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LONG-TERM EFFECTS OF EXERCISE TRAINING ON ANTHROPOMETRIC MEASURES IN OVERWEIGHT AND OBESE ADULTS: A SYSTEMATIC REVIEW WITH META-ANALYSIS

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Abstract:
This systematic review and meta-analysis aimed to evaluate the long-term effects of structured exercise training (≥24 weeks) on anthropometric outcomes in adults with overweight or obesity. Randomized controlled trials comparing supervised exercise training with non-exercise control groups were identified through searches in MEDLINE, EMBASE, Cochrane CENTRAL, and LILACS. Ten trials involving 1,392 participants were included. Random-effects meta-analyses showed that exercise significantly reduced body weight (BW) (mean difference [MD], −1.34 kg; 95% CI, −2.36 to −0.31; $I^2 = 0.0\%$) and waist circumference (WC) (MD, −2.96 cm; 95% CI, −4.77 to −1.15; $I^2 = 0.0\%$), but not body mass index (BMI) (MD, −0.14 kg/m²; 95% CI, −0.67 to 0.39; $I^2 = 0.0\%$). Subgroup analyses revealed greater reductions in BW among participants aged <50 years and in interventions >6 months. For WC, reductions were consistent across subgroups. No significant differences in BMI were observed across age or duration subgroups. Most studies focused on aerobic training; data on resistance or combined modalities were limited. No trials included direct assessments of body composition. These findings support structured exercise training ≥24 weeks as an effective strategy to reduce BW and WC in adults with overweight or obesity.

Keywords: exercise; systematic review; obesity; body weight changes

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1. Introduction

Obesity has emerged as a global epidemic and a pressing public health challenge, with its prevalence doubling or tripling over the past three decades[1]. This upward trend has been largely attributed to rapid urbanization, sedentary behavior, and the widespread consumption of calorie-dense, ultra-processed foods. The consequences are substantial, as obesity is closely linked to several non-communicable diseases, including type 2 diabetes, hypertension, dyslipidemia, and coronary artery disease[2, 3].

In Brazil, the economic burden of obesity is alarming. In 2015, the direct healthcare costs related to obesity reached an estimated US$ 269.6 million, accounting for nearly 2% of national healthcare expenditures. Moreover, a one-point increase in the population's average body mass index (BMI) could lead to approximately US$ 62 million in additional hospitalizations[2]. These figures underscore the urgency of implementing effective, evidence-based interventions that target obesity and its associated complications.

Therefore, the aim of this systematic review and meta-analysis was to evaluate the long-term effects of structured exercise training (≥24 weeks) on anthropometric outcomes (BW, BMI, and WC) in adults with overweight or obesity.

2. Literature Review

The clinical management of obesity typically involves a combination of strategies, including pharmacotherapy, bariatric surgery, and lifestyle modifications. While pharmacological and surgical approaches can be effective in selected cases, they often come with limitations, such as side effects, procedural risks, and restricted applicability[4, 5]. In contrast, behavioral strategies—particularly those involving dietary changes and exercise training—are widely recommended as first-line treatments due to their safety, accessibility, and broad impact on health outcomes[6, 7].

Exercise training plays a central role in this context. Beyond promoting weight loss, it contributes to improvements in body composition, insulin sensitivity, cardiovascular fitness, and psychological well-being[8, 9]. These multifaceted benefits are essential not only for disease prevention but also for enhancing the quality of life in individuals with overweight or obesity.

Nevertheless, the long-term effects of exercise training remain under debate. Although short-term interventions often yield positive outcomes, maintaining adherence over extended periods poses a major challenge[10-12]. In clinical and research settings, it is critical to assess whether structured exercise interventions sustained for at least 24 weeks can produce meaningful and lasting changes in anthropometric markers such as body weight (BW), BMI, and waist circumference (WC), indicators that are strongly associated with cardiometabolic risk[13, 14].

Therefore, the aim of this systematic review and meta-analysis was to evaluate the long-term effects of structured exercise training (≥24 weeks) on anthropometric outcomes (BW, BMI, and WC) in adults with overweight or obesity.

3. Material and Methods

3.1 Search Strategy and Study Selection

This review was conducted according to the Cochrane Handbook for Systematic Reviews of Interventions[15] and followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines[16].

A comprehensive search was conducted in MEDLINE (via PubMed), EMBASE, Cochrane Central Register of Controlled Trials, and LILACS databases. Reference lists of eligible studies were also manually screened. The search strategy included terms such as "exercise," "resistance training," "aerobic training," "physical training," "HIIT," and "high-intensity training" combined with terms related to overweight and obesity. No language restrictions were applied during the search. However, only full-text articles published in English were included in the final analysis. The complete PubMed search strategy is available in the Supplementary Material.

3.2 Eligibility Criteria

3.2.1 Types of Studies

Parallel-group randomized controlled trials (RCTs) assessing the efficacy of structured exercise training in overweight or obese adults.

3.2.2 Participants

Adults (≥18 years) with a baseline body mass index (BMI) ≥25 kg/m², regardless of sex.

3.2.3 Exercise Program

Structured and supervised exercise programs lasting ≥24 weeks. Eligible exercise modalities included (e.g., aerobic training, resistance training, or their combination).

3.2.4 Non-exercise Control Interventions

Control groups that received no structured exercise training and were not exposed to co-interventions such as dietary counseling, pharmacotherapy, or alternative physical activity programs.

3.2.5 Outcome

The primary outcomes were changes in BW, BMI, and WC assessed at the end of the intervention period.

3.3 Selection and Data Collection Process

Titles and abstracts retrieved from the searches were screened independently by two reviewers (PJS and VMS). Full texts were assessed for eligibility when abstracts provided insufficient information. Disagreements were resolved by consensus, and a third reviewer (JMF) was consulted when necessary. The study selection process is illustrated in Figure 1. Rayyan software was used to manage references during the selection process.

Data extraction was also performed independently by two reviewers. Extracted data included sample size, participant characteristics (e.g., age, baseline BMI), and intervention characteristics (e.g., duration, frequency, intensity). Information on outcomes (BW, BMI, WC), including mean changes for baseline values and measures of variability (standard deviation, standard error, or confidence interval), was collected. Discrepancies were resolved through discussion or third-party adjudication. Additionally, exercise-related parameters were detailed, including the duration of exercise training (in weeks), frequency (days/week), and intensity (% of maximum oxygen consumption (VO2max) for aerobic exercise and % of maximum repetition (1RM) for resistance exercise).

3.4 Assessment of Risk of Bias

To evaluate the potential for bias within the included studies, the Cochrane Risk of Bias tool was employed[17]. This instrument is extensively utilized in systematic reviews to evaluate the methodological rigor of randomized controlled trials. It examines seven principal domains: (1) random sequence generation, (2) allocation concealment, (3) blinding of participants and personnel, (4) blinding of outcome evaluation, (5) incomplete outcome data, (6) selective reporting, and (7) other sources of bias, as well as conducting an overall risk of bias assessment. Nevertheless, the domain concerning the blinding of participants and personnel was excluded, as this criterion is not pertinent to exercise intervention studies, in which participant blinding is not practicable. The remaining domains were assessed as presenting a "low risk," "high risk," or "unclear risk" of bias, facilitating a thorough examination of the studies' internal validity.

3.5 Data Analysis

Meta-analyses were performed using random-effects models (DerSimonian and Laird method). Mean differences (MD) and 95% confidence intervals (CI) were calculated for BW, BMI, and WC outcomes. When available, intention-to-treat data were used. An α value of 0.05 was deemed statistically significant. Statistical heterogeneity was evaluated using Cochran's Q test ($P < 0.10$) and the I^2 statistic, with values >50% indicating substantial heterogeneity. Prediction intervals were reported to estimate the expected effect in future studies.

Subgroup analyses were performed to explore the potential influence of age (<50 vs. ≥50 years) and intervention duration (≤6 vs. >6 months). Sensitivity analyses were limited to BW and BMI due to the number of studies available for each outcome. Sensitivity analyses were exclusively feasible for BW and BMI outcomes owing to the substantial number of studies (exceeding 10 studies). All analyses were performed using the R software (version 4.4.1) and the `*meta*` package.

4. Results

4.1 Description of Studies

A total of 427 potentially eligible studies were identified through database searches and reference screening. Of these, ten randomized controlled trials met the inclusion criteria, encompassing 1,392 participants. Among them, eight studies investigated aerobic training, one examined resistance training, and one evaluated a combined training approach. A total of 963 participants were allocated to aerobic training, 30 to resistance training, 53 to combined training, and 370 to the control group. Detailed study characteristics are provided in Supplementary Table 1. Figure 1 displays the PRISMA flow diagram of the study selection process.

4.2 Risk of Bias

As summarized in Supplementary Figure 2, 90% of the included studies reported adequate random sequence generation (9 out of 10), and 60% described allocation concealment (6 out of 10). Blinded outcome assessment was present in 70% (7 out of 10), while 60% (6 out of 10) reported losses and exclusions adequately. All studies (10 out of 10) demonstrated low risk for selective reporting. Overall, 80% (8 out of 10) were judged as having low risk of bias.

4.3 Exercise Training Effects on Anthropometric Measurements

Meta-analysis showed that exercise training significantly reduced body weight (BW), with a MD of −1.34 kg (95% CI: −2.36 to −0.31; I^2 = 0.0%; P for heterogeneity = 0.453), based on 14 arms including 1,541 participants (Figure 2). WC was also significantly reduced by exercise training, with a MD of −2.96 cm (95% CI: −4.77 to −1.15; I^2 = 0.0%; P for heterogeneity = 0.999), derived from five arms with 1,115 participants (Figure 3). Conversely, exercise training did not produce a significant change in body mass index (BMI). The pooled MD was −0.14 kg/m² (95% CI: −0.67 to 0.39; I^2 = 0.0%; P = 0.612), across 12 arms with 1,392 participants (Figure 4).

4.4 Subgroup and Sensitivity Analyses

A subgroup analysis based on age revealed a significant interaction (P = 0.005). Participants younger than 50 years exhibited a greater reduction in BW (MD = −3.10 kg; 95% CI: −4.72 to −1.49; I^2 = 0.0%), whereas those aged 50 or older showed no significant changes (MD = −0.16 kg; 95% CI: −1.47 to 1.16; I^2 = 0.0%) (Supplementary Material Figure 3). When stratified by intervention duration, only studies with follow-up longer than six months demonstrated significant BW reductions (MD = −1.93 kg; 95% CI: −3.14 to −0.73; I^2 = 0.0%). Interventions up to six months did not yield significant effects (MD = 0.22 kg; 95% CI: −1.71 to 2.16; I^2 = 0.0%) (Supplementary Material Figure 4).

No significant subgroup effects were observed for BMI when stratified by age (P = 0.302) or intervention duration (P = 0.348). Participants aged <50 years showed a mean change in BMI of 0.15 kg/m² (95% CI: −0.61 to 0.92; I^2 = 49.5%), while those aged ≥50 years exhibited a mean change of −0.41 kg/m² (95% CI: −1.15 to 0.33; I^2 = 0.0%). Regarding follow-up duration, interventions lasting ≤6 months resulted in a mean difference of −0.43 kg/m² (95% CI: −1.24 to 0.38; I^2 = 0.0%), whereas those exceeding six months yielded a mean change of 0.08 kg/m² (95% CI: −0.62 to 0.79; I^2 = 48.5%).

5. Discussion

This systematic review and meta-analysis of randomized controlled trials evaluated the long-term effects of structured exercise training on anthropometric outcomes in adults with overweight or obesity. We found that exercise training interventions lasting 24 weeks or longer resulted in modest but statistically significant reductions in BW and WC, but not in BMI. Subgroup analyses revealed that greater benefits in BW were observed in younger participants and in interventions lasting longer than six months.

These findings align with previous evidence suggesting that structured and supervised physical activity is an effective lifestyle intervention for reducing adiposity-related outcomes in adults with excess weight[7, 8]. The observed reduction of approximately 1.3 kg in BW and nearly 3 cm in WC may appear modest. However, these changes are considered clinically meaningful, particularly for the prevention of cardiometabolic diseases. WC, in particular, is a sensitive marker of central adiposity and has a strong association with insulin resistance and cardiovascular risk[14, 18].

Interestingly, BMI did not show a significant reduction, which is consistent with previous findings and highlights the limitations of BMI as a proxy for body composition[19, 20]. Some included trials reported increases in lean mass, which may have masked fat loss when using BMI as the sole indicator. Therefore, the use of complementary measures such as WC or fat percentage is encouraged in both clinical and research settings.

The subgroup analysis based on age showed that individuals under 50 years of age experienced greater weight loss than older adults. This may reflect age-related physiological adaptations, such as reduced metabolic flexibility and anabolic resistance, which limit fat loss and muscle gain in older populations[21, 22]. Furthermore, only interventions lasting more than six months were associated with statistically significant weight reductions, supporting previous literature that emphasizes the importance of long-term adherence to physical activity programs for achieving and sustaining benefits[10].

Despite the low statistical heterogeneity observed, several limitations should be considered. First, the majority of included studies focused on aerobic training, with only one study assessing resistance training and one evaluating combined training. This precludes comparative analysis across exercise modalities. Second, intervention fidelity, adherence, and progression were poorly reported, limiting our ability to analyze the impact of training quality. Third, body composition was primarily assessed through BMI, BW, and WC, with no use of imaging methods or fat mass quantification, which may have underestimated relevant physiological adaptations. Although a comprehensive and systematic search strategy was employed, this review was limited to articles published in English with available full text, potentially introducing language bias.

6. Recommendations

The present findings support the recommendation of long-term supervised exercise training as a strategy in the management of overweight and obesity. The effectiveness of exercise in reducing BW and WC highlights its value as a non-pharmacological intervention. Future studies should address gaps in the current literature by including more trials on resistance and combined training, using more precise assessments of body composition, and ensuring transparent reporting of adherence and progression. Moreover, trials with longer follow-up periods are needed to evaluate the sustainability of these effects.

7. Conclusion

In conclusion, this meta-analysis of randomized clinical trials indicates that long-term structured exercise training is associated with modest but clinically relevant reductions in BW and WC among adults with overweight or obesity. These findings support the implementation of exercise interventions lasting at least 24 weeks as a key strategy in obesity management. Given the absence of significant changes in BMI, future research should prioritize more precise assessments of body composition and investigate the differential effects of exercise modalities across age groups and intervention durations.

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Author contributions: PJS and JMF contributed to the design of the review and completion of the search strategy. VMS and PJS completed data screening and data extraction. VMS was responsible for the meta-analysis. VMS, JMF drafted the article. All authors edited and revised the article and approved the final version of the article. Vinícius Mallmann Schneider received a scholarship from Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) - finance code 001. The funders did not have a role in the study design, data collection, analysis, interpretation of results, or the manuscript.

Conflict of Interest Statement

The authors declare no conflicts of interest.

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References

1. Finucane MM, Stevens GA, Cowan MJ, et al. National, regional, and global trends in body-mass index since 1980: systematic analysis of health examination surveys and epidemiological studies with 960 country-years and 9·1 million participants. *Lancet* 2011; 377: 557-567. 2011/02/08. DOI: 10.1016/s0140-6736(10)62037-5.
2. de Oliveira ML, Santos LM and da Silva EN. Direct healthcare cost of obesity in brazil: an application of the cost-of-illness method from the perspective of the public health system in 2011. *PLoS One* 2015; 10: e0121160. 2015/04/02. DOI: 10.1371/journal.pone.0121160.
3. Hammond RA and Levine R. The economic impact of obesity in the United States. *Diabetes Metab Syndr Obes* 2010; 3: 285-295. 2010/01/01. DOI: 10.2147/dmsott.S7384.
4. Garvey WT, Mechanick JI, Brett EM, et al. American Association of Clinical Endocrinologists and American College of Endocrinology Comprehensive Clinical Practice Guidelines for Medical Care of Patients with Obesity. *Endocr Pract* 2016; 22 Suppl 3: 1-203. 2016/05/25. DOI: 10.4158/ep161365.Gl.
5. Sardi BV, Pereira CA, Salgueiro GR, et al. Impacto Da Cirurgia Bariátrica No Perfil Lipídico E Glicêmico Em Pacientes Obesos: Coorte Histórica. *Bioscience* 2022; 80: 4. DOI: 10.55684/80.2.4.
6. Wadden TA, Webb VL, Moran CH, et al. Lifestyle modification for obesity: new developments in diet, physical activity, and behavior therapy. *Circulation* 2012; 125: 1157-1170. 2012/03/07. DOI: 10.1161/circulationaha.111.039453.

7. Powell-Wiley TM, Poirier P, Burke LE, et al. Obesity and Cardiovascular Disease: A Scientific Statement From the American Heart Association. *Circulation* 2021; 143: e984-e1010. DOI: 10.1161/CIR.0000000000000973.
8. Barry VW, Baruth M, Beets MW, et al. Fitness vs. fatness on all-cause mortality: a meta-analysis. *Prog Cardiovasc Dis* 2014; 56: 382-390. 2014/01/21. DOI: 10.1016/j.pcad.2013.09.002.
9. Oppert J-M, Ciangura C and Bellicha A. Physical activity and exercise for weight loss and maintenance in people living with obesity. *Reviews in Endocrine and Metabolic Disorders* 2023; 24: 937-949. DOI: 10.1007/s11154-023-09805-5.
10. Petridou A, Siopi A and Mougios V. Exercise in the management of obesity. *Metabolism* 2019; 92: 163-169. 2018/11/06. DOI: 10.1016/j.metabol.2018.10.009.
11. Carpenter R and Gilleland D. Impact of an exercise program on adherence and fitness indicators. *Applied Nursing Research* 2016; 30: 184-186. DOI: https://doi.org/10.1016/j.apnr.2015.10.007.
12. Rodrigues F, Teixeira D, Macedo R, et al. O Papel Do Divertimento E Das Determinantes Motivacionais Na Persistência Da Prática De Exercício Físico. *Ciência & Saúde Coletiva* 2021; 26: 5303-5313. DOI: 10.1590/1413-812320212611.3.01832020.
13. Khalafi M, Symonds ME, Maleki AH, et al. Combined versus independent effects of exercise training and intermittent fasting on body composition and cardiometabolic health in adults: a systematic review and meta-analysis. *Nutrition Journal* 2024; 23: 7. DOI: 10.1186/s12937-023-00909-x.
14. Ross R, Neeland IJ, Yamashita S, et al. Waist circumference as a vital sign in clinical practice: a Consensus Statement from the IAS and ICCR Working Group on Visceral Obesity. *Nature Reviews Endocrinology* 2020; 16: 177-189. DOI: 10.1038/s41574-019-0310-7.
15. Cumpston M, Li T, Page MJ, et al. Updated guidance for trusted systematic reviews: a new edition of the Cochrane Handbook for Systematic Reviews of Interventions. *Cochrane Database Syst Rev* 2019; 10: Ed000142. 2019/10/24. DOI: 10.1002/14651858.Ed000142.
16. Page MJ, McKenzie JE, Bossuyt PM, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *Bmj* 2021; 372: n71. 2021/03/31. DOI: 10.1136/bmj.n71.
17. Higgins JPT, Altman DG, Gøtzsche PC, et al. The Cochrane Collaboration's tool for assessing risk of bias in randomised trials. *BMJ* 2011; 343: d5928. DOI: 10.1136/bmj.d5928.
18. Klein S, Allison DB, Heymsfield SB, et al. Waist circumference and cardiometabolic risk: a consensus statement from Shaping America’s Health: Association for Weight Management and Obesity Prevention; NAASO, The Obesity Society; the American Society for Nutrition; and the American Diabetes Association. *The American Journal of Clinical Nutrition* 2007; 85: 1197-1202. DOI: 10.1093/ajcn/85.5.1197.

19. Heymsfield SB, Peterson CM, Thomas DM, et al. Why are there race/ethnic differences in adult body mass index-adiposity relationships? A quantitative critical review. *Obes Rev* 2016; 17: 262-275. 2015/12/15. DOI: 10.1111/obr.12358.
20. Reis JP, Macera CA, Araneta MR, et al. Comparison of overall obesity and body fat distribution in predicting risk of mortality. *Obesity (Silver Spring)* 2009; 17: 1232-1239. 2009/02/07. DOI: 10.1038/oby.2008.664.
21. Areta JL, Taylor HL and Koehler K. Low energy availability: history, definition and evidence of its endocrine, metabolic and physiological effects in prospective studies in females and males. *Eur J Appl Physiol* 2021; 121: 1-21. 2020/10/24. DOI: 10.1007/s00421-020-04516-0.
22. Papadopoulou SK. Sarcopenia: A Contemporary Health Problem among Older Adult Populations. *Nutrients* 2020; 12 2020/05/07. DOI: 10.3390/nu12051293.

Appendixes

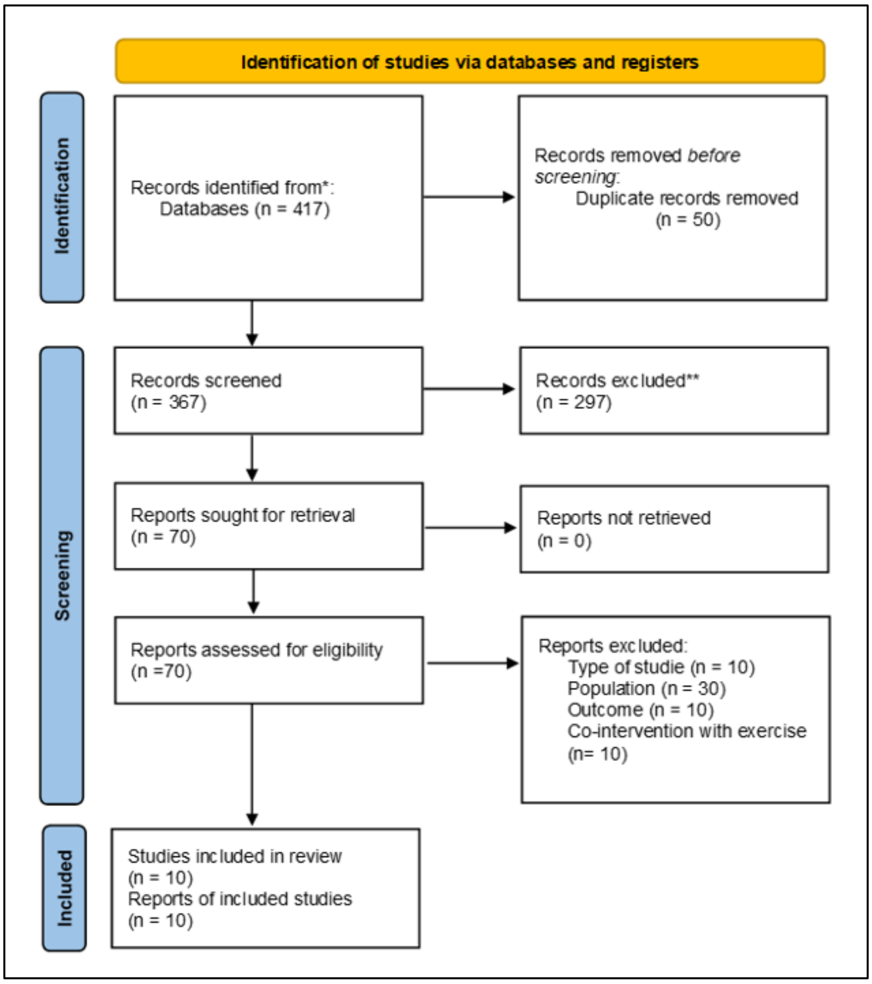

Figure 1: Fluxogram of selection studies

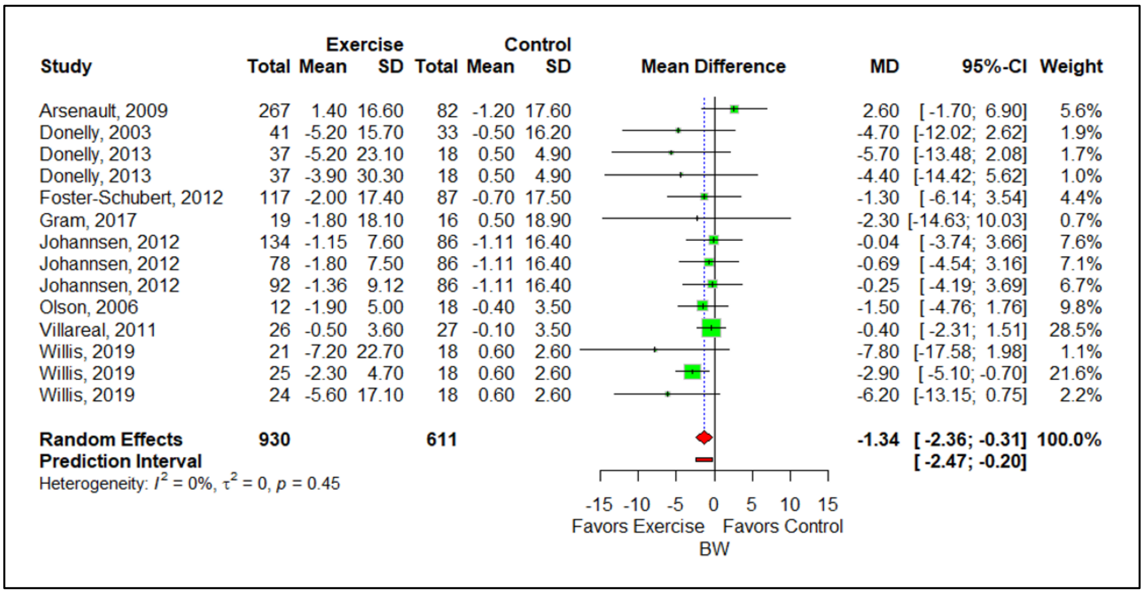

Figure 2: Random-effects meta-analysis of the effects of exercise training compared to control on the reduction of body weight (BW)

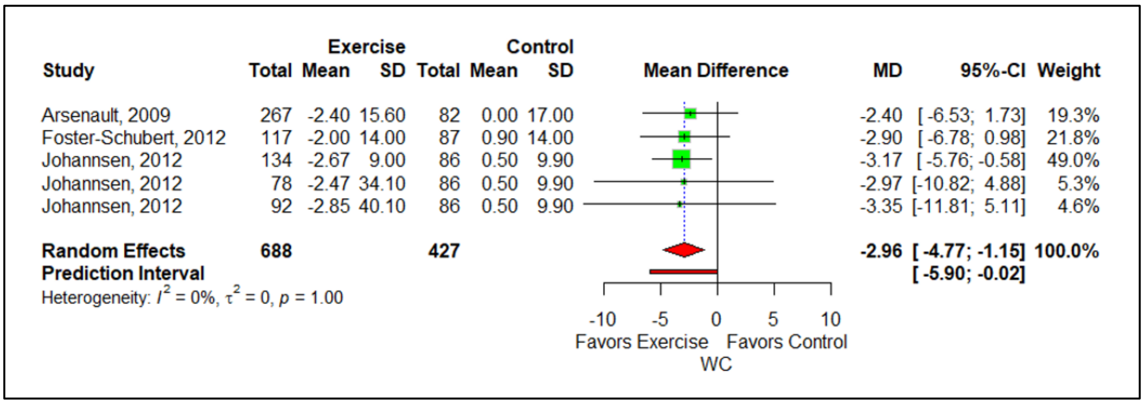

Figure 3: Random-effects meta-analysis of the effects of exercise training versus control on waist circumference (WC) reduction

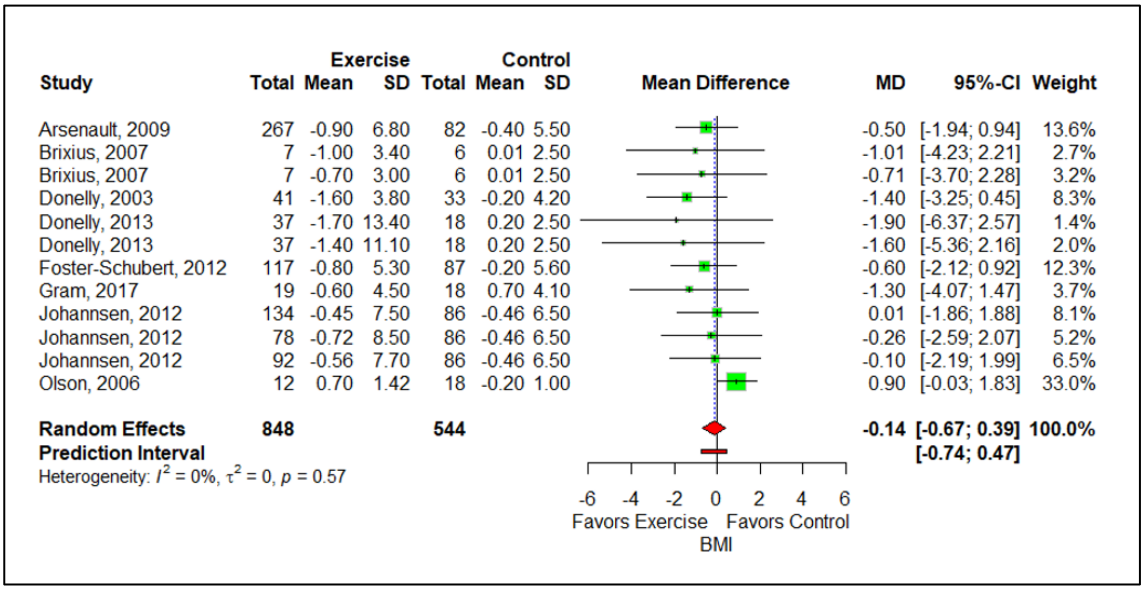

Figure 4: Random-effects meta-analysis of the effects of exercise training versus control on body mass index (BMI)