Journal of Cardiovascular Disease Research

ISSN:0975-3583,0976-2833 VOL12,ISSUE05,2021

EFFECT OF HIGH INTENSITY INTERVAL TRAINING VERSUS LOW INTENSITY CONTINOUS TRAINING ON PHYSICAL FITNESS AMONGOVERWEIGHT ADULT

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ABSTRACT

Objective: The Study aimedto compare between the effect of high intensity interval training versus low intensity continous training on physical fitness among overweight adult. **Methods:** Clinical trial,thirty overweight subjects from both sexes with age range from 20 to 30 yearsoldselectedfromHorusUniversityinNewDamiettacity participated in the study for 12 weeks 3sessions/week and were divided randomly into two groupsofequalnumbers (A&B): **Group A:**subjects in this groupparticipated in sixty-minutes high-intensity interval training exercises 3 times per week for a period of 2 successive months.**Group B:** subjects in this groupparticipated in 60-minutes low-intensity training exercises three times per week for a period of 2 successive months. All subjects were assessed by weight and height scale (BMI), pulse oximeter, the waist circumference (WC),waist hip ratio (WHR), bioelectrical impedance analysis, a mercury sphygmomanometer, VO2max and the 20-meter shuttle run test (20mSRT).**Results:** Comparing both groups pre-study and post-study revealed statisticallysignificant improvement in all measured variables ($P<0.05$) in both groups, with higher percentage of improvement in favor to group A.

Conclusion: Bothhigh intensity interval training and low intensity continous training have an effect on improvingVO_2max and reducing fat mass percentage with higher percentage of improvement in favor to group A.

Key words: High intensity interval training, Low intensity continous training, Physical fitness, Overweight.

INTRODUCTION

Overweight and obesity are defined by the World Health Organization (WHO) as abnormal or excessive fat accumulation that poses a health risk. The body mass index (BMI) is a basic metric for determining overall body fatness. It is computed by dividing the body weight in kilograms by the square of height in meters. Current guidelines from the US Centers for Disease Control and Prevention (CDC) and the World Health Organization (WHO) define a normal BMI range for adults as 18.5 to 24.9, whereas a BMI of 25 kg/m2 is considered overweight, a BMI of 30 kg/m2 is considered obese, and a BMI of 40 kg/m2 is considered severe obesity. [1]

Being overweight or obese raises the potential of all-cause mortality and is a major risk factor for cardiovascular and metabolic diseases, such as atherosclerosis, type II diabetes and metabolic syndrome. [2]

Physical inactivity is one of the leading causes of obesity, and a lack of physical fitness is a risk factor for death on its own. Exercise is a good way to lose weight and improve overall health. [3]

High-intensity interval training (HIIT) is one of the techniques and the proper form of training to enhance the desired physical components because it is a very effective and efficient approach to do so. HIIT training will improve cardiac performance and have a major impact on the body's metabolism(The ability of the body to transform fat into energy) In addition to enhanced metabolism during training, The body's metabolism rises at rest, allowing it to remain in an energy-producing state. [4]

Low-intensity exercise tends to enhance fat oxidation during exercise (but not at rest) and resulting in greater total fat oxidation than moderate- or high-intensity exercise with identical energy expenditure. [5]

ISSN:0975-3583,0976-2833 VOL12,ISSUE05,2021

METHODOLOGY:

Ethicalconsiderations and approval:

The steps of evaluation and designs of the study have been approved by The Research Ethics Committee of the Faculty of Physical Therapy, Cairo University (NO P.T.REC/012/003091) and were registered in clinical trials registry with approval number (NCT04932174).

Study Design: Clinical trial, thirty overweight subjects with ages range from 20 to 30, were recruited from Horus University employees in New Damietta city. Subjects were randomly assigned into to equal-matched groups(A&B). Group A: included 15 overweight participants who participated insixty-minute high-intensity interval training exercises 3 times per week for a period of 2 months. Group B: included 15 overweight participants who participated in 60-minute low-intensity training exercises three times per week for a period of 2 months. Inclusion criteria: subjects with the following criteria have been included to participate in this study, The BMI ranged from 25 to 29.9 kg/m^2, they were between the ages of 20 and 30 years old, Men's waist circumference >88 cm^2 and women's waist circumference >102 cm^2. Content of body fat were assisted by electrical bioimpedence≥33%, Subjects who were participated in this study controlling in their body weight at least one month before starting the study, Followed instructions for healthy life style. Exclusion criteria: Patients with deformities and diseases of the musculoskeletal system, Patients suffering from various neuromuscular diseases, Patients with ulcers and foot abnormalities, Patientswho have had lower limb surgery, Thyroid disorders that are linked to smoking cigarettes, Coronary artery disease history COPD (chronic obstructive pulmonary disease) is a type of asthma.

Procedures: subjects were assigned randomly into two equal groups in numbers, group A and group B. Both groups had an assessment of body weight (Kg) and height (m) were measured by using weight and height scale to calculate body mass index (kg/m^2) before starting the studyto determine the inclusion criteria as regards BMI to include the overweight subjects only in this study e.g. BMI= weight (kg)/height^2(m^2). Then, waist and hip circumference have been measured in all subjects by tape measure by the same clinicians for male and for female after getting training for this to be used for calculation of the waist hip ratio and Bioelectrical impedance analysis: It was used to calculate body fat percent, fat mass, and fat-free mass using a Body Composition Analyzer.Cardiorespiratory fitness:(VO2max)–the standard measure for cardiorespiratory fitness and was assessed via Shuttle run test (SRT). The 20-meter shuttle run test (20mSRT) is Progressive Aerobic Cardiovascular Endurance Run test, has recently been identified as the most widely used field test of CRF among children and adolescents: The 20mSRT includes gradually increase running speed back and forth in time to audio signals from a pre-recorded music CD between two parallel lines 20 meters apart. It is divided into a number of stages (also known as levels), each stage last around one minute and consisting of a number of 20meter laps (also called shuttles). The number of shuttles finishedby each subject were counted and used to estimate $vo_{2\ max}$ through the following equation[6] VO2max= 43.313 + 4.567*sex - 0.560*BMI + 2.785* stage All variables were expressed in their original units, i.e., sex (0=girls and 1=boys), BMI (kg.m-2). [7]Basal metabolic rate: BMR was calculated by using Harris Benedict equation, as- for men, BMR=66+ (13.7 x weight (kg)) + (5 x height (cm)) – (6.8 x age (years)); and for female, BMR=655+ (9.6 x weight (kg)) + (1.8 x height (cm)) – (4.7 x age (years).[8]

- After BMR calculation, total daily energy expenditure (TDEE) was calculated by multiplying the BMR value by activity level as shown below:

- Sedentary = BMR x 1.2 (little or no exercise, desk job)
- Lightly active = BMR x 1.375 (light exercise/ sports 1-3 days/week) Moderately active = BMR x 1.55 (moderate exercise/ sports 6-7 days/week), Very active = BMR x 1.725 (hard exercise every day, or exercising 2 xs/day), Extra active = BMR x 1.9 (hard exercise 2 or more times per day, or training for marathon, or triathlon, etc. [9]

Group A: High intensity interval training, All the subjects started the exercise session with a warm- upperiod for 10 min at an intensity corresponding to 60-70% of HR Max.The High intensity interval training program has been performed in an individualized method as the high intensity phase of the exercise has been calculated for each subject according to his maximum heart rate achieved during the test by calculating 85-90% of HRMax.Training phase for 40 min has been divided into four sets of exercise in the form of 4-min of high intensity (85-90%) of HRmax interspersed by 3 minutes of low intensity walking at the level of 70% of HR max.[10] During the exercise training the speed of the treadmill was increased to allow the subjects' heart rate to raise progressively to reach 90% of HR max throughout the first 1-3minutes of the intervals at the end of the first 4-minute period 70% of the HR max.

Group B:Allsubjects performed exercise training at lowerintensitystarts the exercise session with a warm up period for 10 minute. the low intensity continous training program has been performed in an individualized method as low intensity phase for 45 minutes walking on treadmill at intensity 40-50% MHR (1- 6) weeks then 60% MHR (7-12) weeks[11]. During the exercise training the speed of the treadmill was increased gradually until heart rate reach to 60% of Max HR.

ISSN:0975-3583,0976-2833 VOL12,ISSUE05,2021

Data analysis

Statistical analysis was conducted using SPSS for windows, version 26 (SPSS, Inc., Chicago, IL). Prior to final analysis, data were screened for normality assumption, homogeneity of variance, and presence of extreme scores. This exploration was done as a pre-requisite for parametric calculations of the analysis of difference. Preliminary assumption checking revealed that data was normally distributed for all measured variables, as assessed by Shapiro-Wilk test ($p > 0.05$). There was homogeneity of variances ($p > 0.05$) and covariances ($p > 0.05$), as assessed by Levene's test of homogeneity of variances. Accordingly, non-parametric statistics were used. The independent sample t-test was used to compare whether there is a difference in the dependent variable for the two independent groups. While, paired sample t-test was used to compare whether there is a difference within the same group. Unpaired t-test was used to compare whether there is a difference pre-treatment in the demographic characteristics for the two study groups. Chi-squared test was used to compare whether there is a difference pre-treatment in gender. The alpha level was set at 0.05.

RESULTS:

Demographic and clinical characteristics of participants:

The baseline characteristics of the participants showed that no statistically significant differences existed between both groups (P>0.05), as shown in Table 1. There was also, no significant difference between both groups in gender distribution, the $\chi 2$ value was 0.159 (P>0.05).

- **Pre-treatment comparison between both the groups**

No statistically significant differences were noticed regarding the pre-treatment between the two groups in all measured variables (P>0.05), as shown in Table 2.

- **Pre-treatment and post-treatment comparison in each group**

There was a significant improvement in all measured variables (P<0.05) in both groups, with higher percentage of improvement in favor to group A as shown in Table 2.

- **Post-treatment comparison between both the groups**

There was no statistically significant improvement in all measured variables between both groups (P>0.05). However, there was a significant difference between both groups post-treatment in favor to group A except in (Body fat and waist circumference) as shown in Table 1.

Table1. General characteristics of participants in both groups

	Group A $\bar{x}$ **± SD**	**Group B** $\bar{x}$ **± SD**	**P- value**
Age (Years)	26.4 ± 3.37	26.8 ± 2.33	0.709
Height (cm)	166.6 ± 4.48	163.4 ± 4.04	0.08
Weight (kg)	80.92 ± 5.27	78.52 ± 5.38	0.226
BMI (kg/m2)	29.11 ± 1.05	29.3 ± 0.71	0.573
Gender			

ISSN:0975-3583,0976-2833 VOL12,ISSUE05,2021

Male	4 (26.66 %)	5 (33.33 %)	0.690
Female	11 (73.33 %)	10 (66.66 %)	

P-value: probability value; *Significant at *P*<0.05

Table 2. Comparison between both groups in all measured variables.

Variable	Time	Group A $\bar{x}$ ± SD	Group B $\bar{x}$ ± SD	*P*- Value
Weight (kg)	Before	80.92 ± 5.27	78.52 ± 5.38	0.226
	After	74.36 ± 4.6	74.26 ± 5.7	0.958
	% of change	**↓ 8.1 %**	**↓ 5.42%**	
	P Value	**0.001***	**0.001***	
BMI (kg/m^2)	Before	29.11 ± 1.05	29.3 ± 0.71	0.573
	After	26.78 ± 0.81	27.09 ± 0.88	0.320
	% of change	**↓ 8 %**	**↓ 7.54 %**	
	P Value	**0.001***	**0.001***	
Body fat (%)	Before	37.24 ± 3.79	38.86 ± 2.13	0.160
	After	30.86 ± 3.33	32.56 ± 1.93	**0.045***
	% of change	**↓ 17.13 %**	**↓ 16.21 %**	
	P Value	**0.0001***	**0.001***	
HDL (mg/dL)	Before	41.33 ± 5.27	42.26 ± 5.25	0.631
	After	45.93 ± 6.02	45.66 ± 5.56	0.901
	% of change	**↑ 11.12 %**	**↑ 8.04 %**	
	P Value	**0.001***	**0.001***	
LDL (mg/dL)	Before	147.9 ± 13.97	154.8 ± 31.1	0.443
	After	124.53 ± 14.89	131.86 ± 26.98	0.365
	% of change	**↓ 15.84 %**	**↓ 14.84 %**	
	P Value	**0.001***	**0.001***	
Total cholesterol (mg/dL)	Before	215.0 ± 20.83	213.8 ± 27.46	0.900
	After	194.06 ± 21.53	191.46 ± 12.97	0.692
	% of change	**↓ 9.73 %**	**↓ 10.47 %**	
	P Value	**0.001***	**0.001***	
Triglycerides (mg/dL)	Before	128.4 ± 29.34	124.4 ± 33.31	0.734
	After	118.93 ± 31.5	120.13 ± 30.96	0.917
	% of change	**↓ 7.37 %**	**↓ 3.47 %**	
	P Value	**0.001***	**0.001***	
Vo_2Max (mL/kg/min)	Before	54.94 ± 3.61	54.56 ± 7.95	0.868
	After	79.54 ± 6.83	77.05 ± 10.37	0.443
	% of change	**↑ 44.77 %**	**↑ 41.22 %**	
	P Value	**0.001***	**0.001***	
Waist hip ratio (score)	Before	0.91 ± 0.03	0.90 ± 0.02	0.438
	After	0.83 ± 0.04	0.85 ± 0.04	0.361
	% of change	**↓ 8.8 %**	**↓ 5.55 %**	
	P Value	**0.0001***	**0.001***	
Waist circumference (cm)	Before	104.73 ± 2.6	106.13 ± 2.99	0.183
	After	90.86 ± 7.19	96.06 ± 5.98	**0.04***
	% of change	**↓ 13.24 %**	**↓ 9.48 %**	
	P Value	**0.0001***	**0.001***	

ISSN:0975-3583,0976-2833 VOL12,ISSUE05,2021

$\bar{x}$: Mean; SD: Standard deviation P-value: probability value; *Significant at P<0.05

DISCUSSION:

Overweight problem is considered as widely medical important problem among Egyptians, which can be exacerbated affecting general health frequently, e.g. type II diabetes, hypertension, coronary heart disease, joint pain and deterioration of health related to quality of life so it is valuable to use exercise with overweight participant as a type of less invasive conservative management to control this problem.

In the current study, comparing both groups pre-treatment and post-treatment revealed statisticallysignificant improvement in lipid profile variables (P<0.05) in both groups, with higher percentage of improvement in favor to group A, the result of the present study showed that increased in HDL significantly with percentage about 11.12% : 8.04%, While LDL was decreased with percentage 15.84%: 14.84 %, Also triglyceride was decreased with percentage about 3.37%: 3.47% and cholesterol was decreased with percentage about 9.73%:10.47% for group A and B respectively.

These results came in agreement with **Haskell et al.,2oo7** who founded that the 16-week HIIT program was effective for restoring the lipid profile in women with dyslipidemia, as well as for restoring fasting glucose in women with dyslipidemia associated with hyperglycemia. Moreover, HIIT program was effective for reducing TG independently of subjects' baseline levels, the HDL-C increase observed only in women with metabolic diseases, and the LDL-C decrease observed only in women with altered lipid profiles at baseline support the hypothesis that exercise-induced improvements in blood lipid profile depend on its level at baseline. Moreover, it is noteworthy that the present HIIT-induced improvements on blood lipids were effective in restoring TC, LDL-C and HDL-C of dyslipidemia anddyslipidemia hyperglycemia to levels similar to those of control group during follow-up, and that it occurred with a weekly time commitment 25% to 56% (66 to 112.6min/week divided in 3 exercise sessions) lower than the minimum recommended in current guidelinesthe HIIT program was effective for improving blood pressure, endurance performance and anthropometry in all groups[12].

The improvement in the lipid profile may be as a result of exercise training which cause decrease availability for exchanges with cholesteryl esters in HDL and LDL, which likely results in increased HDL-C levels and LDL particle size. In addition, exercise training likely results in reduced HDL-C degradation and production of smaller HDL particles by the decrease of hepatic lipase activity, which would improve the HDL-C mediating export of excess cholesterol from peripheral tissues and its subsequent excretion via the liver.[13]

In the current study, comparing both groups pre-treatment and post-treatment revealed statisticallysignificant improvement in VO_2 max and body composition variables (P<0.05) in both groups, with higher percentage of improvement in favor to group A, the result of the present study showed that there was increased in VO_2 Max significantly with percentage about 44,77٪ : 41,22٪ for group A and B respectively, While body composition which include waist circumference and waist hip ratio were decreased significantly with percentage about 13.24٪ : 9.48٪ in waist circumference variable and waist hip ratio also decreased with percentage about 8.8٪:5.55٪ for group A and B respectively.

These agree with the result of **Wayne et al.,2019**who reportedVO2 max increased after HIIT by 0.30 liter/ Minute compared with baseline.The increase in VO2 max was greater for HIIT than for non-exercising control conditions (weighted mean difference = 0.28 liter/minute). HIIT also reduced body weight, compared with baseline by 0.7 kg, the HIIT induced weight loss was 1.3 kg in control group compared with non-exercise group.[14]

High intensity interval training is promoted as a superior and time efficient method for reducing body and fat mass and other biomarkers of chronic diseases compared to moderate intensity continuous training. [15,16]

The results of this work, came in agreement with **Kessler et al.,2012** who stated that High intensity interval trainingcan improve cardiorespiratory fitness (increase VO2 max) in adults with varied body weight and health status. HIIT-induced improvements in insulin sensitivity, blood pressure.and body composition' more consistently occur in adults with overweight or obesity classification, with or without high risk of CVD and diabetes—especially if these individuals train for 12 or more weeks[17].

The improvement in Group (A) in our study may be explained by **Alejandro et al.,2021** who reported that HIIT has been shown to be a time-efficient strategy to promote a number of beneficial physiological adaptations, including enhanced maximum oxygen consumption (VO2max), increased fat oxidation, improved exercise capacity, increased insulin sensitivity, and improvements in body composition in adult women[18].

In work done by**Andersenet al.,2020** to study the effect of high intensity interval training on cardiorespiratory fitness, physical activity and body composition on people with schizophrenia. the result of study showed no significant improvement in the VO_2 Max which didn't come in consistent our study. the explanation may be due to that the responders were heavier and older than the non-responder at baseline and thus an important target group within this population.[19]

ISSN:0975-3583,0976-2833 VOL12,ISSUE05,2021

The result of the present study showed that there was decreased body weight and body fat significantly with percentage about 8.1%:5.42% body weight and also decreased in body fat with percentage about 17.13%: 16:21% for both group A and B respectively.

Liepinsh E et al., 2020 reported thatLow-intensity exercise improves bioenergetics and fat oxidation in peripheral blood mononuclear cells (PBMCs), acting as an effective regulator of immune cell metabolism and perhaps reducing inflammation. A higher lipolysis rate was reported during 60 minutes of low-intensity exercise, 30 percent more total energy was used, and two times more fat was destroyed than during the incremental-load exercise workout. Because it causes rapid weariness, a substantial increase in heart rate, and higher cardiovascular risks, vigorous-intensity exercise has a restricted duration. This dramatic rise in fat metabolism and resting metabolic rate (RMR) will promote weight loss (through increased total daily energy expenditure (TDEE)) and fat metabolism (as opposed to carbohydrate metabolism). Interval training as a potential treatment intervention for promoting a lean body is now one of the most strongly discussed exercise strategies[20]

low-intensity exercise can also help you lose weight and fat: in the low-intensity training, both body weight and body fat significantly reduced. Body weight can be effectively reduced by exercising for 150–250 minutes per week.[11]

CONCLUSION:

Both high intensity interval training and low intensity continous training have been improved VO^2max and reduced fat mass percentage with higher percentage of improvement in favor to group A.

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