DOI: https://doi.org/10.53350/pjmhs22167674

ORIGINAL ARTICLE

Is Interval Training more Effective and Efficient Workout for Fat Loss Compared to Continuous Training?A Meta-Analysis

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ABSTRACT
Background: Enhancing regular physical activity can lead to substantial health benefits. Interval-based high-intensity circuit training is an effective and efficient way of reducing body fat, yet the comparison between this type of training and long-term moderate-intensity continuous training is equivocal.
Objectives: the objective was to conduct a meta-analysis for comparing high-intensity interval training with moderate-intensity continuous training on improving body fat.
Method: We searched PubMed, Google Scholar, Scopus, and CINAHL for the following inclusion criteria: (a) Studies that compare high-intensity interval training and moderate-intensity continuous training using body fat as an outcome measure in a healthy population; (b) the frequency of the training at least four weeks; (c) Articles must be in the English language.
Result: A total of 325 participants were included in 10 Randomized Control Trials (RCT). Results revealed that interval training has a mild pooled effect in reducing the body fat of the participants with an effect size of (SMD) of 0.26 (95% of CI=0.00 to 74.84) calculated at the random effect model. I^2 14.87% (95% CI=0.01 to 0.45) in comparison to moderate-intensity continuous training performed during 6-12 weeks.
Conclusion: We concluded that the intensity of effort has a significant impact in reducing fat loss in minimal time compared to continuous long-term exercise with less intensity.
Keywords: Body Fat, Continuous training, Interval-Training, Sprint interval, traditional exercises

INTRODUCTION
Excess body fat has a strong link to a variety of diseases, including cardiovascular disease, metabolic disorders, certain cancers, osteoarthritis, and respiratory problems[1]. On the other hand, Low levels of fat-free mass are linked to a loss of strength, functional capacity, and bone mineral density[2], impairing quality of life. Low levels of fat-free mass and high levels of body fat maximize the risk of developing disability, morbidity, and mortality[3]. Exercise is frequently recommended as a means of improving body composition[4]. A significant proportion of standards and guidelines for obesity management recommend a high volume of exercise. To prevent weight gain or slightly reduce body mass (2–3kg), guidelines recommend 150–250 minutes of moderate-intensity aerobic exercise per week, and up to 60 minutes per day[5, 6]. To lose more weight (5–7.5kg), more than an hour of exercise per day (>420min/week) is recommended, and few people meet these guidelines[7]. Moreover, different doses of exercises in terms of different intensities are often implemented for the purpose of improving body composition and maintaining a healthy lifestyle. Moderate Intensity Continuous Training (MICT) is defined as a moderate workload (<80% of maximum heart rate) performed over a longer period without a defined rest period in a single bout however High-Intensity Interval Training (HIIT) in circuit form is defined as the maximum workload (>80% of maximum heart rate) performed in multiple shorter bouts separated with either low intensity or complete rest intervals[8]. Interval Training (IT), which has some similar health benefits to MICT while requiring less time, may have the potential to promote weight loss.

Even though both MICT and IT have been shown to improve body composition, there is debate over whether one strategy is better than the other for this objective. According to Keating et al little difference was found between MICT and IT workout in body fat reduction[9] referring to the fact that neither intervention obtained clinically significant changes in short time interval On the other hand, Viana et al revealed that IT reduced fat mass by 28.5% greater than MICT[10]. Sultana et al. recently published a meta-analysis, according to the study there was no benefit to low-volume IT on body composition when compared to MICT however they only construct their conclusion in a single measure[11]. Undoubtedly, a such discrepancy may raise the need for more studies that compare the impact of IT and MICT on fat loss. Therefore, we conducted a meta-analysis that compares both IT and MICT on body composition outcomes.

MATERIAL AND METHODS
This meta-analysis was conducted following the guidelines of the "Preferred Reporting Items for Systematic Review and Meta-Analysis[12]. Databases of Google Scholar, and PubMed /MEDLINE were searched on November 23rd, 2022 for studies providing data on IT and MICT. The relevant search strategy was used as below:

Interval Training	"Interval training" OR "High-intensity" OR "High-intensity Circuit Training" OR "Sprint Training" OR "Short bout exercise"
Continuous training	“Continuous Training” OR “Moderate Intensity” OR “ Traditional Training”
Body fat	“Body Fat” OR “Body fat%” OR “ Fat loss”

The search of the article was filtered to the English language and the study design was restricted to a randomized control trial. Two Authors separately analyze the research article contents which include the title, abstract and full text of the relevant articles. Afterward duplicated studies were removed by both authors after a discussion of reviewed articles. Moreover, we screened the reference list to retrieve additional studies.

The articles of interest were chosen based upon the inclusion criteria; 1) the randomized Controlled Trail that directly compares interval training and moderate-intensity continuous training 2) the outcome measure must have body composition including body fat measurement 3) the population must be healthy 4) the frequency must be reported for at least four weeks and the at least once in a week 5) pre and post-treatment comparison must be reported in term of means and standard deviation values 6) the articles should available in the English language. The excluded criteria were; 1) study participants with any co-morbidity 2) unbalanced training intervention 3) incomplete reporting about outcome measures. Two researchers (SM and AAK) worked separately on the search/screening. These researchers gathered all of the titles and abstracts before going over the full texts of the papers that were deemed worthy. Based on the eligibility criteria, decisions were made as to whether a study was significant for inclusion. Any disputes on the inclusion of a given study were settled by both researchers mutually.

Following the characterization of which studies were eligible for inclusion, researchers separately coded the variables for each study as; Author/study with a year of publication, population characteristics, duration of the training, a sample size of each group, workout protocol, frequency of the training, time/session, outcome measure (Table 1).

Table 1: Characteristics of included studies (RPE= Ratings of Perceived Exertion, MICT=Moderate Intensity Continuous Training, IT=Interval Training, BF=Body Fat, THR=targeted heart rate, HR_{max}=heart rate maximum, RM= repetition maximum, HRR= heart rate reserve)

S No	Study	Population	Duration (Weeks)	Groups (n)	Workout protocol	Frequency	Time/session	Outcome
1	Cheema et al., 2015	Obese adult (mean age 39 years)	12	MICT (6) IT (6)	Brisk walking at 4 METs IT: 4–7 intervals at a 2:1 ratio, then 5 boxing drills × 3 intervals at a 2:1 ratio, RPE 15–17 (>75% HRmax)	MICT (4 times) IT (4 times)	MICT (50 min) IT (20 min)	BF
2	Cocks et al., 2016	Obese adult (mean age 25 years)	4	MICT (8) IT (8)	MICT: Continuous cycling @ 65% VO2 peak IT: 4–7 sprints × 30 s at 200% W-max, 120 s at 30 W in-between	MICT (5 times) IT (3 times)	MICT (40-60 min) IT (10-17 min)	BF
3	Fisher et al., 2015	Obese young adult (mean age 17-22 years)	6	MICT (13) IT (13)	MICT: Cycling at 55–65% VO2 peak IT: 4 intervals of 240 s at 15% APmax, then 30 s at 85% APmax, then 120 s at 15% APmax	MICT (5 times) IT (3 times)	MICT (40-60 min) IT (20 min)	BF
4	Higgins et al., 2016	Overweight young females (mean age 20 years)	6	MICT (29) IT (23)	MICT: Continuous cycling at 60–70% HRR IT: 5–7 all-out intervals of 30 s, 240 s active recovery	MICT (3 times) IT (3 times)	MICT (20-30 min) IT (22.5-31.5 min)	BF
5	Koubaa et al., 2013	Obese adolesence (mean age 13 years)	12	MICT (15) IT (14)	MICT: 60–70% of VO2max IT: running for 2 min at 80–90% of VO2max followed by recovery periods of 1 min.	MICT (3 times) IT (3 times)	MICT (30-40 min) IT (10-17 min)	BF
6	Macpherson et al., 2011	Healthy adults (mean age 23 years)	6	MICT (10) IT (10)	MICT: running, 65% of VO2max IT: 4–6 bouts of 30 s maximal running efforts with 4 min of recovery (active recovery encouraged)	MICT (3 times) IT (3 times)	MICT (30-60 min) IT (18-27 min)	BF
7	Panissa et al., 2016	Sedentary women (mean age 28.4` years)	6	MICT (12) IT (11)	MICT: Cycling at 70% HRmax IT: Cycling 15 sets 60 s at 90% HRmax with 30 s recovery period at 60% HRmax	MICT (3 times) IT (3 times)	MICT (29 min) IT (22 min)	BF
8	Pasetti et al., 2012	Sedentary obese females (mean age 46 years)	12	MICT (12) IT (15)	MICT: Deep water running at 65–85% HRR IT: Deep water running 8–15, 15 s sprints with 30s recovery interspersed with 5–14 min intervals at 70–75% HRmax	MICT (3 times) IT (3 times)	MICT (47 min) IT (40 min)	BF
9	Trapp et al., 2008	Healthy sedentary young females (mean age 21 years)	15	MICT (15) IT (15)	MICT: Cycling, 60% VO2peak IT: Cycling, maximum of 60 bouts of 8 s:12 s ratio of sprinting and slow pedaling	MICT (3 times) IT (3 times)	MICT (40-60 min) IT (10-17 min)	BF
10	Shepherd et al., 2015	Overweight adult (mean age 42 years)	10	MICT (44) IT (46)	MICT: Cycling, ~70% MHR IT: Cycling, >90% MHR, repeated sprints of 15–60 s, interspersed with periods of recovery cycling	MICT (5 times) IT (3 times)	MICT (30-45 min) IT (18- 25 min)	BF

We either extracted data from graphs when available via online software or attempted to contact the study's authors in cases where body composition data was not reported numerically. The coding was double-checked by the reviewers.

MedCalc software version 22.0 was used to analyze the data. A continuous measure tool was used with SMD and forest plots to evaluate the pooled effect of eligible studies. The values lie on the negative side of the forest plot favour moderate-intensity continuous training however the positive-sided values indicated the treatment in favour of interval training. Small, moderate, and large effect sizes were determined using the standard Cohen rule of thumb, with 0.2, 0.50, and 0.8 representing small, moderate, and large effect sizes, respectively. The degree of statistical heterogeneity among the incorporated studies was calculated through I^2 values of 25, 50, and 75 percent as low, moderate, and high variability respectively.

RESULTS

The systematic search was conducted on different databases which include Google Scholar, Cochrane center, and Pub Med. The initial review yielded 318 search results, with a total of 10 studies included in the final meta-analysis. A flow chart of the search process, shown in figure 1, depicts the detailed processes of study identification, screening, and inclusion in conformity with eligibility criteria.

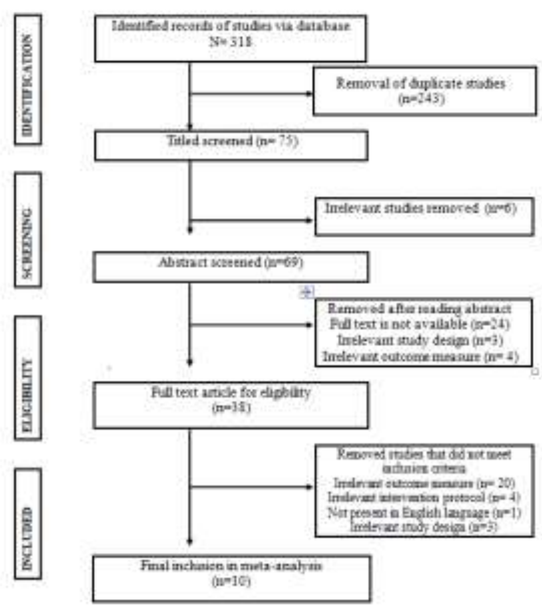

Figure 1: Illustrating PRISMA flow chart depicts study selection practice

Only RCT was appraised in this meta-analysis for determining the effect of interval training and moderate-intensity continuous training on the primary outcome measure of the body fat percentage. (Overall, 10 studies were included with a total of 325 participants; 164 in moderate-intensity continuous training and 161 in the interval training group. The age of the incorporated reported population was 13 years or older. In included studies population was taken as healthy adults. The duration of the exercise training was shown as 12 weeks in three studies, six weeks in four studies, and 4, 15, and 10 in the remaining studies respectively. The exercise intensity was measured in terms of VO_2 max (VO_{2max}), rating Perceived Exertion (RPE), and Heart Rate Maximum (HR_{max}). The moderate intensity Continuous training time duration was reported as 29-60 minutes per session, however, the interval training time duration was reported as 10 to 40 minutes per session. Furthermore, Moderate intensity continuous training frequency was reported as 3-5 times per week, however, interval training frequency was reported as 3-4 times per week. According to our meta-analysis of integrated studies, the most beneficial volume of interval training for achieving health benefits is to perform the training protocol thrice a week for 6-12 weeks in 10-40 minutes at an intensity of >80% of HR_{max}. The I^2 statistics test of heterogeneity was used to ascertain the level of variability among studies. the percentage of inconsistency among studies was found to be very low at 14.87%, with a significant level of P= 0.04, and a 95 % confidence interval (CI) of 0.00 to 74.84 presented in Table 2.

Table 2: Test of Heterogeneity

Q	17.2643
DF	9
Significance level	P = 0.0447
I^2 (inconsistency)	14.87%
95% CI for I^2	0.00 to 74.84

The magnitude of effect size on body fat measure was determined among healthy individuals. As shown in Table 3, the overall effect size revealed a mild pool effect in reducing body fat percentage with an SMD of 0.26 (95 percent CI 0.00 to 74.84) and a significance level of 0.03 measured as a fixed effect model with I2 47.87 percent (95 percent CI=0.01 to 0.45).

Table 3: Pooled effect of interventions on the outcome measure

Study	N1	N2	Total	SMD	SE	95% CI	t	P	Weight (%)	
									Fixed	Random
Cheema et al., 2015	6	6	12	0.0824	0.533	-1.105 to 1.270			4.27	6.44
Cocks et al., 2016	8	8	16	1.028	0.506	-0.0578 to 2.114			4.73	6.91
Fisher et al., 2015	13	13	26	0.776	0.395	-0.0391 to 1.590			7.78	9.46
Higgins et al., 2016	23	29	52	0.645	0.282	0.0783 to 1.212			15.23	13.13
Koubaa et al., 2013	14	15	29	0.475	0.367	-0.278 to 1.227			9.03	10.27
Macpherson et al.,2011	10	10	20	-0.360	0.432	-1.268 to 0.548			6.50	8.50
Panissa et al., 2016	11	12	23	0.486	0.409	-0.364 to 1.336			7.26	9.09
Pasetti et al., 2012	15	12	27	-0.758	0.389	-1.560 to 0.0442			8.00	9.61
Trapp et al., 2008	15	15	30	0.371	0.358	-0.364 to 1.105			9.44	10.52
Shepherd et al., 2015	46	44	90	-0.0122	0.209	-0.428 to 0.403			27.75	16.06
Total (fixed effects)	161	164	325	0.237	0.110	0.0199 to 0.453	2.148	0.032	100.00	100.00
Total (random effects)	161	164	325	0.261	0.161	-0.0551 to 0.577	1.624	0.105	100.00	100.00

As shown in figure 2, the diamond of forest plot of all implemented studies found the positive effect of interval training in reducing body fat percentage.

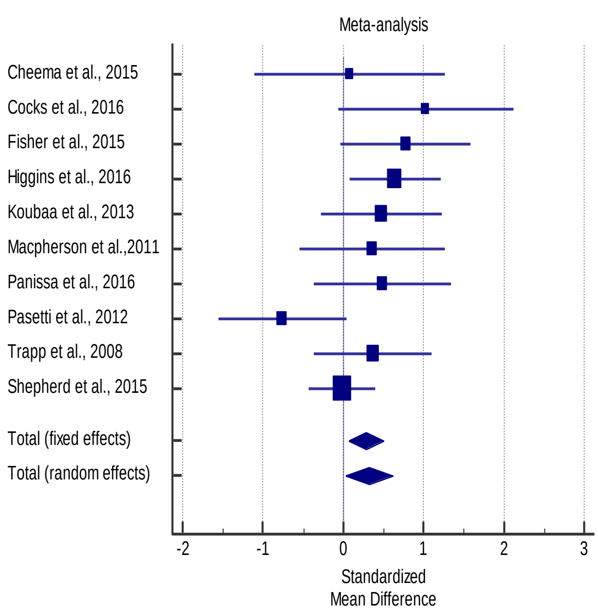

Figure 2: The Forest plot demonstrated the SMD effect

Figure 3 demonstrated an even proportion of studies in a funnel plot indicating, no evidence of publication bias.

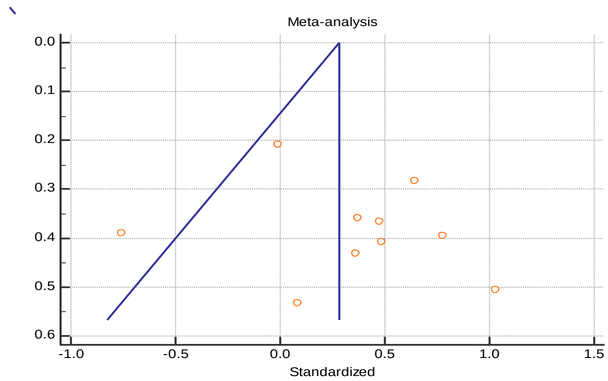

Figure 3: Illustrating the funnel plot for risk of publication bias

DISCUSSION

The present meta-analysis is the most comprehensive study that compares interval training and moderate-intensity continuous training on changes in body fat mass. Our findings shed new light on how two different training strategies can be used to reduce body fat percentage in time efficient manner. The results and practical implications of our data for the primary outcome are discussed below. Our findings show that interval training has a significant impact on body fat percentage reduction among healthy young adult individuals compared to moderate-intensity continuous training, as this study aims to detect the effects of interval training and moderate-intensity continuous training concerning duration, frequency, intensity, and time. We included a total of ten studies (Cheema et al., 2015, Cocks et al., 2016, Fisher et al., 2015, Higgins et al., 2016, Koubaa et al., 2013, Macpherson et al.,2011, Panissa et al., 2016, Pasetti et al., 2012, Trapp et al., 2008, Shepherd et al., 2015) in our study. We retrieved the exercise protocol in terms of FIIT protocol from both incorporated exercises. Our results suggested that the interval-based exercise protocol had a mild pool effect on body fat reduction with an overall effect size SMD of 0.26 (95% CI=0.01 to 0.45) measured as a fixed effect model with I^2 47.87% (95% of CI=0.00 to 74.84) in comparison to moderate intensity continuous exercise regime. It's been suggested that IT may provide better fat-burning results than MICT, owing to higher excess post-exercise oxygen consumption [13]. The fat reduction proposed by the interval training, not only enhances appetite suppression but also enhances fat oxidation and lipolytic hormone activation[14]. Despite the physiological rationale, our results do not support the evidence of interval training fat loss. Moreover, a recent study, suggests that affective responses between interval training and moderate-intensity continuous training may differ only marginally, and that enjoyment response may show a small effect in favour of interval training[15]. Despite various substantial theories about the intensity of exercise effort and its impact on effectiveness or enjoyment, continuous supervision has a positive impact on exercise adherence[16]. Furthermore, the variability of treatment responses to interval training and moderate-intensity continuous training has been understudied, however, there have been numerous studies that affirm there is inter-individual response variation to both exercises for a variety of outcomes[17-19]. Admittedly, some have suggested that such variations could obscure differences in fat loss between interval training and moderate-intensity continuous training [20].

When attempting to draw practical inferences about the effects of IT vs MICT on measures of body composition, the current meta-analysis has several limitations that must be considered. To begin with, the sample size of some of the RCTs included was small. Secondly, we analyze the impact of both exercises on a healthy population; in the future researchers may consider the disease population to determine the impact of the current exercise. Thirdly, we evaluate the influence on one component of body composition, namely body fat percentage, but other predictors of obesity and overweight, such as body weight, Waist-Hip Ratio, and Body Mass Index, may also be investigated in the future. Therefore, we recommend that researchers should investigate the possible effect on male participants with other determinants of overweight and obesity parameters in the future.

CONCLUSION

The meta-analysis concluded that high-intensity interval training has a significant role in reducing body fat percentage among healthy young adult populations compared to moderate-intensity continuous training in an effective and time-efficient manner.

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