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| **CRITICALLY APPRAISED TOPIC** |

**FOCUSED CLINICAL QUESTION**

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| In overweight or obese adolescents, is continuous aerobic exercise or high-intensity interval training more effective for weight loss? |

**AUTHOR**

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**CLINICAL SCENARIO**

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| The number of adolescents who are overweight or obese in the United States is astounding. Obesity can have a significant impact on multiple aspects of health. Cali et al. found that childhood obesity can increase insulin resistance in children and is associated with cardiovascular complications even in earlier stages of life.1 Obesity in children and adolescents is also associated with early hypertension, dyslipidemia, fatty liver disease, and systemic low-grade inflammation leading to early morbidity.1 Another study by Wolf et al found that obesity can also affect the musculoskeletal system, specifically low back pain and osteoarthritis.2Physical activity is one way to address obesity; however, the best treatment plan for weight loss and percent body fat reduction is highly debated. In this critically appraised topic, we are specifically interested in high-intensity interval training in comparison to the more traditional method of continuous aerobic exercise from weight loss. High-intensity interval training is a relatively new approach for weight loss as many weight loss protocols use training that targets maximal lipid oxidation during training, which typically occurs at a low intensity.6Although weight loss as part of physical therapy interventions is not currently reimbursable by most third party insurance companies, physical therapists need to be able to make the most appropriate recommendations to patients and devise evidence based home exercise programs to address obesity as it affects the individual’s overall health and likely plays a role in the issues we are treating. |

**SUMMARY OF SEARCH**

[Best evidence appraised and key findings]

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| * Six studies were located that met the inclusion and exclusion criteria. There were 2 systematic reviews (including randomized control trials, clinical trials, and uncontrolled trials), 2 randomized control trials, 1 case series, and 1 cohort study.
* Obese adolescents had statistically and clinically significant reduction in weight and body fat following both high-intensity and low-intensity aerobic exercise. Low intensity aerobic exercise was found to produce greater lipid oxidation which many authors interpret as a better form of exercise for weight loss.
* Further research is need to compare high-intensity interval training and continuous aerobic training, specifically when considering weight loss as the available studies focus the exercises that correlate with the greatest lipid oxidation rather than overall weight loss. Future studies should investigate the effects of both methods of training on resting metabolism to investigate potential changes. Additional randomized controlled trials with larger sample sizes and decreased selection bias are needed. Finally, studies investigating the effects of exercise on weight loss should attempt to control for diet.
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**CLINICAL BOTTOM LINE**

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| Current best evidence suggests that low-intensity, continuous aerobic exercise can maximize lipid oxidation and is effective for weight loss in adolescents who are obese. Limited evidence regarding high-intensity interval training is available; however, this type of exercise can also, statistically and clinically, significantly reduce weight and body fat. Behavioural modification in conjunction with exercise intervention may result in greater reductions in weight. Diet is another key component of weight loss that should be considered with exercise to optimize outcomes. Further research is required to determine appropriate exercise protocols for weight loss in obese adolescents, including intensity, duration, and frequency. Based on current evidence, a wide variety of exercise programs can be used to reduce weight in obese adolescents and should be modified based on individual characteristics such as abilities, resources, and personal preference. |

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| ***This critically appraised topic has been individually prepared as part of a course requirement and has been peer-reviewed by one other independent course instructor*** |

**SEARCH STRATEGY**

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| **Terms used to guide the search strategy** |
| **P**atient/Client Group | **I**ntervention (or Assessment) | **C**omparison | **O**utcome(s) |
| Adolescen\*Teen\*YouthMinor\*OverweightObes\*Pediatric\* | Endurance train\*Endurance sportEndurance exercise\*EnduranceAerobic exercis\*Continuous exercis\*Low intensity train\*Low-intensity train\*Low intensity exercis\*Low-intensity exercis\* | Anaerobic exercis\*Interval train\*High-intensity train\*High intensity train\*High-intensity interval train\*High intensity interval train\*High-intensity exercis\*High intensity exercis\* | Weight lossWeight reductionWeight-loss |

**Final search strategy:**

*Show your final search strategy from one of the databases you searched. In the table below, show how many results you got from your search from each database you searched.*

PubMed

1. Overweight OR obes\*
2. Endurance OR endurance train\* OR endurance sport OR endurance exercis\* OR aerobic exercis\* OR continuous exercis\* OR low intensity train\* OR low-intensity train\* OR low intensity exercis\* OR low-intensity exercis\*
3. Anaerobic exercis\* OR interval train\* OR high-intensity train\* OR high intensity train\* OR high-intensity interval train\* OR high intensity interval train\* OR high-intensity exercis\* OR high intensity exercis\*
4. Weight loss OR weight reduction OR weight-loss
5. #1 AND #2 AND #3 AND #4

((((Overweight OR obes\*)) AND (Endurance OR endurance train\* OR endurance sport OR endurance exercis\* OR aerobic exercis\* OR continuous exercis\* OR low intensity train\* OR low-intensity train\* OR low intensity exercis\* OR low-intensity exercis\*)) AND (Anaerobic exercis\* OR interval train\* OR high-intensity train\* OR high intensity train\* OR high-intensity interval train\* OR high intensity interval train\* OR high-intensity exercis\* OR high intensity exercis\*)) AND (Weight loss OR weight reduction OR weight-loss)

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| **Databases and Sites Searched** | **Number of results** | **Search Modifications** |
| **PubMed**  | **18** | Not applicable |
| **CINAHL** | **7** | Not applicable |
| **EMBASE** | **10** | Not applicable |

## INCLUSION and EXCLUSION CRITERIA

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| **Inclusion Criteria** |
| * Randomized controlled trials, controlled trials, case series, and uncontrolled trials
* Studies on the adolescent population that are obese or overweight
* Published in English
* Studies on human participants
* Used an exercise protocol
* Measured weight loss or changes in BMI
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| **Exclusion Criteria** |
| * Animal studies
* Narrative review studies
* Expert opinions
* Studies including only adult participants who are overweight or obese
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**RESULTS OF SEARCH**

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| A total of  | \_6\_ | *(6)* relevant studies were located and categorised as shown in the following table (based on Levels of Evidence, Centre for Evidence Based Medicine, 2011) and (Downs & Black and AMSTAR) quality assessment rating scale |

**Summary of articles retrieved that met inclusion and exclusion criteria**

*Note that this table is arranged differently from the example CAT on Sakai. For each article that meets your inclusion and exclusion criteria, score for methodological quality on an appropriate scale, categorize the level of evidence, and note the study design (e.g., RCT, systematic review, case study). Add more rows as necessary.*

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| **Author (Year)** | **Study quality score** | **Level of Evidence** | **Study design** |
| **Romain et al. (2012)\*** | **AMSTAR: 10/11** | **2a** | **Systematic Review – meta-analysis** |
| **LeMur et al. (2002)** | **AMSTAR: 9/11** | **2a** | **Systematic Review – meta-analysis** |
| **Brandou et al. (2005)** | **Downs & Black: 19/32** | **2b** | **Randomized clinical trial** |
| **Wallman et al. (2009)\*** | **Downs & Black: 18/32** | **2b** | **Randomized clinical trial** |
| **Karner-Rezek et al. (2013)** | **Downs & Black: 17/32** | **4** | **Case series** |
| **Tjønna et al. (2009)** | **Downs & Black: 16/32** | **4** | **Cohort study – comparison group not well outlined** |
|  |  |  |  |

\*Study included adult and paediatric participants

\*\*In both Downs & Black and AMSTAR, higher scores indicate better quality.

**BEST EVIDENCE**

The following 3 studies were identified as the ‘best’ evidence and selected for critical appraisal. Reasons for selecting these studies were:

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| * **Romain et al. (2012)**
	+ This is the highest quality systematic review found that addresses both continuous aerobic exercise and high-intensity interval training. This study includes both paediatric and adult participants
* **LeMur et al. (2002)**
	+ Another good quality meta-analysis, this systematic review focuses on a variety of exercise interventions for weight loss in the paediatrics. As weight loss in paediatrics is often treated differently than in adulthood (due to growth), I find this article important for answering my clinical question.
* **Brandou et al. (2005)**
	+ This randomized clinical trial is the strongest study found that compares low-intensity exercise to high-intensity exercise for weight loss in the paediatric population. Though it lacks a true control group, this study clearly outlines the interventions.
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**SUMMARY OF BEST EVIDENCE**

**(1) Description and appraisal of (Impact of high- and low-intensity targeted exercise training on the type of substrate utilization in obese boys submitted to a hypocaloric diet) by (Brandou F, Savy-Pacaux AM, Marie J, et al., 2005)**

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| **Aim/Objective of the Study/Systematic Review:** |
| The purpose of this study was to compare substrates used during exercise combined with a hypocaloric diet in obese children. The study compared two groups, a low intensity exercise group and a high intensity exercise group, and examined the impact each form of exercise coupled with decreased caloric intake had on weight-loss.  |
| **Study Design**[e.g., systematic review, cohort, randomised controlled trial, qualitative study, grounded theory. Includes information about study characteristics such as blinding and allocation concealment. When were outcomes measured, if relevant]Note: For systematic review, use headings ‘search strategy’, ‘selection criteria’, ‘methods’ etc. For qualitative studies, identify data collection/analyses methods. |
| * Randomized Clinical Trial (with a comparison-group design: matched pairs)
* Participants were matched according to stage of puberty (as determined by Tanner stages) and age then randomly assigned to either low-intensity training group (n=7 subjects) or high-intensity training group (8 subjects). No forms of blinding or allocation concealment were discussed.
* Participants began dieting (reducing caloric intake by 300 Kcal/day) two weeks prior to baseline measurements. All measures were taken after 12 hours of fasting prior to exercise intervention. Data collection took place at baseline and after two months.
* Participants engaged in exercise training 2 days/week for 2 months.
* Diet: -300Kcal/day, 17% protein, 30% lipids, 53% carbohydrates
 |
| **Setting**[e.g., locations such as hospital, community; rural; metropolitan; country] |
| All training and data collection took place under the supervision of a sport physician in a controlled laboratory setting in France. |
| **Participants**[N, diagnosis, eligibility criteria, how recruited, type of sample (e.g., purposive, random), key demographics such as mean age, gender, duration of illness/disease, and if groups in an RCT were comparable at baseline on key demographic variables; number of dropouts if relevant, number available for follow-up]Note: This is not a list of the inclusion and exclusion criteria. This is a description of the actual sample that participated in the study. You can find this descriptive information in the text and tables in the article. |
| * N=15 (8 post-puberty, 2 puberty, 5 pre-puberty – determined by Tanner scale)
* Recruitment not described.
* Obese boys – obesity defined by body mass index greater than 97th percentile in comparison to French normative values.
* Exclusion criteria – diabetes mellitus, chronic diseases, endocrine disorders
* High-intensity exercise versus low-intensity exercise group comparison
	+ No statistically significant differences between groups.
	+ High-intensity: pubertal status-Stage II, age-11.8 years, weight-77.7kg, height-1.61meters, BMI-29.5, fat mass-28.9kg, FFM-48.8
	+ Low-intensity: pubertal status – stage III, age-12.8, weight-86.7kg, height-1.68 meters, BMI-30.1, fat mass-29.1kg, FFM-57.6kg
* 15 participants available at follow-up
 |
| **Intervention Investigated**[Provide details of methods, who provided treatment, when and where, how many hours of treatment provided] |
| *Control – Low intensity training group* |
| * Individualized training based on baseline measures – respiratory exchange rate (RER) based on VO2 and VCO2. Lipomax (point were greatest fax oxidation takes place) determined for each participant using RER.
* 2 days/week for 2 months
* Cycling on a ergometer at lipomax
* Overall energy expenditure held constant, therefore total time of each session was approximately 35 minutes.
* Heart rate monitored continuously throughout sessions
* All sessions took place in a laboratory setting with a sports physician
 |
| *Experimental – High intensity training group* |
| * Individualized training based on baseline measures – respiratory exchange rate (RER) based on VO2 and VCO2. Lipomax (point were greatest fax oxidation takes place) determined for each participant using RER.
* 2 days/week for 2 months
* Cycling on a ergometer at lipomax plus 40% of lipomax
* Overall energy expenditure held constant, therefore total time of each session was approximately 20 minutes.
* Heart rate monitored continuously throughout sessions
* All sessions took place in a laboratory setting with a sports physician
 |
| **Outcome Measures** (Primary and Secondary)[Give details of each measure, maximum possible score and range for each measure, administered by whom, where] |
| All measurements taken at baseline and upon completion of intervention (2months) in the laboratory setting with a sports physician.* BMI – kg/m2 compared to normative values in France
* Z-score – “Z = [(Q/M) L – 1]/LS With: Q= BMI, M = median, L = power, S= coefficient of variation. Individual’s values of M, L and S were determined according to Rolland-Cachera” (Brandou et al. page 328)
* Weight – measure in kilograms (Kg)
* Fat free mass – determined via Multifrequency bioelectric impedance
* Fat mass – determined via Multifrequency bioelectric impedance
* Heart rate during exercise
* Maximal Power – using Tanner equation – 3.5Watts x FFM-1
* VO2 and VCO2 measured using electromagnetically braked cycle ergometer (Ergoline Bosh 500) which was connected to a breathing device (ZAN 600)
* Fat oxidation
	+ Fat (mg.min-1)=-1.7012 VCO2 + 1.6946 VO2 - gas volume expressed in milliters per minute (Brandou et al, page 329)
* Carbohydrate oxidation
	+ CHO (mg.min-1) =4.585 VCO2 – 3.2255 VO2 - gas volume expressed in milliters per minute (Brandou et al, page 329)
 |
| **Main Findings**[Provide summary of mean scores/mean differences/treatment effect, 95% confidence intervals and p-values etc., where provided – if you need to calculate these data yourself, put calculations here and add interpretation later, under ‘critical appraisal’ on next page] |
| **Weight Loss**Low Intensity Exercise Group* Significant weight loss occurred in this group, losing an average of 5.2 kg (± 0.7, P< 0.01).
* There was also a significant loss in body fat, averaging 5.07 kg (± 1.7, P < 0.03).
* Fat-free mass was reported as unchanged but not data is available in the article.

High Intensity Exercise Group* Significant weight loss occurred in this group, losing an average of 7 kg (± 0.7, P< 0.01).
* A significant loss in body fat was also observed, averaging 5.8 kg (± 0.9, P < 0.01).
* Although not statistically significant, a trend towards loss in fat-free mass was also observed in this group. Participants lost an average of 1.2 kg in fat-free mass (± 0.9, P = 0.08).

No significant differences were observed in these findings between groups: both groups had significant weight loss and loss of body fat; neither group changed significantly in fat free mass. (Data presented in a figure only, Figure 1)**Substrate Oxidation**Low Intensity Exercise Group* Fat and carbohydrate oxidation do not change after 2 months of training.

High Intensity Exercise Group* Increase in carbohydrate oxidation at 20-30% maximal power (and 48.6 ± 1.6 vs 36.1 ± 4.4 at 20%, 57.1 ± 3.2 vs 44.6 ± 3.9 at 30%, p<0.02)
* Decrease in lipid oxidation at 20-30% maximal power (51.4 ± 1.6 vs 63.8 ± 4.4 at 20%, 42.8 ± 3.2 vs 55.4 ± 3.9 at 30%)

The authors conclude, ”During rest and mild-to moderate exercise, fat predominates as energy source while a shift towards CHO oxidation occurs at higher intensities (p<0.001).” (Brandou et al. page 330). When comparing the two groups, no significant difference was observed in substrate oxidation between the two groups before or after intervention. |
| **Original Authors’ Conclusions**[Paraphrase as required. If providing a direct quote, add page number] |
| “This study shows that in obese children submitted to a hypocaloric diet a two months training protocol at a targeted exercise level maintains the ability to oxidize fat at exercise if it is performed at low intensity while it both decreases fat oxidation and increases CHO oxidation at exercise when performed at high intensity.” (Brandou et al. page 334)Low intensity exercise can maintain fat oxidation during dieting which could aid in overall weight loss. High intensity training, however, decreases lipid oxidation during exercise shifting towards carbohydrate oxidation. |
| **Critical Appraisal** |
| **Validity**[Methodology, rigour, selection, sources of bias, quality score on methodology quality rating scale (indicate the quality assessment tool used and the maximum possible score on that scale, e.g., 7/10 on PEDro scale), appropriateness of analytical approach (e.g., adjustments for confounding variables, management of missing data).]Comment on missing information in original paper. |
| Downs & Black: 19/32 – This indicates a fair study. There are definitely limitations to the study design particularly with the lack of blinding, no true control group, and a sample that does not necessarily represent the population in question.Selection: The selection of participants was not discussed in this study. It is unclear whether participants were recruited via convenience or whether they represent a larger group.Assignment of Groups: Both groups were equal at baseline with no significant differences in measured variables. This was attained by matching participants before randomly assignment pairs to groups. It is important, however, to note that true matched pair design could not be achieved as there was an odd number of participants. The author does not comment on this, but it does not appear to impact the results.Methodology: Interventions are clearly outlined. Diet began 2 weeks prior to baseline measurements and initiation of exercise training. This may influence results as weight and substrate oxidation may have already changed. Overall energy expenditure is kept constant allowing for better measure of which is more effective for weight loss and how oxidation changes with intensity.Sources of Bias: There are no blinding methods described. Selection bias may or may not have been present. Clinical Importance: There are statistically significant changes in substrate oxidation with higher intensity training. At higher intensities, participants had an increase in carbohydrate oxidation and a decrease in fat oxidation. Participants in both groups also lost a statistically significant amount of weight in both the low intensity exercise group (5.2 kg) and the high intensity exercise group (7 kg) over the 8 week intervention period. These decreases in weight are clinically significant as they fall into the range of 1-2 pounds per week recommended by the Centers for Disease Control and Prevention (CDC).9 Statistics: This study lacks the use of exact p-values and does not calculate effect size or power. While appropriate statistical tests are used to determine differences between/within groups (independent t-test, paired t-test, and ANOVA), exact numbers are not given. Sample Size: A small sample size (N=15) is used in this study. The authors do not discuss the sample size or sampling in the article. It is not clear whether or not the author determined the sample size prior to recruiting participants for the study. The study did, however, have statistically significant results and therefore power does not appear to be an issue. |
| **Interpretation of Results**[Favourable or unfavourable, specific outcomes of interest, size of treatment effect, statistical and clinical significance, minimal clinically important difference. You may calculate effect size or confidence intervals yourself from the data provided in the article.] Describe in your own words what the results mean. |
| When comparing low intensity training to high intensity training in combination with a hypocaloric diet, there are several changes that take place. First, it is important to note that both the low intensity and high intensity training groups resulted in statistically significant reductions in weight (p<.01). Both groups lost over 5 kg on average, and this amount falls into the 1-2 pounds of weight loss per week recommended by the CDC.9 Although this seems to be a clinically meaningful amount of weight loss, there are a few additional factors that need to be considered. It is important to note that there is a lack of a control group for comparison. Would a diet intervention alone have allowed for similar changes, or would an exercise only group also result in these changes in weight loss? Next, substrate oxidation needs to be considered. While no changes in oxidation were found in the low intensity training group, statistically significant changes in lipid and carbohydrate oxidation were noted at both 20% and 30% of maximal workout in the high intensity training group. These results are clinical meaningful as determined by a relatively large effect size (r=0.88 at 20% and r=0.87 at 30% in both carb oxidation and lipid oxidation).Given this information, I agree with the authors conclusions. Lipid oxidation remains constant with low intensity exercise while high intensity exercise shifts metabolism towards carbohydrate oxidation rather than lipid oxidation. This is something to keep in mind when recommending training for weight loss. However, it is important to note that both approaches significantly reduced body weight. |

**(2) Description and appraisal of (Factors that alter body fat, body mass, and fat-free mass in pediatric obesity) by (LeMURA, L. M., and M. T. MAZIEKAS, 2002)**

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| **Aim/Objective of the Study/Systematic Review:** |
| The purpose of this systematic review was the quantify changes in body mass, body fat, and body fat-free mass in obese children and adolescents as a result of treatment programs focused on exercise through the use of a meta-analytical approach. The study also aimed to assess strengths and weaknesses of the available literature and make recommendations for further research on the topic. |
| **Study Design**[e.g., systematic review, cohort, randomised controlled trial, qualitative study, grounded theory. Includes information about study characteristics such as blinding and allocation concealment. When were outcomes measured, if relevant]Note: For systematic review, use headings ‘search strategy’, ‘selection criteria’, ‘methods’ etc. For qualitative studies, identify data collection/analyses methods. |
| **Systematic Review****Methods:**Data Sources: The review was limited to studies on children between the ages of 5 and 17 in which body mass, fat-free mass, and percent body fat was measured. The search was completed electronically using the following databases: “Current Contents, MEDLINE, Dissertation Abstracts International, Psycho-logical Abstracts, and Sport Discus” (Lemura, 489). Additional searches were completed by hand to cross-reference and an expert reviewed the bibliography to determine completeness. Studies took place between 1960 and 2001. Descriptive terms used in the search included “children, exercise, obesity, physical activity, and weight loss” (Lemura, 489).Study Selection: Inclusion criteria was as follows:* ≥ 6 subjects per group
* Age: 5-17 years old
* Body mass, body mass index, percent body fat, and fat-free mass were tested through pre- and post-test
* Exercise training was used
* Training programs were at least 3 weeks long
* Full-length publications
* Health children (free from endocrine disorders or diseases)
* Studies were published in English language journals

Data Extraction: Each study was independently reviewed. All disagreements were resolved between reviewers. Studies were coded based on the following:* Exercise program characteristics
* Study characteristics
* Subject characteristics
* Body composition measurement characteristics
* Primary outcomes

Statistical Analysis: The main outcomes of interest in this study were changes in body mass, percent body fat, and fat-free mass. The effect size was determined for each of these. Subgroups were also analysed to determine differences between groups according to the following:* Intensity
* Exercise duration
* Length of training
* Frequency
* Mode
* Method of assessing body composition
* Subject characteristics
* Research design
* Type of intervention program

Effect size computation and analysis: Using the findings in each study, effect size was calculated. These values were then combined creating pooled data. A 95% confidence interval was generated to correct for bias. Publication bias was examined using Kendal τ rank correlation test. ANOVA-like procedures were used to determine whether or not significant differences were found in body mass, percent body fat, and fat-free mass. In order to determine the magnitude and direction of relationships between variables, linear regression was used, while stepwise regression was used to determine which training interventions accounted for the most change. P ≤ 0.05 was set as the alpha level. |
| **Setting**[e.g., locations such as hospital, community; rural; metropolitan; country] |
| The settings in which each of the studies included in the review took place is not described. No data available. |
| **Participants**[N, diagnosis, eligibility criteria, how recruited, type of sample (e.g., purposive, random), key demographics such as mean age, gender, duration of illness/disease, and if groups in an RCT were comparable at baseline on key demographic variables; number of dropouts if relevant, number available for follow-up]Note: This is not a list of the inclusion and exclusion criteria. This is a description of the actual sample that participated in the study. You can find this descriptive information in the text and tables in the article. |
| 945 subjects were included in this study, ranging in age from 5 to 17 years. Subjects were all obese. Most of the participants included were Caucasian although some studies included African American and Hispanic children. Studies included both males and females. All participants were described as “healthy” which the author defined as lack of endocrine disease or disorder and lack of significant co-morbidities which may influence results. |
| **Intervention Investigated**[Provide details of methods, who provided treatment, when and where, how many hours of treatment provided] |
| *Control (or Comparison)* |
| Some studies included in the review had comparison groups. These groups included diet groups, various exercise groups, behavioural-modification groups, or a combination of these interventions. Details of methods were not described in this review. |
| *Experimental* |
| Exercises included aerobic training, walking, cycling, resistance training, stretching, and strength training. Of these forms of exercise, aerobic training was used the most often. Aerobic activities included walking, jogging, swimming, aerobic dance, soccer, and other continuous activities. Length of training ranged from 3 weeks to 30 weeks (mean=12.75 ± 5.9). Each exercise session lasted between 20 and 60 minutes (mean=38 ± 17.5). Exercise intensity was described differently depending on the study. Some studies described intensity as a percentage of a set maximal intensity. These ranged from 45% to 90% of maximal heart rate. One study measured heart rate direction, setting 163 beats per minute as the intensity. Subjects participated in exercise 1-7 days per week (mean=3.9 ± 1.5). Exercise compliance was high, ranging from 90% to 100%. |
| **Outcome Measures** (Primary and Secondary)[Give details of each measure, maximum possible score and range for each measure, administered by whom, where] |
| A variety of outcome measures were used depending on the study. Listed below are the ones described in the review.Primary Outcomes: Body Composition (body mass, percent body fat, and fat-free mass)* Skinfold calipers – 11 studies
	+ Biceps, triceps, subscapular, suprailiac,
* Hydrostatic weighing – 3 studies
* Dual-photon x-ray absorptiometry – 3 studies
* Total body water and bioelectric impedance analysis – 1 study
* Body Mass Index
* Body weight in kilograms

Subgroup Analysis: Study Characteristics* Intensity
	+ Percent of maximum heart rate and VO2max
* Duration
	+ Time spent exercising during each session
* Training Length
	+ How long the training lasted – measured in weeks or months
* Frequency of exercise
	+ Measured in sessions per week
* Mode
	+ The types of exercises and activities used during training
* Method of assessing body composition
	+ See above
* Characteristics of subjects
	+ Sex and VO2max
* Research Design
	+ Randomized control trial, controlled trials, no control group
* Intervention type
	+ Exercise, diet, behavioural modification or a combination of these
 |
| **Main Findings**[Provide summary of mean scores/mean differences/treatment effect, 95% confidence intervals and p-values etc., where provided – if you need to calculate these data yourself, put calculations here and add interpretation later, under ‘critical appraisal’ on next page] |
| Main Effects: Including all designs and intervention types, comparing the effect sizes before and after exercise training in children yielded the results below.* Percent body fat: mean effect size=0.70 ± 0.35; 95% CI=0.21 to 1.1; P<0.01
* Fat-free mass: mean effect size=0.50 ± 0.38; 95% CI=0.03 to 0.57; P<0.05
* Body mass: mean effect size=0.34 ± 0.18; 95% CI=.01 to 0.46; P<0.05
* Body mass index: mean effect size=0.76 ± 0.55; 95% CI=0.24 to 1.7; P<0.01
* VO2max: mean effect size=0.52 ± 0.16; 95% CI=0.18 to 0.89; P<0.05

The changes in body fat percentage showed significant differences between groups when considering exercise intensity. When comparing the highest intensity to the lowest intensity, a Tukey post hoc test revealed significant difference (P<0.01). Increased VO2max and body fat percentage are significantly associated (r-value=0.70, P<0.05) as determined by a linear regression.* 60-65% VO2max: Mean effect size=0.97 ± 0.33; 95% CI=0.31 to 1.9
* ≥66-70% VO2max: Mean effect size=0.65 ± 0.19; 95% CI=0.27 to 1.1
* ≥71% VO2max: Mean effect size=0.29 ± 0.10; 95% CI=-.01 to 0.35

Changes in body fat percentage also differed significantly between groups when considering exercise duration. Exercise sessions less than 30 minutes were significantly different from exercise sessions lasting more than 30 minutes (P<0.03). * ≤30 minutes: Mean effect size=0.57 ± 0.21; 95% CI=0.14 to 0.71
* >30 minutes: Mean effect size=0.95 ± 0.27; 95% CI=0.29 to 1.7

Changes in body fat percentage were also significantly different when comparing modes of exercise. Aerobic exercise and aerobic exercise plus resistance training were significantly different (P<0.02).* Aerobic exercise: Mean effect size=0.58 ± 0.31; 95% CI=0.18 to 0.90
* Aerobic plus resistance exercise: Mean effect size=1.2 ± 0.35; 95% CI=0.34 to 2.1

When comparing differences in program length on body fat percentage, shorter program length (≤10 weeks) were not significantly different from longer program length (>10 weeks).* ≤10 weeks: Mean effect size=0.70 ± 0.40; 95% CI=0.36 to 1.1
* >10 weeks: Mean effect size=0.76 ± 0.30; 95% CI=0.38 to 1.4

Publication bias was not found in this study for effect size changes in fat-free mass (P=.24), VO2max (P=.89), body mass (P=.71), or percent body fat (P=.09). When comparing methods used to determine body composition, skin fold measures using calipers reported significantly larger reductions in body fat percentage (mean effect size = 1.0 ± 0.24; CI = .33 to 1.6) than other methods, including hydrostatic weight, dual-photon x-ray absorptiometry, and total body water with bioelectric impedance analysis (mean effect size = .54 ± .25; CI = .19 to .92; P < .006). The authors also found that changes in body fat percentage and body mass were not different when comparing RCT and no control studies.* Body Fat percentage
	+ RCT: mean=0.68 ± 0.35; CI=.28 to 1.1
	+ No Control: mean=0.70 ± 0.38; CI=0.39 to 1.2
* Body Mass
	+ No Control: effect size mean=0.34 ± 0.14; CI=-0.04 to 0.56
	+ Control trial: effect size mean=0.38±0.21; CI=-0.02 to 0.58

When considering the effects of the various intervention methods and treatment approaches, exercise-only, exercise plus diet, and exercise in conjunction with behavioural modification yielded significant results (P<0.04). With further analysis (the post hoc analysis), significant difference was found only between the exercise plus behavioural modification group and the exercise and diet group (P<0.05).* Exercise only: mean effect size=0.36 ± 0.18
* Exercise and diet: mean effect size=0.33 ± 0.16
* Exercise and behavioural modification: mean effect size=0.63 ± 0.20

Pre-intervention body fat percentage, intensity of intervention exercise (≤60-65% VO2max), exercise mode (aerobic with resistance training) and the type of intervention (behavioural modification and exercise) accounted for approximately 30-59% of variance in body fat percentage, body mass, and fat-free mass. |
| **Original Authors’ Conclusions**[Paraphrase as required. If providing a direct quote, add page number] |
| Overall, exercise has a modest to strong influence on body composition variable including body mass, body fat percentage, and fat-free mass. The groups that demonstrated the greatest decrease in body fat percentage had low exercise intensity over longer durations per session, combined aerobic training with resistance exercises (typically 8-12 repetitions), and included behavioural modification approaches. The findings support the idea that exercise of lower intensity and longer duration could promote fat oxidation. The authors concluded it is possible that the inclusion of high-repetition resistance training could possibly lead to increases in fat-free mass. Behavioural modification interventions are another important finding discussed by the authors. These interventions included family support groups, classes on caloric intake and nutrition, as well as encouragement to engage in spontaneous activity rather than sedentary activities.  |
| **Critical Appraisal** |
| **Validity**[Methodology, rigour, selection, sources of bias, quality score on methodology quality rating scale (indicate the quality assessment tool used and the maximum possible score on that scale, e.g., 7/10 on PEDro scale), appropriateness of analytical approach (e.g., adjustments for confounding variables, management of missing data).]Comment on missing information in original paper. |
| Quality Rating Scale: AMSTAR 9/11* This score indicates very good quality.

Quality of Included Studies* The studies included ranged from randomized controlled trials to studies without control groups. This allows for the inclusion of lower quality studies, but does not include expert opinion or narrative reviews. The authors accounted for the inclusion of studies without control groups by comparing changes in body fat percentage and body mass in randomized controlled trials and controlled trials with studies that lacked control, finding no significant differences between these groups. The results, however, should be interpreted with caution since studies without a control group were included in the review.
	+ Body Fat percentage
		- RCT: mean=0.68 ± 0.35; CI=.28 to 1.1
		- No Control: mean=0.70 ± 0.38; CI=0.39 to 1.2
	+ Body Mass
		- No Control: effect size mean=0.34 ± 0.14; CI=-0.04 to 0.56
		- Control trial: effect size mean=0.38±0.21; CI=-0.02 to 0.58

Search and Study Selection* The authors performed a search using numerous search engines (“Current Contents, MEDLINE, Dissertation Abstracts International, Psychological Abstracts, and Sport Discus” (Lemura, 489)).
* Authors also searched for unpublished studies to control for publication bias. Most of the articles found were eventually published, and therefore, authors used Kendal τ rank correlation test to evaluate publication bias. No publication bias was observed. Cross-references were made by hand and the authors also had an expert in the field review the bibliography to determine completeness.
* Inclusion and exclusion criteria were clearly described in the review. Only studies published in English were included.

Assessing quality of individual studies* The authors do not include much information regarding the validity of included studies or the method by which the quality of each study was assessed. Based on the information provided, bias and quality cannot be determined. The authors do, however, provide information regarding the design of included studies, breaking them into three groups: randomized control trials, controlled trials, and no control trials. Caution should be taken when interpreting results.

Individual Patient Data* Authors used individual patient data to determine effect sizes whenever possible, even contacting investigators for additional data when necessary. This allowed for the creation of subgroups based on intensity, duration, type of intervention, and length of intervention among others.
* There were also times when the authors could not perform subgroup analyses due to the lack of information about participants. The often included subject characteristics such as body weight, body mass index, and body fat percent.
* Since many of the studies used different outcome measures, it was also important to assess whether or not the method of assessment impacted results. The authors found that skin fold measures were associated with higher body fat percentage losses than other methods.

Statistical Analysis: Statistical tests applied were appropriate. Exact data is provided when available.* All calculated effect size that fell outside the 10th to 90th percentile were reviewed for the influence of bias by the authors.
* Pooled Estimate: A random effects model was used to pool heterogeneous data.
* ANOVA-like procedures were used to determined significant differences.
* Linear regression was used to determine magnitude and direction of correlation.
* Final data is reported as mean effect sizes.
* This review does not include a forest plot for graphical display of data.
* Table 4 summarizes the stepwise regression results for predicting body composition changes with exercise.
 |
| **Interpretation of Results**[Favourable or unfavourable, specific outcomes of interest, size of treatment effect, statistical and clinical significance, minimal clinically important difference. You may calculate effect size or confidence intervals yourself from the data provided in the article.] Describe in your own words what the results mean. |
| There are several important outcomes to consider in this systematic review and meta-analysis. First, when applying the results in the clinic it is important to assess clinical significance in addition to statistical significant. To do this, the effect size can be used. This study found that exercise combined with behavioural modification interventions produced statistically significant (P<0.05) results when compared to other interventions including exercise plus diet as well as exercise alone. The mean effect size was calculated to be 0.63 indicating moderate-large effect size. Additionally, the difference in duration of exercise was found to be statistically significant, indicating that longer duration (>30 minutes) results in greater changes in body composition. When looking at the effect size, longer duration has a large effect on changes in body composition indicating clinical significance (Mean effect size=0.95 ± 0.27; 95% CI=0.29 to 1.7). This was also found to be statistically significant (P<0.03). When selecting which forms of exercise to incorporate into a weight loss program, aerobic exercise when combined with resistance training was found to create greater changes in body fat percentage than aerobic training alone at a statistically significant level (P<0.02). This was found to have a large effect size making it clinically meaningful as well (Mean effect size=1.2 ± 0.35; 95% CI=0.34 to 2.1). It should also be noted that aerobic exercise along has an effect size of 0.58 which is a moderate effect and could also be clinically meaningful. Further investigation is warranted. Finally, The intensity of the exercise impacted changes in body fat percentage. Exercises completed at lower a lower intensity resulted in greater body fat percentage reduction at a statistically significant level (P<0.01). The effect size for exercise completed at the established lower intensity (60-65% VO2max) had a mean effect size=0.97 ± 0.33 (95% CI=0.31 to 1.9) which is a large effect and can interpreted as clinical significance. So when selecting interventions to apply clinically, the results suggest using low intensity exercises and providing a behavioural modification component. Resistance exercises in combination with aerobic training will likely yield positive clinical outcomes. Training sessions should last 30 minutes or longer to optimize percent body fat reduction.This review also helped support the idea that body weight alone may not be an accurate measure of the changes taking place in body composition as a result of exercise. While body weight did decrease, larger changes were observed in percent body fat reduction. This emphasizes the need to include measurements beyond weight reduction such as BMI in studies.Interestingly, this review also found that studies using skin fold caliper measurements had higher changes in body composition than other measures at a statistically significant level (P<0.006). This should indicate interpreting the results with caution as the measures may be biased. As 11 of the studies included in this review used skin fold calipers, this may be a source of bias to consider.In addition to this potential source of bias, it is important to note the lack of subject characteristics included in the review or studies. There was also a lot of description regarding the settings in which these studies took place or the selection process for recruiting participants which may all introduce an element of bias. The lack of control groups in many of the included study further limit the interpretation of data. Additionally, exact treatment protocols were not discussed.Overall, the results are promising and clinically relevant. Future studies should areas of bias outlined above.  |

**(3) Description and appraisal of (Physical Activity Targeted at Maximal Lipid Oxidation: A Meta-Analysis) by (A. J. Romain, M. Carayol, M. Desplan, C. Fedou, G. Ninot, J. Mercier, A. Avignon, and J.F.Brun; 2012)**

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| **Aim/Objective of the Study/Systematic Review:** |
| The purpose of this meta-analysis was to determine the effects of exercise on maximal lipid oxidation in obese individuals. It aimed to describe overall characteristics of exercise training as it relates to weight-loss. |
| **Study Design**[e.g., systematic review, cohort, randomised controlled trial, qualitative study, grounded theory. Includes information about study characteristics such as blinding and allocation concealment. When were outcomes measured, if relevant]Note: For systematic review, use headings ‘search strategy’, ‘selection criteria’, ‘methods’ etc. For qualitative studies, identify data collection/analyses methods. |
| **Systematic Review**Literature Search: The authors conducted a search on Pubmed and ISI Web of Science. The authors also manually searched sciences direct database for articles. Articles published in French or English were included if they were published between 1994 and 2012. 1994 was set as the start date using the crossover concept. Search terms included “lipoxmax,” “lipoxmax AND training,” “lipoxmax AND physical activity,” “lipoxmax AND exercise,” “fatmax,” “fatmax AND training,” “fatmax AND physical activity,” “fatmax AND exercise,” “maximal fat oxidation,” “maximal fat oxidation AND training,” “maximal fat oxidation AND exercise,” and “maximal fat oxidation AND physical activity” (Romain, 2). Articles were selected by three different individuals and any differences were settled via discussion. If data was duplicated in studies, only the more recently published study was included.Study Selection: Inclusion criteria* Designed as randomized control trial or clinical trial.
* Maximal fat oxidation point was established and used according to the protocol.
* Participants were male or female, without age restriction, affected by chronic diseases.
* Cholesterol and anthropometric measurements were used and defined as outcome measures

Exclusion criteria* Animal models
* Cross-sectional study design
* Study lacked an intervention
* The intervention was on healthy participants

Extraction and Classification of Data* Selected outcomes were as follows:
	+ Weight
	+ Waist measurement
	+ Fat mass
	+ Serum cholesterol
* Descriptive Data
	+ Author
	+ Year of publication
	+ Pathology
	+ Study sample characteristics
	+ Type of design
	+ Duration of training protocol

Statistical Methods* A random effects model was used to pool data (DerSimonian and Laird method)
	+ First: Pre- and postintervention differences in mean were pooled
	+ Second: Comparison of intervention versus control group in randomized control trials were pooled (only completed for weight as < 3 included studies reported mean differences in additional outcomes
* Heterogeneity was assessed using Cochran’s chi-square test. The extent of heterogeneity was further quantified by estimating between-study variance (I2). When heterogeneity was present, meta regression was calculated to determine which factors impact final pooled estimates.
* Publication bias was examined by using a funnel plot. The plot presented mean differences in weight.
 |
| **Setting**[e.g., locations such as hospital, community; rural; metropolitan; country] |
| The settings in which each of the studies took place is not described in this article. No data available. |
| **Participants**[N, diagnosis, eligibility criteria, how recruited, type of sample (e.g., purposive, random), key demographics such as mean age, gender, duration of illness/disease, and if groups in an RCT were comparable at baseline on key demographic variables; number of dropouts if relevant, number available for follow-up]Note: This is not a list of the inclusion and exclusion criteria. This is a description of the actual sample that participated in the study. You can find this descriptive information in the text and tables in the article. |
| 279 subjects were included in the review from a total of 15 studies that met the inclusion criteria. Six different populations were examined including obese adolescents, obese adults who were not diabetic, patients with metabolic disorders, patients with human immunodeficiency virus (HIV), patients with type two diabetes (T2D), and finally one study with patients receiving neuroleptic treatment (Romain, 2). The minimum number of subjects per study was 7 and the largest study included 39 participants. The review included 3 randomized controlled trials, 2 controlled trials, and 10 clinical trials or random trials. Information regarding how samples were recruited was not included. Demographic information for subjects in each study is not available in this review. |
| **Intervention Investigated**[Provide details of methods, who provided treatment, when and where, how many hours of treatment provided] |
| *Control or Comparison* |
| Many of the studies included did not have a true control group (only 3 of the studies included a true control group). Of the studies where a control group was present, detailed information is not given in the review. Some studies had a comparison group. Again, little information is given outlining the comparison groups.  |
| *Experimental* |
| There were several training protocols outlined, including studies with exercise interventions and studies that had exercise training plus diet interventions. The duration of included studies ranged from 2 months to 12 months. The number of training session per week ranged from 2 to 4 session. The length of training sessions also differed, ranging from 45 minutes to 90 minutes. Some of the included studies did not outline the number of sessions per week while training session per week in one study decreased over the course of the study. All included studies used an ergometer. Of the studies that included a diet component, all used a hypocaloric diet ranging from 300 to 500 Kcal per day below the energy requirements. Some studies did not specifically outline the nutritional components of the diet while several studies used the following nutritional breakdown: 15% protein, 55% carbohydrates, and 30% lipids.  |
| **Outcome Measures** (Primary and Secondary)[Give details of each measure, maximum possible score and range for each measure, administered by whom, where] |
| Primary outcomes:* Weight was measured in kilograms. Waist circumference measures in centimeters. Fat mass was calculated and reported in kilograms. Cholesterol was reported in mmol/L.

Secondary outcomes: Coding used for subgroup analysis* Intervention versus control comparison was calculated for weight.
* Pathology in relation to weight loss
* Duration of training protocol
* Exercise versus diet and exercise interventions for weight loss
 |
| **Main Findings**[Provide summary of mean scores/mean differences/treatment effect, 95% confidence intervals and p-values etc., where provided – if you need to calculate these data yourself, put calculations here and add interpretation later, under ‘critical appraisal’ on next page] |
| **Before versus after Intervention**Weight:11 studies included in the review reported significant weight loss during intervention. Weight loss in all studies ranged from 0 kilograms to 11.5 kilograms. The pooled effect estimate in the before versus after intervention calculation was found to be effect size (ES)= -2.86 kg (CI=-4.07 to -1.64). There was significant heterogeneity among the included studies (P<0.0001, I2 = 82%).Fat Mass:Of the 15 included studies, 10 reported significant fat mass loss when comparing post to pre-intervention measurements. The loss of fat mass varied from -0.01 kg to -12.1 kg. When combining this information, the pooled effect estimate was ES=4.1 kg (95% CI=-5.8 to -2.3). An analysis showed significant heterogeneity among included data (P<0.0001, I2 = 81%).Waist Circumference:Approximately half (7/15) of the included studies reported significant changes in waist circumference from pre to post-assessment. Of all included studies, changes in waist circumference ranged from -2.9 cm to -12.3 cm. When pooling the data, statistically significant (P<0.0001) differences were observed in the pre to post-test values with an effect estimate of ES= -4.9 (95% CI=-6.6 to -3.2). Again significant heterogeneity was found among studies (P=0.02, I2 = 52%).Cholesterol:Only 3 of the included studies found statistically significant changes in cholesterol from before to after invention. Of all included studies, the changes in total cholesterol ranged from 0 mmol/L to 0.66 mmol/L. When data was pooled, pooled effect estimate from before and after intervention was ES=0.26 mmol/L (95% CI=-0.35 to -0.17, P<0.0001). There was no significant heterogeneity between studies (P=0.18). Intervention versus Control:Analysis computed only for weight due to lack of data for other characteristics. 5 studies (N=185 subjects) were included in the analysis. All the studies included reported significant weight loss for the intervention group in comparison to the control group. Data was pooled and the mean difference was ES=-0.37 (95% CI= -0.69 to -0.06, P=0.02). No significant heterogeneity was found between groups (P=0.83, I2=0.0%).**Analysis of Moderators:**Results from analyses of moderators.

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| --- | --- | --- | --- | --- |
| **Moderators** | **Beta** | **Standard Error** | **P-value** | **95% CI** |
| **Weight** |
| Population | 1.05 | 0.12 | <0.001 | 0.81; 1.29 |
| Duration | 0.25 | 0.20 | 0.23 | −0.17; 0.67 |
| Nutrition | −5.09 | 1.47 | 0.003 | −8.18;−2.01 |
| **Fat Mass** |
| Population | 2.19 | 1.57 | 0.19 | −1.32; 5.70 |
| Duration | 1.79 | 2.93 | 0.55 | −4.74; 8.34 |
| Nutrition | −6.75 | 0.97 | <0.001 | −8.92;−4.58 |
| **Waist Circumference** |
| Population | 0.95 | 1.38 | 0.51 | -2.80; 4.90 |
| Duration | 2.07 | 2.16 | 0.36 | -2.80; 6.96 |
| Nutrition | -5.37 | 1.38 | <0.001 | -8.49; -2.25 |

\* Table 2 (Romain, 6)Weight:The two moderators that were significant for weight loss were population and nutrition according to the metaregression (see above). When population was further subdivided, the results were still significant in obese adolescents, metabolic syndrome, and type 2 diabetes (see below).* Obese adolescents: ES=−4.21 (95% CI: −4.48; −3.94) with no heterogeneity (P = 0.52, I2 = 0.0%)
* Metabolic syndrome: ES=−2.60 (95% CI:−3.92;−1.27) heterogeneity not applicable because only 1 study was included
* Type 2 diabetes: ES=−1.95 (95% CI: −2.72; −1.18) with no heterogeneity (P =0.53; I2 =0.0%)

Furthermore, when considering the type of intervention provided, significant weight loss was observed in both the exercise only groups and the exercise plus diet group, with significantly greater changes in weight in the diet plus exercise group. Additionally, heterogeneity was only observed in the exercise alone group and not in the exercise plus diet group. See results below.* Exercise only: ES=−1.95 (95% CI: −3.28; −0.62) with heterogeneity (P<0.001, I2 = 85%).
* Diet plus exercise: ES=−6.81 (95% CI: −9.15; −4.47) without heterogeneity (P = 0.54, I2 = 0.0%).

Fat Mass:For fat mass, only nutrition was a significant moderator (see table above). When further dividing population, significant mean difference was observed in the exercise only group, yet significantly higher results were observed in the exercise and diet groups. See results below.* Exercise only: ES=−1.49 (95% CI: −2.04; −0.94) without heterogeneity (P = 0.99, I2 = 0.0%).
* Diet plus exercise: ES=−8.32 (95% CI: −10.89; −5.74) without significant heterogeneity (P =0.10, I2 =48.6%).

Waist Circumference:For waist circumference, only nutrition was a significant moderator (see table above). When comparing exercise alone and diet plus exercise, both were found to be significant without significant difference between the two groups. See results below.* Exercise only: ES=−3.51 (95% CI: −4.58; −2.43) with no heterogeneity (P = 0.98, I2 = 0.0%).
* Diet plus exercise: ES=−8.87 (95% CI: −11.98; −5.75) without significant heterogeneity (P = 0.19, I2 = 36%).

Cholesterol: Significant heterogeneity was not observed (P = 0.02, I2 = 52%). Moderators of cholesterol were not analysed.Publication Bias:Publication bias was assessed for weight loss before and after the intervention using a funnel plot. A weak trend was observed for smaller studies to report more significant weight loss than larger studies. This could be a sign of publication bias; however, this trend may also be due to the small number of included studies. |
| **Original Authors’ Conclusions**[Paraphrase as required. If providing a direct quote, add page number] |
| The authors of this meta-analysis concluded that “low intensity training targeted at the level of maximal fat oxidation signiﬁcantly decreases body weight, fat mass, waist circumference and total cholesterol” (Romain, 8). Interestingly, some studies reported better outcomes when diet was combined with exercise interventions. This was confirmed by the review as there was a significantly greater change in weight and fat mass in the groups that included diet plus exercise. These results should be interpreted with caution through as it can be hard to separate diet and exercise. Overall, a hypocaloric diet appears to help with weight loss and fat mass loss when combined with exercise.There may be a correlation between the amount of low intensity training performed per week and weight loss but this needs to be further examined. In the review, there was weight loss observed in the study that used a 90min/day exercise protocol that could suggest a need for higher volumes of exercise for weight loss. Furthermore, it is well supported that exercising at a low intensity can maximize lipid oxidation; however, the effects on this form of exercise on resting metabolism has yet to be fully studied. Some studies suggest that other forms of exercise that do not specifically target lipid oxidation may produce changes in resting lipid oxidation and have other health benefits.Some of the areas of potential bias discussed by the authors include publication bias, lack of randomized control trials, relatively small number of included studies, and heterogeneity observed.  |
| **Critical Appraisal** |
| **Validity**[Methodology, rigour, selection, sources of bias, quality score on methodology quality rating scale (indicate the quality assessment tool used and the maximum possible score on that scale, e.g., 7/10 on PEDro scale), appropriateness of analytical approach (e.g., adjustments for confounding variables, management of missing data).]Comment on missing information in original paper. |
| Quality rating scale: AMSTAR 10/11* This score indicates a good quality study.

Quality of Included Studies* This review included studies with the following research designs: randomized controlled trials and clinical trials. Studies were excluded if they had a cross-sectional design. This limits the review to only the highest available studies available that meet the inclusion criteria. It is important to note that only 5 of the studies included in the review had control groups. When comparing the intervention groups to the control groups, the effect size was minimal to moderate (-0.37). The authors attributed this to the lack of power due to a small sample size.

Search and Study Selection* The authors searched only a few databases including PubMed and ISI Web of Science. Further search was completed by hand and 3 different investigators selected included articles. Disagreements were settled via discussion.
* Publication bias was address using a funnel plot. There was a small trend finding smaller studies to report larger changes in weight due to intervention. This may indicate publication bias as smaller studies without significant results may not have been published. The authors also state that the findings could also be due to small number of included studies. This should be interpreted with caution.
* It is not clear whether authors also searched for unpublished materials.
* Inclusion and exclusion criteria were clearly described in the article. Articles published in English and French were included in the study.

Assessing quality of individual studies* Each included article was categorized by study design. There were only 5 randomized controlled trials.
* There is little detail provide to describe the individual studies. Number of subjects in each study and the population is described in Table 1. It is not clear how participants were selected or assigned to treatment groups.
* Specific protocols are not included; therefore, it can be hard to assess bias that may have occurred due to different management of groups.
* There is also no information provided regarding loss of subjects or compliance with interventions.
* Results should be interpreted with caution as information detailing included participants and treatment design is scarce. Given the included data, it is difficult to determine areas of bias.

Individual Patient Data* Very little date regarding individual subjects is provided in the article. The author includes group weight loss, fat mass loss, and waist circumference but does not provide information regarding individuals within the group. Age and gender is not specified.

Statistical Analysis: Statistical tests applied were appropriate. Exact data is provided when available.* A random effects model was used to pool data (DerSimonian and Laird method).
* Heterogeneity was assessed using Cochran’s chi-square test. The extent of heterogeneity was further quantified by estimating between-study variance (I2). When heterogeneity was present, meta regression was calculated to determine which factors impact final pooled estimates. Authors provided explanation for heterogeneity when appropriate.
* Publication bias was examined by using a funnel plot. The plot presented mean differences in weight.
* Exact p-values and confidence were provided. Effect size was calculated as appropriate.
 |
| **Interpretation of Results**[Favourable or unfavourable, specific outcomes of interest, size of treatment effect, statistical and clinical significance, minimal clinically important difference. You may calculate effect size or confidence intervals yourself from the data provided in the article.] Describe in your own words what the results mean. |
| This meta-analysis found various important results that need to be considered. First, it is important to note that only studies that provided exercise treatment at the maximal lipid oxidation level were included. These are typically activities performed at a low intensity. Overall, the study found that exercise treatment performed at a low intensity overall a relatively long treatment session (>45 minutes per day) resulted in statistically significant reductions in weight, fat mass, waist circumference, and cholesterol when comparing before and after intervention values as detailed in the results section. When examining the effect size (ES) of the pooled data, these results can also be interpreted as clinically meaningful except for changes in cholesterol. These results, however, should be interpreted with extreme caution as there was significant heterogeneity found in weight, fat mass, and waist circumference. This may be due to small sample size and limited number of studies included in each calculation. While 11 studies included measurements regarding changes in weight and 10 studies included measurements regarding changes in fat mass, only 7 studies included measurements on waist circumference and 3 studies included measurements regarding cholesterol. This limits the power due to small sample size.* Weight: ES= -2.86 kg (CI=-4.07 to -1.64) indicating a large effect.
* Fat mass: ES=4.1 kg (95% CI=-5.8 to -2.3) indicating a large effect.
* Waist circumference: ES= -4.9 (95% CI=-6.6 to -3.2) indicating a large effect.
* Cholesterol: ES=0.26 mmol/L (95% CI=-0.35 to -0.17) indicating a minimal effect size.

When specifically considering the moderators applied to the data, there were also several statistically significant findings. To begin with, significant weight loss was observed in all of the populations. There was, however, no significant heterogeneity in the data but readers should still take caution when interpreting these results due to the relatively small samples size and number of included studies. The effect sizes were once again large enough to indicate clinical meaningfulness.* Obese adolescents: ES=−4.21 (95% CI: −4.48; −3.94) with no heterogeneity (P = 0.52, I2 = 0.0%)
* Metabolic syndrome: ES=−2.60 (95% CI:−3.92;−1.27) heterogeneity not applicable because only 1 study was included
* Type 2 diabetes: ES=−1.95 (95% CI: −2.72; −1.18) with no heterogeneity (P =0.53; I2 =0.0%)

Additionally, nutrition plus exercise appears to be more effective for weight loss than exercise alone. While both groups had statistically significant and clinically meaningful changes (large effect size), the groups that included nutrition had less heterogeneity and significantly better results. This should cause the reader to interpret results in the exercise only group cautiously; however, it is important to note that only 5 of the studies included in the review had a nutrition component. * Exercise only: ES=−1.95 (95% CI: −3.28; −0.62) with significant heterogeneity (P<0.001, I2 = 85%).
* Diet plus exercise: ES=−6.81 (95% CI: −9.15; −4.47) without significant heterogeneity (P = 0.54, I2 = 0.0%).

When further interpreting data related to the importance of nutrition in combination with exercise in comparison to exercise alone, statistically significant results were found when assessing fat mass in both groups, yet a significantly larger change was observed in the diet plus exercise group. With a large effect size, the results can be interpreted as clinical meaningful as well. Again, the group with diet plus exercise was also found to have less heterogeneity. * Exercise only: ES=−1.49 (95% CI: −2.04; −0.94) without heterogeneity (P = 0.99, I2 = 0.0%).
* Diet plus exercise: ES=−8.32 (95% CI: −10.89; −5.74) without significant heterogeneity (P =0.10, I2 =48.6%).

Lastly, nutrition plus exercise and exercise alone also result in statistically significant reductions in waist circumference. Large effect sizes indicate clinical meaningfulness. While there is no significant heterogeneity in these groups, there are also fewer studies included in the calculations.* Exercise only: ES=−3.51 (95% CI: −4.58; −2.43) with no heterogeneity (P = 0.98, I2 = 0.0%).
* Diet plus exercise: ES=−8.87 (95% CI: −11.98; −5.75) without significant heterogeneity (P = 0.19, I2 = 36%).

Overall, the results indicate that exercise at a low intensity can effectively reduce weight, fat mass, waist circumference, and cholesterol; however, there are several limitations to these results including the limited sample sizes and limited number of included studies. There is also significant heterogeneity present in many of the groups. Finally, when targeting weight loss and fat mass reduction, including nutrition and exercise in the intervention may create better results.  |

**IMPLICATIONS FOR PRACTICE and FUTURE RESEARCH**

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| *Implications for Clinical Practice*The articles included in this appraisal provide evidence to support the use of low intensity aerobic exercise to promote weight loss and treat adolescents who are obese or overweight. Low intensity aerobic exercise optimizes lipid oxidation during activity. High-intensity interval training, however, was also found to create statistically and clinically significant weight loss and body fat reduction in obese adolescents. This form of exercise was less effective at promoting lipid oxidation and actually significantly increase carbohydrate oxidation during activity. Given the results described in the best evidence presented, the current recommended form of exercise for weight loss in adolescents who are obese is low intensity aerobic exercise as it may not only result in weight loss but also promotes lipid oxidation reducing overall fat. There is also weak evidence that supports the use of high-intensity interval training for weight loss in obese adolescents. In addition to exercise, evidence suggests implementing a behavioural modification aspect and diet component to elevate weight loss outcomes. A hypocaloric diet can vary but often include 15% protein, 55% carbohydrates, and 30% lipids. Behavioural modifications could include patient and family education as well as promoting a physically active lifestyle. When applying this information to patients clinically, there are several important considerations to make. First, many of the low-intensity aerobic exercise protocols called for high volumes of exercise (as much as 90min/day) which may not be appropriate for some patients. In this case, it may be feasible to recommend high-intensity interval training for weight loss due to time constraints or fitness components. Conversely, high-level interval training may require a higher state of fitness and function at baseline and not all patients will be able to perform these activities. For those patients, it will be more appropriate to recommend and implement a low intensity aerobic training protocol. One of the biggest issues physical therapists face when implementing exercise protocols aimed at weight loss in adolescents who are obese is the fact that these services are currently not reimbursed by most third party payers. It is imperative that physical therapist still address obesity in practice. The impact obesity has on health cannot be denied and therefore, by choosing to ignore obesity or not treat it, we jeopardize our clinical outcomes. Physical therapist should seek to treat patients with best practice regardless of reimbursement, but when this is not feasible, we can find alternative methods to implement these exercise recommendations. For example, exercise targeted at weight loss can become part of a home exercise plan or at the very least play a component in our patient and family education. *Implications for Future Research*When considering the current level of research available on this topic, there are several implications for future research. To begin with, the current evidence lacks large samples and clinical trials with control groups. In order to increase the power of the statistical findings and limit the influence of biases, more research need to be completed recruiting larger samples and comparing treatments to control groups. This is the case in particular when considering the paediatric population.In addition to larger and more controlled studies, future research should focus on teasing apart several aspects of weight loss protocols including behavioural modification and diet. It is hard to determine the impact of exercise alone in reducing weight and body fat in obese adolescents when there are confounding variable such as a hypocaloric diet. While a combination of several interventions will likely yield the best results, we need research to justify each component’s influence. Finally, the current literature suggests that in order to optimize weight loss, exercise should be performed at a level that promotes the highest lipid oxidation. This is often referred to as “lipo-max.” While this idea is very popular, there may be some shortcomings. For example, it has been suggested that higher levels of intensity may change resting substrate oxidation and could actually increase metabolism immediately following the activity. The current evidence does not examine these ideas. |

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