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# The effects of physical activity interventions on preventing weight gain and the effects on body composition in young adults with intellectual disabilities: Systematic review and meta-analysis of randomised controlled trials.

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**Keywords:** Physical activity; Intervention; Intellectual disabilities; Body composition; Meta-analysis.

**Running title:** Physical activity, weight gain and body composition

**Acknowledgements**

We would like to thank Dr Gonzalez-Aguero for providing individual data for his studies to allow this secondary data analysis to be conducted.

**Conflict of Interest statement**

The authors declare that they have no conflicts of interest.

## [1]Abstract

**Purpose**: To examine the literature on randomised controlled trials examining the efficacy of physical activity interventions to prevent weight gain and the effects on body composition in young adults with intellectual disabilities.

**Methods:** A systematic search of Medline, Emabse, CINHAL, PsychINFO, Cochrane library and ERIC was conducted from 1946 to September 2014. Eligibility criteria included; randomised controlled trials of a physical activity intervention: objective measure of body weight and body composition; young adults (age range 16-24 years) with intellectual disabilities.

**Results:** Six studies met the eligibility criteria. The interventions varied in their prescription of physical activity including aerobic and strength based activities. The mean duration of the interventions was 15.3 (range 10-21 weeks). There was no significant effect of physical activity interventions on body weight (weighted mean difference: -0.17 kg, 95% confidence interval, -1.04 kg to 0.72 kg) and body composition outcomes.

**Conclusion:** The meta-analysis showed that physical activity interventions did not prevent weight gain in young adults with intellectual disabilities. Published studies are inadequate to form firm conclusions. Future longer term studies of interventions specifically designed for this population group are required to elucidate the effects of physical activity interventions on body composition and the prevention of weight gain in young adults with intellectual disabilities.


## Introduction

The prevention of obesity is a major public health priority internationally (1). There is clear evidence of the negative impact of excess body weight on health, increasing the risk of chronic diseases such as cardiovascular disease (2), some cancers (3) and type II diabetes (4). The transition from adolescence to young adulthood is recognised as a particularly high risk period for weight gain (5). This period is

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[1] **Abbreviations**

CI: Confidence intervals; BMI: Body mass index; PRISMA: Preferred reporting items for systematic reviews and meta-analysis; Pedro: Physiotherapy evidence database; WMD: Weighted mean difference; SD: Standard deviation; DEXA: dual energy X-ray absorptiometry.

associated with unhealthy lifestyle characteristics such as a decline in diet quality and decreased physical activity levels (6). This is of concern as once adoption of these unhealthy lifestyle patterns and obesity is established it is shown to continue into adulthood and increase early mortality (7).

Young adults with intellectual disabilities, defined as significant limitations both in intellectual functioning and in adaptive behaviour (including everyday social and practical skills), with onset before the age of 18 years (8), have continuously been reported to have high rates of overweight and obesity (9-11), be less physically active and adopt more sedentary lifestyles than the general population (12). In a population based study, the prevalence of obesity in young adults with intellectual disabilities aged 16-24 was reported to be 28.1%, compared to 10.5% in a comparison sample of young adults who did not have intellectual disabilities (Odds Ratio = 3.37, 95% Confidence Interval (CI) 2.12, 5.37) (9). The prevention of unhealthy weight gain and obesity is therefore a priority for health care and particularly important for young adults with intellectual disabilities (13).

Physical activity is considered an important strategy to prevent weight gain due to its pivotal role in energy balance and the regulation of body weight, through increased energy expenditure (14-16), improved appetite control and reduced energy intake (17, 18). However, despite the negative impact of obesity on health there is a limited evidence-base to inform the management of obesity in individuals with intellectual disabilities (19). The available evidence on physical activity research in individuals with intellectual disabilities has primarily focussed on addressing cardiorespiratory fitness (12, 20, 21). The effects of physical activity interventions on body weight and composition have been recently reviewed; however, these studies included heterogeneous populations including studies involving children adolescents and adults and studies with varying methodological design (22, 23).

In order to provide an evidence-base of the effects of physical activity interventions and provide insight into the development of future studies within the field, it is important that reviews are based on quality randomised controlled trials which aim to eliminate bias and provide an accurate estimate of the intervention effect (24). The main aim of this review is to systematically assess the literature on randomised

controlled trials on the effects of physical activity interventions to prevent weight gain in young adults with intellectual disabilities. Specific objectives also include the evaluation of the effect of physical activity interventions on body composition outcomes (body mass index (BMI), waist circumference, percentage body fat, fat-mass and lean-mass in young adults with intellectual disabilities.

## Methods

This study was conducted in accordance with the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) (25).

### Search strategy

A literature search of the following six electronic databases was conducted from the inception (1946) to and including September 2014: Medline, Embase, CINHAL, PsychINFO, Cochrane library and ERIC. Key words included intellectual disabilities, mental retardation, physical activity, obesity, body weight changes. For the full Medline search strategy, which was adapted for other databases please see Appendix A. The literature search also included hand searching of reference lists of retrieved studies, key journals and systematic reviews.

### Eligibility criteria

The study selections for this review were assessed as eligible by the following inclusion criteria:

- Participants diagnosed with intellectual disabilities;
- Physical activity as a single component intervention;
- Randomised controlled trial study design;
- Included young adults across the age range 16-24 years;
- Studies had to report a specific objective measure of body weight and could include measures of body composition (i.e. BMI, waist circumference, percentage body fat at baseline and follow up).

Studies not published in English language journals were not included for consideration in this review.

**Study selection**

The first author performed the literature search and removed the duplicates. The titles and abstracts were screened and potentially relevant studies were identified. Articles were obtained in full text and were assessed by all reviewers for inclusion. Consensus on included studies was agreed and the final list of studies included in this review.

**Data extraction**

Relevant data from studies was extracted by one reviewer (LH) for assessment of methodology quality and data synthesis. Study details included:

- Author, title, year of publication
- Participants' characteristics
- Research question
- Intervention (i.e. mode of physical activity, frequency, intensity, and duration)
- Outcome measures (anthropometric outcomes i.e. body weight, BMI, waist circumference, percentage body fat, fat-mass and lean mass)
- Results (pre-post means ± S.D for each outcome measure).

**Rating of methodology quality**

Assessment of methodological quality of included studies was performed using the Physiotherapy Evidence Database (PEDro) scale (26, 27). The PEDro scale was developed to assist clinical decision making by identifying studies that are more likely to be valid (26). The PEDro Scale consists of an 11 item checklist designed to score the quality of randomised controlled trials. The first item is a measure of a study's external validity. This is not included in the final calculation of the PEDro score of the study. Internal validity is determined by the remaining 10 items. These items are rated as either a yes or no score. The total ''yes'' score out of 10 determines the overall PEDro score of that study. The individual items rated for each study were as follows: 1) specified eligibility criteria; 2) random allocation of participants; 3) concealment of participant allocation; 4) baseline similarity between groups; 5) blinding of all participants; 6) blinding of all therapists administering the intervention; 7) blinding of all assessors who measured at least one key outcome: 8) measurement of at least one key outcome being obtained by more than 85% of the participants; 9) following up on intention to treat analysis; 10) reporting of results of between group

statistical comparisons for at least one key outcome; and 11) providing both point measures and measures of variability for at least one key outcome. The papers were rated independently by two authors (LH, CM) who then compared ratings and discussed any discrepancies with the second author (CH) to come to a consensus and final score.

**Data synthesis and analysis**

The effect size for each outcome was calculated as the difference in the mean change in the outcome (e.g. body weight) in the intervention group minus the mean change in the outcome in the control group (28). All main authors on the primary studies were contacted. Two studies provided their raw data on individual participants for all relevant outcomes (29, 30). Their data was used to calculate a correlation coefficient from the variance of pre and post intervention data and the variance of the mean change in outcome variable. In studies which included more than one treatment group, groups were combined (sample size, mean and standard deviation from both groups to form a single group) to create a single pair-wise comparison, and to prevent multi-comparisons and a unit-of-analysis error. Sensitivity analysis was performed varying the correlation coefficient from 0.5 to 0.98 to examine the validity of the results. The study findings for each outcome were pooled using the random effects model (31). Statistical heterogeneity for each outcome was assessed by Cochrane's Q statistic, with $p < 0.05$ indicating evidence of statistical heterogeneity. The degree of heterogeneity was measured by the $I^2$ statistic, with $I^2$ e 50% indicating substantial heterogeneity (32). Meta-analysis was performed using Comprehensive Meta-analysis (Version 2.0 for Windows).

**Results**

**Literature Search**

Figure 1 illustrated the results of the search strategy and process of study selection. A total of 2371 studies were initially identified, 587 duplicated were removed and 1770 articles excluded on reviewing the title and abstract as they were obviously irrelevant i.e. did not study participants with intellectual disabilities, did not implement a physical activity intervention. Of the remaining full text articles (n = 14), six met the inclusion criteria and are presented in this review.

********** Insert figure 1 about here**********

**Study characteristics**

A summary of study characteristics of included studies are presented in table 1. All the included studies were published after the year 2000. Three studies were conducted in Spain (29, 30, 33), two studies in Belgium (34, 35), and one in Portugal (36). A total of 178 participants were recruited across the six studies, with a mean total sample size of 30 (range 16-54) participants. Participants' ages ranged from 10 to 30 years and were classified as normal weight to overweight and obese across studies. Participants were diagnosed with mild to moderate level of intellectual disabilities. Four studies included participants with Down syndrome only (29, 30, 33, 36). Two studies did not exclude individuals with Down syndrome, but none of the participants in the study were diagnosed with Down syndrome (34, 35).

********** Insert table 1 about here**********

**Methodological quality**

Table 1 illustrates the PEDro scores for the studies included in this review (n = 6). Five studies were considered to have high methodology quality (a score of six or above) and one study was considered to have fair methodological. Only two studies provided the eligibility criteria of the participants (30, 36). Allocation concealment method and blinding of subjects and therapists who delivered the intervention were not fulfilled in any study. All studies provided information on following up with intention to treat, between group comparisons and point estimates and variability. In addition, to the criteria assessed by the PEDro scale, none of the studies reported a sample size calculation and consisted of small samples which may affect the power of the analysis.

**Physical activity interventions**

Seven types of interventions were prescribed in the included studies, including: a bicycle ergometer intervention and an aerobic training program (34); strength and endurance training intervention (35); conditioning and plyometric jumps training (29); whole body vibration (WBV) which included isometric exercise (30); an aerobic treadmill ergometer intervention (33) and an aerobic rowing ergometer intervention

(36). The mean duration of intervention programs was 15.3 weeks (range 10-21 weeks). The frequency of physical activity sessions was two to three sessions per week for a duration range of 5-65 minutes across studies. The aerobic training component of the interventions was predominately performed at moderate to vigorous intensities (55-75% heart rate reserve or peak heart rate). Strength/conditioning based exercise was performed only in two studies. The intensity varied between individualised based on a participant's capacity (29), to a set intensity of 60-80% of 1RM for three sets of 10 repetitions (35).

**Effects of physical activity interventions**

The effect sizes, weighted mean difference (WMD), are presented in table 2. The random effects model was used to estimate the effect size for all outcomes of body weight and body composition.

**Body weight**

All studies assessed the effect of physical activity on body weight. Five studies were included in the meta-analysis. In these studies physical activity interventions had no effect on body weight (WMD -0.17 kg, 95% CI -1.04 kg to 0.72 kg; P = 0.71), in comparison with the control group (figure 2). There was no statistical heterogeneity in body weight ($I^2 = 24.19$ %).

********** Insert figure 2 about here**********

**Sensitivity Analysis**

Estimates of the effect sizes were calculated using an estimated correlation coefficient for each outcome. Varying the correlation coefficient from 0.5 to 0.98 (correlation coefficient used for the estimate for body weight) did not result in any statistical difference (P = 0.36) between the summary effect (WMD -0.19 kg; 95% CI -4.26 to 03.89) to (WMD -0.17 kg, 95% CI -1.04 kg to 0.72 kg), respectively. This was repeated for all outcomes, with no significant change in the estimate of the weighted effect size (P > 0.05).

**Body mass index**

Four studies investigated BMI as an outcome. The pooled effect size illustrated that physical activity had no effect on BMI (-0.07 kg/m$^2$, 95% CI -0.64 kg/m$^2$ to 0.51 kg/m$^2$; P = 0.82) in comparison to the control group. This results is statistically heterogeneous ($I^2$ = 75.05%).

**Body composition outcomes**

Measures of body composition reported in the included studies were waist circumference, percentage body fat, fat-mass and lean-mass. The overall findings for effects of physical activity interventions were insignificant for all outcomes (table 2) Substantial heterogeneity was found for outcomes waist circumference, percentage body fat and fat-mass ($I^2$ e 50). For forest plots of BMI and all body composition outcomes see Appendix C.

********** Insert table 2 about here**********

The difference in mean change in body composition outcomes within-groups (intervention and control) are presented in table 3. For the purpose of this review clinically significant weight loss and weight maintenance is defined using the recommendation by Stevens *et al.*, (37) as greater than 5 % and less than 3 % change in body weight, respectively. The participants in the physical activity interventions for all studies maintained their body weight over the intervention period. The participants in the control group also maintained their body weight over the study period.

********** Insert table 3 about here**********

**Discussion**

This study reviewed the effects of physical activity interventions on the prevention of weight gain and effects on body composition in young adults with intellectual disabilities. Overall, relatively few published studies were designed to engage young adults in physical activity. None of the studies identified through systematic

searching of the available evidence and the studies included in this review were specifically designed to prevent weight gain.

The meta-analysis indicates that physical activity interventions did not significantly change body weight or BMI in young adults with intellectual disabilities. Possible explanations for the limited effects of physical activity interventions could be attributed to the "dose" of physical activity prescribed in some interventions. The weekly amount of physical activity prescribed in the randomised controlled trials included varied from 80 to 195 minutes per week. Evidence based guidelines recommends that physical activity of 150-250 minutes per week with an energy equivalent of 1200 to 2000 kcal per week is effective to prevent weight gain (38). Only two studies included in this review met current physical activity recommendations (33, 35). This is consistent with the available evidence in that adults with intellectual disabilities engage in low levels of physical activity (20, 39). The barriers reported for participation in physical activity for individuals with intellectual disabilities include a lack of understanding of the benefits or regular physical activity, a lack of awareness of available physical activity options, financial limitations and limited transport and staffing (40, 41). It is important that future studies are developed that take into consideration these barriers and aim to overcome the difficulties for adults with intellectual disabilities in participating in regular physical activity.

In addition, the physical activity interventions were relatively short in duration, average duration of 15.3 (SD 4.0) weeks. This may be typical in exercise science research, as approximately 12 weeks duration or less is sufficient for physiological adaptations and improvements in central aspects of fitness such as cardiorespiratory fitness and metabolic health (42). However, this duration is insufficient in terms of altering body weight. It is recommended by clinical guidelines that a one year intervention period is necessary to examine weight maintenance and the efficacy of an intervention (43, 44). None of the included studies examined long term follow-up measurements.

Participants in both the treatment and control group were clinically defined as maintaining their body weight (± 3 % of initial body weight) for the study period.

Therefore, the first research question, do physical activity interventions prevent weight gain in young adults with intellectual disabilities cannot be addressed by the current available evidence due to the limited changes in body weight gain in the control group. However, research in the general population has shown that participants not receiving any intervention will gain weight over time (45, 46). This is generally accepted to occur at a rate of 0.5-1 kg per year. Therefore, it can be assumed that changes in increasing body weight reported in young adults with intellectual disabilities in the control groups (not statistically significant) in this short time period are likely to continue if examined over a longer duration. The importance of participating in regular physical activity to maintain body weight should therefore be encouraged as this is associated with a reduction in other health risk factors aside from excess body weight (47, 48).

The effects of physical activity interventions on other measures of body composition were inconsistent. Although subgroup analysis was not performed due to the limited number of studies and inadequate quantity of data to calculate the effect size to explore heterogeneity in a meaningful way, these differences in part may be explained by differences in the mode of physical activity. The mode of physical activity investigated across studies, included aerobic based interventions, combinations of strength and endurance, plyometric and conditioning and isometric exercises. Significant improvements were seen when studies included aerobic based physical activity in their intervention (34, 35). However, these were negated when predominantly resistance based studies (29, 30) were included in the weighted analysis. This is consistent with the available literature that suggests that resistance type physical activity plays a limited role in maintaining body weight (38).

The heterogeneity in results may be further explained by the measurement techniques applied to estimate body composition outcomes. Percentage body fat, fat and lean mass were estimated using bio-electrical impedance analysis (33 - 35), dual energy X-ray absorptiometry (DEXA) (29, 30) and by anthropometric techniques (36). The heterogeneity in results due to the different methodology used is in agreement with the reviews by Casey & Rasumssen (22), reporting the effects of physical activity on percentage body fat in individuals with intellectual disabilities and Maiano and

colleagues (59) investigating the effect of lifestyle interventions on body composition in youth with intellectual disabilities.

It was interesting that the majority of studies identified included only participants with Down syndrome. Individuals with Down syndrome have been reported to have suboptimal levels of cardiorespiratory fitness (50), reduced muscle mass and increased adiposity (51) that could affect their participation in physical activity and thus the effectiveness of physical activity interventions (52). However, individuals with Down syndrome make up only a small proportion of young adults with intellectual disabilities. Many young adults with intellectual disabilities who do not have Down syndrome experience high rates of obesity and low levels of physical activity. Therefore, physical activity researchers need to have a broader interest in the health and wellbeing of all young adults with intellectual disabilities.

This review is primarily focussed on the effects of physical activity interventions on body weight and composition; however, it is important to note that the included studies reported improvements in central aspects of fitness such as cardiorespiratory fitness and metabolic health (33-35). This is particularly pertinent to young adults with intellectual disabilities who have reported to have lower levels of cardiorespiratory fitness (53, 54) and increased health needs in comparison to the general population (55).

**Strengths and limitations**

To our knowledge, this is the first review to address a strategy for weight gain prevention research in individuals with intellectual disabilities. A key strength of this review is the inclusion of randomised control trials only. Observational studies of physical activity are often affected by methodological issues. These comprise measurement errors of physical activity, un-measurable confounding factors and reverse causality. Furthermore, this meta-analysis adds to the available evidence on the efficacy of physical activity interventions on body composition by providing a more reliable estimate of the effect size of physical activity interventions than existing narrative reviews.

This review is limited in that articles not published in English were not included, therefore potentially excluding studies fulfilling the eligibility criteria. The

heterogeneity of the sample population in age range limits the generalizability of results specific to young adults aged 16-24. None of the studies specifically targeted young adults, instead including a wide range from children to older adults. This makes it difficult to draw conclusions specifically for this target population, as children included around the ages nine and 11 years of age (girls and boys, respectively) will be going through the pubertal growth spurt and subject to changes in body composition aside from any effects from physical activity. Furthermore, interventions targeted at this age group such as school based physical activity interventions may not be appropriate to young adults who are experiencing a change in their lifestyle including environmental and social settings. In addition, it is unlikely that interventions developed for older adults will be transferable to young adults with intellectual disabilities.

Sample heterogeneity of the included studies also extends to the weight status of the participants. Studies included participants classified clinically as normal weight, overweight and obese. It is therefore difficult to compare studies as obese individuals may require a distinct approach in the prescription of physical activity. Obese individuals are likely to have lower levels of physical fitness and require an alternative strategy to tackle unhealthy weight gain, through a treatment approach in the reduction of body weight. A combination of physical activity plus a dietary intervention may need to be considered to help them lose weight as the role of physical activity on its own for weight loss in individuals with intellectual disabilities, as for other adults from the general population, is only modest (19).

**Implications for future research**

Due to the high rates of overweight and obesity and the low levels of physical activity observed in young adults with intellectual disabilities, there is a need for research to examine whether interventions can support young adults to be more active and maintain a healthy body weight. The studies presented in this review are structured physical activity interventions, which consist of a repetitive set format which is heavily dependent on trained experts to supervise and deliver the intervention. Due to the barriers discussed previously, long term adherence to such interventions is generally considered not to be sustainable in everyday life for individuals with intellectual disabilities. For example Cluphf *et al.*, (56) reported following their

aerobic based interventions (six weeks duration), participants did not continue to participate in regular physical activity. An alternative format of physical activity is lifestyle physical activity, which can include all activities an individual can perform during the course of a day, with accumulating effects on increased energy expenditure (42). Research has shown that higher levels of lifestyle physical activity can prevent initial weight gain (42). Thus, considering the reported barriers to participation in regular physical activity and the poor attrition rates reported in some studies (29) this should be considered as an alternative approach to meet the needs of adults with intellectual disabilities and engage them in regular physical activity participation.

## Conclusion

This review has illustrated the lack of evidence of physical activity interventions specifically designed for young adults with intellectual disabilities. The meta-analysis found that physical activity interventions in young adults with intellectual disabilities did not prevent weight gain or improve body composition. This is due to limitations of the published studies, implementing inadequate duration and dose of the interventions. Although there was no significant effect of physical activity on body weight, physical activity interventions improved health risk factors, which is important for this population group, to prevent health inequalities in later life. Future high quality, adequately powered randomised controlled trials, with a long term intervention and follow up period are required to elucidate the effects of physical activity interventions on the prevention of weight gain and body composition in young adults with intellectual disabilities.

**Authors' contributions**

LH carried out the review and drafted the manuscript. LH, CH and CM reviewed the full text of studies for inclusion. LH and CM rated the studies for methodology quality and reviewed any discrepancies with CH to come to a consensus. All authors read and approved the final manuscript.

**Table and figure legends:**

Table 1: Summary of randomised controlled trials of physical activity interventions.

Table 2: Pooled random effects analysis of effect size (WMD) of outcomes.

Table 3: Changes in weight and body composition of included studies.

Table 4: Quality assessment (PEDro score) of included studies.

Figure 1: Study selection process.

Figure 2: WMD in body weight (kg) between the intervention groups and the control groups.

Figure 3: WMD in BMI (kg/m$^2$) between the intervention groups and the control groups.

Figure 4: WMD in waist circumference (cm) between the intervention groups and the control groups.

Figure 5: WMD in percentage body fat (%) between the intervention groups and the control groups.

Figure 6: WMD in fat-mass (kg) between the intervention groups and the control groups.

Figure 7: WMD in lean-mass (kg) between the intervention groups and the control groups.

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Table 1: Summary of randomised controlled trials of physical activity interventions.

| **Reference** | **Study Population** | **Intervention** | | **Anthropometric Outcomes** | **Quality Rating (PEDro Scale)** |
|---|---|---|---|---|---|
| Boer et al., 2013 | N = 54 adolescent and young adults<br>BMI: 27.7 ± 3.7 kg/m$^2$<br>Age: 17 ± 3.0 years<br>ID: IQ 59 ± 8.6 | **SIT:**<br>**N** = 17<br>**Mode:** Cycle ergometer<br>**Intensity:**<br>**Weeks 1-7:**<br>Sprint bouts (>100 r/min) of 15s at a resistance matching the ventilatory threshold ($VT_R$), 45s relative rest (50 r/min at $VT_R$)<br>**Weeks 8-15:**<br>Sprint bouts and relative rest increased up to 110% of $VT_R$.<br>**Duration:** 40 minutes<br>**Frequency:** 2 times/week, 15 weeks<br><br>**CAT:**<br>**N** = 15<br>**Mode:** Aerobic exercises (cycling/walking/stepping)<br>**Intensity:**<br>**Weeks 1-7:**<br>HR similar to HR at VT (60 r/min)<br>**Weeks 8-15:**<br>Increased to HR at 110% of VT.<br>**Duration:** 40 minutes<br>**Frequency:** 2 times/week, 15 weeks | **Control:**<br>**N** = 15<br>Participated in usual everyday scholar activities without supervised exercise training. | Mean change in:<br>Weight<br>BMI<br>WC<br>%BF | 7 |
| Elmahgoub et al., 2011 | N = 45 adolescents,<br>Age: 14-22 years<br>BMI: 23-48 kg/m$^2$ | **CET3:**<br>**N =** 15<br>**Mode:** Strength and endurance exercises | **Control:**<br>**N =** 15<br>Participated in the | Mean change in:<br>Weight<br>BMI | 6 |

| | | | | | |
|---|---|---|---|---|---|
| | ID: IQ 45-70 | (bicycles and cross trainers)<br><br>**Intensity:**<br>Endurance - 60% - 75% HRR<br>Strength – 60% - 80% 1 RM<br>**Duration:** 50 minutes<br>**Frequency:** 3 times/week, 10 weeks<br><br>**CET2:**<br>**N =** 15<br>**Mode:** strength and endurance exercises (bicycles and cross trainers)<br>**Intensity:**<br>Endurance - 60% - 75% HRR<br>Strength – 60% - 80% 1 RM<br>**Duration:** 50 minutes<br>**Frequency:** 2 times/week, 15 weeks | daily school activities, including physical education lessons | WC<br>Fat mass<br>Fat-free mass | |
| Gonzalez-Aguero et al., 2011 | N = 26 children and adolescents<br><br>Age: 10 – 19 years<br>ID: Down Syndrome | **N =** 13<br>**Mode:** Conditioning and plyometric jumps training<br>**Intensity:** Based in individual capacity<br>**Duration:** 20-25 minutes<br>**Frequency:** 2 times/week, 21 weeks | **N =** 15<br>**Control:** No training | Mean change in<br>Weight<br>BMI<br>%BF<br>Fat mass<br>Fat-free mass | 6 |
| Gonzalez-Aguero et al., 2013 | N = 30 adolescents<br>Age: 12 – 18 years<br>ID: Down Syndrome | **N =** 13<br>**Mode:** Isometric exercises (squat position)<br>**Intensity**:<br>**Duration:** 15-20 minutes<br>**Frequency**: 3 times/week, 20 weeks | **N =** 11<br>**Control:** No training | Mean change in<br>Weight<br>BMI<br>Fat mass<br>Fat-free mass | 5 |
| Ordonez et al., 2013 | N = 20 women<br>Age: 18-30 years<br>ID: IQ 50-69, Down Syndrome | **N =** 11<br>**Mode:** Treadmill ergometer<br>**Intensity:** 55-65% of peak HR increasing by 2.5% every 2 weeks | **N =** 9<br>**Control:** No training | Mean change in<br>WC<br>WHR<br>%BF | 6 |

| | | | | | |
|---|---|---|---|---|---|
| | | **Duration:** 45- 65 minutes<br>**Frequency:** 3 times/week, 10 weeks | | | |
| Valera et al., 2011 | N = 16 young adults<br>Age: 21.4 ± 3.0 years<br>ID: DS with mild to moderate ID | **N =** 8<br>**Mode:** Rowing ergometer<br>**Intensity:** 55-70% peak $VO_2$<br>**Duration:** 25-45 minutes<br>**Frequency:** 3 times/weeks, 16 weeks | **N =** 8<br>**Control:** No training | Mean change in<br>Weight<br>%BF | 6 |

Notes: SIT, Sprint Interval Training; CAT, Continuous Aerobic Training; COM, Combined training; CET2, Combined training twice/week; CET3, Combined training three times/week; ID, Intellectual Disabilities; IQ, Intelligent Quotient; BMI, Body Mass Index; WC, Waist Circumference; %BF, Percentage Body Fat; HR, Heart Rate; HRR, Heart Rate Reserve; 1RM, 1 Maximum repetition, V02, oxygen consumption

Table 2: Pooled random effects analysis of effect size (WMD) of outcomes.

| **Outcome** | **K** | **WMD** | **SE** | **95% CI** | | **Heterogeneity** | | |
|---|---|---|---|---|---|---|---|---|
| | | | | **Lower Limit** | **Upper Limit** | **Q** | **$I^2$** | **p-value** |
| Weight (kg) | 5 | -0.17 | 0.45 | -1.04 | 0.72 | 5.28 | 24.19 | 0.26 |
| BMI (kg/m$^2$) | 4 | -0.07 | 0.29 | -0.64 | 0.51 | 12.02 | 75.05 | 0.01 |
| Waist Circumference (cm) | 4 | -1.14 | 1.47 | -4.03 | 1.75 | 15.24 | 80.32 | 0.002 |
| Percentage Body Fat (%) | 4 | -0.44 | 0.81 | -2.03 | 1.15 | 32.40 | 90.74 | 0.001 |
| Fat-mass (kg) | 3 | -0.26 | 0.68 | -1.60 | 1.08 | 9.48 | 78.92 | 0.01 |
| Lean-mass (kg) | 3 | 0.77 | 0.43 | -0.08 | 1.62 | 5.52 | 63.79 | 0.06 |

Notes: K, Number of studies; WMD, Weighted mean difference; SE, Standard error; CI, Confidence interval: Q, Heterogeneity statistic to test homogeneity; $I^2$, Index of heterogeneity beyond within-study sampling error.

Table 3: Changes in weight and body composition of included studies.

| **Reference** | **Exercise Mode** | **Study Length** | **Intervention** | | | | | | | | **Control** | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **(weeks)** | **N** | **• Weight (kg)** | **• Weight (%)** | **• BMI (kg/m$^2$)** | **• WC (cm)** | **• %BF (%)** | **• FM (kg)** | **• LM (kg)** | **N** | **• Weight (kg)** | **• Weight (%)** | **• BMI (kg/m$^2$)** | **• WC (cm)** | **• %BF (%)** | **• FM (kg)** | **• LM (kg)** |
| Boer et al., 2013 | SIT | 15 | 17 | - 0.8 | -1.0 | -0.7 | -4.3* | -3.8* | - | - | 14 | + 0.7 | +0.9 | 0 | +0.9 | 0 | - | - |
| | CAT | | 15 | - 0.3 | -0.4 | -0.6 | -2.5* | -1.0* | | | | | | | | | | |
| Elmahgoub et al., 2011 | CET2 | 10 | 15 | - 1.0 | -1.3 | -0.3 | -4.0 | - | -2.0 | +1.0 | 15 | 0 | 0 | -0.4 | -1.0 | - | -1.0 | -1.0 |
| | CET3 | 15 | 15 | - 2.0* | -2.4 | -1.0* | -4.0* | | -2.0* | 0 | | | | | | | | |
| Gonzalez-Aguero et al., 2011 | PLY | 21 | 13 | + 1.7 | +4.2 | +0.6 | +1.2 | +0.1 | +0.4 | +1.5* | 13 | + 0.8 | +1.6 | -0.2 | -0.9 | -0.9 | -0.3 | +0.4 |
| Gonzalez-Aguero et al., 2013 | WBV | 20 | 11 | + 0.7 | +1.5 | +0.1 | -0.2 | -0.2 | 0 | +0.7 | 13 | + 0.6 | +1.2 | 0 | -0.8 | -0.6 | -0.1 | +0.5 |
| Ordonez et al., 2013 | AEROBIC | 10 | 11 | - | - | - | -3.2** | -3.9** | - | - | 9 | - | - | - | - | - | - | - |
| Valera et al., 2011 | ROWING | 16 | 8 | + 0.4 | +0.5 | - | - | -0.6 | - | - | 8 | + 0.3 | -0.5 | - | - | -0.1 | - | - |

Notes: SIT, Sprint Interval Training; CAT, Continuous Aerobic Training; COM, Combined training; CET2, Combined training twice/week; CET3, Combined training three times/week; PLY, Conditioning plus plyometric jump training; WBV, Whole body vibration training. * Significant difference between intervention versus control. **Significant difference pre-post intervention.

**Appendix A. Medline Search Strategy**

1. (intellectual* adj (disab* or disorder* or handicap* or impair* or deficien* or subnorm*)).tw.
2. (learning adj (disab* or disorder* or impair* or difficult*)).tw.
3. (development* adj (disab* or disorder* or handicap* or impair* or delay*)).tw.
4. (mental* adj (disab* or disorder* or handicap* or impair* or deficien* or subnorm* or retard*)).tw.
5. exp Intellectual Disability/
6. exp Mentally Disabled Persons/
7. Or/1-6
8. exp Exercise/
9. exp Physical Fitness/
10. exp Sports/
11. (fit* adj (regime* or program*)).tw.
12. ((moderate or vigorous*) adj3 activ*).tw.
13. (physic* adj5 (fit* or train* or active* or endur* or intervention*)).tw.
14. (exercis* adj5 (aerobic* or train* or fit* or activ* or endur or intervention*)).tw.
15. ((leisure or fitness) adj5 (centre* or center* or facility*)).tw.
16. (gym* or circuit* or aqua* or walk* or jog* or run* or swim*).tw.
17. ((cycle or cycling) adj5 (school* or work or workplace or commut* or travel* or equipment* or facility*)).tw.
18. pilates.tw.
19. weight lift* or strength train* or resistance train* or circuit train* or aerobic* train*).tw.
20. ((lifestyle or life-style) adj5 (activ* or physic*)).tw.
21. Or/8-20
22. exp Obesity/
23. exp Body Weight Changes/
24. exp Weight Gain/
25. Weight Loss/
26. obes*.tw.
27. (“weight gain” or “weight loss”).tw.
28. (overweight or “over weight” or “over-weight).tw.
29. (weight adj2 change*).tw.
30. (bmi or “body mass index”).tw.
31. ((bmi or “body mass index”) adj2 (gain or loss or change*)).tw.
32. body composition.tw.
33. Or/22-32
34. 7 and 21 and 33

35. limit 34 to (English language and humans)

**Appendix B. Rating of Methodology quality (PEDro score)**

Table 4: Quality assessment (PEDro score) of included studies.

| | **Criteria** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | Total Score |
| Boer et al., 2013 | ○ | ● | ○ | ● | ○ | ○ | ● | ● | ● | ● | ● | 7 |
| Elmahgoub et al., 2009 | ○ | ○ | ○ | ● | ○ | ○ | ● | ● | ● | ● | ● | 6 |
| Elmahgoub et al., 2011 | ○ | ○ | ○ | ● | ○ | ○ | ● | ● | ● | ● | ● | 6 |
| Gonzalez-Aguero et al., 2011 | ○ | ● | ○ | ● | ○ | ○ | ○ | ● | ● | ● | ● | 6 |
| Gonzalez-Aguero et al., 2013 | ● | ● | ○ | ● | ○ | ○ | ○ | ○ | ● | ● | ● | 5 |
| Ordonez et al., 2013 | ○ | ● | ○ | ● | ○ | ○ | ○ | ● | ● | ● | ● | 6 |
| Valera et al., 2011 | ● | ● | ○ | ● | ○ | ○ | ○ | ● | ● | ● | ● | 6 |
| Total by criteria | 2 | 5 | 0 | 7 | 0 | 0 | 3 | 6 | 7 | 7 | 7 | |

Notes: ● = fulfils PEDro criteria for the item. ○ = does not fulfil PEDro criteria for that item. For full list of each item, please refer to methods section.

**Appendix C. Forest plots of body mass index and body composition outcomes**

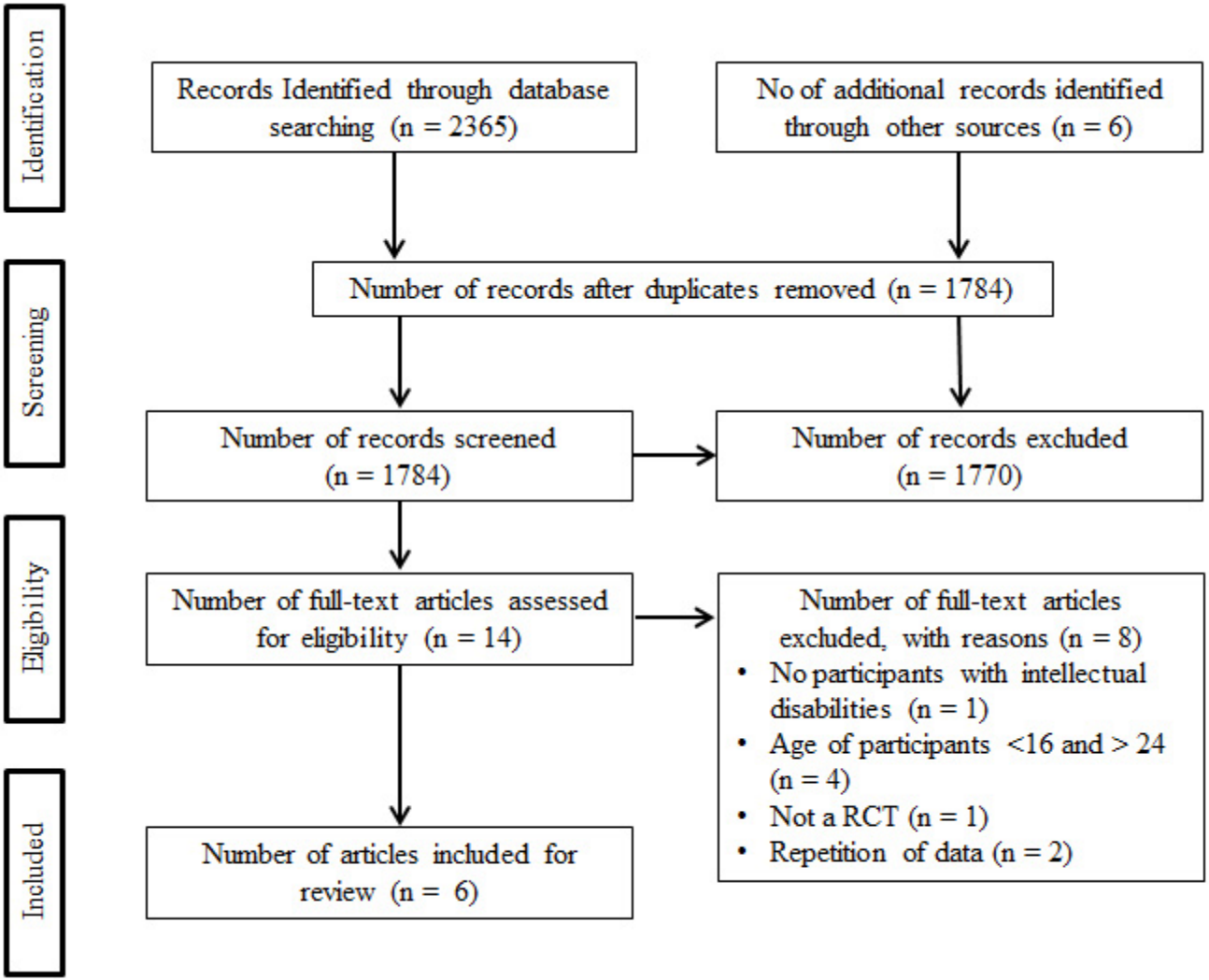
Figure 3: WMD in BMI ($kg/m^2$) between the intervention groups and the control groups.

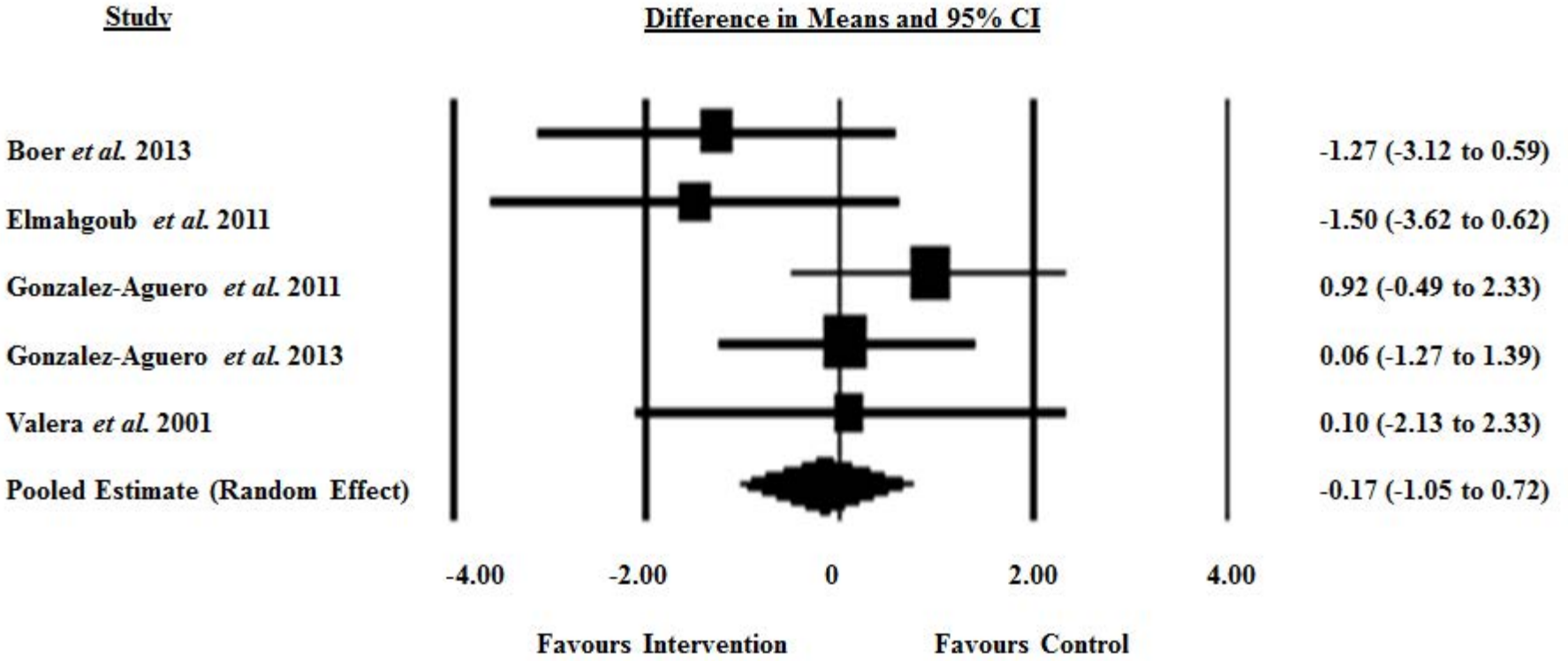
Figure 4: WMD in waist circumference (cm) between the intervention groups and the control groups.

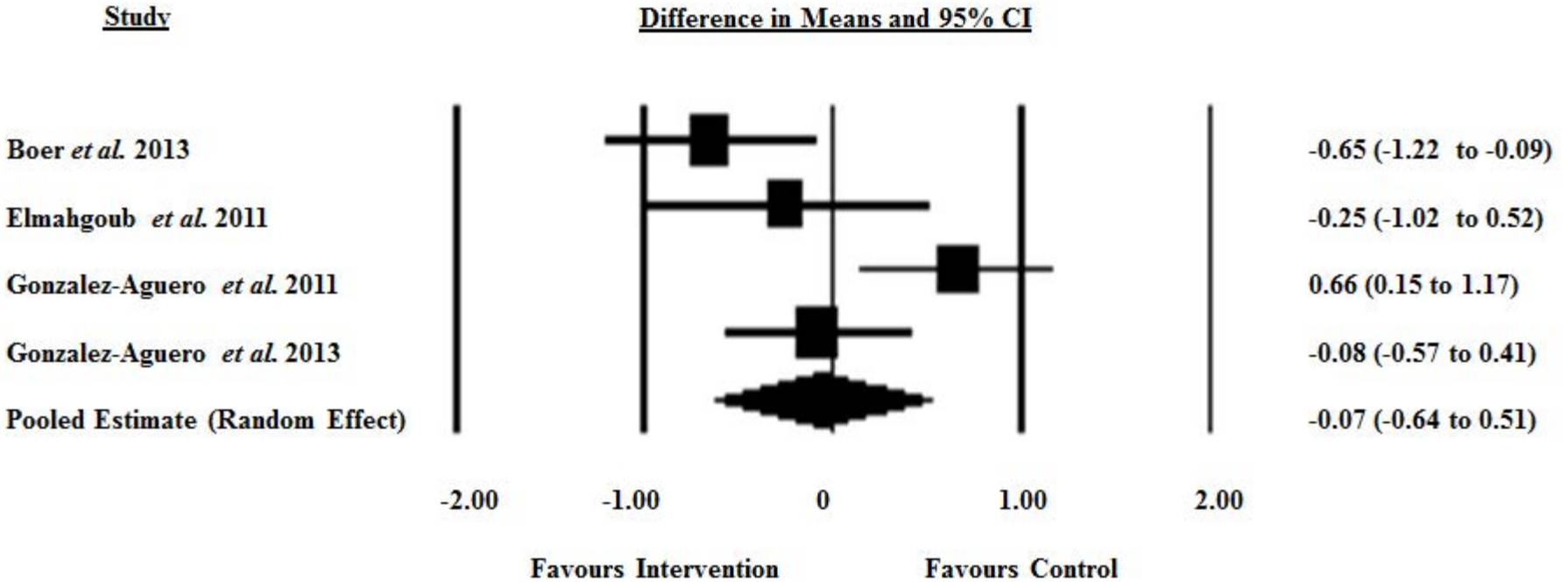
Figure 5: WMD in percentage body fat (%) between the intervention groups and the control groups.

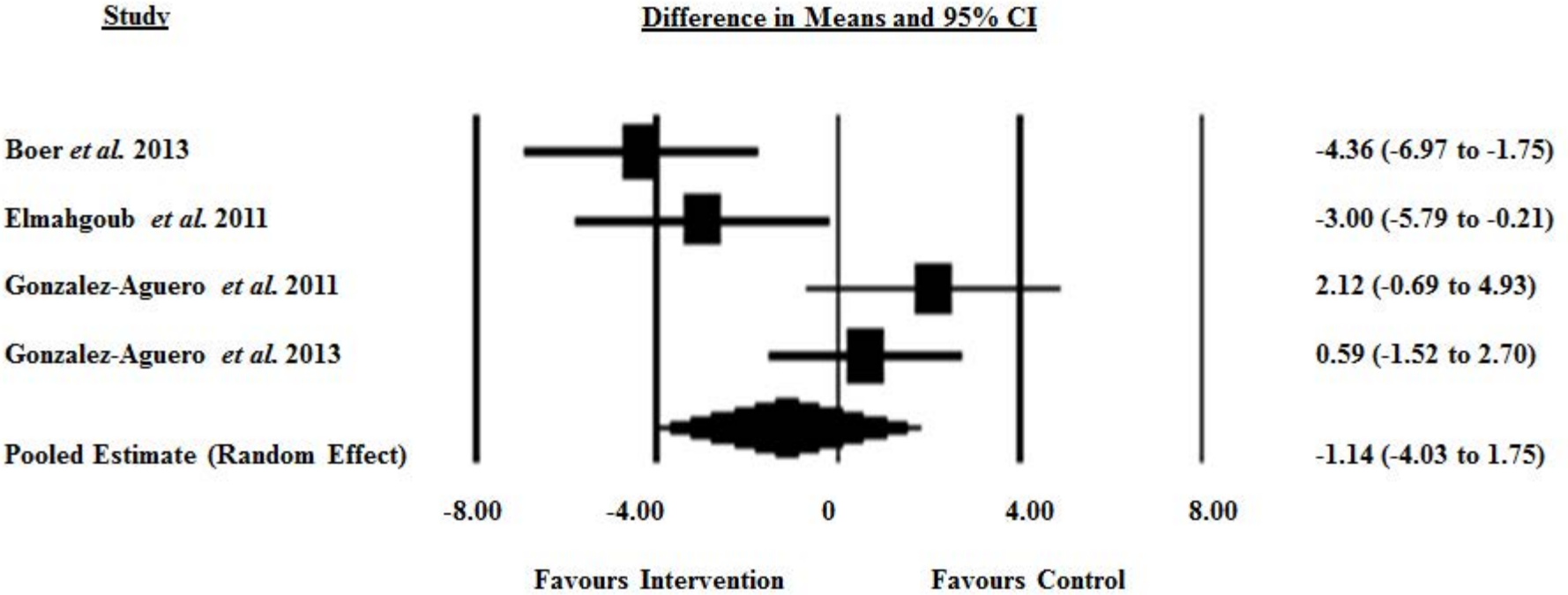
Figure 6: WMD in fat-mass (kg) between the intervention groups and the control groups.

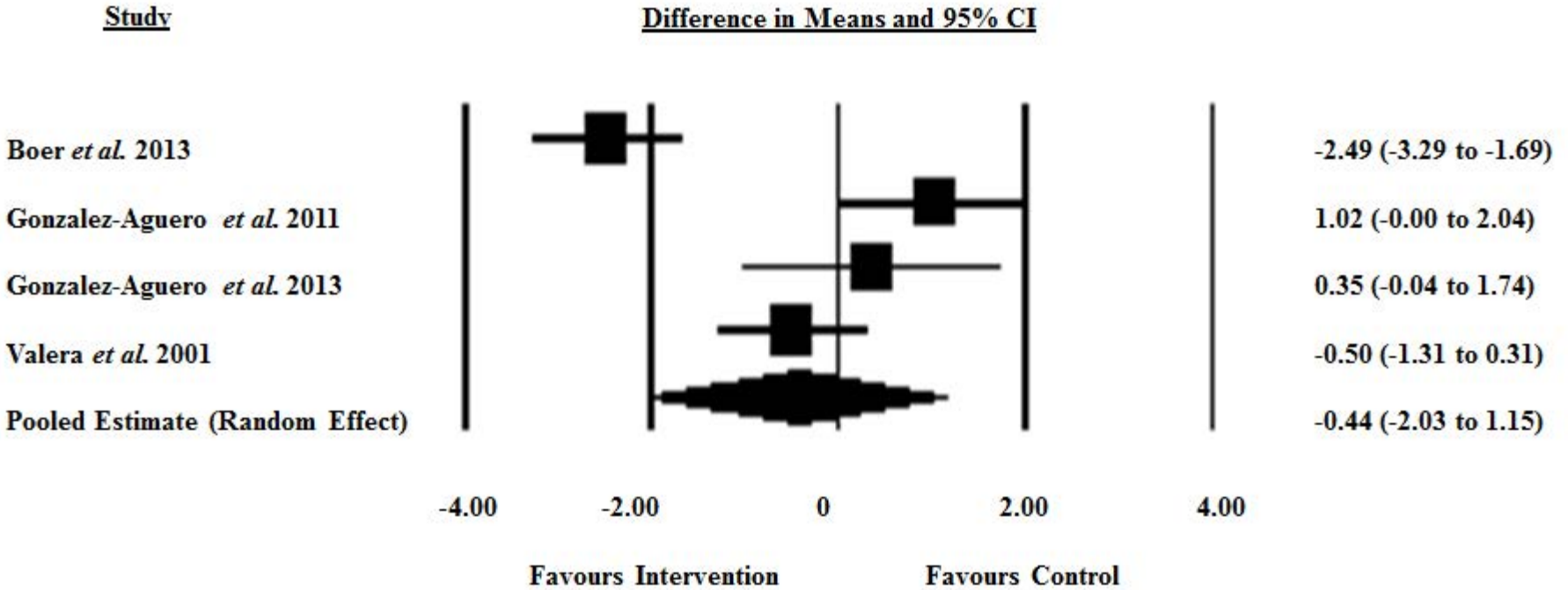
Figure 7: WMD in lean-mass (kg) between the intervention groups and the control groups.

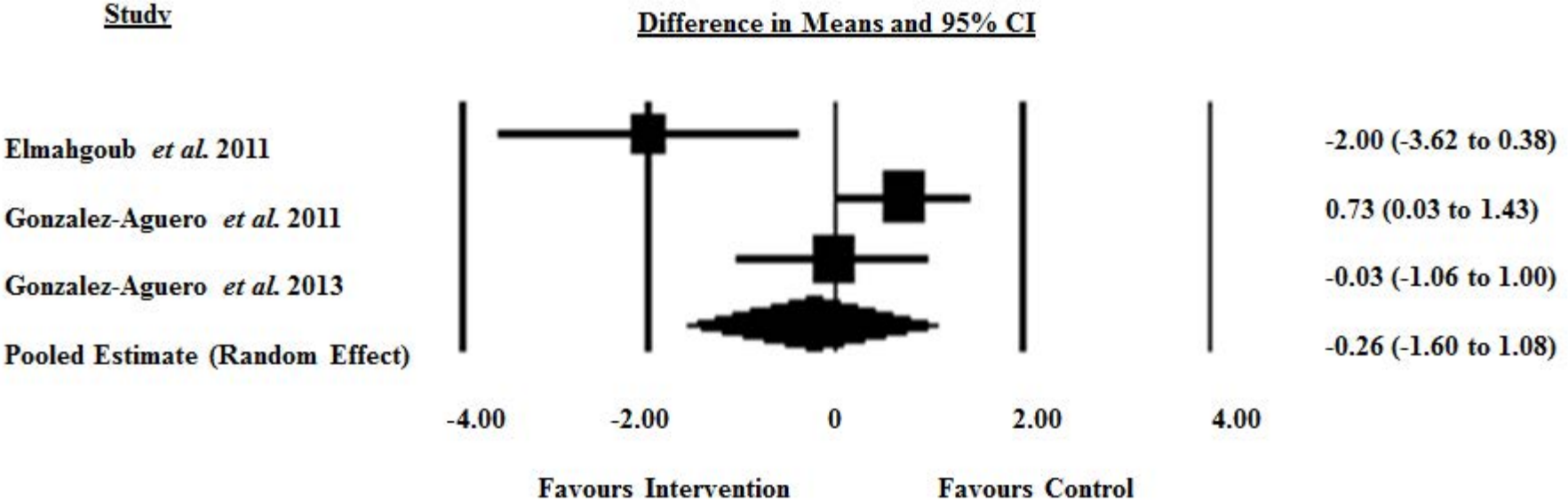

Identification
Screening
Eligibility
Included
Records Identified through database searching (n = 2365)
No of additional records identified through other sources (n = 6)
Number of records after duplicates removed (n = 1784)
Number of records screened (n = 1784)
Number of records excluded (n = 1770)
Number of full-text articles assessed for eligibility (n = 14)
Number of full-text articles excluded, with reasons (n = 8)
• No participants with intellectual disabilities (n = 1)
• Age of participants <16 and > 24 (n = 4)
• Not a RCT (n = 1)
• Repetition of data (n = 2)
Number of articles included for review (n = 6)

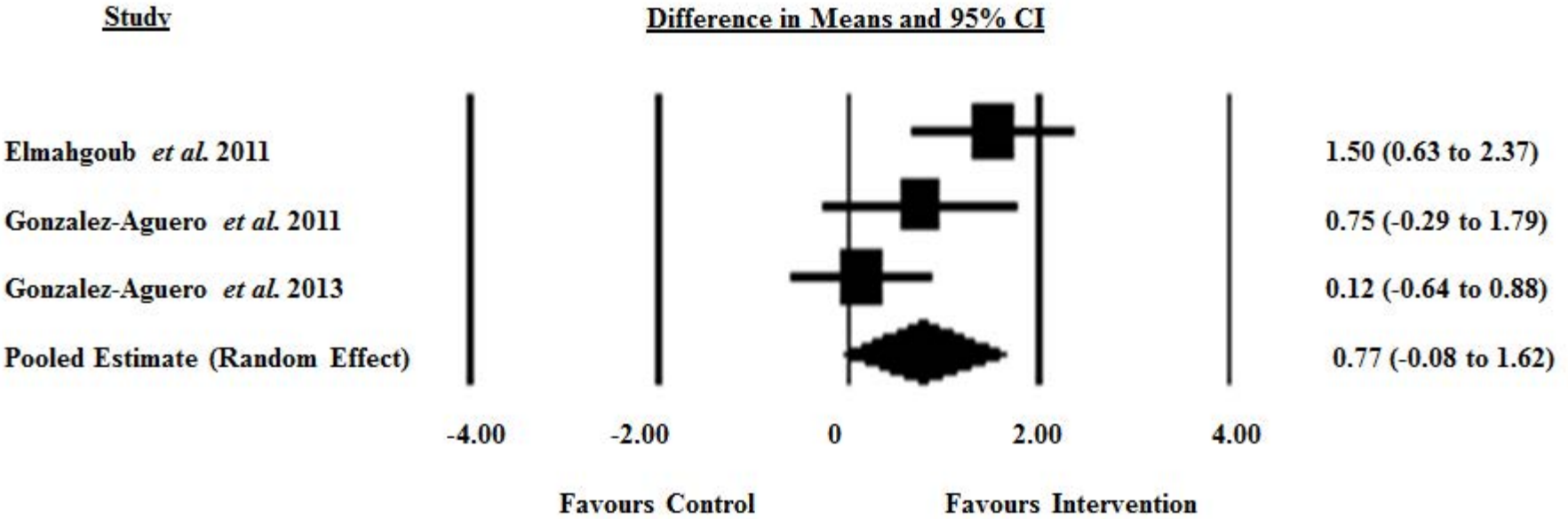

Study
Difference in Means and 95% CI
Boer et al. 2013
Elmahgoub et al. 2011
Gonzalez-Aguero et al. 2011
Gonzalez-Aguero et al. 2013
Valera et al. 2001
Pooled Estimate (Random Effect)
-1.27 (-3.12 to 0.59)
-1.50 (-3.62 to 0.62)
0.92 (-0.49 to 2.33)
0.06 (-1.27 to 1.39)
0.10 (-2.13 to 2.33)
-0.17 (-1.05 to 0.72)
-4.00
-2.00
0
2.00
4.00
Favours Intervention
Favours Control


Study
Difference in Means and 95% CI
Boer et al. 2013
Elmahgoub et al. 2011
Gonzalez-Aguero et al. 2011
Gonzalez-Aguero et al. 2013
Pooled Estimate (Random Effect)
-0.65 (-1.22 to -0.09)
-0.25 (-1.02 to 0.52)
0.66 (0.15 to 1.17)
-0.08 (-0.57 to 0.41)
-0.07 (-0.64 to 0.51)
-2.00
-1.00
0
1.00
2.00
Favours Intervention
Favours Control


Study
Difference in Means and 95% CI
Boer et al. 2013
-4.36 (-6.97 to -1.75)
Elmahgoub et al. 2011
-3.00 (-5.79 to -0.21)
Gonzalez-Aguero et al. 2011
2.12 (-0.69 to 4.93)
Gonzalez-Aguero et al. 2013
0.59 (-1.52 to 2.70)
Pooled Estimate (Random Effect)
-1.14 (-4.03 to 1.75)
-8.00
-4.00
0
4.00
8.00
Favours Intervention
Favours Control


Study
Difference in Means and 95% CI
Boer et al. 2013
Gonzalez-Aguero et al. 2011
Gonzalez-Aguero et al. 2013
Valera et al. 2001
Pooled Estimate (Random Effect)
-2.49 (-3.29 to -1.69)
1.02 (-0.00 to 2.04)
0.35 (-0.04 to 1.74)
-0.50 (-1.31 to 0.31)
-0.44 (-2.03 to 1.15)
-4.00
-2.00
0
2.00
4.00
Favours Intervention
Favours Control


Study
Difference in Means and 95% CI
Elmahgoub et al. 2011
Gonzalez-Aguero et al. 2011
Gonzalez-Aguero et al. 2013
Pooled Estimate (Random Effect)
-2.00 (-3.62 to 0.38)
0.73 (0.03 to 1.43)
-0.03 (-1.06 to 1.00)
-0.26 (-1.60 to 1.08)
-4.00
-2.00
0
2.00
4.00
Favours Intervention
Favours Control


Study
Difference in Means and 95% CI
Elmahgoub et al. 2011
Gonzalez-Aguero et al. 2011
Gonzalez-Aguero et al. 2013
Pooled Estimate (Random Effect)
1.50 (0.63 to 2.37)
0.75 (-0.29 to 1.79)
0.12 (-0.64 to 0.88)
0.77 (-0.08 to 1.62)
-4.00
-2.00
0
2.00
4.00
Favours Control
Favours Intervention