THE DIFFERENCES BETWEEN PERIMETER AND POST BASKETBALL PLAYERS IN SOME AEROBIC AND ANAEROBIC PARAMETERS

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Original scientific paper

Abstract

The aim of this study was to find out the differences between perimeter and post basketball players in aerobic and anaerobic parameters. Thirty-four basketball players from four Bosnian teams were measured for body composition (body height and weight, fat%, fat free mass), aerobic power (VO2max prediction estimated using the multistage shuttle run test), anaerobic capacities (repeated anaerobic sprint test – RAST) and anaerobic power (peak and relative power output generated during the CMJ). The sample was divided in two sub-samples: the first was a group of perimeter basketball players (n = 17) and the second was a group of post players (n =17). The main finding of this research was the existence of differences between the perimeter and post basketball players in aerobic power and relative anaerobic parameters, but not in vertical jump height. The perimeter players had higher aerobic power and higher values of relative anaerobic power and capacities, while the post players have higher values of absolute anaerobic power. The findings confirm that the aerobic and anaerobic tests can be discriminative variables between perimeter and post basketball players. Additionally, the results emphasize the need for improvement of explosive power of the lower limbs in Bosnian players. Also, the coaches can use information obtained in the study to create more individualized strength and conditioning programs for different positional role in order to maximize players' physiological potential which is very important for basketball to be successfully played.

Key words: shuttle run test; repeated anaerobic sprint test

INTRODUCTION

Basketball maybe is not the most popular sport in the world, but for sure is one of the most dynamic sports (Pojskić et al., 2009). It is physically very demanding, with a lot of defensive and offensive actions, requiring players to permanently repeat bouts of intense movements (sprinting, shuffling, jumping…) down the basketball court. Elite basketball players spend 75% of playing time with a heart rate greater than 85% of its maximum value (McInnes et al, 1995). Therefore, in order to play successfully, basketball players must be physically well prepared. They need to have optimally developed levels of explosive power (Hoffman et al., 1996), agility (abdelkrim et al., 2010; Delextrat and Cohen, 2008; Hoffman et al., 1996), aerobic power (Abdelkrim et al., 2006; Abdelkrim et al., 2010, McInnes et al, 1995; Narazaki et al., 2008), anaerobic power (Delextrat and Cohen, 2008; Hoffman et al., 1996) and anaerobic capacities (Apostolidis et al., 2004).

Knowing a fact that basketball is a sport with a high anaerobic component produced by intensive active periods and short rest periods of a game (Abdelkrim et al., 2007; Crisafulli et al., 2002; Hoffman, 2002; McInnes et al., 1995) and that involvement of aerobic maximal power in basketball players is greater than it was first thought (Abdelkrim et al., 2006; McInnes et al, 1995; Narazaki et al., 2008) poses a need for aerobic and anaerobic testing of basketball players, as well as testing and comparing players that play at different team positions.

Typically, there are five main positions in basketball: point guard, shooting guard, small forward, power forward, center, but generally they can be classified as perimeter or small players (point guard, shooting guard, small forward) and post or big players (power forward, center). Perimeter players are generally the shortest and fastest players in the team with the best ball control, while the post players are the tallest and the slowest players on the team. The recent studies have investigated the differences between the post and perimeter players. The results have shown that the post players ware taller and heavier (Jeličić et al., 2002; Sallet et al., 2005; Ostojić et al., 2006; Abdelkrim et al., 2010) and had higher body fat percentage (Sallet et al., 2005; Ostojić et al., 2006; Abdelkrim et al., 2010) than the perimeter players. Additionally, some studies have shown that the perimeter players had better aerobic and anaerobic capacities (Abdelkrim et al., 2010; Cormery et al., 2008; Latin et al., 1994; Ostojić et al., 2006; Sallet et al., 2005;), speed and agility (Abdelkrim et al., 2010; Tsitskaris et al., 2003), while the post players were better in muscular strength and absolute power (Abdelkrim et al., 2010; Ostojić et al., 2006). The reported differences determine the different players' roles in a team.

Unfortunately, to our knowledge there is lack of studies done on Bosnian basketball players. In that regard we tested players from four Bosnian basketball teams and we indirectly assessed two types of immediate (short-term) anaerobic energy systems: adenosine triphosphate and phosphocreatine (testing by players' ability to perform vertical jumps and multiple sprints), and the long-term, aerobic system (evaluated by multistage shuttle run test). Therefore, the aim of this research was to determine the differences in aerobic and anaerobic parameters between post and perimeter basketball players. According to the different team role we hypothesized that the players would differentiate. In addition, we wanted to obtain information of the aerobic and anaerobic parameters of players who play in Bosnian basketball league.

METHODS

Participants

Thirty-four healthy basketball players from four teams of the Bosnian Premier League voluntarily participated in the study. The sample was divided in two sub-samples: the first was a group of perimeter basketball players (n = 17) and the second was a group of post players (n = 17). Their age and anthropometric characteristics are given in table 1.All players had played at national level. All of them were healthy without any history of neuromuscular diseases or reported injury in the previous six months. At the time of research they had 8.2 ± 3.1 years of competitive experience. Their anthropometric characteristics are presented in Table 1. According to their clubs' head coaches, they trained 10 hours a week (5 sessions of 2 hours each) on court, improving technical and tactical skills, and 4.5 hours a week (3 sessions of 1.5 hours each) off court in the gym improving their strength, power and endurance, with a championship game played every Saturday or Sunday. They were informed about the purpose of the study, testing protocols, research benefits and potential risks. All of them signed a written informed consent form in order to participate in the study. The study was conformed to the principles of the Declaration of Helsinki on human experimentation (WMADH , 2000).

Table 1.
Mean ± SD and (ranges) of age and the anthropometric characteristics of the participants

VARIABLES	PERIMETER PLAYERS (n = 17)	POST PLAYERS (n = 17)
Age	19.12 ± 3.44 (15-26)	19.74 ± 2.98 (17-28)
Height (cm)	186.82 ± 7.18 (174.0-191.2)*	199.75 ± 4.43 (197.8-207.2)
Body mass (kg)	79.47 ± 12.23 (68.8-92.3) *	97.58 ± 9.69 (94.2-114)
Body fat (%)	12.71 ± 3.21 (7.2-21.2)	14.04 ± 5.11 (9.8-23.3)
Fat free mass (%)	86.55 ± 5.13 (79.3-92.53)	84.43 ± 4.55 (77.6-84.33)

*Values significantly different from those obtained by the post players; $p < 0.05$

Procedures

The players were tested immediately after the 2008/2009 season finished, during a two-week break. The assessment sessions were conducted over three separate days, between 9 and 11 a.m., with 48 hours between the sessions. To minimize variation in climatic and other conditions, shuttle run test was performed in a sport hall on a parquet floor. The RAST test was performed in a track and field stadium. All players were familiarized with the testing procedures before the assessments. All of them were encouraged to make as much effort as possible during all tests. A ten-minute general warm-up (jogging), seven minutes of active dynamic stretching and activities to increase intensity (sprints and jumps) were performed before testing.

Players from each team were randomly split into two groups with an equal number of players. During the first testing day, body composition was assessed for each player. After that they performed the warm-up and then a multistage shuttle run test that was used to estimate maximal oxygen consumption (VO2max). On the second day the players was tested by countermovement jump in order to estimate their maximal anaerobic power. On the third day the parameters of anaerobic capacities were assessed using the Repeated Anaerobic Sprint Test (RAST).

Instruments

Body height (BH) was measured to the nearest 0.01m with a portable stadiometer (Astra scale 27310, Gima, Italy). *Body weight (BW)*, *body fat percentage (FAT%)* and *fat free mass (FFM)* were measured by a bioelectric body composition analyzer (Tanita TBF-300 increments 0.1%; Tanita, Tokyo, Japan).

Vertical jump performance (CMJ - counter movement jump) was assessed according to the protocol described by Bosco et al. (1983). Players were asked to start from an upright position with straight legs and with hands on hips (in order to eliminate contribution of arm swing on jump height) and to do a downward movement before the jump. Players performed a natural flexion before take-off. The participants were instructed to land in an upright position and to bend the knees on landing. Each player performed three maximal CMJ jumps, allowing three minutes of recovery in between. The highest score was used for analysis. The jumps were assessed using a portable device called the OptoJump System (Microgate, Bolzano, Italy) which is an optical measurement system consisting of a transmitting and receiving bar (each bar being one meter long). Each of these contains photocells, which are positioned two millimeters from the ground. The photocells from the transmitting bar communicate continuously with those on the receiving bar. The system detects any interruptions in communication between the bars and calculates their duration. This makes it possible to measure flight time and jump height during the jump performance. The jump height is expressed in centimeters. The reliability of CMJ in this study was very high (ICC = .93; α = 93; CV = 7.3%).

Maximal aerobic power (VO2max) was estimated using the 20m shuttle run test according to Leger and Gadoury (1989). The test consisted of shuttle running in the preset pace. The running pace was preset by the shuttle run test protocol and played on a CD player. In the test, the participant ran 20-metre long shuttles after a signal was sounded. At the start of the test, the participant had to run at a speed of 8 km/h to get to the opposite line before another signal was sounded. The running speed increased every minute by 0.5 km/h. When the subjects were not able to keep up the pace, the last covered shuttle was used for calculating and estimating the VO2max. The test-retest reliability coefficients are 0.89 for children and 0.95 for adult men and women.

Anaerobic capacity was assessed with the Running-based Anaerobic Sprint Test (RAST). Zacharogiannis et al. (2004) reported that this test can replace the Wingate test as an estimate of anaerobic power and capacity. Each athlete performed a twelve minute warm up (five minutes of jogging and seven minutes of active dynamic stretching) which was followed by a three minute recovery. The test consisted of six sets of 35m discontinuous sprints. Each sprint represented a maximal effort with 10 seconds allowed between each sprint for the turnaround. After completion of the test, the following variables were calculated: Maximal Power (MaxPOW), Average Power (AvePOW), Minimal Power (MinPOW), Fatigue Index (FI) and Relative Maximal Power (R-MaxPow). The variables were calculated by the following equations: Power = Weight (kg) × Distance (m¸) ÷ Time (sł). Maximum power = the highest value of six sprints, Minimum power = the lowest value of six sprints, Average power = sum of all six values ÷ 6, Fatigue Index = (Maximum power - Minimum power) ÷ Total time for the 6 sprints, R-MaxPow = Maximum power / Weight. Test reliability (r = 0.90) was reported by Balčiūnas et al. (2006).

Anaerobic power. Peak power and relative peak power output generated during the CMJ were estimated using two separate equations. The first was developed by Sayers et al. (1999) for estimating peak power output: PAPw (Watts) = (51.9 · height CMJ (cm)) + (48.9 · body mass (kg)) – 2007 and the second was derived from the first and represents relative peak power output standardized to the subject's weight: R-PAPw (W/kg) = PAPw (watts) / mass (kg). Each player performed three maximal CMJ jumps as described before, with 3 minutes of recovery in between. The highest score was used for analysis.

Statistical Analyses

Descriptive statistics (mean, standard deviation, and range) were calculated for each variable. Data sets were checked for normality using the Kolmogorov-Smirnov test and by the visual observation of normality plots. Reliability and validity of countermovement test was assessed with an intraclass correlation coefficient (ICC), Cronbach's Alpha reliability coefficients (α) and Coefficient of Variation (CV). Differences between the groups were detected by independent sample t test. Significance for all statistical tests was set at $p \leq 0.05$. All statistical analyses were completed with the SPSS software statistical package (SPSS Inc., Chicago, IL; Version 14.0).

RESULTS

The descriptive statistics were calculated for all tested variables including age and anthropometric characteristics. Table 2 shows the mean value, standard deviation and range, as well as the differences between the perimeter and post players in the measured parameters. The table shows the differences between the perimeter and post in six out of eleven variables.

Table 2.
The differences between the perimeter and post players in aerobic and anaerobic parameters (mean ± SD and range)

VARIABLES	PERIMETER PLAYERS (n = 17)	POST PLAYERS (n = 17)
VO2max (ml · kg^{-1} · min^{-1})	64.36 ± 7.05 (40.84-76.41)*	57.91 ± 7.23 (46.77-69.0)
CMJ height (cm)	40.40 ± 5.04 (33.3-53.6)	36.04 ± 3.80 (29.3-44.3)
RAST Maximal Power (Watts)	772.96 ± 129.38 (579.7-998.8)	858 ± 108.92 (595.8-986.5)
RAST Minimum Power (Watts)	513.14 ± 109.16 (365.7-750.1)	531.9 ± 83.47 (371.1-659.8)
RAST Average Power (Watts)	634.87 ± 109.64 (451.7-839.1)	712.65 ± 69.45 (579.5-795.8)
RAST Fatigue Index (Watts/s)	8.08 ± 2.49 (4.68-15.33)*	10.48 ± 2.24 (6.70-13.99)
RAST Relative Maximal Power (Watts/kg)	14.90 ± 1.08 (12.78-16.95)*	13.44 ± 1.46 (8.96-14.98)
RAST Relative Minimal Power (Watts/kg)	9.89 ± 1.42 (7.49-13.0)*	8.31 ± 1.08 (7.13-10.52)
RAST Relative Average Power (Watts/kg)	12.24 ± 1.13 (10.62-14.48)*	11.15 ± .70 (9.99-12.41)
CMJ Peak Power Output (Watts)	3874.42 ± 639.3 (2740.50-5005.53)*	4536.4 ± 458.4 (3775-5379)
CMJ Relative Peak Power Output (Watts/kg)	50.02 ± 3.46 (44.93-60.02)	47.51 ± 2.06 (43.94-52.14)

*Values significantly different from those obtained by the post players; $p < 0.05$

Discussion

These findings confirm the results of the previous investigations conducted in order to compare players who play at different team positions in their aerobic and anaerobic parameters (Abdelkrim et al. 2010, Ostojić et al., 2006). The perimeter players have higher aerobic power and higher values of relative anaerobic power and capacities, while the post players have higher values of absolute anaerobic power.

The fact that perimeter players have higher aerobic power can be explained by the specific requirements of the position. These players are excellent ball handlers who control the tempo of the game by fast dribbling and transitions. Also, our findings can be supported by the results obtained by Abdelkrim et al. (2007) who reported that guards spent significantly higher live time competing in high-intensity activities than centers.

In the present study the centers are significantly taller and heavier which is in line to the previous studies. The centers morphological characteristics determine their role in the game. They usually play near or inside the painted area, trying to get rebounds, score points close to the basket and block opponents' shots. Using their body weight they efficiently set the screens and box-out opponent players. They use their heavier bodies and strengths to efficiently complete their tasks in a team.

The average age of the perimeter players is 19.12 ± 3.44 years and 19.74 ± 2.98 of the post players, which is not in line with previous studies (Ostojić et al., 2006; McInnes et al., 1995; Sallet et al., 2005). The players involved in our study are younger. Also, the both groups of the players are smaller and lighter then players measured in previous studies (Ostojić et al., 2006; Sallet et al., 2005; Abdelkrim et al., 2010).

The perimeter players showed better anaerobic capacities considering relative values obtained from the RAST test's parameters. They were better in relative maximal, average and minimal power output, as well as in ability to resist anaerobic fatigue (FI - fatigue index). Although, there were differences in the absolute values of the power output during the applied tests, the differences were not significant.

Additionally, there were not any significant differences in CMJ height and CMJ peak and relative power output between the groups. These results are in line with study conducted by Ostojić et al. (2006) who found similar results between different positional roles, but a disappointing fact that players from Bosnian league had drastically poorer results in CMJ height (perimeter players: 40.4 cm; post players: 36.1cm) comparing to players from the studies conducted by Ostojić et al. (2006) who reported CMJ height values between 54.6 cm and 59.7 cm and Hoffman et al. (1996) and McInnes et al. (1995) who reported values of vertical jump height around 70 cm.

Encouraging fact is that the both groups of players had very well developed aerobic power that were between 57 ml · kg^{-1} · min^{-1} for post players and 67 ml · kg^{-1} · min^{-1} for the perimeter players, which is better than values reported by some other studies (Ostojić et al., 2006; Abdelkrim et al., 2010). This can be explained by smaller and lighter bodies of the players from the both groups comparing to elite players who had poorer aerobic power, but better anaerobic power and capacities.

The obtained differences between the groups can be attributed to the different training regime, but also to the different body composition. Also, the results suggest importance of introducing more extensive and intensive plyometric programs and trainings for Bosnian players, as well as better selection of players who have high values of anaerobic power.

Practical aspects

In practice, this information is very important, especially to Bosnian basketball coaches and players because there was very few studies looked into the physiological profile of Bosnian basketball players. This findings confirm that the aerobic power test (the multistage shuttle run test), the Running-based Anaerobic Sprint Test and the countermovement jump test can be discriminative variables between perimeter and post basketball players. The results emphasize the need for improvement of explosive power of the lower limbs in Bosnian players. Also, the coaches can use this information to create more individualized strength and conditioning programs for different positional role in order to maximize their physiological potential that is very important for basketball to be successfully played.

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RAZLIKE IZMEĐU VANJSKIH I UNUTRAŠNJIH KOŠARKAŠA U NEKIM AEROBNIM I ANAEROBNIM PARAMETRIMA

Originalni naučni rad

Sažetak

Cilj ove studije je bio da se otkriju razlike između košarkaša koji igraju na vanjskim pozicijama i onih koji igraju na unutrašnjim pozicijama u nekim aerobnim i anaerobnim pokazateljima. Tridesetčetiri košarkaša iz četiri bosanska tima su učestvovala u istraživanju. Njima je izmjeren sastav tijela (tjelesna težina, tjelesna visina, postotak masnog tkiva u organizmu i postatak tkiva oslobođenog masti), aerobna snaga (VO2 predikcija na osnovu više razinskog shuttle run testa), anaerobni kapaciteti (na osnovu parametara anaerobnog ponavljajućeg sprint testa) i anaerobna snaga (maksimalni i relativni izlaz snage proizveden za vrijeme vertikalnog skoka sa pripremnom fazom). Uzorak ispitanika je podijeljen na dva subuzorka: prvu grupu je činilo 17 vanjskih igrača koliko je činilo i drugu grupu unutrašnjih igrača. Glavni nalaz ovog istraživanja je postojanje razlika između unutrašnjih i vanjskih igrača u aerobnoj snazi i relativnim anaerobnim kapacitetima, dok nije bilo razlika u visini vertikalnog skoka. Vanjski igrači su imali bolju aerobnu snagu i veće vrijednosti relativne anaerobne snage i kapaciteta, dok su unutrašnji igrači imali bolju absolutnu anaerobnu snagu. Rezultati potvrđuju da primjenjeni aerobni i anaerobni testovi mogu poslužiti kao diskriminativne varijable između vanjskih i unutrašnjih igrača. Dodatno, rezultati naglašavaju potrebu usavršavanja eksplozivne snage donjih ekstremiteta kod bosanskih košarkaša. Također, treneri mogu koristiti informacije dobivene u ovom istraživanju da kreiraju više individualizirane kondicione treninge i programe za igrače koji igraju na različitim pozicijama, a s ciljem da maksimiziraju njihov fiziološki potencijal koji je vrlo važan kako bi se uspješno igrala košarka.

Ključne riječi: shuttle run test; RAST test

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Received: 18 February 2012
Accepted: 03 May 2012