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The Effect of Harvard Step-Test and Shuttle Run-Test Training on Increasing Exercise Pulse Frequency in Junior High School Students

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Abstract

The objectives of this study were (1) to determine the effect of increasing Harvard Step-test exercise on increasing exercise pulse frequency in junior high school students; (2) to determine the effect of increasing Shuttle Run-test exercise on increasing exercise pulse frequency in junior high school students; (3) to determine the difference in the effectiveness of Harvard Step-test and Shuttle Run-test exercises on increasing exercise pulse frequency in junior high school students. The method used in this research is an experiment using Two Group Pretest-Postest Design. The samples used in this study were 46 students of Junior High School Plus Shafiyyatul Amaliyyah. The group pairing technique used was ordinal pairing. Data analysis techniques in this study used descriptive prerequisite tests and hypothesis testing. The results showed that there was a significant effect of Harvard Step-test exercise on increasing exercise pulse frequency in junior high school students with a significance value of p of 0.01. There is an effect of Shuttle Run-test exercise on increasing exercise pulse frequency in junior high school students with a significance value of p of 0.00 < 0.05. There is a difference in the effectiveness of Harvard Step-test and Shuttle Run-test exercises on increasing exercise pulse frequency in junior high school students, but not significant, as evidenced by paired t tests, the Harvard Step-test exercise group gets a mean of 44.652 for increasing student pulse frequency. While the Shuttle Run-test training group got an average of 41.792. Based on the results of the study, it can be concluded that the Harvard Step-test exercise has a more effective pulse rate increase compared to the Shuttle Run-test exercise.

How to Cite

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INTRODUCTION

Physical exercise or physical activity has a direct effect on the cardiovascular system, with acute and chronic effects. The acute effect of physical exercise is to increase pulse rate and respiratory frequency. Furthermore, the results of a previous study found that aerobic exercise performed for 2x30 minutes can increase pulse frequency, blood lactic acid, body temperature, and exercise blood pressure (Sandi et al., 2016). The chronic effect of exercise is to increase the size of the heart, especially the left ventricle, increase blood supply, decrease resting pulse frequency, normalise blood pressure, and improve blood distribution (Sharkey, 2011). Similarly, regular physical exercise has several benefits for the cardiovascular system, including; normalising blood pressure, strengthening the heart muscle, lowering resting pulse frequency, and improving the ability of the cardiovascular system to transport oxygen (Kuntaraf, Kl., Kuntaraf, 2009).

There are basically two types of endurance, namely aerobic and anaerobic endurance. Aerobic endurance is an activity that depends on the availability of oxygen that helps burn energy sources, so it also depends on the optimal work of various organs such as the heart, lungs, and blood vessels to transport oxygen so that the process of burning energy sources can run perfectly (Palar et al., 2015). Some examples of sports that use aerobic endurance are gymnastics, swimming, cycling and football. While anerobic endurance is found in sports that use a lot of energy in a short time causing oxygen debt, for example: sprint running, weightlifting (Palar et al., 2015).

The exercises performed should be exercises that will increase the work ability of the heart and maximum oxygen consumption and lung vital capacity. Exercises up and down the Harvard Step-test bench and Shuttle Run-test are included in aerobic exercise. These exercises if done continuously or intermittently can increase maximal oxygen consumption. Cardiorespiratory fitness is best improved by continuous or intermittent exercise (Ismaryati et al., 2009).

The Harvard Step-test exercise is a dynamic/functional body fitness test. It is one of the most commonly used step tests to calculate a physical fitness index based on a person's cardiovascular endurance (Aguss, 2020), ((Aguss et al., 2021). The Harvard Step-test was first developed by Graybriel Brouha & Heath in 1943. This test aims to measure aerobic capacity for muscle work and its ability to recover from work (Syaifulloh & Aguss, 2021), (Aguss & Fahrizqi, 2020)

Gunawan in (Mubaligin et al., 2018) states that the Harvard Step-test exercise can also be called the up and down stairs exercise, this up and down stairs exercise is done to increase the elements of speed and strength in physical condition. Because the elements of speed and strength are a fundamental part of endurance. Muscular endurance is the ability of muscles to undergo contractions with sub-maximal loads repeatedly or maintain muscle contractions within a certain period of time, if you have good muscular endurance, you can do long activities without experiencing fatigue, but on the contrary if you do not have good endurance, you will easily experience fatigue. A person's endurance can continue to be improved through stair climbing exercises, this stair climbing exercise aims to increase leg muscle endurance.

Up and down stairs exercise is an exercise by running or jumping using stairs made of iron, wood, boards or wall stairs. This exercise is a progressive increase in training load (overload). This exercise is getting heavier and heavier, but the increase in training load must be little by little. This is to keep from over training and the athlete's adaptation process to loading will be guaranteed regularity. Increasing the training load should be done 2 or 3 times a week. Yuliansyah (Mahdi, 2017)

Harvard Step-test exercise is one type of exercise in the form of going up and down stairs repeatedly. The overall training model involves contraction of all muscles in the lower limbs, both jumping, resting, lifting weights (own body weight) which requires strength, speed and coordination of these two elements of ability. Exercise is carried out with a measured, systematic and programmed intensity, based on the workload and intensity given for each exercise. This is determined based on the size of the training pulse. However, the author has not found standardised literature that explains whether the two training models have a meaningful effect on increasing leg muscle explosive power (Triyosa Mayang Sari, 2019).

Harvard Step-test exercise is one type of exercise that is effective for burning fat, this exercise is also effective for strengthening the heart and increasing endurance. In every minute, the activity of climbing stairs is estimated to expend energy or burn calories 8-11 times Anggraeni in (Mahdi, 2017).

Then according to Remmy Muchtar in (Sukarman, 2022) one form of exercise to increase agility is the Shuttle Run-test or running back and forth. The elements of motion in the Shuttle

Run-test exercise, namely running by changing direction and body position, speed, balance are components of agility motion so that this exercise can be used to improve agility. The advantage of the Shuttle Run-test exercise is that this exercise is oriented towards footwork, speed gets a large portion in this exercise.

According to (Sajoto, 1995) agility is a person's ability to change direction, in a position in a particular arena. Shuttle Run-test is a test to measure foot agility, but in the Shuttle Run-test test the testi must also move the block with a distance of 4 x 10 metres so that the testi must also be agile in taking the block in a fast time. The purpose of the Shuttle Run-test is to train straight changes in body movement. Athletes run back and forth as fast as possible from one point to another 10 times. Every time he reaches one point he must try to quickly turn his body to run towards another point.

According to (Harsono, 1988) the advantages of the Shuttle Run-test are, psychologically the Shuttle Run-test movement is easier to remember so that it allows athletes to fully concentrate on running speed, and if done continuously athletes get used to the sharp turning angle (180 degrees), sharper than the turning angle of zigzag running (45 and 90 degrees), while the disadvantages of the Shuttle Run-test are that during training the possibility of muscle injury is greater because the Shuttle Run-test demands muscle strength to stop suddenly then turn around to run in the opposite direction, and requires high concentration when turning directions. This is because there is often a loss of balance.

The same thing also happens when doing physical exercise such as cycling, the heart will beat faster and stronger. The more the speed of the bicycle pedals increases, and also the more uphill the track, the heart rate will increase, otherwise if the bicycle pedal speed is lowered, and the track is downhill, the exercise pulse frequency will decrease slowly. After a period of rest, the pulse frequency will return to its original state. The change in pulse frequency during exercise and immediately after exercise is called the acute effect of exercise. If exercise is done regularly and continuously with the right dosage, there will be an improvement in body function in the form of a decrease in resting pulse frequency. The decrease in resting pulse frequency compared to before the exercise programme is called the chronic effect of exercise (Nala, 2011).

The acute effect of exercise on changes in pulse frequency is that the pulse frequency increases as the intensity of exercise increases. This increase in resting pulse frequency is because during exercise, the need for blood to transport oxygen to active body tissues will increase (Foss & Keteyian, 1998). In addition to acute effects, exercise also causes chronic effects in the form of a decrease in resting pulse frequency (Janseen, 1989).

Heart rate or pulse is controlled by the nervous system. In this regulatory system, the response in the form of increased nerve impulses from the brainstem to the sympathetic nerves will cause a decrease in blood vessel diameter and an increase in heart rate frequency. Changes in heart rate, both increase and decrease are regulated by sympathetic and parasympathetic activity (Syaifuddin, 2006). In addition to sympathetic nerves and parasympathetic nerves, heart rate frequency is also regulated by epinephrine and norepinephrine (Ganong, 2008).

By giving Harvard Step-test and Shuttle Run-test exercises, it is expected that there will be an increase in exercise pulse rate in students. The objectives of this study were (1) to determine the effect of increasing Harvard Step-test exercise on increasing exercise pulse frequency in junior high school students; (2) to determine the effect of increasing Shuttle Run-test exercise on increasing exercise pulse frequency in junior high school students; (3) to determine the difference in the effectiveness of Harvard Step-test and Shuttle Run-test exercise on increasing exercise pulse frequency in junior high school students.

METHODS

This research is an experimental study used to find the effect of treatment on others under controlled conditions, the controlled conditions in question are the results of research that are converted in the form of numbers, for the analysis used is statistical analysis (Sugiyono, 2011). The same thing was also stated by (Arikunto, 2006).

This research is an experimental study with test techniques in data collection. Experimental research aims to test the effect of a variable on another variable or test how the causal relationship between one variable and another variable. This agrees with what is conveyed (Abraham & Supriyati, 2022) experimental research is research that seeks to find a causal relationship between the independent variable and the dependent variable, where the independent variable is deliberately controlled and manipulated. or experiment (experiment research) is an experimental activity (experiment), which aims to determine a symptom or influence that arises, as a result of certain treatments. According to (Sugiyono, 2012),

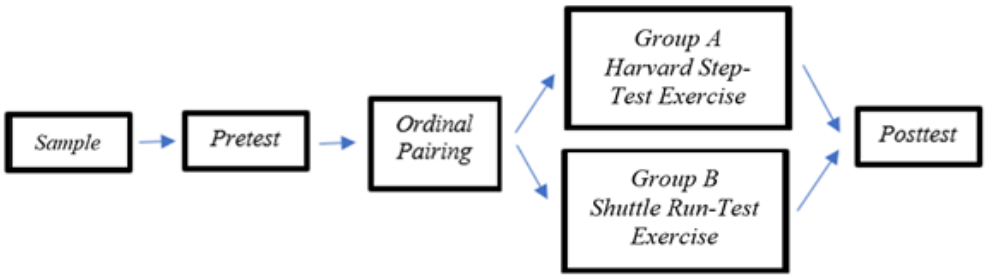

Figure 1. Two Group Pretest-Posttest Design

experimental research is a research method used to find the effect of certain treatments on others in controlled conditions. According to Donald Ary in the journal (Sulhan, 2020) says that experimental research is the most difficult research (shopisticated) in hypothesis testing.

The research design used is 'Two Groups Pretest-Posttest Design', which is a research design that has a pretest before being treated and a posttest after being treated. Thus it can be known more accurately, because it can compare with the situation before being treated (Sugiyono, 2008)

The pre-test aims to divide the two groups and compare with the post-test results. Treatment or training was carried out for 16 meetings. The training process for 16 times can be said to be trained, because there have been persistent changes (Tajliek Soegiardo, 1991) below is the research design used in this study.

Population is the whole subject of research (Arikunto, 2002). and According to (Sugiyono, 2009) population is a generalization area consisting of objects or subjects that have certain quantities and characteristics set by researchers to be studied and then concluded. The population of this study were all students of JUNIOR HIGH SCHOOL Plus Shafiyyatul Amaliyyah.

The sample in this study amounted to 46 students. (Nurgiantoro, 2004) explains that the sample is part of the population which is then used as a data source. And according to (Sugiyono, 2009)is part of the number and characteristics possessed by the population. The sample of this study used purposive sampling technique, obtained 46 students, namely with the criteria: (1) grade 8, (2) male gender, (3) in good health, (4) able to follow 16 exercises.

The group pairing technique used was ordinal pairing. Ordinal pairing is based on ordinal criteria (Hadi, 2000). Sampling using the ordinal pairing system by giving an initial test (pretest), then the pretest results are ranked and divided into two groups. This method is done by arranging the sample in a list and taking from top to bottom (Hadi, 2000). Ordinal pairing is a pair of research samples or a way of grouping samples using a ranking system, then placing samples in each group following the "letter S" pattern. The purpose of using ordinal pairing is to equalize the ability of the samples in each group. Based on the ordinal pairing technique, the research samples will be grouped as follows group A = 23 students were given the Harvard Step-test exercise treatment, group B = 23 students were given the Shuttle Run-test exercise treatment.

Data analysis techniques in this study used descriptive prerequisite tests and hypothesis testing. Before hypothesis testing, prerequisite tests need to be carried out. Testing of measurement data related to research results aims to help the analysis be better. For this reason, in this study normality and homogeneity tests will be carried out.

RESULTS AND DISCUSSION

Physical fitness is needed by everyone to carry out daily activities or activities. A person's physical fitness can be said to be good is by heart health. According to (Rifa'I et al., 2020) one indicator of heart health is the pulse rate. In healthy people in general, the pulse frequency reflects the heart rate, therefore the pulse frequency is the same as the contraction of the heart ventricles. Of course, to increase the pulse frequency requires exercises that can maintain cardiorespiratory fitness such as harvard and shuttle run exercises. According to (Setiawan, 2024) the harvard exercise method has been widely used to measure cardiorespiratory fitness levels in various age groups and fitness levels. This is because Harvard exercise can reduce the oxygen demand of the heart muscle needed at the level of physical exercise. Based on research conducted (Rizki, 2022) explains the impact of harvard training to be lightning fast heart rate frequency recovered back to a reasonable frequency, until it continues to be good as well as its ability. Physical exercise plays an important role in maintaining or improving a person's physical fitness level. The higher

a person's physical fitness level, the higher their physical work ability. According to the results of research (Nugroho et al., 2022) explained that there was a significant increase in physical fitness after being given the shuttle run training treatment. Then supported by the results of research conducted by (Wardani & Irawadi, 2020) the application of shuttle run agility training has an influence on increasing physical fitness.

The research results and discussion will be presented sequentially including: (1) description of research results, (2) prerequisite test analysis, and (3) hypothesis testing. Hypothesis testing in this study will be presented sequentially, among others: (a) there is an effect of Harvard Step-test training on increasing exercise pulse rate in junior high school students, (b) there is an effect of Shuttle Run-test training on increasing exercise pulse rate in junior high school students, (c) there is a difference in the effectiveness of Harvard Step-test and Shuttle Run-test training on increasing exercise pulse rate in junior high school students.

The data from this study is in the form of pretest data and posttest data which is a description of each variable contained in this study. The research process took place in three stages consisting of pretest (initial test), treatment (giving treatment) and posttest (final test). The first stage is the initial measurement (pretest) to obtain initial data on the basal pulse rate of junior high school students before doing the activity. The second stage is the provision of treatment in the form of Harvard Step-test and Shuttle Run-test exercises that last for 5 minutes. The third stage is the final measurement (posttest) to get the final data of the exercise pulse in students after doing the activity. Students' pretest and posttest pulse data are outlined in the following table.

Pretest and posttest of the Harvard Step-test group

The pretest and posttest data of the exercise pulse of junior high school students are presented in the table below:

Table 1. Pretest and Posttest Data of Basal Pulse Rate and Resting Pulse Rate of Harvard Step-test Group

Harvard Step-test Data		
Pretest	Posttest	Difference
71	87	16
60	92	32
46	80	34
67	101	34
69	108	39
76	109	33
54	98	44
57	117	60
63	98	35
51	102	51
62	122	60
54	117	63
49	96	47
62	118	56
44	92	48
51	98	47
55	101	46
62	96	34
49	98	49
49	98	49
57	111	54
62	98	36
58	118	60

Descriptive statistics of the pretest and posttest pulse rates of students in the Harvard Step-test group are presented in the table below.

Table 2. Results of Pretest and Posttest Basal Pulse Rate and Resting Pulse Rate of Harvard Step-test Group

Statistic	Harvard Step-test Data	
	Pretest	Posttest
N	23	23
Mean	57,74	102,39
Std.deviation	8,286	10,878
Minimum	44	80
Maximum	76	122

Pretest and posttest of the Shuttle Run-test group

The pretest and posttest data of the exercise pulse of junior high school students are presented in the table below:

Table 3. Pretest and Posttest Data of Basal Pulse Rate and Resting Pulse Rate of Shuttle Run-test Group

Shuttle Run-test Data		
Pretest	Posttest	Difference
68	95	27
69	95	26

63	120	57
65	86	21
66	107	41
55	116	61
63	102	39
69	97	28
54	108	54
61	99	38
72	101	29
60	96	36
62	115	53
62	121	59
70	127	57
69	103	34
58	98	40
55	96	41
62	106	44
54	101	47
57	103	46
59	108	49
63	97	34

Descriptive statistics of the pretest and posttest pulse rates of students in the Shuttle Run-test group are presented in the table below.

Table 4. Results of Pretest and Posttest of Basal Pulse Rate and Resting Pulse Rate of Shuttle Run-test Group

Statistic	Data Harvard Step-test	
	Pretest Pretest	Posttest
N	23	23
Mean	62,43	104,22
Std.deviation	5,442	9,954
Minimum	54	86
Maximum	72	127

Prerequisite Test Result

Normality Test

The data normality test in this study used the Shapiro-Wilk method. The results of the data normality test conducted on each group were analyzed with the SPSS version 29 for windows software program with a significance level of 5% or 0.05. A summary of the normality test results is presented in the following **Table 5**.

Based on **Table 5** the statistical analysis of the normality test that has been carried out using the Shapiro-Wilk test in the table above, it shows that all pretest and posttest data obtained from the results of the data normality test have a significance value of $p > 0.05$, which means that the data is normally distributed.

Table 5. Summary of Normality Test Results

Group	Significance	Description
Pretest Harvard Step-test	0,763	Normal
Posttest Harvard Step-test	0,188	Normal
Pretest Shuttle Run-test	0,315	Normal
Posttest Shuttle Run-test	0,170	Normal

Homogeneity Test

The homogeneity test is carried out to test the equality of several samples that are homogeneous or not. The homogeneity test is intended to test the similarity of variance between preetest and posttest. The homogeneity test in this study is the Levene Test. The homogeneity test results are presented in the following **Table 6**.

Table 6. Summary of Homogeneity Test Results

Group	Levene Statistic	Significance	Description
Pretest Harvard Step-test	1,110	0,304	Homogen
Posttest Harvard Step-test	1,059	0,315	Homogen
Pretest Shuttle Run-test	0,106	0,748	Homogen
Posttest Shuttle Run-test	0,071	0,792	Homogen

Based on **Table 6** the statistical analysis of the homogeneity test that has been carried out using Wilk's Levene Test in the table above. The calculation results obtained a significance value ≥ 0.05. This means that the data group has a homogeneous variant. Thus the population has the same variant or homogeneous.

Hypothesis Test

Hypothesis 1 (the effect of Harvard Step-test exercise on increasing exercise pulse frequency)

The first hypothesis reads "There is an effect of Harvard Step-test training on increasing exercise pulse frequency". The research conclusion is declared significant if the t value> t table and sig value is smaller than 0.05 (Sig < 0.05). Based on the results of the analysis obtained data

in the following **Table 7.**.

Table 7. T-test of Pretest and Posttest Results of Increased Pulse Rate Frequency of Harvard Step-test Group

Statistic	Result
Mean	44,652
Std.deviation	11,715
Std.eror mean	2,443
Lower	49,718
Upper	39,586
T	18,280
Df	22
Sig	,001

From the t test results in the **Table 7** above, it can be seen that the t value is 18.280 and the t table (df 22) is 3.792 with a significance value of p of 0.01 < 0.05, meaning that H0 is rejected. Thus Ha which states that "There is a significant effect of Harvard Step-test exercise on increasing exercise pulse frequency in junior high school students".

Hypothesis 2 (the effect of Shuttle Run-test training on increasing exercise pulse frequency)

Table 8. T-test of Pretest and Posttest Results of Increased Pulse Rate Frequency of Shuttle Run-test Group

Statistic	Result
Mean	44,652
Std.deviation	11,715
Std.eror mean	2,443
Lower	49,718
Upper	39,586
T	18,280
Df	22
Sig	,001

From the t test results in the **Table 8** above, it can be seen that the t value is 17.334 and t table (df 22) 3.792 with a significance value of p of 0.00 <0.05, meaning that H0 is rejected. Thus Ha is accepted which states that "There is an effect of Shuttle Run-test training on increasing exercise pulse frequency in junior high school students".

Hypothesis 3 (difference in effectiveness of Harvard Step-test and Shuttle Run-test exercises in increasing exercise pulse frequency)

The third hypothesis reads "There is a difference in the effectiveness of Harvard Step-test and Shuttle Run-test exercises on increasing exercise pulse frequency". The research conclusion is declared significant if the t value > t table and sig value is smaller than 0.05 (Sig < 0.05). Based on the results of the analysis obtained data in the following **Tabel 9.**

Tabel 9. T-test of the Difference in the Effect of Harvard Step-test and Shuttle Run-test Training on the Increase in Exercise Pulse Rate

Group	Mean	T value	T table	Sig.
Harvard Step-test	44,652	18,280	3,792	,001
Shuttle Run-test	41,792	17,334	3,792	,001

From the t-test results in the **Tabel 9** above, it can be seen that the Harvard Step-test t value is 18.280 and t table (df 22) 3.792 and the Shuttle Run-test t value is 17.334 and t table (df 22) 3.792 with a significance value of p of 0.01 < 0.05, meaning H0 is rejected. Thus Ha which states that "There is a difference in the effectiveness of Harvard Step-test and Shuttle Run-test exercises on increasing exercise pulse frequency in junior high school students, but not significant", is proven based on paired t-test, Harvard Step-test exercise group gets an average of 44.652 for increasing student pulse frequency. While the Shuttle Run-test exercise group got an average of 41.792. Based on the above results, it can be concluded that the Harvard Step-test exercise has an increase in exercise pulse rate in junior high school students that is more effective than the Shuttle Run-test exercise.

CONCLUSION

Harvard training can also be called training up and down stairs, training up and down stairs is done to increase the elements of speed and strength in physical condition. Shuttle run training is a form of sprint training that tests speed, agility, and rapid changes in direction. Based on the research results that have been obtained with data analysis and hypothesis testing, it can be concluded (1) there is an effect of shuttle run training on increasing exercise pulse frequency; (2) there are differences in the effectiveness of Harvard and shuttle run training on increasing exercise pulse frequency, but not significant. Based on the results of the analysis, it is evident that based on

the paired t-test, the Harvard training group gets an average of 44.652 for the increase in pulse frequency of students, while the Shuttle run group gets an average of 41.792. Based on the results of the study, it can be concluded that Harvard exercise has a more effective increase in pulse rate compared to Shuttle run exercise.

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