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POWER, HEART RATE AND PERCEIVED EXERTION RESPONSES TO 3X3 AND 4X4 BASKETBALL SMALL-SIDED GAMES

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ABSTRACT: Despite the interest drawn by game adaptations in players' performance development, no study examined the effects of these task constraints in basketball games exercise intensity. Therefore, the aim of this study is to identify differences in power, heart rate and perceived exertion responses to 3x3 and 4x4 basketball small-sided games. Eight young male basketball players participated in this study. Player's individual peak heart rate value and global perceived exertion was registered immediately after two small-sided games, 3x3 and 4x4. Additionally, squat jump and countermovement jump were used to assess power. Our results show that both small-sided games promoted high physiological demands, whereas the players performed the tasks above 80% of HRmax. Nevertheless, another interesting finding of this study is related to the fact that 3x3 contributed to higher physiological demands than the 4x4. The significant increase in the countermovement jump posttest jump results could suggest that the 4x4 were not played as quickly nor intensely as the 3x3. Decreases of the space and number of players in game allow greater self-recreation of players and greater intervention in game. Therefore, the heart rate response during the series displays a higher physiologic impact in 3x3 than in 4x4.

KEYWORDS: Training intensity; heart rate; rating of perceived exertion; basketball

Introduction

Challenges in sport sciences and coaching are not exclusively focused in clarifying the complex structures of performance and their associated parameters. The understanding of interactions between different capacities, contexts and other variables could delimit its influence on the performance of players and teams. Basketball is played by two teams of five players running in an area of approximately 450m^2. However, during the training process, it is common to reduce the number of players on each team and the size of the playable area. These small-sided games are present in the majority of methods used for basketball training. The players are more actively involved in these games and face with higher and continuous concentration all the demands, without breaks. Furthermore, with this reduce game format all players are encouraged to better develop awareness of basic attack and defense elements. Technical and tactical dividends are evident, once players have more time in contact with the ball and therefore more success in decision-making. Additionally, at this point, available evidence suggests that these constraints (i.e., playing area and number of players) promote higher levels of enjoyment and dedication among players, who therefore, further develop at this level (Wall & Côté, 2007). Despite the interest drawn by game adaptations in players' performance development, to authors' knowledge, no study examined the effects of these task constraints on the exercise intensity of basketball games. Similarly, no study has evaluated the physiological, technical, tactical or psychological responses caused by this type of games. Such information could be useful for coaches and to help improve the design of effective physical training programs. Therefore, the aim of this study is to identify differences in power, heart rate and perceived exertion responses to 3x3 and 4x4 basketball small-sided games.

Methods

Participants and procedures

Eight young male basketball players participated in this study (weight: 65.2±5.9 kg, age: 15.5±0.6 years old, and height: 178.1±7.2 cm). Data collection was divided into three stages. First, in order to obtain the player's individual peak heart rate value (HRmax) during this period, all subjects completed the yo-yo intermittent recovery test level 2. Second and third stages corresponded to the application of 3x3 and 4x4 small-sided games. The games total duration was 25 min and consisted in 4×4 min bouts interspersed with 3 min active recovery. The court sizes used for both games kept the ratio player/area of $12m^2$ and $16.8m^2$, respectively for 3x3 and 4x4 games. The participants were well familiarized with all this protocols.

Instruments

Heart rate (HR) was measured (5 s recording intervals) via short-range radiotelemetry (Polar Team Sport System, Polar Electro, Finland). Perceived exertion was registered immediately after the games using the OMNI Perceived Exertion Scale (0-10, Robertson et al., 2005). The Ergojump (Globus Inc., Treviso, Italy) was used to measure the squat jump and countermovement jump flight time and jump height. Results were analyzed using Student *t* test. Statistical significance was set at 5%. Corresponding Cohen's effect sizes were also calculated. All data were analyzed with the statistical package SPSS for Windows, release 16.0 (SPSS Inc., Chicago, IL).

Results

The means, standard deviations, and univariate differences are presented in Tables 1 and 2. The heart rate responses were not significantly different between the two different games (3X3, 173.4±8.3 beats min^{-1}; 4X4, 164.7±16.2 beats min^{-1}). These values

corresponded to an exercise intensity of 87±4% HRmax and 83±4% for 3X3 and 4X4, respectively. These similarities in the heart rate responses to the small-sided game formats were maintained when the individual 4 min exercise and recovery periods were analyzed separately. Perceived exertion was also very similar between both games (3X3, 3.0±0.5; 4X4, 4.1±0.8). No significant differences were found between 3X3 and 4X4 neither between pre and post-tests in squat jump. Differences were, however, identified in 4X4 pre and post-test in countermovement jump, both in flight time ($p=0.021$, $d=0.683$) and height ($p=0.019$, $d=0.694$).

Table 1

Table 2

Discussion

The purpose of this study was to is to identify differences in power, heart rate and perceived exertion responses to 3x3 and 4x4 basketball small-sided games. Our results show that both games promoted high physiological demands, whereas the players performed the tasks above 80% of HRmax. Thus, one may argue that these small-sided games can be used for basketball-specific aerobic training with multifactorial training benefits. All these results confirm the recommendation made to coaches to use this training method as a specific physical training, also called integrated training. Indeed, sided games produce similar cardiovascular stress as other intermittent exercises specifically designed to improve athletes' endurance (Kelly & Drust, 2008). One of the differences between sided games and short-duration intermittent running training methods is the presence of the ball, which imposes a specific activity and allows the improvement of technical and tactical skills with high player motivation. Nevertheless, another interesting finding of this study is related to the fact that the 3X3 game contributed to higher physiological demands than the 4X4 game. Despite the

inexistence of significant differences between both games it is important to enhance the fact that reducing the number of players and the playable area seems to increase the game intensity. Several studies have been confirming the physiological impact of small-sided games on diverse team sports (see Hill-Haas et al., 2008). The game area, the number of players, the game instructions, the number and duration of the series or the total duration of the session directly influence the activity of the players and the physiological impact. Indeed, Rampinini et al. (2007) showed that the intensity of sided games increases while the number of players decreases. Nevertheless, this is also dependent on the playing area, with the game intensity increasing when the available game area is decreased.

The results of the jump protocol reflected significant differences in 4X4 countermovement jump, both in flight time and height. The significant increase in the posttest jump results could suggest that the 4X4 were not played as intensively as the 3X3. Decreases of the space and number of players in game may allow greater self-recreation of players and greater intervention in game. Thus, the HR response during the series displays a higher physiological impact in 3X3 than 4X4.

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TABLE 1. RESULTS OF THE DESCRIPTIVE AND INFERENTIAL STATISTICS OF HEART RATE AND PERCEIVED EXERTION.

		Heart Rate						RPE	
		Period	**Bout**	**Active Recovery**	**% maximum per period**	**% maximum per bout**	**% maximum in active recovery**	**Period**	**Bout**
3X3	Effort 1	176,0±6,9	173,4	152,2	88,4	87,1	76,5	1,7±0,2	3,0
	Effort 2	175,9±9,1			88,4			2,5±0,4	
	Effort 3	170,4±7,7			85,6			3,5±0,4	
	Effort 4	171,1±9,6			86,0			4,2±1,0	
4X4	Effort 1	165,9±17,7	164,7	144,7	83,3	82,7	72,7	2,8±0,4	4,1
	Effort 2	167,1±17,6			83,9			3,8±0,9	
	Effort 3	165,9±15,1			83,3			4,7±0,9	
	Effort 4	160,1±14,2			80,4			5,0±1,0	

TABLE 2. RESULTS OF THE DESCRIPTIVE AND INFERENTIAL STATISTICS OF ERGOJUMP TESTS.

Test	**3X3 (3x3)**			**4X4 (4x4)**		
	M		SD	M		SD
Squat Jump, cm						
Flight time						
Pre-test	0,521	±	0,026	0,498	±	0,034
Post-test	0,503	±	0,034	0,499	±	0,033
t	1,240			-0,054		
p	0,270			0,958		
Height						
Pre-test	0,366	±	0,073	0,305	±	0,042
Post-test	0,311	±	0,043	0,306	±	0,039
t	1,979			-0,046		
p	0,105			0,965		
Countermovement jump, cm						
Flight time						
Pre-test	0,553	±	0,040	0,549	±	0,035
Post-test	0,549	±	0,037	0,570	±	0,041
t	0,486			-2,959		
p	0,648			0,021*		
ES				0,683		
Height						
Pre-teste	0,390	±	0,072	0,370	±	0,048
Post-teste	0,371	±	0,049	0,400	±	0,055
t	0,811			-3,046		
p	0,454			0,019*		
ES				0,694		

$p \leq .05$