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Body Weight Training Therapy: An Effective Way to Improve Cardiac Lung Endurance and Flexibility After Shin Splint Injury

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ABSTRACT: The culture of running has spread throughout the world, this can be seen from various running events in various parts of the world from the 5K, 10K, Half Marathon and Full Marathon categories. Every runner has the same chance of experiencing the risk of injury, one of which is shin splints. Shin splints are injuries that are often experienced by runners caused by repeated running on hard surfaces or excessive and hard use of the leg flexors.

When someone experiences an injury, there will automatically be a decrease in physical fitness, especially the physical fitness of the health component. The most important components in the post-injury phase are heart lung endurance and flexibility. Heart lung endurance will help someone supply oxygen throughout the body and flexibility will help someone in performing joint movements freely. Choosing the right therapy during and after an injury is the main key to restoring a runner's performance.

This study used a quasi-experimental method with one group pretest-posttest design. The population in this study were 96 runners who were members of a running community in Yogyakarta. The sampling technique in this study used purposive sampling with inclusion and exclusion criteria totaling 30 people. The treatment was carried out 24 times with a frequency of 4 times a week. The instruments in this study were a 12-minute run or cooper test to measure heart lung endurance and a goniometer to measure joint flexibility.

The results of this study are that the exercise therapy program has been proven to increase cardiopulmonary endurance through an increase in running values of 16.41% and can increase flexibility in knee and ankle ROM with an average increase in ROM of 41.52%. Exercise therapy using body weights can increase cardiopulmonary endurance and flexibility after shin splint injury..

KEYWORDS: Body Weight Training, Cardiac Lung Endurance, Flexibility, Shin Splint

I. INTRODUCTION

Sports are referred to as systematic and structured musculoskeletal system activities by considering the frequency, intensity, type and time that has been determined (Yulienugroho, 2018). Sports with various characteristics can be done individually or in groups, either used for the purpose of improving performance or for recreation. One of the most popular sports in the world, including in Indonesia, is running (Ridwan et al., 2024). Sports can be interpreted as measurable and targeted physical activities to improve a person's physical fitness, one of which is running.

Running is one of the most popular sports in the world. The culture of running has spread throughout the world, this can be seen from the many various running events or competitions held in various parts of the world with seven major marathon events, namely: Tokyo Marathon, Boston Marathon, London Marathon, Sydney Marathon, Berlin Marathon, Chicago Marathon and New York Marathon. In Indonesia, the culture of running has also spread nationally and the largest is the Borobudur Marathon. The running numbers offered range from 5K, 10K, Half Marathon and Full Marathon. The success of runners in participating in running events can be influenced by several factors, such as technical, physical and mental factors (Ridwan et al., 2023)prime level of physical fitness or a fairly high level of fitness to be able to complete the numbers in a running event (Zulkarnain & Nugraha, 2023).

Poor physical fitness, unpreparedness of runners, and excessive use can cause injuries to runners. Injuries to runners can usually also be caused by inadequate muscle strength and flexibility, functional irregularities of structural tissues, uneven surfaces, use of inappropriate shoes or footwear, and inefficient running patterns (Jannah et al., 2022). In relation to injuries to runners with various underlying factors, regular evaluation and training are needed to maintain the athlete's fitness level and improve athlete performance to avoid repeated injuries.

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Injuries in runners that often occur such as patellofemoral pain, Achilles tendinitis, plantar fasciitis, ITB syndrome, shin splints and others. In runners, injuries that often occur due to excessive exercise loads (overtraining) on the lower legs are Shin Splints. According to the American Medical Association's Nomenclature of Athletic Injuries, shin splints are pain and discomfort in the legs caused by repeated jogging on hard surfaces or excessive and hard use of the leg flexors. Most runners experience pain around the inner shin bone at some point, among athletes this condition is known as "shin splints" (N. S. J. Deshmukh et al., 2022). Shin splints that are not treated immediately can have serious consequences, including fractures. Given the large number of cases of injury in athletes, especially runners with shin splint injuries, a strategy is needed to reduce injuries in runners and increase heart and lung endurance and flexibility levels in athletes after shin splint injuries through various physical exercises, one of which is using body weight training therapy.

Weight training is chosen as an exercise therapy to increase heart lung endurance and muscle strength in the form of isometric, isotonic and isokinetic exercises. This exercise is done using weights in the form of equipment or without equipment with your own body weight which is carried out systematically according to the procedures on various targeted muscles of the body (Afiyan et al., 2023). Weight training can be used to improve physical fitness, heart lung endurance and increase muscle flexibility in each individual, especially in athletes (Archila et al., 2021). Weight training is important for athletes to do in order to reduce the recurrence of injuries and to improve athlete performance.

The deep weight training applied in this study uses body weight with variations of basic exercises such as squats, lunges, sumo squats, calf rises, push-ups, back ups, up down planks, sit-ups and chair deeps that have been adjusted to the needs when running. The advantages of deep weight training therapy are that it is cheap and easy to do. This exercise therapy aims to determine the level of effectiveness of deep weight training to increase heart lung endurance and flexibility in runners after shin splint injuries. The urgency of this study is to provide knowledge to the general public, especially runners after shin splint injuries, so that they can quickly return to their best performance.

II. METHOD

A. Procedure

The training was given for 6 weeks with a frequency of 4 training sessions per week or 24 meetings.

B. Sample

The population in this study was 96 people who were registered as members of the Yogyakarta running community. The research sample was 30 people. people determined by *purposive sampling method*, with the following criteria: 1) runners aged 20-40 years, 2) healthy or not currently sick or undergoing treatment for illness, 3) have experienced shin splint injuries 4) body weight in the normal category, 5) willing to follow all the training given.

C. Data Analysis Instruments and Techniques

The instrument used in this study was a 12-minute run or *cooper test* which aims to measure heart lung endurance. This instrument has a validity value of 0.744 and a reliability value of this instrument is 0.697. Goniometer to measure flexibility or range of motion (ROM) of joints. The data collection technique used in this study used the *pretest-posttest* research data instrument. Data analysis used in this study used descriptive analysis, statistical analysis and effectiveness testing using the paired t test formula.

III. RESULTS AND DISCUSSION

Data collected based on intervention and recording of 12-minute running measurement results as follows:

A. Descriptive Analysis

Pretest data conducted before treatment was given and posttest data was obtained when the sample had been given treatment. The following is a descriptive analysis of the pretest and posttest:

1. ROM Data

ROM data on the sample was obtained using a goniometer measuring instrument to obtain pretest and posttest data. The following is the ROM data on the research sample:

a. Knee ROM

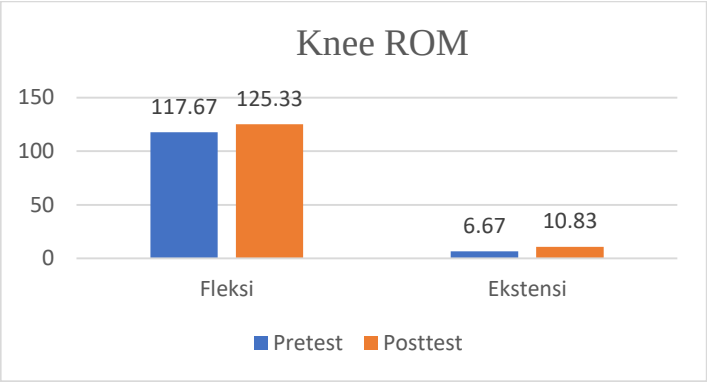


Figure 1. Average Knee ROM Values

Figure 1 on the knee ROM shows an increase in the average value of the pretest and posttest data of the knee joint flexion extension movement. The average in the pretest flexion movement was 117.67 and the posttest flexion was 125.33 at that value the average increase was 7.66. The average in the pretest extension movement was 6.67 and the posttest extension was 10.83 at that value the average increase was 4.16.

b. ROM Ankle

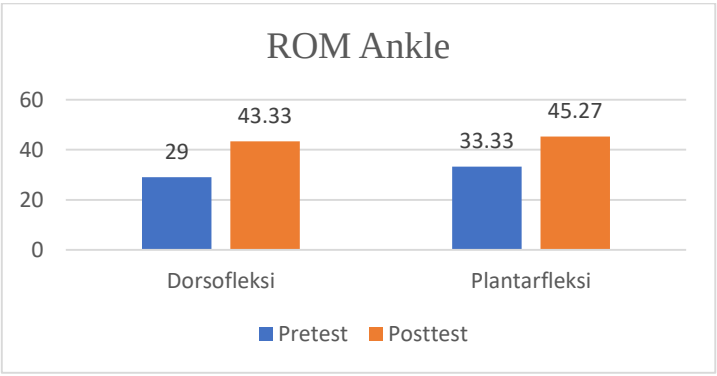


Figure 2. Average Ankle ROM Values

Figure 2 on ankle ROM shows an increase in the average value of the pretest and posttest data of ankle joint dorsiflexion and plantarflexion movements. The average for the pretest dorsiflexion movement was 29 and the posttest dorsiflexion was 43.33 with an average increase of 14.33. The average for the pretest plantarflexion movement was 33.33 and the posttest plantarflexion was 45.27 with an average increase of 11.94.

2. Weight Training Data

The deep weight training data was obtained from the results of a 12-minute run test. The following is the 12-minute run data.

Table 1. Pretest and Posttest Results of Body Weight Training with 12 Minutes of Running

No	Pretest Results	Mark	Posttest Results	Mark	Difference
1	2470	50	2700	61	230
2	2400	52	2560	57	160
3	2510	55	2750	65	240
4	2350	54	2510	67	160
5	2500	57	2755	68	255
6	2610	54	2870	64	260
7	2510	56	2780	63	270
8	2540	53	2810	70	270
9	2620	61	2800	58	180
10	2550	54	2802	65	252

No	Pretest Results	Mark	Posttest Results	Mark	Difference
11	2400	50	2630	70	230
12	2550	58	2780	72	230
13	2340	49	2600	61	260
14	2580	59	2860	54	280
15	2560	50	2700	56	140
16	2480	55	2715	65	235
17	2510	56	2745	63	235
18	2300	53	2595	68	295
19	2550	58	2820	70	270
20	2698	66	2850	56	152
21	2580	59	2808	59	228
22	2587	51	2740	56	153
23	2200	48	2490	63	290
24	2350	50	2655	61	305
25	2400	48	2580	62	180
26	2560	59	2745	63	185
27	2300	48	2550	60	250
28	2100	47	2400	56	300
29	2460	51	2620	62	160
30	2450	53	2695	64	245
Average	2467,166667	53.8	2697,166667	62.63333333	230
Min	2100	47	2400	54	140
Max	2698	66	2870	72	305

Table 1 shows that the results of the pretest and posttest measurements of weight training using a 12-minute run showed an average difference of 230 meters. Based on the results and values of the 12-minute run, it can be concluded that there was an increase in the average value after weight training was carried out.

B. Paired Sample t-Test

Analysis in research This using paired sample t-test. This test aims to determine whether there is a difference in the pretest and posttest data after weight training was carried out on 30 samples for 24 meetings. The decision making for the paired t-test is, if the p value <0.05 then it indicates a significant difference, while if the p value> 0.05 then it indicates no difference. The following This served table t-test results:

Table 2. Paired t-test Result

Variables	Sig.	Distribution
12 Minute Run Results	0,000	Significant
12 Minute Run Value	0,000	Significant
Knee Flexion ROM	0,000	Significant
Knee Extension ROM	0,000	Significant
Ankle Flexion ROM	0,000	Significant
Ankle Extension ROM	0,000	Significant

Table 2 Hypothesis test results using paired t-test obtained mark significant in every test variable with sig value <0.05 which can conclude that there is significant difference between pretest and posttest results. Differences the caused by exercise burden in with 12-minute run.

C. Effectiveness Test

1. 12 Minute Run

The percentage of effectiveness of the weight training treatment on cardiopulmonary endurance can be seen from the 12-minute run value. This result is calculated based on the average value of *the pretest* and *posttest* using the N-Gain formula. Through the calculation of effectiveness, the following values are obtained:

$$\text{Efektivitas} = \frac{Posttest - Pretest}{Pretest}\ x\ 100\%$$

$$\text{Efektivitas} = \frac{62{,}63 - 53{,}8}{53{,}8}\ x\ 100\% = 16{,}41\%$$

The percentage of effectiveness of 12-minute running for 24 meetings in increasing heart and lung endurance obtained an effectiveness value of 16.41%.

2. Range of Motion (ROM)

The percentage of effectiveness of deep weight training treatment on increasing joint flexibility can be known through increasing range of motion in the joints, increasing ROM is calculated based on the average value of *the pretest* and *posttest* using the N-Gain formula. Through the calculation of effectiveness, the following values are obtained:

a. Knee Flexion

$$\text{Efektivitas} = \frac{Posttest - Pretest}{Pretest}\ x\ 100\%$$

$$\text{Efektivitas} = \frac{125{,}33 - 117{,}67}{117{,}67}\ x\ 100\% = 6{,}5\%$$

The percentage of effectiveness of increasing knee flexion ROM based on the formula obtained an effectiveness value of 6.5%.

b. Knee Extension

$$\text{Efektivitas} = \frac{Posttest - Pretest}{Pretest}\ x\ 100\%$$

$$\text{Efektivitas} = \frac{10{,}83 - 6{,}67}{6{,}67}\ x\ 100\% = 62{,}36\%$$

The percentage of effectiveness of increasing knee extension ROM based on the formula obtained an effectiveness value of 62.36%.

c. Ankle Dorsoflexion

$$\text{Efektivitas} = \frac{Posttest - Pretest}{Pretest}\ x\ 100\%$$

$$\text{Efektivitas} = \frac{43{,}33 - 29}{29}\ x\ 100\% = 49{,}41\%$$

The percentage of effectiveness of increasing ankle dorsiflexion ROM based on the formula obtained an effectiveness value of 49.41%.

d. Ankle Plantarflexion

$$\text{Efektivitas} = \frac{Posttest - Pretest}{Pretest}\ x\ 100\%$$

$$\text{Efektivitas} = \frac{45{,}27 - 33{,}33}{33{,}33}\ x\ 100\% = 47{,}82\%$$

The percentage of effectiveness of increasing ankle plantar flexion ROM based on the formula obtained an effectiveness value of 47.82%.

The average value of the overall ROM effectiveness test results on the knee and ankle joints obtained an average value of ROM improvement effectiveness of 41.52%. This average value shows an effective value in increasing ROM and can increase joint flexibility in post-shin splint athlete runners and have followed the exercise therapy program for 24 meetings.

Based on the research results obtained, that weight training using body weight itself in runners has good results during treatment. Based on the results of weight training on increasing heart lung endurance and flexibility of runners in each individual,

it can be seen to have a good effect due to changes in results with an increase in value from before being given weight training treatment and after weight training. The results of this increase in value can be said to be effective in increasing heart lung endurance through increasing running results from 66 meters to 72 meters. Increased flexibility in runners can be seen through increased ROM in the knee joints and ankle joints in runners. The average increase in flexibility through increased ROM obtained a value of 41.52% which indirectly weight training in running 12 minutes can increase flexibility in runners.

Injuries are one of the causes of decreased cardiopulmonary endurance and flexibility in runners. The most common injuries among runners are calves, shin splints, iliotibial band syndrome, plantar fasciitis and hamstrings (Agustin & Puspitasari, 2022). The most common type of injury among runners is shin splints (N. S. Deshmukh & Phansopkar, 2022).

Shin splints or also known as Medial Tibial Stress Syndrome (MTSS) are injuries that are most often described as leg pain due to activity along the shin, this condition is caused by inflammation of the muscles, tendons, and bone tissue structures (N. S. Deshmukh & Phansopkar, 2022). Shin splint injuries can be caused by overuse by runners (Becker et al., 2018). Shin splint injuries in runners have a percentage of 60% (Naderi et al., 2020). Runners who suffer from shin splint injuries have decreased performance, especially in terms of cardiopulmonary endurance and athlete flexibility.

Strength, endurance, and flexibility are the main components possessed by runners (Mahbubi et al., 2021). Post-shin splint injury, cardiopulmonary endurance and flexibility are one of the main components that can be improved in runners. Cardiopulmonary endurance is the body's ability to reduce fatigue when doing activities in free time. This condition is very important to ensure that the heart, respiration, blood circulation, and blood circulation function at peak efficiency, especially in runners (Bolung et al., 2024; Zulheri Is & Septi Hariansyah, 2020). Flexibility itself is the body's capacity to move freely, maximally and without limitations (Mahbubi et al., 2021). Cardiopulmonary endurance and flexibility in runners are very important to improve athlete performance and support their participation in running events and improve athlete achievement. Runners who experience injuries or post-shin splint injuries need physical activity or exercise to rebuild their cardiopulmonary endurance and flexibility. One of the physical activities that can be done by runners is weight training.

Internal weight training or body weight training is an exercise that emphasizes how to exercise using the weight of your own body (Wahyuntoro & Rismayanthi, 2019). Exercise using your own body weight is an effective exercise that can be done anywhere, anytime without having to spend excessive costs. One of the body weight training that can be done is a 12-minute run which aims to increase heart lung endurance and flexibility in athletes (Kristi et al., 2023). The 12-minute run is in accordance with the goals to be achieved by athletes, especially those who have injuries or post-shin splint injuries to restore performance.

Physical activity by doing body weight training or body weight training can restore physical condition faster after an injury (Kartika et al., 2023). The main components after injury in running athletes have been shown to increase with body weight training with body weight using a 12-minute running instrument aimed at strengthening the heart, lung and flexibility components. Weight training with a 12-minute run can improve physical fitness, which is one of the right strategies in post-injury recovery. Through regular 12-minute running or cooper test training, you can build strength, speed and muscle endurance so that you can have the ability to recover quickly after an injury because you have good VO2 Max (Kartika et al., 2023).

Weight training using a 12-minute running instrument or cooper test for 24 meetings with 4 training sessions a week has proven effective in increasing heart lung endurance which can be seen from the results of the analysis of 24 running exercises which showed an increase. This exercise has also proven effective in increasing athlete flexibility through ROM measurements carried out on the knee and ankle joints.

IV. CONCLUSIONS

Based on the results of the study, it can be concluded that deep weight training is proven to be effective in increasing cardiopulmonary endurance and flexibility after shin splint injury. This result can be proven by the increase in running and ROM test results in the study sample. Deep weight training can increase cardiopulmonary endurance through an increase in running values of 16.41% and can increase flexibility in knee and ankle ROM with an average increase in ROM of 41.52%.

The results of this study can be a means to conduct deep weight training with the aim of increasing heart lung endurance and flexibility for runners and the general public. Positive results in this study can have different situations for each individual with their respective fitness levels, for that, consultation of training or training programs can be carried out with medical personnel in their fields in order to adjust the exercise therapy program according to personal needs with the aim of increasing heart lung endurance and flexibility in the body.

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