BLOOD LACTATE CONCENTRATION DURING A BASKETBALL MATCH

[1]Nikola Aksović,
[2]Filip Milanović,
[3,4]Dejan Nikolić,
[5]Maria Cristina Man,
[6]Laishram Santosh Singh.
[1]Faculty of Sports and Physical Education, University of Nis, Nis, Serbia,
[2]Department of Orthopedic Surgery and Traumatology, University Children's Hospital, Belgrade, Serbia,
[3]Faculty of Medicine, University of Belgrade, Serbia,
[4]Department of Physical Medicine and Rehabilitation, University Children's Hospital, Belgrade, Serbia,
[5]Department of Physical Education and Sports, "December 1, 1918" University of Alba Lulia, Romania, Romania,
[6]Department of Physical Education and Sports Science, Manipur University, Canchipur, India.

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REVIEW ARTICLE

Summary: Blood lactate level and heart rate are the most frequently measured physiological responses of basketball players during a game. The aim of the systematic review of the current literature was to examine the concentration of lactate during a basketball game, as well as to determine the concentration of lactate according to player position, level of play, geographical location and gender during the game. Time comparisons in separate studies revealed that lactate concentration was significantly lower in the second half than in the first. Professional players achieve higher lactate concentrations compared to semi-professional players. In addition, intrinsic and matching factors may contribute to the observed player variation, including the intensity of play prior to blood sampling, as well as the physiological preparation of the player's test sample. Blood lactate concentration is higher in Australian basketball players than in Tunisians, Spanish and British basketball players. Further research should quantify lactate concentration and heart rate in relation to active and total playing time, which is a recommendation for future researchers.

Key words:basketball players, physical demands, physiological responses, heart rate, lactates

INTRODUCTION

Basketball is a high-interruption game, involving repeated transitions between offense and defense and frequent movement changes (McInnes, Carlson, Jones, & McKenna, 1995; Aksović & Berić, 2017). During a basketball game, periods of high intensity activity are interrupted by periods of low to moderate intensity activity (Aksović, Berić, Kocić, Jakovljević, & Milanović, 2020). These activities differ in structure of intensity, distance, frequency and duration. However, the variation

between the current studies and those conducted before 2000 may be partly attributable to changes in the rules. These rule changes include shortening the attacking time after gaining possession (from 30 to 24 s) and reducing the time to move the ball into the opponent's half (from 10 to 8 s). These changes are important to note when collecting evidence from existing research spanning decades.

In addition to the above physical demands, understanding the physiological response is important in order to understand the overall stress imposed during a basketball game. Blood lactate level and heart rate are the most frequently measured physiological responses of basketball players during a game (Montgomery, Pine, & Minahan, 2010; Scanlan, Dascombe, Reaburn, & Dalbo, 2012; Klusemann, Pine, Foster, & Drinkvater, 2012; Hulka, Cuberek, & Belka, 2013; Vencurik, 2014; Vencurik & Nikodym, 2015) Elevated blood lactate concentration indicates that rapid glycolysis plays an important contribution to the energy needs of players (McInnes et al., 1995), while heart rate is an indirect indicator of the use of aerobic energy sources. An abundance of studies examined the physical needs and physiological reactions of basketball players during a match, the results and conclusions of which were summarized in the form of a review paper published (Ziv & Lidor, 2009). However, most of the analyzed works were published before the rule change that drastically changed the physical and physiological requirements of basketball, so the comprehensive analysis is in relation to the period of play, the position of the players, the level of play. and geographic location remained unclear in the aforementioned review paper, despite the fact that all of the aforementioned elements are very important to basketball players, fitness coaches, and sports scientists. An important indicator of the load imposed during the match, such as distance, has only been measured in recent studies (Hulka, Cuberek, & Belka, 2013) that allow consideration in a systematic review. It should be noted that in recent years more and more attention has been paid to the research of basketball players (Conte et al., 2015; Delektrat et al., 2015; Scanlan, Dascombe, Kidcaff, Peucker, & Dalbo, 2015). A recent systematic review (Stojanović et al., 2018) incorporated the latest research on the physical demands and physiological responses of both sexes during a basketball game, enabling more precise development of optimal training approaches to achieve the desired performance. In this context, physiological responses during a basketball game according to period of play, position, level of play, geographic location, and gender. Thus, the aim of the systematic review of the current literature was to examine the concentration of lactate during a basketball game, as well as to determine the concentration of lactate according to player position, level of play, geographical location and gender during the game enabling more precise development of optimal training approaches to achieve the desired performance. In this context, physiological responses during a basketball game according to period of play, position, level of play, geographic location, and gender.

Thus, the aim of the systematic review of the current literature was to examine the concentration of lactate during a basketball game, as well as to determine the concentration of lactate according to player position, level of play, geographical location and gender during the game. enabling more precise development of optimal training approaches to achieve the desired performance. In this context, physiological responses during a basketball game according to period of play,

position, level of play, geographic location, and gender. Thus, the aim of the systematic review of the current literature was to examine the concentration of lactate during a basketball game, as well as to determine the concentration of lactate according to player position, level of play, geographical location and gender during the game.

METHOD

Search strategy

An electronic search of papers was performed in the following databases: PubMed, MEDLINE, ERIC, Google Scholar and ScienceDirect. The search was performed using the following terms (individually or in combination): basketball players, lactate, pulse.

All titles and abstracts are screened for potential papers to be included in the systematic review. Lists of previous and original research were also reviewed. Relevant studies were obtained when the studies met the inclusion criteria, after a detailed search. Wherever possible, the research strategy was modified and adapted to each database survey in order to increase the sensitivity of this review paper. A systematic review of papers was performed in accordance with methodological guidelines and in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) consensus (Moher, Liberati, Tetzlaff, & Altman, 2019).

RESULTS

A total of 96 articles were identified from the database search with an additional six articles identified through reference lists. After removing duplicates and eliminating articles based on review of titles and abstracts, 62 studies remained. Two researchers independently conducted the evaluation of the remaining 62 studies. After the final screening process, 10 studies were included in the systematic review. A detailed overview of the selection of papers and the process of their inclusion can be found in Figure 1.

Picture 1. Study selection flow chart

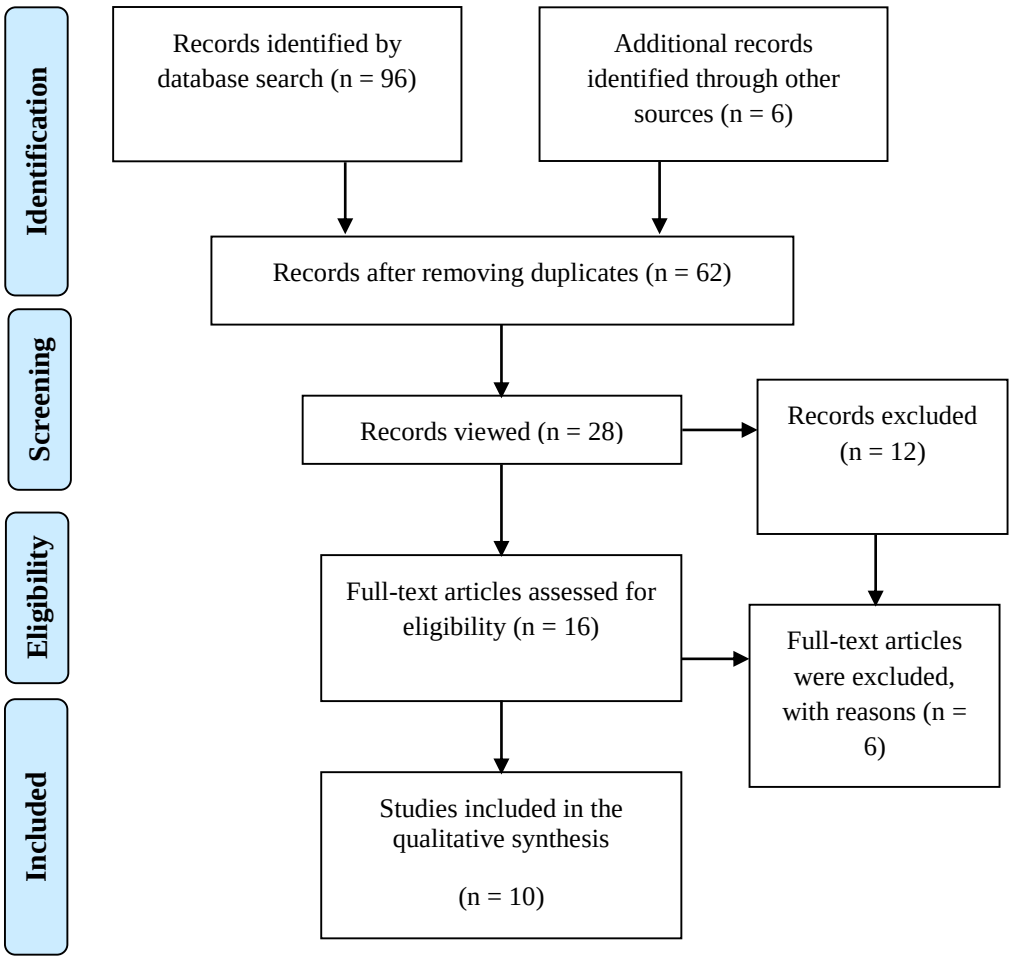

Table 1.Blood lactate concentration (mmol/L) by playing position, playing level, geographical location and gender during the match

Study	Game level / location gender / n	Groups	Playing First halftime	period Second half	A whole basketball match
McInnes et al. (1995)	National Basketball League / Australia / M / 8	All players	-	-	6.8 ± 2.8
Janeira & Maia (1998)	National League Portugal / M / 64	All players	4.5 ± 0.8	3.4 ± 0.5	-
Rodriguez-Alonso et al. (2003)	International and National Team / Spain / Women / 25	PG, SG F, PF, C	-	-	5.7 ± 2.1a,b 4.2 ± 2.1 3.9 ± 2

Rodriguez-Alonso et al. (2003)	International and National Team / Spain / Women / 25	International National training course	5.1 ± 2.4 5.6 ± 1.8 2.8 ± 1.3 c	4.8 ± 2.1 4.9 ± 2.2 2.7 ± 1.0c	5.0 ± 2.3 5.2 ± 2 2.7 ± 1.2 c
Abdelkrim et al. (2007)	National League U19 / Tunisia / M / 38	PG, SG SF, PF C All players	6.05 ± 1.3 d	4.9 ± 1.5	6.4 ± 1.2b 4.9 ± 1.2 5.5 ± 1.2
Matthew & Delectrat (2009)	University sports association / UK / F / 9	All players	5.4 ± 1.5	5.0 ± 1.4	5.2 ± 2.7
Narazaki et al. (2009)	College League II / USA / M & W / 6 and 6	M F All players	-	-	3.2 ± 0.9 4.2 ± 1.3
Abdelkrim et al. (2010)	National League U19 / Tunisia / M / 18	All players	6.2 ± 1.4	5.3 ± 1.4	5.8 ± 1.3
Abdelkrim et al. (2010)	National League U19 / Tunisia / M / 38	International National Man on man Zone	6.6 ± 1.2e 5.7 ± 1.2	5.7 ± 1.2e 4.4 ± 1.4	6.1 ± 1.1e 5.0 ± 1.1 5.2 ± 1.3 5.8 ± 1.1
Scanlan et al. (2012)	State basketball League / Australia / W / 12	PG, SG F, PF, C All players	3.7 ± 0.7 4.4 ± 2.3 4.1 ± 1.7	4.0 ± 1.5 3.2 ± 0.6 3.4 ± 1	3.8 ± 1.0 3.7 ± 1.6 3.7 ± 1.4

Abbreviations: PG – guard; SG – shooter; SF – small forward; PF – progressive; C – center; M – basketball players; F – basketball players; In – below; UK – United Kingdom; significantly ($p < 0.05$) different from small forward; b significantly ($p < 0.05$) different from the centers; c significantly ($p < 0.05$) different from official (national and international) matches; d significant ($p < 0.05$) difference between the first and second half; e significant ($p < 0.05$) difference between groups.

DISCUSSION

Measurement of lactate concentration provides important insight into the physiological response of players, i.e. blood lactate concentration is used as an indicator of energy production by rapid glycolysis (Matthew & Delektrat, 2009; Abdelkrim et al., 2010). The mean blood lactate concentration during a basketball game is slightly above 50% of maximal capacity (51.5–55.9%, range: 2.7 to 6.8 mmol/L; Table 1) (Matthew & Delektrat, 2009), which indicates an important energy contribution through glycolysis. Therefore, these findings indicate the importance of anaerobic preparation for the rapid glycolytic energy pathway of basketball players (Castagna et al. 2008; Castagna, Impelizzeri, Rampinini, D'Ottavio, & Manzi, 2008; Castagna, Impelizzeri, Chaouachi, Ben Abdelkrim, & Manzi, 2011).

Accordingly, high-intensity maintenance and repetition training should be included in basketball players with the goal of improving tolerance to high blood lactate levels and improving lactate threshold markers to overcome fatigue. Also, aerobic training is necessary to maximize lactate clearance during recovery (Balsom, Gaitanos, Ekblom, & Sjodin, 2004) and enhance phosphocreatine regeneration (Tomlin & Wenger, 2001). Therefore, the development of training that considers the interaction between the aerobic and anaerobic systems during the game is necessary to prepare the player for the physiological stress imposed on him. Time comparisons in separate studies reveal that lactate concentration is significantly lower in the

second half compared to the first (Janeira & Maia, 1998; Matthew & Delektrat, 2009; Rodriguez-Alonso, Fernandez-Garcia, Perez-Landaluce, & Terrados, 2003) probably due to a tendency of less vigorous activity and an increase in the number of interruptions towards the end of the match, which allows the removal of lactate. Furthermore, greater performance of low-intensity activity towards the end of a match may result in an increase in the rate of fat metabolism for energy production, which explains the reduced blood lactate concentration. A higher percentage of time spent in high-intensity backfield activities compared to forwards (small forwards and forwards) and centers explains the higher lactate concentration observed in these positions (5.7 vs. 4.2 and 3.9 mmol/L; 6.4 vs. 5.5 and 4.9 mmol / L) (Abdelkrim, El Fazaa, & El Ati, 2007). According to the level of play, professional players (McInnes, Carlson, Jones, & McKenna, 1995; Narazaki, Berg, Stergiou, & Chen, 2009; Abdelkrim, Castagna, El Fazaa, & El Ati, 2010; Klusemann, Pine, Foster, & Drinkvater, 2012) achieve higher lactate concentrations compared to semi-professional players (Rodriguez-Alonso et al., 2003). These observations are consistent with the increased frequency of activity observed in elite basketball players (Abdelkrim et al., 2007). In addition, intrinsic and match factors may contribute to the observed player variation, including the intensity of play prior to blood sampling, as well as the physiological preparation of the player's sample. Also, significant differences were observed among top players in different countries. Available blood lactate concentrations appear to be higher in 25 Australian basketball players than in Tunisian (Abdelkrim, Castagna, El Fazaa, & El Ati, 2010; Abdelkrim et al., 2003) and Spanish (Rodriguez-Alonso et al. al., 2003) and British basketball players (Matthew & Delektrat 2009). However, data obtained from Australian players were recorded before the rule was changed in 2000 and must be treated with caution (McInnes, Carlson, Jones, & McKenna, 1995). Despite great variability between players at different positions, levels of play, and geographic location, gender data show that male and female basketball players achieve similar lactate concentrations during a match (men: 3.2–6.8 mmol/L; women: 2.7–5 .7 mmol/L; Table 1). However, the existing literature in basketball is mainly based on not measuring the lactate concentration in the blood, which should be taken into account when interpreting the findings because no significant correlation has been established between lactate concentration in muscles and blood (Krustrup et al., 2006), where the rate of lactate elimination is higher in muscle than in blood during recovery (Bangsbo, Mohr, & Krustrup, 2006).

CONCLUSION

Studies comparing a sample of players of different levels suggest that a higher level of competition causes more intermittent exertion than a lower level, resulting in higher lactate concentrations. The results of the study show that the concentration of lactate is significantly lower in the second half compared to the first. Professional players achieve higher lactate concentrations compared to semi-professional players. Also, significant differences were observed among top players in various countries, i.e. blood lactate concentration is higher in Australian basketball players than in Tunisian, Spanish and British basketball players. Consequently, more attention should be paid to occasional fitness training,

especially for players who are moving to a higher level, or who are competing at the top and international levels.

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Correspodence:
Nikola Aksović
Faculty of Sports and Physical Education, University of Nis, Nis, Serbia
e-mail: kokir87np@gmail.com