RELATIONSHIP BETWEEN THE FREQUENCY OF HAND MOVEMENTS DURING DRIBBLING AND REACTION SPEED HIGH-SKILLED FIELD HOCKEY PLAYERS

Abstract: Very few works have been devoted to the study of stickhandling technique in field hockey. The article presents for the first time the data on the relationship between the frequency of hand movements of the leading hand in the dribbling test in 15 seconds and the reaction speed of high-skilled female field hockey players. Significant $p \leq 0.05$ and $p \leq 0.01$ correlations of two forms of fastness manifestation are noted. The negative correlation of the last five-second segment of rotational movements, against the background of fatigue of muscles involved in rotational movements, with the speed of the simple visual-motor reaction (SVR) -0.698 ($p \leq 0.01$) and positive correlation 0.579 ($p \leq 0.05$) with the number of errors in this test were revealed. Prolonged performance of such a complex technical technique in field hockey as dribbling and dodging is limited by a decrease in reaction speed and the manifestation of a greater number of errors.

Keywords: field hockey, dribbling frequency, simple visual-motor reaction, reaction to a moving object, highly skilled field hockey players

Introduction: In sports, any motor action can be considered in terms of a set of kinematic characteristics, which are variable in such parameters as: tempo, rhythm, frequency [5]. The stick is the tool, the object that largely determines the style and varieties of games. Without a stick we can imagine neither hockey with a puck, nor field hockey, nor Russian hockey, as well as golf, floorball, roller hockey. It is not excluded the possibility of the appearance of other varieties of games with objects similar to the stick. All these games are based on the stick as an instrument of influence on the ball or puck [2].

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There are very few works devoted to the study of stickhandling technique [2]. The basis of hockey stick technique is such factors as speed of movement, speed of reactions, frequency of rotational movements of the leading hand 'pronation-supination', intermuscular coordination [9], and the beauty of hockey technique is determined by the rotational movements of the stick with the hands, largely determining the skill, style of hockey player.

It is believed to be an innate human property that depends on the frequency of impulses sent from moto neurons, i.e., the lability of nerve centers, as well as the lability of muscles [3]. The frequency of movements does not lend itself well to training. The mechanism for increasing the maximum frequency of movements is the phenomenon of rhythm assimilation by a functional system discovered by N.V. Golikov and formulated as a physiological law by A.A. Ukhtomsky, which is associated with an increase in the functional lability of nerve centers and executive organs (muscles) [3].

The physiological mechanisms and anthropometric features of the athlete have an important influence on the stickhandling technique. The frequency of shifting the ball or puck, the amplitude of movements largely determines the efficiency of the opponent's rounding. The frequency of movements is one of the forms of manifestation of speed abilities [5], as well as reaction speed.

In the literature there is practically no information about technical means of training and improving the technique of stick and ball (puck) possession [9]. The issues of using computer information technologies in technical training in game sports have been considered by authors [10,12]. Some researchers have proposed technologies for training passes [1] in sports games.

There is absolutely no data on their quantitative evaluation. Taking into account that the basis of stickhandling technique consists of sequential movements not only of hands and the whole upper shoulder girdle, it is necessary to study the quickness of different variants of athletes' reactions. The number of muscle chains

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involved, their intermuscular coordination, and the frequency of nerve impulses transmitted by the analyses to the CNS and then to the executive organs influence the frequency of movements and reaction speed [6].

An interesting test related to the study of ball speed (dribbling) was developed by Australian specialists for field hockey players, which simultaneously assessed ball skills and special dexterity. A total of 27 men and 32 women from different national teams were studied. The test consisted of 3 attempts to complete an obstacle course at maximum speed using a hockey ball and 3 more attempts of the same course without ball handling. Electronic chronometers recorded the time of distance travelled with the ball (dribbling), without the ball (sprint), and the difference between dribbling and sprinting. Significance between the tests was set at $p<0.05$. Subjects with a higher level of playing technique showed significantly faster dribbling ($p<0.001$) and a significantly lower difference between sprinting without the ball and dribbling ($p<0.001$). The dribbling test tested here, having sufficient validity and reliability for use in testing the level of special performance of field hockey athletes, can also be used for objective control of the development of special skills [11]. Success in sport requires repeated performance of certain biomechanical patterns at a high level [13]. In order to effectively assess limb performance and the dominance of one of them, it is necessary to analyses the corresponding biomechanical requirements of a particular sport. For example, stick use in ice hockey represents certain bimanual asymmetrical high-speed actions [13]. It is worth noting preliminary studies on the frequency of hand activity in field hockey with young field hockey players of different ages and genders. The research was based on two patents: “A device for determining the frequency and accuracy of human hand movements during pronation and supination” [4] and programs “Control of the frequency of arbitrary movements of hockey players' hands” conducted by Shishkov I.Y. et al. [7] conducted by Shishkov I. Yu. et al. during 2023-24 years [14].

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The second form of fastness manifestation is the time of simple and complex reaction. In our opinion, these two indicators should be closely related to the frequency of rotational movements of the leading hand.

Organization of the study. The testing was conducted on the basis of the ROC Innovation Centre in Kislovodsk city during the training camp of the women's team ‘Dynamo’ Elektrostal city (Moscow region) in the preparatory period of February-March 2024. 13 hockey players took part in the examinations. The sportswomen are Russian field hockey and indoor hockey champions in 2021-23. The average age M=22,7±4,13 years, weight M=57,6±6,9 kg. All girls are masters of sports of the Russian Federation. Permission to conduct the research was obtained.

Purpose of the study. To reveal the interrelation and interdependence of various indices of two forms of fastness manifestation: movement frequency and reaction speed of hockey players of high qualification.

Methods. Simple visual-motor response (SVMR) was measured to assess the level of central nervous system activation in response to light stimuli. The athlete performed the simple visual-motor response test. Thirty-five light stimuli were presented, of which the first 5 were training stimuli and the remaining 30 were scoring stimuli. The task was to press the ‘YES’ button as soon as possible after the light signal was presented. The measured reaction times (RT, Ms) were the average time for 30 reactions (Ms). Individual reaction time was defined as the interval between the appearance of the sound signal and the response; variability (Ms) - standard deviation of reaction time; errors - the sum of preemptions (the number of responses with reaction time less than 100 (Ms) and omissions (the number of responses with reaction time more than 500 Ms).

To assess individual peculiarities of the nervous system organisation in terms of speed and accuracy of response to spatio-temporal events (as one of the components of anticipation) and to identify the degree of nervous system (NS)

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equilibrium in terms of the balance of excitation and inhibition processes, the Moving Object Reaction Test (AR) was used. In both tests the device 'Psychophysiologist UPFT-1/30' (MEDICOM MTD) was used. The following indicators were measured: accuracy (%) - the proportion of accurate reactions, i.e., reactions whose latent period differs by no more than 50 ms relative to the ideal reaction time; variability (ms) - the standard deviation of the absolute difference between the time of the real reaction and the accurate one; NS balance - the ratio of the total time of delays to the total time of anticipations (in absolute value) [2].

A month before the training camp, a test was conducted to investigate the frequency of club rotation with the left hand. On the basis of the developed software [7] and obtained patent No. 2732219 C1 RF, MPC A61B 5/11 'Device for determining the frequency and accuracy of human hand movement during pronation and supination: No. 2020104730' [4] studies of the frequency of hockey players' hand movements were carried out. The stick rotation frequency was determined by the number of movements 'pronation-supination' of the left hand by time segments 0-5,0 s, 5,1-10,0 s, 10,1-15,0 s and in total for 15 s. To control the stick rotation frequency while dribbling the ball we used MPU9250 sensor (TDK manufacturer), which provides registration of the stick rotation. The information was collected at a frequency of 1000 Hertz. Data processing was carried out using Excel spreadsheet. Pairwise parameters were calculated by calculating Pearson correlation coefficient.

Results of the study. Table 1 presents the results of the study of speed and accuracy of reaction to spatial and temporal events (anticipation reaction), simple visual-motor reaction (SVMR), hand strength and frequency of rotational movements "pronation-supination" when dribbling on the spot for five-second time segments.

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Table 1 Testing results of hockey players (n=13) of the Dynamo-Elektrostal team in the preparatory period

№	Name	Age	Weight (kg)	anticipatory reaction (AR)			Simple visual motor response (SVMR)			Hand strength (H)				Number of dribbling rotations (sec.)			∑ Rotstions (number)
				(Ms)	variability	HC	(Ms)	variability	Errors (number)	Left	Right	Power %	Asymmetry	0-5,0	5.1-10	10.1-15	
1	Der-na A.	19	45	67	40	2,49	213	42	0	272	257	60	5	12	11	11	34
2	Zim-na V.	25	60	40	81	1,36	201	21	1	342	318	56	7	13	12	11	36
3	Utk-na D.	16	63	47	34	7,60	271	46	1	284	293	47	-3	12	10	10	32
4	Liv-s V.	18	65	83	42	2,89	200	25	1	384	346	57	10	13	12	12	37
5	San-na K.	21	63	47	65	1,77	188	20	6	319	303	50	5	12	11	13	36
6	Khal-va N.	24	53	57	66	2,68	234	83	2	360	338	67	6	13	14	13	40
7	Knia-va A.	19	52	43	60	3,62	240	33	0	305	301	50	1	12	11	11	34
8	Koro-va K.	31	63	50	106	0,78	196	40	2	351	321	55	9	14	13	13	40
9	Batu-va D.	24	63	50	57	0,00	197	33	4	289	271	45	6	12	10	13	35
10	Kulik-va K.	23	48	40	65	1,49	233	52	0	270	261	56	3	13	14	10	37
12	Aru-a S.	24	57	63	66	1,89	193	30	0	328	278	54	15	14	14	13	41
17	Milk-ova N.	28	65	33	84	1,78	228	38	0	458	441	70	4	10	12	11	33
13	S-s N.	23	52	50	74	2,97	208	30	0	273	280	54	-3	14	11	12	37
M		22,6	57,6	51,5	64,6	2,4	215,5	37,9	1,3	325,0	308,3	55,4	5,0	12,6	11,9	11,7	36,3
± δ		4,13	6,87	13,30	19,54	1,84	24,12	16,5	1,84	54,2	48,7	7,15	4,97	1,12	1,44	1,17	2,78
V%		18,2	11,9	25,8	30,2	76,	11,1	43,5	140,9	16,6	15,8	12,8	99,3	8,8	12,0	9,9	7,6

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Pearson's pairwise correlation showed a number of reliable relationships at the level of 0.01 and 0.05. Without giving the whole correlation matrix, we will highlight the most significant reliable relationships. This is the asymmetry of the strength indices of the hands: negative balance with the index of the nervous system equilibrium in the anticipation reaction -0.566 ($p \leq 0.05$) and the time of SVMR -0.653 ($p \leq 0.05$), positive correlation was noted with the frequency of rotational movements from the 5th to the 10th, from the 10th to the 15th second, and in general for the whole test respectively 0.599, 0.561 and 0.646 ($p \leq 0.05$).

Four reliable correlations were noted with the balance of the nervous system equilibrium of the anticipation response: negative correlation value with the age of the athletes -0.698 ($p \leq 0.01$); the variability of the anticipation response -0.584 ($p \leq 0.05$); the asymmetry of the strength indices of the hands -0.566 ($p \leq 0.05$) and with the SVMR time 0.767 ($p \leq 0.01$). Also, four reliable correlations were noted each for the pairs: the frequency of rotational movements of the hands in the last 5 of 15 seconds and the final result of the test. The last five-second segment of rotational movements, according to the subjects' comments, took place against the background of fatigue of the muscles involved in rotational movements and had a reliable negative correlation with SVMR speed -0.698 ($p \leq 0.01$) and three positive correlations with the number of errors during SVMR 0.579 ($p \leq 0.05$), asymmetry of hand strength indices 0.561 ($p \leq 0.05$) and the total result of the rotational frequency for 15 sec. 0,666 ($p \leq 0,05$). The last value does not require comments, as both indices are directly dependent on each other.

Conclusion. The test ‘Reaction to a moving object’ (AR) showed that with age the ratio of the total delay time to the total advance time (absolute value) in older female hockey players decreases -0.698 ($p \leq 0.01$), which in our opinion is a consequence of the manifestation of game experience ‘game sense’. This is confirmed by a reliable correlation with the time of simple visual-motor reaction (SVMR) 0.767 ($p \leq 0.01$).

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The revealed negative correlation of the last five-second segment of rotational movements, against the background of fatigue of the muscles involved in rotational movements, with the speed of simple visual-motor reaction (SVMR) -0.698 ($p \leq 0.01$) and positive values of 0.579 ($p \leq 0.05$) with the number of errors in the same test.

Thus, as a result of the study, multifaceted interrelationships of two forms of quickness manifestation in high-skilled female athletes were revealed. First of all, it concerns the results of simple visual-motor reaction and manifestation of errors with the frequency of rotational movements of hands 'pronation-supination' at the end of the test. Prolonged performance of such a complex technical technique in field hockey as dribbling and circling is limited by a decrease in reaction speed and the manifestation of more errors.

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