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Original Article

Endurance cardiovascular, core and leg strength development using AMRAP, EMOM and for time training program

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Abstract:
The aims of the study were (1) to analyze the effect of the As Many Rounds/ Reps as Possible (AMRAP) on increasing core strength, leg strength, and endurance cardiovascular, (2) to analyze the effect of the FST Every minute on the minutes (EMOM) to increase core strength, leg strength, endurance cardiovascular, (3) to analyze the effect of the FST FOR TIME to increase core strength, leg strength, endurance cardiovascular, (4) The different of effect on AMRAP, EMOM and FOR TIME to increase core strength, leg strength, endurance cardiovascular. The sample of this study is male with an age of 25-40 years old with a total of 30 recreational runners in Surabaya. This type of study is quantitative using ordinal pairing technique. Pre and post data test by measuring leg dynamometer (kg), 30 second sit up test and multistage fitness test / MFT (ml/kg/minute). The results: 1) The AMRAP group had the results in leg muscle strength significant increase of 14% greater than FOR TIME and less than EMOM which was 14% (7% vs 15% < 0.05), core strength had significant increase compared to the EMOM and FOR TIME groups by 11% (7% vs 7% < 0.05), endurance cardiovascular had a significantly greater increase between the EMOM and FOR TIME groups by 6% (2% vs 3% <0.05), 2) EMOM Groups had significant increase in leg muscle strength 15% greater than AMRAP and FPR TIME groups by 15% (14% vs 7% < 0.05), abdominal strength had a significant increase between AMRAP and FOR TIME groups of 7% (11% vs 7%< 0.05), cardiovascular endurance had a significant increase between the AMRAP and FOR TIME group by 2% (6% vs 3% > 0.05), 3) FOR TIME group, the results obtained on leg muscle strength had a significant increase between AMRAP and EMOM by 7% (14% vs 15% < 0.05), core strength had a significant increase between AMRAP and EMOM groups by 7% (11% vs 7% <0.0.5), endurance cardiovascular had a significant increase between AMRAP and EMOM groups of 3% (6% vs 2% < 0.05). 4) There is an analysis result that there is no significant difference in the effects between AMRAP, EMOM and FOR TIME caused by the results of the MANOVA test at the mean fifferent sig evel > 0.05 and the presentation increase of variables in each group is not much more than 20% of the AMRAP, EMOM and FOR TIME group results. Conclusion: the results of this study prove that there is a significant effect of the effectiveness of functional strength training using AMRAP, EMOM and FOR TIME groups on increasing leg muscle strength, core strength and endurance cardiovascular. The three groups did not have a significant different in influence because the results of multivariate test analysis at sig level > 0.05.
Key Words: endurance cardiovacular, core strength, leg strength, amrap, emom, for time.

Introduction

Sports Science is the science that studies the fields of health sports, recreational sports and achievement. The development of sports science has been supported by research related to sport performance, sport coaching, strength and conditioning, sport medicine, sport nutrition, sport therapy, sport education and physical fitness (Beattie, 2021). The experts in the field of physical fitness, sports analysis, sports therapy, rehabilitation and special sports management also study the basics of sports science. Cassemiro (2017) argued about the importance of an expert in the field of sports science, especially fitness sports, where in his knowledge he studies and tackles the impact of obesity in the United States so that this can reduce the status of deaths due to diabetes, cancer and other diseases. Neves (2014) also revealed the importance of the field of sports science, especially in the fitness trainer community in New York in developing and promoting fitness training to support the healthy lifestyle of teenagers to the elderly. Angel (2015), Box (2019), Byrne (2014), Wibowo (2020), Inovero (2017), Kasa (2014), Nurhasan (2022) suggests that fitness training is one of them, namely functional strength training Agron (2014) regarding quantitative research on sport and exercise science by providing manipulation of functional strength training exercises (FST) to increase endurance, strength, power, balance which is needed by

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someone in carrying out daily activities and is also needed by an athlete (according to the sport). Zhang (2018), Zaton (2015), Yükse (2018), Wibowo (2021), Fathir (2021) suggests that someone who likes to do physical activities such as sports running or other aerobic exercise doing weight training to help increase core muscle strength, lower extremity/limb muscle strength and usually also to support physical performance such as speed and endurance when running/biking. Fathir (2021), Byrne (2014), Seidl (2014), Glinemann (2014), Garcia (2017), Liu (2017) argued that the reason people like running is to lose weight and improve their physical fitness, while Agron (2014), Ratamess (2012), Wibowo (2021) suggested that maintaining fitness can be done through an exercise program. functional strength training, functional exercises are exercises using media such as suspension training, dumbbells, barbells and kettlebells.

Media functional training has advantages in dynamic movements, so that the arm muscles, leg muscles and core or rectus abdominius and oblique muscles can move actively in one movement mode. Feito (2018), Mirizo (2020), Sermaxhaj (2017) also revealed that functional training has a significant ability to improve biomotor components such as strength, endurance, power, speed in runners. Apart from that, functional training has other advantages as a prevention of injuries in dynamic sports (Wibowo, 2021). Along with the times, where the training model began to have many innovations and variations, one of which was using functional training media. So, it is necessary to carry out in-depth research to determine the effect of manipulation of functional strength training training programs in increasing leg muscle strength, core strength and cardiovascular endurance. Wibowo (2020), Suparto (2019), Ozbay (2019), Wilson (2017), Robinson (2014), Delgado (2022) suggests that the components of physical condition that must be considered by a person before doing physical activities such as running/other aerobic exercises is doing strength training. The reason is because one of the basic components of physical condition is the most important and needed by everyone in doing physical exercise (daily activities/sports) and in almost all sports events. Grant (2017), Pinillos (2017), argues that athletics in long-distance running numbers really requires an element of strength. Strength training will affect running performance and can help improve other physical conditions such as cardiovascular endurance, speed, power, agility, with linear movements (Born, 2016).This study applied the interval method with functional strength training (FST) exercises with the AMRAP, EMOM and FOR TIME models in the running community by reviewing the increase in training on core muscle strength, leg muscle strength and cardiovascular endurance which was carried out 3 times a week for 6 weeks.

Material & methods

This type of research is a quasi-experimental quantitative model (quasi-experimental) because there is treatment given to the sample (Bogdan, 1998). There are three sample training groups, namely AMRAP, EMOM and FOR TIME. The three variations will include 6 types of movement sequences consisting of: Barbell Deadlift, Barbell Back Squat, Erg Ski, Assault Airbike, Barbell Bench Press Barbell Clean, Lunges, TRX Atomic Pike, Barbell Row, Bosu v-up, Medicine Ball Russian Twist (Exos, 2019). This study aims to analyze the effectiveness and effect of training on leg muscle strength, core muscles and cardiovascular endurance in male recreational runners.

The location for this research was in the city of Surabaya, to be precise at the International Youth Center Building at Surabaya State University which is located at the Unesa Lidah Wetan Campus Complex, Surabaya 60213 and Training Zone Indonesia. The population of this study is the running community in Surabaya City aged 25-40 years who actively participate in weekday and weekend running activities in Surabaya, totaling 131 people. A good sample should represent the population as far as possible. Researchers took a sample of 25% of the total population, this is in the opinion of Doma (2019) if the number of subjects is greater than 100, then 10-% 25% or more can be taken. Because the population in this study amounted to 131 people, researchers only took 35% of the total population (Maksum, 2010), namely 30 people as a sample from the running community in Surabaya City. Determination of the sample in this study was carried out after the pretest on each member of the running community. The sample grouping method in this study used the ordinal pairing method. In placing the sample in each group following the pattern of the letter "S", where the purpose of using this method is by ranking the pretest results of the entire sample, starting from rank 1 to 30 (rank 1 in group 1, rank 2 in group 2, rank 3 in group 3, rank 4 in group 3, rank 5 in group 2, rank 6 in group 1, rank 7 in group 1, rank 8 in group 2, and so on). Based on this technique, 3 groups were obtained and each group consisted of 10 people which group 1 AMRAP, group 2 EMOM, group 3 FOR TIME training. Pre and post data test by measuring leg dynamometer (kg), 30 second sit up test and multi stage fitness test / MFT (ml/kg/minute).

Table 1. Baseline characteristics of participants. *

	AMRAP (n = 10)	EMOM (n= 10)	FOR TIME (n=10)
Age (y)	26.14 0.95	26.50 0.98	27.31 0.96
Height (cm	176.71 7.03	178.36 7.20	177.41 5.31
Weight (kg)	73. 51 7.62	74.81 9.12	73.45 9.21
Body mass index (kg. m^{-2})	21,42 3.35	23, 65 4.15	22, 45 3.25
Viscelar Fat	2 5.21	3 5.12	2 3.50

Participants reported to the laboraory; assessed for endurance cardiovascular test using MFT (VO2Max test), strength with leg strength dynamometer test and core strength with 30 seconds sit up test.

Statistical Analyses

The author analyzes the scientific literature and methodology with quantitative research methods Independent T-test and MANOVA were conducted to compare cardiovascular endurance (CF), strength and core stability between groups. This descriptive data discusses the average, standard deviation, variance, maximum and minimum values, as well as the percentage increase in the test results of leg muscle strength, abdominal muscle strength and cardiovascular endurance of the three experimental groups (exercise group I with AMRAP, exercise group 2 with EMOM , exercise group 3 with FOR TIME) the three types of groups were analyzed using descriptive statistical techniques (Donoghue, 2010). The data description uses the help of the Statistical Product and Service Solution (SPSS) program specifically for the MacBook series 20. To test the normality of data distribution, the Shapiro-Wilks method was used (Rencher, 2002). If the significance level in the statistical test is greater than 0.05, the data is stated to be normally distributed (Rencher, 2002). The Levenes's variant homogeneity test was carried out to find out whether the data collected was homogeneous or not (Rencher, 2002). Rencher (2002) revealed that to find out whether there are differences in the effect of AMRAP, EMOM and FOR TIME exercises on leg muscle strength, abdominal muscle strength and cardiovascular endurance: Manova (Multivariate of analysis), with the level of hypothesis rejection at $\alpha = 0.05$ and paired T test (t test), with a hypothesis rejection rate at $\alpha = 0.05$. The results of the study were analyzed and elaborated according to the hypotheses that had been determined beforehand which would explain the effect of the AMRAP, EMOM and FOR TIME functional strength training (FST) exercises on increasing abdominal muscle strength and cardiovascular endurance.

Results

The results of this study are a collection of empirical or real facts to describe the effect of the AMRAP, EMOM and FOR TIME model groups on increasing leg muscle strength, core strength and cardiovascular endurance. In this study only established the relationship of the independent variable, namely functional strength training (FST) to increasing leg muscle strength, core strength and cardiovascular endurance. In order to achieve the research objectives that had been formulated earlier, treatment was given based on research design and variables which lasted for six weeks consisting of eighteen treatments with a treatment frequency of three times a week for the AMRAP, EMOM and FOR TIME model groups.

The probability of error in this study is 0.05. The descriptives that will be presented in this discussion include determining the mean (mean) and standard deviation of the data from the dependent variables, namely leg muscle strength, core strength and cardiovascular endurance of each group.

Table 2. Description of Leg Muscle Strength Data

Group	N	*Pre Test*	*Post Test*	*Difference*
AMRAP	10	*Mean = 91,2000* SD = 23,11229	*Mean = 103, 9500* SD = 22,18539	*Mean = 12,75* SD = 0,9269
EMOM	10	*Mean = 86,0000* SD = 18,87385	*Mean = 99,0000* SD = 20,39063	Mean = 4,0000 SD = 1,51678
FOR TIME	10	*Mean = 89,2500* SD = 22,32245	*Mean = 95,5800* SD = 25,26301	*Mean = 6,33* SD = 2,94056

From the results (Table 2) of the leg muscle strength variable data in the AMRAP group after being given treatment for six weeks, it showed an increase of 14%, the EMOM group experienced an increase of 15% and the FOR-TIME group experienced an increase of 7%. it can be concluded that the leg muscle strength of the AMRAP experienced a significant increase <the EMOM group and was better than the FOR-TIME group. The following can be explained in the graph below:

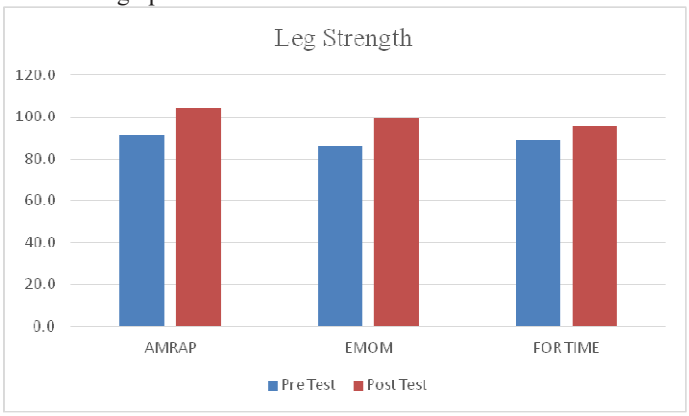

Fig 1. Graph of Data Acquisition of Pre test and Post Test of Leg Strength

Table 3. Acquisition Data of Pre test and Post test of Core Strength

Group	N	*Pre Test*	*Post Test*	*Difference*
AMRAP	10	*Mean = 22,1000* SD = 4,60555	*Mean = 24,5000* SD = 3,59784	*Mean = 2,4* SD = 1,00771
EMOM	10	*Mean = 22,1000* SD = 3,84274	*Mean = 23,7000* SD = 3,56059	*Mean = 1,6* SD = 0,28215
FOR TIME	10	*Mean = 22,2000* SD = 3,73571	*Mean = 23,8000* SD = 3,45768	*Mean = 1,6* SD = 0,27803

From the results (Table 3) of the core strength variable data in the AMRAP group after being given treatment for six weeks, it showed an increase of 11%, the AMRAP group experienced an increase of 7% and the EMOM group experienced an increase of 7%. it can be concluded that FOR TIME's core strength experienced a significant increase in the AMRAP group, which was greater than that of the EMOM group and the FOR TIME group. The following can be explained in the graph below:

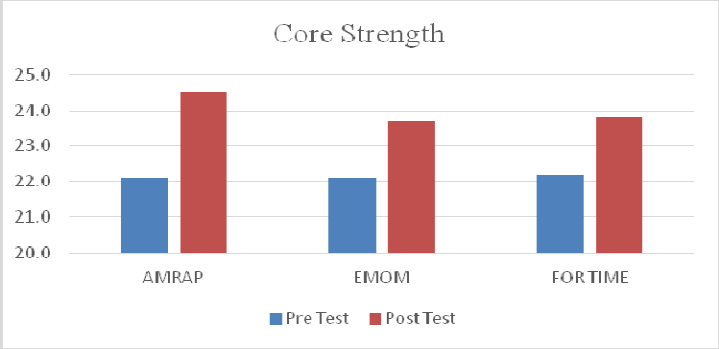

Fig 2. Graph of Data Acquisition of Pre test and Post Test Core Strength

Table 4. Acquisition Data of Pre-test and Post-test of Cardiovascular Endurance

Group	N	*Pre Test*	*Post Test*	*Difference*
AMRAP	10	*Mean = 43,1900* SD = 4,63740	*Mean = 45,8800* SD = 4,00633	*Mean = 2,69* SD = 0,63107
EMOM	10	*Mean = 44,4200* SD = 3,94090	*Mean = 45,4200* SD = 3,98157	*Mean = 1,6* SD = 0
FOR TIME	10	*Mean = 43, 8700* SD =4,23689	*Mean = 45,3000* SD = 4,17639	*Mean = 1,6* SD = 0,27803

From the results (Table 4) of the data on the cardiovascular endurance variable in the AMRAP group after being given treatment for six weeks, it showed an increase of 6%, the AMRAP group experienced an increase of 2% and the EMOM group experienced an increase of 3%. it can be concluded that the cardiovascular endurance of FOR-TIME experienced a significant increase in the AMRAP group, which was greater than that of the EMOM group and the FOR-TIME group. The following can be explained in the graph below:

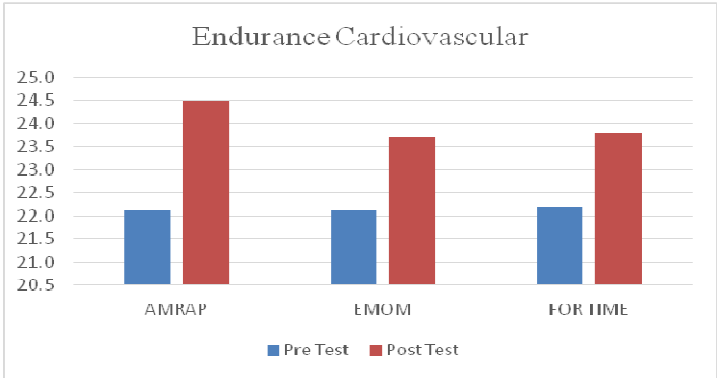

Fig 2. Graph of Data Acquisition of Pre test and Post Test Endurance Cardiovascular

Based on the results of the analysis in table 1, table 2, table 3 above, the data can be interpreted as follows:

a. Given the AMRAP training model there was no significant difference in leg muscle strength to the EMOM group, the magnitude of the difference between the AMRAP and EMOM training models was 4.9500 with a significance of 0.630.

b. Given the AMRAP training model there was no significant difference in leg muscle strength to the FOR-TIME group, the magnitude of the difference between the AMRAP and FOR TIME training models was 8.3700 with a significance of 0.417.
c. Given the EMOM training model there was no significant difference in leg muscle strength to the FOR-TIME group, the magnitude of the difference between the EMOM and FOR TIME training models was 3.4200 with a significance of 0.739.
d. Given the AMRAP training model there was no significant difference in abdominal muscle strength to the EMOM group, the magnitude of the difference between the AMRAP and EMOM training models was 0.8000 with a significance of 0.617.
e. Given the AMRAP training model there was no significant difference in abdominal muscle strength to the FOR-TIME group, the magnitude of the difference between the AMRAP and FOR TIME training models was 0.7000 with a significance of 0.662.
f. Given the EMOM training model there was no significant difference in abdominal muscle strength to the FOR-TIME group, the magnitude of the difference between the EMOM and FOR TIME training models was 0.1000 with a significance of 0.950.
g. Given the AMRAP training model there was no significant difference in cardiovascular endurance to the EMOM group, the magnitude of the difference between the AMRAP and EMOM training models was 0.4600 with a significance of 0.803.
h. Given the AMRAP training model there was no significant difference in cardiovascular endurance to the FORTIME group, the magnitude of the difference between the AMRAP and FOR TIME training models was 0.5800 with a significance of 0.752.
i. Given the EMOM training model there was no significant difference in cardiovascular endurance to the FOR-TIME group, the magnitude of the difference between the EMOM and FOR TIME training models was 0.1200 with a significance of 0.948.

Furthermore, to make it easier to read the post hoc analysis that has been done, the following will clarify the differences in data for each group with the variables used.

Table 5. Post Hoc Test Summary

No	Variable	Difference	*p*
1	Leg Strength	*AMRAP >< EMOM*	0,630
		AMRAP >< FOR TIME	0,417
		EMOM >< FOR TIME	0,739
2	Core Strength	*AMRAP >< EMOM*	0,617
		AMRAP >< FOR TIME	0,662
		EMOM >< FOR TIME	0,950
3	Endurance Cardiovascular	*AMRAP >< EMOM*	0,802
		AMRAP >< FOR TIME	0,752
		EMOM >< FOR TIME	0,948

The explanation from table 4 means that the AMRAP and EMOM training model groups did not have a significant difference in increasing leg muscle strength due to the p-value level > 0.05, in the AMRAP and FOR TIME training models there was a significant difference seen from the p-value level <0.05. Core strength did not have a significant difference from the AMRAP, EMOM and FOR TIME groups and there was no significant difference between AMRAP, EMOM and FOR TIME in increasing cardiovascular endurance.

Dicussion

Relationship between Functional Strength Training (FST) Exercise and Physical Components of Cardiovascular Endurance, Core Strength and Leg Muscle Strength FST or an abbreviation of functional strength training is a weight training model using external weights or body weights as a medium for training cardiovascular strength and endurance or in its definition as a form of training method that uses high intensity or training loads but with a circuit model. using body weight as the load of the exercise. If viewed from a physiological aspect, energy metabolism when athletes do training and matches is one of the keys to improving performance and maintaining it (Grassman, 2010). However, if examined more deeply, there are various limitations that can hinder this aspect. This certainly has an impact on prolonged fatigue which can reduce performance and achievement.

Exercise in physical activity is generally separated into two aspects of metabolism, namely aerobic and anaerobic (Asher, 2015). These exercises of course aim to improve aspects of physical condition, especially cardiovascular endurance, preventing and slowing down fatigue that is achieved during matches. Time constraints and tight match schedules carried out by an athlete make coaches have to make exercises that are practical and applicable, safe, effective and efficient. Furthermore, trainers must make training effective and efficient (Anthony, 2021).

Usually, exercises that use dominant anaerobic energy such as weight training and exercises that use dominant aerobic energy are carried out separately. Usually, weight training is carried out 2-3 times a week, ranging from an intensity of 40% to 80% of the maximum load. In addition, exercise with the aim of increasing aerobic energy is recommended with an intensity of 150 minutes per week with a moderate intensity of 40% to 60%.

Although this training protocol is scientifically proven to improve the physical condition of cardiovascular strength and endurance in athletes (Dantas, 2018). However, the reality is that there is no full time to do one exercise with another due to the increasingly dense competitive climate in this modern sports era. In designing a bosu exercise program, there are several contraindications that should be avoided in its implementation, such as people who are overweight, obese, have not been exercising for a long time, a history of previous injuries and people who have a history of diseases such as high blood pressure, heart disease (Daniel, 2021). This is because bosu exercises cause isometric contractions, which can cause valsalva maneuvers in the body (Brooks, 2015).

For the selection of types of exercise, recommendations from Jefrey (2017), Selenica (2022) argue that exercise should be able to initiate an increase in strength in all large muscle groups, use large muscle groups in the body as an adequate load in the exercise and create exercises that are balanced in the distribution of the training load (Falatic, 2015). Meanwhile, for the sequencing of exercises, it must be based on the concentric and eccentric nature of the muscles, for example upper body exercises can be followed up with lower body exercises and for the number of exercises in one form of circuit training (Craig, 2021). According to a literature review, as many as 6 to 12 exercises can be done, but there is no exact number in the number of exercises (Box, 2019).

In this study, the variables studied were the increase in leg muscle strength, core strength and cardiovascular endurance. Fundamentally, every human body is equipped with basic sensory capabilities to maintain muscle strength so that everyone is able to maintain body stability in simple daily movements (Angel, 2015) such as walking, running, pushing, jumping and others. The results of the study obtained good results and had a significant effect on increasing strength.

Conclusions

Based on the results of trials on samples from the running community in Surabaya, it was concluded that there was a significant effect of AMRAP training on leg muscle strength, abdominal muscle strength and cardiovascular endurance, namely there was an increase in the variables of abdominal muscle strength, leg muscle strength and cardiovascular endurance. The results obtained in KOT have an increase with the highest percentage compared to other variables, which is 22%, this is evidenced by the average pre-test result of 91.20 and post-test of 103.95. While the gain on KOP has the lowest increase of 12% as evidenced by the average pre-test results of 22.10 and 24.50 post-test. So that in the AMRAP group after being given treatment for six weeks, it showed an increase, it can be concluded that leg muscle strength > Cardiovascular Endurance > Core strength.

Effect of FST EMOM on leg muscle strength, abdominal strength and cardiovascular endurance. Based on the results of trials on samples from the running community in Surabaya, it was concluded that there was a significant effect of EMOM training on leg muscle strength, abdominal muscle strength and cardiovascular endurance, namely there was an increase in the variables of core strength, leg muscle strength and cardiovascular endurance. The results obtained in KOT have an increase with the highest percentage compared to other variables, which is 36%, this is evidenced by the average pre-test result of 86.00 and post-test of 99.00. While the gain on KOP has the lowest increase of 18% as evidenced by the average pre-test result of 22.10 and post-test of 23.70. So that in the AMRAP group after being given treatment for six weeks, it showed an increase, it can be concluded that leg muscle strength > Cardiovascular endurance > Core strength.

Effect of FST FOR TIME on leg muscle strength, abdominal strength and cardiovascular endurance. Based on the results of trials on samples from the running community in Surabaya, it was concluded that there was a significant effect of FOR TIME training on leg muscle strength, abdominal muscle strength and cardiovascular endurance, namely there was an increase in the variables of abdominal muscle strength, leg muscle strength and cardiovascular endurance. The results obtained in KOT have an increase with the highest percentage compared to other variables, which is equal to 35%, this is evidenced by the average pre-test results of 89.25 and post-test of 95.58. While the gain on KOP has the lowest increase of 15% as evidenced by the average pre-test results of 22.20 and 23.80 post-test. So that in the AMRAP group after being given treatment for six weeks, it showed an increase, it can be concluded that leg muscle strength > Cardiovascular Endurance > Abdominal muscle strength.

Differences in the effect of AMRAP, EMOM and FOR TIME exercises. Each group has an influence on the increase in the variables used, but the magnitude of the increase in each group is different. There are three models of functional training used in this study, including FST AMRAP, FST FORTIME and FST EMOM. Each ratio has different characteristics for each variable used. The effectiveness ratio for each variable is also different. The AMRAP FST model is effectively used to increase cardiovascular endurance, because it requires a shorter rest time. If the break is used too long it will reduce the effect of the treatment because AMRAP is considered high intensity.

The FST FORTIME model increases abdominal muscle strength the most because it doesn't require fast rest intervals. FST EMOM increased the most in the components of leg muscle strength.

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