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DIFFERENT TEAM DEFENSE TACTICS AND HEART RATE DURING A FIELD HOCKEY MATCH

INTRODUCTION

Modern professional training in different sports is based on many variables observed during training matches and competitions [4, 5, 6]. The recording of physical activity and measurement of different physiological parameters of players during a match can be useful to estimate demands during a field hockey game. This issue has been discussed in relation to different sports by many researchers [3, 5]. One of such variables is the heart rate, which displays an internal picture of body's reaction to diverse physical and psychological loads. Monitoring the heart rate is used to control adaptation changes during a training process and qualify the types of exercise [2] to prepare better individual exercise loads for competitors.

The researchers and coaches note that the replacement of natural grass with an artificial playing surface has changed different elements of field hockey games such as players' technical, tactical and physiological requirements [3]. Field hockey has become a swift and skill-based game [1], in which numerous changes of action require a high level of endurance and velocity preparation [4].

The above transformations point to the question of relationships between energy cost, heart rate and tactical tasks in field hockey. Publications on this subject have been rare and very often they are merely theoretical presumptions.

There are different defense and attack systems in field hockey. The most popular team defense tactics in field hockey are: man-to-man marking, zone marking and combination of both. In *man-to-man marking*, one defender takes on a specific responsibility for one opponent. Although the opponent may have difficulty escaping and using space, this system requires a huge

amount of discipline from every player on the team. With *zone marking*, each defender takes responsibility for an opponent entering their zone of defense. The zone concentrates on the region of greatest danger but also ensures that cover is provided around the zone should the point of attack be changed to another area on the field [1].

But which system is better and more effective for a team? Which tactics system permits to realize the assumptions of the game with lower energetic expenditure? Which system lets the players achieve the final effect (win) at the lower cost? The available literature gives no clear answer to these questions.

The main objective of this study was to examine the heart rate responses and estimate energy expenditure of competitive field hockey played in two different team defense tactics: man-to-man marking and zone marking, to see which one will turn out to be useful in planning tactical solutions with reference to players' capabilities.

METHODS

Ten players from the Polish National Field Hockey Team took part in the study. Height and body mass (standard tools), body fat (BIA 101, Italy; BODYGRAM[®] ver.1.3), maximal oxygen uptake (Oxycon Mobile, Jeager), were measured in all subjects (Table 1). The results were obtained as a part of a larger research project carried out by the Department of Theory of Sport in cooperation with the Departments of Anthropology and Physiology of University School of Physical Education in Poznań, Poland.

Table 1. Individual characteristics of players

Subject	Playing position	Age (year)	Height (cm)	Weight (kg)	Body fat (%)	BMI	VO _{2max} (ml/kg/min)
1	Centre back	30	186.5	82.6	17.7	23.9	49.6
2	Right back	23	177.0	77.3	8.5	24.7	48.5
3	Left back	30	172.5	71.5	13.9	24.2	51.6
4	Centre midfield	31	171.4	67.7	10.5	23.2	59.9
5	Left midfield	23	177.5	75.5	14.8	24.1	55.8
6	Right midfield	20	174.8	67.0	5.4	22.1	58.6
7	Centre midfield	23	175.7	66.9	11.9	21.8	53.3
8	Right wing	30	169.5	64.3	15.3	22.5	52.6
9	Left wing	33	176.6	70.5	25.5	22.8	59.3
10	Centre forward	23	179.6	70.3	14.6	21.9	54.0
Mean±SD		26.60±4.60	176.11±4.76	71.36±5.61	13.81±5.47	23.12±1.05	54.32±4.00

The heart rate (HR) of each player was recorded at 5-second intervals during two friendly matches between Poland and Russia, played in two different team defense tactics: man-to-man marking (the first match – M I) and zone marking (the second match – M II) using the Polar Team SystemTM (Polar Electro, Finland). This device consisted of an electrode belt which recorded ECG signals without using a wristwatch (unlike in older version of sport-testers), which is important as it is easy and more practical to use, especially during a field hockey match or training. The belt was strapped around the chest at the lower end of the sternum. The data stored in the belt was transferred to the computer and processed with the Polar Precision PerformanceTM 4 SW after the matches. On the basis of individual players' data, the program displayed the heart rate (beats/min) and automatically estimated energy expenditure (kcal).

The collected data were grouped, depending on a player's position, into the backs, midfielders and forwards.

The results were then statistically processed. The means and standard deviations were calculated using Microsoft Excel. To assess the significance of differences between the mean values in consecutive observations, a t-test for a dependent sample was used ($p=0.05$).

RESULTS

The individual characteristics of players are shown in Table 1. It can be concluded that the competitors constituted a rather homogenous group taking into consideration the presented data.

The mean value of the heart rate in the first match was 130.70 ± 8.52 (beats/min) and 123.70 ± 10.04 (beats/min) in the second one. The average maximal heart rate amounted to 186.00 ± 6.53 (beats/min) (M I) and 182.50 ± 6.75 (beats/min) (M II). The energy expenditure amounted to 885.10 ± 193.82 (kcal) in M I and 833.90 ± 194.56 (kcal) in M II.

Table 2. Individual internal reaction on competition loads. (* $p=0.05$)

Subject n=10		Mean HR (beats/min)		Maximal HR (beats/min)		Energy expenditure (kcal)	
		M I	M II	M I	M II	M I	M II
1	Centre back	141	138	192	184	1202	1186
2	Right back	128	123	178	175	980	944
3	Left back	123	112	186	175	804	676
4	Centre midfield	136	125	188	188	921	868
5	Left midfield	118	115	173	172	625	715
6	Right midfield	127	115	192	182	737	667
7	Centre midfield	148	142	194	193	110	1175
8	Right wing	126	123	187	189	625	763
9	Left wing	127	116	183	183	486	812
10	Centre forward	133	128	187	184	1011	1033
Mean±SD		130.70±8.52	123.70*±10.04	186.00±6.53	182.50*±6.75	885.10±193.82	833.90*±194.56

The differences between the first and the second match in each parameter were statistically significant. Detailed results are shown in Table 2.

The analysis of data, considering a player's position on the pitch, has shown that the mean value of HR in every case decreases during the second match as compared with the first match (Tab. 3).

Conclusions:

The results of this study suggest that the zone marking system is less loaded than the man-to-man system, as regards the energy expenditure and heart rate. The study shows that heart rate monitoring is the most viable method of internal loads in field hockey. In order to physically prepare players for competition, their

Table 3. Internal reaction dependence on playing position

Playing position	Mean HR (beats/min)		Maximal HR (beats/min)		Energy expenditure (kcal)	
	Match I	Match II	Match I	Match II	Match I	Match II
Backs	130.67±3.29	124.33±13.05	185.33±7.02	178.00±5.20	995.33±199.44	935.33±255.11
Midfielders	132.25±12.81	124.25±12.74	186.75±9.50	183.75±9.03	845.75±208.86	856.25±208.86
Forwards	128.67±3.79	122.33±6.03	185.67±2.31	185.33±3.21	827.33±193.68	869.33±142.84
Mean ±SD	130.70±8.52	123.70±10.04	186.00±6.53	182.50±6.75	885.10±193.82	833.90±194.56

Another situation was noted in the case of energy expenditure. The midfielders and forwards used up more energy in the second match than in the first one, even if the HR was lower. In the case of the backs the energy expenditure was lower in M II. Detailed results are presented in Table 3.

training programme should take into consideration loads assigned to each individual playing position in different playing defense systems in order to stimulate these competitive demands in terms of real play for loads equal or higher than during a real match.

DISCUSSION

Field hockey players cover the average distance about 10.000 m during one match. The distance depends on the playing position and amounts to 9.300 m for defenders, 10.300 m for midfielders and 10.870 m for forwards. The medium velocity was estimated at 2.2-2.59 m/s and maximal (temporary) velocity at 8.03-9.27 m/s [4].

It is clear that the level of loads for each competitor during a match is high. Astrand and Rodahl [2] classified exercise as extremely heavy, if the heart rate amounted to 150 beats/min. The maximal heart rate in this study (186±6.53 and 182.5±6.75 beats/min) and average HR (130.7±8.52 and 123.7±10.04 beats/min) indicate therefore high physiological requirements of the game. Different authors [2, 3, 5] emphasize that specific training of maximal aerobic power must be one of the fundamental components in the physical training programme. The heart rate gives some information about the energy system being used. However, the coach must also remember about the anaerobic components of physical training, because they take up to 60% of competitor effort (Sharkey, 1986) and are required during a field hockey game. The studied players confirm this fact with their results of VO_{2max} (54.32±4.00 ml/kg/min – tab. 1) during proper preparation to play.

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