High-Intensity Interval Training and High-Intensity Resistance Training on Body Fat Percentage and Aerobic Fitness among Female Overweight Adults

Asfarina Jitwil
asfarinajitwil@gmail.com
Faculty of Sports Science & Recreation, Universiti Teknologi MARA Kampus Samarahan, Cawangan Sarawak, Malaysia

Patricia Pawa Pitil
patriciapitil@yahoo.com,
Faculty of Sports Science & Recreation, Universiti Teknologi MARA Kampus Samarahan, Cawangan Sarawak, Malaysia

Wan Juliana Emeih Wahed
juliewahed@gmail.com
Faculty of Art & Design, Universiti Teknologi MARA Kampus Samarahan, Cawangan Sarawak, Malaysia

Abstract

The prevalence of overweight or obesity has increased worldwide and this was associated with increased risk factors for cardiovascular disease. Studies also had suggested that individuals with the high accumulation of body fat in the abdominal region were at greater risk of developing metabolic syndrome. Existing studies had not directly studied a comparable amount of high-intensity interval training (HIIT) and high-intensity resistance training (HIRT) on the improvement of body composition and aerobic fitness. The purpose of this study was to compare the effects between 6 weeks of HIIT and HIRT on body fat percentage and aerobic fitness among overweight female adults. Fourteen sedentary female were recruited and assigned to two groups; HIIT (n = 7) and HIRT (n = 7), aged 22.571 ± 1.399 years, height 155.929 ± 2.841cm, weight 63.464 ± 5.873 kg and BMI 26.079 ± 2.032 kg/m^2. Both training interventions were conducted with 90% of heart rate maximum which included 12 types of bodyweight exercises performed 30 seconds with 10 seconds of transition time between bouts of exercises for 2 -3 sets for HIIT and 75% of 1-RM for HIRT consisting of compound of push and pull exercises targeting large muscle groups of 10 repetitions for 3 sets with 2 minutes rest interval. The results showed that there were significant differences in body fat percentage ($p < .05$) and aerobic fitness ($p < .05$) in both training programs. In comparing the two trainings, HIRT produced greater significant improvement in aerobic fitness than HIIT. However, body fat percentage did not differ significantly between these trainings ($p > .05$). In conclusion, both HIIT and HIRT were effective in reducing body fat percentage and improving aerobic fitness among overweight female adults.

Keywords: *High intensity interval training; high intensity resistance training; body fat percentage; aerobic fitness; overweight; female adults*

Introduction

The prevalence of overweight and obese population has increased all over the world especially among adults in developing countries among adults (Ng, Fleming, Robinson, Thomson, & Margono (2014). The

incident of obesity is reported highest higher among females compared with males (WHO, 2017). The lack of time to exercise is always being the main reason of physical inactivity. Additionally, the declining of energy expenditure in relation to inclining of energy consumption through excess calories intake cause the incidence of excessive bodyweight, and if prolonged, lead to obesity (Wiklund, 2016). Overweight and obesity are closely linked to cardiovascular disease (Ramirez-Velez, Hernandez, Castro, Tordecilla-Sanders, Gonzalez-Ruiz, Correa-Bautista, Izquierdo & Garcia-Hermoso, 2016). As overweight and obesity are global epidemics, cardiovascular disease follows the same path (Murray, 1996).

A better understanding on what types of exercise interventions that could influence the energy expenditure of those with excess bodyweight is needed (Fisher, Brown, Brown, Alcorn, Noles, Winwood, Resuehr, George, Jeansonne & Allison, 2015). Therefore, resistance training and aerobic training are prescribed for sedentary and obese population because they can promote improvement in body composition, biochemical markers, blood pressure and heart rate as well as muscular strength and aerobic capacity (Contro, Bianco, Cooper, Sacco, Macchiarella, Traina & Proia, 2017). Most inactive individuals stated time constraint as the main obstacle to engage in a regular exercise. Thus, an effective time in exercise protocols may potentially increase individuals' compliance with exercise interventions. With respect to resistance exercise, a low volume but with high intensity training protocol seem to be the most time efficient way to improve muscular parameter compared with high intensity training (Kemmler, Wittke, Bebenek, Frohlich & Stengel, 2016). Interestingly, there was a study that compared the effects of HIIT on the combination of these two; resistance training and interval training, on cardio metabolic health in adults to promote treatment for obesity (Ramirez-Velez et al., 2016). However, the result is still inconclusive and limited in literature.

Higher exercise intensity could lead to greater aerobic fitness and indirectly would improve strength and body composition. In addition, it was suggested that interval training consisting of both endurance and resistance training might be ideal rather than focusing only on single mode of exercise (Paoli, Pacelli, Moro, Marcolin, Neri, Battaglia, Sergi, Bolzetta & Bianco, 2013). The comparison between which types of exercise that could give benefit to health-related fitness is still lacking in literature with the time constraint among the sedentary and overweight population to get active. Some studies have been done, however they were still controversial. Differences in results may be due to different types of training intensity, training volume and training length (Gerosa-Neto, Antunes, Campos, Rodrigues, Ferrari, Neto, Junior & Lira, 2016). Moreover, there is a need to conduct an intense training involving resistance training among overweight population (Paoli, Pacelli, Bargossi, Marcolin, Guzzinati, Neri, Bianco & Palma, 2010) to observe its effect among the overweight population. Therefore, the purpose of this study was to compare the effect of 6 weeks of HIIT **a**nd HIRT on body fat percentage and aerobic fitness of sedentary female adults with overweight profile.

Methodology

Study Design

This study employed the experimental design which was pre-test - post-test randomized groups designed to compare the effect of HIIT (n = 7) and HIRT (n = 7) on body fat percentage and aerobic fitness among female overweight adults. Participants who matched the study requirement were randomly assigned into one of two groups.

Participants

A convenience sampling technique was employed for recruiting the participants. The participants were readily available (S. K & Given Lisa, 2008) with a total of *N* =14 female adults with age = 22.571 ± 1.399 years old, height = 155.929 ± 2.841 cm, weight = 63.464 ± 5.873 kg, Body mass index (BMI) = 26.079 ± 2.032 kg/m^2 (overweight: 25kg/m^2 – 29.9kg/m^2) (World Health Organization, 2017) currently sedentary but in a healthy condition without any chronic disease or injury and do not take any prescribed medication or under the supervision of a physician. The research and ethics approval were sought from the faculty before conducting the study. Written consent form, general health screening by using Physical Activity Readiness Questionnaire (PAR-Q) and also physical activity level was measured by using International Physical Activity Questionnaire (IPAQ) of short last 7 days self-administered format was obtained from the participants. Only those who passed the PAR-Q and measured as sedentary took part in this study. All the participants underwent a familiarization session before the actual data collection.

Training Program

This 6-week training program for HIIT and HIRT were conducted 3 times per week with 90% of heart rate maximum (HRmax). For HIIT, the training session involved 12 types of body weight exercises (squats, static lunges, shoulder bridge, standing single leg calf raises, push-ups, incline bench push-ups, triceps dips, crunches, side crunches, back raises, step-ups, and side-to-side jumps over skipping rope) . These exercises were performed for 30 seconds with 10 seconds of transition time between bouts of exercises (Klika & Jordan, 2013). The total time to complete the entire exercises was approximately 7 minutes. The training was repeated for 2 to 3 sets per session; 2 sets for the first 3 weeks and then 3 sets for the next 3 weeks with the rest interval between sets of 4 minutes. Before the training session started, the heart rate of the participants were recorded as well as during and after the training. The heart rate needs to be monitored as the participants need to reach the target heart rate.

Meanwhile, HIRT was conducted 3 times per week as well with 90% of HRmax, which is approximately 75% of one repetition maximum (1-RM) (Logan, Fornasiero, Abernathy, & Lynch, 2000). This training consisted of simple, compound of push and pull and the squat movement which targeting large muscle groups (chest press, seated row and squat). The participants were familiarized with the equipment and the machine before starting the training program and to determine their multiple RM. A 10-RM test with the exercises included in the training program was conducted. The training performed of 10 repetitions for each of the three compound push, pull and squat movement for 3 sets with the rest interval between sets was 2 minutes. All participants performed warm-up and cool-down before and after each exercise session.

Table 1: HIIT and HIRT training program

Variables	HIIT	HIRT
Frequency	3 times/week	3 times/week
Intensity	90% of HRmax	75% of 1-RM (target at 90% of HRmax)
Time	Work:rest = 30s : 10s 7 minutes per set ~ 30 minutes per session Rest interval between set : 4 minutes	30 – 35 minutes per session Rest interval between set : 2 minutes
Volume	12 exercises x 2-3 sets	10 reps per exercise x 3 sets
	(Klika & Jordan, 2013)	(Logan, Harris, Duncan, Plank, Merien & Schofield, 2016)

Measurement

The height of the participants was measured using the stadiometer to the nearest 0.1cm. The measurement for BMI (kg/m^2), body fat percentage and aerobic fitness was conducted before (pre-test) and 48 hours after the intervention (post-test). Body weight and body fat percentage were measured by the bioelectrical impedance analysis by using a body composition analyzer (Omron Karada Scan HBF-212). For aerobic fitness, it was assessed using 20m multistage shuttle run test by following a standard protocol (Handbook, 1983). It involved running between two lines set 20 m apart at a pace dictated by a recording emitting tones at appropriate intervals. Velocity was 8.5km/hr for the first minute, which increased by 0.5km/hr every minute thereafter. The test score achieved by the participant was the number of 20 m shuttles completed before the participant either withdrew voluntarily from the test or failed to be within 3 m of the end lines on two consecutive tones. The prediction of VO_2max was calculated based the equation of Leger and Gadoury (1989).

Statistical Analysis

The data collected were analysed by using Statistical Package of Social Science (SPSS) version 22.0. Normality data were tested by using Kolmogorov-Smirnov analysis revealed that the data for body fat percentage and aerobic fitness were normally distributed. Data collected were presented in mean and standard deviation (*M* ± *SD*). A two-way repeated measure analysis of variance (ANOVA) was to be employed to measure the effect of HIIT and HIRT on body fat percentage and aerobic fitness among female overweight adults. The statistical significant level was set at 0.05 ($p < .05$).

Results

Table 2 (p.30) showed the descriptive statistic for pre and post-test of body fat percentage and aerobic fitness in HIIT and HIRT groups. Both groups showed significant improvement in body fat percentage and aerobic fitness ($p < .05$). There was a significant main effect for repeated measures time (pre – post) in body fat percentage (Wilks Lambda = .478, $F = 13.130$, $df = 1$, $p < .05$) and aerobic fitness (Wilks' Lambda = .411, F = 17.223, df = 1, $p < .05$).

In comparing these two types of training, training, there was a significant difference for aerobic fitness ($p < .05$), while body fat percentage did not show significant difference ($p > .05$).

Table 2: Descriptive statistics for pre and post-test of body fat percentage and aerobic fitness

Types of jump	Group	Pre-test	Post-test
		M (± *SD*)	
Body fat (%)	HIIT [w, ǂ]	34.100±4.024	33.443±3.761*
	HIRT [w, ǂ]	31.386±1.252	30.571±1.527*
Aerobic fitness (m/kg/min)	HIIT [¥, €]	21.629±2.279	22.379±2.510*
	HIRT [¥, €]	23.974±2.040	25.929±2.369*

[w]Wilks' Lambda = .478, F = 13.130, p = .003 ($p < .05$)
[¥]Wilks' Lambda = .411, F = 17.223, p = .001 ($p < .05$).
*$p < .05$ (Significance within group, pre vs post)
ǂ $p > .05$ (Significance between group, body fat % - HIIT vs HIRT)
€ $p < .05$ (Significance between group, aerobic fitness – HIIT vs HIRT)

Discussion

This study was intended to measure the effectiveness of six weeks of different types of high intensity training; HIIT and HIRT on body fat and aerobic fitness among the overweight female adults. The results demonstrated a positive improvement in both variables in both types of training. The synthesis of body fat percentage happened greater following HIIT and also HIRT due to the increasing metabolic activity of the system. Interestingly, the HIRT suggested a greater reduction in body fat percentage as compared to HIIT. Body fat percentage reduced 1.93% in HIIT while HIRT reduced 2.6%.

Many previous studies agreed that aerobic exercise is the best type of exercise for total body fat loss (Ali, El-Refay & Ali, 2015; Okura, Nakata, Lee, Ohkawara & Tanaka, 2005), however, in this study, the resistance training (HIRT) demonstrated a greater improvement in body fat percentage even though the difference between the type of training was not significant ($p > .05$).

The result of this study was consistent with a study by Norizzati, Sarina, Maisarah and Raja Nurul Jannat (2018) where they found superior improvement in waist circumference following resistance training in comparison with aerobic training and concurrent training (aerobic training + resistance training) even there was no difference between the types of training given. This indicated that neither training regime is superior at reducing body fat percentage statistically. Waist circumference is always used as criteria for measuring body composition, and this measurement is typically used as a surrogate measure of the visceral fat area (Matsuzawa, 2005; Grundy, Cleeman, Daniels, 2005).

In the present study, body fat percentage was served as the measurement for body composition. Even though both types of training were high intensity, a greater volume in resistance training could contribute to the greater reduction of body fat percentage. An increased in muscle activation during the HIRT contributed to the further fat mass reduction (Howley, 2000; Ogwumike, Arowojolu, & Sanya, 2011). In addition, The HIRT participants improved greater than HIIT could be due to the increase in lean tissue mass and gain muscle mass, thus this elicits changes in body fat percentage (Logan et al., 2015). The greater the reduction of body fat, the greater the lean muscle tissue that utilized for whole body exercises, thus the greater the development of skeletal muscles. In addition, the HIRT might improve lipid metabolism at rest as supported by a study examining the respiratory ratio 22 hours after HIRT. The respiratory ratio appeared to be lowered 22 hours after the HIRT indicated a greater usage of fat as energy supply (Paoli, Moro, Marcolin, Neri, Bianco, Palma & Grimaldi, 2012).

On the other hand, the HIIT methodology has been widely studied by Gibala and McGee (2008) where endurance type movement (eg. cycling) was chosen as the protocol of training. In the present study, the HIIT involved body weight exercises of various muscle groups in the training protocol. The researchers chose a training program adapted from Klika and Jordan (2013) to align with the HIRT where the resistance training recruited major muscles of compound exercises. Some findings have suggested that HIIT is an effective stimulus for reducing body fat level, even in the absence of weight loss for those individuals with large fat mass (Boutcher, 2011; Laforgia, Withers & Gore, 2006) which might be similar to the present finding.

Aerobic fitness also demonstrated an improvement in both HIIT and HIRT. In comparing these two types of training, HIRT (8.16%) produced a significant greater improvement than HIIT (3.47%). The possible underlying mechanism responsible for this result is due to the increase in the number of mitochondrial or the increase of mitochondrial density, which resulted in the generation of more adenosine triphosphate (ATP) for working muscles, thereby produced greater force generation for a longer duration (Gibala, 2009). The adaptation offered by HIRT might increase vascular resistance (Cornelissen & Fagard, 2005; Nuttamonwarakul, Amatyakul & Suksom, 2012) due to the variable of training of targeting 90% of heart rate maximum even though the load of the training was set at 75% of 1-RM. This could promote the improvement of vasodilator capacity of skeletal and myocardial muscle

tissue and thus caused increment in vessel diameter (Cornelissen & Fagard, 2005; Nuttamonwarakul, Amatyakul & Suksom, 2012). The maximal target heart rate in these two types of training resulted in aerobic fitness improvement after six weeks of intervention, thus increased of fat oxidation and the maximal of mitochondrial enzyme activities that could affecting the body fat percentage too. Exercise-induced adaptations in mitochondrial function depend on the intensity of training and appear to be explained predominately by increased expression of mitochondrial enzymes that facilitate aerobic metabolism (Lundby & Jacobs 2016). High intensity training is responsible in these adaptations.

Conclusion

It is noteworthy that the present study which had demonstrated six weeks of high intensity training of interval body weight and resistance training produced significant improvement in body fat percentage and aerobic fitness among overweight female adults. However, in comparing these two types of training, there is no significant different of body fat percentage. Aerobic fitness exhibited a significant superior improvement in HIRT as compared to HIIT. Therefore, intense training could benefit in body fat percentage reduction as suggested by this study. Those who want to benefit in aerobic fitness should undergone HIRT as it facilitates more muscle activation and development.

Limitation and Future Direction

The current study focused on sedentary overweight female adults. Future studies using obese or male participants are recommended. More specific changes could be discussed in the future studies by using different populations. Expanding the duration of intervention would be useful to understand the response of aerobic fitness and body fat percentage in long term training (more than 12 weeks). Adding more variables such as metabolic syndrome risk factors (eg; blood pressure, blood glucose, lipoprotein) in conducting a similar study is also recommended to further measure and understand the specific response on intense exercise. For physical trainers, interventions on controlling overweight and obese populations should include intense interval and resistance training.

Acknowledgements

The researchers wish to thank the kind co-operation of the participants and the faculty research committee for the permission to conduct the study. The researchers have no conflict of interest.

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