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Mini Review (Systematic Review)

Dose-Dependent Effects of Physical Exercises on Anthropometric Parameter among Overweight/Obese Individuals: Systematic Review

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A B S T R A C T

Physical Activity is primarily a central approach for maintaining the healthy weight therefore developing effective dose of physical exercises in term of intensity, duration and type is more crucial now a days. This systematic review summarizes the impact of physical exercises dose on Body weight (BW), body fat percentage (PBF) and body mass index (BMI) in individuals with overweight and obesity. From February to August 2021, a systematic literature search strategy was used, with four electronic databases yielding 2,750records. After screening the study titles, abstracts and full texts according the eligibility criteria, we included 100 studies in our final analysis. Aerobic (endurance-based exercises) and anaerobic (strength/resistance training) both exercises with low to moderate intensities improves anthropometric characteristics in overweight/obese population from trivial to moderate effect size (0.2-1.0)ranging from eight weeks to 12-months of duration, However, combination of training (High intensity circuit training/High Intensity Interval Training, HICT/HIIT)substantially decreases the BMI, BW and PBF in overweight and obese individuals from small to large effect size (0.2-1.2) ranging from three to twenty-four weeks of duration. Yet, the optimal combination of the ratio of circuit training intervals necessary to produce effective results in overweight and obese population is still ambiguous. Thus, further studies are needed to determine the optimal ratio of bouts intervals to produce most efficient HICT/HITT training programs in less time.

Introduction

Obesity is a complex condition associated with extensive range of multiple chronic diseases including coronary heart disease, diabetes mellitus different types of cancers, sleep apnea and certain breathing disorders[1] the World Health Organization (WHO) declared obesity as a disease state and is defined as Body Mass Index (BMI) over 25 is consider overweight, and over 30 is obese.[2]

Obesity as disease state is a great concern for two important reasons[1] the soaring rate of escalating of the obesity among adult population in both developed and developing countries[2] obesity related health issues also impact young individuals, such as childhood obesity is one of the significant concern that has reached into the epidemic level in both industrialized and emerging countries. According to the WHO, 10% children and adolescent with age range 5-17 years having obesity worldwide.[3] Moreover, studies reported that obesity related mortality in adulthood is highly associated with childhood obesity and may lead to increase chance of developing cardio-metabolic diseases and cancers.[4-6]

Generally, obesity is the root cause of many complicated chronic diseases therefore, the long term prevention and control on obesity epidemic has become the utmost need of the societies. Comparative to pharmacotherapy and surgerical procedures, optimal amount of physical activity is considered as the cost effective way for maintaining healthy body weight and body fat.Multiple studies well documented the evidence of significant association between physical activity and weight loss [7-10] but the quantification of exercise dose in term of type, intensity and duration is still the research gap found in clinical management of obesity. Evidence have revealed that type and dose of exercises are essential components to manage optimal body weight and body fat therefore dose-dependent physical exercise programs should be well reported to facilitate the adoption and maintenance of regular exercises.[11] Furthermore, sedentary lifestyle has

negatively impact the overall quality of life in individual with overweight and obesity. However, the American College of Sports and Medicine (ACSM) recommended 150 minutes/week of moderate intensity of exercise is recommended for adult population. With the advent of time, ACSM recommended combination therapies including High Intensity Circuit Training (HICT) because of increased efficiency and practicality. The concept is to combine the aerobic and resistance training into one bout of approximately 7 minutes and then repeating the bout 2 to 3 times progressively.[12] A study reported that aerobic exercises not only decrease body fat percentage but also improve the overall physical performance in obese individuals. [13] Similarly, another study found that high intensity aerobic exercises profoundly reduce the body fat percentage in 12 weeks of training session.[14] This systematic review aims to provide the evidence of Different physical training protocols including aerobic, anaerobic and combined exercises on anthropometric parameters (body weight and body fat percentage and BMI) in overweight and obese individuals.

Methodology

Inclusion criteria of the studies

The Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) guideline was used for reporting the conducted trials. Furthermore, for reporting the inclusion criteria of the studies the Population, Intervention, Comparison, Outcome (PICO) approach was used. Following inclusion criteria were used in the study; (1) studies with Randomized Control Trials (RCTs) (2) Population of the study were overweight and obese individuals (3) Participants were human subjects(4) Physical exercise were given as an Intervention (5) the studies which analyses the impact of physical exercises on anthropometric parameters (body weight, body fat and BMI) of the individual.

Exclusion criteria of the studies

The studies were excluded upon meeting the following criteria; (1) did not meet the minimum criteria of study design (e.g., observational studies, case report) (2) did not given the desire intervention (Physical Exercises protocol) (3) used language other than English in the studies.

Searching Strategy of the studies

To ensure the systematic searching of the relevant articles we used electronic databases including PubMed, Scopus, Web of Sciences and Sports Medicine and Education Index from March to Aug 2021. We used multiple key words and synonyms terms as well in the MeSH database with or without Boolean logics. Following key term were used; Exercise, Aerobic training, Anaerobic training, overweight, obesity, High Intensity Circuit Training (HICT), Endurance training, Strength training, Sprint training, Body weight, Body fat, Body Mass Index, Fat Free mass. Following Boolean operators were used with key terms; ['exercise training' OR 'endurance training' OR 'combine training' OR 'high-intensity training' OR 'high- intensity interval training' OR 'aerobic training' OR 'anaerobic strength-based training' OR 'strength training' OR 'resistance training' OR 'endurance exercise program' OR 'low-intensity training' OR 'moderate-intensity training' OR 'low-moderate training exercise' OR ' maximal aerobic capacity' OR 'anaerobic performance' OR 'aerobic performance' OR 'physical training performance' OR 'maximal strength capacities' OR 'circuit exercises' OR 'sprint intervals'] ['body weight' OR 'body fat' OR 'fat f free mass' OR 'body lean mass' OR 'body mass index' OR 'weigh-height ratio' OR 'adipose tissues' OR 'muscle mass' OR 'physical fitness' OR 'lean muscle mass' OR 'BF' OR 'BW' OR 'BMI'] AND ['intensity' OR 'duration' OR 'type' OR 'time' OR 'mode']. Moreover, further relevant studies were also searched by the citation and reference lists of included studies however, the heterogeneity was found between the studies due to large numbers of outcome and intervention component were evaluated.

Selection criteria of the studies

On the bases of inclusion and exclusion criteria the relevant outcomes of studies including body weight, body fat %, BMI, physical exercises (aerobic, anaerobic, combine) and doses of exercise training (intensity, duration, type) were screened critically by the two investigators. Furthermore, full text articles were screened followed by the potential screening of concern abstracts.

Quality Assessment of the studies

The quality of included articles were evaluated by using the Physiotherapy Evidence Database (PEDro) scale that was known for the valid tool, subjected to parametric statistical analysis of methodological quality of RCTs. The PEDro scale has total 11 items which inspected the internal validity (criterion 1) and external validity (criterion 2-9) of the RCTs. Furthermore, criterion 10-11 examined the statistical quality of the article results. The cut-off score of PEDro scale 6 indicated the overall high quality of the trails hence it is sufficient tool to describe the quality assessment of the studies.[21-24] Two authors of this study were examined the quality of the included trails.

Results

Our systematic search identified 2,750 records in four electronic databasesshown in Figure 1. Following the title, abstract and full text screening, and final analysis included 100

studies; Table I shows the characteristics for these studies. The incorporated studies were execute in 20 countries (Turkey, Australia, Singapore, Saudia Arabia, USA, Brazil, Korea, Poland, Denmark, Canada, South and north Africa, Iran, Sweden, China, Spain, UK, Italy, Germany, Malaysia and Greece). Furthermore, 82 of the included studies were categorized"high quality"; ≥6 PEDro score while 8 studies were "low quality"; ≤5 PEDro score shown in Table II. Out of 100 integrated studies, 49 examined aerobic exercises, 24 examine anaerobic exercises and 27 studies examine high-intensity interval training/high intensity circuit training exercises. The total number of 3,256 participants went through training sessions and completed the studies. The least to maximum duration of the exercises were reported from 3 weeks to 18-months respectively. However most of the studies conducted the training sessions in 8-12 weeks and reported the greater effect size in reducing body fat percentage, Body weight and BMI. The effect size (ES) of the outcome was calculated using the following equation: ES= (Post $_{mean}$-Pre $_{mean}$)/SD. According to Hopkins et al., ES were considered as trivial, small, moderate, large and very large (<0.2), (0.2-0.6), (0.6-1.2), (1.2-2.0) and (2.0-4.0) respectively.

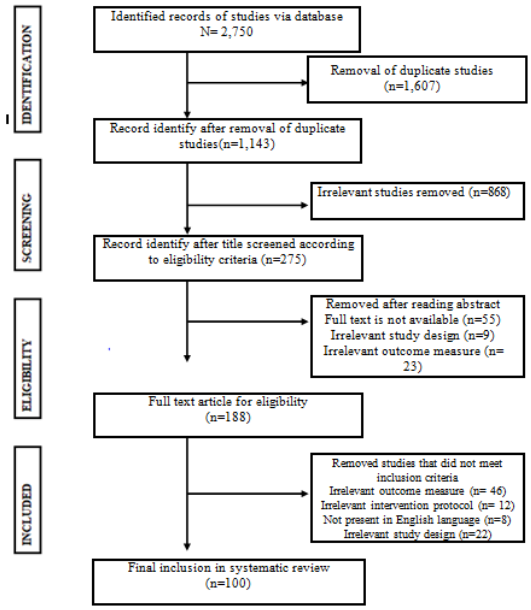

Figure: 1 PRISMA flow diagram of literature search

Risk of bias assessment

According to PEDro scoring the quality of incorporated studies were summarized in Table 3. We included total hundred studies out of which eight studies were observed low-quality (≤5 PEDro score), ninty-two studies were high-quality evidence(≥6 PEDro score).

Dose response effect of exercise training on anthropometric par ameters

Aerobic exercise effects

We examine total of forty-nine studies that evaluate the effect of aerobic or endurance exercise training and their effect on body composition (BMI, BW and PBF) in individuals with overweight and obesity among 1,894 participants. The summarized effect of doses of exercise with respect tointensity and duration were shown in Table II. The selection of appropriate exercise intensity is extensively important factor for effective exercise protocol. In included studies the intensities of aerobic exercises were reported in term of % of Maximum Heart Rate (MHR), % of Vo_2 maximum, % of Targeted Heart Rate (THR), % of Heart Rate Reserve (HRR) and ventilator Threshold (VT). Besides, twenty-seven (Donges et al, Kim et al, Sanal et al, Wong et al, Saif et al, Dow at el, Regaieg et al, Thomson et al, Skrypnik et al, Savoye et al, Dieli-Conwright et al, Alizadeh et al, Nunes et al, Goldfield et al, Irwin et al, Imayama et al, Stewart et al, Hill et al, Tan et al, Cadenas-Sanchez et al, Herring et al, Cambell et al, Amanat et al, Cambell et al, Kemmler et al, Parhampour et al, Paoli et al) out of forty-nine studies reported exercises intensities from 40%- 85% of MHR with ES range from trivial to moderate (0.2-1.0), showing significant improvement in BMI,BW and PBF. Additionally, Saif et al showed remarkable improvement in BMI with the very large ES (1.0) incorporated 60-70% of MHR, another study showed large ES (1.07) in reducing BW using 65 % of MHR in overweight and obese population. on the other hand, nine studies (, Rosenkilde et al, Baria et al, Hays et al, Lee et al, Redman et al, Sun et al, Courneya et al and Church et al) reported exercise intensities from 40%-85% of $vo_{2\ max}$with ES range from trivial to moderate (0.2-1.0) respectively. Furthermore, Monterio et al incorporate the 65-85% $vo_{2\ max}$ intensity of aerobic exercise and reported significant reduction (ES=1.02) in PBF among overweight and obese subjects. Moerover, one study(Rayes et al) showed no benefits in anthropometric characteristics due to heterogeneous nature of findings. However, moderate-intensity aerobic exercises showing greater improvement in BMI, BW and PBF among overweight and obese individuals. Subsequently, fourteen (Sanal et al, Wong et al, Saif et al, Dow at el, Park et al, Baria et al, Hays et al, Alizadeh et al, Nunes et al,Herring et al, Amanat et al, Ho et al, Courneya et al and Paoli et al) **See more references, mentioned in alphabetical order in table I-III.**

out of forty-nine studies reported the duration of 12 weeks aerobic exercises on anthropometric parameters. A greater part of included studies suggested that 8-12 weeks aerobic exercises is adequate to produce considerable improvement in BMI,BW and PBF (Sanal et al, Wong et al, Saif et al, Dow at el, Park et al, Baria et al, Hays et al, Alizadeh et al, Nunes et al,Herring et al, Amanat et al, Ho et al, Courneya et al, Paoli et al, Vatansev et al, Kim et al, Rayes et al, Roh et al and Schroeder et al).Few studies (Baria et al, Savoye et al, Lebon et al, Goldfield et al, Redman et al, Irwin et al) have recommended non-linear association between exercise duration and anthropometric characteristics improvement. Results of the incorporated studies suggested that 8-12 weeks of aerobic exercises significantly improve BMI, BW and PBF however, longer duration (20-48 weeks) exercises grantlittle supplementary benefits.

Anaerobic exercise effects

A total of twenty-four studies (868 participants) evaluated the effect of anaerobic or strength training exercise and their effect on body composition (BMI, BW and PBF) in individuals with overweight and obesity. Table II summarizes the effects of different exercise doses in terms of intensity and duration. The adoption of adequate anaerobic exercise intensity is a key component for improvement in body composition. In included studies the intensities of anaerobic exercises were reported in term of % of 1 Repetition Maximum 1(RM), % of Maximum Heart Rate (MHR) and rating perceive exertion from Borg Scale. Furthermore, fifteen (Donges et al, Kim et al, Thomson et al, silva et al, Nunes et al, Freitas et al, Mavros at el, Dawson et al, Cadenas-Sanchez et al, Herring et al, Amanat et al, Kemmler et al, Liao et al, Binder et al, Parhampour et al) out of twenty-four studies reported exercises intensities from 6%- 100% of 1RM with ES range from trivial to moderate (0.2-0.6) in improvement of BMI,BW and PBF. Moreover, Dawson et al showed moderate improvement (ES; 0.1-0.7) in PBF and BW, incorporated 60-83% of 1 RM among overweight and obese population. On the other hand, miller et al reported that exercise with intensity of 12-16 Borg scale scoring showing great improvement in reducing BW. Besides, one study (Goldfeild et al) showed no benefits in anthropometric characteristics due to diverse character of findings. However, Lee at el has suggested that 60% of baseline1RM is more than enough for improvement in BMI in obese population.Afterward, seven studies (Saif et al, Nunes et al,Herring et al, Ho et al, Dawson et al, Laoi at el, Amanat et al) reported the 12 weeks duration of anaerobic exercises that improve anthropometric parameters significantly with ES (0.2-0.7) range from small to moderate correspondingly.In one study Kim et al reported that 8 weeks continuous anaerobic exercises moderately (ES; 0.69) improve the PBF. However, Mcguigan et al suggested in their study that 8 weeks of strength training decrease the PBH significantly, in overweight and obese population additionally, Schroeder et al also shows the similar effects in 8 weeks of training. Moreover, several studies (Freitas et al, Skrypnik et al, lee et al) recommended 3 months of strength training duration for better effects in BMI, PBF and BW. Likewise, further included studies suggested 9-months, 18-months, 10 weeks, 20 weeks and 24 weeks respectively for long-term benefits of anaerobic exercises.

High-Intensity Circuit Training/ High-Intensity Interval Training effects

The included studies of HIIT/HICT were twenty-seven that evaluate the effects of exercise protocol on BMI, PBF and BW among overweight and obese population with 494 numbers of participants. The effect of doses of HIIT/HICT exercise with respect to intensity and duration were shown in Table II. The selection of appropriate exercise intensity is a critical factor in developing an effective exercise protocol. In incorporated studies reported exercise intensities in term of % of Maximum Heart Rate (MHR), perceived exertion according to Borg scale, % of Targeted Heart Rate (THR), % of Heart Rate Reserve (HRR), % of 1 Repetition maximum (1RM) and ventilator Threshold (VT). more to the point, ten studies (Domaradzki et al, Kim et al, Kim et al, Ludin et al, Meckling et al, Eather et al, Seo et al, Nunes et al, Sperlichet al, Davis et al, Gutin et al) out of twenty-seven measure HICT/HIIT exercise intensity with range of 50%-90% of MHR with demonstrating small to moderate improvement in body composition. Furthermore, Sperlich et al found that 65% of MHR moderately reduce PBF in obese subjects while Seo et al and Nunes et al also reported the similar effect on same outcome measure with intensity of 60%-90% of MHR. However Meckling et al showing little more improvement in PBH with the intensity of 65%-80% of MHR. Besides this,Lebon et alshowing large scale improvement in BMI by incorporated intensity of HICT exercise with >90% of HRR. Similarly, Batrakoulis et al and Marcos-Pardo et al also showing similar effects on PBF with exercise intensity >65% of HRR and 60%-80% of 1RM respectively. On larger scale the effective reduction in BW was observed with the exercise intensity of 65%-75% of HRR (Paoli et al). Hence it was observed that several studies reported significant improvement in BMI, PBF and BW with moderate-High intensity (50%-90% of MHR/ 60%-90% of HRR) exercises among overweight and obese populace. Another key dose of exercise (duration) also plays a significant role for effective and efficient exercise protocol. Out of twenty-seven studies twelve studies **See more references, mentioned in alphabetical order in table I-III** (Heydari et al, Kim et al,Paoli et al Fett et al, Ludin et al,

Meckling et al, Branco et al, Khammassi et al, Nunes et al, Paoli et al, Marcos-Pardo et al, Bocalini et al) reported 12 weeks duration of HICT/HIIT exercises that improve anthropometric parameters significantly with ES (0.2-0.7) range from small to moderate respectively. Several included studies (Heydari et al, Kim et al, Paoli et alFett et al, Ludin et al, Meckling et al, Branco et al, Khammassi et al, Nunes et al, Paoli et al, Marcos-Pardo et al, Bocalini et al, Ether et al, Boclani et al, Keating et al, Gutin et al, Balachandran et al, Davis et al, Seo et al, Fisher et al) suggested that 8-20 weeks HICT/HIIT exercises is adequate to produce considerable improvement in BMI, BW and PBF. However, few studies (Fett et al, Kong et al, Miller et al) have recommended non-linear association between exercise duration and anthropometric characteristics improvement. Results of the incorporated studies suggested that 12-20 weeks of HICT/HIIT exercises significantly improve BMI, BW and PBF, while longer duration (20 weeks-12 months) exercises contributes moreadditional benefits.

Discussion

According to the findings of this systematic review, the moderating influence of endurance based exercise intensity is unclear. However, moderate-intensity strength training exercise, on the other hand, appears to be linked better results in improvement in anthropometric parameters. Further, the evidence also reveals that individuals with obesity who underwent either low or high intensity circuit training improved their body compositionas well as cardio-metabolic parameters and strength. Although, the optimal combination of the ratio of circuit training intervals necessary to produce most effective results in overweight and obese population is ambiguous. Furthermore, the current systematic review suggested that HICT/HIIT is the more efficient exercise protocol in comparison of aerobic and anaerobic exercise. In the same way, their impact on lipid oxidation and overall health parameters, HICT/HIIT exercises improve aerobic fitness and combat physical deconditioning, which is common in overweight and obese people. Deconditioning, in fact, poses a considerable risk because it is accompanied not only by poor physical conditioning but also by metabolic dysfunction, which exacerbates the threat for developing co-morbidities and promotes non-adherence to physical exercise protocols.[25] High intensity exercises build motivation in individual with overweight and obesity compare to low intensity exercises.[26] Additionally, low-intensity exercises are not enough to produce changes in PBF in obese individuals. According to the studies, 8-12 weeks workout is sufficient for improving BW, PBF and BMI, and a lengthier workout offers little additional benefit.[27] In terms of exercise prescription, the findings imply that short-duration activity is sufficient to anthropometric parameters. However, A lack of time is a common stumbling block for people who want to exercise.[28] Short duration circuit training combine with aerobic and anaerobic exercises have a good influence BMI, which means that more people will be motivated to exercise regularly. We discovered a non-linear relationship between aerobic exercise and PBF effects, despite the conventional belief that body composition improvement and exercise length are positively associated. The link between exercise duration and affective reaction is still a mystery. It is observed in review articles that exercising for 3 weeks has little impact on the body composition; nevertheless, lengthy duration of activity can cause weariness and evoke withdrawal-like responses.[29] When compared to aerobic exercise, anaerobic exercise can effectively reduce BW and sometimes provides additional advantages in maintaining cardio-metabolic parameters. Similarly, HICT/HIIT exercises can have similar effects on body composition in short duration when compare with aerobic exercises alone. However, we revealed inconsistent results when it came to the efficacy of aerobic exercise, which was likely related to the substantial heterogeneity of participant characteristics between studies. On the other hand, efficacy of HICT/HIIT exercises has been observed.It has been proposed that, when compared to aerobic exercise, anaerobic training improves performance more quickly.[30] Adults need at least 150 minutes of moderate (or 75 minutes of strenuous) aerobic activity and muscle training on two or more days each week, according to the Physical Activity Guidelines for Americans (Office of Disease Prevention and Health Promotion, 2008).To the best of our knowledge, the benefits of exercise on physical health have been well documented, but there has been no authorized inspection of the link between exercise dose and its effect on anthropometric parameters. As overweight and obesity reached in its epidemic state now a day[31], a better knowledge of the exercise dose and its relationship with anthropometric parameters is more important. Based on our included studies review, we found the anaerobic exercise has a stronger effect on muscular performances that are short-term and involve high capacity demands which is continuously required for constants training aiming to Improve BW,BMI and PBF. However, endurance training alone can be found as beneficial as strength training, lowering the PBF, improves BW and BMI although, long term effects on anthropometric parameter with combining of both exercises in short duration well documented in several studies.[32] Therefore, HICT/HIIT can be found more beneficial in improving anthropometric parameter among overweight and obese individuals.

Conclusion

It is well documented in literature that benefits of physical exercises have promising effects on anthropometric parameters among overweight and obese population but a better knowledge of the exercise duration intensity and its relationship with anthropometric parameters is more important. As a result, we presented in this systematic study that moderate-intensity anaerobic exercise is linked to improvement in anthropometric parameters however the current systematic review suggest that HICT/HIIT is the more efficient exercise protocol in comparison of aerobic and anaerobic exercise. HICT/HIIT exercises with eight to twelve weeks of duration are more effective in improving anthropometric parameters. Although, the optimal combination of the ratio of circuit training intervals necessary to produce effective results in overweight and obese population is still ambiguous. Thus further studies are needed to determine the optimal ratio of bouts intervals to produce most efficient HICT/HITT training programs in less time.

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See more references, mentioned in alphabetical order in table I-III.

TABLE: 1 Characteristics of studies that examine the dose response of physical exercises on anthropometric parameters
Abbreviations: Maximum Heart Rate; MHR, Repetition Maximum; RM, Targeted Heart Rate; THR, Maximum Aerobic Velocity; MAV, Heart Rate Reserve; HRR, Rate of Perceived Exertion; RPE, Ventilatory Threshold; VT

Authors Detail	Country	Population	Sample Size	Age (mean/SD/range)	Intensity	Duration
AEROBIC EXERCISES						
Alizadeh et al (2013)	Iran	Overweight/obese women	15	33.1±7.7	64-76% of MHR	12 weeks
Amanat et al (2020)	Iran	Overweight women	15	40-60	60-75% of MHR	12 weeks
Antonet al (2011)	USA	Overweight women	17	55-79	6-20 Borg scale	24 weeks
Baria et al (2014)	Brazil	Obese Men	10	52.1 ± 11.4	40-60%	12 weeks

					VO2max	
Boer et al (2014)	South Africa	Overweight Boys and girls	15	16.7	According to VT	15 weeks
CadenasSanchez et al (2016)	Spain	Overweight and obese children	50	8-11	80% of MHR	20 weeks
Cambell et al (2010)	Germany	Overweight women	87	50-75	60-75 % 0f MHR	12 months
Cambell et al (2015)	USA	obese men and women	117	35-65	50-85% of MHR	36 weeks
Church et al (2007)	USA	Overweight and obese women	155	45-75	50% of VO2 max	6 months
Courneya et al (2009)	UK	Overweight and obese men and women	60	21-39	60-75% of VO2 max	12 weeks
Davis et al (2012)	USA	Obese Children	73	7-11	>150 bpm HR	13 weeks
Dieli-Conwright et al (2018)	USA	Overweight/obese women	50	53±10.4	65-85%MHR	16 weeks
Donges et al (2012)	Australia	Overweight males and females	25	40-65	70-75% of MHR	10 weeks
Dow at al (2017)	USA	Obese male and females	37	41-64	65-75% MHR	12 weeks
Goldfield et al (2015)	Canada	Obese male and females	75	14-18	65-85% of MHR	26 weeks
Hays et al (2004)	USA	Overweight men and women	11	55-80	80% of VO2max	12 weeks
Herring et al (2017)	UK	obese men and women	12	44.3±7.9	64-77% of MHR	12 weeks
Hill et al (2007)	Australia	Overweight men and women	19	25-65	75% of MHR	12 weeks
Ho et al (2013)	Australia	Overweight and obese men and women	15	44-62	60% of HRR	12 weeks
Imayama et al (2012)	USA	Overweight and obese women	117	58.1	85% of MHR	1year
Irwin et al (2003)	USA	Overweight women	87	59.6±62.5	40-75% oh MHR	12 months
Kallings et al (2009)	Sweden	Overweight men and women	47	>65	Borg score >12	6 months
Katzel et al 1995	USA	Obese male	17	46-80	50-60% of HRR	9 months
Kemmler et al (2010)	Germany	Overweight women	123	65-80	60-70% MHR	18-months
Kim et al (2015)	Korea	Overweight and obese males and females	10	25.7±4.1	65-80% of MHR	8 weeks
Lebon et al (2014)	Canada	Overweight and obese females	15	50-70	40-85% HRR	6 months
Lee et al (2012)	Canada	Obese Male	16	15.2±1.9	60-75% Vo2max	3 months
Monterio et al (2015)	Brazil	Obese gils and boys	18	11.0±11.42	65-85% VO2 peak	20 weeks
Nicklaset al (2009)	USA	Overweight/Obese females	38	50-70	70-75% of HRR	20 weeks
Nunes et al (2019)	Brazil	Obese women	13	62.9	70% of MHR	12 weeks
Paoli et al (2010)	Italy	Overweight men and women	10	50-60	65% of MHR	12 weeks
Parhampour et al (2021)	Iran	Overweight men and women	15	35-55	65-75% of MHR	6 weeks
Park et al (2020)	Korea	Obese Women	18	44.8±5.2	HR according to LT	12 weeks

Rayes et al (2019)	Brazil	Overweight/Obese male and females	21	30-66	VT correspondin g to the HR	8 weeks
Redman et al (2007)	USA	Overweight men and women	12	25-50	40-60% of Vo2 max	24 weeks
Regaieg et al (2013)		Obese boys and girls	14	12-14	70-85% of MHR	16 weeks
Roh et al (2014)	Korea	0bese men	10	23.00 ± 2.36	70% OF HRR	8 weeks
Rosenkilde et al (2012)	Denmark	Overweight males	18	20-40	70 of VO2max	13 weeks
Saif et al (2015)	Saudia Arabia	Obese adult	40	18-25	60-70% MHR	12 weeks
Sanal et al (2013)	Turkey	Overweight and obese males and females	33	39.0±10.5	50-85% of MHR	12 weeks
Savoye et al (2007)	USA	Overweight children	105	8-16	80% MHR	1 year
Schroeder et al (2019)	USA	Overweight/Obese females	17	45-74	40-70% of HRR	8 weeks
Skrypnik et al (2015)	Poland	Obese Women	21	18-65	50-60% MHR	3 month
Stewart et al (2005)	USA	obese women	51	55-75	60-70% of MHR	6 month
Sun et al (20110	China	Overweight girls and boys	25	13.6±0.7	40-60% of VO max	10 weeks
Tan et al (2016)	China	Overweight and obese men	24	30-65	60-75% of MHR	6-months
Thomson et al (2008)	Australia	Overweight and obese women	31	29.3±0.7	60-65% MHR	20 weeks
Vatansev et al (2010)	Turkey	Overweight and obese women	58	41.55 ± 6.72	60-70% of THR	8 weeks
Wong et al (2008)	Singapore	Adolescents obese male	12	13-14	65-85% of MHR	12weeks
ANAEROBIC EXERCISES						
Amanat et al (2020)	Iran	Overweight women	15	40-60	60-80% of 1RM	12 weeks
Binder et al(2005)	USA	Overweight men and women	53	83 6 3	65-100% 1RM	9-months
CadenasSanchez et al (2016)	Spain	Overweight and obese children	50	8-11	60-100% of MHR	20 weeks
Dawson et al (2018)	USA	Overweight men and women	16	68.6±8.4	60-83% of 1RM	12 weeks
Donges et al (2012)	Australia	Overweight males and females	35	40-65	70-75% of 1RM	10 weeks
Freitas et al (2018)	Australia	Obese men and women	26	45-55	55% of 1RM	3 months
Goldfield et al (2015)	Canada	Obese male and females	78	14-18	8RM	26 weeks
Herring et al (2017)	UK	obese men and women	12	44.3±7.9	60% of 1RM	12 weeks
Ho et al (2013)	Australia	Overweight and obese men and women	16	44-62	10RM	12 weeks
Kemmler et al (2010)	Germany	Overweight women	123	65-80	60-70% 1RM	18-months
Kim et al (2015)	Korea	Overweight and obese males and females	10	26.4±2.9	65-80% of 1RM	8 weeks
Lee et al (2012)	Canada	Obese Male	16	15.2±1.9	60% of baseline RM	3 months
Liao et al (2018)	China	Overweight and obese	33	67.3±5.1	80-95% of	12 weeks

		women			1RM	
Mavros et al (2014)	Australia	obese men and women	41	67.2±4.9	80% of 1RM	12 months
McGuigan et al (2009)	Australia	Overweight /Obese girls and boys	48	7-12	19-12 RM	8 weeks
Miller et al (2021)	Australia	Overweight and obese men and women	100	50-75	12-15 Borg scale	24 weeks
Nunes et al (2019)	Brazil	Obese women	13	62.9	70% of 1RM	12 weeks
Parhampour et al (2021)	Iran	Overweight men and women	15	35-55	65-75% of 1RM	6 weeks
Saif et al (2015)	Saudia Arabia	Obese adult	40	18-25	60-70% MHR	12 weeks
Schroeder et al (2019)	USA	Overweight/Obese females	17	45-74	18-20 MHR	8 weeks
Sgro et al (2009)	Australia	Overweight and obese girls and boys	16	7-12	3-12 1RM	24 weeks
Silva et al (2018)	Brazil	Obese women	41	>60	50% of 1RM	16 weeks
Skrypnik et al (2015)	Poland	Obese Women	21	18-65	50-80% MHR	3 month
Thomson et al (2008)	Australia	Overweight and obese women	33	29.3±0.7	6-75% 1RM	20 weeks
HIGH-INTENSITY CIRCUIT TRAINING/HIGH-INTENSITY INTERVAL TRAINING						
Balachandran et al (2014)	USA	Overweight/obese men and women	8	60-90	30-90% of 1 RM	15 weeks
Batrakoulis et al (2018)	Greece	Overweight and obese women	14	36.4±4.4	>65% of HRR	20 weeks
Bocalini et al (2012)	Brazil	Obese females	16	>60	70 of THR	12 weeks
Boer et al (2014)	South Africa	Overweight Boys and girls	17	18	According to VT	15 weeks
Branco et al (2019)	Brazil	Overweight and obese Females	33	13-17	6-20 Borg scale	12 weeks
Davis et al (2011)	USA	Overweight/Obese boys and girls	14	14-18	70-85% of MHR	16 weeks
Domaradzki et al (2020)	Poland	Adolescents overweight boys and girls	58	16.2	75-80% of MHR	10 weeks
Eather et al (2019)	Australia	Overweight and obese male and females	22	18-25	85% of MHR	8 weeks
Fett et al (2008)	Brazil	Obese females	25	36±12	70-80% of HRR	12 weeks
Fisher et al (20150	USA	Overweight and obese men	15	17-22	15-85% of MAP	6 weeks
Gutin et al (1995)	USA	Obese females	12	7-11	60-80% of MHR	10 weeks
Heydari et al (2012)	Australia	Overweight young males	25	24.7 ± 4.8	RPE on Borg scale 6-20	12weeks
Keating et al (2017)	Australia	Overweight and obese men and women	15	29-59	80-85% of 1RM	8 weeks
Khammassi et al (2018)	North Africa	Overweight and obese male	20	18-21	50-100% 0f MAV	12 weeks
Kim et al (2018)	Korea	Obese females	10	22	50-60% of MHR	12 weeks
Kong et al (2016)	China	Obese females	14	18-30	Borg scale 6-20	5 weeks
Lebon et al (2014)	Canada	Overweight and obese females	34	50-70	>90% HRR	6 months

Ludin et al (2015)	Malaysia	Overweight and obese females	10	23.2 ± 0.33	70% of MHR	12 weeks
Marcos-Pardo et al (2019)	Spain	Overweight females and males	15	65-75	60-80% of 1RM	12 weeks
Meckling et al (2007)	Canada	Overweight and obese females	15	21-56	65-80% of MHR	12 weeks
Miller et al (2014)	Canada	Obese men	8	34.3 ± 12.1	6-20 Borg Scale	4 weeks
Nunes et al (2019)	Brazil	Obese women	13	62.3	>80% MHR	12 weeks
Ouerghi et al (2017)	North Africa	Overweight and obese men	9	17-20	100-110% of MAV	8 weeks
Paoli et al (2010)	Italy	Overweight men and women	10	50-60	65-755 of HRR	12 weeks
Paoli et al (2013)	Italy	Overweight men	19	61±3.3	50-75% of HRR	12 weeks
Seo et al (2019)	Korea	Overweight and obese boys and girls	32	12.92 ± 1.69	60-90% MHR	16 weeks
Sperlich et al (20170	Germany	Overweight females	11	18-35	65 % of MHR	3 weeks

TABLE 2: Physiotherapy Evidence Database (PEDro) score of Included studies
Note: ■ indicates "yes" score, □ indicates "No" score

Studies	Eligibility Criteria	Random Allocation	Concealed Allocation	Homogenous Groups	Blinded Subjects	Blinded Therapist	Blinded Assessors	Drop out 5%	Intension to treat analysis	Between groups comparison	Point estimates and Variability	PEDro sum
Alizadeh et al (2013)	■	■	■	■	□	□	□	□	■	■	■	7
Amanat et al (2020)	■	■	□	■	□	■	■	■	■	■	■	9
Antonet al (2011)	■	■	□	■	□	□	■	■	■	■	■	8
Balachandran et al (2014)	■	■	□	□	■	□	■	■	□	■	■	7
Baria et al (2014)	■	■	□	■	□	□	■		■	■	■	7
Batrakoulis et al (2018)	■	■	■	■	□	□	□	■	■	■	■	8
Binder et al(2005)	■	■	■	■	□	□	■	■	■	■	■	9
Bocalini et al (2012)	■	■	□	■	□	□	□	□	□	■	■	5
Boer et al (2014)	■	■	□	■	□	□	■	■	■	■	■	8
Boer et al (2014)	■	■	□	□	□	□	■	■	□	■	■	6
Branco et al (2019)	■	■	□	■	□	□	■	■	■	■	■	8
CadenasSanchez et al (2016)	■	■	□	■	□	□	□	■	■	■	■	7
Cambell et al (2010)	■	■	■	■	■	□	■	□	■	■	■	9
Church et al (2007)	■	■	■	■	□	■	■	■	■	■	■	10
Courneya et al (2009)	■	■	■	■	□	□	□	□	■	■	■	7
Davis et al (2011)	■	■	■	■	■	□	□	■	■	■	■	9

Dawson et al (2018)	■	■	■	□	■	□	■	□	■	■	■	8
Dieli-Conwright et al (2018)	■	■	■	■	□	□	□	■	■	■	■	8
Domaradzki et al (2020)	■	□	□	■	□	□	□	□	□	■	■	4
Donges et al (2012)	■	■	□	■	□	□	□	□	■	■	■	6
Dow at al (2017)	■	■	□	□	□	□	□	■	■	■	■	6
Eather et al (2019)	■	■	□	■	□	□	□	■	■	■	■	7
Fett et al (2008)	■	□	□	■	□	□	□	□	□	■	■	4
Fisher et al (2015)	■	■	■	■	■	□	■	■	■	■	■	10
Freitas et al (2018)	■	■	■	□	□	□	□	□	■	■	■	6
Goldfield et al (2015)	■	■	□	■	■	□	□	□	■	■	■	7
Gutin et al (1995)	■	□	□	■	□	□	□	■	■	■	■	6
Hays et al (2004)	■	■	□	■	□	□	□	□	■	■	■	6
Herring et al (2017)	■	■	■	■	□	□	□	■	■	■	■	8
Heydari et al (2012)	■	■	□	■	□	□	□	■	□	■	■	6
Hill et al (2007)	■	■	□	■	■	■	□	□	■	■	■	8
Ho et al (2013)	■	■	□	■	□	□	□	□	■	■	■	6
Imayama et al (2012)	■	■	■	■	□	□	■	■	■	■	■	9
Irwin et al (20030	■	■	□	□	□	□	■	■	■	■	■	8
Kallings et al (2009)	■	■	□	■	□	□	□	■	■	■	■	7
Katzel et al (1995)	■	■	□	■	□	□	□	■	■	■	■	7
Keating et al (2017)	■	■	■	■	■	□	□	■	■	■	■	9
Kemmler et al (2010)	■	■	□	■	■	□	□	□	■	■	■	7
Khammassi et al (2018)	■	■	□	■	□	□	□	□	■	■	■	6
Kim et al (2018)	■	■	□	■	□	□	□	■	■	■	■	7
Kong et al (2016)	■	■	□	■	□	□	□	■	□	■	■	6
Lebon et al (2014)	■	■	■	□	■	□	■	□	■	■	■	8
Lee et al (2012)	■	■	□	■	□	□	□	□	■	■	■	6
Liao et al (2018)	■	■	■	■	□	■	□	■	■	■	■	9
Ludin et al (2015)	■	■	□	■	□	□	□	□	□	■	■	5
Marcos-Pardo et al (2019)	■	■	■	■	□	□	□	■	■	■	■	8
Mavros et al (2014)	■	■	■	■	■	■	□	■	■	■	■	10
McGuigan et al (2009)	■	□	□	■	□	□	□	■	■	■	■	6
Meckling et al (2007)	■	■	■	■	□	■	□	■	■	■	■	9

Miller et al (2014)	■	□	□	□	□	□	□	□	■	□	■	3
Miller et al (2021)	■	■	□	■	□	□	■	■	■	■	■	8
Monterio et al (2015)	■	■	□	■	□	□	■	■	■	■	■	8
Nicklaset al (2009)	■	■	□	■	□	□	■	■	■	■	■	8
Nunes et al (2019)	■	■	□	■	□	□	□	□	■	■	■	6
Ouerghi et al (2017)	■	■	□	■	□	□	□	□	□	■	■	5
Paoli et al (2010)	■	■	□	■	□	□	□	■	■	■	■	7
Paoli et al (2013)	■	■	□	■	□	□	□	■	□	■	■	6
Parhampour et al (2021)	■	■	□	■	□	□	■	□	■	■	■	7
Park et al (2020)	■	■	□	■	□	□	□	■	■	■	■	7
Rayes et al (2019)	■	■	□	■	□	□	■	■	■	■	■	8
Redman et al (2007)	■	■	□	■	□	□	□	□	■	■	■	6
Regaieg et al (2013)	■	■	□	■	□	□	□	□	■	■	■	6
Roh et al (2014)	■	■	□	□	□	□	□	■	■	■	■	6
Rosenkilde et al (2012)	■	■	□	■	■	■	□	■	■	■	■	9
Saif et al (2015)	■	□	□	■	□	□	■	□	■	■	■	6
Sanal et al (2013)	■	■	□	■	□	□	□	□	■	■	■	6
Savoye et al (2007)	■	■	□	□	□	□	□	■	■	■	■	6
Schroeder et al (2019)	■	■	□	■	□	□	■	■	□	■	■	7
Seo et al (2019)	■	■	■	■	■	□	■	■	□	■	■	9
Sgro et al (2009)	■	■	□	■	□	□	□	■	■	■	■	7
Silva et al (2018)	■	□	□	■	□	□	□	□	■	■	■	5
Skrypnik et al (2015)	■	■	□	■	□	□	□	■	■	■	■	7
Sperlich et al (2017)	■	■	□	■	□	□	□	■	■	■	■	7
Stewart et al (2005)	■	■	□	■	□	□	□	■	■	■	■	7
Sun et al (20110	■	■	□	■	□	□	□	■	■	■	■	7
Tan et al (2016)	■	■	□	■	□	□	□	■	■	■	■	7
Thomson et al (2008)	■	■	□	■	□	□	□	■	■	■	■	7
Vatansev et al (2010)	■	□	□	■	□	□	□	□	□	■	■	4
Wong et al (2008)	■	■	□	■	□	□	□	□	■	■	■	6

TABLE III: Effect of Physical exercise training on Body Mass Index, Body Fat Percentage and Body Weight.						
Authors Detail	**Population**	**Age (mean/SD/range)**	**Intensity**	**Duration**	**Effect Size**	**Outcomes (body weight, body fat%, BMI)**
AEROBIC EXERCISES						
Alizadeh et al (2013)	Overweight/obese women	33.1±7.7	64-76% of MHR	12 weeks	0.41	BF %
Amanat et al (2020)	Overweight women	40-60	60-75% of MHR	12 weeks	0.16 0.36 0.13	BMI BF % BW
Antonet al (2011)	Overweight women	55-79	6-20 Borg scale	24 weeks	NA	BMI BW
Baria et al (2014)	Obese Men	52.1 ± 11.4	40-60% VOmax	12 weeks	0.01 0.00	BMI BW
Boer et al (2014)	Overweight Boys and girls	16.7	According to VT	15 weeks	0.20 0.14 0.20	BMI BF % BW
CadenasSanchez et al (2016)	Overweight and obese children	8-11	80% of MHR	20 weeks	NA	BMI BF % BW
Cambell et al (2015)	obese men and women	35-65	50-85% of MHR	36 weeks	NA	BMI BF % BW
Cambell et al (2010)	Overweight women	50-75	60-75 % 0f MHR	12 months	NA	BF % BW
Church et al (2007)	Overweight and obese women	45-75	50% of VO2 max	6 months	0.27	BF %
Courneya et al (2009)	Overweight and obese men and women	21-39	60-75% of VO2 max	12 weeks	0.01 0.02	BW BF %
Davis et al (2012)	Obese Children	7-11	>150 bpm HR	13 weeks	0.13	BF %
Dieli-Conwright et al (2018)	Overweight/obese women	53±10.4	65-85%MHR	16 weeks	0.36 0.92 0.40	BMI BF % BW
Donges et al (2012)	Overweight males and females	40-65	70-75% of MHR	10 weeks	0.10	BMI
Dow at al (2017)	Obese male and females	41-64	65-75% MHR	12 weeks	0.74 0.63 0.42	BMI BF % BW
Goldfield et al (2015)	Obese male and females	14-18	65-85% of MHR	26 weeks	NA	BMI BW
Hays et al (2004)	Overweight men and women	55-80	80% of VO2max	12 weeks	NA	BMI BF % BW
Herring et al (2017)	obese men and women	44.3±7.9	64=77% of MHR	12 weeks	NA	BMI BF % BW
Hill et al (2007)	Overweight men and women	25-65	75% of MHR	12 weeks	0.13 0.51 0.37	BMI BF % BW
Ho et al (2013)	Overweight and obese men and women	44-62	60% of HRR	12 weeks	NA	BMI BF % BW
Imayama et al (2012)	Overweight and obese women	58.1	85% of MHR	1year	NA	BMI
Irwin et al (2003)	Overweight women	59.6±62.5	40-75% oh MHR	12 months	NA	BMI BW
Kallings et al (2009)	Overweight men and women	>65	Borg score >12	6 months	NA	BMI BF % BW
Katzel et al (1995)	Obese male	46-80	50-60% of HRR	9 months	NA	BF %

Kemmler et al (2010)	Overweight women	65-80	60-70% MHR	18-months	0.33	BW
Kim et al (2015)	Overweight and obese males and females	25.7±4.1	65-80% of HR_{max}	8 weeks	0.3 0.10 0.42	BF % BW BMI
Lebon et al (2014)	Overweight and obese females	50-70	40-85% HRR	6 months	0.02 0.22 0.02	BMI BF % BW
Lee et al (2012)	Obese Male	15.2±1.9	60-75% Vo2 max	3 months	0.30 0.04	BMI BW
Monterio et al (2015)	Obese gils and boys	11.0±11.42	65-85% VO2 peak	20 weeks	0.48 1.02 0.07	BMI BF % BW
Nicklaset al (2009)	Overweight/Obese females	50-70	70-75% of HRR	20 weeks	NA	BMI BF % BW
Nunes et al (2019)	Obese women	62.9	70% of MHR	12 weeks	0.13 0.19 0.14	BMI BF % BW
Paoli et al (2010)		50-60	65% of MHR	12 weeks	1.07	BW
Parhampour et al (2021)	Overweight men and women	35-55	65-75% of MHR	6 weeks	0.26 0.20	BMI BW BF %
Park et al (2020)	Obese Women	44.8±5.2	HR according to LT	12 weeks	1.20 1.00 2.50	BW BMI BF %
Rayes et al (2019)	Overweight/Obese male and females	30-66	VT corresponding to the HR	8 weeks	0.05 0.07 0.02	BMI BF % BW
Redman et al (2007)	Overweight men and women	25-50	40-60% of Vo2 max	24 weeks	NA	BMI BF % BW
Regaieg et al (2013)	Obese boys and girls	12-14	70-85% of MHR	16 weeks	0.01 0.40 0.30	BMI BF % BW
Roh et al (2014)	0bese men	23.00 ± 2.36	70% OF HRR	8 weeks	0.56 0.43 0.64	BMI BW BF %
Rosenkilde et al (2012)	Overweight males	20-40	70 of VOmax	13 weeks	NA	BMI BF % BW
Saif et al (2015)	Obese adult	18-25	60-70% MHR	12 weeks	1.02	BMI
Sanal et al (2013)	Overweight and obese males and females	39.0±10.5	50-85% of MHR	12 weeks	0.30 0.21	BMI BW
Savoye et al (2007)	Overweight childern	8-16	80% MHR	1 year	NA	BMI BF % BW
Schroeder et al (2019)	Overweight/Obese females	45-74	40-70% of HRR	8 weeks	NA	BMI BF % BW
Skrypnik et al (2015)	Obese Women	18-65	50-60% MHR	3 month	0.23 0.18	BMI BW
Stewart et al (2005)	obese women	55-75	60-70% of MHR	6 month	NA	BMI BF % BW
Sun et al (2011)	Overweight girls and boys	13.6±0.7	40-60% of VO2 max	10 weeks	0.29 0.65 0.11	BMI BF % BW
Tan et al (2016)	Overweight and obese men	30-65	60-75% of MHR	6-months	NA	BMI BW

Thomson et al (2008)	Overweight and obese women	29.3±0.7	60-65% MHR	20 weeks	0.54 1.04	BW BF %
Vatansev et al (2010)	Overweight and obese women	41.55 ± 6.72	60-70% of THH	8 weeks	0.20 0.70 0.50	BMI BF % BW
Wong et al (2008)	Adolescents obese male	13-14	65-85% of MHR	12weeks	0.40 0.10 0.23	BMI BF % BW
ANAEROBIC EXERCISES						
Amanat et al (2020)	Overweight women	40-60	60-80% of 1RM	12 weeks	0.12 0.24 0.08	BMI BF % BW
Binder et al (2005)	Overweight men and women	83 6 3	65-100% 1RM	9-months	0.11	BF %
CadenasSanchez et al (2016)	Overweight and obese children	8-11	60-100% of MHR	20 weeks	NA	BMI BF % BW
Dawson et al (2018)	Overweight men and women	68.6±8.4	60-83% of 1RM	12 weeks	0.12 0.74	BF % BW
Donges et al (2012)	Overweight males and females	40-65	70-75% of 1RM	10 weeks	NA	BMI
Freitas et al (2018)	Obese men and women	45-55	55% of 1RM	3 months	0.04	BMI
Goldfield et al (2015)	Obese male and females	14-18	8RM	26 weeks	NA	BMI BW
Herring et al (2017)	obese men and women	44.3±7.9	60% of 1RM	12 weeks	NA	BMI BF % BW
Ho et al (2013)	Overweight and obese men and women	44-62	10RM	12 weeks	NA	BMI BF % BW
Kemmler et al (2010)	Overweight women	65-80	60-70% 1RM	18-months	NA	BW
Kim et al (2015)	Overweight and obese males and females	26.4±2.9	65-80% of 1RM	8 weeks	0.28 0.69 0.19	BMI BF % BW
Lee et al (2012)	Obese Male	15.2±1.9	60% of baseline RM	3 months	NA	BMI BW
Liao et al (2018)	Overweight and obese women	67.3±5.1	80-95% of 1RM	12 weeks	0.29	BF %
Mavros et al (2014)	obese men and women	67.2±4.9	80% of 1RM	12 months	NA	BMI BF % BW
McGuigan et al (2009)	Overweight /Obese gils and boys	7-12	19-12 RM	8 weeks	0.09 0.58 0.10	BMI BF % BW
Miller et al (2021)	Overweight and obese men and women	50-75	12-15 Borg scale	24 weeks	0.39	BW
Nunes et al (2019)	Obese women	62.9	70% of 1RM	12 weeks	0.13 0.19 0.14	BMI BF % BW
Parhampour et al (2021)	Overweight men and women	35-55	65-75% of 1RM	6 weeks	0.24 0.17	BMI BW
Saif et al (2015)	Obese adult	18-25	60-70% MHR	12 weeks	0.80	BMI
Schroeder et al (2019)	Overweight/Obese females	45-74	18-20 MHR	8 weeks	NA	BMI BF % BW
Sgro et al (2009)	Overweight and obese girls and boys	7-12	3-12 1RM	24 weeks	0.21 0.23	BF % BW
Silva et al (2018)	Obese women	>60	50% of 1RM	16 weeks	0.02 0.15 0.01	BMI BF % BW

Skrypnik et al (2015)	Obese Women	18-65	50-80% MHR	3 month	0.25 0.54 0.19	BMI BF % BW
Thomson et al (2008)	Overweight and obese women	29.3±0.7	6-75% 1RM	20 weeks	0.46 0.41	BW BF %
HIGH-INTENSITY CIRCUIT TRAINING/HIGH-INTENSITY INTERVAL TRAINING						
Balachandran et al (2014)	Obese male and females	60-90	30-90% of 1 RM	15 weeks	0.10	BF %
Batrakoulis et al (2018)	Overweight and obese women	36.4±4.4	>65% of HRR	20 weeks	0.12 1.42 0.46	BMI BF % BW
Bocalini et al (2012)	Obese females	>60	70 of THR	12 weeks	0.57 0.66	BF % BW
Boer et al (2014)	Overweight Boys and girls	18	According to VT	15 weeks	0.14 0.54 0.42	BMI BF % BW
Branco et al (2019)	Overweight and obese Females	13-17	6-20 Borg scale	12 weeks	0.29 0.51 0.10	BMI BF % BW
Davis et al (2011)	Overweight/Obese boys and girls	14-18	70-85% of MHR	16 weeks	NA	BMI BF % BW
Domaradzki et al (2020)	Adolescents overweight boys and girls	16.2	75-80% of HR_{max}	10 weeks	0.28 0.49 0.44	BMI BF % BW
Eather et al (2019)	Overweight and obese male and females	18-25	85% of MHR	8 weeks	0.33 0.04 0.16	BMI BF % BW
Fett et al (2008)	Obese females	36±12	70-80% of HRR	12 weeks	NA	BMI BF % BW
Fisher et al (20150	Overweight and obese men	17-22	15-85% of MAP	6 weeks	0.29 1.06 0.94	BMI BF % BW
Gutin et al (1995)	Obese females	7-11	60-80% of MHR	10 weeks	0.15 0.04	BMI BF %
Heydari et al (2012)	Overweight young males	24.7 ± 4.8	RPE on Borg scale 6-20	12weeks	1.00 1.81 0.55	BMI BF % BW
Keating et al (2017)	Overweight and obese men and women	29-59	80-85% of 1RM	8 weeks	0.41 0.12	BMI BW
Khammassi et al (2018)	Overweight and obese male	18-21	50-100% 0f MAV	12 weeks	0.63 1.07 0.345	BMI BF % BW
Kim et al (2018)	Obese females	22	50-60% of MHR	12 weeks	0.28 0.69 0.19	BMI BF % BW
Kong et al (2016)	Obese females	18-30	Borg scale 6-20	5 weeks	0.04 0.08 0.04	BMI BF % BW
Lebon et al (2014)	Overweight and obese females	50-70	>90% HRR	6 months	1.00 0.22 0.02	BMI BF % BW
Ludin et al (2015)	Overweight and obese females	23.2 ± 0.33	70% of MHR	12 weeks	0.02 0.02 0.07	BMI BF % BW
Marcos-Pardo et al (2019)	Overweight females and males	65-75	60-80% of 1RM	12 weeks	0.20 1.04 0.53	BMI BF% BW
Meckling et al (2007)	Overweight and obese females	21-56	65-80% of MHR	12 weeks	0.22 0.72 0.26	BMI BF % BW

Miller et al (2014)	Obese men	34.3 ± 12.1	6-20 Borg Scale	4 weeks	NA	BMI BF %
Nunes et al (2019)	Obese women	62.3	>80% MHR	12 weeks	0.13 0.42 014	BMI BF % BW
Ouerghi et al (2017)	Overweight and obese men	17-20	100-110% of MAV	8 weeks	0.11 0.21 0.10	BMI BF 5 BW
Paoli et al (2010)	Overweight men and women	50-60	65-755 of HRR	12 weeks	1.05	BW
Paoli et al (2013)	Overweight men	61±3.3	50-75% of HRR	12 weeks	1.24	BW
Seo et al (2019)	Overweight and obese boys and girls	12.92 ± 1.69	60-90% MHR	16 weeks	0.05 0.35 0.27	BMI BF % BW
Sperlich et al (2017)	Overweight females	18-35	65 % of MHR	3 weeks	0.26 0.35 0.24	BMI BF % BW