Heart Rate and Energy System Analysis: Study on Men's Doubles Badminton

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Abstract
The more accurate athletes' physiological data, the easier it takes to maximize the performance. It is crucial to acknowledge the standard heart rate (HR) and energy system as the prerequisite of men's doubles badminton. This study aims to quantitatively analyze the standard HR during the game, while the anaerobic threshold was examined to determine the percentage of the energy system. Further, this study is descriptive research which utilized repeated measurement analysis using Polar Team to obtain data during the game in full competition system. In conclusion, the result indicates the average HR during the game is in a submaximal category and the extent of anaerobic energy system which determined from the anaerobic threshold that reached almost 50%.

Keywords: Heart rate, energy system, badminton, men's double

Introduction
Men's double badminton is a sport that requires special preparation of all things, one of which is physiological factors. This is made clear by Less that improving badminton performance requires a combination of aerobic and anaerobic fitness (Lees, 2003) which reflected in the demands of games with high intensity and disjointed. Ming Kai, et al (1995) explained that elite players need a combination of aerobic and anaerobic systems and the percentage depends on the demands of the competition. It is proved that the men's doubles player needs different specific physiological needs with a single player or double the other.The research results of Alcock A and Cable N.T. (2009) Shows the average and peak results of heart rate double players during matches 75% and 89%. In one double player, HR remains above 90% maximum for 46.9% playing time. The duration of the match ranges from 45 minutes, according to the high-level average game with the current score system (Gawin, W. Beyer, C. & Seidler, M. 2015).

The study results of Alcock A and Cable N. Team (2009) showed that the HR pattern of men's doubles was stable at the start of the match and fluctuated during the match. HR in doubles shows major changes throughout the game and the majority when playing is in the range of 70-80% maximum. This explains that the athlete's abilities are different which is usually caused by a balanced game so that the players are required to play harder with longer demonstrations.

In addition, the main points that are rarely discussed in research are the performance of several players, namely the dominant energy system. The dominant energy system in male double badminton players with fast and high power characteristics requires them to move using a lot of anaerobic energy. This determination of the dominant energy system can be done by determining the point of emergence of the anaerobic threshold. This is needed by every male double player to maintain his performance while playing with an intermittent type where there are high agility and strength movement. During the match, oxygen consumption for aerobic energy production is complemented by an anaerobic mechanism, resulting in a significant increase in lactic and metabolic acidosis, so this event is called an anaerobic threshold (Wasserman K., 1984). Some factors that are considered to influence changes in threshold include the biggest factor that changes the threshold is about 65-80% of VO2 max training in athletes with long duration and at 50-60% in individuals who are less mobile (SK Powers, & Howley ET., 2010).

Methods

This research is in the form of quantitative with descriptive type. The number of samples is 16 players with the sampling technique using purposive sampling with the criteria of activities of badminton students who have regional, provincial, national achievements and have participated in international championships. The matches are carried out 7 times for 3 consecutive days by each pair of players with the implementation of each day including on the first day 3 matches and the next day each of the two matches.

Retrieval of data is divided into 2 types including taking HR on Game data carried out in the field using the help of the polar team taken for 7 times the match is recorded every 30 seconds. While anaerobic threshold data collection was carried out in a laboratory with fitmate pro 1 test. Test assumptions carried out there are 2 parts, namely the test for normality and sphericity. The process of analyzing data is two ways including descriptive and inferential. Descriptive is used to calculate the percentage of anaerobic energy system which is calculated from the anaerobic threshold divided by time multiplied by 100 and describes the average HR in Game results for 7 matches. While repeated measurements are used to calculate the heart rate in games in seven matches.

Result and Discussion

Table 1. Physiological characteristics of athletes

Player Team	HR on The Game		% Anaerobic System	
	P1	P2	P1	P2
1	181	183	39.2	50
2	172	174	64.7	28.6
3	174	182	53.3	38.5
4	172	181	64.7	45.5
5	171	152	36.4	41.7
6	176	174	56.3	50
7	179	168	53.8	41.7
8	175	178	41.2	44.4
MEAN	174.5		46.9	

The results of the HR on Game above indicate that each pair has a higher HR, this indicates that the height of each partner's HR is due to several factors including being an attacker who functions to carry out many attacks such as smashes or drives and receives a lot of pressure from opponents. This is inversely proportional to the pair with a partner who has lower HR indicating that the majority of these players become play makers during the match. Overall, the average HR of male doubles players during competitions in the sub-maximal category is 174.5 ± 7.This shows that the game of men's double does not always carry out a continuous smash attack but rather does a lot of short playing such as netting, pushing backwards and drives to lure opponents to lift the shuttlecock.

When viewed from the results of the percentage of the anaerobic system, there are two teams of players whose energy systems are predominantly aerobic. It can be said that the two team partners did not tolerate long intensity movements. Also, each of the other pairs that one partner has an anaerobic dominant energy system shows that the game tends to be unbalanced in the attack, it is evident that the results of monitoring in the playing field tend to be one of the pairs to be a full play maker. This is the weakness of every couple when attacked by an opponent. Overall, the average percentage of the anaerobic system is 46.9 ± 10. Clarified from the results of Alvarez et al. (2014), it is explained that the increase in anaerobic threshold seen from% AT-HR max on players influences significant body adaptability to high-intensity stresses.

Table 2. Test of normality in each match

Match	Shapiro-Wilk
	Sig.
M1	.061
M2	.486
M3	.281
M4	.936
M5	.461
M6	.460
M7	.297

The results of the above normality test illustrate that the assumptions made show all normal data. Next is the calculation of the variance of similarity by looking at the results of the Mauchly's Test of Sphericity table.

Table 3. Test the similarity of variants

Mauchly's Test of Sphericity[a]	
Within Subjects Effect	Sig.
Match	.031

The results of the table above show that there is no significant difference in HR on the game between matches. So that this can be deduced every time the average HR on game difference is too small.

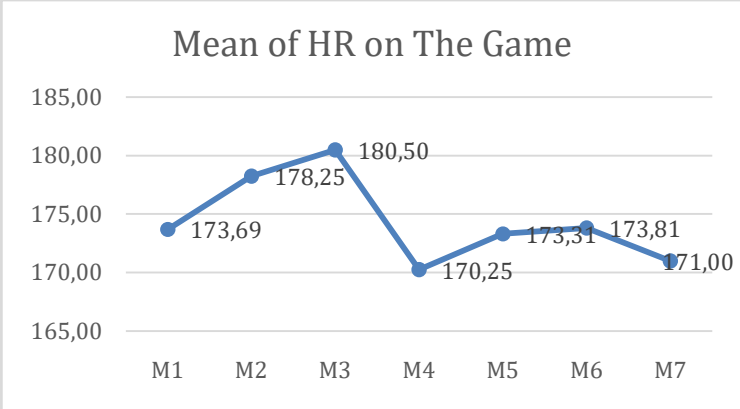

Figure 1. Average heart rate of each match

The small difference in plain view can be seen in match three vs four. But we need to see the difference significantly from the pairwise table below.

Table 4. The results of the comparison of the significant heart rate in each match

Pairwise Comparisons					
(I) Match		Mean Difference (I-J)	Sig.[b]	95% Confidence Interval for Difference[b]	
				Lower Bound	Upper Bound
M2	M4	8.000*	.007	2.580	13.420
	M7	7.250*	.047	.118	14.382
M3	M4	10.250*	.017	2.130	18.370
	M5	7.188*	.044	.207	14.168
	M7	9.500*	.004	3.478	15.522

The table above proves that there are too few differences, from 49 comparisons only five comparisons differ significantly. We can see the table above shows that the most significant differences were found in matches 3 and 4 with a mean of different magnitudes 10.250 with a range of differences between 2,130 to 18,370 in the 95% confidence level.This indicates that the fourth match in each player has a decrease in physiological side caused by fatigue as a result of the lack of maximum recovery time after doing the third match.

Conclusion

Each pair of male double badminton players is expected to have anaerobic dominant energy system with the help of a consistent decrease in recovery pulse so that it is easier to tolerate fatigue during intermittent play. The HR on Game limit is recommended to maximize the performance of each point by maintaining or immediately lowering HR to the submaximal limit.

References

Cabello D, Padial P, Lees A, and Rivas F. (2004). Temporal and physiological characteristics of elite women's and men's singles badminton. *Int J Appl Sport Sci*, 16 (2): 1–26.

Cabello M. D, & González-Badillo J. (2003). Analysis of the characteristics of competitive. badminton. *Br J Sports Med*, 37 (1): 62–6.

Cheong, H. O. et al.(2009). Physiological characteristics of elite and sub-elite badminton players. *Journal of Sports Sciences*. 27(14): 1591–1599. doi: 10.1080/02640410903352907

Chee L. M., Chen C. K. and Ghosh A. K., (2008) Time Motion and Notational Analysis of 21 Point and 15 Point Badminton Match Play. *International Journal of Sports Science and Engineering* Vol. 02 (2008) No. 04, pp. 216-222

Chin MK, Wong AS, So RC, et al. (1995). Sport specific fitness testing of elite badminton players. *Br J Sports Med*, 29 (3): 153–7.

Chien-Lu, T., Chan-Chang, Y., Mei-Shiu, L., & Kuei-Shu, H. (2005). The surface EMG activity analysis between badminton smash and jump smash. *23 International Symposium on Biomechanics in Sports*. 483-486.

Cosmed (2012). *Fitmate Series Cardio Pulmonary Exercise Testing & Nutritional Assessment, Fitmate User manual* (14th Ed). Italy.

Fahimi F, & Vaezmousavi M. (2011). Physiological patterning of short badminton serve: a psychophysiological perspective to vigilance and arousal. *World Appl Sci J*, 12 (3): 347–53.

Faude, O., et al., (2007). Physiological characteristics of badminton match play. *Eur J Appl Physiol*, 100: 479–485.

Glaister M. (2005). Multiple sprint work: physiological responses, mechanisms of fatigue and the influence of aerobic fitness. *Sports Med*.35:757–77.

Jeyaraman R, District E, & Nadu T. (2012). Prediction of playing ability in badminton from selected anthropometrical physical and physiological characteristics among inter collegiate players. *Int J Adv Innov Res*, 2 (3): 11.

Majumdar P, et al. (1997). Physiological analysis to quantify training load in badminton. *Br J Sports Med*. 1997;31(4):342–5.

Phomsoupha, M., & Laffaye, G. (2015). The science of badminton: game characteristics, anthropometry, physiology, visual fitness and biomechanics. *Sports Medicine*, 45(4), 473-495.

Polar Team. (n.d.). *User guide manual*. Diperoleh dari https://support.polar.com/e_manuals/Team_Pro/Polar_Team_Pro_user_manual_English/manual.pdf

Qi-Qi Zhang (2016). The Analysis and Conclusion of 2015 Chinese Badminton Team's Result in Sudirman Cup. *3rd International Conference on Advanced Education and Management*. ISBN: 978-1-60595-380-9.validation

Singh, J., Raza, S., & Mohammad, A. (2011). Physical characteristics and level of performance in badminton: a relationship study. *J Educ Pract*, 2 (5): 6–10.

Singh, R. (2012). Assessment of physiological variables of badminton players. *Int J Behav Soc Mov Sci*, 1 (4): 166–73.

Subramanian, A. (2013). Investigation of the factors predominent to badminton playing ability. *Acad Sport Sch*, 2 (8): 1–6.

Tiwari, L. M., Rai, V., & Srinet, S. (2011). Relationship of selected motor fitness components with the performance of badminton player. *Asian J Phys Educ Comput Sci Sports*, 5 (1): 88–91.

Wonisch, M., Hofmann, P., Schwaberger, G., Duvillard, S., & Klein, W. (2003). Validation of a field test for the non-invasive determination of badminton specific aerobic performance. *Br J Sports Med*. 37:115–118

Zhong, D. & Xie, X. (2008). Study on skill of third stroke for excellent players in badminton's men's double. *Journal of Capital Institute of Physical Education*, 20 (5), 123-125.