise with resistance training showed the largest effect size for reducing HbA_{1C} than any other type of intervention (Table 3).

3.7. Sensitivity analysis

The sensitivity analyses were conducted to examine the robustness of the results for each outcome by excluding one study at a time. No results were significantly altered, supporting the robustness of our results.

4. DISCUSSION

A total of 126 RCTs that investigate the effects of exercise for patients with type 2 diabetes were included in the meta-analysis. We observed significant effect sizes, ranging from small to medium, of the two primary outcomes (HbA_{1C} and FBG). We also observed statistically significant results on secondary outcomes, namely lipid profiles (total cholesterol, HDL, LDL, and triglycerides), SBP, DBP, anthropometric components, insulin, HOMA-IR, and inflammatory markers (TNF-alpha, IL-6, CRP). The robustness of these findings was confirmed by significant results in the sensitivity analysis.

The relationship between sedentary lifestyles and the risk of diabetes has increasingly gained attention even in developing countries. It has been found that diabetes mellitus had a higher prevalence in urban dwellers who were obese and involved in less physical activity.[29] In concordance with the findings of previous meta-analyses and systematic reviews assessing exercise interventions for patients with diabetes [20,21,30], the updated meta-analysis supports the beneficial effects of exercise interventions for a range of prognosis-related outcomes of diabetes.

A clinically relevant lowering of both HbA_{1C} and FBG is a key marker of improved glycemic control. A 0.5% reduction of HbA1C was considered clinically relevant [31] and any reduction in HbA_{1C} may lead to the reduction of cardiovascular disease risk in patients with type 2 diabetes.[32] Thus, findings from our study that exercise interventions achieved a reduction in HBA_{1C} of -0.46 (CI = -0.56 to -0.38) should be considered of clinical importance. Exercise increases the concentration of insulin-regulated glucose transported, known as GLUT4, in the cell membrane and increases the glucose uptake in the skeletal muscles.[33] A review study revealed that glucose fluctuation correlated with diabetic complications by reactive oxygen that disrupt cells and tissue.[34] It has been observed in animal-based research and modeling of mice and rats with both two types of diabetes that glucose fluctuations can alter renal tissue structure, promote renal fibrosis, and thicken capillary basal membrane.[35]

Notably, combining aerobic exercise with resistance training has shown the greatest effect in reducing HbA1C compared to other exercise interventions. Aerobic exercise (endurance training) increases heart and breathing rates, enhancing oxygen consumption across multiple organs and tissues.[36] Resistance exercise (strength training) triggers metabolic adaptations in skeletal muscles through molecular pathways, promoting inter-organ communication, which underlies many benefits.[37] This combination positively impacts cardiac, vascular, and skeletal muscle health, leading to improved body composition and glycemic control, particularly in those with poor baseline glycemic control.[38,39] Six months of combined aerobic and resistance training has been shown to improve fasting plasma glucose, serum insulin, and HbA1C levels.[40]

Similar to the results of our meta-analysis, the results of a systematic review and metanalysis of patients with metabolic syndrome [41] revealed a significant effect of exercise on metabolic outcomes, including changes in triglycerides, cholesterol, and LDL cholesterol, but not HDL cholesterol. Managing metabolic outcomes is a priority for individuals with type 2 diabetes because cardiovascular disease constitutes the major cause of mortality in individuals with diabetes. The key strategies for lowering the risk of cardiovascular disease include regulating blood glucose and blood lipid profile values and decreasing blood pressure.[42]

Regular exercise is well known to improve blood glucose control and enhance insulin sensitivity and glucose absorption in type 2 diabetes.[14] As expected, we found that exercise interventions have medium effects on the insulin and insulin resistance outcomes in people with type 2 diabetes. In this study, insulin resistance was evaluated using HOMA-IR, its calculated using fasting plasma insulin and fasting plasma glucose. HOMA-IR has been approved and validated for insulin resistance [43]; quantification using HOMA-IR is more convenient.

This study revealed significant effects of an exercise intervention on most of the anthropometric components, which were BMI, WC, and WHR. WC and WHR are indicators of visceral obesity, which has been considered to serve as a better predictor of type 2 diabetes and prediabetes.[44] Combined physical activity can result in mild to moderate changes in body compositions in obese persons with type 2 diabetes.[45] Conversely, a reduction in physical activity with increased sedentary behavior leads to a change in the body compositions with loss of lean mass and accretion of body fat, particularly abdominal fat.[46]

In individuals with type 2 diabetes, endothelial dysfunction and inflammatory markers such as CRP, IL, and TNF-alpha are significantly elevated, contributing to low-grade systemic inflammation.[47] This study found that exercise can reduce inflammation by decreasing adipocytokine production and cytokine release from skeletal muscles, endothelial cells, and the immune system, while also enhancing antioxidant status. Aerobic, resistance, and combined exercises each had different effects on cytokine levels in type 2 diabetes.[48]

Although this study showed significant effects of exercise interventions on outcomes in patients with type 2 diabetes, statistical heterogeneity was found in the results. To investigate the sources, we conducted meta-regression and moderator analyses, revealing that differences in intervention types influenced effect sizes for most outcomes. Overall, exercise is an effective intervention for type 2 diabetes, but combination exercise had a larger effect size than aerobic or resistance training alone and other interventions such as Taichi, Yoga, and Pilates. The latest ADA guidelines recommend combining aerobic and resistance training for optimal glucose and lipid management in type 2 diabetes.[49] Similarly, a recent network meta-analysis found that combined exercise better controlled FBG, insulin, and BMI in prediabetes patients compared to other exercise types.[50,51]

Strength and limitation

This meta-analysis conducted searches of seven databases; as a result, we included 126 RCTs that evaluated various outcomes related to the prognosis of individuals with type 2 diabetes. However, this meta-analysis has several limitations. First, we included all exercise intervention types, which may have contributed to the high heterogeneity of this study. Second, publication bias was detected in several outcomes. Nevertheless, all effect sizes remained significant after adjustment with the trim-and-fill method. Third, we did not include articles published in languages other than English, which may have created a language bias. Fourth, most studies were judged to have a high risk of bias, and multiple studies were judged to have some risk of bias. Therefore, these results should be interpreted with caution.

5. CONCLUSION

Exercise interventions have beneficial effects on the levels of HbA1c and FBG, lipid

profile values, blood pressure, anthropometric measurements, insulin level, the HOMA-IR, and inflammatory markers in patients with type 2 diabetes. Although heterogeneity was found to be high, the combination of aerobic exercise with resistance training yielded the largest effect size for reducing HbA1c levels compared with other types of exercise interventions.

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Conflict of Interest: We confirm that all authors' names meet the Diabetes Care criteria for authorship. The authors declare no conflict of interest that could inappropriately influence the work.

Ethical clearance: We registered for the meta-analytic review at PROSPERO (CRD42021247775).

Author's contribution.

Data gathering and idea owner of this study: P.V.T

Study design: P.V.T, N.M.N, & T.Q.H

Data gathering: P.V.T, N.M.N, & T.Q.H

Writing and submitting manuscript: N.M.N, & T.Q.H

Editing and approval of final draft: P.V.T

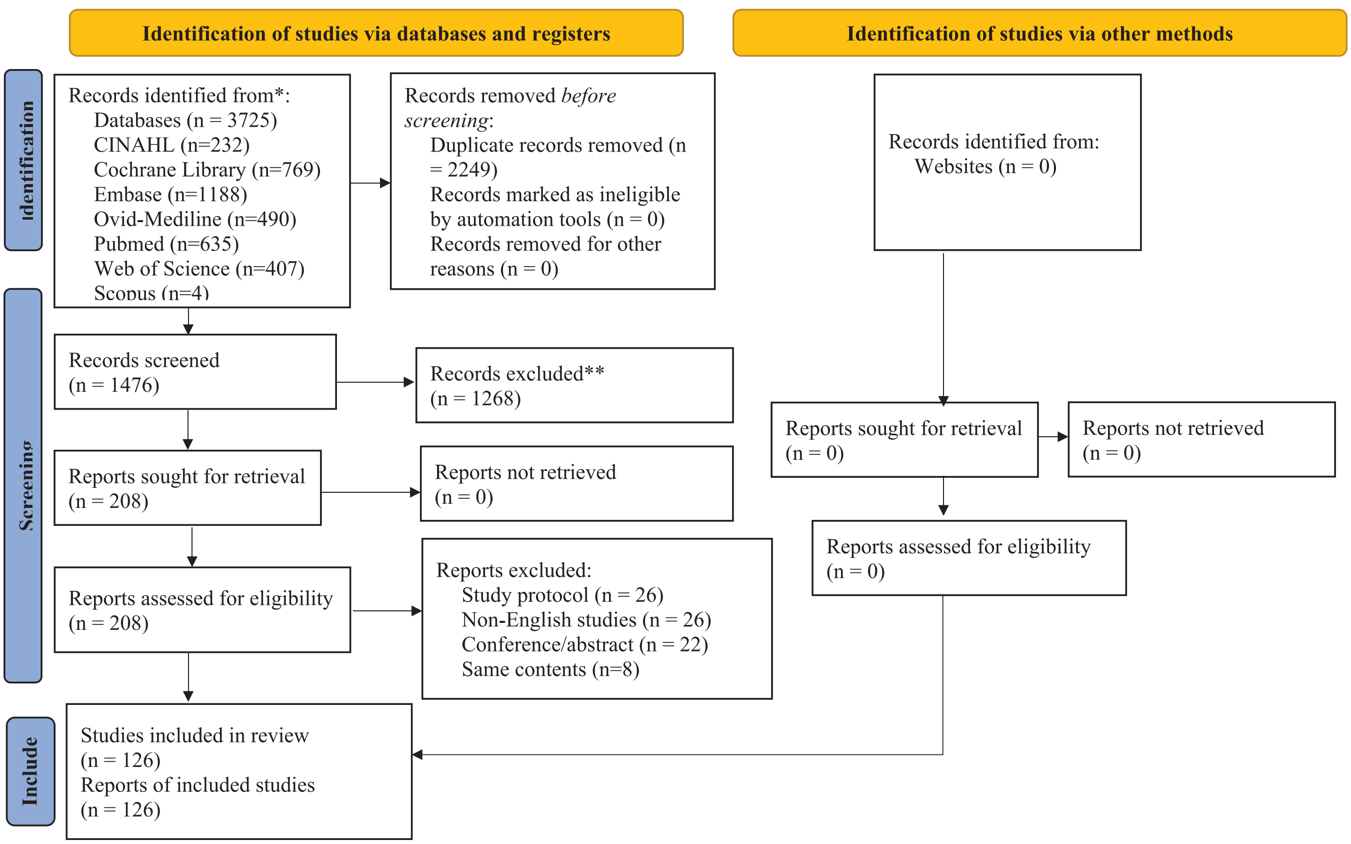


Figure 1. Preferred reporting items for systematic review and meta-analyses (PRISMA) 2020 flow diagram

Table 1. Characteristics of studies included in the meta-analysis.

Author/year	Country	Setting	Arm/n	Mean age (SD)	% male	Type of interventions	Intervention duration	Delivery	Control group type
Abd El- Kader et al. 2013	Saudi Arabia	Community	IG: 25 CG: 25	IG: N/A CG: N/A	IG: N/A CG: N/A	Aerobic exercise	3 months	Face-to-face	Mild aerobic exercise
Loimaala et al. 2009	Finland	Hospital	IG: 24 CG: 24	IG: 53.6(6.2) CG:54.0(5.0)	IG: N/A CG: N/A	Aerobic exercise	24 months	Face-to-face	Standard care
Lucotti et al. 2011	Italy	Hospital	IG: 20 CG: 27	IG:61.5(11.5) CG:58.1(9.9)	IG: 35.00 CG:37.04	Combined	3 weeks	Face-to-face	Aerobic exercise
Madden et al. 2011	Canada	Community	IG: 20 CG: 20	IG:71.9(1.1) CG:71.3(0.9)	IG: N/A CG: N/A	Aerobic exercise	3 months	Face-to-face	Strength training
Magalhães et al. 2019	Portugal	Community	IG: 28 CG: 27	IG:59.0(8.1) CG:59.7(6.5)	IG: 51.9 CG: 46.4	Combined	12 months	Face-to-face	Standard care
Maharaj & Nuhu. 2016	Nigeria	Community	IG: 45 CG: 45	IG:40.5(6.5) CG:38.5(5.7)	IG: 48.9 CG: 46.7	Aerobic exercise	9 weeks	Face-to-face	Read health magazines and watched videos
Maiorana et al. 2002	Australia	Hospital	IG: 16 CG: 16	IG:52.0(2.0) CG:52.0(2.0)	IG:87.5 CG: 87.5	Combined	2months	Face-to-face	Usual care
Jorge et al. 2011	Brazil	Hospital	IG: 12 CG: 12	IG:57.9(9.8) CG:53.4(9.8)	IG:50 CG: 50	Combined	3 months	Face-to-face	Light stretching exercises
Mendham et al. 2014	Australia	Community	IG: 16 CG: 10	IG:39.5(10.6) CG:36.1(16.1)	IG:100.0 CG:100.0	Aerobic exercise	3 months	Face-to-face	Continue usual inactive lifestyle
Metcalfe et al. 2018	UK	Clinic	IG:11 CG: 11	IG:52.0(6.0) CG:52.0(6.0)	IG:100.0 CG:100.0	Aerobic exercise	1 week	Face-to-face	Remained sedentary lifestyle

Table 1 (continued.)

Author/year	Country	Setting	Arm/n	Mean age (SD)	% male	Type of interventions	Intervention duration	Delivery	Control group type
Miyauchi et al. 2016	Japan	Hospital	IG:92 CG:95	IG:67.2(9.2) CG:62.0(10.6)	IG:78.3 CG:56.8	Aerobic exercise	6 months	Face-to-face	Walking exercise
Middlebrooke et al. 2006	UK	Clinic	IG:22 CG:30	IG:61.8(7.7) CG:64.6(6.8)	IG: N/A CG: N/A	Aerobic exercise	6 months	Face-to-face	Standard care
Miller et al. 2017	Australia	Community	IG:16 CG:13	IG:67.6(5.2) CG:66.9(5.3)	IG:62.5 CG:46.2	Resistance exercise	12 months	Face-to-face Telephone calls	Home-training dumbbells
Miller et al. 2020	Australia	Community	IG:100 CG:80	IG:62.0(6.2) CG:61.1(6.2)	IG:64.0 CG:63.3	Resistance exercise	6 months	Face-to-face Telephone calls	Usual care
Moe et al. 2011	Norway	Community	IG:13 CG:13	IG:56.2(8.2) CG:57.7(7.8)	IG:100.0 CG:100.0	Aerobic exercise	3 months	Face-to-face	Resistance exercise
Mortensen et al. 2019	Denmark	Hospital	IG:10 CG:11	IG:57.0(9.0) CG:53.0(7.0)	IG:70.0 CG:54.5	Aerobic exercise	3 months	Face-to-face	Moderate-intensity endurance training
Motahari-Tabari et al. 2015	Iran	Clinic	IG:27 CG:26	IG:49.3 CG:49.0	IG:0.0 CG:0.0	Aerobic exercise	2 months	Face-to-face	Usual care
Sudarsono et al. 2019	Indonesia	Hospital	IG:22 CG:20	IG:51.7(7.8) CG:50.1(7.2)	IG:22.7 CG:45.0	Combined	3 months	Face-to-face	Cardiorespiratory exercises
Natesan et al. 2015	USA	Community	IG:11 CG:12	IG: N/A CG: N/A	IG:0.0 CG:0.0	Aerobic exercise	2 months	Face-to-face	Wait-list control

Table 1 (continued.)

Author/year	Country	Setting	Arm/n	Mean age (SD)	% male	Type of interventions	Intervention duration	Delivery	Control group type
Okada et al. 2010	Japan	Hospital	IG:21 CG:17	IG:61.9(8.6) CG:64.5(5.9)	IG:47.6 CG:64.7	Combined	3months	Face-to-face	Usual care
Pandey et al. 2017	Canada	Clinic	IG:21 CG:19	IG:68.0(9.0) CG:65.0(9.0)	IG:76.0 CG:63.0	Aerobic exercise	3 months	Face-to-face	MICT
Pedersen et al. 2019	Denmark	Hospital	IG:26 CG:29	IG:62.3(5.7) CG:63.8(6.7)	IG:85.0 CG:72.0	Aerobic exercise	12 months	Face-to-face	Low energy diet
Plotnikoff et al. 2010	Australia	Clinic	IG:27 CG:21	IG:55.0(12.0) CG:54.0(12.0)	IG:29.6 CG:38.1	Resistance exercise	4 months	Face-to-face	Non-training
Praet et al. 2008	Netherland	Clinic	IG:49 CG:43	IG:61.0(9.0) CG:59.0(9.0)	IG:55.1 CG:46.5	Aerobic exercise	12 months	Face-to-face	Medical fitness
Rahbar et al. 2017	Iran	Clinic	IG:13 CG:15	IG: 48.3(5.0) CG: 48.6(4.8)	IG:N/A CG:N/A	Aerobic exercise	2 months	Face-to-face	Usual care
Ranasinghe et al. 2021	Siri Lanka	Clinic	IG:28 CG:30	IG:52.0(9.8) CG:49.3(7.0)	IG:55.1 CG:46.5	Aerobic exercise	3 months	Face-to-face	Standard treatment
Rech et al. 2019	Brazil	Hospital	IG:17 CG:21	IG:70.5(7.4) CG:68.0(6.5)	IG:58.8 CG:47.6	Resistance exercise	3 months	Face-to-face	Active control program
Rehman et al. 2017	Pakistan	Hospital	IG:51 CG:51	IG:N/A CG:N/A	IG:N/A CG:N/A	Aerobic exercise	6 months	Face-to-face	Routine medication and dietary
Rezaei et al. 2017	Iran	Clinic	IG:10 CG:10	IG:42.0(3.6) CG:43.5(2.8)	IG:0.0 CG:0.0	Aerobic exercise	10 weeks	Face-to-face	Usual care

Table 1 (continued.)

Author/year	Country	Setting	Arm/n	Mean age (SD)	% male	Type of interventions	Intervention duration	Delivery	Control group type
Sabag et al. 2020	Australia	Hospital	IG:12 CG:11	IG:54.8(2.4) CG:51.9(1.4)	IG:40.0 CG:70.0	Aerobic exercise	3 months	Face-to-face	Low- volume HIIT
Schneider et al. 2016	USA	Hospital	IG:15 CG:14	IG:53.3(6.0) CG:53.4(8.4)	IG: 0.0 CG: 0.0	Aerobic exercise	6 months	Face-to-face	Usual Care
Shabani et al. 2015	Iran	Hospital	IG:10 CG:10	IG:50.2(4.8) CG:51.3(6.6)	IG: 0.0 CG: 0.0	Resistance exercise	3 months	Face-to-face	Usual Care
Shakil-ur-Rehman et al. 2017	Pakistan	Hospital	IG:51 CG:51	IG:53.7(8.7) CG:55.0(7.6)	IG:N/A CG:N/A	Aerobic exercise	6 months	Face-to-face	Usual Care
Shenoy et al. 2010	India	Clinic	IG:15 CG:14	IG:53.1(4.4) CG:51.0(5.4)	IG:75.0 CG:70.0	Aerobic exercise	2 months	Face-to-face	Usual Care
Sigal et al. 2007	Canada	Community	IG:64 CG:63	IG:54.7(7.5) CG:54.8(7.2)	IG:75.0 CG:70.0	Combined	6 months	Face-to-face	Supervised exercise
Snel et al. 2012	Netherlands	Clinic	IG:13 CG:14	IG:53.0(2.5) CG:56.1(2.4)	IG:61.5 CG:42.9	Aerobic exercise	4 months	Face-to-face	Very low-calorie diet
Sokolovska et al. 2020	Latvia	Clinic	IG:14 CG:26	IG:60.6(7.4) CG:60.9(8.8)	IG:42.9 CG:26.9	Aerobic exercise	4 months	Face-to-face	Usual Care
Sparks et al. 2013	USA	Hospital	IG:18 CG:10	IG:60.4(7.3) CG:60.8(8.0)	IG:50.0 CG:20.0	Resistance exercise	9 months	Face-to-face	Weekly stretching and relaxation classes
Stolinski et al. 2008	Switzerland	Hospital	IG:8 CG:9	IG:59.0(3.0) CG:55.0(3.0)	IG:50.0 CG:55.6	Aerobic exercise	6 months	Face-to-face	Usual Care
Sung & Bae 2012	Korea	Hospital	IG:22 CG:18	IG:70.2(4.7) CG:70.1(3.6)	IG:31.8 CG:38.9	Aerobic exercise	6 months	Face-to-face	Usual Care

Table 1 (continued.)

Author/year	Country	Setting	Arm/n	Mean age (SD)	% male	Type of interventions	Intervention duration	Delivery	Control group type
Swift et al. 2012	USA	Hospital	IG:58 CG:37	IG:58.7(8.0) CG:58.5(5.6)	IG:45.8 CG:29.7	Resistance exercise	9 months	Face-to-face	Weekly stretching and relaxation classes
Taheri et al. 2019	Iran	Clinic	IG:25 CG:25	IG:50.4(4.8) CG:50.9(4.8)	IG:80.0 CG:80.0	Resistance exercise	5 months	Face-to-face	Muscle stretching
Tan et al. 2018	China	Community	IG:16 CG:15	IG:63.0(2.3) CG:62.9(2.6)	IG:0.0 CG:0.0	Aerobic exercise	3 months	Face-to-face	Maintain physical activity
Teychenne et al. 2015	Australia	Community	IG:162 CG:156	IG:56.3(8.7) CG:55.5(8.6)	IG:40.0 CG:42.0	Resistance exercise	12 months	Face-to-face	Exercises and intensity prescribed
Tomas-Carus et al. 2016	Portugal	Hospital	IG:22 CG:21	IG:59.9 CG:58.9	IG:37.5 CG:78.6	Combined	3 months	Face-to-face	Usual care
Tsang et al. 2008	Australia	Community	IG:18 CG:20	IG:N/A CG:N/A	IG:11.1 CG:30	Others type of exercise (Taichi)	4 months	Face-to-face	Sham exercise
Van Dijk et al. 2013	Netherlands	Community	IG:20 CG:20	IG:64.0 (1.0) CG:64.0 (1.0)	IG:100.0 CG:100.0	Aerobic exercise	1 month	Face-to-face	Activities of daily living
Vinetti et al. 2015	Italy	Hospital	IG:10 CG:10	IG:61.5 (5.9) CG:58.5 (9.6)	IG:100.0 CG:100.0	Combined	12 months	Face-to-face	Standard medical care
Winding et al. 2018	Denmark	Hospital	IG:13 CG:17	IG:54.0 (6.0) CG:57.0 (7.0)	IG:53.8 CG:71.4	Aerobic exercise	3 months	Face-to-face	Usual care

Table 1 (continued.)

Author/year	Country	Setting	Arm/n	Mean age (SD)	% male	Type of interventions	Intervention duration	Delivery	Control group type
Winnick et al. 2007	USA	Clinic	IG:9 CG:9	IG:48.4 (8.4) CG:50.9 (3.2)	IG:22.2 CG:33.3	Aerobic exercise	1 week	Face-to-face	Energy balance
Wycherley et al. 2010	Australia	Community	IG:14 CG:16	IG: N/A CG: N/A	IG: N/A CG: N/A	Resistance exercise	4 months	Face-to-face	Low-fat diet alone)
Yan et al. 2014	Mozambique	Clinic	IG:9 CG:10	IG: N/A CG: N/A	IG: N/A CG: N/A	Aerobic exercise	12 months	Face-to-face	Usual care
Yang et al. 2011	USA	Hospital	IG:13 CG:12	IG:N/A CG:N/A	IG:N/A CG:N/A	Others type of exercise (Yoga)	3 months	Face-to-face	Health-education
Yang et al. 2017	Canada	Community	IG:20 CG:20	IG:49.8 (1.4) CG:52.2(1)	IG:40.0 CG:70.0	Resistance exercise	6 months	Face-to-face	Usual care
Yang et al. 2020	China	Hospital	IG:30 CG:30	IG:47.7 (7.3) CG:45.2(8.8)	IG:53.3 CG:53.3	Combined	3 months	Face-to-face	Maintain original lifestyles
Yavari et al. 2012	Iran	Clinic	IG:15 CG:15	IG:48.2 (9.2) CG:51.5(8.5)	IG:N/A CG:N/A	Aerobic exercise	13 months	Face-to-face	Maintain present lifestyles
Yamamoto et al. 2020	Japan	Hospital	IG:18 CG:17	IG:73.2 (2.6) CG:73.3(2.5)	IG:50.0 CG:58.8	Resistance exercise	12 months	Face-to-face	Maintain daily activities
Youngwanichsetha et al. 2013	Thailand	Hospital	IG:32 CG:32	IG:35.0 (5.6) CG:36.1(4.8)	IG:0.0 CG:0.0	Others type of exercise (tai chi qigong)	3 months	Face-to-face	Usual care

Table 1 (continued.)

Author/year	Country	Setting	Arm/n	Mean age (SD)	% male	Type of interventions	Intervention duration	Delivery	Control group type
Yucel & Uysal. 2016	Turkey	Clinic	IG:24 CG:21	IG:58.5 (7.0) CG:53.5(9.0)	IG:0.0 CG:0.0	Others type of exercise (Pilates exercise)	3 months	Face-to-face	Usual care
Li et al. 2020	China	Hospital	IG:24 CG:29	IG:61.7(6.9) CG:58.6(10.8)	IG:50.0 CG:48.0	Others type of exercise (tai chi qigong)	3 months	Face-to-face Instructional DVD	Low-level stretching activity
Larose et al. 2011	Canada	Hospital	IG:24 CG:29	IG:54.5(7.3) CG:53.8(7.2)	IG:62.5 CG:62.5	Combined	6 months	Face-to-face	Resistance exercise
Lambers et al. 2008	Belgium	Hospital	IG:18 CG:11	IG:55.2(8.2) CG:57.5(8.6)	IG:88.9 CG:54.5	Aerobic exercise	3 months	Face-to-face	Normal daily activities
Kour et al. 2019	India	Hospital	IG:74 CG:74	IG:37.2(4.0) CG:37.5(4.2)	IG:55.4 CG:63.5	Combined	4 months	Face-to-face	Dietary control
McDermott et al. 2014	India	Community	IG:21 CG:20	IG:47.0(9.7) CG:47.2(9.1)	IG:43.0 CG:35.0	Others type of exercise (Yoga)	2 months	Face-to-face	Daily walks in the park
Kataoka et al. 2018	Japan	Hospital	IG:6 CG:6	IG:60.8(14.2) CG:66.8(9.8)	IG:50.0 CG:50.0	Resistance exercise	2 weeks	Face-to-face	Traditional aerobic exercise
Karstoft et al. 2014	Denmark	Hospital	IG:10 CG:10	IG:60.3(2.3) CG:60.3(2.3)	IG:70.0 CG:70.0	Aerobic exercise	2 weeks	Face-to-face	No walking
Karstoft et al. 2013	Denmark	Hospital	IG:12 CG:8	IG:57.5(2.4) CG:57.1(3.0)	IG:66.7 CG:62.5	Aerobic exercise	4 months	Face-to-face	Continue habitual lifestyle

Table 1 (continued.)

Author/year	Country	Setting	Arm/n	Mean age (SD)	% male	Type of interventions	Intervention duration	Delivery	Control group type
Kadoglou, Vrabas et al. 2012	Greece	Hospital	IG:26 CG:27	IG:58.4(5.7) CG:62.9(4.2)	IG:34.6 CG:37.0	Aerobic exercise	3 months	Face-to-face	Encourage physical activity
Kadoglou et al. 2012	Greece	Hospital	IG:23 CG:24	IG:61.5(5.4) CG:64.6(4.3)	IG:30.4 CG:20.8	Resistance exercise	3 months	Face-to-face	A structured exercise counseling
Hwang et al. 2019	Korea	Community	IG:18 CG:16	IG:65.0(2.0) CG:61.0(2.0)	IG:50.0 CG:50.0	Aerobic exercise	2 months	Face-to-face	Usual care
Hsieh et al. 2016	Taiwan	Hospital	IG:15 CG:15	IG:70.6(4.2) CG:71.8(4.5)	IG:33.0 CG:40.0	Resistance exercise	3 months	Face-to-face	Usual care
Hordern et al. 2009	Australia	Hospital	IG:111 CG:112	IG:56.1(11.7) CG:55.0(8.5)	IG:53.0 CG:57.0	Combined	12 months	Face-to-face Telephone calls	Usual care
Hegde et al. 2020	India	Community	IG:20 CG:20	IG:57.1(5.9) CG:57.5(5.5)	IG:55.0 CG:50.0	Others type of exercise (Yoga)	3 months	Face-to-face Education material and DVD	Sham yoga
Gulsin et al. 2020	UK	Hospital	IG:22 CG:30	IG:50.5(6.5) CG:48.6(6.2)	IG:59.0 CG:53.0	Aerobic exercise	3 months	Face-to-face	Standard lifestyle advice
Gram et al. 2010	Denmark	Clinic	IG:24 CG:22	IG:59.0(10.0) CG:61.0(10.0)	IG:58.3 CG:59.1	Combined	12 months	Face-to-face	Usual care

Table 1 (continued.)

Author/year	Country	Setting	Arm/n	Mean age (SD)	% male	Type of interventions	Intervention duration	Delivery	Control group type
Gordon et al. 2008	Cuba	Hospital	IG:77 CG:77	IG:64.0 CG:63.6	IG:19.5 CG:19.5	Others type of exercise (Hatha yoga)	6 months	Face-to-face Education booklet	Attending physician regularly
Goldhaber-Fiebert et al. 2003	USA	Community	IG:40 CG:35	IG:60.0(10.0) CG:57.0(9.0)	IG:17.5 CG:25.7	Aerobic exercise	3 months	Face-to-face	Standard medical care
Gholami et al. 2020	Iran	Community	IG:16 CG:15	IG:53.4(9.1) CG:52.2(8.5)	IG:59.0 CG:57.0	Aerobic exercise	3 months	Face-to-face	Maintain habitual physical activity
Gainey et al. 2016	Thailand	Hospital	IG:12 CG:11	IG:58.0(3.0) CG:63.0(2.0)	IG:16.7 CG:18.2	Aerobic exercise	3 months	Face-to-face	Traditional walking
Fritz et al. 2011	Sweden	Community	IG:20 CG:30	IG:63.0 CG:60.5	IG:35.0 CG:33.0	Aerobic exercise	4 months	Face-to-face	Maintain habitual lifestyle
Figueira et al. 2013	Brazil	Hospital	IG:14 CG:14	IG:56.0(2.0) CG:56.0(2.0)	IG:35.7 CG:35.7	Combined	2 weeks	Face-to-face	Cycle ergometer
Fayehun et al. 2018	Nigeria	Hospital	IG:23 CG:23	IG:N/A CG:N/A	IG:34.8 CG:39.1	Aerobic exercise	3 months	Face-to-face	Maintain normal activity habits
Ezema et al. 2019	Nigeria	Hospital	IG:25 CG:25	IG:51.7(5.0) CG:51.4(5.0)	IG:44.0 CG:44.0	Aerobic exercise	2 months	Face-to-face	Usual care
Ezema et al. 2015	Nigeria	Clinic	IG:30 CG:24	IG:47.5(4.4) CG:47.1(4.4)	IG:N/A CG:N/A	Aerobic exercise	2 months	Face-to-face	Usual care

Table 1 (continued.)

Author/year	Country	Setting	Arm/n	Mean age (SD)	% male	Type of interventions	Intervention duration	Delivery	Control group type
Acar et al. 2014	Turkey	Clinic	IG: 6 CG: 10	IG:55.1(8.1) CG:57.8(10.0)	N/A	Combined	3 months	Face-to-face	Medical therapy and offer walking
Akbarpour et al. 2021	Iran	Community	IG: 10 CG: 10	IG: N/A CG: N/A	IG: 0 CG: 0	Resistance exercise	2 months	Face-to-face	Usual care
Akinci et al. 2018	Turkey	Hospital	IG: 21 CG: 22	IG:50.1(6.5) CG:53.5(6.67)	IG: 33.3 CG: 18.1	Combined	3 months	Face-to-face	physical activity counselling
Alam et al. 2004	UK	Hospital	IG: 9 CG: 9	IG: 59.5 (2.5) CG: 55.3 (3.2)	IG: 44.4 CG: 55.6	Aerobic exercise	6-months	Face-to-face	Personal exercise program
AminiLari et al 2016	Iran	Clinic	IG: 13 CG: 15	N/A	IG: 0 CG: 0	Combined	3 months	Face-to-face	Usual care
Araiza et al 2006	Mexico	Hospital	IG: 15 CG: 15	IG: 49 (11) CG: 51 (10)	N/A	Aerobic exercise	6 weeks	Face-to-face	Maintain activity habits
Baasch-Skytte et al. 2020	Denmark	Community	IG: 21 CG: 23	IG: 61.2 (7.1) CG: 61.0 (6.2)	IG: 100 CG: 100	Aerobic exercise	10 weeks	Face-to-face	Moderate intensity continuous training
Bacchi et al. 2012	Italy	Hospital	IG: 20 CG: 20	IG: 57.2 (1.6) CG: 55.6 (1.7)	IG: 70 CG: 70	Aerobic exercise	4 months	Face-to-face	Resistance training
Balducci et al. 2012	Italy	Clinic	IG: 288 CG: 275	N/A	IG: 60.1 CG: 50.8	Combined	12 months	Face-to-face	Standard care

Table 1 (continued.)

Author/year	Country	Setting	Arm/n	Mean age (SD)	% male	Type of interventions	Intervention duration	Delivery	Control group type
Banitelebi et al. 2018	Iran	Hospital	IG: 14 CG: 14	IG:54.14(5.43) CG:55.36(5.94)	IG: 0 CG: 0	Combined	10 weeks	Face-to-face	Usual care
Belli et al. 2019	Brazil	Community	IG: 9 CG: 10	IG: 53.4 (2.3) CG: 55.9 (2.2)	IG: 0 CG: 0	Aerobic exercise	3 months	Face-to-face	Dietary evaluation
Botton et al. 2018	Brazil	Hospital	IG: 22 CG: 22	IG: 70.6 (6.7) CG: 68.6 (7.1)	IG: 54.5 CG: 63.6	Resistance exercise	12 weeks	Face-to-face	Low -intensity exercise
Bouchi et al 2020	Japan	Hospital	IG: 72 CG: 69	IG: 59 (10) CG: 57 (11)	IG: 63.9 CG: 62.3	Aerobic exercise	6 months	Face-to-face	DAPA and usual care
Brinkmann et al. 2019	Germany	Community	IG: 15 CG: 15	IG: 61 (8) CG: 59 (9)	N/A	Combined	2 months	Face-to-face	Training in the fed state
Brun et al. 2008	France	Hospital	IG: 13 CG: 12	IG: 58.9 (3.6) CG: 60.6 (1.8)	IG: 69.2 CG: 58.3	Aerobic exercise	12 months	Face-to-face	Usual routine treatment
Castaneda et al 2002	US	Clinic	IG: 31 CG: 31	IG: 66 (2) CG: 66 (1)	IG: 32.3 CG: 38.7	Resistance exercise	4 months	Face-to-face	Usual medical care
Cauza et al 2005	Austria	Hospital	IG: 22 CG: 17	IG: 56.4 (1.1) CG: 57.9 (1.4)	IG: 50 CG: 52.9	Resistance exercise	4 months	Face-to-face	Endurance training
Cauza et al 2006	Austria	Hospital	IG: 10 CG: 10	IG: 57.1 (1.6) CG: 56.9 (1.6)	IG: 50 CG: 50	Combined	8 months	Face-to-face	Encourage physical activity
Cheung et al 2009	Australia	Community	IG: 20 CG: 17	IG: 59 (8.7) CG: 62 (6.7)	IG: 35 CG: 29.4	Resistance exercise	4 months	Face-to-face	Usual care
Choi et al. 2012	Korea	Hospital	IG: 38 CG: 37	IG:53.8(7.2) CG:55.0(6.0)	IG: 0.0 CG:0.0	Aerobic exercise	3 months	Face-to-face	Usual care

Table 1 (continued.)

Author/year	Country	Setting	Arm/n	Mean age (SD)	% male	Type of interventions	Intervention duration	Delivery	Control group type
Church et al 2010	US	Community	IG: 76 CG: 41	IG: 55.4 (8.3) CG: 58.6 (8.2)	IG: 35.5 CG: 37	Combined	9 months	Face-to-face	Weekly stretching and relaxation classes
Cohen et al 2008	Australia	Community	IG: 16 CG: 17	IG: 60.6 (6.9) CG: 60.4 (8.5)	IG: 50.0 CG: 47.1	Resistance training	14 months	Face-to-face Telephone calls	Upper body resistance training
Cruz et al 2019	Brazil	Clinical-based	IG: 6 CG: 6	N/A	IG: 0 CG: 0	Resistance exercise	2 weeks	Face-to-face	low exercise intensity
Cuff et al 2003	US	Hospital	IG: 10 CG: 9	IG: 59.4 (1.9) CG: 63.4 (2.2)	IG: 0 CG: 0	Combined	4 months	Face-to-face	Supervised aerobic training program
Dadgostar et al 2016	Iran	Clinic	IG: 51 CG: 51	IG: 50.1(6.3) CG: 49.6(5.5)	IG: 0 CG: 0	Aerobic exercise	3 months	Face-to-face	HET
Dadrass et al. 2019	Iran	Clinic	IG: 12 CG: 12	IG: 54.9 (5.9) CG: 53.8(6.6)	IG: 100 CG: 100	Resistance exercise	3 months	Face-to-face	Maintain normal daily life
Dede et al. 2015	Turkey	Hospital	IG: 30 CG: 30	IG: 52.5 (7.5) CG: 55.5 (8.4)	IG: 50 CG: 46.7	Aerobic exercise	3 months	Face-to-face	Maintain normal daily life
Dixit et al 2014	India	Clinic	IG: 40 CG: 47	N/A	N/A	Aerobic exercise	2 months	Face-to-face	Education for foot care and diet

Table 1 (continued.)

Author/year	Country	Setting	Arm/n	Mean age (SD)	% male	Type of interventions	Intervention duration	Delivery	Control group type
Dunstan et al 2002	Australia	Clinic	IG: 16 CG: 13	IG: 67.6 (5.2) CG: 66.9 (5.3)	IG: 62.5 CG: 46.2	Combined	6 months	Face-to-face	Static stretching exercises
Dunstan et al 2005	Australia	Community	IG: 18 CG: 18	N/A	N/A	Combined	12 months	Face-to-face Telephone calls	Moderate weight loss
Dunstan et al 2006	Australia	Community	IG: 28 CG: 29	IG: 60.5 (8.2) CG: 62.4 (8.3)	IG: 50.0 CG: 55.2	Resistance exercise	12 months	Face-to-face	Home-based training
Egger et al 2013	Austria	Community	IG: 16 CG: 16	IG: 64.5 (71) CG: 65.2 (8.6)	IG: 31.3 CG: 50	Resistance exercise	2 months	Face-to-face	Cycle ergometers
Emerenziani et al 2015	Italy	Community	IG: 15 CG: 15	IG: 66.7 (4.9) CG: 66.9 (4.2)	N/A	Aerobic exercise	3 months	Face-to-face	Maintain usual lifestyle

Note: HIIT, high-intensity interval training; HET, home-based exercise-therapy program; MICT, moderate-intensity continuous exercise training; DAPA, sodium glucose cotranspoter 2 inhibitor dapagliflozin;

Table 2. Effect size for different outcomes of exercise interventions

Item	Number of studies	Hedges' g	95% CI	P
HbA1c	89	-0.64	-0.76 to -0.52	< 0.001
FBG	84	-0.79	-0.97 to -0.61	< 0.001
Total cholesterol	56	-0.79	-1.1 to -0.53	< 0.001
HDL	60	-0.52	-0.66 to -0.37	< 0.001
LDL	58	-0.71	-0.91 to -0.51	< 0.001
Triglyceride	58	-0.71	-0.88 to -0.54	< 0.001
BMI	74	0.33	0.24 to 0.42	< 0.001
SBP	53	-0.52	-0.64 to -0.40	< 0.001
DBP	52	-0.54	-0.68 to -0.39	< 0.001
HOMA-IR	33	-0.77	-0.99 to -0.55	<0.001
WC	41	-0.49	-0.64 to -0.35	<0.001
WHR	16	-0.26	-0.44 to -0.09	0.003
Insulin	33	-0.78	-1.01 to -0.55	<0.001
TNF-alpha	09	0.56	0.27 to 0.84	<0.001
IL-6	10	0.60	0.13 to 1.06	0.012
CRP	15	-0.41	-0.53 to -0.29	<0.001

Table 3. Meta-regression analysis

Outcome	Mean age			% male		
	Number of studies	Coefficient (95%CI)	*P* value	Number of studies	Coefficient (95%CI)	*P* value
HbA1C	82	-0.88 (-1.34, -0.39)	**0.004**	78	-0.42 (-0.57, -0.28)	**<0.001**
FBG	76	-1.63 (-2.19, -1.08)	**<0.001**	70	-0.96 (-1.11, -0.81)	**<0.001**
Total Cholesterol	54	-0.73 (-1.48, 0.005)	0.052	49	-0.93 (-1.12, -0.73)	**<0.001**
LDL	55	-0.32 (-1.02, 0.37)	0.36	52	-1.05 (-1.24, -0.86)	**<0.001**
HDL	57	-1.18 (-1.89, -0.46)	**0.001**	53	-0.91 (-1.08, -0.73)	**<0.001**
Triglyceride	55	-0.69 (-1.45, 0.47)	0.07	50	-0.74 (-0.92, -0.56)	**<0.001**
SBP	49	-1.01 (-1.69, -2.94)	**0.003**	43	-0.47 (-0.68, -0.25)	**0.0002**
DBP	48	0.02 (-0.64, 0.69)	0.95	43	-0.49 (-0.70, -0.28)	**0.0001**
Triglyceride	55	-0.69 (-1.45, 0.47)	0.07	50	-0.74 (-0.92, -0.56)	**<0.001**
HOMA-IR	28	0.01 (-1.31, 1.34)	0.98	29	-0.62 (-0.88, -0.36)	**<0.001**
WC	36	-0.91 (-1.97, 0.14)	0.09	37	-0.61 (-0.79, -0.42)	**<0.001**
Insulin	29	-0.04 (-1.09, 1.02)	0.94	27	-0.30 (-0.57, -0.04)	**0.03**
IL-6	9	0.56 (-1.13, 2.25)	0.52	7	0.11 (-0.23, 0.47)	0.52
TNF-alpha	8	1.04 (-0.84, 2.92)	0.28	7	0.02 (-0.87, 0.91)	0.96
CRP	14	-1.25 (-2.56, 0.06)	0.06	14	-0.40 (-0.72, -0.08)	**0.015**

Table 4. Moderator analysis

Variable	HbA1C				
	Number of studies	Effect size (95%CI)	*P*	Between groups	
				Q value	P value
Setting Community Clinic Hospital	 21 21 47	 -0.52 (-0.70, -0.35) -0.81(-1.10, -0.52) -0.62 (-0.78, -0.45)	 <0.001 <0.001 <0.001	0.74	0.25
Type of intervention Aerobic exercise Resistance exercise Combined Others	 40 21 23 5	 -0.66 (-0.83, -0.49) -0.58 (-0.86, -0.29) -0.71(-0.93, -0.49) -0.49 (-0.81, -0.17)	 <0.001 <0.001 <0.001 0.003	1.46	0.69
Intervention duration ≤ 6 months > 6 months	 71 18	 -0.63 (-0.75, -0.50) -0.70 (-0.97, -0.43)	 <0.001 <0.001	0.25	0.62

Table 4 (continued.)

Variable	Total cholesterol					FBG				
	Number of studies	Effect size (95%CI)	*P*	Between groups		Number of studies	Effect size (95%CI)	*P*	Between groups	
				Q value	P value				Q value	P value
Setting										
Community	12	-0.33 (-0.51, -0.14)	0.001	9.86	**0.007**	19	-0.58 (-0.78, -0.37)	<0.001	3.16	0.21
Clinic	15	-1.10 (-1.62, -0.48)	<0.001			26	-0.83(-1.18, -0.48)	<0.001		
Hospital	29	-0.86 (-1.27, -0.46)	<0.001			39	-0.87 (-1.16, -0.57)	<0.001		
Type of intervention										
Aerobic exercise	29	-0.67 (-0.99, -0.34)	<0.001	0.66	0.88	44	-0.91 (-1.16, -0.66)	<0.001	11.25	**0.01**
Resistance exercise	10	-0.80 (-1.34, -0.26)	0.004			18	-0.41 (-0.59, -0.22)	<0.001		
Combined	14	-0.66 (-1.03, -0.30)	<0.001			16	-0.58 (-0.85, -0.32)	<0.001		
Others	3	-1.92 (-5.45, 1.62)	0.288			6	-1.45 (-3.11, 0.22)	0.09		
Intervention duration										
≤ 6 months	48	-0.79(-1.09, -0.48)	<0.001	0.002	0.96	72	-0.81 (-1.01, -0.60)	<0.001	0.69	0.41
> 6 months	8	-0.77 (-1.32, -0.22)	0.006			12	-0.64 (-0.99, -0.29)	<0.001		

Table 4 (continued.)

Variable	LDL					HDL				
	Number of studies	Effect size (95%CI)	*P*	Between groups		Number of studies	Effect size (95%CI)	*P*	Between groups	
				Q value	P value				Q value	P value
Setting										
Community	11	-0.82 (-1.28, -0.37)	<0.001	0.24	0.33	11	-0.86 (-1.48, -2.45)	0.006	0.60	0.74
Clinic	7	-0.89 (-1.36, -0.43)	<0.001			18	-0.67(-0.98, -0.36)	<0.001		
Hospital	30	-0.55 (-0.79, -0.31)	<0.001			31	-0.36 (-0.50, -0.23)	<0.001		
Type of intervention										
Aerobic exercise	31	-0.68 (-0.98, -0.39)	<0.001	0.03	0.99	34	-0.46 (-0.65, -0.27)	<0.001	6.75	0.08
Resistance exercise	11	-0.72 (-1.12, -0.32)	<0.001			11	-1.04 (-1.69, -0.39)	0.002		
Combined	13	-0.71 (-1.10, -0.33)	<0.001			13	-0.30 (-0.43, -0.17)	<0.001		
Others	3	-0.76 (-2.08, 0.55)	0.256			2	-0.72 (-1.60, 0.17)	0.114		
Intervention duration										
≤ 6 months	48	-0.76(-1.01, -0.52)	<0.001	4.12	**0.04**	52	-0.57 (-0.75, -0.39)	<0.001	6.56	**0.01**
> 6 months	10	-0.36 (-0.66, -0.07)	0.017			8	-0.29 (-0.41, -0.16)	<0.001		

Table 4 (continued.)

Variable	SBP					Triglyceride				
	Number of studies	Effect size (95%CI)	*P*	Between groups		Number of studies	Effect size (95%CI)	*P*	Between groups	
				Q value	P value				Q value	P value
Setting										
Community	13	-0.27 (-0.43, -0.11)	0.001	8.75	**0.013**	12	-0.69 (-1.11, -0.28)	0.001	0.60	0.74
Clinic	14	-0.56 (-0.81, -0.31)	<0.001			16	-0.83(-1.23, -0.43)	<0.001		
Hospital	26	-0.62 (-0.81, -0.43)	<0.001			30	-0.65 (-0.85, -0.44)	<0.001		
Type of intervention										
Aerobic exercise	29	-0.60 (-0.80, -0.40)	<0.001	3.00	0.39	34	-0.91 (-1.17, -0.64)	<0.001	14.45	**0.002**
Resistance exercise	9	-0.44 (-0.66, -0.22)	<0.001			9	-0.59 (-0.93, -0.25)	0.001		
Combined	11	-0.38 (-0.55, -0.21)	<0.001			12	-0.43 (-0.70, -0.17)	0.001		
Others	4	-0.37 (-0.78, 0.04)	0.076			3	-0.19 (-0.45, 0.08)	0.17		
Intervention duration										
≤ 6 months	41	-0.50(-0.65, -0.36)	<0.001	0.15	0.70	51	-0.76 (-0.95, -0.57)	<0.001	3.78	0.052
> 6 months	12	-0.56 (-0.78, -0.33)	<0.001			7	-0.39 (-0.71, -0.07)	0.018		

Table 4 (continued.)

Variable	HOMA-IR					DBP				
	Number of studies	Effect size (95%CI)	*P*	Between groups		Number of studies	Effect size (95%CI)	*P*	Between groups	
				Q value	P value				Q value	P value
Setting										
Community	8	-0.70 (-1.10, -0.31)	<0.001	1.28	0.53	13	-0.43 (-0.67, -0.19)	<0.001	1.86	0.39
Clinic	9	-0.68 (-1.11, -0.25)	0.002			14	-0.73(-1.10, -0.37)	<0.001		
Hospital	16	-0.91 (-1.28, -0.53)	<0.001			25	-0.50 (-0.72, -0.28)	<0.001		
Type of intervention										
Aerobic exercise	15	-1.01 (-1.46, -0.56)	<0.001	8.46	**0.04**	28	-0.60 (-0.83, -0.38)	<0.001	9.94	**0.02**
Resistance exercise	6	-0.95 (-1.55, -0.36)	0.002			9	-0.76 (-1.37, -0.16)	0.014		
Combined	11	-0.50(-0.73, -0.26)	<0.001			11	-0.26 (-0.37, -0.15)	<0.001		
Others	1	-0.02 (-0.65, 0.61)	0.95			4	-0.19 (-0.49, 0.11)	0.22		
Intervention duration										
≤ 6 months	26	-0.78 (-1.06, -0.51)	<0.001	0.01	0.94	41	-0.47 (-0.66, -0.31)	<0.001	1.66	0.19
> 6 months	7	-0.77 (-1.19, -0.55)	<0.001			11	-0.74 (-1.07, -0.40)	<0.001		

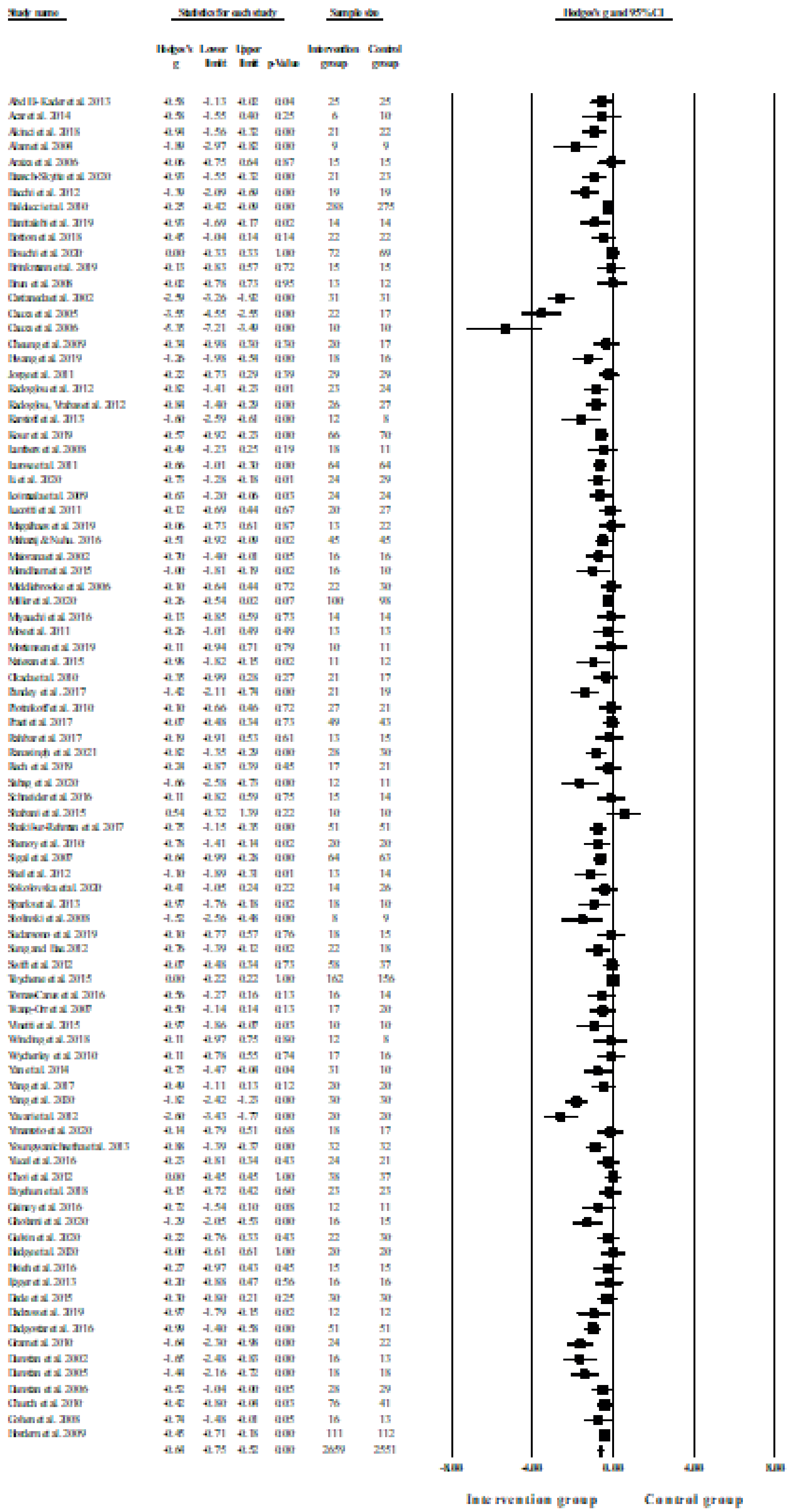
Table 4 (continued.)

Variable	Insulin					WC				
	Number of studies	Effect size (95%CI)	*P*	Between groups		Number of studies	Effect size (95%CI)	*P*	Between groups	
				Q value	P value				Q value	P value
Setting										
Community	9	-0.61 (-0.89, -0.34)	<0.001	1.28	0.53	15	-0.27 (-0.42, -0.13)	<0.001	4.50	0.024
Clinic	7	-0.94 (-1.64, -2.34)	0.009			12	-0.82(-1.21, -0.43)	<0.001		
Hospital	17	-0.27 (-1.16, -0.48)	<0.001			14	-0.46 (-0.65, -0.27)	<0.001		
Type of intervention										
Aerobic exercise	15	-1.14 (-1.59, -0.69	<0.001	10.12	**0.02**	18	-0.63 (-0.94, 0.34)	<0.001	2.46	0.48
Resistance exercise	8	-0.74 (-1.21, -0.28)	0.002			10	-0.43 (-0.75, -0.11)	0.009		
Combined	8	-0.34 (-0.60, -0.07)	0.013			10	-0.37 (-0.51, -0.23)	<0.001		
Others	2	-0.42 (-0.92, 0.08)	0.10			3	-0.31 (-0.84, 0.22)	0.253		
Intervention duration										
≤ 6 months	27	-0.80 (-1.06, -0.54)	<0.001	0.02	0.89	29	-0.51 (-0.73, -0.29)	<0.001	0.76	0.38
> 6 months	6	-0.75 (-1.34, -0.16)	0.013			12	-0.40 (-0.51, -0.29)	<0.001		

Table 4 (continued.)

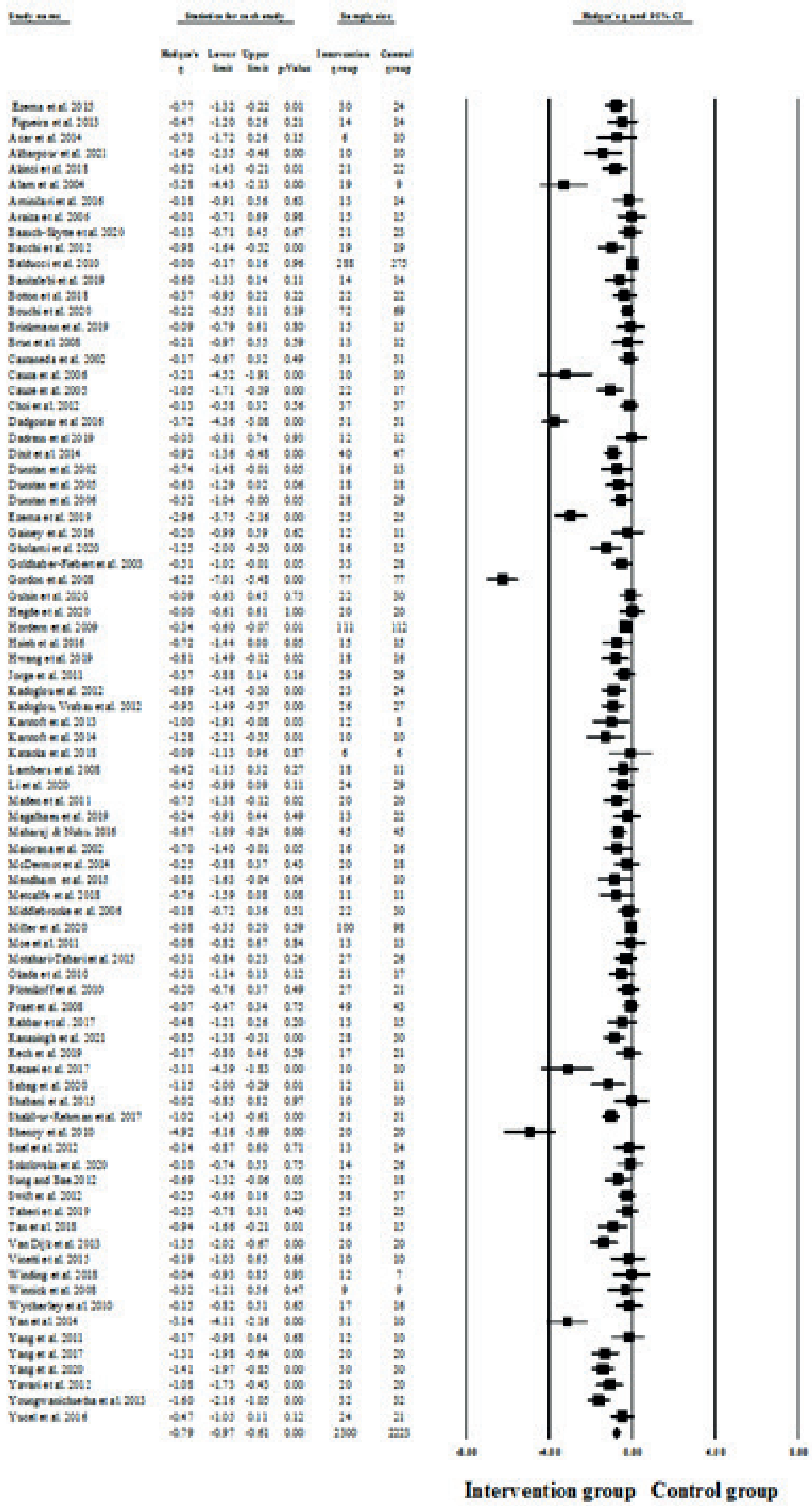
Variable	BMI					IL-6				
	Number of studies	Effect size (95%CI)	*P*	Between groups		Number of studies	Effect size (95%CI)	*P*	Between groups	
				Q value	P value				Q value	P value
Setting										
Community	22	0.46 (0.24, 0.67)	<0.001	2.24	0.33	2	0.52 (0.02, 1.02)	0.04	0.69	0.71
Clinic	20	0.30 (0.13, 0.47)	<0.001			3	1.17(-0.41, 2.75)	0.15		
Hospital	32	0.28 (0.18, 0.38)	<0.001			5	0.45 (-0.17, 1.08)	0.16		
Type of intervention										
Aerobic exercise	39	0.36 (0.23, 0.49)	<0.001	7.60	0.06	5	0.17 (-0.05, 0.40)	0.14	1.91	0.39
Resistance exercise	15	0.44 (0.15, 0.73)	0.003			2	1.82 (-1.41, 5.05)	0.27		
Combined	16	0.17 (0.07, 0.28)	0.001			3	0.77 (-0.42, 1.96)	0.21		
Others	4	0.53 (0.04, 1.01)	0.035			0	-	-		
Intervention duration										
≤ 6 months	60	0.35 (0.24, 0.46)	<0.001	1.86	0.17	10	0.60 (0.13, 1.06)	0.012	0	1.00
> 6 months	14	0.24 (0.13, 0.35)	<0.001			0	-	-		

A. Effect of exercise intervention on HbA1C



Heterogeneity: $I^2 = 73.53$, $p < 0.001$

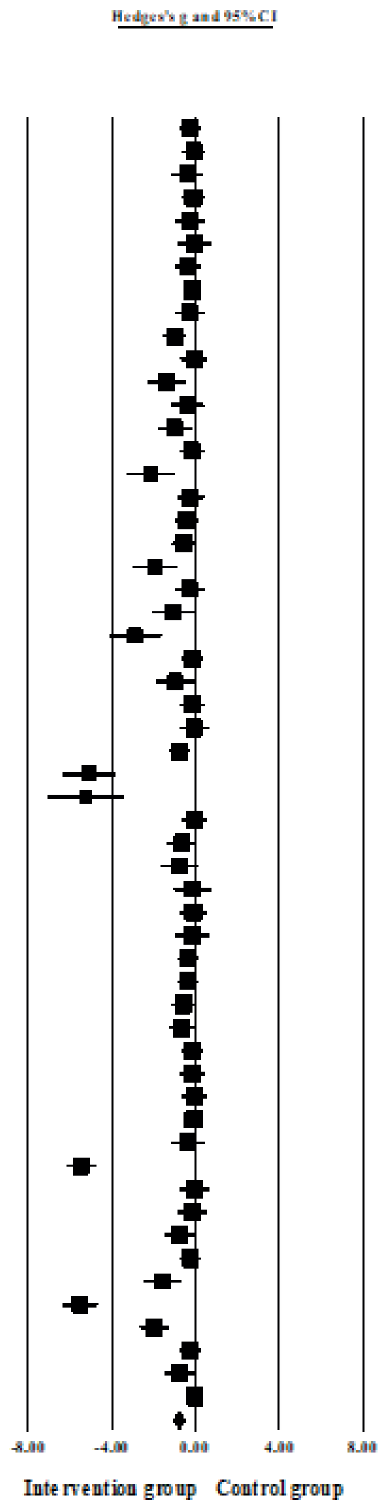
B. Effect of exercise intervention on FBG



Heterogeneity: $I^2 = 87.21$, $p < 0.001$

C. Effect of exercise intervention on Total cholesterol

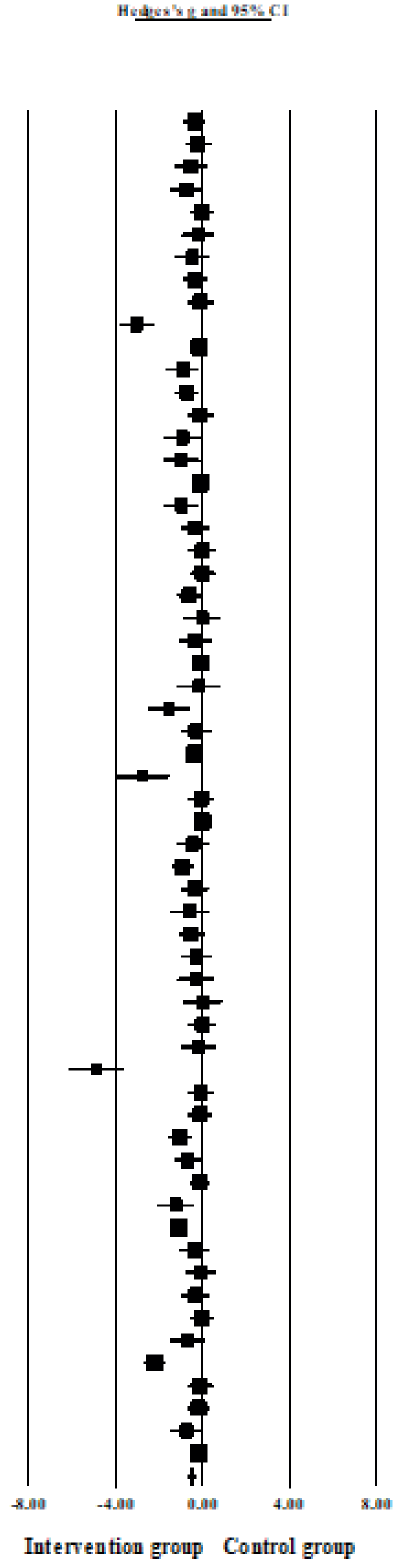
Study name	Statistics for each study				Sample size	
	Hedges's g	Lower limit	Upper limit	p-Value	Intervention group	Control group
Jorge et al. 2011	-0.28	-0.79	0.23	0.29	29	29
Lucotti et al. 2011	-0.08	-0.65	0.48	0.77	20	27
Mendham et al. 2015	-0.39	-1.16	0.38	0.32	16	10
Middlebrooke et al. 2006	-0.10	-0.65	0.44	0.71	22	30
Moe et al. 2011	-0.26	-1.01	0.49	0.50	13	13
Mortensen et al. 2019	-0.03	-0.85	0.79	0.95	10	11
Okada et al. 2010	-0.35	-0.98	0.28	0.27	21	17
Praet et al. 2008	-0.13	-0.53	0.28	0.54	49	43
Rahbar et al . 2017	-0.26	-0.98	0.47	0.49	13	15
Ramsingh et al. 2021	-0.98	-1.54	-0.43	0.00	26	28
Rech et al. 2019	-0.08	-0.71	0.55	0.80	17	21
Rezaei et al. 2017	-1.37	-2.31	-0.43	0.00	10	10
Sabag et al. 2020	-0.38	-1.18	0.41	0.35	12	11
Snel et al. 2012	-0.97	-1.75	-0.19	0.01	13	14
Sokolovska et al. 2020	-0.16	-0.79	0.48	0.63	14	26
Stolinski et al. 2008	-2.14	-3.29	-0.98	0.00	8	9
Hwang et al. 2019	-0.24	-0.90	0.42	0.48	18	16
Kadoglou et al. 2012	-0.43	-1.00	0.14	0.14	23	24
Kadoglou, Vrabas et al. 2012	-0.57	-1.11	-0.03	0.04	26	27
Karstoft et al 2013	-1.95	-3.00	-0.90	0.00	12	8
Lambers et al 2008	-0.26	-0.99	0.47	0.49	18	11
Acar et al. 2014	-1.05	-2.07	-0.02	0.05	6	10
Alam et al. 2004	-2.89	-4.15	-1.63	0.00	9	10
Balducci et al. 2010	-0.13	-0.65	0.39	0.62	288	15
Belli et al. 2011	-0.96	-1.88	-0.05	0.04	9	10
Botton et al 2018	-0.15	-0.74	0.43	0.60	22	22
Brinkmann et al. 2019	-0.08	-0.77	0.62	0.83	15	15
Castaneda et al. 2002	-0.75	-1.26	-0.24	0.00	31	31
Cauza et al. 2005	-5.10	-6.39	-3.81	0.00	22	17
Cauza et al. 2006	-5.21	-7.03	-3.39	0.00	10	10
Sung and Bae 2012	-0.06	-0.67	0.55	0.85	22	18
Tan et al. 2018	-0.64	-1.34	0.06	0.07	16	15
Vinetti et al. 2015	-0.74	-1.61	0.13	0.10	10	10
Winding et al 2018	-0.12	-1.01	0.77	0.79	12	7
Wycherley et al. 2010	-0.10	-0.76	0.57	0.78	16	17
Yang et al. 2011	-0.15	-0.96	0.66	0.72	12	10
Yang et al. 2017	-0.33	-0.83	0.17	0.20	30	30
Yang et al. 2020	-0.33	-0.83	0.17	0.20	30	30
Yavari et al. 2012	-0.56	-1.18	0.06	0.07	20	20
Akinci et al. 2018	-0.68	-1.29	-0.08	0.03	21	22
Pedersen et al. 2019	-0.18	-0.70	0.35	0.51	26	29
McDermot et al. 2014	-0.14	-0.76	0.49	0.67	20	18
Bacchi et al. 2012	-0.06	-0.69	0.56	0.84	19	19
Choi et al. 2012	-0.08	-0.53	0.36	0.71	38	37
Gainey et al. 2016	-0.39	-1.18	0.41	0.34	12	11
Gordon et al. 2008	-5.46	-6.15	-4.77	0.00	77	77
Hsieh et al. 2016	-0.07	-0.76	0.63	0.85	15	15
Emerenziani et al. 2015	-0.16	-0.86	0.53	0.64	15	15
Egger et al. 2013	-0.75	-1.45	-0.05	0.03	16	16
Dede et al. 2015	-0.23	-0.73	0.27	0.37	30	30
Dadrass et al. 2019	-1.55	-2.43	-0.66	0.00	12	12
Dadgostar et al. 2016	-5.52	-6.36	-4.67	0.00	51	51
Gram et al. 2010	-1.97	-2.66	-1.27	0.00	24	22
Goldhaber-Fiebert et al. 2003	-0.26	-0.76	0.24	0.31	33	28
Dunstan et al 2002	-0.74	-1.48	-0.01	0.05	16	13
Hordern et al. 2009	-0.02	-0.28	0.24	0.89	111	112
	-0.79	-1.05	-0.53	0.00	1506	1224



Heterogeneity: $I^2 = 89.85$, $p < 0.001$

D. Effect of exercise intervention on HDL

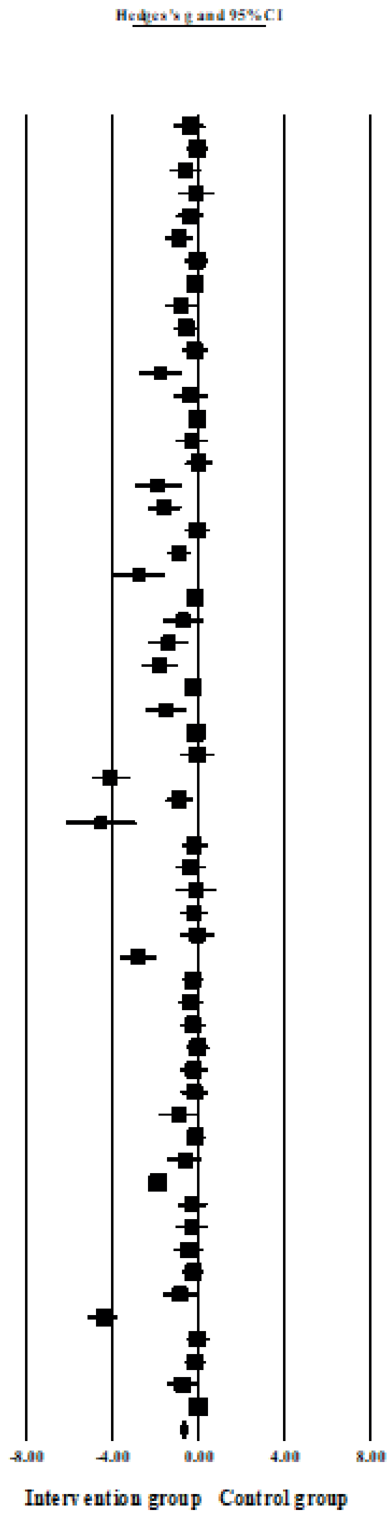
Study name	Statistics for each study				Sample size	
	Hedges's g	Lower limit	Upper limit	p-Value	Intervention group	Control group
Jorge et al. 2011	-0.35	-0.86	0.17	0.19	29	29
Lucotti et al. 2011	-0.20	-0.77	0.37	0.49	20	27
Mendham et al. 2015	-0.54	-1.32	0.24	0.18	16	10
Miyauchi et al. 2016	-0.76	-1.50	-0.01	0.05	14	14
Middlebrooke et al. 2006	-0.03	-0.57	0.52	0.92	22	30
Moe et al. 2011	-0.20	-0.95	0.54	0.59	13	13
Mortensen et al. 2019	-0.46	-1.26	0.35	0.27	10	13
Okada et al. 2010	-0.34	-0.88	0.21	0.22	22	30
Pandey et al. 2017	-0.10	-0.73	0.53	0.75	21	17
Plotnikoff et al. 2010	-3.03	-3.86	-2.21	0.00	27	21
Praet et al. 2008	-0.17	-0.58	0.24	0.41	40	43
Rahbar et al . 2017	-0.91	-1.67	-0.15	0.02	13	15
Ramasingh et al. 2021	-0.70	-1.25	-0.16	0.01	26	28
Rech et al. 2019	-0.11	-0.73	0.52	0.74	17	21
Rezaei et al. 2017	-0.93	-1.82	-0.04	0.04	10	10
Sabag et al. 2020	-0.96	-1.80	-0.13	0.02	12	11
Sigal et al. 2007	-0.10	-0.45	0.25	0.57	64	63
Snel et al. 2012	-0.97	-1.75	-0.19	0.01	13	14
Sokolovska et al. 2020	-0.33	-0.97	0.31	0.32	14	26
Hwang et al. 2019	0.00	-0.64	0.64	1.00	18	18
Kadoglou et al. 2012	0.00	-0.56	0.56	1.00	23	24
Kadoglou, Vrabas et al. 2012	-0.61	-1.15	-0.06	0.03	26	27
Karstoft et al. 2013	0.00	-0.86	0.86	1.00	12	8
Lambers et al. 2008	-0.34	-1.07	0.39	0.36	18	11
Larose et al. 2011	-0.08	-0.43	0.26	0.64	64	64
Acar et al. 2014	-0.18	-1.13	0.78	0.72	6	10
Akbarpour et al. 2021	-1.56	-2.53	-0.59	0.00	10	10
Araiza et al. 2006	-0.31	-1.01	0.39	0.39	15	15
Balducci et al. 2010	-0.35	-0.51	-0.18	0.00	288	275
Belli et al. 2011	-2.78	-4.01	-1.55	0.00	9	10
Bellon et al. 2018	-0.07	-0.65	0.51	0.81	22	22
Bouchi et al. 2020	0.00	-0.33	0.33	1.00	72	69
Brun et al. 2008	-0.44	-1.21	0.32	0.26	13	12
Castaneda et al. 2002	-0.91	-1.43	-0.39	0.00	31	31
Cauza et al. 2005	-0.36	-0.98	0.27	0.26	22	17
Cauza et al. 2006	-0.59	-1.45	0.27	0.18	10	10
Sung and Bae 2012	-0.50	-1.12	0.12	0.12	22	18
Tan et al. 2018	-0.27	-0.96	0.42	0.44	16	15
Vinetti et al. 2015	-0.29	-1.14	0.55	0.50	10	10
Winding et al. 2018	-0.00	-0.89	0.89	1.00	12	7
Wycherley et al. 2010	-0.00	-0.66	0.66	1.00	17	17
Yang et al. 2011	-0.18	-0.99	0.63	0.66	12	10
Yang et al. 2017	-4.90	-6.13	-3.67	0.00	20	20
Yavari et al. 2012	-0.08	-0.69	0.53	0.79	20	20
Akinci et al. 2018	-0.12	-0.71	0.47	0.69	21	22
Yang et al. 2020	-1.06	-1.60	-0.53	0.00	30	30
Bacchi et al. 2012	-0.70	-1.34	-0.06	0.03	19	19
Choi et al. 2012	-0.13	-0.58	0.32	0.57	38	37
Gaines et al. 2016	-1.24	-2.10	-0.37	0.01	12	11
Gordon et al. 2008	-1.10	-1.44	-0.76	0.00	77	77
Hsieh et al. 2016	-0.39	-1.10	0.31	0.27	15	15
Emerenziani et al. 2015	-0.09	-0.78	0.61	0.81	15	15
Egger et al 2013	-0.33	-1.01	0.35	0.34	16	16
Dede et al. 2015	-0.04	-0.54	0.46	0.87	30	30
Dadgostar et al. 2019	-0.68	-1.48	0.11	0.09	12	12
Dadgostar et al. 2016	-2.19	-2.68	-1.70	0.00	51	51
Gram et al. 2010	-0.10	-0.67	0.46	0.72	24	22
Goldhaber-Fiebert et al. 2003	-0.18	-0.67	0.32	0.49	33	28
Dunstan et al. 2002	-0.74	-1.48	-0.01	0.05	16	13
Hordern et al. 2009	-0.20	-0.47	0.06	0.13	111	112
	-0.52	-0.66	-0.37	0.00	1720	1695



Heterogeneity: $I^2 = 75.38$, $p < 0.001$

E. Effect of exercise intervention on LDL

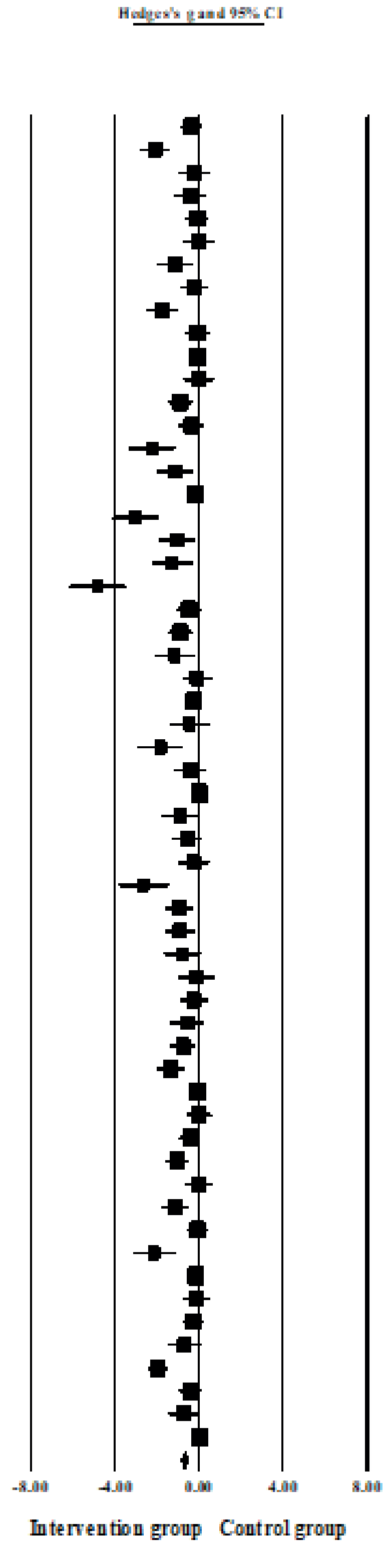
Study name	Hedges's g	Lower limit	Upper limit	p-Value	Intervention group	Control group
	Statistics for each study				Sample size	
Miyauchi et al. 2016	-0.44	-1.17	0.29	0.24	14	14
Middlebrooke et al. 2006	-0.08	-0.62	0.47	0.78	22	30
Moe et al. 2011	-0.63	-1.40	0.13	0.10	13	13
Mortensen et al. 2019	-0.10	-0.92	0.72	0.81	10	11
Okada et al. 2010	-0.38	-1.01	0.25	0.24	21	17
Pandey et al. 2017	-0.91	-1.56	-0.27	0.01	21	19
Plotnikoff et al. 2010	-0.09	-0.65	0.47	0.75	27	21
Praet et al. 2008	-0.15	-0.56	0.26	0.47	40	43
Rahbar et al . 2017	-0.83	-1.58	-0.08	0.03	13	15
Ramsingh et al. 2021	-0.58	-1.12	-0.04	0.03	26	28
Rech et al. 2019	-0.18	-0.81	0.45	0.57	17	21
Rezaei et al. 2017	-1.77	-2.77	-0.76	0.00	10	10
Sabag et al. 2020	-0.38	-1.18	0.41	0.35	12	11
Sigal et al. 2007	-0.06	-0.41	0.28	0.72	64	63
Snel et al. 2012	-0.32	-1.06	0.41	0.39	13	14
Sokolovska et al. 2020	-0.00	-0.64	0.64	1.00	14	26
Stolinski et al. 2008	-1.90	-3.00	-0.79	0.00	8	9
Hwang et al. 2019	-1.59	-2.35	-0.83	0.00	18	16
Kadoglou et al. 2012	-0.06	-0.62	0.50	0.83	23	24
Kadoglou, Vrabas et al. 2012	-0.91	-1.47	-0.35	0.00	26	27
Karstoft et al. 2013	-2.75	-3.96	-1.54	0.00	12	8
Larose et al. 2011	-0.13	-0.48	0.21	0.46	64	64
Acar et al. 2014	-0.72	-1.71	0.27	0.15	6	10
Akbarpour et al. 2021	-1.39	-2.33	-0.44	0.00	10	10
Amini et al. 2006	-1.80	-2.64	-0.97	0.00	15	15
Balducci et al. 2010	-0.27	-0.44	-0.11	0.00	288	275
Belli et al. 2011	-1.51	-2.49	-0.52	0.00	9	10
Bouchi et al. 2020	-0.12	-0.45	0.21	0.46	72	69
Brun et al. 2008	-0.08	-0.84	0.68	0.84	13	12
Castaneda et al. 2002	-4.08	-4.95	-3.21	0.00	31	31
Cauza et al. 2005	-0.90	-1.55	-0.24	0.01	22	17
Cauza et al. 2006	-4.54	-6.18	-2.90	0.00	10	10
Sung and Bae 2012	-0.21	-0.82	0.41	0.51	22	18
Tan et al. 2018	-0.36	-1.05	0.34	0.31	16	15
Winding et al. 2018	-0.11	-1.01	0.78	0.80	12	7
Wycherley et al. 2010	-0.21	-0.87	0.46	0.55	17	16
Yang et al. 2011	-0.06	-0.86	0.75	0.89	12	10
Yang et al. 2017	-2.82	-3.69	-1.95	0.00	20	20
Yang et al. 2020	-0.28	-0.79	0.22	0.27	30	30
Yavari et al. 2012	-0.36	-0.97	0.25	0.25	20	20
Akinci et al. 2018	-0.26	-0.84	0.33	0.39	21	23
Pedersen et al. 2019	-0.04	-0.56	0.48	0.87	26	29
McDermott et al. 2014	-0.23	-0.86	0.39	0.47	20	18
Bacchi et al. 2012	-0.20	-0.82	0.43	0.53	19	19
Vinetti et al. 2015	-0.95	-1.84	-0.06	0.04	10	10
Choi et al. 2012	-0.14	-0.59	0.31	0.54	38	37
Gainey et al. 2016	-0.64	-1.44	0.17	0.12	12	11
Gordon et al. 2008	-1.91	-2.29	-1.53	0.00	77	77
Hsieh et al. 2016	-0.29	-0.99	0.41	0.41	15	15
Emerenziani et al. 2015	-0.30	-1.00	0.40	0.40	15	15
Egger et al. 2013	-0.44	-1.12	0.25	0.21	16	16
Dede et al. 2015	-0.26	-0.76	0.25	0.32	30	30
Dadgostar et al. 2016	-4.44	-5.16	-3.72	0.00	51	51
Dadrass et al. 2019	-0.86	-1.67	-0.05	0.04	12	12
Gram et al. 2010	-0.02	-0.59	0.55	0.94	24	22
Goldhaber-Fiebert et al. 2003	-0.16	-0.66	0.34	0.53	33	28
Dunstan et al. 2002	-0.74	-1.48	-0.01	0.05	16	13
Hordern et al. 2009	-0.01	-0.27	0.25	0.93	111	112
	-0.71	-0.91	-0.51	0.00	1668	1637



Heterogeneity: $I^2 = 86.13$, $p < 0.001$

F. Effect of exercise intervention on Triglyceride

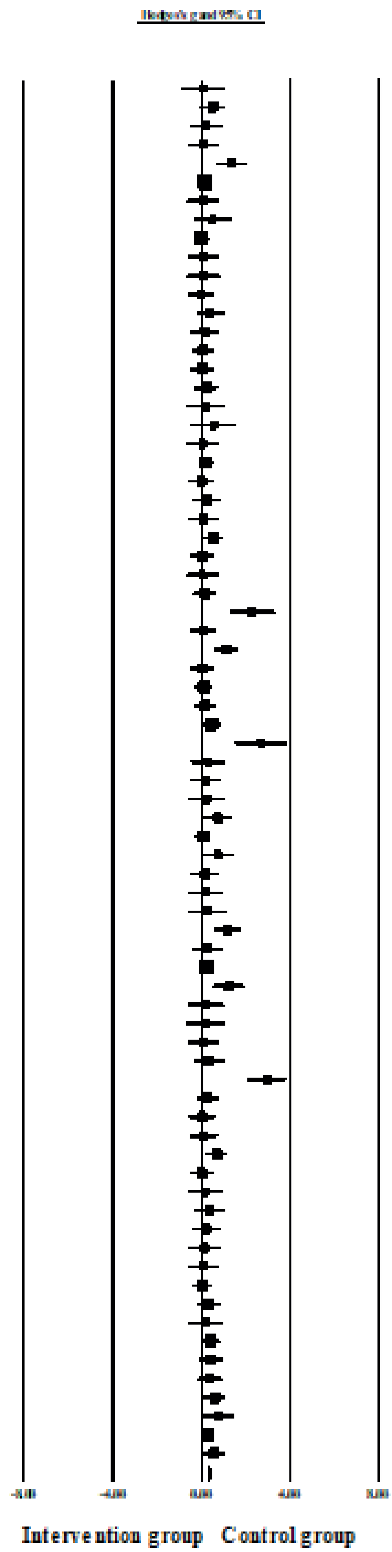
Study name	Hedges's g	Lower limit	Upper limit	p-Value	Intervention group	Control group
Jorge et al. 2011	-0.37	-0.88	0.15	0.16	29	29
Lucotti et al. 2011	-2.11	-2.83	-1.40	0.00	20	27
Mendham et al. 2015	-0.25	-1.00	0.50	0.51	19	10
Miyauchi et al. 2016	-0.41	-1.14	0.31	0.27	14	14
Middlebrooke et al. 2006	-0.10	-0.64	0.44	0.72	22	30
Moe et al. 2011	-0.03	-0.77	0.71	0.94	13	13
Mortensen et al. 2019	-1.16	-2.05	-0.27	0.01	10	11
Okada et al. 2010	-0.26	-0.89	0.36	0.41	21	17
Pandey et al. 2017	-1.78	-2.50	-1.06	0.00	21	19
Plotnikoff et al. 2010	-0.10	-0.66	0.47	0.74	27	21
Praet et al. 2008	-0.08	-0.48	0.33	0.71	49	43
Rahbar et al. 2017	-0.03	-0.76	0.69	0.93	13	15
Ramsingh et al. 2021	-0.90	-1.45	-0.34	0.00	26	28
Rech et al. 2019	-0.38	-1.01	0.25	0.24	17	21
Rezaei et al. 2017	-2.24	-3.33	-1.15	0.00	10	10
Sabag et al., 2020	-1.14	-2.00	-0.29	0.01	12	11
Sigal et al. 2007	-0.19	-0.54	0.16	0.28	64	63
Snel et al. 2012	-3.03	-4.12	-1.94	0.00	13	14
Sokolovska et al. 2020	-1.03	-1.89	-0.17	0.02	14	9
Stolinski et al. 2008	-1.27	-2.26	-0.27	0.01	8	9
Hwang et al. 2019	-4.85	-6.18	-3.52	0.00	18	16
Kadoglou et al. 2012	-0.48	-1.06	0.09	0.10	23	24
Kadoglou -b et al. 2012	-0.89	-1.45	-0.34	0.00	26	27
Karstoft et al. 2013	-1.17	-2.10	-0.24	0.01	12	8
Lambers et al. 2008	-0.08	-0.81	0.65	0.83	18	11
Larose et al. 2011	-0.24	-0.59	0.11	0.17	64	64
Acar et al. 2014	-0.46	-1.43	0.51	0.36	6	10
Alam et al. 2004	-1.86	-2.92	-0.79	0.00	9	9
Arora et al. 2006	-0.43	-1.14	0.27	0.23	15	15
Balducci et al. 2010	-0.01	-0.18	0.15	0.89	288	275
Belli et al. 2011	-0.92	-1.82	-0.01	0.05	9	10
Brinkmann et al. 2019	-0.55	-1.27	0.16	0.13	15	15
Brun et al. 2008	-0.26	-1.02	0.50	0.50	13	12
Cauza et al. 2006	-2.65	-3.82	-1.47	0.00	10	10
Sung and Bae. 2012	-0.96	-1.60	-0.31	0.00	22	18
Tan et al. 2018	-0.92	-1.64	-0.20	0.01	16	15
Vinetti et al. 2015	-0.80	-1.68	0.07	0.07	10	10
Winding et al. 2018	-0.13	-1.02	0.76	0.77	12	7
Wycherley et al. 2010	-0.27	-0.93	0.40	0.44	17	16
Yang et al. 2011	-0.56	-1.38	0.27	0.18	12	10
Yang et al. 2017	-0.77	-1.40	-0.14	0.02	20	20
Yavari et al. 2012	-1.36	-2.03	-0.68	0.00	20	20
Bouchi et al. 2020	-0.10	-0.43	0.23	0.55	72	69
Akinci et al. 2018	-0.01	-0.60	0.57	0.97	21	22
Castaneda et al. 2020	-0.45	-0.94	0.05	0.08	31	31
Yang et al. 2020	-1.06	-1.60	-0.53	0.00	30	30
McDermott et al. 2014	-0.02	-0.64	0.60	0.95	20	18
Bacchi et al. 2012	-1.14	-1.81	-0.46	0.00	19	19
Choi et al. 2012	-0.09	-0.53	0.36	0.71	38	37
Gainey et al. 2016	-2.15	-3.16	-1.15	0.00	12	11
Gordon et al. 2008	-0.18	-0.49	0.14	0.27	77	77
Egger et al. 2013	-0.15	-0.82	0.53	0.67	16	16
Dale et al. 2015	-0.26	-0.76	0.24	0.31	30	30
Dadgostar et al. 2016	-1.98	-2.45	-1.51	0.00	51	51
Dalmas et al. 2019	-0.71	-1.51	0.09	0.08	12	12
Goldhaber-Fiebert et al. 2003	-0.44	-0.94	0.07	0.09	33	28
Dunstan et al 2002	-0.74	-1.48	-0.01	0.05	16	13
Hordern et al. 2009	-0.01	-0.28	0.25	0.92	111	112
	-0.71	-0.88	-0.54	0.00	1666	1612



Heterogeneity: $I^2 = 80.17$, $p < 0.001$

G. Effect of exercise intervention on BMI

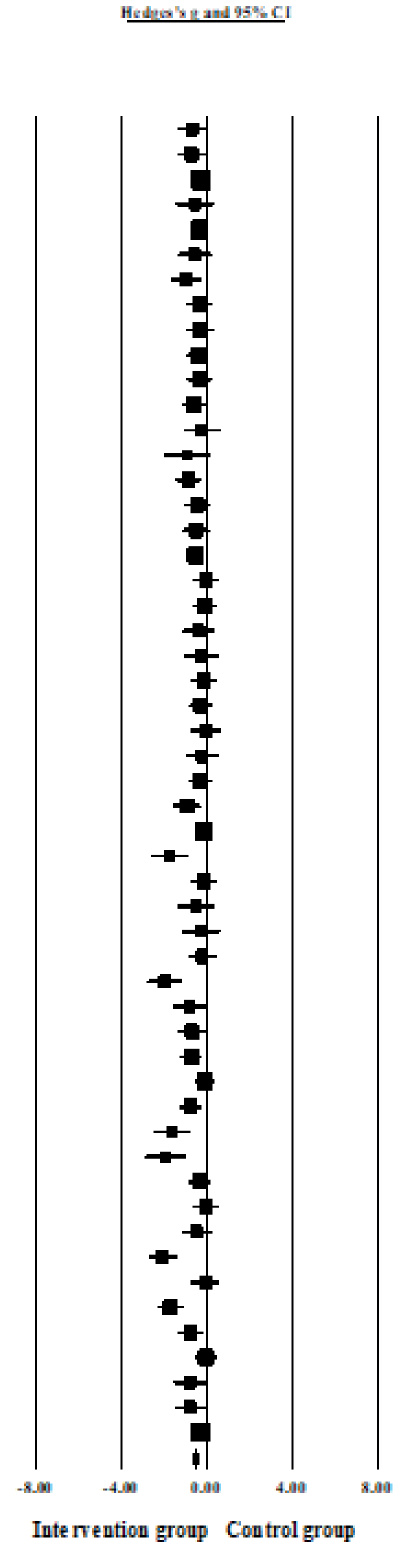
Study name	Statistics for each study				Sample size	
	Hedges's g	Lower limit	Upper limit	p-Value	Intervention group	Control group
Acar et al. 2014	0.097	-0.860	1.055	0.845	6	10
Akinci et al. 2018	0.513	-0.083	1.110	0.092	22	21
Aminilari et al. 2016	0.206	-0.518	0.929	0.577	15	15
Araiza et al. 2006	0.069	-0.627	0.766	0.845	15	15
Bacchi et al. 2012	1.389	0.693	2.086	0.000	19	19
Balducci et al. 2010	0.157	-0.008	0.322	0.062	288	275
Banitalebi et al. 2019	0.052	-0.667	0.772	0.886	14	14
Belli et al. 2011	0.517	-0.359	1.393	0.247	9	10
Brachi et al. 2020	0.000	-0.328	0.328	1.000	72	69
Brinkmann et al. 2019	0.086	-0.611	0.782	0.810	15	15
Brun et al. 2008	0.090	-0.679	0.859	0.837	15	12
Cauza et al. 2005	0.000	-0.620	0.620	1.000	22	17
Cheung et al. 2009	0.403	-0.236	1.042	0.216	20	17
Hwang et al. 2019	0.150	-0.508	0.809	0.654	18	16
Jorge et al. 2011	0.052	-0.456	0.560	0.841	29	29
Kadoglou et al. 2012	0.032	-0.531	0.594	0.912	23	24
Kadoglou, Vrabas et al. 2012	0.218	-0.315	0.750	0.423	26	27
Karstoft et al. 2013	0.196	-0.663	1.055	0.654	12	8
Kataoka et al. 2018	0.539	-0.528	1.605	0.322	6	6
Lambers et al. 2008	0.044	-0.685	0.774	0.905	18	11
Larose et al. 2011	0.206	-0.140	0.551	0.243	64	64
Lucotti et al. 2011	0.000	-0.569	0.569	1.000	20	27
Maiden et al. 2011	0.238	-0.372	0.847	0.445	20	20
Magalhaes et al. 2019	0.075	-0.595	0.745	0.826	15	22
Maharaj & Nuhu. 2016	0.536	0.119	0.953	0.012	45	45
Middlebrooke et al. 2006	0.037	-0.505	0.579	0.895	22	30
Mo et al. 2011	0.047	-0.697	0.792	0.901	15	13
Motahari-Tabari et al. 2015	0.143	-0.388	0.674	0.598	27	26
Nalwan et al. 2015	2.273	1.247	3.300	0.000	11	12
Okada et al. 2010	0.064	-0.562	0.690	0.842	21	17
Pedersen et al. 2019	1.120	0.558	1.683	0.000	26	29
Plotnikoff et al. 2010	0.038	-0.523	0.599	0.894	27	21
Praet et al. 2008	0.109	-0.297	0.516	0.598	49	43
Ranasinghe et al. 2021	0.160	-0.349	0.669	0.537	28	30
Rehman et al. 2017	0.479	0.088	0.870	0.016	51	51
Rezaei et al. 2017	2.691	1.508	3.875	0.000	10	10
Sabag et al. 2020	0.314	-0.480	1.108	0.438	12	11
Schneider et al. 2016	0.188	-0.521	0.898	0.603	15	14
Shabani et al. 2015	0.267	-0.576	1.111	0.534	10	10
Shenoy et al. 2010	0.742	0.113	1.371	0.021	20	20
Sigal et al. 2007	0.043	-0.302	0.389	0.806	64	63
Snel et al. 2012	0.737	-0.021	1.495	0.057	15	14
Sokolovska et al. 2020	0.157	-0.480	0.795	0.629	14	26
Sparks et al. 2013	0.194	-0.558	0.946	0.613	18	10
Stolinski et al. 2008	0.285	-0.624	1.194	0.539	8	9
Taheri et al. 2019	1.181	0.589	1.774	0.000	25	25
Tan et al. 2018	0.278	-0.411	0.968	0.429	16	15
Teychane et al. 2015	0.231	0.011	0.451	0.040	162	156
Tsang-Orr et al. 2007	1.230	0.538	1.922	0.000	20	17
Vinetti et al. 2015	0.188	-0.654	1.029	0.662	10	10
Winding et al. 2018	0.179	-0.713	1.071	0.694	12	7
Wycherley et al. 2010	0.083	-0.583	0.749	0.807	17	16
Yan et al. 2014	0.336	-0.367	1.039	0.349	31	10
Yang et al. 2017	2.935	2.050	3.820	0.000	20	20
Yang et al. 2020	0.277	-0.225	0.779	0.280	30	30
Yavari et al. 2012	0.040	-0.568	0.647	0.898	20	20
Yamamoto et al. 2020	0.104	-0.544	0.753	0.752	18	17
Youngwanichsetha et al. 2013	0.693	0.194	1.192	0.006	32	32
Yucel et al. 2016	0.027	-0.548	0.603	0.926	28	21
Gainey et al. 2016	0.148	-0.641	0.938	0.713	12	11
Gholami et al. 2020	0.386	-0.306	1.079	0.274	16	15
Hegde et al. 2020	0.218	-0.392	0.827	0.484	20	20
Emamzadani et al. 2015	0.140	-0.557	0.837	0.694	15	15
Egger et al. 2013	0.057	-0.618	0.733	0.868	16	16
Dixit et al. 2014	0.020	-0.397	0.438	0.924	40	47
Dede et al. 2015	0.343	-0.160	0.846	0.181	30	30
Dadarse et al. 2019	0.202	-0.573	0.976	0.610	12	12
Dadgostar et al. 2016	0.440	0.050	0.830	0.027	51	51
Gram et al. 2010	0.437	-0.139	1.012	0.137	28	22
Fritz et al. 2011	0.381	-0.181	0.943	0.184	20	30
Goldhaber-Fiebert et al. 2003	0.597	0.088	1.105	0.021	35	28
Cohen et al. 2008	0.745	0.008	1.481	0.048	16	13
Hordern et al. 2009	0.262	-0.001	0.525	0.051	111	112
Gaikin et al. 2020	0.555	0.003	1.108	0.049	22	30
	0.330	0.240	0.419	0.000	2156	2115



Heterogeneity: $I^2 = 46.05$, $p < 0.001$

H. Effect of exercise intervention on SBP

Study name	Hedges's g	Lower limit	Upper limit	p-Value	Intervention group	Control group
	Statistics for each study				**Sample size**	
Araiza et al. 2006	-0.66	-1.38	0.05	0.07	15	15
Bacchi et al. 2012	-0.70	-1.34	-0.06	0.03	19	19
Balducci et al. 2010	-0.27	-0.43	-0.10	0.00	288	275
Belli et al. 2011	-0.54	-1.41	0.34	0.23	9	10
Bouchi et al. 2020	-0.32	-0.65	0.01	0.06	72	69
Brun et al. 2008	-0.55	-1.32	0.23	0.17	13	12
Castaneda et al. 2002	-0.91	-1.65	-0.18	0.01	15	15
Cauza et al. 2005	-0.33	-0.95	0.30	0.31	22	17
Hwang et al. 2019	-0.31	-0.98	0.35	0.35	18	16
Jorge et al. 2011	-0.40	-0.91	0.11	0.12	29	29
Kadoglou et al. 2012	-0.33	-0.89	0.24	0.26	23	24
Kadoglou, Vrabas et al. 2012	-0.56	-1.10	-0.02	0.04	26	27
Karstoft et al. 2013	-0.22	-1.08	0.64	0.62	12	8
Kataoka et al. 2018	-0.91	-2.01	0.20	0.11	6	6
Loimaala et al. 2009	-0.84	-1.42	-0.26	0.00	24	24
Lucotti et al. 2011	-0.41	-0.99	0.16	0.16	20	27
Maden et al. 2011	-0.49	-1.11	0.13	0.12	20	20
Maharaj & Nuhu. 2016	-0.51	-0.93	-0.10	0.02	45	45
McDermot et al. 2014	-0.02	-0.64	0.60	0.95	20	18
Middlebrooke et al. 2006	-0.05	-0.60	0.49	0.84	22	30
Moe et al. 2011	-0.36	-1.11	0.39	0.35	13	13
Mortensen et al. 2019	-0.26	-1.09	0.57	0.54	10	11
Okada et al. 2010	-0.13	-0.76	0.50	0.69	21	17
Plotnikoff et al. 2010	-0.25	-0.81	0.32	0.39	27	21
Praet et al. 2008	-0.01	-0.75	0.74	0.99	13	13
Rahbar et al . 2017	-0.18	-0.90	0.55	0.63	13	15
Ranasingh et al. 2021	-0.28	-0.79	0.23	0.29	28	30
Sheynoy et al. 2010	-0.90	-1.54	-0.27	0.01	20	20
Sigal et al. 2007	-0.09	-0.44	0.26	0.61	64	63
Snel et al. 2012	-1.72	-2.58	-0.86	0.00	13	14
Sokolowska et al. 2020	-0.12	-0.76	0.52	0.71	14	26
Vinetti et al. 2015	-0.51	-1.36	0.35	0.24	10	10
Winding et al. 2018	-0.26	-1.15	0.64	0.57	12	7
Wycherley et al. 2010	-0.19	-0.86	0.47	0.57	17	16
Yan et al. 2014	-1.94	-2.76	-1.13	0.00	31	10
Yang et al. 2011	-0.77	-1.61	0.06	0.07	12	10
Yavari et al. 2012	-0.67	-1.30	-0.05	0.03	20	20
Youngwanichsetha et al. 2013	-0.71	-1.21	-0.21	0.01	32	32
Choi et al. 2012	-0.08	-0.52	0.37	0.74	38	37
Ezema et al. 2015	-0.74	-1.28	-0.19	0.01	30	24
Figueira et al. 2013	-1.60	-2.43	-0.76	0.00	14	14
Gainey et al. 2016	-1.90	-2.86	-0.94	0.00	12	11
Gulsin et al. 2020	-0.31	-0.85	0.24	0.27	22	30
Hegde et al. 2020	-0.03	-0.63	0.58	0.94	20	20
Hsieh et al. 2016	-0.46	-1.16	0.25	0.20	15	15
Ezema et al. 2019	-2.06	-2.74	-1.38	0.00	25	25
Egger et al. 2013	-0.05	-0.73	0.62	0.87	16	16
Dede et al. 2015	-1.68	-2.27	-1.10	0.00	30	30
Gram et al. 2010	-0.72	-1.31	-0.14	0.02	24	22
Goldhaber-Fiebert et al. 2003	-0.02	-0.51	0.48	0.95	33	28
Dunstan et al 2002	-0.78	-1.52	-0.04	0.04	16	13
Cohen et al. 2008	-0.74	-1.48	-0.01	0.05	16	13
Hordern et al. 2009	-0.26	-0.52	0.00	0.05	111	112
	-0.52	-0.64	-0.40	0.00	1510	1464

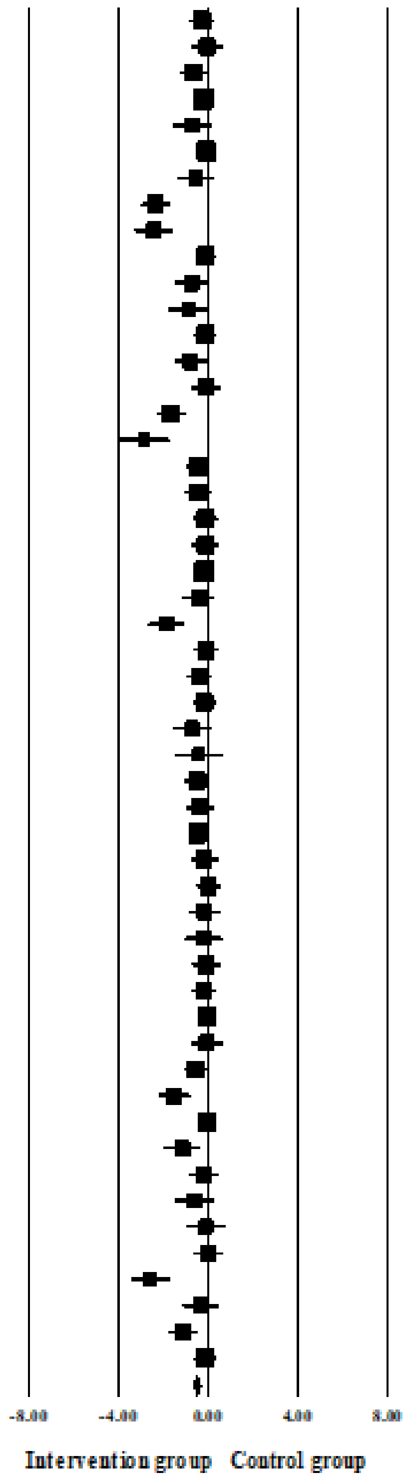


Heterogeneity: $I^2 = 56.38$, $p < 0.001$

I. Effect of exercise intervention on DBP

Study name	Hedges's g	Lower limit	Upper limit	p-Value	Intervention group	Control group
Ezema et al. 2015	-0.29	-0.82	0.24	0.29	30	24
Araiza et al. 2006	-0.06	-0.76	0.63	0.86	15	15
Bacchi et al. 2012	-0.67	-1.31	-0.03	0.04	19	19
Balducci et al. 2010	-0.23	-0.40	-0.07	0.01	288	275
Belli et al. 2011	-0.71	-1.60	0.18	0.12	9	10
Bouchi et al 2020	-0.09	-0.42	0.23	0.57	72	69
Brun et al. 2008	-0.58	-1.35	0.20	0.14	13	12
Castaneda et al. 2002	-2.35	-2.99	-1.71	0.00	31	31
Cauza et al. 2005	-2.45	-3.27	-1.62	0.00	22	17
Choi et al. 2012	-0.12	-0.57	0.32	0.59	38	37
Cohen et al 2008	-0.74	-1.48	-0.01	0.05	16	13
Cuff et al. 2003	-0.88	-1.79	0.02	0.06	10	9
Dede et al. 2015	-0.15	-0.65	0.35	0.57	30	30
Dunstan et al 2002	-0.78	-1.52	-0.04	0.04	16	13
Egger et al 2013	-0.13	-0.81	0.55	0.71	16	16
Ezema et al. 2019	-1.68	-2.32	-1.05	0.00	25	25
Gainey et al. 2016	-2.89	-4.04	-1.74	0.00	12	11
Goldhaber-Fiebert et al. 2003	-0.49	-0.99	0.02	0.06	33	28
Gram et al. 2010	-0.47	-1.04	0.11	0.11	24	22
Gulsin et al. 2020	-0.13	-0.68	0.41	0.63	22	30
Hegde et al. 2020	-0.14	-0.75	0.46	0.64	20	20
Hordern et al. 2009	-0.21	-0.47	0.05	0.12	111	112
Hsieh et al. 2016	-0.44	-1.14	0.27	0.22	15	15
Hwang et al 2019	-1.89	-2.68	-1.09	0.00	18	16
Jorge et al. 2011	-0.11	-0.61	0.40	0.68	29	29
Kadoglou et al. 2012	-0.40	-0.97	0.17	0.16	23	24
Kadoglou, Vrabas et al. 2012	-0.20	-0.73	0.33	0.47	26	27
Karstoft et al. 2013	-0.73	-1.62	0.15	0.10	12	8
Kataoka et al. 2018	-0.45	-1.51	0.61	0.41	6	6
Lucotti et al. 2011	-0.49	-1.07	0.08	0.09	20	27
Maden et al 2011	-0.38	-0.99	0.24	0.23	20	20
Maharaj & Nuhu. 2016	-0.49	-0.90	-0.07	0.02	45	45
McDermot et al 2014	-0.19	-0.82	0.43	0.55	20	18
Middlebrooke et al 2006	0.00	-0.54	0.54	1.00	22	30
Moe et al. 2011	-0.17	-0.92	0.57	0.65	13	13
Mortensen et al. 2019	-0.24	-1.06	0.59	0.57	10	11
Okada et al 2010	-0.11	-0.74	0.52	0.73	21	17
Plotnikoff et al. 2010	-0.21	-0.77	0.35	0.47	27	21
Praet et al. 2008	-0.02	-0.43	0.38	0.91	49	43
Rahbar et al. 2017	-0.06	-0.78	0.66	0.86	13	15
Ramsingh et al. 2021	-0.57	-1.09	-0.06	0.03	28	30
Shenoy et al. 2010	-1.52	-2.21	-0.83	0.00	20	20
Sigal et al. 2007	-0.07	-0.42	0.27	0.68	64	63
Snel et al. 2012	-1.15	-1.94	-0.36	0.00	13	14
Sokolovska et al. 2020	-0.19	-0.83	0.45	0.56	14	26
Vinetti et al. 2015	-0.61	-1.47	0.26	0.17	10	10
Winding et al. 2018	-0.12	-1.01	0.77	0.79	12	7
Wycherley et al. 2010	0.00	-0.67	0.67	1.00	17	16
Yan et al. 2014	-2.59	-3.49	-1.70	0.00	31	10
Yang et al. 2011	-0.36	-1.17	0.46	0.39	12	10
Yavari et al 2012	-1.13	-1.79	-0.48	0.00	20	20
Youngwanichsetha et al. 2013	-0.15	-0.64	0.33	0.54	32	32
	-0.54	-0.68	-0.39	0.00	1534	1481

Hedges's g and 95% CI

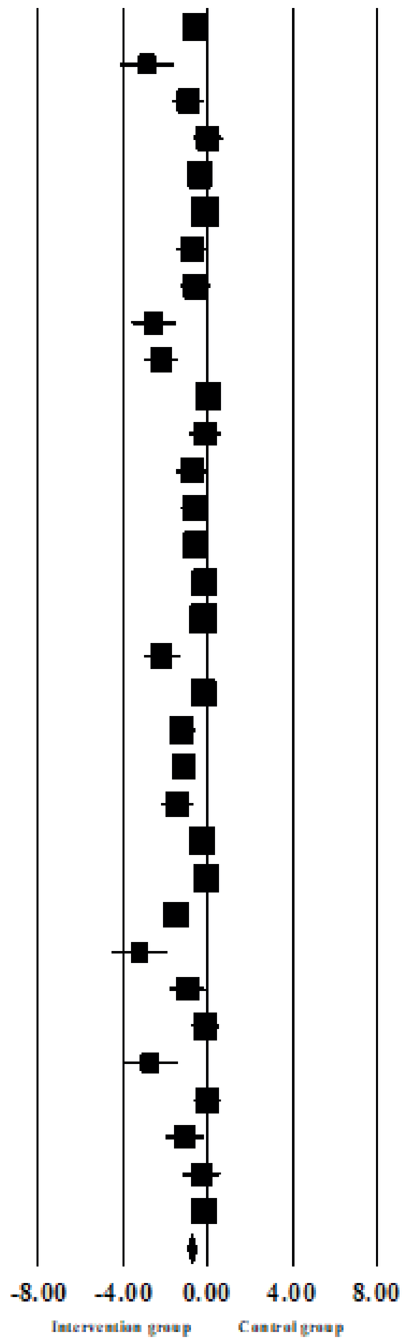


Heterogeneity: $I^2 = 72.43$, $p < 0.001$

J. Effect of exercise intervention on HOMA-IR

Study name	Statistics for each study				Sample size	
	Hedges's g	Lower limit	Upper limit	p-Value	Intervention group	Control group
Abd El- Kader et al. 2013	-0.64	-1.20	-0.08	0.02	25	25
Alam et al. 2004	-2.87	-4.16	-1.59	0.00	9	9
Aminilari et al. 2016	-0.91	-1.67	-0.15	0.02	13	15
Araiza et al. 2006	0.00	-0.70	0.70	1.00	15	15
Baasch-Skytte et al. 2020	-0.39	-0.97	0.20	0.20	21	23
Balducci et al. 2010	-0.13	-0.30	0.03	0.11	288	275
Banitalebi et al. 2019	-0.73	-1.48	0.01	0.05	14	14
Brinkmann et al. 2019	-0.60	-1.32	0.11	0.10	15	15
Brun et al. 2008	-2.55	-3.59	-1.51	0.00	13	12
Cauza et al. 2005	-2.22	-3.02	-1.43	0.00	22	17
Choi et al. 2012	-0.00	-0.45	0.45	1.00	38	37
Dadrass et al. 2019	-0.12	-0.89	0.65	0.76	12	12
Dunstan et al. 2002	-0.74	-1.48	-0.01	0.05	16	13
Dunstan et al. 2005	-0.66	-1.32	-0.01	0.05	18	18
Dunstan et al. 2006	-0.55	-1.07	-0.03	0.04	28	29
Gulsin et al. 2020	-0.16	-0.71	0.38	0.55	22	30
Hordern et al. 2009	-0.20	-0.46	0.06	0.14	111	112
Hwang et al. 2019	-2.20	-3.04	-1.36	0.00	18	16
Jorge et al. 2011	-0.22	-0.73	0.29	0.40	29	29
Kadoglou et al. 2012	-1.23	-1.84	-0.62	0.00	23	24
Kadoglou, Vrabas et al. 2012	-1.14	-1.72	-0.57	0.00	26	27
Magalhaes et al. 2019	-1.44	-2.19	-0.69	0.00	13	22
Miller et al. 2020	-0.27	-0.55	0.01	0.06	100	98
Praet et al. 2008	-0.10	-0.51	0.30	0.62	49	43
Ranasingh et al. 2021	-1.51	-2.08	-0.93	0.00	28	30
Rezaei et al. 2017	-3.23	-4.53	-1.92	0.00	10	10
Sabag et al. 2020	-0.96	-1.80	-0.13	0.02	12	11
Sokolovska et al. 2020	-0.12	-0.75	0.52	0.72	14	26
Stolinski et al. 2008	-2.75	-4.04	-1.46	0.00	8	9
Tsang-Orr et al. 2007	-0.02	-0.65	0.61	0.95	17	20
Vinetti et al. 2015	-1.09	-2.00	-0.19	0.02	10	10
Winding et al. 2018	-0.32	-1.21	0.58	0.49	12	7
Yang et al. 2020	-0.20	-0.70	0.30	0.43	30	30
	-0.77	-0.99	-0.55	0.00	1079	1083

Hedges's g and 95% CI

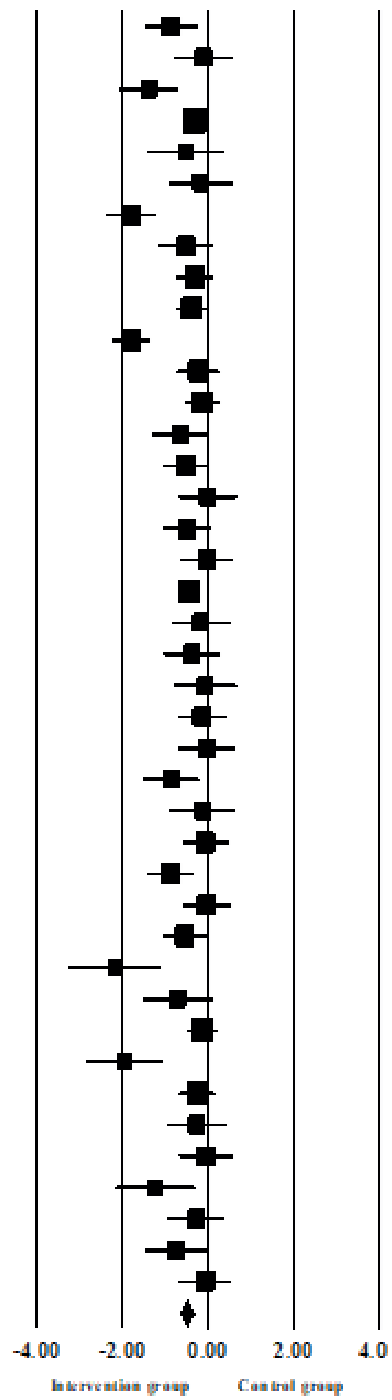


Heterogeneity: $I^2 = 80.86$, $p < 0.001$

K. Effect of exercise intervention on WC

Study name	Hedges's g	Lower limit	Upper limit	p-Value	Intervention group	Control group
Akinci et al 2018	-0.87	-1.48	-0.25	0.01	22	21
Araiza et al 2006	-0.10	-0.80	0.59	0.77	15	15
Bacchi et al 2012	-1.39	-2.09	-0.69	0.00	19	19
Balducci et al 2010	-0.32	-0.49	-0.16	0.00	288	275
Belli et al 2011	-0.52	-1.40	0.35	0.24	9	10
Brun et al 2008	-0.17	-0.93	0.59	0.66	13	12
Castaneda et al 2002	-1.80	-2.38	-1.21	0.00	31	31
Cheung et al 2009	-0.51	-1.16	0.13	0.12	20	17
Choi et al 2012	-0.31	-0.76	0.14	0.18	38	37
Church et al 2010	-0.37	-0.75	0.01	0.06	76	41
Dadgostar et al 2016	-1.81	-2.27	-1.35	0.00	51	51
Dede et al 2015	-0.24	-0.74	0.26	0.35	30	30
Dixit et al 2014	-0.13	-0.55	0.29	0.55	40	47
Dunstan et al 2005	-0.66	-1.32	-0.01	0.05	18	18
Dunstan et al 2006	-0.52	-1.04	-0.00	0.05	28	29
Egger et al 2013	-0.01	-0.68	0.67	0.98	16	16
Gram et al 2010	-0.49	-1.07	0.09	0.10	24	22
Hegde et al 2020	-0.04	-0.64	0.57	0.91	20	20
Hordern et al 2009	-0.45	-0.71	-0.18	0.00	111	112
Hsieh et al 2016	-0.17	-0.86	0.53	0.64	15	15
Hwang et al 2019	-0.38	-1.04	0.28	0.26	18	16
Lambers et al 2008	-0.06	-0.79	0.67	0.87	18	11
Lucotti et al 2011	-0.14	-0.71	0.43	0.62	20	27
Magalhaes et al 2019	-0.02	-0.69	0.65	0.95	13	22
McDermot et al 2014	-0.87	-1.52	-0.21	0.01	20	18
Moe et al 2011	-0.13	-0.87	0.62	0.74	13	13
Motahari-Tabari et al 2015	-0.06	-0.59	0.47	0.82	27	26
Pedersen et al 2019	-0.88	-1.42	-0.33	0.00	26	29
Plotnikoff et al 2010	-0.04	-0.60	0.52	0.88	27	21
Ranasingh et al 2021	-0.56	-1.07	-0.04	0.04	28	30
Rezaei et al 2017	-2.20	-3.28	-1.12	0.00	10	10
Sabag et al 2020	-0.71	-1.52	0.11	0.09	12	11
Sigal et al 2007	-0.12	-0.47	0.22	0.48	64	63
Snel et al 2012	-1.94	-2.84	-1.04	0.00	13	14
Swift et al 2012	-0.26	-0.67	0.15	0.21	58	37
Tan et al 2018	-0.26	-0.95	0.43	0.45	16	15
Tsang-Orr et al 2007	-0.05	-0.68	0.58	0.88	17	20
Vinetti et al 2015	-1.23	-2.16	-0.31	0.01	10	10
Wycherley et al 2010	-0.28	-0.94	0.38	0.41	17	17
Yan et al 2014	-0.75	-1.46	-0.03	0.04	31	10
Yang et al 2017	-0.06	-0.67	0.54	0.84	20	20
	-0.49	-0.64	-0.35	0.00	1362	1278

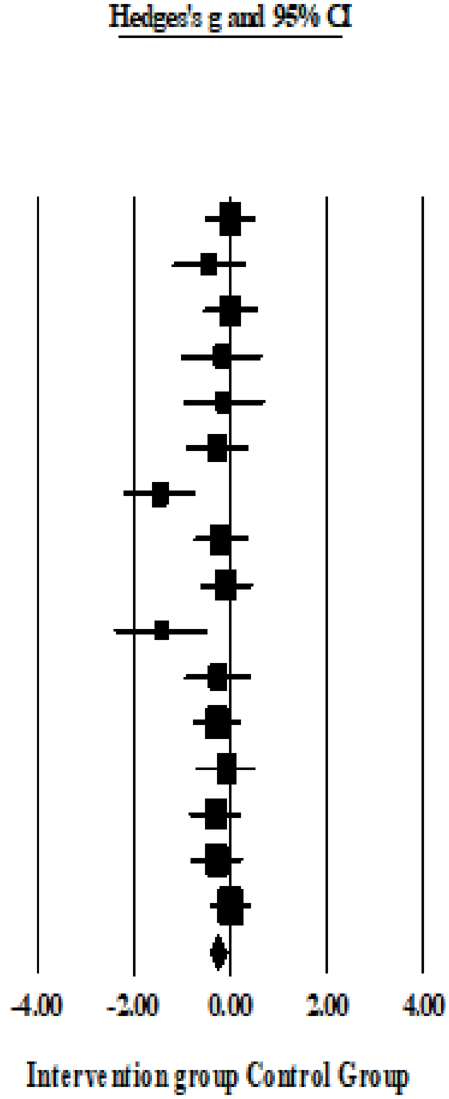
Hedges's g and 95% CI



Heterogeneity: $I^2 = 66.56$, $p < 0.001$

L. Effect of exercise intervention on WHR

Study name	Hedges's g	Lower limit	Upper limit	p-Value	Intervention group	Control broup
Jorge et al. 2011	0.00	-0.51	0.51	1.00	29	29
Moe et al. 2011	-0.44	-1.19	0.32	0.26	13	13
Plotnikoff et al. 2010	0.00	-0.56	0.56	1.00	27	21
Rezaei et al. 2017	-0.19	-1.03	0.65	0.66	10	10
Shabani et al. 2015	-0.15	-0.99	0.69	0.73	10	10
Sokolovska et al. 2020	-0.27	-0.91	0.37	0.41	14	26
Hwang et al. 2019	-1.46	-2.21	-0.72	0.00	18	16
Kadoglou et al. 2012	-0.20	-0.76	0.37	0.50	23	24
Kadoglou, Varabas et al. 2012	-0.09	-0.62	0.44	0.73	26	27
Karstoft et al. 2013	-1.43	-2.39	-0.46	0.00	12	8
Tan et al. 2018	-0.26	-0.95	0.43	0.46	16	15
Yang et al. 2020	-0.28	-0.78	0.22	0.28	30	30
Madden et al. 2011	-0.09	-0.70	0.52	0.77	20	20
Motahari-Tabari et al. 2015	-0.31	-0.84	0.23	0.26	27	26
Pedersen et al. 2019	-0.28	-0.81	0.24	0.29	26	29
Dixit et al. 2014	0.00	-0.42	0.42	1.00	40	47
	-0.26	-0.44	-0.09	0.00	341	351

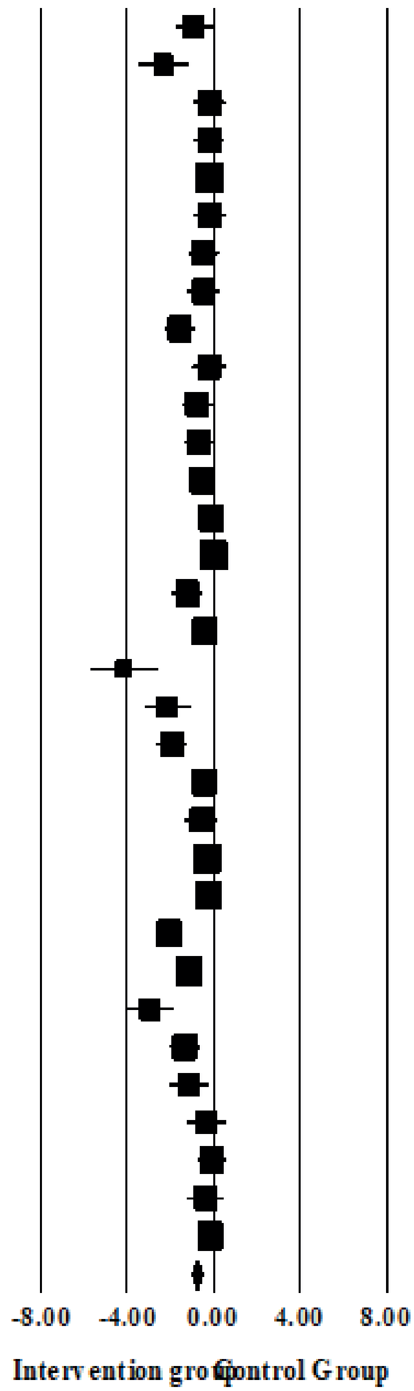


Heterogeneity: $I^2 = 25.34$, $p = 0.17$

N. Effect of exercise intervention on Insulin

Study name	Statistics for each study				Sample size	
	Hedges's g	Lower limit	Upper limit	p-Value	Intervention	Control
Akbarpour et al. 2021	-0.92	-1.81	-0.03	0.04	10	10
Alam et al. 2004	-2.34	-3.50	-1.17	0.00	9	9
Aminilari et al. 2016	-0.21	-0.93	0.51	0.57	13	15
Araiza et al. 2006	-0.20	-0.89	0.50	0.58	15	15
Balducci et al. 2010	-0.17	-0.33	-0.00	0.05	288	275
Banitalebi et al. 2019	-0.19	-0.91	0.53	0.61	14	14
Brinkmann et al. 2019	-0.48	-1.19	0.23	0.18	15	15
Brun et al. 2008	-0.45	-1.21	0.32	0.26	13	12
Cauza et al. 2005	-1.57	-2.28	-0.86	0.00	22	17
Dadrass et al 2019	-0.22	-1.00	0.55	0.58	12	12
Dunstan et al. 2002	-0.74	-1.48	-0.01	0.05	16	13
Dunstan et al. 2005	-0.66	-1.32	-0.01	0.05	18	18
Dunstan et al. 2006	-0.52	-1.04	-0.00	0.05	28	29
Gulsin et al. 2020	-0.09	-0.63	0.46	0.75	22	30
Hordern et al. 2009	-0.00	-0.26	0.26	0.99	111	112
Hwang et al. 2019	-1.22	-1.94	-0.50	0.00	18	16
Kadoglou et al. 2012	-0.43	-1.00	0.14	0.14	23	24
Karstoft et al. 2013	-4.16	-5.71	-2.61	0.00	12	8
Karstoft et al. 2014	-2.13	-3.19	-1.06	0.00	10	10
Loimaala et al. 2009	-1.93	-2.61	-1.26	0.00	24	24
McDermot et al. 2014	-0.45	-1.08	0.19	0.17	20	18
Mendham et al. 2015	-0.57	-1.35	0.21	0.15	16	10
Miller et al. 2020	-0.30	-0.58	-0.02	0.04	100	98
Motahari-Tabari et al. 2015	-0.22	-0.76	0.31	0.41	27	26
Ranasingh et al. 2021	-2.06	-2.69	-1.43	0.00	28	30
Shakil-ur-Rehman et al. 2017	-1.18	-1.59	-0.76	0.00	51	51
Snel et al. 2012	-2.95	-4.02	-1.88	0.00	13	14
VanDijk et al. 2013	-1.34	-2.01	-0.67	0.00	23	18
Vinetti et al. 2015	-1.16	-2.07	-0.25	0.01	10	10
Winding et al. 2018	-0.34	-1.24	0.55	0.45	12	7
Wycherley et al. 2010	-0.07	-0.73	0.60	0.85	17	16
Yang et al. 2011	-0.37	-1.18	0.45	0.37	12	10
Yang et al. 2020	-0.15	-0.65	0.35	0.55	30	30
	-0.78	-1.01	-0.55	0.00	1052	1016

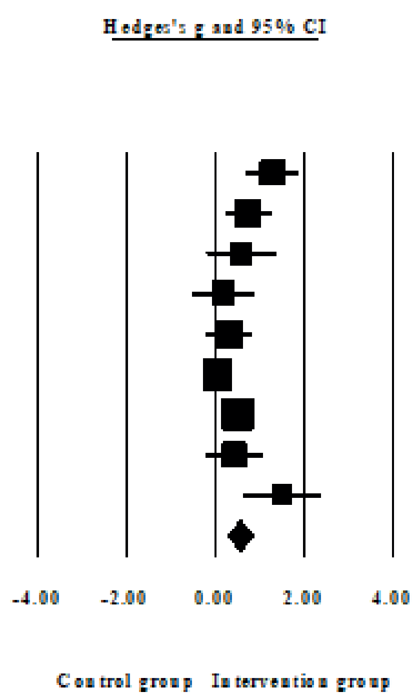
Hedges's g and 95% CI



Heterogeneity: $I^2 = 81.52$, $p < 0.001$

M. Effect of exercise intervention on TNF-alpha

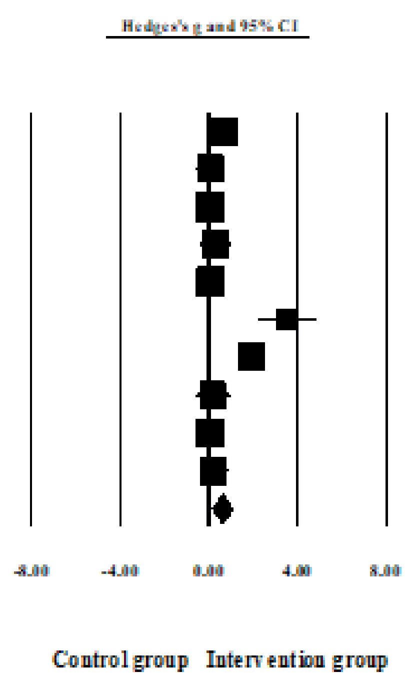
Study name	Hedges's g	Lower limit	Upper limit	p-Value	Intervention group	Control group
Abd El- Kader et al. 2013	1.29	0.69	1.89	0.00	25	25
Jorge et al. 2011	0.74	0.22	1.27	0.01	29	29
Mendham et al. 2015	0.58	-0.20	1.36	0.14	16	10
Brinkmann et al. 2019	0.18	-0.51	0.88	0.60	15	15
Pedersen et al. 2019	0.31	-0.22	0.83	0.25	26	29
Bouchi et al. 2020	0.05	-0.28	0.38	0.77	69	69
Miller et al. 2017	0.50	0.20	0.80	0.00	100	80
Rech et al. 2019	0.43	-0.21	1.06	0.19	17	21
Dadrass et al 2019	1.49	0.61	2.38	0.00	12	12
	0.56	0.27	0.84	0.00	309	290



Heterogeneity: $I^2 = 61.30$, $p = 0.008$

O. Effect of exercise intervention on IL-6

Study name	Hedges's g	Lower limit	Upper limit	p-Value	Intervention group	Control group
Abd El- Kader et al. 2013	0.72	0.15	1.28	0.01	25	25
Banitalebi et al. 2018	0.07	-0.59	0.72	0.84	17	17
Bouchi et al. 2020	0.06	-0.27	0.39	0.71	72	69
Brinkmann et al. 2019	0.29	-0.41	0.99	0.42	15	15
Choi et al. 2012	0.08	-0.37	0.53	0.73	38	37
Dadrass et al 2019	3.51	2.26	4.77	0.00	12	12
Jorge et al. 2011	1.93	1.31	2.54	0.00	29	29
Mendham et al. 2015	0.19	-0.58	0.96	0.63	16	10
Middlebrooke et al. 2006	0.05	-0.50	0.59	0.87	22	30
Rech et al. 2019	0.22	-0.41	0.85	0.49	17	21
	0.60	0.13	1.06	0.01	263	265

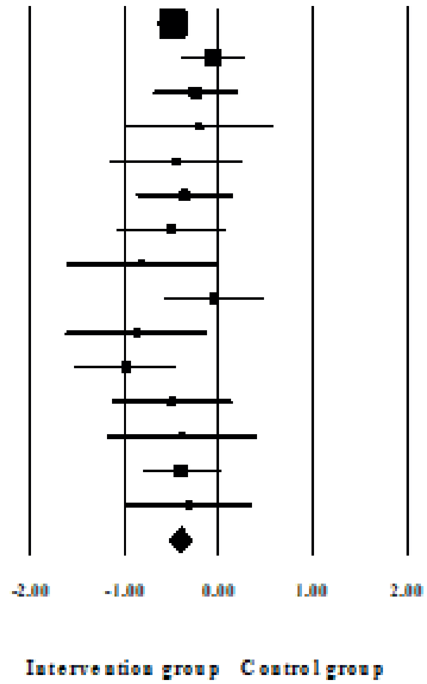


Heterogeneity: $I^2 = 84.35$, $p < 0.001$

P. Effect of exercise intervention on CRP

Study name	Statistics for each study				Sample size	
	Hedges's g	Lower limit	Upper limit	p-Value	Intervention	Control
Balducci et al. 2010	-0.49	-0.65	-0.32	0.00	288	275
Bouchi et al 2020	-0.06	-0.39	0.27	0.72	72	69
Choi et al. 2012	-0.25	-0.70	0.20	0.28	38	37
Dadrass et al. 2019	-0.20	-0.98	0.57	0.60	12	12
Hsieh et al. 2016	-0.46	-1.16	0.25	0.20	15	15
Jorge et al. 2011	-0.37	-0.88	0.15	0.16	29	29
Kadoglou et al. 2012	-0.50	-1.07	0.07	0.09	23	24
Mendham et al. 2015	-0.82	-1.62	-0.02	0.04	16	10
Pedersen et al. 2019	-0.05	-0.57	0.47	0.85	26	29
Rahbar et al. 2017	-0.88	-1.63	-0.12	0.02	13	15
Ranasingh et al. 2021	-0.99	-1.53	-0.45	0.00	28	30
Rech et al. 2019	-0.50	-1.13	0.14	0.12	17	21
Sabag et al. 2020	-0.39	-1.18	0.41	0.34	12	11
Swift et al. 2012	-0.40	-0.81	0.02	0.06	58	37
Wycherley et al. 2010	-0.32	-0.99	0.35	0.35	17	16
	-0.41	-0.53	-0.29	0.00	664	630

Hedges's g and 95% CI



Heterogeneity: $I^2 = 6.01$, $p = 0.39$

Study ID	Weight	Randomization process	Deviations from intended interventions	Mising outcome data	Measurement of the outcome	Selection of the reported result	Overall Bias
Abd El- Kader et al.,2013	1	?	+	+	?	?	!
Jorge et al., 2011	1	?	?	+	?	+	!
Loimaala et al. 2009	1	?	?	+	?	+	!
Lucotti et al. 2011	1	?	?	+	?	?	!
Madden et al. 2011	1	?	+	+	+	?	!
Magalhães et al., 2019	1	?	?	+	?	?	!
Maharaj & Nuhu 2016	1	?	?	+	?	?	!
Maiorana et al. 2002	1	−	?	+	?	?	−
Mendham et al. 2014	1	−	?	+	?	?	−
Metcalfe et al. 2018	1	?	?	+	?	+	!
Miyauchi et al. 2016	1	−	?	+	?	?	−
Middlebrooke et al. 2006	1	?	?	+	?	?	!
Miller et al. 2017	1	?	?	+	?	?	!
Miller et al. 2020	1	+	?	+	+	+	!
Moe et al. 2011	1	?	+	+	?	+	!
Mortensen et al. 2019	1	+	+	+	?	?	!
Motahari-Tabari et al., 2015	1	+	+	+	?	?	!
Sudarsono et al. 2019	1	+	+	+	?	+	!
Natesan et al. 2015	1	+	+	+	+	+	+
Okada et al. 2010	1	−	+	+	?	?	−
Pandey et al. 2017	1	?	+	+	?	?	!
Pedersen et al. 2019	1	+	+	+	+	+	+
Plotnikoff et al. 2010	1	+	+	+	+	+	+
Praet et al. 2008	1	?	+	+	?	?	!
Rahbar et al. 2017	1	+	+	+	+	+	+
Ranasinghe et al. 2021	1	+	+	+	+	+	+
Rech et al. 2019	1	+	+	+	?	?	!
Rehman et al. 2017	1	?	+	+	?	?	!
Rezaei et al. 2017	1	?	+	+	?	?	!
Sabag et al. 2020	1	+	+	+	?	?	!
Schneider et al. 2016	1	+	+	+	?	+	!
Shabani et al. 2015	1	?	+	+	?	?	!

Figure 2. Risk of bias assessment

Figure 2 (continued)

Shakil-ur-Rehman et al 2017	1	?	+	+	?	?	!
Shenoy et al. 2010	1	?	+	+	?	?	!
Sigal et al 2007	1	+	+	+	+	+	+
Sn et al 2012	1	?	+	+	?	?	!
Sokolovska et al. 2020	1	?	+	+	?	?	!
Sparks et al 2013	1	−	+	+	?	?	−
Stolinski et al. 2008	1	?	+	+	+	+	!
Sung & Bae 2012	1	?	+	+	?	?	!
Swift et al. 2012	1	?	+	+	?	?	!
Taheri et al 2019	1	?	+	+	?	+	!
Tan et al 2018	1	?	+	+	?	?	!
Teycherne et al 2015	1	+	+	+	+	+	+
Tomas-Carus et al 2016	1	−	+	+	?	?	−
Tsang et al. 2008	1	?	+	+	+	?	!
Van Dijk et al 2013	1	?	+	+	?	+	!
Vinetti et al 2015	1	?	+	+	?	+	!
Winding et al 2018	1	?	+	+	?	?	!
Winnick et al 2007	1	?	+	+	?	?	!
Wycherley et al 2010	1	?	?	+	?	+	!
Yan et al. 2014	1	?	+	+	?	?	!
Yang et al 2011	1	?	+	+	?	?	!
Yang et al 2017	1	+	+	+	+	+	+
Yang et al 2020	1	−	+	+	?	?	−
Yavari et al. 2012	1	?	?	+	?	?	!
Yamamoto et al. 2020	1	?	+	+	?	+	!
Youngwanichsetha et al. 2013	1	+	+	+	+	?	!
Yucel & Uysal 2016	1	?	+	+	?	+	!
Li et al 2020	1	+	+	+	+	+	+
Larose et al 2011	1	?	+	+	?	+	!
Lambers et al 2008	1	−	?	+	+	?	−
Kour et al 2019	1	?	?	+	?	?	!
McDermott et al. 2014	1	+	+	+	+	+	+
Kataoka et al 2018	1	?	+	+	?	+	!
Karstoft et al 2014	1	?	+	+	?	+	!
Karstoft et al 2013	1	?	+	+	?	?	!
Kadoglou et al 2012	1	?	+	+	?	?	!
Kadoglou E et al 2012	1	+	+	+	+	+	+
Hwang et al 2019	1	?	+	+	+	+	!
Hsieh et al 2016	1	+	+	+	+	+	+
Hordern et al. 2009	1	?	?	+	?	+	!
Hegde et al. 2020	1	?	+	+	?	?	!
Gulsin et al 2020	1	+	+	+	?	+	!
Gram et al 2010	1	+	+	+	?	+	!
Gordon et al. 2008	1	?	+	+	?	?	!

Figure 2 (continued)

Goldhaber-Fiebert et al. 2003	1	?	+	+	?	?	!
Gholami et al 2020	1	+	+	+	?	+	!
Gainey et al 2016	1	+	+	+	?	?	!
Fritz et al 2011	1	−	+	+	?	?	−
Figueira et al 2013	1	?	+	+	+	+	!
Fayehun et al. 2018	1	+	+	+	?	?	!
Ezema et al. 2015	1	?	?	+	?	?	!
Ezema et al. 2019	1	?	+	+	+	?	!
Acar et al. 2014	1	?	+	+	?	?	!
Akbarpour et al. 2021	1	?	?	+	+	?	!
Akinci et al 2018	1	+	+	+	+	+	+
Alam et al 2004	1	?	+	+	+	?	!
AminiLari et al 2016	1	?	+	+	?	?	!
Araiza et al 2006	1	?	+	+	+	?	!
Baasch-Skytte et al 2020	1	?	+	+	+	?	!
Bacchi et al. 2012	1	+	+	+	−	?	−
Balducci et al. 2012	1	+	+	+	?	?	!
Banitelebi et al 2018	1	+	+	+	?	?	!
Belli et al. 2019	1	?	+	+	?	?	!
Botton et al. 2018	1	+	+	+	?	+	!
Bouchi et al 2020	1	+	?	?	?	?	!
Brinkmann et al 2019	1	+	?	+	?	?	!
Brun et al 2008	1	?	?	+	?	?	!
Castaneda et al 2002	1	?	+	+	+	?	!
Cauza et al 2005	1	?	+	+	+	?	!
Cauza et al 2006	1	?	+	+	?	?	!
Cheung et al 2009	1	?	+	+	?	?	!
Choi et al 2012	1	?	?	+	?	?	!
Church et al 2010	1	?	+	+	+	?	!
Cohen et al 2008	1	?	+	+	?	?	!
Cruz et al 2019	1	+	+	+	?	+	!
Cuff et al 2003	1	?	+	+	?	?	!
Dadgostar et al 2016	1	?	+	+	+	+	+
Dadrass et al 2019	1	+	+	+	+	+	!
Dede et al 2015	1	?	+	+	+	?	!
Dixit et al 2014	1	?	+	+	?	?	!
Dunstan et al 2002	1	?	+	+	?	?	!
Dunstan et al 2005	1	?	?	+	?	?	!
Dunstan et al 2006	1	?	?	?	?	?	!
Egger et al 2013	1	?	?	+	+	?	!
Emerenziani et al 2015	1	?	+	+	?	?	!

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