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Effectiveness of exercises intensity in improving cardiorespiratory fitness and body fat percentage among obese adults: A systematic review and meta-analysis

Nurul Najwa Aminul Mahzan[1], Noor Fatihah Ilias[1], Mohd Noorazam Abdul Razak[2]
Hashbullah Ismail[1*]

[1]Faculty of Sport Science and Recreation
Universiti Teknologi Mara
Malaysia

[2]Faculty of Education
Universiti Teknologi Mara
Malaysia

*Corresponding author's email: hashbullah@uitm.edu.my

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ABSTRACT

Exercise, as a non-pharmacological strategy, has demonstrated positive effects in managing cardiorespiratory fitness and adiposity among obese individuals. However, the comparative effectiveness of Moderate-Intensity Continuous Training (MICT) and High-Intensity Interval Training (HIIT) remains inconclusive. This study aimed to identify the most efficient exercise intensity for improving cardiorespiratory fitness and reducing body fat percentage in obese individuals. This review only included subjects who had a mean BMI of ≥30 kg/m^2, percentage body fat >30kg, aged between 18 and 60 years old and only consisted of intervention of exercises alone without caloric restriction. The study employed HIIT intervention at 85% Heart Rate Reserves (HRR) and MICT at 60% HRRA systematic search of electronic databases was conducted from 1970 to October 2022, yielding twenty eligible studies. The PRISMA flowchart guided study selection, meanwhile the quality of included studies was assessed using TESTEX criteria. The results of the study indicated no significant difference between HIIT and MICT in improving cardiorespiratory fitness (WMD = 0.27; 95% CI: 0.01 to 0.53; P = 0.04; I^2: 25%) or percentage body fat (WMD: 0.23; 95% CI: -0.53 to 0.07; P = 0.13; I^2: 67%) among obese adults. Despite small changes, both exercise modalities demonstrated improvements. Therefore, health practitioners are encouraged to prescribe exercises tailored to individual preferences, as HIIT and MICT provide equivalent effects. This study contributes to the understanding of exercise interventions for managing obesity-related health outcomes.

Keywords: *Obese Adults, Aerobic exercises, Body Composition, High Interval Intensity Training, Moderate Continuous Intensity Training*

INTRODUCTION

Obesity has indeed emerged as a formidable public health challenge on a global scale, with current sharp rise in obesity rates, highlighting its undeniable status as a global crisis (Koliaki et al., 2023). Thus this issues need to be addressed immediately. Suggestion by Koliaki et al., 2023 exercise is undeniably a crucial component of comprehensive strategies aimed at addressing the obesity epidemic. Numerous studies have highlighted the effectiveness of regular physical activity in promoting weight loss, improving metabolic health, and reducing the risk of obesity-related complications (Armannia et al., 2022; Westbury et al., 2023). Two types of aerobic exercise that often draw attention are oderate-intensity continuous training (MICT) and High-intensity interval training (HIIT). The MICT performed continuously at a steady state elicits a heart rate response of 50%–60% HRmax. Meanwhile, HIIT targets intensities between 80% and 100% HRmax. In controlling obesity, moderate-intensity considered the best option because it is a beneficial exercise to start with for obese people and can reduce the risk of injury and minimize chronic inflammation (A. Alahmadi2014 et al; Arboleda-Serna et al., 2022) MICT also has an effective capability to reduce visceral fat and improve body composition, cardiovascular fitness, and other health-related parameters (Miyamoto-Mikami et al., 2015; Ross et al., 2004; Yu et al., 2021). However, HIIT has been recognized as an essential strategy for weight loss, adiposity, and cardio-metabolic factors (Dias et al., 2018; A. S. Higgins et al., 2003; Smith-Ryan et al., 2016; Whyte et al., 2010). In obese patients, HIIT shows more incredible benefits than MICT in reducing adiposity and safe for obese (Vaccari et al., 2020; Zhang et al., 2020). Somehow, a study by Viana et al., 2019 and Rugbeer et al., 2021reported that HIIT and MICT offer similar benefits in reducing body adiposity. These prolonged contradictions between the effectiveness of exercise intensity among obese are still a favourite topic to be discussed. In order to resolve this inconsistency finding our review is expected to provide an insightful perspective regarding this issue.

However, the most efficacious exercise prescription for improving anthropometry, cardiorespiratory fitness (CRF), remains unknown (O'Donoghue et al., 2021). Precise consideration is crucial when suggesting an aerobic exercise training program for people with issues linked to obesity (Chiu et al., 2017). In controlling obesity, moderate-intensity is considered the best option because it is a beneficial exercise to start with for obese people and can reduce the risk of injury and minimize chronic inflammation (A. Alahmadi, 2014; Castro et al., 2017). Not only that, MICT also has an effective capability to reduce visceral fat and improve body composition, cardiovascular fitness, and other health-related parameters (Hong et al., 2014; Miyamoto-Mikami et al., 2015; Ross et al., 2000). However, recently HIIT has been recognized as an essential strategy for time efficiency and has more incredible benefits than MICT in reducing adiposity Smith-Ryan et al., 2016; Higgins et al., 2003; Tjønna et al., 2008; Trapp et al., 2008; Whyte et al., 2010). To add up, a study by Viana et al. 2019 states that HITT and MICT offer similar benefits in reducing body adiposity. This is supported by research studies that both HIIT and MICT are not superior to each other (Armannia et al., 2022; Kramer et al., 2023; Rugbeer et al., 2021).

These prolonged contradictions between the effectiveness of exercise intensity among obese are still a favourite topic to be analyzed. To settle controversies arising from conflicting issues in which exercise routine with different exercise intensities for obese people. Thus, this study expected to recognize the most efficient intensity of exercise that contributes to the greater impact on obesity to cardiorespiratory fitness and body fat percentage among obese adults by systematically reviewing the effectiveness of high-intensity interval training (HIIT) versus moderate-intensity continuous training (MICT) in cardiorespiratory fitness(CRF) among obese adults and systematically review the effectiveness of high- intensity interval training (HIIT) versus moderate-intensity continuous training (MIICT) in percentage body fat (PBF) obese adults

Significance of study

This study may provide additional knowledge regarding the most effective training program that focus on exercise intensity for the optimal benefit in controlling obesity. In addition, this study may give a insightful perspective for health practitoners in prescribing the optimal exercise training and updating the current approach of exercise for the treatment and management of obese. To add up, this review may provide additional information on exercise training as an alternative way for controlling obesity in obese patients and indirectly reducing the numbers of anti-obese drug.

Limitation of study

Meta-analysis includes only published studies, that might causing a publication bias that may overestimate the actual magnitude of an effect. Plus,one number cannot summarize a research field to summarize large amounts of varying information using a single number is a controversial aspect of meta-analysis, as it ignores the fact that treatment effects may vary from study to study. Next,in meta-analysis heterogeneity refers to the degree of dissimilarity in the results of individual studies may cause varies of sum up results through pooling effect.

Delimitation of study

The researcher addressed publication bias in this review with visuals based on a "funnel plot". The basis of this is observed effect sizes are plotted according to sample size should scatter around an underlying "true" value, producing a funnel pattern. Gaps in the plot indicate potential unpublished studies and the possibility of bias**.**

METHODOLOGY

The electronic database of PubMed, MEDLINE, Google Scholar, CINAHL, and SPORT Discuss were searched. Enlisted publication in the database were searched up from year 1970 to 20 October 2022 by two different assessors, with the third assessor decided to resolve any disagreements. A search strategy was developed and reviewed by all authors. The search term constructed involves a list of synonyms of the word to expand the search. The appropriate search term notation will be used. Obese OR Obesity OR Unhealthy weight OR high Body Mass Index OR excess fat, continuous training OR Moderate-intensity continuous training OR MICT OR CONT, high-intensity interval training OR HIIT OR high- intensity training exercise OR high-intensity workout, cardiorespiratory fitness OR cardiorespiratory fitness OR physical fitness OR aerobic fitness, body composition OR anthropometric OR body composition measurement OR body composition analysis OR body composition testing. An attempt to collect unpublished data by emailing the author Studies only included participants with ages> 18 years old to 60 years old, BMI of ≥30 kg/m^2 exercise-based intervention only, intervention includes aerobic exercise and studies that only involve human participation. Meanwhile, exclusion criteria for the study were excluded if the population that overweight and did not meet a BMI of ≥30 kg/m^2 and body fat percentage ≥30 kg, excluded from the review if the intervention includes diet restriction as this review only looks at the effects of exercises alone. Next, the paper was excluded if the non-English manuscript and study quality assessment score less than 10.The PRISMA flow diagram used visually summarises the screening process, including initial records of the number of articles found and then makes the selection process transparent by reporting on decisions made at various stages of the systematic review. This study calculated changes in post-intervention means by subtracting baseline from post-intervention values. This review consists of a continuous type of data where each individual's outcome is a measurement of a numerical quantity. A random effects model was used in this review as this model is appropriate for capturing uncertainty resulting from heterogeneity among studies. Revman version 5.3 software (The Nordic Cochrane Centre Denmark) was used to construct forest plots and funnel plots for this review.

Data Synthesis and Statistical Analysis

Study quality was assessed by Tool for the Assessment of Study Quality and Reporting in Exercise (TESTEX). A 15-point scale was specific to exercise training studies (Smart et al., 2015). The quality score of the papers was based on tertiles, where 0–5 points were considered low quality, 6-10 points were considered medium quality and 11–15 points were considered high quality. Based on the TESTEX scores, the identified 20 studies obtained a median score of 9.This study calculated changes in post-intervention mean by subtracting baseline from post-intervention values. This review consists of the continuous type of data where each individual's outcome is a measurement of a numerical quantity Mean differences from baseline in these data were calculated. A random effects model was used in this review as this model is appropriate for capturing uncertainty resulting from heterogeneity among studies. Revman version 5.3 software (The Nordic Cochrane Centre Denmark) was used to construct forest plots and flunnel plots. Continuous data are reported as mean ± SD, 95% confidence interval, actual p values for pre-post intervention change for each group or if only the level of statistical significance $p < 0.05$ becomes $p = 0.049$, $p < 0.01$ becomes $p = 0.0099$ and p = not significant becomes $p = 0.051$.

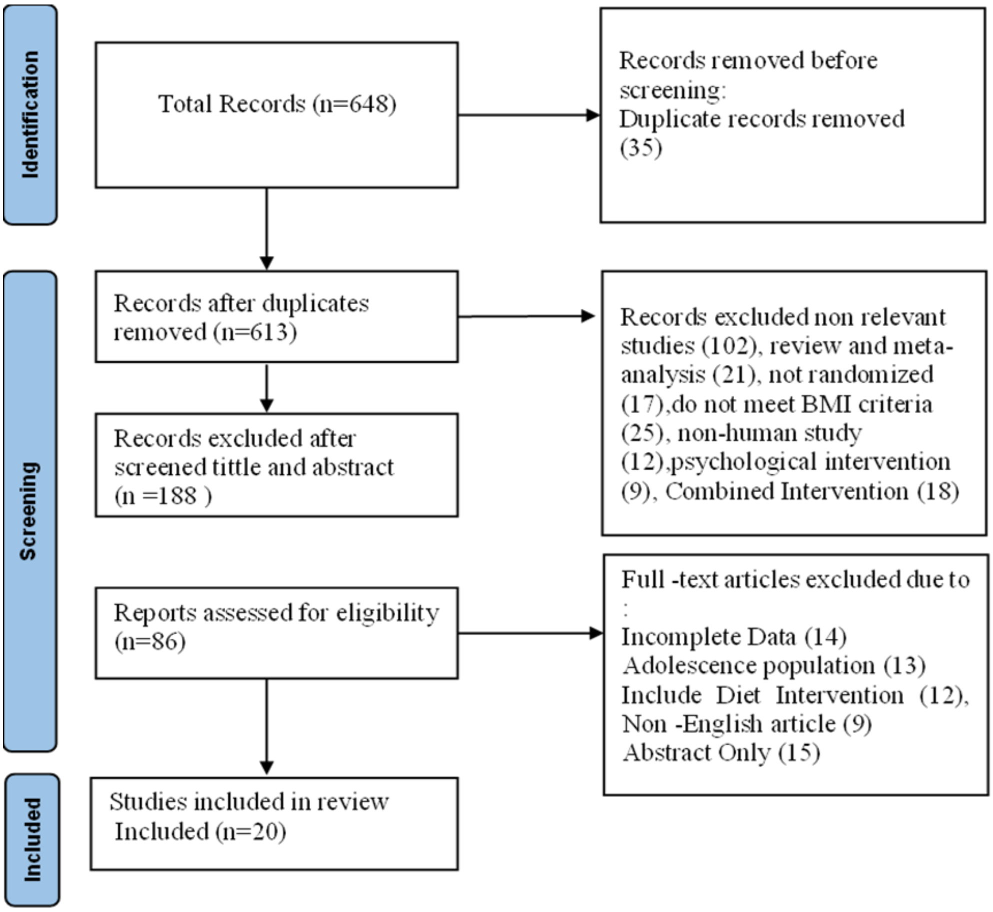


Figure 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram

Table 1 : Traning charasteristic of varies studies

Authors &Years	Age	n	Exercise modality	Duration (weeks)	Sessions per week	Training protocol
Barry *et al*. (2018)	19.8 ± 1.0	33	Cycling	12	5	HIIT: 1min at 90% HRmax with 1min recovery periods MICT: 20–60 min of continuous exercise at 65 Hrmax
Benjamin et al. (2020)	31 ± 8 *	31	Running	12	3	HIIT: 90% HRmax; MICT: 70% of HRmax
Cheema et al. (2015)	40.2 ± 6.5	12	Boxing/walking	2	3	HIIT: 80%-90% HRR MICT: 60%-70% HRR
Cocks et al. (2016)	25±1	30	Cycling	4	3	SIT: 4–7 intervals of 80%-90% of Hrmax MICT: 40-60min cycling 65%˙HRmax
Dupuit et al. (2020)	33.6 ±11.6	30	Running	3	3	HIIT: 8s: 12 rest of speed cycling MICT: 40min cycling continuous at 60% HR
Gerosa et al. (2018)	9.6 ± 4.9	32	Running	6	3	HIIT : 10×1:1min 100% VO2max MICT :35min 65% VO2max
Garnier et al. (2019)	37 ± 7	23	Cycling	12	3	HIIT: 6 intervals of 1 min each at an intensity that elicited 75 to 85 % HRR MICT: 15 min of continuous physical activity at 50 to 60 % HRR.
Higgins et al. (2016)	55.3 ± 13.2	52	Cycling	6	3	HIIT: 30-second 'all out' sprints MICT: 60-70% heart rate reserve (HRR) for 20-30 minutes
Hornbuckle et al (2017)	30.5± 6.8	14	Cycling	16	3	HIIT : Weeks 1–2: 2min @ 60–70% HRmax Weeks 3–4: 25 min @ 60–70% HRmax Week 5–16: 3 min @ 60–70% HRmax 1 min @ 80–90% HRmax Repeat x 7

Continue

Martins et al (a) 2016	22.9 ± 2.4	46	Cycling	6	3	HIIT : 8 s of sprinting and 12 s of recovery phase
Martins et al (b) 2016	22.4 ± 0.7	46	Cycling	15	3	MICT: Continuous cycling at 70% of Hrmax
Robinson et al (2015)	32.1 ± 8.7	38	Cycling	2	3	HIIT: 4:1 min intervals at 85%–90%HRpeak) MICT: 20 min of cycling 60%–65% HRmax
Lunt et al (2014)	21 ± 1	32	Cycling	12	4	WALK: 10 warm up ,33 moderate walk + 5 cool down 48 min; AIT:warm up : 4 high intensity : 3 recovery :4 high intensity 3 , 5 cool down
Sawyer et al (2016)	21.5 ± 1.7	18	Cycling	8	3	HIIT: 60%-70% of HRmax followed by 1-min intervals designed to elicit 90–95% of MICT: at 50–60% of HRmax followed by 30 min of exercise at 70–75%
Skylerk et al (2013)	37.8 ± 5.8	16	Cycling	2		SIT: 6 sessions of 8-12 x 10s sprints MICT: 10 sessions of 30 min at 65% HRmax
Sabag et al (2020)	54.6 ±31.4	35	Cycling	12	3	HIIT: 4 min of cycling at a work rate equivalent to 90% VO2peakMICT: 40 -55 min of continuous cycling.
Soran et al (2022)	26.3± 3.41	36	Cycling	12	3	HIIT: 4 intense intervals of 4 minutes with an intensity of 90% of the maximum heart rate MICT: Walking continuously at 50%-60% Hrmax
Candrawati et al (2022)	18.8 ± 1.0	28	Cycling	12	3	HIIT: 4 x 4 minutes intervals (85 - 95% HRmax) and 3 x 3 minutes of rest/recovery (60% HRmax) MICT: Continuous cycling at 60 - 80% HRmax

Scott Home HIIT et al (2019)	36±10	9	Bodyweight exercises	12	NA	HIIT: 1-min intervals were composed of two different 30-s body weight exercises with no rest in between.
Scott Lab HIIT et al (2019)		10	Cycling		3	HIIT: 1-min intervals were composed of 30-s cycle with no rest in between
Scott Home MICT et al (2019)		13	Swimming/ cycling/running/walking		NA	MICT: Exercise at an advised exercise intensity of 65% predicted HRmax.
Petrick et al (2021)	37.4 ± 15.1	23	Cycling	6	3	SIT performed 3 d·wk−1 (weeks 1–2, 4rep weeks 3–4, 5 rep; weeks 5–6, 6 rep END involved 30–40 min at a power output corresponding to ~60% (weeks 1–2, 30 min; weeks 3–4, 35 min; weeks 5–6, 40 min)
Scherjeve et al (2008)		40	Cycling	12	3	HIIT: 4×4-min intervals at 85–95% of HRmax with 3min active breaks in between the intervals MICT: Walked continuously for 47 min at 60–70%.

RESULT AND DISCUSSION

Study or Subgroup	HIIT Mean	HIIT SD	HIIT Total	MICT Mean	MICT SD	MICT Total	Weight	Mean Difference IV, Random, 95% CI
Benjamin 2020	3.14	3.0839	16	2.1	1.9643	15	2.0%	1.04 [-0.77, 2.85]
Cheema 2015	2.6	0.9272	6	1.6	0.5706	6	7.1%	1.00 [0.13, 1.87]
Cocks 2016	2.4	2.8542	8	4.7	5.5894	8	0.4%	-2.30 [-6.65, 2.05]
Dupuit 2020	5.1	6.5978	9	3.2	4.1398	9	0.3%	1.90 [-3.19, 6.99]
Garnier 2018	5	6.9515	10	4	6.5852	13	0.2%	1.00 [-4.60, 6.60]
Gerosa 2019	2.9	15.4752	13	3.2	8.89	13	0.1%	-0.30 [-10.00, 9.40]
Higgins 2016	4.1	5.1852	23	1.9	2.785	29	1.2%	2.20 [-0.15, 4.55]
Hornbuckle 2017	2	3.7346	16	0.2	0.2961	11	1.9%	1.80 [-0.04, 3.64]
Lunt 2014	1.4	0.1773	14	1.3	0.7736	9	14.8%	0.10 [-0.41, 0.61]
Martins a 2015	2.6	0.9272	6	2.9	1.0342	6	4.7%	-0.30 [-1.41, 0.81]
Martins b 2015	2.2	0.5713	5	2.9	1.0342	6	6.0%	-0.70 [-1.67, 0.27]
Robinson 2015	1.5	1.7274	20	1.5	1.605	18	5.1%	0.00 [-1.06, 1.06]
Sabag 2020	1.1	1.7222	12	2.3	3.601	12	1.3%	-1.20 [-3.46, 1.06]
Sawyer 2016	4.1	2.4398	9	3.1	1.8448	9	1.6%	1.00 [-1.00, 3.00]
Scherjeve 2008	0.33	0.2925	14	0.16	0.1336	13	30.3%	0.17 [0.00, 0.34]
Scott HIIT- HOME 2019	3.8	4.916	9	1.6	2.6341	13	0.5%	2.20 [-1.32, 5.72]
Scott HIIT- LAB 2019	5	6.9515	10	1.6	2.6341	13	0.3%	3.40 [-1.14, 7.94]
Skylerk 2013	0.4	0.4757	8	0.001	0.0012	8	22.3%	0.40 [0.07, 0.73]
Total (95% CI)			**208**			**211**	**100.0%**	**0.27 [0.01, 0.53]**

Heterogeneity: Tau² = 0.05; Chi² = 22.59, df = 17 (P = 0.16); I² = 25%
Test for overall effect: Z = 2.06 (P = 0.04)

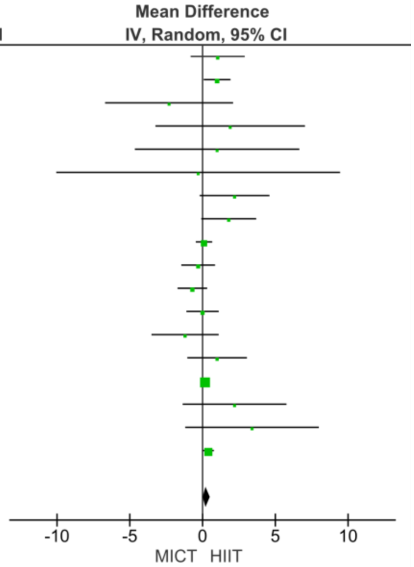


Figure 2. Forest plot of changes in peak oxygen consumption in HIIT vs MICT

The finding of no significant difference between High-Intensity Interval Training (HIIT) and Moderate-Intensity Continuous Training (MICT) on cardiorespiratory fitness (CRF) as indicated by a weight mean difference (WMD) of 0.27 (0.01,0.53), P = 0.04) with confidence interval (CI) 95% and a low degree of heterogeneity (I^2 = 25%) due to varies studies of exercises protocol. This result challenges the prevailing notion that HIIT may offer superior benefits for improving CRF compared to MICT among obese adults however, the lack of statistically significant difference suggests that both exercise modalities could be equally effective in enhancing CRF in this population. Above all, four studies in our reviews show higher changes which are in the HIIT group. The study by Dupuit et al. (2020), shows the highest increase in peak oxygen consumption with 5.1 mL/(kg·min), and a second study by Scott et al. 2019 shows changes in peak oxygen consumption with 5 mL/(kg·min) meanwhile followed by both studies with the same amount of changes with 4.1 mL/(kg·min) (Higgins et al., 2016; Sawyer et al., 2016). Those four studies only studies by Dupuit et.al 2020 choose running as an exercise modality while the rest continues with cycling exercises. To discuss these four studies that display huge changes both studies with highest changes in peak oxygen consumption undergo 12-week intervention (Dupuit et al., 2020; Scott et al., 2019). Both studies reach 80%-90% of heart rate reserves.

In contrast, the MICT group displayed one study with great changes with 4.7mL/(kg·min) that underwent 12 weeks of intervention with exercises intensity of 50% to 60 % HRR. The study increased progressively the duration per session with 5 minutes for each week and 35 minutes for week 5 until 12 with 60% HRR. From this finding, we found that the 12-week duration of HIIT shows a higher improvement in CRF among obese adults compared to MICT intervention that also undergoes 12-week duration training. Due to this change might be influenced by the capability of HIIT exercises to enhance peripheral vascular function, as evidenced study by Rakobowchuk et al. (2009), leading to increased arterial compliance and endothelial function may optimize blood flow and oxygen supply to working muscles, further enhancing cardiorespiratory fitness. However, MICT offers a gentler introduction to physical activity, making it suitable for individuals with physical conditioning such as obesity plus it also allows obese individuals to gradually acclimate to exercise without undue strain on their cardiovascular and musculoskeletal system (Jakicic et al., 2019).S omehow, our finding noted that the changes between these two group is only 0.4 mL/(kg·min). It's not superior to each other in terms of effectiveness. Thus, we conclude that, regardless of which intensity HIIT and MICT both of these aerobic exercises clearly show a positive effect on improving CRF among obese adults.

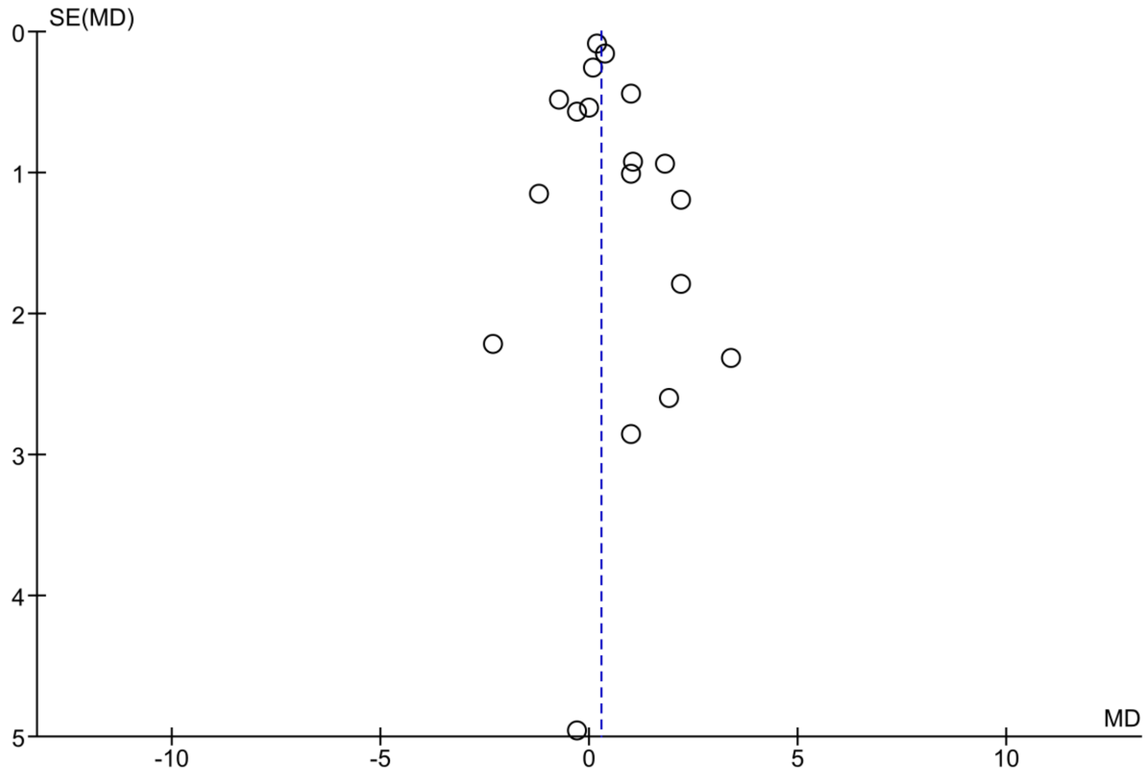
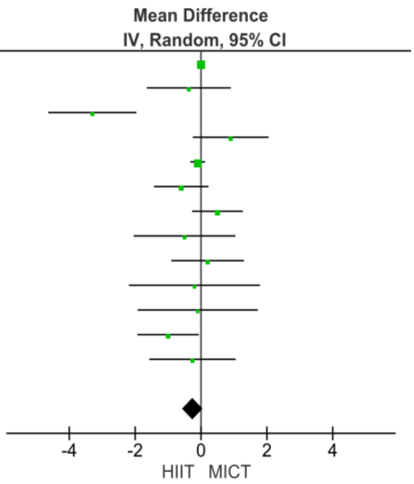


Figure 3. Funnel plot of cardiorespiratory fitness between HIIT and MICT

Funnel plot shows the study's estimated effect size for cardiorespiratory fitness between HIIT and MICT. Few larger studies with greater precision are displayed at the top meanwhile there is one study with lower precision at the bottom. This meta-analysis summary may display an asymmetry, this is might be influenced by a small number of studies. However, the flunnel plot above shows a low risk of bias.



	HIIT			MICT				Mean Difference
Study or Subgroup	Mean	SD	Total	Mean	SD	Total	Weight	IV, Random, 95% CI
Barry 2018	-0.1	0.0982	16	-0.1	0.1027	17	21.9%	0.00 [-0.07, 0.07]
Candrawati 2022	-1.15	1.9816	14	-0.78	1.3441	14	4.6%	-0.37 [-1.62, 0.88]
Cheema 2015	-4.6	1.6404	6	-1.3	0.107	6	4.3%	-3.30 [-4.62, -1.98]
Cocks 2016	-0.4	0.1906	8	-1.3	1.6199	8	5.4%	0.90 [-0.23, 2.03]
Hornbuckle 2017	-0.2	0.3735	16	-0.1	0.1481	11	20.2%	-0.10 [-0.30, 0.10]
Lunt 2014	-1.1	1.4932	16	-0.5	0.7058	17	8.6%	-0.60 [-1.40, 0.20]
Petrick 2021	-0.3	0.4697	12	-0.8	1.1845	11	9.4%	0.50 [-0.25, 1.25]
Sawyer 2016	-0.8	2.1437	9	-0.3	0.9186	9	3.4%	-0.50 [-2.02, 1.02]
Scherjeve 2008	-0.89	1.2438	14	-1.09	1.5852	13	5.8%	0.20 [-0.88, 1.28]
Scott HIIT- HOME 2019	-1.7	2.1993	9	-1.5	2.4695	13	2.1%	-0.20 [-2.17, 1.77]
Scott HIIT- LAB 2019	-1.5	2.0855	10	-1.4	2.3048	13	2.5%	-0.10 [-1.90, 1.70]
Skylerk 2013	-1.1	1.3082	8	-0.1	0.1189	8	7.4%	-1.00 [-1.91, -0.09]
Soran 2022	-2.19	1.7098	12	-1.93	1.5068	12	4.4%	-0.26 [-1.55, 1.03]
Total (95% CI)			**150**			**152**	**100.0%**	**-0.23 [-0.53, 0.07]**

Heterogeneity: Tau² = 0.11; Chi² = 36.67, df = 12 (P = 0.0003); I² = 67%
Test for overall effect: Z = 1.50 (P = 0.13)

Figure 4. Changes in Percentage Body Fat between HIIT versus MICT

The findings of this meta-analysis reveal an interpretation regarding the effects of High-Intensity Interval Training (HIIT) versus Moderate-Intensity Continuous Training (MICT) on body fat percentage among individuals with obesity. While individual studies may show favourable outcomes for HIIT over MICT, particularly in terms of body fat variation, the pooled analysis across thirteen studies did not yield significant differences between the two training modalities. The result shows no significant difference suggesting WMD: -0.23 (-0.53,0.07), 95% CI, *P= 0.13* both HIIT and MICT interventions may have comparable effects on body fat percentage in obese individuals however only small changes were observed. Somehow, it's noteworthy that the substantial heterogeneity observed among the included studies (I^2 = 65%) indicates variability in the results, which may stem from differences in study designs, participant characteristics, intervention protocols, or outcome measures. Therefore, while some studies may suggest potential benefits of HIIT, such as the study by Cheema et al.,2015 with huge changes in of reduction -4.6 body fat percentage by doing HIIT exercises in a 12-week intervention somehow the overall evidence does not support a clear superiority of HIIT over MICT in terms of body fat reduction among individuals with obesity. A study by Cheema et al., 2015 with the most unique approach chose boxing as a modality of exercises compared to their study that underwent exercises mostly cycling and running. Somehow, one more study from the HIIT group also shows quite a great change with a reduction of -2.19 of body fat percentage while undergoing the same duration of training intervention which is 12 weeks but comes out with a different result with -2.41 of body fat percentage. It might be a difference in exercise modalities that influence these contradicting outcomes, as a study by Cheema et al., 2015 practising boxing that might require more bodily movement rather than a study by Sooran et al., 2022 that mixed running and walking on a treadmill during exercises. Meanwhile, for MICT there is a small change in body fat reduction shown in all thirteen studies. This means MICT is also capable of reducing the body fat percentage among the obese population even with the minimal reduction.

It is clear that both HIIT and MICT provide a positive effect on body fat reduction although HIIT may offer certain advantages in terms of time efficiency and cardiovascular benefits, however the lack of significant differences in body fat reduction in the HIIT group this review suggests that MICT remains a viable option, particularly for individuals who may find high-intensity exercise challenging or prefer a more gradual approach to physical activity. Future research should aim to clarify the underlying mechanisms driving body fat changes in response to different exercise modalities and identify factors that may influence individual responses to HIIT and MICT interventions among individuals with obesity. Additionally, studies with larger sample sizes and standardized outcome measures could help provide clearer insights into the comparative effectiveness of HIIT and MICT in promoting body fat loss and overall health outcomes in this population.

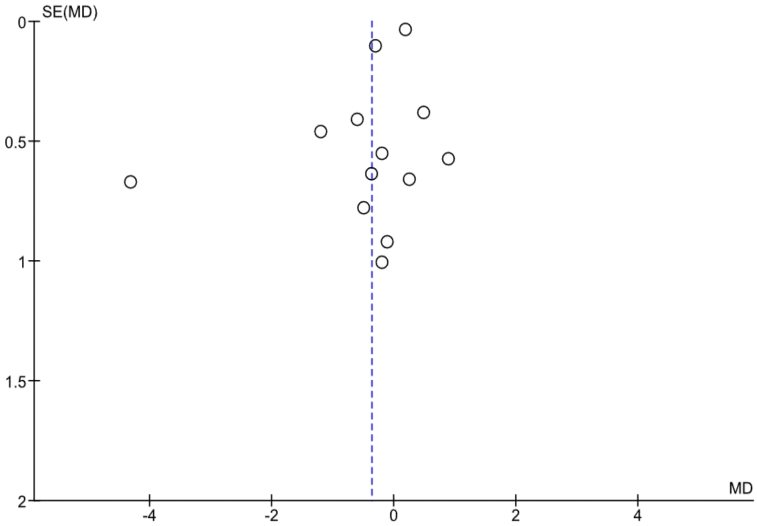


Figure 5. Funnel plot of percentage body fat between HIIT vs MICT

Funnel shows the study estimated effect size for percentage body fat between HIIT and MICT. Most of the studies with greater precision are displayed at the top meanwhile there is one study with lower precision at the bottom. This meta-analysis summary may display a greater asymmetry, this might be influenced by a small number of studies leading to asymmetry in the funnel plot. Somehow flunnel plot above shows the moderate risk of bias in most studies.

CONCLUSION

Overall, this meta-analysis does not conclusively favour HIIT over MICT for improving cardiorespiratory fitness and body fat percentage among obese adults. Although, some individual studies suggest favourable outcomes for HIIT, particularly in cardiorespiratory fitness improvement and body fat reduction, the pooled analysis across both studies HIIT and MICT did not reveal significant differences between the two training intensities.Thus, this review that regardless of HIIT or MICT both of these training provide a cardiorespiratory fitness improvement and body fat percentage.On top of that, health practitioners or trainers might be considering the developing of training programs based on individual preferences among obese adults as it might enhance the enjoyment and positive adherence towards exercises.

AUTHORS' CONTRIBUTION

Mohd Noorazam Abdul razak contributed to the study conception and design. Study search, study selection, quality assessment, data extraction and analysis were performed by Noor Fatihah Ilias and Hahsbullah Ismail. The first draft of the manuscript was written by Nurul Najwa Aminul Mahzan and all authors critically revised the manuscript. All authors read and approved the fnal manuscript.

CONFLICT OF INTEREST

The author has no conflict of interest to declare.

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