ASSESSMENT OF SPEED AND STRENGTH OF ICE HOCKEY PLAYERS THROUGHOUT A THREE-YEAR TRAINING CYCLE

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Abstract:
The study deals with assessment of speed and strength of ice hockey players throughout a three-year training cycle. A reference sample consisted of 8 senior ice hockey players. Upon completion of summer preparatory period ice hockey players performed tests designed to assess body composition, strength and anaerobic-alactic capacity and sport-specific fitness. The significance in differences between 2013 and 2015 was determined by Wilcoxon *T* test. The results showed progressive enhancement of lower-body explosive power after one year. Statistical processing of data showed that lower pedaling rate is associated with increased power in first five seconds, which was probably determined by gains in muscle mass. The fatigue index increased, which indicates increased anaerobic power and dynamic speed-strength capacity with hypothesized recruitment of fast-twitch muscle fibers.

INTRODUCTION

Hockey performance is characterized by alternation of short-term exercise interval performed at maximal intensity with rest intervals. Match results depend on those game phases that rely on actual level of players' speed and strength disposition [1, 2]. During the long-term sports preparation players adapt to training stimuli, which induce a variety of responses in human organism and affect stability of internal environment. The efficiency of adaptation processes requires smooth, gradual and adequate repetition of training stimuli [4]. Periodization of the annual training cycle is important in terms of maintaining desired performance level during the entire season. As for physical conditioning, intense conditioning period and preseason period seem to be crucial in terms of condition development [6]. The primary objective of the summer preparatory period is to fulfill principal adaptation demands, to develop or maintain high level of aerobic capacity, to ensure strength gains and bioenergetic activation under anaerobic conditions through manipulation with load.

THE MATERIAL AND THE METHODOLOGY

The reference sample consisted of 8 senior ice hockey players on the roster of a top Slovak ice hockey team. The players may be characterized as elite players on the team which is a league champion and a regular participant in European Champions Hockey League. Table 1 shows basic characteristics for 6 forwards, 1 defenseman and 1 goaltender. The purpose of the study was to monitor changes in speed and strength throughout a three-year period.

Table 1. Sample characteristics

YEAR	n	Age	Body height *(cm)*		Body weight *(kg)*		Muscle mass *(%)*		Fat *(%)*	
			x	**s**	**x**	**s**	**x**	**s**	**x**	**s**
2013	8	25.6	183.5	6.6	85.5	7.6	43.9	0.4	11	0.2
2014	8	26.6	183.6	6.5	87.4	7.1	50.8	1.2	12.4	2.1
2015	8	27.6	184	6.5	88.4	7.6	49.5	1.1	14.2	1.8

Note. **n** - sample size, **x** - arithmetic mean, **s** - standard deviation.

Upon completion of summer preparatory period players performed initial testing in the Diagnostic Center of Faculty of Sports, University of Prešov in Prešov. First, players were tested for body composition using InBody 720 body composition analyzer. Players also performed a lower-body explosive power test on the jumping ergometer FiTRO Jumper. The test consisted of repeated two-legged jumps performed with maximal effort to achieve the greatest jump height and the shortest contact time possible, respectively. Players performed a 10-second test of lower-body explosive power without using their arms. The anaerobic-alactic capacity was assessed by performing a 30-second Wingate test. The players performed the test on a bicycle ergometer in a stable mode with a constant friction resistance computed according to their body weight (7.5 N.kg-1). The objective of the test was to maintain peak power during the entire test. Pedaling rate was variable depending on 5-second interval starts, which were a part of the test protocol. Among parameters measured were peak and mean anaerobic power computed in 5-second intervals. Peak anaerobic power is achieved during the first 5-second interval and reflects player's anaerobic-alactic capacity. Mean anaerobic power recorded during the entire test demonstrates the level of anaerobic capacity. The percentage decline in anaerobic power from the initial to the final interval is referred to as fatigue index, which indirectly reflects the activation of fast-twitch, or slow-twitch muscle fibers.

The assessment of significance in differences between 2013 and 2015 was determined by Wilcoxon *T* test at $p<.05$. To qualitatively process the results, logical methods of synthesis, induction and comparison were applied. Collected data were evaluated graphically and practically.

RESULTS AND DISCUSSION

Three-year training sustained by elite ice hockey players seems to be sufficient to induce significant changes in speed and strength. On the other hand, long-term monitoring of elite players is extremely demanding. Figure 1 shows progressive increase in lower-body explosive power after one year. This indicates the appropriateness of the strength training stimuli performed off the ice. This manifested most significantly in vertical jump height, where the difference equaled 5.6 cm.

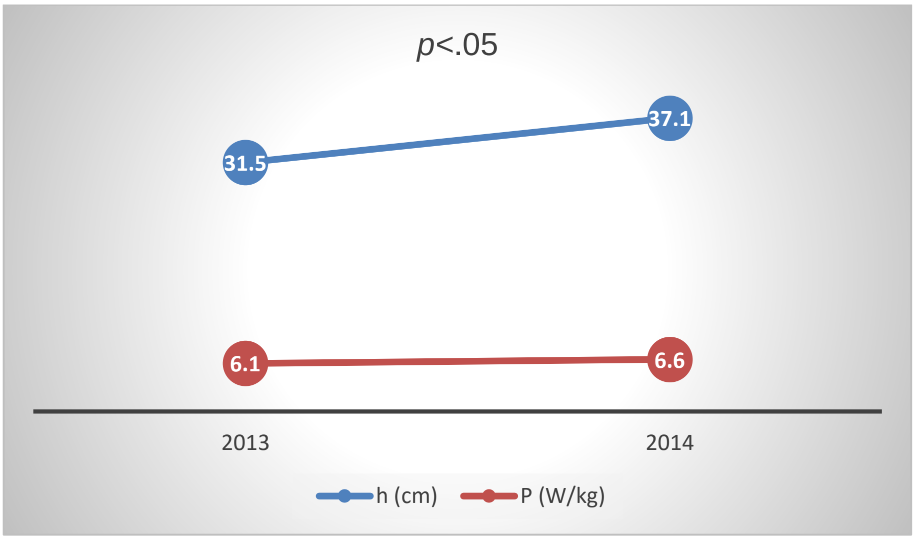

Figure 1. Assessment of lower-body explosive power (n = 8)

Table 2 shows mean values of Wingate test throughout a three-year training cycle. The mean values of anaerobic power ranged from 9.31 W/kg to 12.78 W/kg. Fatigue index increased indicating increased anaerobic power and dynamic speed-strength disposition with hypothesized recruitment of fast-twitch muscle fibers. Decline in anaerobic power at the end of the test was insignificant which indicates that fatigue index equaling 43.4% was sufficient compared to values achieved by NHL players whose values increased to 52% [2]. Intra-individual assessment based on repeated measurements showed that throughout the three-year period the most significant increase in fatigue index from 39.2% to 58.3% was found for a goaltender.

Table 2. Mean Wingate test scores throughout a three-year training cycle (n = 8)

YEAR	BW *(kg)*	Rpm 0 - 5s.	W	W/kg	Rpm 25 - 30s.	W	W/kg	Fatigue index
2013	85.5	178.4	884.1	10.3	91.2	550.1	6.4	37.7 %
2014	87.4	181.2	930.2	10.6	91.7	565.8	6.5	38.4 %
2015	88.4	168.4	976	11	86.6	543.2	6.1	43.4 %

Note. **BW**-body weight; **Rpm**-revolutions per minute; **s**-seconds; **W**-power in watts; **kg**-kilogram.

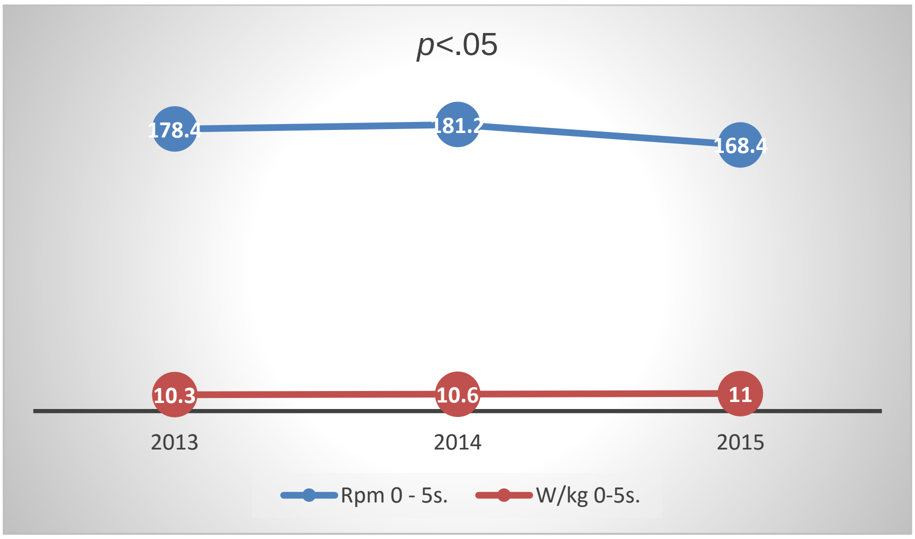

Figure 2. Pedaling rate and anaerobic power per kilogram body weight (n = 8)

Changes in absolute and relative values of peak anaerobic power may most probably be attributed also to gains in body weight. There were no significant differences between playing positions, which was probably caused by low sample sizes of defensemen and goaltenders. Training content may be considered a crucial factor underlying changes in speed and strength.

Statistical processing of data showed that anaerobic power increases with decreased pedaling rate during first five seconds (see Figure 2), which is determined by gains in muscle mass. The evaluation of other Wingate test scores did not reveal statistical significance throughout the three-year period (see Table 4).

Table 3. Significance level of variables throughout 2013 to 2015

Variables	*p*
Body weight	0.051
Muscle mass %	**0.035***
Fat %	**0.035***
Jumping ergometry h (cm)	**0.011***
Jumping ergometry P (W/kg)	**0.012***
Pedaling rate 0-5 seconds	**0.011***
Absolute power in watts	0.123
Power in watts per kilogram body weight	0.326
Pedaling rate 25-30 seconds	0.093
Absolute power in watts	0.888
Power in watts per kilogram body weight	0.161
Fatigue index %	0.092

***Note.* ***$p<.05$

Compared to performances achieved by adult players expressed as percentiles, performance during the third year may be classified above 90th percentile [5]. Norm-referenced databases for ice hockey players demonstrate variability of test protocols causing high variability of collected data. Compared to NHL studies, we may conclude that defensemen and forwards achieved anaerobic power equaling 12.3 W/kg. Goaltenders showed slightly lower level of anaerobic power which equaled 11.9 W/kg [2]. Goaltender included in the study showed a progressive increase in anaerobic power from 9.31 to 11.96 W/kg. Studies have shown changes between defensemen and forwards in absolute and relative values of anaerobic capacity and anaerobic power [3]. Compared to values recorded for NHL players [2], values of anaerobic capacity and anaerobic power were higher by 10 to 20 %.

CONCLUSIONS

Training of elite ice hockey players is characterized by regular and purposeful activity performed to achieve particular goals. The process of sports preparation is based on the annual training cycle, which begins in form of intense off-ice conditioning. In the long-term, this period may be referred to as crucial. During this period players show progressive development of conditioning abilities the level of which fluctuates minimally during the regular season. Professional ice hockey players benefit most from the development and maintenance of boundary performance parameters not only during the annual training cycle but also during their entire athletic career. Higher level of peak anaerobic power and anaerobic capacity of senior ice hockey players is usually attributed to greater volume of muscle mass and strength capacity, which fall into the category of anaerobic preconditions which are highly dependent on age. During the three-year monitoring period, the age of 27 years seems to be crucial in terms of progressive development of speed and strength. Various training contents during the summer indicate content variability, which in the long-term was progressive in terms of the development of speed and strength of players.

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