Journal of Physical Education and Sport ® (JPES), Vol. 22 (issue 10), Art 298, pp. 2340 - 2345, October 2022
online ISSN: 2247 - 806X; p-ISSN: 2247 – 8051; ISSN - L = 2247 - 8051 © JPES

Original Article

The cardiovascular responses on difference exercise intensity and the relationship with body composition among sedentary college students

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Published online: October 31, 2022
(Accepted for publication October 15, 2022)
DOI:10.7752/jpes.2022.10298

Abstract:
Sedentary individuals are persons who live unhealthy lifestyles and lack any physical activity. Being physically inactive may lead to risk factor for mortality instance, obesity, cardiovascular disease and diabetes. Insufficient physical activity may cause damaging cardiovascular health and it changes the outcomes of the health that effect on body composition and health. Therefore, exercises have been recommended as a useful strategy to curb sedentary lifestyles. The different types of exercise intensities that may result in different effects such as cardiovascular responses and body composition changes among sedentary. The purpose of this study was to compare the effectiveness of different exercise intensities and to determine the relationship on cardiovascular response and body composition among sedentary students. A total of (N=36, age=24.36±3.02 years old; weight= 56.36±7.58 kg; height=160.87±6.23 cm) sedentary subjects of short high intensity interval training (SHIIT) group (n=12), long high intensity interval training (LHIIT) (n=12) and moderate intensity continuous training (MICT) (n=12) were participating in this study. Body composition outcomes were body mass index (BMI), waist-hip ratio (WHR), and visceral fat was taken using the In-body screening device for pre and post data. Next, exercise Stress Testing (EST) protocol using treadmill was conducted to determine Peak VO_2 during pre-test screening. Next, during pre-test and exercise intervention subjects resting heart rate (RHR), resting systolic blood pressure (SBP) and resting diastolic blood pressure (DBP) were taken. The subjects required to follow all the training given 3 times per week for 4 weeks. LHIIT consisted of 20 minutes of effort through with work that required of >85% HRR and 60% of HRR for the recovery phase. The duration of LHIIT that subjects were to perform was 1 min of work with 30 second of recovery. SHIIT consisted of the work at an intensity >85% HRR. The circuit started with 30 seconds of cycling that repeated until finish the subject's reps with a bout interceded by a recovery session of 30 seconds. MICT were conducted with continuous cycling at 55%-65% of VO_2 max for 58 minutes. The estimation of the exercise volume for one session exercise intervention is 400 kcal. Two-Way Repeated Measure ANOVA was used to analyse RHR, SBP, and DBP changes among sedentary students. Study one showed that there was a significant difference between groups on reduction of RHR, p=0.04 while there was no significant difference between groups on reduction of SBP, p=0.87 and DBP, p=0.527. Study two showed that there is a significant relationship between cardiovascular response and body composition among all sedentary students F (2,33); r=6.763, p<0.001. In conclusion, four weeks of different exercise intensities revealed no effects on the reduction of blood pressure responses but it may affect in lowering RHR.
Key Words: **Long high intensity interval training, Short high intensity interval training, Moderate intensity continuous training, Cardiovascular responses, Body composition**

Introduction

Overall health can be improved, and the diseases may be prevented if the sedentary people start changing their physical inactive lifestyles active lifestyles by involving physical activity or exercise program. Exercise is good to improve health that subsequently reduces the risk of chronic disease, weight management, maintenance fitness level and anthropometrics indices of the body. (Ismail, et al., 2013) Exercise helps to improve peak VO_2, VCO_2, respiratory exchange ratio, heart rate, body composition and muscular strength among sedentary people. Aerobic exercise with several intensities may give different effect in improving cardiovascular responses and lowering body composition among sedentary students. Intensity plays a major role to determine the effectiveness of training programs among athletes. High intensity interval training (HIIT) can be defined as repeated bouts of short to moderate duration exercise from 10 seconds to 4 minutes with the training heart rate more than 85% of heart rate reserve. High-intensity activity has a relative intensity level of at least 90% HRmax. Using absolute measures, high-intensity activities are those requiring at least 9 METs. Meanwhile, moderate intensity continuous training (MICT) can be defined as the level of training between 40% to 60% of

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heart rate reserve training and at least in 30 minutes per session. Moderate-intensity activities range from 3 < 6 METs or have a relative intensity of 55 < 70% HR max. (Norton, 2010, Ismail, et al., 2014)

Material & Methods

Research Design

Recruited subjects were randomly divided into three groups; Long High Intensity Interval Training (LHIIT), Short High Intensity Interval Training (SHIIT) and Moderate Intensity Continuous Training (MICT). Baseline data was taken, and subjects were given the intervention of doing three various types of exercise intensities in four weeks duration of the investigators.

Participants and Target Population

A total subject was (N= 36) volunteered to participate in this study. Thirty-Six (N=36) subjects were chosen to accommodate three groups (LHIIT, SHIIT and MICT) with twelve subjects each group. Subjects were recruited after getting their consent and fulfilling the inclusion criteria such as age must be between 20 years to 32 years old and BMI between 19 kg/m^2 to 24 kg/m^2. The subjects were not participating in exercise at least three to six onths. For exclusion criteria; the subjects were not eligible to follow this study if they have a severe orthopaedic disease that would prohibit the exercise. Other medical condition or has serious disease such as hypertension, iabetes or unstable angina was also excluded from this study.

Anthropometric and Body Composition Measurement

Weight and height of the subjects were measured using a portable stadiometer (SECA model 213, Hamburg, Germany) to the nearest 0.1 cm. The body mass index (BMI), waist hip ratio (WHR) and visceral fat were determined using the InBody 500 bioelectrical impedance analyser (InBody Co Ltd., Cerritos, CA, USA) at the pre-data subjects. Subjects stood on the platform of the device barefoot with the soles of their feet on the electrodes. Then, subjects grasped the handles of the unit with their thumb and fingers to maintain direct contact with the electrodes. They stood for one minute while maintaining their elbows extended fully and their shoulder joint abducted to approximately a 30-degree angle. Then, using the bioelectrical impedance analyser (BIA) they were measured on the WHR, BMI and visceral fat.

Cardiovascular Responses Analysis

Cardiovascular response analysis was based from the measurement of peak VO_2, systolic blood pressure (SBP), diastolic blood pressure (DBP) and resting heart rate (RHR) during pre-test and post exercise intervention for sedentary lifestyle subjects. Subjects proceeded to exercise stress testing using treadmill following Modified Bruce protocol to determine peak VO_2, VCO_2, ventilations, respiratory exchange ratio, and resting heart rate. During the stress testing, blood pressure, rating perceived exertion (RPE), Dyspnea and Angina scales were measured at each stage of the test as a safety precaution for the subjects.

Heart rate measurement was used to determine the intensity of exercise. The average intensity was indicated as (% of age predicted HR max). Heart rate was measured using a Polar Heart Rate monitor (T-31, PolarElectro) and was controlled based on resting heart rate and heart rate maximum for pre and post session. During intervention, in 4 weeks RHR was taken before starting each exercise session. Blood pressure (BP) was measured to assess the safety and efficacy of exercise. During an exercise session, BP measurement was taken every 5 minutes until subject ended the exercise session.

Intervention

Subjects performed the cycling with strictly followed the prescript exercise based on the high intensity interval training (HIIT) and moderate intensity continuous training (MICT) using Stationary Cybex 500 bicycle ergometer. The subjects were attended four (4) weeks of HIIT and MICT and for three times/week. Each group has different exercise intervention intensities and reps per session based on individual capability.

Long High Intensity Interval Training (LHIIT)

LHIIT method was based on Alves et al. (2017), which consisted of a cycling exercise session beginning with 5 minutes of warming up and dynamic stretching to increase heart rate intensity at 40-60% HRR. LHIIT consisted of 15 minutes of effort through with work that required of 90% HRR and 60% HRR for the recovery phase. The duration of LHIIT that subjects were to perform was 1 min of work with 30 second of recovery with total 15 reps per session. Upon completion of the training session, the subjects were doing a cooling down session for five minutes. The estimated total duration for LHIIT is 30 minutes. To make sure all groups received the same amount of exercise volume, exercise duration was varied and depending on the level of fitness and body weight. The estimation of the exercise volume for one session exercise intervention was 400 Kcal.

Table 1. Exercise Intervention for LHIIT

	Time (min/sec)	**Intensity (% HRR)**
Warm Up	5 minutes	40-60% HRR
Exercise	15 reps (1 minutes)	90% HRR
	30 second rest each reps	60% HRR
Cooling Down	5 minutes	20-40% HRR
Total Exercise Time	35 minutes	
Total Volume	400 kcal	

Short High Intensity Interval Training (SHIIT)

SHIIT group started with a warm up session that consist of 5 minutes with dynamic stretching to increase heart rate intensity at 40-60% HRR. SHIIT consisted of the work at an intensity of 80% HRR. The circuit started with 30 seconds of cycling that repeated until 8 reps with a bout interceded by a recovery session of 30 seconds. The total time to complete the SHIIT was 20 minutes and the subjects needed to follow and attend the program. This method was based on the study by Fisher et al. (2015). All groups receive the same amount of exercise volume and exercise duration is varied and depending on the level of fitness and body weight. The estimation of the exercise volume for one session exercise intervention is 400 Kcal, three times per week for four weeks.

Table 2. Exercise Intervention for SHIIT

	Time (min/sec)	**Intensity (% HRR)**
Warm Up	5 minutes	40-60% HRR
Exercise	8 reps (30 seconds)	80% HRR
	30 second rest each reps	60% HRR
Cooling Down	5 minutes	20-40% HRR
Total Exercise Time	20 minutes	
Total Volume	400 kcal	

Moderate Intensity Continuous Training (MICT)

MICT consisted of five minutes of warm up session with dynamic stretching to increase heart rate to intensity at 40-60% HRR. MICT were conducted with continuous cycling at 55-65% of VO_2 max on a Monark cycle ergometer. This session was run for 58 minutes in accordance to Fisher et al. (2015). Upon completion, subjects continued with cooling down activities for five minutes. All groups received the same amount of exercise volume and exercise duration was varyied depending on the level of fitness and body weight. The estimation of the exercise volume for one session exercise intervention is 400 Kcal.

Table 3. Exercise Intervention for MICT

	Time (min/sec)	**Intensity (% HRR)**
Warm Up	5 minutes	40-60% HRR
Exercise	45 minutes	55-65% HRR
Cooling Down	3 minutes	20-40% HRR
Total Exercise Time	58 minutes	
Total Volume	400 al	

Statistical Analysis

The statistical package for the Social Science (SPSS) version 23 were used to analyse the data. The descriptive statistics such as mean (M), standard deviation (SD), were used to describe the demographic variables of the subjects such as age, height, and weight of the subjects. Inferential Statistic was used to determine Two-Way Repeated Measure ANOVA that used to compare effectiveness of different exercise intensity on resting heart rate (RHR), systolic blood pressure (SBP) and diastolic blood pressure (DBP) among sedentary students. Bonferroni Post Hoc Test was used to determine the higher effectiveness of the group. Next, Multiple Regression was chosen to determine the relationship between Peak VO_2, Waist Hip Ratio and Visceral fat. The significant value was set at $p<.05$. A significant F test indicates that the null hypothesis is rejected.

Results

Resting Heart Rate (RHR) Changes on 4 Weeks of Exercise Intervention among Sedentary Students.

Table 4 showed that the results of the weekly changed of RHR for subjects in four (4) weeks. The RHR of subjects has changed after four weeks of exercise intervention.

Table 4. Changes of RHR (bpm) with Different Exercise Intensity.

WEEKS	**SHIIT (n=12)**	**LHIIT (n=12)**	**MICT (n=12)**
Week 1	91.25±8.97	90.42±10.16	82.00±7.01
Week 2	90.33±8.80	89.25±10.12	81.00±7.01
Week 3	88.42±8.35	87.42±9.77	80.33±6.95
Week 4	84.17±8.17	84.42±8.15	77.92±5.50
Total Changes	7.08	6	4.08

Two-Way Repeated Measure ANOVA was used to analyse the comparison between the effectiveness of four weeks exercise intervention between SHIIT, LHIIT and MICT on RHR among subjects. Table 5 showed test within group effect for RHR in 4 weeks changes between different exercise intensities among sedentary students. The main effect over time was ($F,3, 1.28 = 213.45$; $p<0.001$ $\eta 2p = .866$) bpm after four weeks of exercise intervention. There was a significant difference effect on different exercise intensities from week one till week four ($p<0.001$) on RHR among sedentary students. There was a significant difference group effect between

SHIIT, LHIIT and MICT on changes of reduction of RHR (F,2, 33 = 3.641; p=0.04 η2p = .181) bpm after exercise intervention in sedentary students.

Table 5: Test of Within and Between Group Effect for Changes on RHR (bpm) between SHIIT, LHIIT and MICT.

Variable	Sig.	Partial Eta Squared
Within Group	<0.001	.866
Between Group	.04	.181

Systolic Blood Pressure (SBP) changes on 4 Weeks Exercise Intervention among Sedentary Students.

SBP was measured before exercise intervention for four groups in every session of exercise intervention. The data presented by a week in four weeks of exercise duration. Table 6 showed data mean and standard deviation of subjects before exercise intervention for four groups. There was no significant difference between three groups on SBP.

Table 6: Changes of SBP (mmHg) with Different Exercise Intensity.

Weeks	SHIIT (n=12)	LHIIT (n=12)	MICT (n=12)
Week 1	122.33±2.02	121.58±1.88	121.42±7.85
Week 2	119.33±.99	119.92±1.62	120.42±3.53
Week 3	120.08±2.35	119.92±3.26	120.92±2.47
Week 4	118.92±1.44	120.25±3.02	120.00±4.88
Total Changes	3.41	1.33	1.42

Table 7 showed test within group effect and between group effect for SBP in 4 weeks changes between different exercise intensities among sedentary students. The main effect over time was (F,3, 1.95 = 4.32; p<0.001; η2p = .116) mmHg after four weeks of exercise intervention. There was a significant difference effect from week one until week four (p<0.001) on SBP. There was no significant difference between group effect on SHIIT, LHIIT and MICT in changes of reduction SBP (F,2, 33 = 1.42; p=0.87; η2p = .009) mmHg after exercise intervention in sedentary students.

Table 7: Test of Within and Between Group Effect for Changes on SBP (mmHg) between SHIIT, LHIIT and MICT.

Variable	Sig.	Partial Eta Squared
Within Group	<0.001	.116
Between Group	.87	.009

Diastolic Blood Pressure (DBP) on 4 Weeks Exercise Intervention among Sedentary Students.

Table 8 showed the data mean and standard deviation of subjects before exercise intervention for four groups.

Table 8: Changes of DBP (mmHg) with Different Exercise Intensity.

WEEKS	SHIIT	LHIIT	MICT
Week 1	80.08±4.14	80.42±2.07	80.08±3.42
Week 2	79.58±1.44	78.75±1.66	78.67±2.31
Week 3	79.00±1.04	78.50±1.24	77.50±3.63
Week 4	78.08±2.07	77.83±2.04	77.67±2.93
Total Changes	2	2.59	2.41

Table 9 showed that test within group effect and between group effect for DBP in 4 weeks changes between different exercise intensities among sedentary students. The main effect over time was (F, 3, 1.622 = 6.86; p<0.001 η2p = .172) mmHg after four weeks of exercise intervention. There was a significant difference effect from week one until week four (p<0.001) on DBP among sedentary students. There was no significant difference between group effect on SHIIT, LHIIT and MICT in changes of reduction of DBP (F, 2,33 = .653; p=0.527 η2p = .038) mmHg after exercise intervention.

Table 9: Test of Within and Between Group Effect for Changes DBP (mmHg) between SHIIT, LHIIT and MICT.

Variable	Sig.	Partial Eta Squared
Within Group	<0.001	.116
Between Group	.87	.009

Multiple Regression

Relationship of Peak VO_2, Waist Hip Ratio and Visceral Fat among Sedentary Students.

There was a significant relationship between cardiorespiratory response and body composition, F (2,33) = 6.763, p <0.001, R = .539, and contributes to the variance (R^2 = .291). Figure 4 showed that the scatter plot of the relationship among cardiorespiratory response and body composition. There was a positive relationship among the variable because when peak VO_2 increase, the waist-hip ratio decreases and visceral decrease.

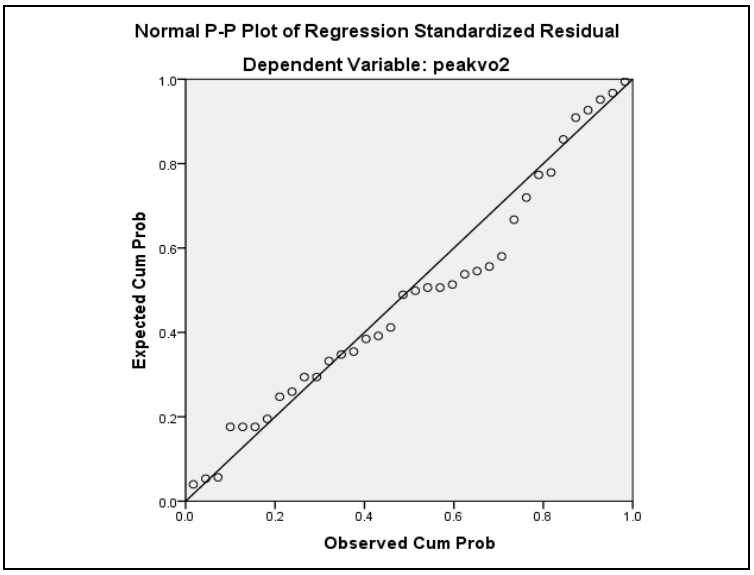

Figure 4. Plot of Regression on Relationship Peak VO_2, waist-hip Ratio and Visceral Fat.

Discussion

Cardiovascular Responses on Exercise Intensity among Sedentary Students

This study showed that lowering resting heart rate (RHR) among sedentary students is based on the parasympathetic and the amount of blood flow in the body with different exercise intensity. Low RHR happens when the blood flow increases during exercise which lead to increases the vasodilatory capacity of the arteries and increases vascular tone and anti-atherosclerosis activities. Exercise will dilate the arteries in skeletal muscle and increase blood vessel resistance by increasing the energy demand. However, when the energy demand increased, the oxygen will increase too, and it helps lowering the RHR. Another factor that influences on lowering RHR was parasympathetic and sympathetic. Regular aerobic exercise may affect the parasympathetic nerve and increase the stroke volume and subsequently lowering the RHR which it is a positive effect on reducing cardiovascular disease. Parasympathetic supply heart from neurons that cardiovascular centre in medulla oblongata which make up vagus nerve and reach heart then contact with SA node and AV node. After that the nerve release acetylcholine and decrease SA node and AV node then possibly reduced the RHR.

Exercise intensity not only helped in lowering RHR but it also helped to reduce systolic blood pressure (SBP) and diastolic blood pressure (DBP). A mechanism that lowering SBP is based on two factors; cardiac output (Q) and stroke volume (SV). One of the factors that cause a reduction in SBP was an improvement in cardiac output and stroke volume. Cardiac output is a product of heart rate which is the number of beats per minute and stroke volume is the volume of blood pumped per beat. Thus, increasing heart rate and stroke volume help in lowering SBP among sedentary students. The mechanisms of reducing SBP are directly proportional to the effect of cardiac output to the total peripheral vascular resistance. SBP were higher as cardiac output increase, while reduction in cardiac output were lowered the SBP. Another possible physiological mechanism that reducing SBP are the systemic adaptation of increasing arterial wall, arterial stiffness and increase in central nitric acid oxide synthase activity, thus improve the endothelial function. Other mechanism of reducing SBP is related to hemodynamic and neural factors after exercise. The improvement in neural factors can cause of reducing sympathetic nervous system activity, thus decrease the secretion of vasoconstrictor hormone. Besides, SBP was controlled by baroreflex which was a buffering mechanism that counteracts changes in heart rate, myocardial contractility, and peripheral resistance to increase or decrease of SBP.

The mechanism for lowering DBP after exercise is related to the length of the blood vessel, the lumen diameter in the arteries and the vein that developed new blood vessel. Higher blood flow through the blood vessel were providing the working muscles with oxygen and decreased peripheral vascular resistance, which leads to the reduction of DBP. The mechanism of DBP related to blood flow condition and changes in peripheral vascular resistance among sedentary people. The reduction in DBP after four weeks of intervention was directly related on peripheral vascular resistance, that increase vasoconstriction in sedentary subjects. In addition, improvement in vascular function has resulted in greater vasodilation activity by reducing peripheral vascular resistance and leads to a reduction in DBP. For the conclusion, lowering cardiovascular responses was related to blood flow, higher in oxygen, cardiac output and stroke volume. Higher intensity produces more oxygen to sedentary students that can reduce capacity of cardiovascular responses.

The Relationship of Peak VO_2 and body composition among sedentary Students.

Aerobic capacity (Peak VO_2) and body composition frequently associated each other, and these two variables often implied and strongly inter-related. Excessive amount of body fat was hindering the action towards cardiac function and those sedentary students were participating in exhaustive exercise. The possibility of excessive hyperactive body musculature fails to uptake enough oxygen was higher in the amount of fat mass. Increased energy demands can help to reduce the weight, waist and hip circumference. One of the potential mechanisms is the higher lipolytic response of visceral fat from the effects of catecholamines released during physical activity and marked as lipolysis in the visceral tissue and help reduce the visceral fat. The higher level of the aerobic capacity inversely associated with the volume of visceral adipose tissue. In addition, the higher aerobic capacity can increase catecholamines levels, which can affect on adipocytes lipolysis through the receptors. Catecholamines are more active in lipolytic activity in visceral adipose tissue and, as a result of this mechanism, visceral fat may be lost due to aerobic capacity. A reduction of the visceral fat after an exercise may due to the need for extra energy to facilitate body movement. Supplying more oxygen to the working muscles might reduce visceral fat for the sedentary.

Conclusions

As exercise training intensity increases, so may the magnitude of improvement in cardiovascular responses, although time spent exercising should be considered. The result of different exercise training has shown that there is an improvement of cardiovascular response and body composition. The higher intensity of exercise, the greater reduction of weight subjects and thus may help reduce the cardiovascular disease. Hence, exercise intensity can be considered as a valuable tool or measurement for reducing weight and helped reduce cardiovascular disease among sedentary subjects.

Acknowledgment: The project is partially funded through a Lestari SDG grant (600-RMC/LESTARI SDG-T 5/3 (152/2019)) Universiti Teknologi MARA.

Conflicts of interest: No conflicts of interest are declared by the authors.

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