Original Article

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Anaerobic performance in 30s Wingate test as one of the possible criteria for selection Czech hockey players into National Hockey League

Jan Heller[ABCDE], Pavel Vodicka[ABC], Michael Janek[BC]

Biomedical Laboratory, Faculty of Physical Education and Sport, Charles University, Prague, Czech Republic

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Abstract

Introduction: The selection into the National Hockey League (NHL) is based on criteria reflecting job analysis of a professional ice hockey player and the requirements of the game. Only few Czech elite ice hockey players succeed to participate in NHL and their number is decreasing in the last decade. *Aim of Study:* The aim of the study was to find out and evaluate the level of anaerobic readiness of Czech hockey forwards and defenders playing in the NHL and to compare their anaerobic performance with that in elite national hockey players from the Czech extra-league. *Material and Methods:* Results of 30s Wingate anaerobic test obtained in 26 forwards and 16 defenders, Czech hockey players from the NHL (from 2001/2002 to 2015/2016 seasons) were compared with the reference values of elite Czech ice hockey players. The comparison was based on the mean values, rate of dispersion, and effect sizes were calculated using Cohen's *d* coefficient. *Results:* In forwards, both absolute and relative values of peak power (PP) and anaerobic capacity (AnC) found in Czech players in NHL were higher (d>1) than in elite Czech national players. In defenders, only the value of AnC relative to body mass showed small effect (d=0.36), but absolute and relative values of PP and absolute value of AnC were higher (d>1) than in elite Czech national players. *Conclusion:* The results of the study indicate that anaerobic readiness evaluated by 30s Wingate test may be, besides dominant on-ice skills, one of the criteria for entry to the top ice hockey competition.

Keywords: anaerobic capacity, anaerobic power, National Hockey League, professional ice hockey players, Wingate test

Address for correspondence: Jan Heller - Biomedical Laboratory, Faculty of Physical Education and Sport, Charles University, Prague, Czech Republic, email: heller@ftvs.cuni.cz

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INTRODUCTION

Ice hockey is a physically highly demanding contact sport game involving repeated bouts of high-energy outputs, with shifts lasting from 30 to 60 seconds [1,2]. Giving the anaerobic nature of the sprint-based shifts related to anaerobic glycolysis and the aerobic recovery and the radio between shifts and periods, the energy metabolism is assumed 69 % of anaerobic metabolism (immediate energy sources and anaerobic glycolysis) and 31 % of aerobic metabolism [2]. The success in the elite level requires players to develop well-rounded fitness including anaerobic sprint ability, a strong aerobic endurance base, and high levels of muscular strength, power, and endurance [3,4]. Despite of overwhelming number of participants in amateur hockey, only the most skilled players will ever achieve the goal of being drafted to play in the National Hockey League (NHL).

The National Hockey League is regarded as the world's elite level of professional competition. Every year at about 270 prospects from around the world are selected in nine rounds of a player draft. Amongst those players selected, a small number will sign contracts, few of these players will play and fewer still will have any success in the NHL. It had been suggested that the odds of being drafted into the NHL and playing more than a single season is less than a 5 in 10,000 chance [5]. In order to identify the best prospects, NHL scouts evaluate junior hockey players on a number of job-related criteria, and base their draft or "hiring" decision on these criteria. In effect, these criteria reflect a job analysis of a professional ice hockey player and the requirements of the game. These criteria for the assessment of the NHL potential of a player include body size and strength, quality of skating and shot, puck-handling, hockey sense, competitiveness, leadership, poise/composure and defense/physical play [5]. Although there are infinite combinations of "real-world" factors that interact to make one player more skilled than the other, there are also specific and quantifiable characteristics that can be used to determine a player's physiological capacity using standard off-ice testing procedures. At the elite hockey level, there have been long-standing debates among scouts, coaches, strength and conditioning specialists and physiologists as to the relative utility of off-ice tests for talent identification and selection into elite world ice hockey teams. Off-ice fitness test of the NHL Entry Draft include anthropometry and body fat assessments, testing of grip strength, bench press, push-ups, sit-ups, standing long jump, vertical jump, upper body push and pull and flexibility using a sit and reach test. Two physiological tests are used of the NHL Entry Draft, maximum aerobic power test (VO_2max) on a cycle ergometer using incremental protocol and 30s Wingate test using flying protocol and loading 9 % of body mass [2]. From the physiological assessments, the anaerobic exercise testing is of a primary importance in ice hockey players because of anaerobic power and capacity constitute main determinant of performance [6]. Strength and power, related to anaerobic energy metabolism, are particularly important for rapid acceleration in skating, shooting, maintaining position, checking and for stopping and rapid changes in direction. It had been demonstrated that the demands on strength and power are increasing more than the demands on aerobic capacity and overall physical fitness [3]. Regardless the importance of anaerobic performance capacity in ice hockey players there is only little evidence on the role of off-ice anaerobic testing and on-ice success in elite ice hockey players. Only few Czech elite ice hockey players succeed to participate in NHL, and some of selected players seem to be highly skilled but do not exhibit excellent results in physiological off-ice tests. In addition, the importance of physiological tests (off-ice tests) is often questioned by some ice hockey players and coaches.

Therefore, the aim of the study was to find out and evaluate the level of anaerobic readiness of Czech hockey forwards and defenders that succeeded in the NHL Entry Draft, and then were successfully playing in the NHL at least for one season.

MATERIAL AND METHODS

The study was based on the retrospective analysis of the results of 30s Wingate anaerobic test from the database of the Biomedical laboratory, Faculty of Physical Education and Sport, Charles University in Prague. The database contained the results obtained in 18,000 ice hockey players aged 15 to 35 years, from the 1999 to 2017 seasons. The standard testing in all the ice hockey players included measurements of the body height to the nearest 0.5 cm and body mass to the nearest 0.1 kg, body fat assessment and an amount of fat-free mass (FFM) calculation were based on the calliperation of 10 skinfolds (method of the International Biological Program, IBP) [7]. All the 30s Wingate tests were performed on the cycle ergometer Monark E824 using breaking force of 6 $W \cdot kg^{-1}$ that equals 0.106 $kg \cdot kg^{-1}$ [8,9]. Power output in every revolution was computed on-line and after completing the test peak power (PP), mean power (MP) and minimum power were established by the software using standard algorithms: Peak power was defined as the highest power output during the test averaged over 5 consecutive seconds during the 30 s test. Anaerobic capacity (or total work) was determined as a product of mean power (i.e. average power output during the test) and time duration of the test, i.e. 30 seconds. Fatigue index was calculated as a percentage of peak power (PP) minus minimum power divided by peak power and multiplied by 100. Prior to the test, all the subjects performed individualized stretching exercises and a standardized 5-min-lasting warm-up cycle exercise at a resistance 1.0 to 1.5 kg, at a cadence ranging from 60 to 90 rpm, interspersed with all-out sprints of cycling last 4 to 5 s of each minute. To eliminate the possibility of fatigue after warm up, a brief rest period followed the warm-up before testing was initiated [10]. The subjects were verbally encouraged to achieve their peak power within the first few seconds and to perform at their maximum throughout the test till the last seconds. Peak heart rate values were recorded at the end of the test using a short-range radio telemetry system (Polar Electro, Kempele Finland) and peak blood lactate concentration was assessed at the 5th min of recovery [11]. The main results presented in this study are 5s PP [W, $W \cdot kg^{-1}$] and total work or anaerobic capacity AnC [kJ, $J \cdot kg^{-1}$].

A study group of Czech ice hockey players from the NHL was created based on the following criteria: a player had completed the 30s Wingate test in Biomedical laboratory FTVS UK (1); he had an active NHL career during the seasons 2001-2016 (2); he played at least 55 games in the NHL (this means that he successfully passed 2/3 of a playing season or more) (3); the time between testing in the laboratory and entry draft or active career was less or equal to 2 years (4); the player had a minimal age of 17 years, and/or maximal age of 35 years (5). From all the Czech ice hockey players in the NHL in the season 2001 to 2016 (n=190) a group of 100 players, forwards and defenders had passed 30s Wingate anaerobic test in the Biomedical laboratory, Faculty of Physical Education and Sport. Considering into account all the criteria of the selection stated above, the final study sample contained 26 forwards and 16 defenders, aged 20.5±4.4 years and 23.2±4.5 years, respectively. Data are expressed as means and standard deviations. The comparison of Czech players from NHL and players from Czech extra-league - the reference values for elite Czech ice hockey players [10] - was based on the mean values, rate of dispersion, and effect sizes were calculated using Cohen's *d* coefficient.

RESULTS

The comparison of age, height, mass and body mass index (BMI) of Czech ice hockey players in the NHL, players from the Czech Extra-league and anthropometric data in NHL players from the study of Quinney et al. [12] [Table 1] showed that both groups of NHL players tended to be higher and heavier than the average players from Czech Extra-league. Also the body mass index of the NHL players tended to be higher (approximately 26 $kg \cdot m^{-2}$) than in the average players from Czech Extra-league (approximately 25 $kg \cdot m^{-2}$).

Table 1. A comparison of age, height, mass and body mass index (BMI) in Czech ice hockey players playing in the NHL, in players from the Czech Extra-league [11] and in NHL players from the study of Quinney et al. 2008 [12].

Indicator	Czech players in NHL	Czech Extraleague[1]	NHL[2]
Age [years]	21.5	21.6	24.6
Height [cm]	185.9	181.4	184.6
Mass [kg]	89.6	83.1	90.2
BMI [$kg \cdot m^{-2}$]	25.9	25.2	26.4

[1]… Czech extra-league – reference values, Heller & Vodička, 2014 [11]; [2]… NHL players, Quiney et al., 2008 [12]

Table 2. A comparison of absolute and relative values of peak power (PP, PP·kg^{-1}) and anaerobic capacity (AnC, AnC·kg^{-1}) in forwards – Czech ice hockey players playing in the NHL (n=26, age 20.5±4.4y, height 184.7±4.8 cm, mass 86.9±6.5 kg) and in players from the Czech Extra-league.

Forwards	Czech players NHL	Czech players Extra-league[1]	d – value	Effect size
PP [W]	1319.6 ± 124.6	1155.8 ±117.5	1.35	Large
PP kg^{-1} [W·kg^{-1}]	15.15 ± 0.90	14.38 ±0.42	1.10	Large
AnC [kJ]	31.2 ± 3.0	27.7 ± 2.4	1.29	Large
AnC·kg^{-1} [J·kg^{-1}]	359 ± 18	345 ± 5.5	1.04	Large

[1]… Czech extra-league – reference values – Heller & Vodička, 2014 [11]

Table 3. A comparison of absolute and relative values of peak power (PP, PP·kg^{-1}) and anaerobic capacity (AnC, AnC·kg^{-1}) in defenders – Czech ice hockey players playing in the NHL (n =16, age 23.2±4.5 y, height 187.8±4.2 cm, mass 94.0±6.7 kg) and in players from the Czech Extra-league.

Defenders	Czech players NHL	Czech players Extra-league[1]	d – value	Effect size
PP [W]	1383.3 ± 91.1	1272.2 ± 111.2	1.09	Large
PP kg^{-1} [W·kg^{-1}]	14.74 ± 0.99	13.95 ± 0.40	1.05	Large
AnC [kJ]	32.4 ± 2.1	29.0 ± 2.2	1.58	Large
AnC·kg^{-1} [J·kg^{-1}]	345 ± 19	339 ± 5.9	0.36	Small

[1]… Czech extra-league – reference values – Heller & Vodička, 2014 [11]

In forwards [Table 2], both absolute and relative values of peak power (PP) and anaerobic capacity (AnC) found in Czech players in NHL were higher (d>1) than in elite Czech national players from the Czech extra-league. In defenders [Table 3], only the value of AnC relative to body mass showed small effect (d=0.36), but absolute and relative values of PP and absolute value of AnC were higher (d>1) than in elite Czech national players.

DISCUSSION

Main results of the study had shown that successful Czech ice hockey players tended to be higher and heavier than average Czech Extra-league players and also exhibit body mass index of approximately 26 kg.m^{-2}, whereas lower body height, lower body mass and lower body mass index seem to be disadvantage for the Draft Entry into NHL. Burr et al. [2] described anthropometric and physiological profiles of NHL Entry Draft hockey players (n=835, age 18 years), and he found the average body mass 86,2 kg and 90,2 kg, height 184 cm and 188 cm, body fat 9,4 and 10.0 % and BMI 25.5 and 25.2 kg·cm^{-2}, in forwards and defenders, respectively. His multivariate models comparing National Hockey League Entry Draft predictor variables and draft-selection-order showed that the anthropological profile so called "body index" (body height, lean body mass and muscular development) and peak anaerobic power are the strongest predictor for the draft selection. "Body index" is associated with the full-contact nature of ice hockey. In physical altercations for control of the puck, and at the moment of collision during a body check, larger, stronger players who possess greater muscle mass will generally be at an advantage. Although some degree of fat mass may be advantageous for injury protection during collision or as added mass for inertia while hitting, muscle mass is what helps propel players across the ice and it can stabilize joints at impact. In the models presented by Burr et al. [2] "body index" was important mostly in forwards, suggesting that being a larger and leaner forward may be important for success in trying to fend off opposing forward and defense.

Small but evident position-related differences in peak power and anaerobic capacity are in agreement with the data published by Vescovi et al. [13]. Also Duncan and Lyons [14] analyzed positional differences among forwards and defensemen. Defensemen tended to be endomorphic mesomorphs, whereas forwards tended to be balanced mesomorphs. In general, the defensemen have higher body mass, body fat and a lower anaerobic power related to body mass (by 5 %) than forwards. The differences in anthropometric and physiological variables between forwards and defensemen seem to be related to the different technical and tactical demands of their respective position. Defensemen are primarily used to breakdown the opposing attack by blocking or checking opposing players. As a result higher body mass, greater body fatness and greater endomorphy may increase inertia for blocking and may provide a bigger body surface area for forwards to navigate around. This may be particularly important given that defensemen will generally have to skate backwards whilst forward players should generally be able to outskate defensemen as they will be skating forwards. The greater mesomorphy scores in defensemen may also be important allowing for more forceful checking of opposition players and sustaining repeated attacks by opposing players. Lower mesomorphy scores and higher anaerobic power in forwards compared to defensemen may also be important where speed and agility of attack are of primary concern. For example, forwards are more likely to cover greater distances during ice-hockey due to the need of fore-check and back-check, i.e. check opposing players in all areas of the rink, whereas defensemen will tend to only back check i.e. check opposing players in their half of the rink [14].

The results of our study also show that Czech ice hockey players from the NHL possess higher peak anaerobic power and anaerobic capacity than the average ice hockey players from Czech Extra-league. The values found in Czech ice hockey players from the NHL were very close to those found in Czech national team, winner of the World Championship 2010 that was also tested in the Biomedical laboratory, Faculty of Physical Education and Sport, Charles University in Prague. The peak power in forwards of the winning team attained 1307±71 W and 15.4±0.7 $W \cdot kg^{-1}$ and anaerobic capacity 30.5±1.5 kJ and in relative values 359.5±16.1 $J \cdot kg^{-1}$. In defenders of the winning team, the peak power attained 1391±94 W and 15.0±0.5 $W \cdot kg^{-1}$ and anaerobic capacity 31.8±2.1 kJ and in relative values 342.5±10.1 $J \cdot kg^{-1}$. Also these data confirm the hypothesis on the importance of anaerobic readiness in elite ice hockey players evaluated by off ice testing.

CONCLUSION

The results of the study indicate that anaerobic readiness evaluated by 30s Wingate test may be, besides dominant on-ice skills, one of the criteria for entry to the top world ice hockey competition. During physiological testing, however, other attributes and markers may be of a great importance such as apparent motivation, attitude, and ability to perform under pressure. Sometimes even low developed young players may be selected, when they are suspected to made great improvements and may be ultimately better players than those exhibiting good physiological qualities but less prospective future development.

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REFERENCES

1. Montgomery DL. Physiology of ice hockey. Sports Med 1988; 5(2): 99-126.
2. Burr JF, Jamnik RK, Baker J, Macpherson A, Gledhill N, McGuire EJ. Relationship of physical fitness test results and hockey playing potentioal in elite-level ice hockey players. J Strength Cond Res 2008; 22(5): 1535-1543.
3. Cox MH, Miles DS, Verde TJ, Rhodes EC. Applied physiology of ice hockey. Sports Med 1995; 19(3): 184-201.
4. Glaister M. Multiple sprint work: Physiological responses, mechanisms of fatigue and the influence of aerobic fitness. Sport Med 2005; 35(9): 757-777.
5. Perlini AH, Halverson, TR. Emotional intelligence in the National Hockey League. Can J Behav Sci 2006; 38(2): 109-119.

6. Carey DG, Drake MM, Pliego GJ, Raymond RL. Do hockey players need aerobic fitness? Relation between VO_2max and fatigue during high-intensity intermittent ice skating. J Strength Cond. Res 2007; 21(3): 963-966.
7. Parizkova, J. Body fat and physical fitness. Hague: Nijhoff; 1977.
8. Vandewalle H, Peres G, Heller, J, Monod H. All-out anaerobic capacity tests on cycle ergometers. Eur J Appl Physiol 1985; 54(2): 222-229.
9. Heller J. Aerobic and anaerobic tests with ice hockey players. IIHF Prague 2004 International Coaching Symposium. Prague: IIHF; 2004.
10. Inbar O, Bar-O, O, Skinner JS. The Wingate anaerobic test. Human Kinetics: Champaign; 1996.
11. Heller J, Vodička P. Anaerobic performance capacity in Czech ice hockey players: A comparison of the results in forwards, defenders and goalkeepers aged 15 to 35 years. In: Flemr, L et al. editors. Physical Activity in Science and Practice. Prague: Karolinum; 2014, p. 149-57.
12. Quinney HA, Dewart R, Game A, Snydmiller G, Wartburton D, Bell G. A 26 year physiological description of a National Hockey League team. Appl Physiol Nutr Metab 2008; 33(4): 753-760.
13. Vescovi JD, Murray TM, Vanheest JL. Positional performance profiling of elite ice hockey players. Int J Sports Physiol Perf 2006; 1(2): 84-94.
14. Duncan MJ, Lyons M. Positional differences in the kinanthropometric and physiological characteristics of elite British ice-hockey players. In: Duncan M, Lyons M. editors. Advances in Strength and Conditioning Research, New York: Nova Science Publishers; 2009, p. 1-6.