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Heart rate and body temperature response of wheelchair basketball players in small-sided games

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Abstract

The purpose of this study was to analyze the physiological response of wheelchair basketball (WB) players during the different bouts of a training task (4 vs. 4). Twelve WB players participated in this study (25.3 ± 2.4 years). Five sessions of the small-sided games (SSG) were performed, with 4 sets each session and a rest interval of 2 min between each one. Significant differences were found (p<0.05) in heart rate peak (HRpeak) in the last three bouts in comparison to the first (169.5 ± 12.47, 170.78 ± 12.80, 170.03 ± 11.78 vs. 167.19 ± 11.74 beat•min^{-1}). Mean HR (HRmean) showed a similar trend, but there were also significant differences (p<0.05) between the second and third bouts (156.37 ± 12.04 vs. 158.21 ± 11.82 beat•min^{-1}). Body temperature remained constant during the first three bouts and showed a significant increase (p<0.05) in the fourth bout. During the SSG, HRmean was similar to that obtained in other studies of official matches, so they could represent an adequate training task for improving WB performance. However, special attention should be paid to the number of bouts performed in the training sessions as the physiological response was not constant.

Key words: heart rate, temperature, internal load, intensity, fatigue.

1. Introduction

Wheelchair basketball (WB) is one of the most popular specialties in the Paralympic Games (Croft *et al*., 2010), and is played by athletes who have a physical disability (paraplegia, amputations, spinal cord injuries, joint or musculoskeletal injuries, and similar conditions) which prevent them from playing able-bodied (AB) basketball players. This sport is regulated at the national level by the Spanish Federation of Sports for People with Physically Disabilities (FEDDF) and at the international level by the International Wheelchair Basketball Federation (IWBF), organizations which are responsible for the promotion and supervision of sports for people with physical disabilities.

Previous studies have analyzed the physiological responses of WB players in different game situations (Bloxham *et al*., 2001; Coutts, 1992). In this way the aerobic capacity has been defined as an important element for these WB players (Goosey-Tolfrey, 2005;

Vanlandewijck *et al*., 1999). These studies have determined that about 28% of the active part of the game is anaerobic and high intensity, with a multitude of accelerations and continual contests for the ball, while 48% of the total match time is taken up with recovery (Bloxham *et al*., 2001). In the same line of thought, other authors state that during the match the players reach high mean heart rates, which implies a great demand on cardiovascular capacity (Croft *et al*., 2010).

Sports coaches and scientists who are interested in this sports specialty are continually trying to improve training methods and optimize drills to respond to the specific needs of the game (Roy *et al*., 2006). In the same way as with AB sports, studies are necessary to determine the requirements of the different tasks, and it is crucial to know their physiological demand to guarantee that training reflects the demands of the sport and the competition.

One of the most frequently used drills by basketball coaches with the aim of inducing physical adaptations and specific abilities in their players is playing in small-sided games (Taylor, 2004). These small-sided games (SSG) are frequently played using modified courts and rules and a smaller number of players on the court (Castagna *et al*., 2011). These games are less structured than traditional training methods, but are very popular with players of all ages and levels (Castagna *et al*., 2011). Exercise intensity in SSG has typically been assessed by monitoring heart rate (HR), blood lactate or rating of perceived exertion (Hill-Haas *et al*., 2011). However, HR is the most common measure used to objectively monitor training intensity in many sports (Achten and Jeukendrup, 2003). Several studies have shown that it is an indicator of exercise intensity (Drust *et al*., 2007; Esposito *et al*., 2004). However, in spite of the large number of scientific research papers which have been published on SSG in different sports (Ade *et al*., 2014; Delextrat and Martínez, 2014; Harrison *et al*., 2013) we have not found any systematic study which aimed to evaluate the physiological demands of SSG in WB players. Consequently to gain information on the physiological response of specific WB tasks could be of great practical interest (Stone and Kilding, 2009).

The objectives of this study were therefore, on the one hand, to analyze the physiological response (HRpeak, HRmean and body temperature) of elite WB players in a type of SSG (4 vs. 4), and on the other, to determine the differences in these physiological variables among the different bouts.

2. Methods

2.1. Study design

The study lasted 5 weeks between November and December when the team was in the middle of the League competition. Five sessions were organized (once a week on Tuesdays), of a 4 vs. 4 SSG, with 4 sets separated by a 2 min rest period of passive recovery between each one (Dellal *et al*., 2011), on their own training court and in a space of 28 x 15 m. All the players knew the rules of the SSG as it was a customary drill in their team training. In all the sessions the two teams were formed in such a way as to have equal total points on the IWBF classification system. Before each session all the players performed a standard warm-up which consisted in 5 min smoothly propelling

the wheelchair, two accelerations of 10 m in a straight line and two accelerations of 20 m with a change of direction. The players were not allowed to drink any liquids during the SSG.

2.2. Participants

Twelve WB players (25.3 ± 2.4 years, 77.3 ± 4.1 kg, 11.2 ± 1.4% body fat) who were members of a team which played in the First Division of the Spanish WB League participated in this study. All the participants had a minimum of 5 years experience in this sport specialty and possessed a license from the FEDDF and the corresponding IWBF functional classification. None of the participants carried out specific strength training, and all trained twice a week and played an official match every week. The study was carried out with the consent of the club they belonged to. All the participants were informed about the objectives of the research, participated voluntarily in the study from which they could withdraw at any time, and signed the required informed consent. The procedures followed the guidelines of the Declaration of Helsinki (2013) and were approved by the Ethics Committee at the University of the Basque Country (UPV/EHU).

2.3. Procedures

Heart rate monitoring:

Heart rate (HR) was monitored (Croft *et al*., 2010; Delextrat and Kraiem, 2013) during all the SSG bouts every 5 s (Polar Team Sport System®, Polar Electro Oy, Finland) (Los Arcos *et al*., 2013). In this way HRpeak was obtained for the game and HRmean for each of the bouts.

Body temperature:

Body temperature was taken by measuring the temperature in the ear with a thermometer (ThermoScan® IRT 4520 5, Braun GmbH, Kronberg, Germany) immediately after finishing each of the sets of SSG, following the protocol stipulated by Hamilton *et al*. (2013).

2.4. Statistical Analysis

The statistical analysis was carried out using the Statistical Package for Social Sciences (SPSS Inc, version 20.0 Chicago, IL, U.S.A.). The results are presented as means ± standard deviation (SD). All the variables showed a normal distribution according to the Shapiro-Wilk test. Repeated measures ANOVA and Bonferroni post hoc tests were used to determine the differences existing among the different bouts of the SSG. The upper limit for statistical significance was set at $p<0.05$.

3. Results

HRpeak reached by the players in the 4 sets of SSG was 167.38 ± 11.62 beat•min^{-1}. Significant differences ($p<0.05$) were found in HRpeak reached in bouts 2, 3 and 4 with regard to that attained in bout 1 (Figure 1).

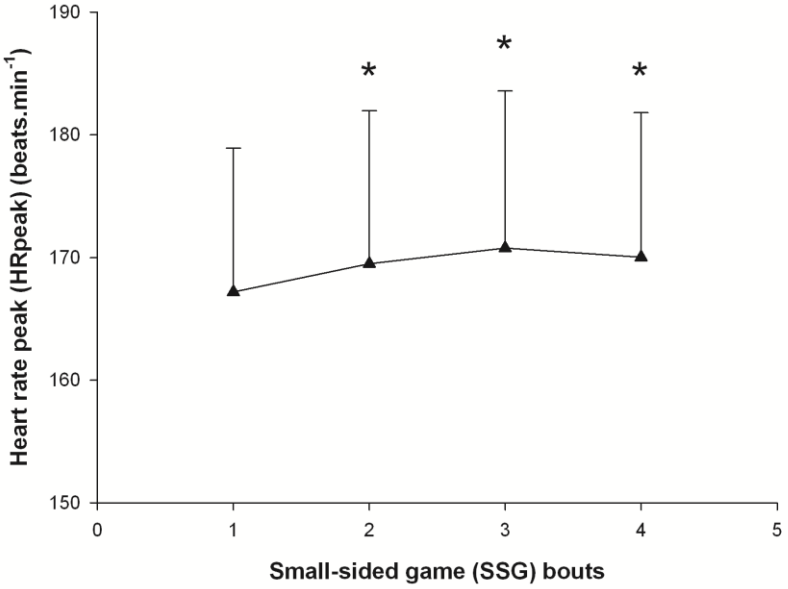

Figure 1 Heart rate peak (HRpeak) response in the different bouts of the small-sided games. *Significant differences in comparison with bout 1, $p<0.05$.

The WB players participating in this study obtained an average HRmean in the four bouts of 156.44 ± 11.46 beat•min^{-1}. The results of the HRmean in each of the bouts are shown in Figure 2. Significant differences ($p<0.05$) were obtained between sets 1-2, 1-3, 1-4 and 2-3.

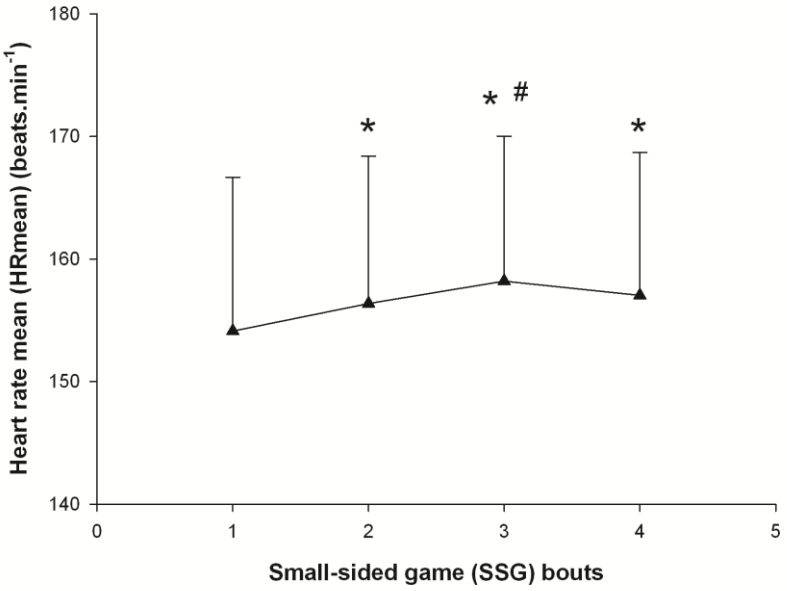

Figure 2 Heart rate mean (HRmean) response in the different bouts of the small-sided games. *Significant differences in comparison with set 1, $p<0.05$. #Significant differences in comparison with set 2, $p<0.05$.

Mean body temperature in the 4 bouts was 36.86 ± 0.61 ºC. The players' body temperature was maintained constant during the first three bouts but increased significantly in the last one (Figure 3).

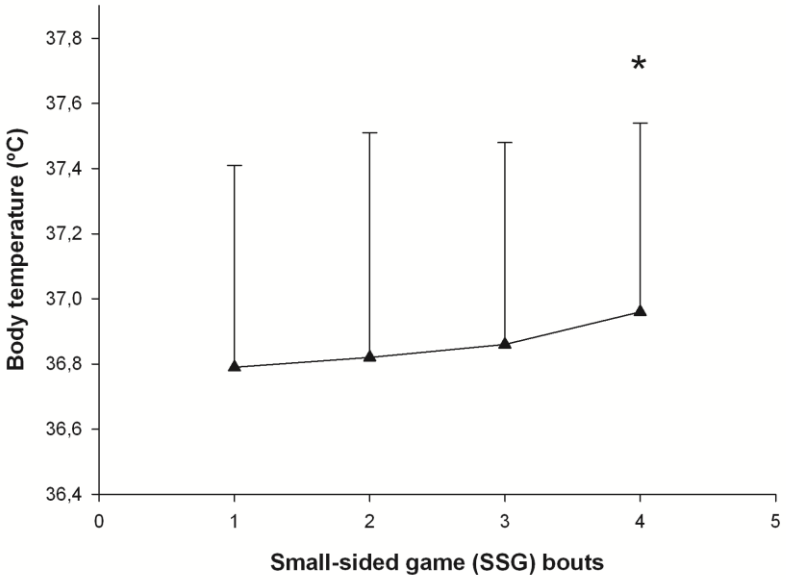

Figure 3 Body temperature response in the different bouts of the small-sided games (SSG). * Significant differences in comparison with bouts 1, 2 and 3, $p<0.05$.

4. Discussion

The physiological demands of matches and SSG have been widely studied in basketball. However, we have not found any studies which analyze the requirements of these games in WB players. Therefore the main objective of this study was to analyze the physiological response (HRpeak, HRmean and body temperature) of WB player during the different sets of a training drill (4 vs. 4). The results of the research suggest that 4 vs. 4 SSG produced a HRmean similar to that obtained in other studies in official games, so that it represents a valid training drill for improving WB performance. However, the coaches should pay special attention to the number of bouts performed in the training session as the physiological response (HRpeak, HRmean and body temperature) was not constant throughout all the bouts.

The results obtained in the present study, mean values for the 4 bouts and during the five weeks of the intervention showed a HRpeak of 167.38 ± 11.62 beat•min^{-1}. These values were 13.5% lower than those obtained by Croft *et al*. (2010) in elite WB players in official matches during the Paralympic World Championship (190 ± 12 beat•min^{-1}). However, the HRmean registered by the players in the present study in the SSG was similar (156.44 ± 11.46 vs. 163 ± 11 beat•min^{-1}, mean difference = 4.02%) to that obtained by WB players in an official match in the study by Croft *et al*. (2010). Coutts (1988) also reported similar results in a match placed by WB players (148 ± 6.4 beat•min^{-1}, range: 135-181 beat•min^{-1}). In spite of the differences found in HRpeak between the SSG and the match, the results from the present study determined that the HRmean in a SSG of 4 vs. 4 was similar to that observed during an official match. This

aspect suggests that SSG can be a useful training tool for simulating competitive conditions.

This is the first study which we have found which analyzed the response of these physiological variables in different SSG bouts with WB players and determined that the physiological response (HRpeak, HRmean and body temperature) was not constant during all the bouts. With regard to HRpeak, differences were revealed in the last three sets 2, 3 and 4 (169.5 ± 12.47, 170.78 ± 12.80 and 170.03 ± 11.78 beat•min^{-1}) in comparison with the first (167.19 ± 11.74 beat•min^{-1}). HRmean showed a similar trend (156.37 ± 12.04, 158.21 ± 11.82, 157.03 ± 11.68 vs. 154.00 ± 12.54 beat•min^{-1}), although there were significant differences between the second and the third bouts (156.37 ± 12.04 vs. 158.21 ± 11.82 beat•min^{-1}). Regarding the results obtained, it can be concluded that the intensity of the exercise for the WB players increased up until the third set and then curiously in the fourth set HRmean did not change in comparison with the third. These results contrast with the data obtained on body temperature. This variable remained constant during the first three sets and then increased significantly in the fourth (36.79 ± 0.62, 36.82 ± 0.69, 36.86 ± 0.62 vs. 36.96 ± 0.58 ºC,). Body temperature plays an important role in physical performance (West *et al*., 2013), as its increase has been associated with fatigue in athletes. Several studies state that during exercise there is a loss of body water which provokes an increase in body temperature (Armstrong *et al*., 1985; Buono and Wall, 2000; Sawka, 1992). If there is not an adequate consumption of liquids the player's capacity for thermoregulation is diminished (Jung *et al*., 2005; Murray *et al*., 1987; Sawka, 1992) and thus their ability to perform. The players in our study were not allowed to drink any liquids during the SSG, so that dehydration could have been one of the causes of the increase in body temperature. This aspect is interesting for coaches, and further research is warranted into the causes and preventive measures which could be applied to maintain the levels of hydration and temperature in WB players, especially with those who have spinal cord injuries as they have a diminished capacity for thermoregulation (Bhambhani, 2002).

However, in spite of the significant increase in body temperature in the last bout, this was not reflected in an increase in HRpeak or HRmean in the fourth set. This aspect can be considered as coinciding with the lack of correlation between HR variables and body temperature. According to the results obtained, it can be seen that these variables respond differently during the SSG bouts. Further studies are therefore necessary to analyze the response of these variables and determine which parameters are the most suitable for observing the level of fatigue in the different SSG bouts.

5. Conclusions

The HRmean registered by the WB players during a SSG of 4 vs. 4 was similar to the values obtained in other studies of official matches, which suggests that the physiological demands could be similar. This aspect shows that SSG could be a useful tool for simulating competitive conditions.

The analysis of the physiological response shows that it was not constant throughout all the bouts. HR increased up until the third set, while body temperature only increased

significantly in the fourth set. Dehydration is thought to be one of the possible causes of the increase in body temperature in the last set, so that it could be advisable to study the optimal quantity of liquid that WB players should consume in more depth.

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