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A study on the effect of basketball specific endurance circuit training on the heart rate of male young basketball players: the case of second division male basketball players

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Abstract
Basketball is a game that is typically performed in an intermittent manner, and includes numerous bursts of explosive activity. Thus, implementation of training methods that best develop anaerobic fitness is of significant importance to basketball coaches and players. The aim of this study was to determine the effects of a basketball specific endurance circuit training on the heart rate of second division young male basketball players. To accomplish the purpose of the study twenty four (24) male second division young basketball players were selected from Challengers Sport club, Gulele Kifle Ketema Sport club, Arat Kilo Sport club, and School of Tomorrow Sport club. These Second division Young male basketball players were randomly assigned into two groups: the experimental group (EG, n = 12) those who made basketball specific endurance circuit training group and control group (KG, n = 12). The mean age of the selected players was 16.85 ± 0.67. Resting and exercise heart rate were selected as criterion variables. Exercise heart rate was measured during multistage fitness test using polar heart rate monitor. The experimental group (EG) was made up of the players from basketball team, which in addition to basketball trainings also took part in complex training. The control group (KG) was made up of the players from basketball team, who at that time only took part in basketball trainings. The basketball specific endurance circuit training was administered 3 days per week for six weeks. They performed 2 minutes of work at 90 to 95% of targeted heart rate using the Karvonen method. They performed 8 repetitions during the first and second week, followed by 10 repetitions during the third and fourth week and 12 repetitions during the fifth and sixth week of training. This was followed by 2 minutes of active resting at 60 to 70% of targeted heart rate. In this study 1:1 work rest ratio was followed. Both the groups were tested before and after training, the experimental program lasted for 6 weeks (3x per week). Data processing was carried out using the SPSS statistical program. To determine the effect of circuit training on abilities of young basketball players, the analysis of covariance ANCOVA was used. The result of the study showed that resting heart rate and exercise heart rate between the groups was significant, indicating a significant difference between the two groups on posttest scores. The findings of the study show that significant decrease in resting and exercise heart rate. It can be concluded that basketball specific endurance circuit training is effective in improving the cardiovascular fitness of male second division young basketball players during competitive phase.

Keywords: circuit training, grip strength, heart rate, basketball, grip dynamometer, young players

Introduction
Circuit training is a method of fitness training that is designed to develop general, all-round physical and cardiovascular fitness. Most of the Coaches and Basketball players use high-intensity circuit training to prepare for competitions. Conventionally, the coaches and trainers have planned conditioning programs for their teams by following regimens used by teams that have successful win and loss records. This type of reasoning is not sound because win and loss records alone do not scientifically validate the conditioning programs used by the successful teams. Basketball, initially a slow activity with the ball, grew into a very dynamic activity. Fast actions are characteristics of today's basketball game (Kocić & Berić, 2015) [6]. Regular endurance training improves performance during tasks that rely mainly on aerobic energy metabolism, in large part by increasing the body's ability to transport and utilize oxygen and by altering substrate metabolism in working skeletal muscle. Training for players generally emphasizes participation in long - duration low - or moderate-intensity exercise during the base or preparation phase of the season, with the inclusion of shorter - duration high - intensity efforts as the competitive phase approaches. Morgan and Adamson at the University of Leeds first developed circuit training in the 1950's. It is a versatile training method as it can be adapted for many different situations, sections of the population and fitness requirements, and can be used at any time of the year. While the exercises are normally laid out in a circular pattern, the pattern can be varied for motivational purposes to that of a star, square, semi-circle, V-shape, line or zigzag. In actual fact, the successful team might be triumphant by desirable quality of its greater athletes and not its outstanding conditioning program. Without a doubt, the planning of an efficient athletic conditioning program can best be accomplished by the application of proven physiological training principles. Optimizing training programs for athletes is important because failure to properly condition an athletic team results in a poor performance and often defeats.

Circuit training is a method of fitness training that is designed to develop general, all-round physical and cardiovascular fitness. The term 'sport-specific training' implies that exercises should mimic as much as possible the actions of the body during participation in a given sport. Specificity should not, however, be over emphasized when selecting resistance exercises because it could lead to imbalances. Consequently, finding a balance between general and specific exercises would be appropriate in a circuit. The importance of developing good conditioning programs based on the specific physiological demands of each sport is considered a key factor to success (Gillam 1985; Taylor 2003 and 2004) [4, 14, 15]. The basketball player needs to train multiple components of fitness. Thus, the athlete will concurrently perform various modes of training (e.g., strength, anaerobic, endurance). In this study was employed sport specific circuit training. This incorporates skills and movements specific to the sport, at intensities sufficient to promote aerobic adaptations, are being increasingly implemented in the professional team sports environment (Lawson, 2001) [7]. The perceived benefit of performing sports-specific exercise is that the training will transfer better into the athletes' competitive environment and that the greatest training benefits occur when the training stimulus simulates the specific movement patterns and physiological demands of the sport (McArdle *et al*., 1996) [8]. The purpose of the study was to examine the effectiveness of a basketball specific endurance circuit training on aerobic capacity and the heart rate of second division young male basketball players.

Methodology

Selection of participants

The sample of participants in this study consisted of 24 second division young club basketball players. The participants were selected from four clubs named Challengers Sport club, Gulele Kifle Ketema Sport club, Arat Kilo Sport club, and School of Tomorrow Sport club. These participants were randomly assigned into two groups: the experimental group (EG, n=12) those who made basketball specific endurance circuit training group and control group (KG, n=12). The mean age of the selected players was 16.85 ± 0.67. The selected players had 3.8 ± 3.1 years of playing experience and regularly participate in training prior to the commencement of this study. The experimental group (EG) consisted of basketball players of basketball team, who in addition to the basic technical and tactical training (3x per week) also had complex training for a period of 6 weeks (3x per week). The control group (KG) was made up of the basketball players of basketball team, who at that time only had technical and tactical training (3x per week). All participants were subjected to medical examination by a general medical practitioner before participation in the study to ensure that there was a sufficient standard to be able to take part in fitness testing and training.

Variables and tests

Aerobic capacity, resting heart rate and peak heart rate were selected as criterion variables. Exercise heart rate was measured during the multistage fitness test by wearing polar heart rate monitor. Initially the resting heart rate was measured after 10 minutes of rest.

Design of the study

For the present study pretest – posttest randomized group design (Thomas *et al*., 2005) [16] which consists of a control group (KG) and an experimental group (EG) was used to find out the effect of sports specific circuit training on the selected physiological variables. Equal numbers (twelve) of participants were assigned randomly to all the groups. Experimental group (EG) was exposed to training with a set of drills selected for specific purposes. The experimental group (EG) underwent training for a period of six weeks (42 days). The training sessions were conducted three days a week (i.e. Tuesday, Thursday and Saturday).

Collection of Data

All the participants were tested on physiological variables prior to training and after six weeks of training at Arat Kilo Educational Center. The testing session consists of warm-up and test mixed together with rest. All tests were explained and demonstrated. Before testing, participants were given practice trials to become familiar with the testing procedures. All tests were counterbalanced pre testing and post testing to ensure that testing effects were minimized. Participants performed each test as per test procedure and the scores of best trials were taken for this study.

Sports specific circuit training

Experimental Group (EG) is supplemented with sports specific circuit training replaced the regular physical fitness activity. However, control group (KG) performed regular physical activity. The training was carried out in outdoor basketball court. Basketball, initially a slow activity with the ball, grew into a very dynamic activity. Fast actions are characteristics of today's basketball game (Kocić & Berić, 2015) [6]. This sports specific circuit training was based on a previous design (Smith, 2004) [12] and adapted to mimic as closely as possible the movement patterns of basketball match play as reported by Mclnnes *et al*., (1995) [9]. The sports specific circuit training was administered 3 days per week for six weeks. The Experimental Group (EG) performed 2minutes of work at 90 to 95% of targeted heart rate using the Karvonen method. They performed 8 repetitions during the first and second week, followed by 10 repetitions during the third and fourth week and 12 repetitions during the fifth and sixth week of training. This was followed by 2 minutes of active resting at 70 to 80% of targeted heart rate. In this study 1:1 work rest ratio was followed. This training protocol was adopted from Helgerud *et al*. (2001) [5]. The average running time of one circuit was 59 s and the total distance covered during one lap was approximately 153 m, with 60.2% of the movements forward sprinting and 39.8% side shuffling. The portion of the circuit considered 'offence' activity where a basketball was dribbled, was 55.6% while 44.4% was considered 'defensive' activity without the ball. Three layups, three rebounds, seven vertical jumps, one pivot and 20 changes of direction were completed during one repeat of the circuit.

The heart rate monitor was used to measure peak heart rate when performing the circuit. The participants wore polar heart rate transmitter belt and watch (Polar heart rate monitor

watch, Finland). The training intensity was fixed between 90 to 95% of THR (Training Heart Rate). When the players perform below or above the prescribed intensity the watch will produce beep sound to alter their intensity accordingly.

The description of the circuit

1-2 forward sprint; 2-3 hurdle jump; 3-4 forward sprint; 4 pivot left; 4-5 shuffle left; 5-6 shuffle right; 6-7 shuffle left; 7-8 shuffle right; 8-9 shuffle left; 9 - 10 shuffle right; 10-11 hurdle jump; 12 vertical jump (collect ball upon landing); 13-14 Zig Zag Dribble; 14-15 speed dribble with complete lay-up; 15 collect the rebound; 15-16-15 speed dribble with complete lay-up; 15 collect the rebound; 15-17-15 speed dribble with complete lay-up; 15 collect the rebound; 15-18 run and place the ball in basket; 18 throw the medicine ball; 18-19-20 forward sprint.

Statistical analysis

The collected data were evaluated for the effect of endurance circuit training on the above-mentioned abilities of basketball players; the analysis of covariance ANCOVA was used. The proposed hypothesis was tested at 0.05 level of confidence. SPSS statistic software package (SPSS Company, America, version 17.0) was used. The level of statistical significance was set at a $p<0.05$.

Results

Table 1 clearly shows that aerobic capacity, resting heart rate and peak heart rate between the groups was significant, it indicate that after adjusting pre-test scores, there was a significant difference between the two groups on posttest scores on aerobic capacity, resting heart rate and peak heart rate. The findings of the study show that significant increase in aerobic capacity and decrease in resting and peak heart rate. The changes are presented in table - 1.

Discussion

In the present study, basketball specific endurance circuit training for six weeks has significantly decreased resting and exercise heart rate. Resting heart rate refers to the number of times a heart contracts in one minute (beats per minute or BPM) while at complete rest.

Table 1: Changes in aerobic capacity and heart rate

Variables	Groups	Pre-test	Post-test	% of changes	*F*
Resting HR (beats/min)	EG	55.66 ± 2.53	52.08 ± 2.23	6.43	28.05* (p = 0.000)
	KG	54.50 ± 2.57	54.75 ± 2.83	0.42	
Peak HR (beats/min)	EG	198.58 ± 3.57	192.33 ± 3.82	3.14	32.20* (p = 0.000)
	KG	197.08 ± 4.81	197.67 ± 3.22	0.29	

KG – Control Group; EG – Experimental Group

The normal heart rate depends upon age, gender and health and can vary greatly for both athletes and non-athletes. In general, a person's resting heart rate indicates their basic fitness level. The stronger the heart, the more blood it can pump during each contraction, and the less frequently it needs to beat to get adequate blood flow (circulation) and oxygen to the body tissues. A well trained athlete can have a very low resting heart rate and pump more blood than an unconditioned individual. In the present study Experimental Group showed 3.58 beats/min changes is elicited. The percentage reduction in resting heart rate between pretest to posttest was 6.48%. These changes are extracted as a result of sports specific endurance circuit training imparted to the young second division male basketball players. The amount of blood pumped out of the left ventricle of the heart with each contraction is called the stroke volume. Although some conditions can affect a person's stroke volume, endurance and high intensity cardiovascular exercise training often increases stroke volume (Bonaduce *et al*. 1998) [3]. A larger stroke volume results in a lower (resting) heart rate (Nottin *et al*. 2002) [11]. However, longer diastole influences the resting heart rate in a11thletes (Nottin *et al*. 2002) [11].

In this study Experimental Group showed 3.14% (6.25 beats /min) reductions in peak heart rate. These changes are caused because of sports specific endurance circuit training which resulted in improvement of aerobic capacity. Heart rate increases in parallel with increasing exercise intensity. Heart rate is stimulated to increase through the activation of mechano-, chemo- and baroreceptors sending afferent signals to the cardiovascular control centre in the brain. This in turn adjusts sympathovagal balance to the SA node bringing about a change in HR. At the onset of exercise, there is a rapid increase in HR. Due to its speed of response; this is suggested to arise through a withdrawal of parasympathetic modulation which enables the HR to increase up to the intrinsic rate of approximately 100beats/min. Thereafter, any increase in HR is stimulated through an increased sympathetic modulation. Increased sympathetic cardiac modulation is evident from approximately 25% peak VO2 onwards and by the time exercise reaches an intensity of 50–60% of peak VO2, data suggest that vagal modulation disappears all together. Very few studies have reported the dynamics of autonomic control of HR during exercise in children. Those studies that have been performed report similar findings to those observed in adults. Due to training adaptations these changes are found in the present study.

Conclusion

Basketball specific endurance circuit training is effective in improving the cardiovascular fitness of male young basketball players during competitive phase.

Sports specific circuit training design was based on a previous design and adapted to mimic as closely as possible the movement patterns of basketball match play. The training is very easy to practice in the Basketball court which improves the aerobic capacity. The basketball specific endurance circuit induced greater improvements in aerobic fitness, suggesting it was somewhat effective in improving aerobic fitness during the competitive season.

Future studies should investigate the influence of other

variables, such as training volume (low versus high), training period (preseason versus in-season), and the player's initial fitness level, on fitness improvement. The influence of these training programs should also be examined in professional adult players with higher training and competitive demands.

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