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CHARACTERISTICS OF DIFFERENCES IN ENERGY EXPENDITURE AND HEART RATE DURING INDOOR AND OUTDOOR FIELD HOCKEY MATCHES

Key words: field hockey, indoor hockey, heart rate, energy expenditure, polar team system, competitive loads.

ABSTRACT

The types of internal loads players use up during field hockey matches have been well-known; however, there is no available data with reference to indoor hockey – a "new-old" game created on the basis of the outdoor version of field hockey by enthusiasts of playing the game all year round. Indoor hockey competitions are currently held at the top world level. The main aim of this study was to examine possible differences in players' heart rate and energy expenditure in both kinds of field hockey, and estimate the influence indoor hockey could have on top league competitors' preparation for the outdoor season. The research revealed no differences in the specific character of indoor and outdoor hockey matches, and it pointed to the necessity of careful inclusion of indoor hockey practice into field hockey training macrocycles.

INTRODUCTION

Contemporary professional training in different sports involves a number of variables during training practice competitions [7, 9]. One of these variables is the athlete's heart rate. Heart rate is an easy to use factor to control adaptation changes during training and adjust the type of exercise [2] to prepare individual exercise loads for competitors more effectively [6]. Individual preparation of each player on a team depends on the knowledge of personal predispositions to different kinds of work. Recently, the winter training form of field hockey has become a new sport itself under the name of "indoor hockey". Thus, if competitive loads in outdoor and indoor hockey can be similar, the players' preparation for competition can be realized in a similar way as well.

There are two different kinds of field hockey play: "Hockey, or field hockey as it is known in some parts of the world, is a stick and ball game with origins dating back thousands of years. It is traditionally played on grass, but more often these days – especially at the top level and in certain countries – hockey is played on synthetic surfaces. In hockey, two teams of eleven players compete against each other using their 'hooked' sticks to hit, push, pass and dribble a small, hard, usually white, ball, with one aim in mind – to score by getting the ball into the opponents' goal. To do that, they have to get the ball past the other team's goalkeeper, who protects the goal, and logically, tries to keep the ball out!" [4]. Time of play it is 2 x 35 minutes. Indoor Hockey is a version of Outdoor or Field Hockey. "It developed in Europe in the 1950s mainly to allow keen hockey players to continue

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enjoying their sport during periods of bad winter weather. Since it is an exciting and enjoyable version of the game, it is now played in many locations around the world. It can actually be played on any hard, smooth and flat surface but is usually played in a sports hall. The pitch is smaller than an outdoor field. It is only 44 m by 22 m at most. Indoor hockey also uses 10 cm boards down the longer pitch side-lines. This keeps the ball in play for longer and helps to create a fast, flowing and exciting game. In indoor hockey, two teams of six players compete against each other using their 'hooked' sticks to play a small, hard, often white but sometimes colored, ball. In indoor hockey the ball may only be pushed and not hit or flicked" [4]. Time of play varies in different countries.

Field hockey has never been a popular research area, and indoor hockey has not been even touched upon in any study so far. Taking into consideration the needs and numerous questions of field hockey coaches, the main objective of this study was to examine the heart rate and estimate energy expenditure of field hockey players during indoor and outdoor matches.

The following research questions were formulated:

1. Can indoor hockey matches be an appropriate form of training for field hockey players?
2. Is it possible to use indoor hockey to perfect technical and tactical elements of field hockey players?
3. Should indoor hockey be a training element of field hockey? Or should it be a completely different sport with separate training requirements?

The study attempts to provide answers to these questions as they have not been covered in any professional literature so far.

METHODS

The study used the footage of semifinal matches of the Polish outdoor (MI) and indoor (MII) hockey premier league. Seven male players who played in both (outdoor and indoor) matches (age: 27.13±4.15 years; height: 1.75±5.61 m; weight: 72.26±6.54 kg; VO_{2max} 53.04±3.86 $ml \cdot kg^{-1} \cdot min^{-1}$) took part in the study. The players' body height and body mass (standard tools), body fat (BIA 101, Italy; BODYGRAM® ver.1.3), maximal oxygen uptake (Oxycon Mobile, Jeager) were measured. The study was conducted in the Department of Theory of Sport of the University School of Physical Education in Poznań (Poland). The players' detailed characteristics are presented in Table 1.

An experimental procedure was developed to determine the heart rate and energy expenditure of indoor and outdoor hockey players. The heart rate (HR) of each player was recorded at five-second intervals using the Polar Team System™ (Polar Electro, Finland). It consisted of an electrode belt which recorded ECG signals without a wristwatch. It was easier and more practical to use than some traditional sport testers, especially during field hockey matches 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 a PC and processed using Polar Precision Performance ™ 4 SW after the matches. With the use of data from the players, the program displayed the heart rate trace (beats/min) and automatically estimated energy expenditure (kcal) with reference to individual data. The collected data was classified depending on a player's position into the backs, midfielders and forwards.

The results were statistically analyzed using Statistica 8 package for Windows (StatSoft, Inc., 2007) and expressed as mean (M) and standard deviation (SD). To check normality distribution the Shapiro-Wilk Test was used. To establish signify-cant differences between the mean values a t-test for a dependent sample was used. The level of statistical significance was set at $p<0.05$.

RESULTS

The players of both teams were homogenous groups, taking into account the collected data (age, height and body mass, body fat and VO_{2max}). The players' individual characteristics are shown in Table 1.

The energy expenditure amounted to 893.9±222.9 (kcal) in M1 and 749.6±137.4 (kcal) in M2. The mean value of the heart rate in the first match was 131.4±10.6 (beats/min) and 133.6±9.9 (beats/min) in the second one. The mean maximal heart rate was 185.4±7.5 (beats/min) (M1) and 188.6±7.1 (beats/min) (M2).

The differences between the first and the second match in the case of each examined parameter were statistically non-significant (Table 2).

The analysis of data, which takes into consideration the player's position on the pitch and indoor court, revealed that the mean values of HR were similar in each case: the highest value of HR were noted in the forwards, backs and midfielders. The highest energy expenditure was observed in the backs (outdoor) and forwards (indoor), and the lowest in the midfields (in both matches) (Table 3).

Table 1. Individual characteristic of players

	Age (year)	Height (cm)	Weight (kg)	Body fat (%)	VO_{2max} ($ml \cdot kg^{-1} \cdot min^{-1}$)
Middle back	31	186.5	82.6	17.7	49.6
Right back	24	177.0	77.3	8.5	48.5
Left back	32	172.5	71.5	13.9	51.6
Centre midfield	31	171.4	67.7	10.5	59.9
Left midfield	23	177.5	75.5	14.8	55.8
Centre forward	23	175.7	66.9	11.9	53.3
Right wing	30	169.5	64.3	15.3	52.6
M±SD	27.7±4.15	175.7±5.61	72.3±6.54	13.2±3.13	53.0±1.04

Table 2. Individual players' internal reactions to competition loads during indoor and outdoor matches

	Energy Expenditure (kcal)			Mean HR (bmp)			Maximal HR (bmp)		
	outdoor	indoor	diff.	outdoor	indoor	diff.	outdoor	indoor	diff.
Middle back	1202	915	287	141	131	10	192	193	1
Right back	980	713	267	128	125	3	178	179	1
Left back	804	534	270	123	120	3	186	189	3
Centre midfield	921	734	187	136	138	2	188	193	4
Left midfield	625	677	52	118	130	12	173	178	4
Centre forward	1100	930	170	148	147	1	194	193	1
Right wing	625	744	119	126	144	18	187	195	8
M ±SD	893.9±222.9	749.6±137.4	144.3	131.4±10.6	133.6±9.9	2.1	185.4±7.5	188.6±7.1	3.1

Table 3. Internal reactions of hockey players depending on their position during the game

	Energy Expenditure (kcal)		Mean HR (bmp)		Maximal HR (bmp)	
Position	outdoor	indoor	outdoor	indoor	outdoor	indoor
Back	995.3	720.7	130.7	125.3	185.3	187.0
Midfield	773.0	705.5	127.0	134.0	180.5	185.5
Forward	862.5	837.0	137.0	145.5	190.5	194.0
M±SD	893.9±222.9	749.6±534.0	131.4±10.6	133.6±9.9	185.4±7.5	188.6±7.1

DISCUSSION

Field hockey players cover an average distance of about 10 000 m during one match. The distance depends on the player's position during the game and amounts to 9 300 m for defenders, 10 300 m for midfielders and 10 870 m for forwards on the average. The medium velocity was estimated at 2.2-2.59 m/s and maximal (temporary) velocity at 8.03-9.27 m/s [5]. Spencer et al. [10] noted that field hockey players spent most time during a game walking (46.5% of time), jogging (40.5%), standing (7.4%) and sprinting (1.5 %). No similar data in relation to indoor hockey is currently available. However, we can say that indoor hockey is faster and requires from players a higher level of speed and speed-endurance considering the size of the play area. In the case of outdoor hockey we can say that the most important is endurance-speed connected with endurance and speed as the main components.

The load of competitors during both matches was clearly high. Astrand and Rodahl [2] classified exercise as extremely heavy, if heart rate exceeded 150 beats/min. The maximal heart rate in this study (185.4±7.5 bmp – outdoor; 188.6±7.1 bmp – indoor) and mean HR (131.4±10.6 bmp – outdoor; 133.6±9.9 bmp – indoor) indicate therefore the high physiological requirements of the team games under study. The aforementioned authors as well as others [7, 3] emphasize that specific training of maximal aerobic power must be one of the most fundamental components in physical training programmes. The heart rate gives some information about the energy system being used. Moreover, the coach has to remember about competitive loads characteristic of specific preparation. In the case of hockey the main emphasis is put on speed, which is the basis for the anaerobic system. However, the coach must also remember about the aerobic components of physical training as they take up 60% of the player's effort [8] and game requirements. Field hockey has become a swift and skill-based game [1]. Numerous changes of action require very good preparation of endurance, speed endurance and velocity [5]. On the other hand, it should be kept in mind that a place for indoor games in the whole annual microcycle must be found, if one wants to play the game all year long. Outdoor [3, 6] and indoor matches have a similar background but dpecific characteristics of competitive loads are different and this is the basis of the optimal training program.

In conclusion, the results of this study showed no statistically significant differences between indoor and outdoor field hockey matches in terms of players' heart rate and energy expenditure. It was confirmed that heart rate monitoring was the most viable method of measuring internal loads in field hockey. In order to physically prepare players for competition, training programmes should involve the loads of individual playing positions, inclusion in the training macrocycle, etc. It should also be remembered that the inclusion of indoor hockey in a macrocycle should be carefully planned as this kind of play can potentially disturb the process of development of main physical skills for field hockey. The most important characteristics of indoor matches include competitive loads based on speed and speed endurance that take place when players should prepare basic endurance for the outdoor season. The next important observation is the risk of overloads and injuries resulting from the lack of any break between indoor and outdoor seasons. It especially refers to those players who play indoor and outdoor hockey on the same teams.

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