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Original Article

The effect of cardiovascular responses on aerobic exercise and relationship between pulmonary function and body composition among sedentary students

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Abstract:
Numerous studies have recorded the benefits of exercise to cardiovascular responses, pulmonary function and body composition. Sedentary lifestyle can lead to the degradation of cardiovascular responses. Another factor that may influence the effect of exercise is gender, but less supportive data have been documented. Therefore, the purpose of the study was to compare the effects of aerobic exercise on resting heart rate (RHR), resting systolic blood pressure (SBP), and resting diastolic blood pressure (DBP) between male and female among sedentary individuals. The secondary objective was to determine the relationship between pulmonary function ((force vital capacity (FVC) and body composition (percentage of body fat (PBF) and fat free mass (FFM)) among sedentary individuals. Thirty sixth healthy individuals (17 males and 19 females) performed aerobic exercise on a stationary cycle ergometer with moderate to vigorous intensity 40% to 85% of heart rate reserve (HRR) and the duration of cycling exercise was 30 minutes to 40 minutes. The individuals required to follow all the training given 3 times per week for 4 weeks. FVC, PBF, and FFM measurements were taken during pre-test while RHR, resting SBP, and resting DBP were taken during pre-test and every week of exercise intervention. There was a significant difference over time on RHR, resting SBP, and resting DBP on exercise between male and female ($p < 0.001$). However, RHR, SBP, and DBP showed no significant difference between male and female in the effect of exercise ($p > 0.05$). The finding also showed that there was no correlation between the FVC and PBF ($r = -0.10$, $p = 0.56$) and FFM ($r = 0.02$, $p = 0.91$). In conclusion, aerobic exercise will improve the cardiovascular responses for both gender and no relationship between pulmonary function and body composition among sedentary students, perhaps due to there have a similar fitness level at the baseline.
Key Words: **Exercise, Gender, Resting heart rate, Blood pressure, Pulmonary function**

Introduction

The person who left or not doing any physical activity or exercise in three (3) to six (6) months can be known as sedentary people. Nowadays, sedentary people have been spiralled globally among adults. Being physically inactive may lead to risk factors for mortality for instance obesity, cardiovascular diseases, and chronic obstructive pulmonary disease (COPD) can be increased [2]. A study by [3] stated that a sedentary lifestyle can lead to degradation of respiratory indices which could place one at high risk for developing chronic obstructive pulmonary disease (COPD). Insufficient physical activity may cause damaging cardiovascular health. Physical inactivity among sedentary people with changes outcomes of the health that influence poor body composition and health. Other than that, the effect of sedentary lifestyles, increased the metabolic risks of the individuals such as raised in blood pressure, blood glucose, potentially to gain excess weight and the chance to develop non-communicable disease such as heart disease, chronic lung diseases cancers and diabetes [1,6]. Correspondingly, gender also is an important variable need to take into consideration. Exercise is beneficial to male in lowered cardiovascular disease (CVD) risk, and linked to female in the prevention of CVD, hypertension, and osteoporosis [4]. Both genders gain health benefits and potentially decrease the risk of CVD depending on the level, mode and intensity of the physical activities.

In local population, which was in Malaysia context, prevalence of sedentary people was 25.1% [5]. Nevertheless, there were no data about gender differences among Malaysian. Most of the samples from the findings are European and American, yet the gender differences between these two contexts were vastly different. Therefore, based on local context, it is imperative to investigate further gender differences of a sedentary population. Thus, it is necessary to study the gender differences for future references.

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Material & methods

The first objective of this study was to compare the effect of exercise on RHR, SBP, and DBP between male and female sedentary students. The second objective is to determine the relationship between pulmonary function (FVC) and body composition (PBF and FFM) among sedentary students.

Target Population, Sampling Technique, and Sampling Size

The target population of this study was sedentary students at Universiti Teknologi MARA (UiTM) Shah Alam. The subjects that eligible to involve in this study are the subjects that are sedentary students with a range of age between 20-40 years old with a BMI between 19 kg/m² to 24 kg/m². They were able to perform cycling exercise and to be physically inactive for at least three to six months. In this study, Sedentary student that was eligible was individuals who did not reach the physical activity recommendations of 30 minutes per week of moderate intensity exercise (40% to 60% HRR). However, subjects that will not be eligible in the study are any subjects who have knee or lower back pain or any serious disease. The subjects that not eligible in the study are the subjects who are at severe orthopaedic disease that would prohibit the exercise and taking any medication such as hypertension, diabetes and unstable angina. Inability to participate in a prospective study for any logistic reason was excluded. Fifty-sixth N=56 subjects were chosen based on the criteria in purposive sampling. A total subject (n = 56) volunteered to participate in this study, unfortunately (n = 8) subjects were drop out and only (n = 48) subjects that able to complete the study. However, another (n = 12) subjects from control group were excluded from the study due to incomplete the 4 week exercise intervention and only (n = 36) subjects were able to complete the 4 week exercise intervention. The subjects of this study were divided into two groups which were male and female.

Data Collection

The subject was asked a few questions that related to their previous medical problem and musculoskeletal assessment and required to fill up inform consent, medical history form, and PAR-Q Plus form. Then, the briefing and instructions about the study was given to the subjects by the researcher. Weight and height were measured during the first phase of general screening. After completing phase 1, all the subjects continue to phase 2 which was pre-test. Phase 2 consisted of pre-exercise screening such as heart rate monitor, blood pressure monitor, body composition, pulmonary function test, resting electrocardiogram (ECG), and followed with stress testing. Resting heart rate was measured by polar heart rate while blood pressure was measured by sphygmomanometer and stethoscope. Besides, body composition (percentage body fat and fat free mass) has been measured through bioelectrical impedance analysis (BIA), and pulmonary function (force vital capacity) measurement was taken by spirometry (COSMED). Subjects then proceeded with 4 weeks of exercise intervention on a stationary cycle ergometer in which performed at gym FSR. Before started the intervention, subjects received demonstrations to ensure a standardized intervention thus controlling the quality of the experiment. The subjects were divided into two groups which were gender (male and female) with a total of 4 weeks after the permission to participate in the research study. Twelve training sessions were held for the subjects which were performed 3 days a week for 4 weeks. Resting heart rate and resting blood pressure were taken for every week. Heart rate and blood pressure were monitored before, during and after exercise intervention.

Experimental Design

A group of repeated measure study design was used to test the hypothesis in the first study. This design was selected to compare the difference in the effect of exercise on RHR, SBP, and DBP between male and female among sedentary students. Subjects in this study were divided into two groups which were male and female. The correlational research design was used in a second study to test the hypothesis. The design was selected to determine the relationship between pulmonary function and body composition among sedentary students. In the second study, the independent variable was body composition which was Percentage of Body Fat (PBF) and Fat Free Mass (FFM). The dependent variable was the pulmonary function which was Force Vital Capacity (FVC). The subjects in this study were focused on sedentary students only.

Intervention

The treatment which was cycling exercise was performed by the sedentary people at the FSR UiTM physiology laboratory using Stationary Cybex 500 bicycle ergometer. Heart rate reserve (HRR) used to determine heart rate zone during exercise based on individual fitness level. The exercise intervention consisted of 5 minutes with dynamic stretching to increase heart rate to ready state intensity at 40% to 60% heart rate reserve (HRR). The work intensity that was required for aerobic exercise was 40% to 85% of heart rate reserve (HRR). Motivation was given to the subjects during the exercise intervention and they could drink to avoid dehydration. Heart rate was measured and observed by using polar heart rate to make sure the subjects able exercise at desire intensity. Subject required to maintain cadence during the cycling exercise the end of the exercise phase session. Subjects were not allowed to stop immediately after end the exercise phase. They required to continue cycling for 5 minutes cool down phase. The duration of cycling exercise phase was 30 minutes to 40 minutes. The total times to complete the exercise intervention were 40 minutes to 50 minutes and all the subjects need to follow all the training given 3 times per week for 4 weeks. The prescription of this study was calculated by using target heart rate (THR) zone training based on individual load, however the exercise

volume was same amount depending on the fitness level and body composition. The estimation of the exercise volume for one session exercise intervention was 400 Kcal. Refer to table 1.

Table 1. Exercise Intervention

	Time (min/sec)	Intensity (% HRR)
Warm-Up	5 minutes	40-60% HRR
Exercise	30 – 40 minutes	40-85% HRR
Cool Down	5 minutes	20-40% HRR
Total Exercise Time (Min)	40 - 50 minutes	
Exercise Volume (Kcal)	400 Kcal	

Results

Two-way repeated measure ANOVA was used to compare the difference in the effect of exercise on resting heart rate (RHR) and resting blood pressure (BP) such as resting heart rate (RHR), resting systolic blood pressure (SBP), and resting diastolic blood pressure (DBP) between male and female among sedentary students. Next, the correlation was used to determine the relationship between pulmonary function which was force vital capacity (FVC) and body composition such as percentage body fat (PBF) and fat free mass (FFM). The significant value of $p < .05$ was set.

Table 2. Changes of Resting Heart Rate (b.min^{-1}) in 4 weeks

Week	*Male (N = 17)	Change	Female (N = 19)	Change
Week 1	**86.76 ± 8.15**		**88.89 ± 10.76**	
Week 2	**85.71 ± 8.22**	**1.05**	**87.84 ± 10.68**	**1.05**
Week 3	**84.18 ± 7.77**	**1.53**	**86.36 ± 2.06**	**1.48**
Week 4	**80.06 ± 6.92**	**4.12**	**82.42 ± 9.24**	**3.94**
Total Change		**6.71**		**6.47**

*Group of higher significant effect

Figure 1 showed that the results of the study demonstrated that there was a significant effect of reduction on RHR after four weeks of exercise intervention in sedentary student (F, (3, 1.196) = 212.61, p = 0.001, η^2p = 0.86). Total changes of RHR for the first week to four weeks of exercise intensity was 6.71 bpm for male while 6.47 bpm for female. Refer to Table 2. There was no significant effect between group effect in the reduction of RHR after exercise intervention in sedentary students (F, (1, 34) = 0.53, p = 0.47, η^2p = 0.02).

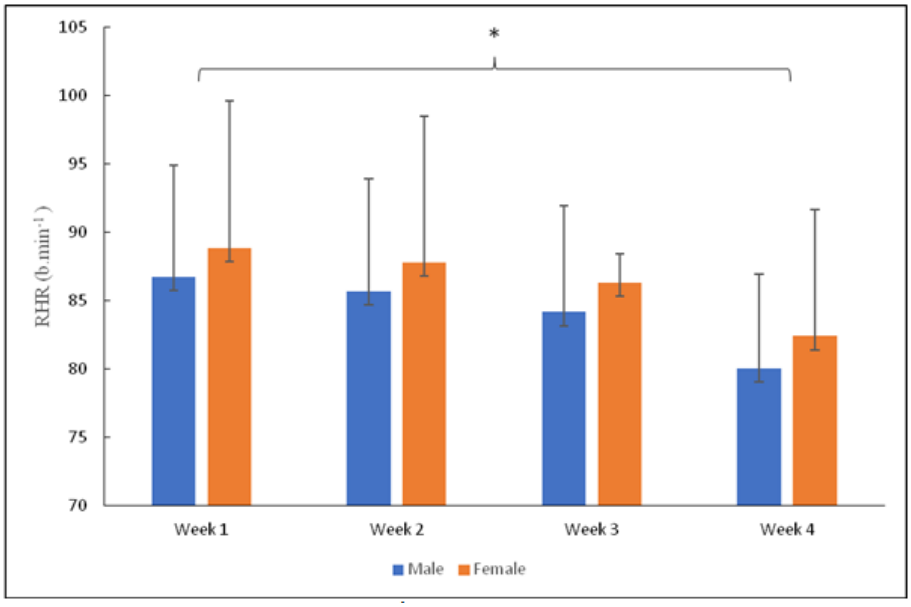

Figure 1. Changes of Resting Heart Rate (b.min^{-1}) in 4 Weeks of Exercise. *Significant effect of time ($p < 0.05$)

Table 3. Changes of Resting Systolic Blood Pressure (mmHg) in 4 Weeks

Week	Male (N = 17)	Change	*Female (N = 19)	Change
Week 1	**121.41±1.54**		**122.11±5.74**	
Week 2	**119.82±1.74**	**1.59**	**119.95±2.74**	**2.16**
Week 3	**120.24±3.21**	**-0.42**	**120.26±2.26**	**-0.31**
Week 4	**119.59±3.12**	**0.65**	**119.84±3.66**	**0.42**
Total Change		**1.82**		**2.26**

*Group of higher significant effect

The result showed there was a significant effect of reduction in SBP after four weeks of exercise intervention in sedentary student (F, (3, 2.12) = 3.46, p = 0.034, η^2p = 0.92). Refer figure 2. Table 3 showed the total changes reduction of SBP from the first week until four weeks of exercise was 1.82 for male while 2.26 mmHg for female. This finding showed there was no significant effect between group effect on changes in the reduction of SBP after the exercise intervention on sedentary students (F (1, 34) = 0.17, p = 0.69, η^2p = 0.01).

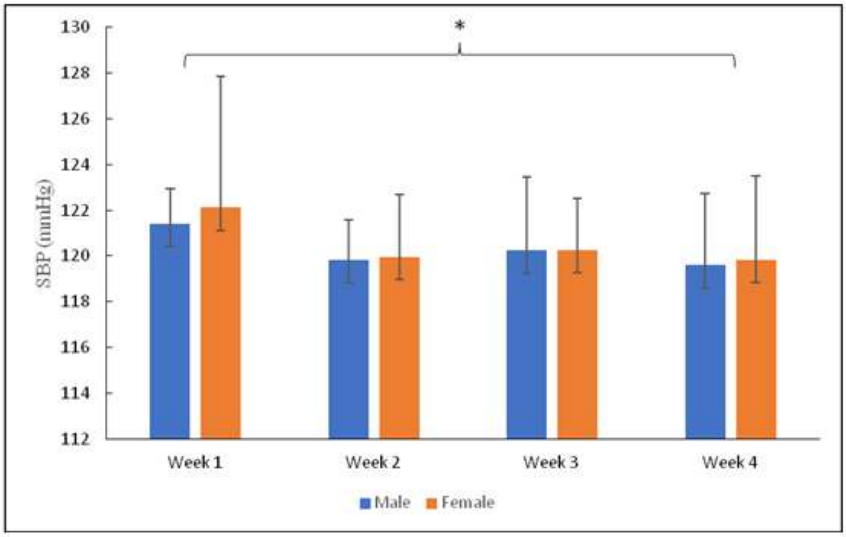

Figure 2. Changes of Resting Systolic Blood Pressure (mmHg) in 4 Weeks of Exercise. *Significant effect of time ($p < 0.05$)

Table 4. Changes of Resting Diastolic Blood Pressure (mmHg) in 4 Weeks

Week	Male (N = 17)	Change	*Female (N = 19)	Change
Week 1	**81.24±2.33**		**80.79±1.84**	
Week 2	**79.29±2.26**	**1.95**	**78.84±2.04**	**1.95**
Week 3	**79.12±2.18**	**0.17**	**78.26±2.49**	**0.58**
Week 4	**77.94±2.77**	**1.18**	**77.42±0.96**	**0.84**
Total Change		**3.29**		**3.36**

*Group of higher significant effect

The findings of the study showed that there was a significant effect of reduction in DBP after four weeks of exercise intervention in sedentary student (F, (3, 2.28) = 22.93, p = 0.001, η^2p = 0.40). Refer Figure 3. The total changes reduction of DBP from the first week until four weeks of exercise intervention was 3.29 for male while 3.36 mmHg for female (Table 4). This finding showed there was no significant effect between group effect on changes in the reduction of DBP after the exercise intervention on sedentary students (F, (1, 34) = 1.23, p = 0.28, η^2p = 0.04).

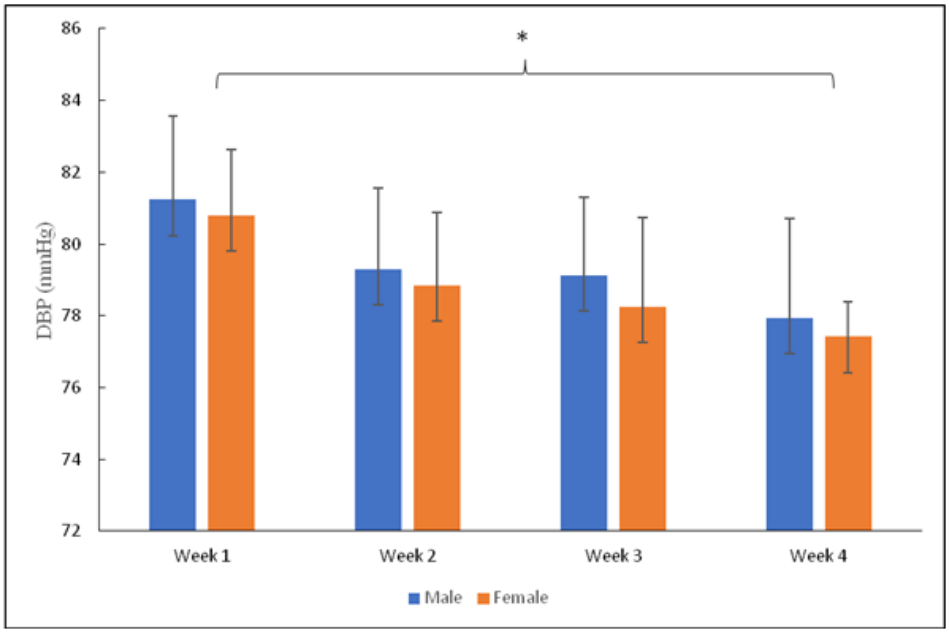

Figure 3. Changes of Resting Diastolic Blood Pressure (mmHg) in 4 Weeks of Exercise. *Significant effect of time ($p < 0.05$)

This study showed that there was no significant relationship between FVC and PBF ($r = - 0.10$, $p = 0.56$). This study showed no significant correlation between FVC and FFM ($r = 0.02$, $p = 0.91$).

Discussion

Effect of Exercise on Resting Heart Rate between Male and Female among Sedentary Students

The possible mechanism reduction of RHR was due to acceleration of development in the parasympathetic nervous system activity. Regular aerobic exercise can affect the parasympathetic nerve, thus increasing stroke volume and lowering the RHR which has a positive effect on the reduction cardiovascular disease. During exercise, vasodilation in active skeletal muscle and vessel resistance in less active organs increased supply the metabolic demand. Consequently, the cardiac output may increase to ensure blood flow which, may raise the heart rate. Next, elevated heart rate associated with increased mechanical stress, which eventually increased the stiffening of the arterial wall. The increased arterial wall may increase pulse, blood flow and shear stress resulting reduced RHR. Reduction in RHR occurs when the stroke volume with prolonged diastole raises the shear stress. Based on the gender differences of four weeks of exercise intervention, the result showed the male group was better changes in the reduction of RHR as compared to female. One of the possible mechanisms there was a significantly different between gender on RHR is the size of the heart. Besides, females had a different intrinsic rhythmic to their heart's pacemaker which causes them to beat more quickly.

Effect of Exercise on Resting Systolic Blood Pressure between Male and Female among Sedentary Students

The changes happen because regular exercise leads to a reduction in SBP. The total changes reduction of SBP in this study was 2.26 mmHg in four weeks. The potential mechanisms that cause SBP reduction after exercise are related to the cardiac output reduction which was controlled by two neural control systems, central command and the exercise pressor reflex. Exercise training may reduce sympathetic activity in sedentary students that leading to reduction of SBP. It has been shown that exercise was effective in reduced SBP in sedentary students. This finding showed there was no significant effect between both genders in changes in the reduction of SBP after exercise intervention.

Effect of Exercise on Resting Diastolic Blood Pressure between Male and Female among Sedentary Students

Improving in structural adaptation can lead to increased blood flow via the blood vessel which provides oxygen to working muscles and decreased peripheral vascular resistance leading to a decrease in DBP. Exercise enhances endothelial function and thus improves the structure of blood vessel, including the length, diameter, the numbers of blood vessels and inner part of the blood vessels, which may reduce systemic vascular resistance and eventually lower the DBP after regular exercise. A decrease of DBP can reduce cardiovascular disease risk in sedentary students. The possible factor that caused no gender difference on DBP after 4 weeks of exercise intensity was level of physical activity. Since the subjects of this study were sedentary students which lack

physical activity, the fitness level of both genders was possibly similar. The mechanism which leads to a greater reduction of DBP after four weeks of exercise intervention was linked to the endothelial function improvement. Increased calcium in the endothelial cell encourages the nitric oxide production that responsible for dilation of the blood vessel which leads to a greater reduction in peripheral vascular resistance and an indirect reduction in DBP after exercise. There was no difference in gender differences in DBP changes in sedentary students.

Relationship between Force Vital Capacity and Percentage of Body Fat Among Sedentary Students

This study showed that there was no significant relationship between FVC and PBF. Since this study was a generally healthy population which did not include high risk population, such as overweight and obesity, the PBF of the subjects were possibly similar which may difficult to affect the pulmonary function.

Relationship between Force Vital Capacity and Fat Free Mass Among Sedentary Students

This study showed no significant correlation between FVC and FFM. The possible reason that causes no correlation was the level of physical activity. The FFM may possibly higher if the individual was high with physical activity. Since this study was included sedentary population, possibly the subjects in this study may be similar in term of physical fitness level so the difference in FFM can't be seen.

Conclusions

In conclusion, aerobic exercise will improve the cardiovascular responses for both gender and no relationship between pulmonary function and body composition among sedentary students. There is no correlation between pulmonary function and body composition among sedentary students perhaps because they have a similar of fitness level.

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

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