Circuit training based physical condition training model to increase speed, agility, arm power, and limb muscle power of basketball athletes

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Abstract

Background and Study Aim	Basketball involves skills that must be applied dynamically, explosively and repeatedly. Players must be able to speed up and slow down with control, especially when dribbling, shooting or bouncing the ball. The purpose of the study was to test a circuit training-based physical condition training model to increase speed, agility, arm power, and leg muscle power for basketball athletes.
Material and Methods	This type of research is an experiment with two groups, namely the experimental group (n = 28) and the control group (n = 28). The samples were male athletes aged 15-18 years. Subjects had participated in competitions and all players were healthy with no history of illness or injury reported in the previous 3 months. The instruments were 20-meter running test speed, agility (Illinois Test with Dribbling the Ball), arm power (MEDBALL), and leg power (Counter Movement Jump Test). The data analysis technique was a t-test.
Results	The results of the study can be concluded that the circuit training-based physical condition training model consisting of 6 posts, is effective for increasing speed (0.017 < 0.05), agility (0.000 < 0.05), arm power (0.000 < 0.05), and leg muscle power (0.036 < 0.05) of basketball athletes. We recommend that basketball coaches consider incorporating a circuit training-based physical condition training model in training, as a simple and practical model to improve athletes' physical condition.
Conclusions	We recommend that basketball coaches consider including a circuit training-based physical condition training model in training, as a simple and practical model for improving athletes' physical condition. For researchers who intend to continue or replicate this study, it is recommended to conduct tighter control in the entire series of experiments.
Keywords:	training model, circuit training, physical condition, basketball

Introduction

Basketball is a game played by two teams, each of which consists of five players, each team tries to put the ball into the opponent's ring, and prevent the opponent from scoring. Basketball has several basic playing techniques, including shooting, dribbling, defense, pivot and others [1]. The way to get points in a basketball game is by putting the ball into the ring. Mostly to get points players have to jump to do lay ups and jump shots. This shows that players must have good jumping skills, so as to produce maximum performance. Basketball games have complex movements, meaning that the movements consist of a combination of elements of motion that are neatly coordinated. In addition, it involves skills that must be applied dynamically, explosively, and repeatedly. Basketball players must be able to speed up and slow down with control, especially when dribbling, shooting or bouncing the ball [2].

In addition to technique, the physical components that must be possessed by basketball players are such as agility, strength, endurance, coordination, balance, speed and explosive power [3]. Movement when dribbling a basketball is constantly changing, generally it can be done slowly or very quickly depending on the goals or conditions that occur when the player dribbles. The movement of a good basketball player is characterized by fast and agile movement when making attacks with dribbling the ball. Therefore, speed and agility are needed in basketball games, especially when carrying the ball to pass opposing players [4]. Good agility can prevent painful injuries.

The importance of arm power and leg muscle explosiveness in basketball is that shooting is a complex movement involving various components of physical conditions that support each other. Shooting requires synchronization between the legs, waist, shoulders, wrist strength and fingers which are interrelated and support each other. Basketball sports in jump shoot techniques, leg muscle power functions to make sudden movements and require full exertion, to get hard and directed jump shots to support the achievement of maximum shots. Leg muscles affect the ability or results of repulsion [5]. The higher a person's jump the closer to the ring, and the easier it is to enter the ball in doing lay ups.

The function of the leg muscles is to support the body and to provide an initial energy boost. Players to produce the right jump shoot need contributions from leg muscle explosiveness and balance which are expected to produce good and accurate shots [6].

Efforts to improve the achievements of basketball players, one of which is by training. Exercise is one of the factors that is very decisive in achieving sports achievements. The form of exercise chosen will also be very decisive in achieving the desired training target. Physical exercise that is done properly, measured and regularly and with adequate nutritional intake will improve fitness that can be seen or observed. Preparation of an exercise program, there needs to be an assessment of muscle contraction, exercise dosage which includes training load, number of sets, rhythm, repetitions, and recovery [7]. Basketball players rely on attributes related to speed, agility, arm power, and leg muscle power to perform key movements during on-court performances. However, the effectiveness of exercise-related training models in basketball has not been fully identified, implemented, and evaluated. One training method that can be used is circuit training.

Circuit training is an exercise program combined from several exercise items whose purpose in doing an exercise will not be boring and more efficient. Circuit training is an exercise program consisting of several stations and at each station an athlete performs a predetermined type of exercise. One circuit training is said to be complete, when an athlete has completed training at all stations in accordance with the predetermined dosage [8, 9]. Each station consists of an exercise performed for 45 seconds, and exercise repetitions between 15-20 times, rest time in one station before moving to the next station is 1 minute or less [10]. Circuit training has elements of physical condition [11]. Circuit training with aerobic and anaerobic training has synergistic effects on cardiovascular and strength [11, 12]. Circuit training can also shape the character of an athlete. Weight training can be included in the circuit training program to maximize training [13, 14]. Through circuit training the athlete's condition can be maximally formed by combining elements and other aspects of the sport. Circuit training includes exercises for speed, agility, arm power, and leg muscle power.

In our opinion, the advantages of circuit training are training heart strength and lowering blood pressure, increasing various components of physical condition simultaneously in a relatively short time, muscle power will be trained and adaptability increased, does not require expensive gym equipment, can be adjusted in various areas or training places, saves time and can be done by many people at once. Based on the background that has been stated above, the researchers are interested in conducting research on circuit training-based physical condition training models to increase the speed, agility, arm power, and leg muscle power of basketball athletes. The results of the study are expected to increase knowledge and existing training methods to be used as exercises to increase the speed, agility, arm power, and leg muscle power of basketball athletes.

Materials and Methods

Participants

This study has two groups: the experimental group (n = 28) - given a circuit training-based physical condition training mode; the control group (n = 28) - taken based on random sampling. Pretest measurements were taken. Pretest data was used to determine groups based on ordinal pairing techniques, so that the initial abilities of the experimental group and control group were not different. The samples were male athletes aged 15-18 years in basketball clubs in the Special Region of Yogyakarta, Indonesia. Subjects had participated in competitions and all players were healthy with no history of illness or injury reported in the previous 3 months.

Informed Consent: Before the study commenced, all participants and their legal guardians were provided with detailed information regarding the purpose, procedures, potential risks, and benefits of the experiment. Informed consent was obtained from both the participants and their legal guardians, ensuring that they had a comprehensive understanding of the study and voluntarily agreed to participate. The consent forms were written in a language easily understood by the participants and their legal guardians.

Ethics Committee Approval: The research protocol, including the study design, participant recruitment, and data collection procedures, was submitted to and approved by the ethics committee of university.

Research Design

This type of research is experimental. This experimental research is a study in which at least one manipulation variable will be found to study cause-and-effect relationships. Therefore, experimental research will definitely be closely related to the activity of testing a hypothesis. This is done to look for influences, relationships, and differences in changes to the group or variable being studied. The instrument to measure the pretest and posttest is a 20 meter running speed test [15], agility using the illinois test with dribbling the ball [16], arm power using seated medicine ball toss (MEDBALL) [17], and leg power using counter movement jump test [15]. Then given treatment for 18 meetings, with reps and sets increasing at each meeting. The circuit training-based physical condition training model to increase speed, agility, arm power, and leg muscle power for basketball athletes in Figure 1.

Figure 1. Circuit training-based physical condition training model.

Statistical Analysis

The statistical analysis for this study utilized the t-test as the primary statistical method. Two types of t-tests were employed: the paired sample t-test and the independent sample t-test. The significance level (alpha) was set at 0.05. Statistical techniques such as Shapiro-Wilk tests were applied to assess normality, while tests like Levene's test were used to evaluate homogeneity. The statistical analysis was conducted using the Statistical Package for the Social Sciences (SPSS) software, specifically version 21. SPSS.

Results

The results of the pretest and posttest of speed, agility, arm power, and leg muscle power of basketball athletes are presented in Table 1.

Normality Test

A test for normality is a method of determining whether the distribution of data in a sample can reasonably be attributed to a particular population with a normal distribution. Calculate this normality test with Shapiro-Wilk. Normality test results are shown in the table 2.

Based on the statistical analysis of the normality test performed using the Shapiro-Wilk test in Table 2 the results of the normality test with a value of p > 005 show that the data follows a normal distribution.

Homogeneity Test

Homogeneity test is used to test the homogeneity of a homogeneous or non-uniform sample of a population. Homogeneity test using the Levene test. A test is considered homogeneous if the p-value > 005. The results of the homogeneity test are shown in the table 3.

Based on the analysis in Table 3 using Levenes test p≥ 0.05 values were found. These results indicate that the population is equally diverse or homogeneous because there is a similar diversity in the data set.

Hypothesis Test Results

The hypothesis test of this study was analyzed with t test which is an independent paired sample test using SPSS version 21 software for hypothesis analysis. The results of hypothesis testing are explained below:

Based on the analysis results in Table 4, it can be explained that (1) the speed data obtained the t value 2.464 and p-value 0.017 <0.05, these results indicate there is a significant difference between the experimental group and the control group. The speed of the experimental group given the circuit training-based physical condition training model is better than the control group with a difference of 0.36 seconds. (2) agility data obtained t value 6.648 and p-value 0.000 <0.05, these results indicate there is a significant difference between the experimental group and the control group. The agility of the experimental group given the circuit training-based physical condition training model is better than

Table 1. Pretest and posttest of speed, agility, arm power, and leg muscle power.

Data	Experimental Group (n=28)				Control Group (n=28)			
	Pretest		Posttest		Pretest		Posttest	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Speed (s)	3.79	0.62	3.41	0.57	3.78	0.53	3.78	0.54
Agility (s)	25.64	0.48	24.46	0.81	25.64	0.47	25.63	0.46
Arm Power (m)	8.59	0.35	9.60	0.62	8.60	0.33	8.81	0.49
Limb Muscle Power (cm)	41.54	3.57	44.25	3.72	41.57	3.35	42.14	3.63

Table 2. Normality test results.

Data	Experimental Group (n=28)		Control Group (n=28)	
	Pretest	Posttest	Pretest	Posttest
Speed	0.228	0.140	0.206	0.094
Agility	0.116	0.543	0.120	0.102
Arm Power	0.128	0.410	0.132	0.220
Limb Muscle Power	0.112	0.208	0.109	0.088

Table 3. Homogenity test results.

Data	Levene Statistic	Sig.
Pretest-Posttest Speed	0.357	0.552
Pretest-Posttest Agility	0.578	0.241
Pretest-Posttest Arm Power	1.734	0.193
Pretest-Posttest Limb Muscle Power	0.035	0.853

Table 4. Independent sample test experiment group and control group.

Independent Samples Test			
Data	t-test for Equality of Means		
	t	Sig. (2- tailed)	Difference
Speed	2.464	0.017	0.36 (s)
Agility	6.648	0.000	1.17 (s)
Arm Power	5.305	0.000	0.79 (m)
Limb Muscle Power	2.146	0.036	2.11 (cm)

the control group with a difference of 1.17 seconds. (3) arm power data obtained t value 5.305 and p-value of 0.000 <0.05, these results indicate there is a significant difference between the experimental group and the control group. The arm power of the experimental group given the circuit training-based physical condition training model is better than the control group with a difference of 0.79 meters. (4) leg power data obtained t value 2.146 and p-value of 0.036 <0.05, these results indicate there is a significant difference between the experimental group and the control group. The experimental group's limb power given a circuit training-based physical condition training model is better than the control group with a difference of 2.11 centimeters.

Discussion

The results showed that the circuit training-based physical condition training model consisting of 6 posts was effective in increasing the speed, agility, arm power, and leg muscle power of basketball athletes. The training is carried out for 8 weeks, each athlete first warms up, core exercises for each post, and cools down. The circuit training program increased the muscle strength, agility, anaerobic capacity, and cardiovascular endurance of the study subjects. To choose a set of activities to increase physical fitness, use this program as a guidance [17, 18]. In a single training session, circuit training is one of the most effective workouts for enhancing physical capabilities such as strength, aerobic and anaerobic endurance, flexibility, and coordination [20]. Strength and endurance can be developed using the circuit training technique [21]. The benefits of circuit training on speed, leg, arm, and agility are tremendous. An effective way to increase running speed, agility, and strength in the upper and lower body is through circuit training [22].

Circuit training with speed, agility, and speed training produces higher results for agility than circuit training with jumping training [23]. During the six-week training period for circuit training coupled with speed agility speed up combination training and circuit training with jump rope training, upper body long-term muscular endurance performance was greatly enhanced [24]. For the 12-week training period, the circuit strength training group had significant interaction effects and meaningful effect sizes, and the mean effect size for the CT was noticeably higher [25]. Wijaya [26] researched that six posts make up the circuit training activity that will be performed: post 1 is a sit-up, post 2 is a push-up, post 3 is a jumping jack, post 4 is a run, post 5 is a shuttle run, and post 6 is a squat jump. According to the findings, on the first and second days after receiving isotonic fluids, participants' systolic blood pressure and heart rates significantly decreased as a result of body adaptation, however on the third to fifth days, there was no drop. Participants who were administered mineral water saw a substantial rise in their systolic blood pressure and heart rate. Diastolic blood pressure is unaffected by the administration of isotonic fluids or minerals. However, a rise was seen in blood sodium levels.

Muñoz-Martínez [27] shows that the goal of this systematic review and meta-analysis was to assess published research that looked at the effects of resistance circuit-based training on maximum oxygen absorption and one-repetition upper-body strength in healthy individuals. The meta-analysis revealed that resistance circuit-based training is effective in raising maximum oxygen uptake and one-repetition maximum bench press in healthy people, regardless of the study design. Karuppasamy [28] determined how certain physical and physiological factors in male volleyball players responded to plyometric training and circuit training. 24 male volleyball players between the ages of 18 and 25 were chosen at random. According to the findings, plyometric and circuit training dramatically increased anaerobic and aerobic capacity as well as muscular endurance, flexibility, agility, and explosive strength.

Sobrero [29] studied the differences existence in health and performance measures in women participating in High intensity functional training (HIFT) or traditional circuit training (TCT) after a six-week training program. The results both groups increased body mass, and improved muscular endurance, upper body strength, lower body power, and agility. In addition, the HIFT group decreased body fat, while the TCT group increased body fat. Marcos-Pardo [30] found out how resistance circuit training at a moderate to high intensity affected senior citizens' body composition, functional independence, muscular strength, and quality of life was the goal. There was a randomised controlled study. Both sexes showed significantly greater values of physical strength and a considerable improvement in functional autonomy. However, there were no differences in these groups' quality of life that could be seen. The other variables showed no signs of change. When groups were compared, similar findings were established. Resistance training at a moderate-to-high intensity increased both men's and women's upper and lower body strength significantly while also increasing their overall lean body mass and functional capacity. This research differs from our own study. Our research focuses on circuit training-based models for improving the physical conditioning of basketball athletes, with the goal of enhancing speed, agility, arm power, and leg muscle strength. The circuit training program in our study consists of six stations. Station 1 includes exercises such as jumping rope, push-ups, ickey shuffle, and shuttle runs. Station 2 comprises jump squats, x-drills, triangle drills, and tricep dips. Station 3 involves lateral squats, biceps curls, four corner drills, and high knee runs. Station 4 incorporates lunges, tricep curls, m-drills, and high knees. Station 5 features band lateral walks, Hindu push-ups, zig-zag runs, and heel kicks. Lastly, station 6 consists of hurdle hops, tricep resistance band exercises, hexagon drills, and kicking.

Conclusions

Based on the results of the study, it can be concluded that the circuit training-based physical condition training model consisting of 6 posts is effective in increasing the speed, agility, arm power, and leg muscle power of basketball athletes. These results are indicated by speed data ($0.017 < 0.05$), agility ($0.000 < 0.05$), arm power ($0.000 < 0.05$), and leg muscle power ($0.036 < 0.05$). The results of the study can be used as material for consideration for coaches in making appropriate training programs to increase the speed, agility, arm power, and leg muscle power of basketball athletes. Thus the exercise will be effective and get results in accordance with what is expected. Based on our results, we recommend that basketball coaches consider including a circuit training-based physical condition training model in training, as a simple and practical model for improving athletes' physical condition. For researchers who intend to continue or replicate this study, it is recommended to conduct tighter control in the entire series of experiments.

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Conflict of interest

We know of no conflicts of interest associated with this publication, and there has been no significant financial support for this work that could have influenced its outcome. As the corresponding author, I confirm that the manuscript has been read and approved for submission by all the named authors.

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