

Bodyweight Circuit Training for Basketball Beginner Athletes' Aerobic Endurance

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Abstract—This research aims to study: (1) the effect of circuit training and rest between 2-minutes and 3-minutes circuit on basketball athletes' aerobic endurance, (2) the effect of gender on basketball athletes' aerobic endurance, and (3) the interaction between circuit training (2-minutes and 3-minutes rest) and gender (male and female) on basketball athletes' aerobic endurance. This research applied an experiment method with a 2x2 factorial design. There were differences between the 2-minutes rest and 3-minutes rest on male and female aerobic groups. In overall, there is an increased aerobic ability with circuit training and 2-minutes and 3-minutes rest between sets in either male or female group. However, 3-minutes rest causes the aerobic ability to increase more.

Keywords—circuit training, rest, aerobic endurance.

I. INTRODUCTION

Aggressive, quick, active, and explosive characteristics of basketball [1] should be surely supported by good physical abilities. One of that is aerobic endurance. The reason is that group sports demand its players to have a high aerobic fitness level, hence facilitating anaerobic performances from the implementation of high movement intensity during matches [2]. Endurance training is one of the dominant trainings to improve athlete performances to face matches [3].

One of the training methods used to train aerobic endurance is the circuit training method [4]. Basically, the training method is designed to train and improve general fitness as muscular strength, power, muscular endurance, general endurance [5], [6], speed, strength, and activeness [7]. Therefore, it can be used as one of the training methods to improve physical conditions [8]. In this circuit training, the variable between-set time was manipulated to analyze the effect of 2-minutes and 3-minutes rest between set on aerobic abilities. If the repetition of one set of training was conducted before three minutes of healing time, the source of ATP re-synthesis would improve. In this condition, muscles worked by using anaerobic glycolysis energy to create ATP. Anaerobic glycolysis was similar to the phosphagen system that would generate lactate accumulation on active muscles [9]. However, on the other side, rest with a slight difference as two and three minutes was claimed not to have a contrastive difference, such as during squats for muscular strength. In fact, 2-minutes and 4-minutes rest did not significantly influence muscular strength [10].

II. METHODS

A. Research Type

The research method applied was the experiment method using the 2x2 factorial design. In this research, a preliminary test was given to every group and ended by the final test

B. Research Time and Location

This research was conducted in February-March 2018. The training was done eighteen times and the frequency was 3 times a week. The training duration was about 45 minutes each. The research was performed in GOR Bola Basket GMC Arena Cirebon.

C. Population and Sample

The research population was 248 16-years-old male and female basketball athletes that had routinely participated the training for two years. Furthermore, the sample used in this research consisted of 24 male and female basketball beginner athletes (twelve athletes for each category).

TABLE I. DESIGN OF 2x2 FACTORIAL RESEARCH

Circuit Training (A) Gender (B)	2-minutes Rest (A1)	3-minutes Rest (A2)
Male (B1)	A1B1	A2B1
Female (B2)	A1B2	A2B2

Information:

- A1B1 : Male athlete group given circuit training with 2-minutes rest between sets.
- A2B1 : Male athlete group given circuit training with 3-minutes rest between sets.
- A1B2 : Female athlete group given circuit training with 2-minutes rest between sets.
- A2B2 : Female athlete group given circuit training with 3-minutes rest between sets.

D. Data Collection Technique and Instrument

Data was collected during the preliminary and final tests; while instrument used to measure the ability of aerobic endurance was 20-meters multistage fitness test.

E. Data Analysis Technique

Data analysis technique applied in this research was by using SPSS 19 and two-ways ANOVA at the significance level $\alpha < 0.05$.

F. Circuit Training Program

Training intensity at each post that was thirty seconds to perform exercises with interval rest between posts which was 10-15 seconds were proven to be able to continuously managed by athletes. Athletes could observe this by checking their training pulses [29] manually or by using a heart rate monitor.

The total time used for training and circuit repetition was as follows:

- During the first and second week, the total time used for training at each circuit was six minutes with two repetition sets.
- During the third and fourth week, the total time used for training at each circuit was six minutes with three repetition sets.
- During the fifth and sixth week, the total time used for training at each circuit was six minutes with four repetition sets.

Exercise types used in this research were:

1. 10-meters shuttle run
2. Push up
3. Back up
4. Sit up
5. Lunge
6. Plank
7. 5-meters slide defense
8. Squat trust

III. FINDINGS AND DISCUSSION

TABLE II. DATA OF AEROBIC ENDURANCE PRETEST AND POSTTEST RESULTS

NO.	MALE GROUP					
	CIRCUIT TRAINING 2-MINUTEST REST			CIRCUIT TRAINING 3-MINUTEST REST		
	Pre test	Post test	Difference	Pre test	Post test	Difference
1	40.2	44.3	4.1	42.3	48.2	5.9
2	38.2	43.7	5.5	43.7	50.5	6.8
3	36.1	39.5	3.4	43.0	49.2	6.2
4	39.2	40.8	1.6	39.2	45.4	6.2
5	40.2	41.5	1.3	41.1	44.9	3.8
6	40.8	42.0	1.2	39.5	43.0	3.5
Difference	2.9			5.4		
NO.	FEMALE GROUP					
	CIRCUIT TRAINING 2-MINUTEST REST			CIRCUIT TRAINING 3-MINUTEST REST		
	Pre test	Post test	Difference	Pre test	Post test	Difference
1	40.8	44.4	3.6	37.5	40.2	2.7
2	39.5	43.0	3.5	41.1	44.4	3.3
3	38.5	42.0	3.5	39.5	44.7	5.2
4	36.8	41.5	4.7	39.2	42.3	3.1
5	38.2	40.2	2.0	40.2	43.7	3.5
6	36.8	41.5	4.7	40.2	43.0	2.8
Difference	3.7			3.4		

Data gathered in this research was the result of preliminary, final, and aerobic endurance tests. Preliminary test gave preliminary data before treatments were given to the research subject; while the final test gave research data after treatments were given to the research subject. Above is the result of pretest and posttest data from each training group.

TABLE III. STATISTICAL DESCRIPTION OF AEROBIC ENDURANCE PRETEST AND POSTTEST RESULTS

CIRCUIT TRAINING	GENDER	STATISTICS	PRE TEST	POST TEST
2-MINUTES REST	MALE (A1B1)	Total	234.7	251.8
		Mean	39.1	42
		SD	1.73944	1.79518
	FEMALE (A1B2)	Total	230.6	252.6
		Mean	38.43	42.1
		SD	1.55778	1.44499
3-MINUTES REST	MALE (A2B1)	Total	248.8	281.2
		Mean	41.5	46.9
		SD	1.85329	2.87727
	FEMALE (A2B2)	Total	237.7	258.3
		Mean	39.62	43.1
		SD	1.22868	1.65257

A. Result of Hypothesis Testing

1. Effect of Circuit Training with 2-minutes and 3-minutes Resting Time between Circuits on Basketball Athletes' Aerobic Endurance

From the statistical testing by using two-ways ANOVA, we derived the sig level of $0.002 \leq 0.05$ (see Table 4), implying that H_0 was rejected; while H_a was accepted. It meant that there was a relation between circuit training with 2-minutes and 3-minutes rest and basketball beginner athletes' aerobic endurance.

TABLE IV. RESULTS OF STATISTICAL TESTING BY USING TWO-WAYS ANOVA ON CIRCUIT TRAINING WITH 2-MINUTES AND 3-MINUTES REST ON AEROBIC ENDURANCE.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Training	51.334	1	51.334	12.582	.002

2. Gender Influence on Basketball Athletes' Aerobic Endurance

From the statistical testing by using two-ways ANOVA, we derived the sig level of $0.037 \leq 0.05$ (see Table 5), implying that H_0 was rejected; while H_a was accepted. It indicated that gender difference affected aerobic endurance.

TABLE V. RESULTS OF STATISTICAL TESTING BY USING TWO-WAYS ANOVA ON GENDER INFLUENCE ON AEROBIC ENDURANCE

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Gender	20.350	1	20.350	4.988	.037

3. Interaction between Circuit Training (2-minutes and 3-minutes Rest) and Gender (Male and Female) on Basketball Athletes' Aerobic Endurance

From the statistical testing by using two-ways ANOVA, we derived the sig level of $0.027 \leq 0.05$ (see Table 6), suggesting that H_0 was rejected; while H_a was accepted. It implied that in circuit training, 2-minutes and 3-minutes resting time and gender, influenced basketball beginner athletes' aerobic endurance.

TABLE VI. RESULTS OF STATISTICAL TESTING BY USING TWO-WAYS ANOVA ON INTERACTION BETWEEN CIRCUIT TRAINING AND GENDER ON AEROBIC ENDURANCE

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Training*Gender	23.404	1	23.404	5.736	.027

B. Discussion

1. Endurance training, power development, and 3-minutes rest between sets could prevent excessive fatigue and saved more energy, especially for sports requiring skills [11][12]. Furthermore, when performing training to optimally develop power, athletes were suggested to take a rest for three minutes between sets to avoid any downgraded performance in each repetition. Abilities to manage repetition by always maintaining a stable intensity at a high training volume could provide more benefits to muscular strength [13, 14].

If repetition of one set of training was conducted three minutes before healing time, then the source of ATP re-synthesis would improve. In this condition, muscles would work by applying the anaerobic glycolysis energy system to produce ATP. Anaerobic glycolysis was similar to phosphagen system creating lactate accumulation on active muscles. Acid lactate would disturb both ATP re-synthesis and metabolism. Therefore, accumulating acid lactate would impede energy supply on active muscles [9]. It would also disturb the execution of motion tasks. It needed three minutes to make ATP return to 100% [4], so that interval rest between set should be designed longer for the phosphocreatine re-synthesis process and consistence in performing motion tasks [10].

2. Sex difference had been identified as the key factor in terms of physical performances observed from the body height, body weight, body fat, muscular mass, aerobic capacity and anaerobic threshold as the result of genetic factor and hormonal differences [15, 16, 17]. Furthermore, from taxonomic points of view, after both male and female taxonomy was generally measured, the result proved that men had better motion speed, precision control, body motion coordination, reaction time [18, 19] than female.

Gender differences could be understood and defined better on the sport activities and motor skills. Men had

anthropometric factors, high concentration due to their sexual hormones, and anabolic actions, causing them to have bigger muscular hypertrophy [20]. There were biological differences found between men and women as higher testosterone, more hemoglobin content and muscular mass, and less fat were in men than that in women [21, 22]. It generated bigger aerobic and anaerobic energy systems, causing power production of men to be bigger than that of women [23, 28].

Besides, men had more muscular mass in their upper body than women. The largest ratio of gender differences was in muscular mass and upper body strength, especially the arm [24, 25], so that the muscular mass did not only affect the capacity to create power and energy, but also the execution of motion task and technical mastering. Another difference was that men had better power output in general or in upper body and less lean mass in general or in upper body and arms than women. Such differences cause men to have better power and aerobic capacity peak than women [26].

In conclusion, gender differences were indeed influenced by physiological mechanism, especially in energy consumption [27, 20].

3. Referring to the results of statistical testing by using Two-ways ANOVA and further testing by using the Tukey test, we figured out that circuit training (with 2-minutes and 3-minutes resting time) and gender (male and female) affected basketball beginner athletes' aerobic endurance.

IV. CONCLUSION

Referring to the results and conclusion of this research, the implication is: the research results can be regarded as a reference and consideration for coaches, athletes, or basketball advisors while designing and making training programs aiming to train and improve aerobic endurance. Therefore, trainings for improving aerobic endurance will be more effective and give expected output.

This research shows that circuit training by using an internal burden (body weight) with 3-minutes resting time can give more effective results to improve aerobic endurance for 16-years-old basketball beginner athletes.

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