Assessment Of Various Intensities Of Short Term Exercise On Blood Pressure And Reaction Time In Healthy Young Adults – An Experimental Study

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Citation

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Abstract

The purpose of this study is to investigate the effect of various intensities of short term exercise on blood pressure and reaction time. Fifty six normotensive subjects participated in the study. The participants were randomized into two exercise groups, one exercising at 40% of heart rate reserve and another exercising at 70% of heart rate reserve. Resting blood pressure and post-exercise blood pressure at 0, 10, 20, and 30 minutes, as well as pre-and post-exercise reaction time were taken. 2 sessions of aerobic exercise were performed and mean result calculated. Systolic blood pressure shows significant decrease starting from 10 minutes until 30 minutes post-exercise as compared to resting systolic blood pressure in both exercise groups. Diastolic blood pressure and mean arterial pressure decreased significantly starting at 10 minutes post-exercise in the group with 40% exercise intensity and starting at 20 minutes in the group with 70% exercise intensity. Our results also showed that there was no significant decrease in post-exercise systolic, diastolic blood pressure and mean arterial pressure between both groups with 40% and 70% intensities of exercise. Also, our study results revealed that reaction time does not differ significantly before and after a single bout of acute exercise at 40% and 70% of heart rate reserve. In conclusion, level of intensity of a single-bout of exercise does not affect the amount of post-exercise hypotension, nor does a single-bout of exercise influence the reaction time of the subjects.

INTRODUCTION

Aerobic exercise is currently being promoted as a lifestyle modification that lowers resting blood pressure, especially in persons with elevated levels.1 The Sixth Report of the Joint National Committee on the Prevention, Detection, Evaluation, and Treatment of High Blood Pressure2, as well as the 1999 World Health Organization Guidelines for the Management of Hypertension3, recommended aerobic exercise as a non-pharmacological method of lowering resting blood pressure in adults.

Post-exercise hypotension (PEH) is characterized by a blood pressure (BP) value that is lower than the pre-exercise value that persists for minutes or hours after an exercise session.4 The optimum intensity of exercise required to achieve a desirable reduction in blood pressure has yet to be defined, as results of various studies were inconsistent.5,6,7,8 The American College of Sports Medicine recommends the intensity of training of 55/65%–90% of maximum heart rate (HRmax) for cardiovascular fitness.9 However, it is unknown whether this level of moderate to high intensity of exercise is needed as per lowering blood pressure is concerned.

Reaction time (RT) is the elapsed time between the presentation of a sensory stimulus and the subsequent behavioural response.10 Studies on humans and animals showed that aerobic exercise could improve some aspects of cognition and mental working capacity.11,12 Many studies have concluded that during exercise, reaction time is shorten.13,14,15 Few studies have concluded that reaction time pre- and post-exercise are not significantly different.16

The objective of this experimental study is to assess the effect of various intensities of short term exercise on blood pressure and reaction time. We hypothesized that the rate of blood pressure decline may be associated with the different intensities of exercise. We also hypothesized that exercise in different intensities affects reaction time post-exercise.

METHODOLOGY

Study design

Study was done in Melaka-Manipal Medical College (MMMC) from January 2013 to February 2013. A parallel randomized controlled trial design was used. The MMMC Research Ethics Committee approved the study protocol and written informed consent was obtained from all participants. The confidentiality and autonomy of the participants was maintained.

Subjects

A total of fifty-six subjects between the ages of 21-25 years participated in this study. The subjects were chosen from the student population of Melaka Manipal Medical College comprising of 700 students. We included only MBBS students from batch 25 and 26. We excluded students who are diagnosed with, asthma, diabetes mellitus, cardiovascular disease, those advised by a doctor not to exercise or to only exercise under medical supervision, those who were on medications known to affect blood pressure as well as those who are not cooperative. The subjects were randomly divided into two groups using simple randomization with the help of random number table. The two exercise groups corresponded to the following exercise sessions on a treadmill with heart rate monitor: one exercising at 40% of heart rate reserve and another exercising at 70% of heart rate reserve.

Data collection

Prior to the exercise, all of the subjects filled in a self-administered structured questionnaire. The demographic variable comprised of name, roll number, batch, age, sex, ethnicity and contact number. The anthropometric variable includes weight and height. Next, we asked about their exercise habits, how many days per week do they exercise vigorously enough to sweat, what type of exercise(s) do they participate in and what is the average duration of their exercise. Using Physical Activity Index, 5 levels of physical fitness are then obtained: sedentary, poor, fair, very good and high.19 Next, we inquired if the subjects have been advised by a doctor that they should not exercise OR that they should only exercise under medical supervision. We also asked if they are taking any long term medication (except oral contraceptive).

We asked about history of smoking and if yes, the number of cigarettes per day. Then, we asked about their consumption of alcohol and caffeinated drinks. We also questioned if they have any family history of hypertension, asthma, diabetes mellitus, stroke, heart disease, bleeding disorders, or cancer. Finally, we inquired about their perception on exercise on a Likert scale on a score of 1-5 with 5 being strongly agree and 1 being strongly disagree, if exercise can affect blood pressure or reaction time and if we should exercise regularly.

Study protocol

The maximum heart rate was determined for each subject using the formula proposed by Tanaka H, et al20:

208-0.7xAge = Maximum Heart Rate

(HRmax)

Using the Karvonen formula21,the heart rate reserve was calculated:

Maximum Heart Rate-Resting Heart Rate=Heart Rate Reserve (HRR)

Then the exercise intensity was calculated:

40% Target Heart Rate = (40/100XHRR)

+Resting Heart Rate

70% Target Heart Rate= (70/100xHRR)

+Resting Heart Rate

Pre-exercise measurements, exercise protocol, and post-exercise measurements were carried out at the approximately the same time of the day for each subject. Pre-exercise measurements consisted of systolic blood pressure (SBP), diastolic blood pressure (DBP) and resting heart rate (RHR), measured in the right arm of the subjects in seating position following 10 minutes of quiet rest using a digital sphygmomanometer (Medisana - Upper arm blood pressure monitor MTP, model 51040). SBP and DBP were used to calculate mean arterial pressure (MAP) using the formula: MAP = (2DBP+SBP)/3.

Reaction time was measured with the ruler drop test using a plastic 30cm ruler. The subject sits near the edge of a table, resting their elbow on the table so that their wrist extends over the side. The assessor holds the ruler vertically in the air between the subject's thumb and index finger which is 5cm apart, but not touching. The zero mark (0cm) is aligned with the subject's fingers. The subject indicates when they are ready. Without warning, the ruler is released and let to drop; the subject must catch it as quickly as possible as soon as they see it fall. The distance between the bottom of the ruler and the top of the subject's thumb where the ruler has been caught is recorded in centimeters. The test is repeated 3 times and the average value used in the assessment. Using the formula t = Ö(2d/g), where d = the distance the ruler fell (meters), g = the acceleration of gravity (9.8 m/s2), and t = the time the ruler was falling (seconds) 22, the reaction time of the subject was calculated. The reaction time was taken before and after the exercise session.

Subjects dressed in exercise clothing for each session. The inclination of the treadmill was set at 5.0%. The subjects were asked to perform brisk walking on the treadmill as warm-up for 5 minutes and then adjust the treadmill speed gradually to reach his/her target heart rate. The subjects ran on the treadmill for 15 minutes at either 40% or 70% of target heart rate. During exercise, subjects were allowed to drink water at their discretion.

After the exercise, the subjects were taken to a peaceful and noise-free environment to repeat the measurement of blood pressure, heart rate and reaction time. The blood pressure and heart rate was measured at 0 (right after exercise), 10, 20, and 30 minutes post-exercise. We performed the ruler drop test within 0 to 3 minutes post-exercise and again the average of 3 measurements was used in this assessment. After a minimum of 24 hours interval, this test was repeated with the same exercise intensity for the same subjects.

Data analysis

Data was processed and entered into Microsoft Excel. Data analysis was done using Epi Info 3.5.1. We used both descriptive and inferential statistics. The arterial pressures before the exercise and after the exercise were compared using Student's paired t-test. BP readings were averaged over the two exercise days and the mean of post-exercise arterial pressures of the two exercise groups were compared using unpaired t-test. Level of significance was set at 0.05.

We also used tables and graphs to present our data

RESULTS

A total of 56 subjects participated in this study. Percentage dropout, defined as the number of subjects who did not complete the study is 25%, therefore only the data of 42 subjects were included in our study. There were a total of 23 subjects in 40% exercise intensity group and 19 subjects in the 70% exercise intensity group.

Table 1a

Characteristic via quantitative analysis amongst subjects exercising at 40% and 70% HRR

	40%	70%	t-test	P-value
	Mean (±SD)	Mean (±SD)		
Age (years)	23.1 (1.0)	23.3 (0.9)	0.740	0.460
Weight (kg)	60.6 (9.3)	58.3 (12.3)	0.699	0.489
Height (m)	1.63 (0.08)	1.62 (0.097)	0.405	0.688
BMI (kg/m²)	22.9 (3.5)	22.2 (4.0)	0.650	0.519

The above table shows the qualitative analysis of the physical characteristics of the subjects of both exercise groups. There is no significant difference between the age, weight, height, and BMI between subjects of both exercise groups (p value >0.05, Table Ia).

Table 1b

Baseline characteristics amongst subjects exercising at 40% and 70% HRR.

	40%	70%		
	Case No. (%)	Case No. (%)	Chi Square	P-value
Gender (Male)	7 (30.4)	5 (26.3)	0.09	0.769
Gender (Female)	16 (69.6)	14 (73.7)		
BMI				
Underweight	2 (8.7)	1 (5.3)	-	1.000
Normal†	17 (73.9)	14 (73.7)	-	
Overweight†	4 (17.3)	4 (21)	-	
Physical Fitness				
Sedentary†	3 (13.0)	7 (36.8)	-	0.041***
Poor†	5 (21.7)	8 (42.1)	-	
Fair†	8 (34.8)	2 (10.5)	-	
High	7 (20.4)	2 (10.6)	-	
Smoking†				
Yes	1 (4.3)	0 (0)	0.85	1.000
No	22 (95.7)	19 (100)		
Alcohol†				
Yes	1 (4.3)	0 (0)	0.85	1.000
No	22 (95.7)	19 (100)		
Caffeinated Drink				
Soft Drink	2 (8.7)	2 (10.5)	-	0.715
Coffee†	10 (43.5)	6 (31.6)	-	
Tea†	4 (17.4)	1 (5.3)	-	
Family History				
DM†	9 (39.1)	11 (57.9)	-	0.573
Hypertension†	4 (17.4)	1 (5.3)	-	
Stroke†	3 (13.0)	3 (15.8)	-	
IHD†	4 (17.4)	5 (26.3)	-	

† Fisher's exact test is used

The above table shows the baseline characteristics of various important variables of both exercise groups. There is no significant difference between the gender, BMI categories,

and history of smoking and taking caffeinated drinks, family history of various common disease between subjects of both exercise groups (p value >0.05, Table Ib). There is however a significant difference in the level of physical fitness between the two exercise groups.

Figure 1

Plot of blood pressure response before and after exercise for both 40% and 70% exercise intensity groups. SBP, systolic blood pressure; DBP, diastolic blood pressure; MAP, mean arterial blood pressure.

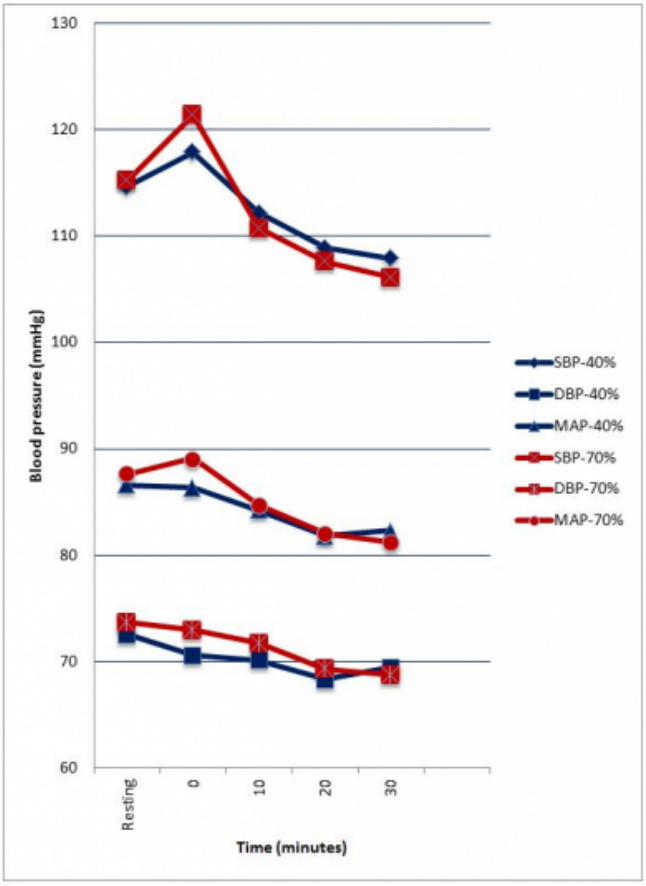


Table 2

Paired T-test

Blood pressure		Group	p-value
Systolic blood pressure, mmHg	Resting vs 0 minutes	40%	0.049***
		70%	0.021***
	Resting vs 10 minutes	40%	0.132
		70%	<0.001***
	Resting vs 20 minutes	40%	<0.001***
		70%	<0.001***
	Resting vs 30 minutes	40%	<0.001***
		70%	<0.001***
Diastolic blood pressure, mm/Hg	Resting vs 0 minute	40%	0.128
		70%	0.493
	Resting vs 10 minutes	40%	0.047***
		70%	0.331
	Resting vs 20 minutes	40%	0.003***
		70%	0.004***
	Resting vs 30 minutes	40%	0.026***
		70%	0.001***
Mean arterial pressure, mm/Hg	Resting vs 0 minutes	40%	0.828
		70%	0.158
	Resting vs 10 minutes	40%	0.023***
		70%	0.136
	Resting vs 20 minutes	40%	<0.001***
		70%	<0.001***
	Resting vs 30 minutes	40%	0.001***
		70%	<0.001***

After exercise there was an initial rise in blood pressure at 0 minutes (immediately after exercise), followed by a gradual reduction in systolic, diastolic blood pressures, and MAP in both groups (Figure 1). Significant reduction of SBP was seen starting at 20 minutes and 10 minutes post-exercise respectively in the groups who exercise at 40% and 70% intensity.Reduction of DBP and MAP was significant in the group who exercise at 40% intensity. starting at 10 minutes post-exercise ($p < 0.05$), whereas reduction was significant starting at 20 minutes post-exercise in the group with 70% exercise intensity.

Table 3

Unpaired T-test

			Mean	SD	T-test	P-value
Systolic blood pressure, mm/Hg	Resting	40%	114.7	8.4	0.1473	0.8837
		70%	115.2	13.0		
	0 minutes	40%	117.9	11.6	0.8581	0.3959
		70%	121.4	15.1		
	10 minutes	40%	112.2	11.0	0.4278	0.6711
		70%	110.8	10.4		
	20 minutes	40%	108.9	7.9	0.4290	0.6702
		70%	107.6	11.9		
	30 minutes	40%	107.9	8.4	0.5076	0.6146
		70%	106.1	14.3		
Diastolic blood pressure, mm/Hg	Resting	40%	72.5	7.1	0.5739	0.5692
		70%	73.7	6.5		
	0 minutes	40%	70.6	7.0	1.1972	0.2383
		70%	73.0	5.9		
	10 minutes	40%	70.1	8.2	0.6330	0.5303
		70%	71.7	7.8		
	20 minutes	40%	68.3	7.1	0.4486	0.6561
		70%	69.3	6.3		
	30 minutes	40%	69.5	6.1	0.3972	0.6934
		70%	68.7	6.3		
Mean arterial pressure, mm/Hg	Resting	40%	86.6	6.2	0.4299	0.6696
		70%	87.6	8.4		
	0 minutes	40%	86.4	6.8	1.2202	0.2295
		70%	89.1	8.0		
	10 minutes	40%	84.2	8.4	0.2331	0.8169
		70%	84.7	7.5		
	20 minutes	40%	81.8	6.3	0.0873	0.9308
		70%	82.0	7.5		
	30 minutes	40%	82.3	5.8	0.4999	0.6199
		70%	81.2	8.5		

When comparing both groups who exercise at different exercise intensity of 40% and 70%, there was no significant difference in post-exercise systolic, diastolic blood pressure and mean arterial pressure (p value >0.05, Table III).

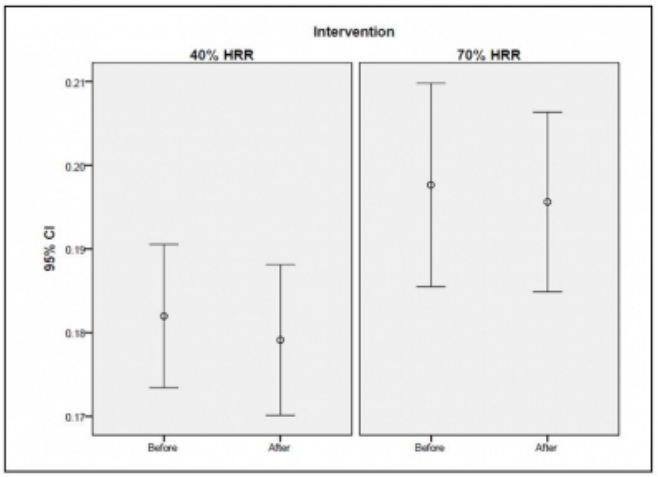
Table 4

Qualitative analysis of the difference in reaction time before and after exercise.

Reaction time	Mean reaction time before exercise (seconds)	Mean reaction time after exercise (seconds)	Pre vs Post exercise (p-value)
40%	0.182	0.179	0.497
70%	0.198	0.196	0.638

Figure 2

Mean reaction time before and after exercise



There is a decrease in reaction time after exercise, but the difference were found not to be significant in both groups (p>0.05).

The average reaction time for both 40% and 70% exercise groups was 0.182 and 0.198 seconds at resting, and 0.179 and 0.195 after exercise.

DISCUSSION

In our experimental study on assessment of various intensities of short term exercise on blood pressure namely systolic and diastolic, and reaction time in healthy young adults of Melaka Manipal Medical College (MMMC) population, we found that exercise performed at 40% and 70% intensities produced significant fall in blood pressure. Systolic blood pressure shows significant decrease starting from 10 minutes until 30 minutes post-exercise as compared to resting systolic blood pressure in both exercise groups. Diastolic blood pressure and mean arterial pressure decreased significantly starting at 10 minutes post-exercise in the group with 40% exercise intensity and starting at 20 minutes in the group with 70% exercise intensity. Our results also showed that there was no significant decrease in post-exercise systolic, diastolic blood pressure and mean arterial pressure between both groups with 40% and 70% intensities of exercise. Also, our study results revealed that reaction time does not differ significantly before and after a single bout of acute exercise at 40% and 70% of heart rate reserve. From the above, it can be concluded that our results are consistent as similarly shown in previous studies.21-29 that a single bout of steady-state exercise significantly decreases post-exercise blood pressure. Post-exercise

hypotension is characterized by a persistent drop in systemic vascular resistance that is not completely offset by increases in cardiac output.31,32 The mechanism of vasodilation during exercise is not fully understood and many compounds like potassium, adenosine, nitric oxide have been suggested as the cause.30 Vasodilatation increases venous pooling of blood which in combination with loss of plasma volume associated with exercise, leads to a reduction in central venous pressure and cardiac filling pressure, which led to the decrease in blood pressures.30

Our results also showed that different exercise intensities have no effect on the magnitude of blood pressure decline. Pescatello et al found no difference in the magnitude of fall in blood pressure observed following 30-min bouts of cycle ergometry at 40 and 70% of VO2Peak in a hypertensive population.33 Forjaz et al found similar decrease in blood pressure following 45 min of exercise at intensities of 30, 50 and 80% of VO2 Max.34 Using a resistance exercise model, Brown et al, compared three sets of five exercises at 40 and 70% of one repetition maximum (RM) and demonstrated similar pressure decrements between trials.37 There is no convincing evidence that the blood pressure response to dynamic aerobic training differs according to training intensity when between 40% and 70% of net maximal exercise performance (moderate to hard intensity).36

Our result also showed that the simple reaction time measured before exercise and during recovery period did not differ significantly. This is consistent with the result of the study done by Yagi et al which shows that both visual and auditory reaction time during exercise was shorter compared to baseline and recovery period, but reaction time at baseline and recovery period did not differ from each other.37 Snowden et al reviewed 30 large studies and found that exercise had inconclusive results on attention, general cognition, memory, and several other measures of mental function.38 The study done by Collardeau et al also shows that simple reaction time did not differ pre-exercise and post-exercise.14

As much as measures were taken to highly avoid it, there were still few limitations in the study done. Firstly, our study analysed the effect of exercise on blood pressure up to 30 minutes of post-exercise only, thus we are not aware of the response of blood pressure to exercise from there onwards. Apart from this, we did not study the response of blood pressure to exercise in those with cardiovascular diseases such as hypertension thus our study did not make clear of the response of blood pressure to exercise in this group of people, which is important from medical point of view.

Although the blood pressure reduction seen in this study is small, it is found that the 2mmHg reduction in resting systolic blood pressure observed has been associated with reductions in mortality of 4% from coronary heart disease, 6% from stroke, and 3% from all causes.39 In view of this, mild to moderate exercise which ranges from brisk walking to slow jogging should be taken as an important point when advising lifestyle modification due to its short-term hypotension effect, and the fact that it is a more generally acceptable exercise level among adults and elderly.

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