Anthropological Review • Vol. 81(4), 379–392 (2018)

Anthropological Review
Available online at: https://doi.org/10.2478/anre-2018-0033

Body composition and physical performance of Slovak Ice hockey players with different training approach during pre-season preparation

Veronika Candráková Čerňanová[1], Ján Čerňan[2], Zuzana Danková[3], Daniela Siváková[1]

[1]Department of Anthropology, Faculty of Natural Sciences, Comenius University in Bratislava, Slovakia
[2]Sport Diagnostics, Slovakia
[3]Biomedical Center Martin, Jessenius Faculty of Medicine in Martin, Comenius University in Bratislava, Slovakia

Abstract: The pre-season preparation aim is to improve the components of physical performance through the changes in training intensity, gradual increment in volume, variation in training frequency and optimizing the body composition. The problem in team sports is the lack of individualization, because most coaches in team sports focus their training on the group and not on improving each player's strengths and weaknesses. The aim of this study is to identify differences in the body composition and physical performance of young ice-hockey players (15-18 years) with different pre-season training approaches (collective vs. individual). This longitudinal study monitored 13 ice-hockey players with collective training and 8 ice-hockey players with individual training during their pre-season preparation. Body composition was measured by bioimpedance analyzer BIA 101 (Akern, S.R.L.) and the Myotest PRO determined player physical performance in power, force and velocity. Performance and body composition comparisons showed gradual increase in the differences between the two studied groups during the training process. This increase escalated to significant differences in the final output test results and was especially noted in the upper limbs power and force (p=0.016; p<0.001) and lower limbs power and force (p=0.029; p=0.001) with better performance results by individual training approach. Stepwise linear regression also showed significant relationship between upper limbs power, resistance (p<0.001) and fat mass (p<0.001). The upper limbs force was significantly associated with intra-cellular (p<0.001) and extra-cellular water (p=0.026), body cell mass index (p<0.001), basal metabolic rate (p<0.001) and training approach (p<0.001), while the lower limbs power was significantly associated with total body water (p<0.001), training approach (p=0.033) and the pre-season preparation phase (p<0.001). In addition, the training approach (p<0.001), preparation phase (p<0.001), player position (p=0.012) and fat free mass (p<0.001) were significantly associated with lowers limb force. Our results indicate the importance of using an individual training approach and optimal body composition in physical performance progression.

Key words: team sports, individualization, training, bioimpedance analysis, sport performance

Original Research Article Received September 9, 2018 Revised November 7, 2018 Accepted November 19, 2018
DOI: 10.2478/anre-2018-0033 © 2018 Polish Anthropological Society

Introduction

Ice hockey is one of the fastest collective games and it is characterized by high intensity shifts for 30-60 seconds interspersed with a 2-3 minutes rest period. Each shift requires rapidly accelerated skating, frequent changes in direction and velocity, intense physical contact and aggression and the execution of a variety of skilled maneuvers (Montgomery 1988; Cox et al. 1995; Roczniok et al. 2016).

The energy for this physically demanding game must come from both aerobic and anaerobic energy system; but with constantly changing contributions from each. Anaerobic glycolysis provides 69% of the energy demands, including demands for anaerobic sprint ability, power and force development. In contrast, the body's aerobic metabolism has a much minor role, producing only 31 % of energy demands for endurance ability (Montgomery 1988; Cox et al. 1995; Bogdanis et al. 1996; Janot et al. 2015). The development and maximizing of these energy systems is essential for on-ice skating performance (Janot et al. 2015) and therefore good pre-season preparation is the basis for a competitive season where players can then focus on game-skills and tactics. The goal of pre-season preparation is to improve the components of physical performance, particularly: endurance, perseverance in speed, explosive, force and speed.

Studies by Burr et al. (2008) and Farlinger et al. (2007) showed that off-season improvement through training is related to on-ice performance. The character of ice hockey requires not only a high level of physical performance but also an optimal body composition that supports the development of athlete fitness (Kramer et al. 1999). Optimal body composition varies in different sports, but body composition changes offers information on specific adaptation to different physical training regimes and training load (Melchiorri et al. 2007; Dey et al. 2015). Results of body composition analysis are widely used to indicate total body fitness; including nutritional and health status, water homeostasis and the degree of usability of fat-free mass for physical activity (De Lorenzo et al. 2003; Melchiorri et al. 2007).

Success in sport at the elite level requires effective training which should be well structured and should include a time-schedule for variation in training load. There is direct positive relationship between the quantity and quality of work completed and performance improvement, therefore a continual increase in training load is necessary to ensure the body's capacity to compete at the highest level. This load progression is achieved through different ways, including changes in training intensity, gradual increment in volume and variation in training frequency. The individual approach is required to meet such progression in training, and also in competition, because each player has unique current ability and potential to improve. The real problem in team sports is the lack of individualization, because most coaches in team sports focus their training on the group and not on improving each player's strengths and weaknesses (Bompa 1994; Morgans et al. 2014).

Our experience confirms that the quality and intensity of off-ice training, including the changes in player body composition parameters, makes all the difference in physical performance between players with an individual training approach and those in the collective training process.

This study therefore evaluates the potential differences in the body composition and physical performance between ice hockey players with different training approach during pre-season preparation. This will confirm our hypothesis and also underline the preference for individual training for elite ice hockey performance.

Material and Methods

Study sample and data collection

Ice-hockey players were divided to two training groups, one group with collective training (n=18; 13 completed the study) and one group with individual training procedure (n=8) during their pre-season preparation. The pre-season training program lasted three months and all participants were tested three times; at the start of the training season, in the middle and in a final output test just before the start of the hockey competition. All tests covered both body composition and sport performance. Physical performance parameters included upper and lower limbs power, force and velocity and these parameters were conducted as dependent variables in analyses. Training approach (collective vs. individual), preparation phase (beginning, middle and end), player`s position (goalkeeper, forward, defender), age, and body composition parameters were consider as independent parameters.

The total number of participants was 26; with 18 players having collective off-season preparation and 8 players with the individual training approach. The following players were excluded from participation; those injured during pre-season preparation and those who did not complete all required sport performance tests and body composition analyses. The final study sample was 21 ice hockey players: 13 players with collective training (mean age 15.18±0.75 years; range 15-17 years) and 8 ice hockey players with individual training (mean age 17.14±0.90 years; range 16-18 years). All players in this study were based in Topoľčany (Slovakia) and its surrounds. While the collective training group all played for Topoľčany Hockey Club in Slovak Hockey League (category of youth; age range 15-18 years), the individual approach group also included some players from hockey clubs in the USA, Sweden, The Czech Republic and Austria. The required sample size was calculated for this study design. According to results, a sample of 8 subjects per group was sufficient to explicate the date with large effect size level of 1.8 and power level of 0.8. The significance alpha level of 0.05 was considered. All participants gave informed consent, and also parental signed permission was obtained. Our study complied with the Declaration of Helsinki ethical principles.

Trainings, sport performance tests and body composition analyses were performed in Topoľčany, because there were needed to keep the continuity of training schedule for both tested groups. The assembled data included anthropometric measurements, bioelectrical impedance analysis (BIA) and the Myotest PRO. The BIA and anthropometric parameters were performed in the morning after 12 hours fasting by qualified anthropologist, followed by the Myotest PRO after breakfast and proper warm-up so that the power, force and velocity of player physical performance could be accurately measured. The validity of the Myotest in measuring force and power in bench press and half-squat was confirmed in many studies (Kraemer 2010; Comstock et al. 2011). All sport performance tests were monitored by certified professional strength-and-conditioning coach.

The maximum number of players in the individually trained group was four, and each player received an individual plan based of the sports performance tests results for a particular part of the pre-season preparation. This preparation was divided into the three important categories of initial, middle and terminal training results, and the plan was modified according to player needs during the entire preparation. The training schedule ensured conditions that best enabled the development of sport strength, velocity and endurance.

The collective trained group was divided into subgroups of 3–4 players based on sport performance results; so that players with similar results were placed in the same subgroup. Each subgroup was then allocated the training plan for a particular part of the pre-season preparation, but the barbell weight in the weightlifting component was not individualized. This training was mostly scheduled for the same time on the same days although this is not considered to maximize training effectiveness.

Anthropometry

Body weight (kg) was taken without clothes or shoes on a personal scale with 0.1kg accuracy and body height (cm) was measured by Sieber and Hegner anthropometer with 0.5 cm accuracy. Both these were performed by a qualified anthropologist using Knussmann (1988) standard anthropometric techniques.

BIA (Bioelectrical Impedance Analysis)

Body composition analysis was determined by bioimpedance analyzer (BIA 101-Akern S.r.l.) and BODYGRAM software (version 1.3 for Windows) for the following parameters: Fat Mass (FM-kg), Fat Free mas (FFM-kg), Body Cell Mass (BCM-kg), Muscle Mass (MM-kg), Total Body Water (TBW-L), Intra-cellular Water (ICW-L), Extra-cellular Water (ECW--L), Phase Angle (PA-°), Basal Metabolic Rate (BMR-kcal), Body Cell Mass Index (BCMI), Resistance (Rz-Ohm) and Reactance (Xc-Ohm). In addition to 12 hours fasting, the following criteria were imposed: 12 hours absence from strenuous physical activity, 48 hours abstinence from alcohol consumption and bladder--emptying 30 minutes before body composition monitoring (Kyle et al. 2004). All BIA measurements were performed on the right side with a gel electrode attached to hand, wrist, ankle and foot.

MYOTEST

The MYOTEST PRO diagnosed the force and speed-force components of the upper and lower limbs. This included power (W), force (N) and velocity (cm/s). Participants were tested by two performance programs at the "*Expert*" level; Bench Presses Test for the upper limbs performance progression and Half-Squat for the lower limbs performance progression. This "*Expert*" level is defined as 'the level imposed on professional athletes accustomed to training with weights'. The barbell weights for male athletes tested at "*Expert*" level was 40 kg in Bench Press Test, and 90 kg in Half-Squat Test. Before test execution, the athletes had 10 minutes warm-up including cardio-activity at low intensity (120 bpm/maximum) and trunk stability exercises. After that the athletes familiarized themselves with movement that we wanted to test according to the following procedure: 2x5 repetitions at low intensity, 2x5 repetitions at medium intensity, and 2x3 repetitions at high intensity, then they had 3 minutes break. Firstly we started with Bench Press Test with following steps: ice-hockey player lies on the bench, raises the barbell and stays still; at the long beep the player lowers barbell right to his chest and remains in this static position; at the short beep the player drives the barbell up with the aim to achieve maximum velocity by gripping it firmly until full extension of the arms; the player stays in the extended arms position waiting for long beep, then he lowers the barbell into the bent position. After 5 repetitions, the double beep signals the end of the test. The Half-Squat test was as follows: ice-hockey player places the barbell on his shoulder and stands still; at the long beep the player bends the knees to 90 degrees, stabilizes the barbell and stands still; at the short beep the player jumps up as high as possible without any countermovement while firmly keeping the load on his shoulders; the landing should by as soft and smooth as possible; after landing the player returns to the standing position and waits for long beep before bending his knees and short beep before jumping. After 5 repetitions, the double beep signals the end of the test. The Bench Press and Half-Squat test results include the average of the three best repetitions for upper and lower limbs power, force a velocity.

Data analysis

The data distribution was tested by Kolmogorov-Smirnov test and Shapiro-Wilk test. The comparison of sport performance parameters and body composition parameters between groups with different training approach was done by General Linear Model (GLM). These analyzes were adjusted for age. General Linear Model – Repeated Measure Anova was used in analyzes with repeated measure design, i.e.: comparison of physical performance parameters and body composition parameters at the beginning, middle and end of pre-season preparation separately by training approach.

Stepwise linear regression then established the factors influencing elite athlete sport performance. The linear regression independent variables for power, force and velocity were as follows; the training approach (individual; collective); preparation phase (beginning, middle, and end); players' age and position (goalkeeper, forward, and defender); FM (kg); FFM (kg); TBW, ICW and ECW (L); BCM (kg); MM (kg); BMR (kcal); BCMI; Rz(Ohm); Xc(Ohm); and PA (°). The average Z-score calculated from power, force and velocity of upper and lower limbs was determined for each player and this established the individuals with the best sport performance. The IBM SPSS software (version 22) was used for these analyzes. A p value of 0.05 was used to establish the criteria for statistical significance.

Results

Table 1 displays parameters of the physical performance and the body composition which showed statistically significant differences between players with different training approach in each pre-season preparation stage. The players using the individual approach achieved better results than collectively trained players in each pre-season preparation phase.

The admission test phase highlighted significant differences between these two groups in four parameters, upper and lower limbs force ($p=0.004$; $p=0.011$); intracellular water [both in litres and %] ($p=0.033$; $p=0.005$) and extracellular water [%] ($p=0.005$). The middle test phase showed statistically significant difference in lower limbs power ($p=0.037$), upper and lower limbs force ($p<0.001$; $p=0.005$) and intracellular water ($p=0.023$). Most importantly, the end of pre-season preparation increased these statistically significant differences to eight parameters: power of upper and lower limbs ($p=0.016$; $p=0.029$); upper and lower limbs force ($p<0.001$; $p=0.001$), intracellular water ($p=0.022$), phase angle ($p=0.043$), basal metabolic rate ($p=0.040$) and resistance ($p=0.029$).

Table 2 lists the physical performance comparison in each pre-season prepara-

Table 1. Comparison of physical performance and body composition of hockey players in different phase of pre-season preparation according to training approach

Phase of preparation	Parameters	Collective approach (N=13)		Individual approach (N=8)		p^*
		Mean	SD	Mean	SD	
Admission test	Physical performance					
	Force of upper limbs (N)	512.92	35.68	775.13	98.05	0.004
	Force of lower limbs (N)	1797.52	180.44	2437.45	178.65	0.011
	Body composition					
	Intracellular water (L)	24.86	3.64	35.60	3.11	0.033
	Intracellular water (%)	54.13	3.65	66.84	2.18	0.005
	Extracellular water (%)	45.88	3.65	33.16	2.18	0.005
Middle test	Physical performance					
	Force of upper limbs (N)	520.26	49.42	792.90	93.39	<0.001
	Power of lower limbs (W)	2548.33	389.98	3569.40	689.32	0.037
	Force of lower limbs (N)	1866.71	190.82	2579.73	235.69	0.005
	Body composition					
	Intracellular water (L)	25.36	3.59	35.26	1.73	0.023
Output test	Physical performance					
	Power of upper limbs (W)	526.85	150.24	776.66	224.1	0.016
	Force of upper limbs (N)	531.52	42.03	807.14	74.03	<0.001
	Power of lower limbs (W)	2762.33	496.40	3868.94	804.35	0.029
	Force of lower limbs (N)	1909.70	175.89	2710.77	261.33	0.001
	Body composition					
	Intracellular water (L)	27.05	4.44	36.41	3.11	0.022
	Phase angle (°)	7.84	0.31	8.84	0.65	0.043
	Basal metabolic rate (kcal)	1849.25	163.89	2128.70	136.06	0.040
	Resistance (Ohm)	478.00	36.69	414.29	43.98	0.029

Legend: N – number of ice hockey players; SD – standard deviation, p^* - adjusted for age tion phase for collectively and individually trained players. The results of admission test and middle test (p^1), middle test and output test (p^2), and admission test and output test (p^3) were compared. Significant improvements were found in the collective approach between the admission test and middle test in power (p^1=0.009) and lower limbs force (p^1<0.001). The middle and output test comparisons displayed significant increase in power and upper limbs velocity (p^2=0.001, p^2=0.001) and in lower limbs power and force (p^2=0.025, p^2=0.015). Comparison of the beginning and the end of pre-season preparation had statistically significant improvements in all tested parameters: upper and lower limbs power (p^3<0.001, p^3<0.001); force (p^3=0.007, p^3<0.001) and velocity (p^3=0.001, p^3<0.001).

However, players with individual approach significantly improved at each stage of the preparation and in all tested physical performance parameters.

Table 2. Comparison of physical performance parameters at the beginning, middle and end of pre-season preparation by training approach

Parameters of physical performance	Admission test		Middle test		Output test		p^1	p^2	p^3
	mean	SD	mean	SD	mean	SD			
Collective approach (N=13)									
Power of upper limbs (W)	424.63	157.44	444.31	175.04	526.85	150.24	0.468	0.001	<0.001
Force of upper limbs (N)	512.92	35.68	520.26	49.42	531.52	42.03	0.367	0.134	0.007
Velocity of upper limbs (cm/s)	96.02	32.65	100.33	36.08	116.06	28.49	0.397	0.001	0.001
Power of lower limbs (W)	2372.18	464.68	2548.33	389.98	2762.33	496.40	0.009	0.025	<0.001
Force of lower limbs (N)	1797.52	180.44	1866.71	190.82	1909.7	175.89	<0.001	0.015	<0.001
Velocity of lower limbs (cm/s)	146.17	18.83	152.41	12.17	160.77	17.44	0.110	0.062	<0.001
Individual approach (N=8)									
Power of upper limbs (W)	630.25	272.1	713.25	245.25	776.66	224.1	0.001	0.003	<0.001
Force of upper limbs (N)	775.13	98.05	792.90	93.39	807.14	74.03	0.024	0.002	<0.001
Velocity of upper limbs (cm/s)	98.16	36.76	109.58	32.60	118.39	27.47	0.003	0.002	<0.001
Power of lower limbs (W)	3190.78	525.17	3569.40	689.32	3868.94	804.35	0.001	<0.001	<0.001
Force of lower limbs (N)	2437.45	178.65	2579.73	235.69	2710.77	261.33	0.036	0.003	0.004
Velocity of lower limbs (cm/s)	143.11	17.02	154.38	18.17	160.03	20.93	0.001	<0.001	<0.001

Legend: N – number of ice hockey players; SD – standard deviation; p^1 – comparison of admission and middle tests; p^2 – comparison of middle and output tests; p^3 – comparison of admission and output tests

Table 3 highlights the statistically significant differences in body composition parameters between each stage of pre-season preparation for collectively and individually trained players. The most significant changes in the collective approach were established between the beginning and the middle of the preparation, particularly: body weight (p^1=0.017), fat mass (p^1=0.011, p^1=0.016), BMI (p^1=0.016), fat free mass (p^1=0.016), total body water (p^1=0.025), extra-cellular water (p^1=0.002) and intra-cellular water (p^1=0.002). The comparison of admission and output tests indicated significant improvement only in the hydration status; concretely in intra- and extra-cellular water [%] (p^3=0.042, p^3=0.042) and all other parameters had no significant changes.

The situation in the individually trained group was diametrically opposed;

Table 3. Comparison of body composition parameters at the beginning, middle and end of pre-season preparation for each training group separately

Parameters of physical performance	Admission test		Middle test		Output test		p^1	p^2	p^3
	mean	SD	mean	SD	mean	SD			
Collective approach (N=13)									
Body weight [kg]	71.38	12.12	71.91	10.72	76.25	12.5	0.017	0.006	0.090
Fat mass [kg]	10.03	4.42	11.18	4.04	13.08	4.25	0.011	0.138	0.087
BMI	22.38	2.49	22.38	2.04	23.31	2.43	0.016	0.024	0.051
Fat free mass [%]	86.28	4.09	84.69	3.75	83.13	3.10	0.016	0.232	0.110
Fat mass [%]	13.73	4.09	15.31	3.75	16.88	3.10	0.016	0.232	0.110
Total body water [%]	64.89	4.07	63.36	3.48	61.51	3.32	0.025	0.105	0.201
Extracellular water [%]	45.88	3.65	43.93	5.57	41.96	6.31	0.002	0.362	0.042
Intracellular water [%]	54.13	3.65	56.07	5.57	58.04	6.31	0.002	0.362	0.042
Individual approach (N=8)									
Muscle mass [kg]	47.03	4.20	46.44	2.18	48.09	4.34	0.496	0.550	0.004
Body cell mass [kg]	39.03	3.39	38.61	1.86	39.90	3.40	0.520	0.582	0.002
Intracellular water [L]	35.60	3.11	35.26	1.73	36.41	3.11	0.508	0.605	0.002
Basal metabolic rate [kcal]	2086.76	128.49	2070.30	80.15	2128.70	136.06	0.747	0.630	0.002
Body cell mass index	11.47	0.76	11.53	0.87	11.57	0.64	0.290	0.614	0.001

Legend: N – number of ice hockey players; SD – standard deviation; p^1 – comparison of admission and middle tests; p^2 – comparison of middle and output tests; p^3 – comparison of admission and output tests all significant changes were recorded in body composition in the comparison of the admission and output tests. These players had significant increases in muscle mass (p^3=0.004), body cell mass (p^3=0.002), intra-cellular water (p^3=0.002), basal metabolic rate (p^3=0.002), and body cell mass index (p^3=0.001).

Table 4 shows Stepwise Linear Regression results of the following relationships in physical performance (upper and lower limbs power, force and velocity as dependent variables); training approach (collective vs. individual), preparation phase (beginning, middle, end), player's position (goalkeeper, forward, defender), age and body composition parameters, namely: resistance, reactance, phase angle, fat mass, fat free mass, total body water, extra-cellular water, intra-cellular water, body cell mass, muscle mass, basal metabolic rate and body cell mass index. The above mentioned parameters were consider as independent variables in the regression.

Table 4. Stepwise linear regression of selected statistically significant variables influencing physical performance

Dependent	Adjusted R^2 for model	Independent	Estimate	S.E.	t	*p*
Power of upper limbs (W)	0.746	Resistance (Ohm)	-2.981	0.427	-6.988	<0.001
		Fat Mass (kg)	18.434	4.488	4.107	<0.001
Force of upper limbs (N)	0.945	Intracellular water (L)	22.937	3.249	7.060	<0.001
		Extracellular water (L)	6.753	2.922	2.311	0.026
		Body cell mass index	47.176	8.821	5.348	<0.001
		Basal metabolic rate (kcal)	-0.437	0.109	-3.992	<0.001
		Training approach	162.977	21.693	7.513	<0.001
Velocity of upper limbs (cm/s)	0.578	Fat Free Mass (kg)	3.332	0.416	8.005	<0.001
		Training approach	-32.914	7.707	-4.271	<0.001
Power of lower limbs (W)	0.809	Total body water (L)	81.744	9.212	8.873	<0.001
		Phase of preparation	252.464	59.691	4.230	<0.001
		Training approach	261.200	118.602	2.202	0.033
Force of lower limbs (N)	0.933	Fat Free Mass (kg)	18.926	2.437	7.765	<0.001
		Phase of preparation	82.846	20.008	4.141	<0.001
		Training approach	495.009	43.937	11.266	<0.001
		Player's position	93.120	35.367	2.633	0.012
Velocity of lower limbs (cm/s)	0.488	Reactance (Ohm)	-0.972	0.332	-2.929	0.005
		Muscle Mass (kg)	0.948	0.451	2.102	0.042
		Phase of preparation	9.105	2.348	3.877	<0.001

LEGEND: R^2 – the coefficient of determination (i.e. the proportion of data explained by the model), Estimate – the estimated coefficients of the Estimate; S.E. – standard error of the mean; t – t statistic; *p* – the value of significance

Upper limbs physical performance: Regression analysis highlighted the training approach influence on force and velocity; the individual approach had significant impact on force improvement ($p<0.001$), and the collective approach showed significant velocity increase ($p<0.001$). Power improvement depended on Fat Mass gain ($p<0.001$) and resistance decrease ($p<0.001$) while increased force was associated with increased ICW ($p<0.001$), ECW ($p=0.026$), BCMI ($p<0.001$) and decreased basal metabolic rate ($p<0.001$). In addition, velocity increase was also associated with Free Fat Mass gain ($p<0.001$).

Lower limbs physical performance: Stepwise regression analysis revealed power increase in each training phase from initiation to middle to end ($p<0.001$), with increased total body water ($p<0.001$) and dependence on individual training approach ($p=0.033$). Increase in force was associated with Free Fat Mass gain ($p<0.001$), each training preparation phase ($p<0.001$), individual training approach ($p<0.001$) and player position. Here, the defenders achieved the best re-

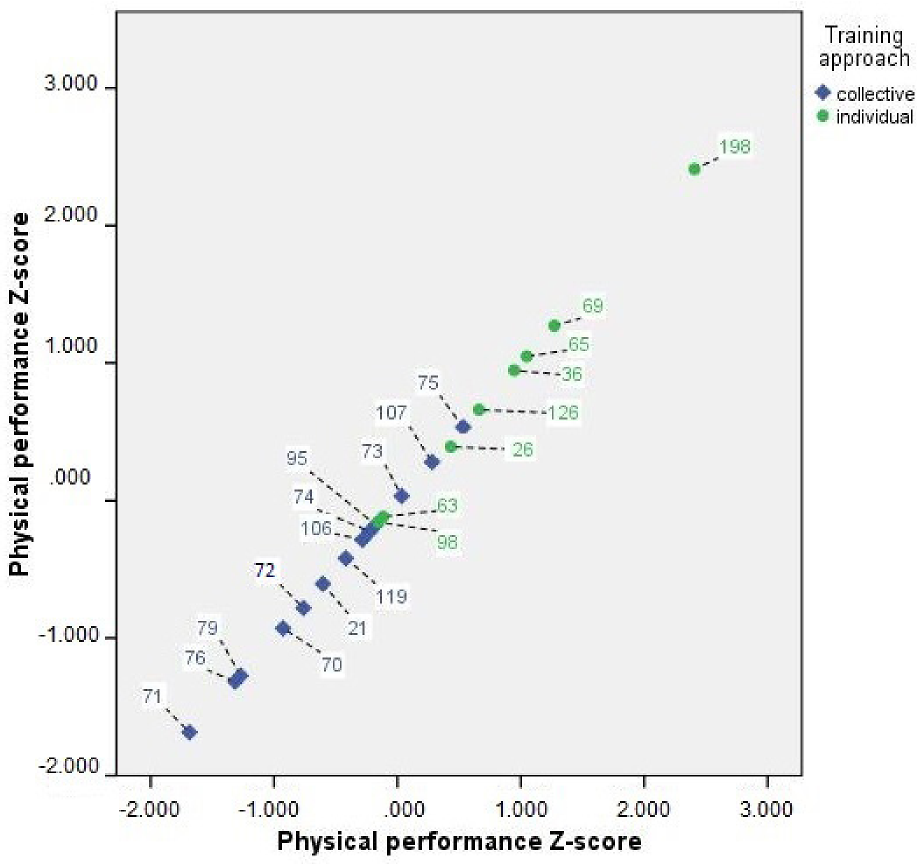

Fig. 1. Physical performance Z-scores of ice hockey players by different training approach

sults ($p=0.012$). The muscle mass growth ($p=0.042$), preparation phase ($p<0.001$) and reactance decrease ($p=0.005$), all increased lower limbs velocity.

Figure 1 illustrates the average Z-score of physical performance for each player. The results highlighted that players using the individual training approach had the highest Z-scores and therefore the best pre-season training performance. In the area of the lower Z-score, there are mostly located the players with collective approach.

Here, the player identified ID Number 198 achieved the best physical performance. This 16-year-old defender in the individual training group was 196cm tall, weighed 112 kg and had 20% body fat. This robust body structure provided 2,407.6 kcal basal metabolic rate, and this was the highest for all players in either group. In contrast, the 15-year-old player identified as ID Number 71 with 176cm height, 64 kg body weight and 17.7% body fat recorded the lowest physical performance.

Discussion

The main goals of our study are to determine which training approach produces the most improved physical performance in young Slovak ice hockey players' pre-season preparation, and to establish which other factors influence improved performances. Investigated parameters included those required in the entire pre-season preparation phase for player body composition and positional play.

Performance and body composition comparisons showed gradual increase in the differences between the two studied groups during the training process. This increase escalated to significant differences in the final output test results and was especially noted in the power and force of physical performance in players with the different training approaches when the output test was conducted. Janot et al. (2015) and Farlinger et al. (2007) recorded that these two parameters closely correlate with on-ice performance.

The individual training approach influences on physical performance could be explained as follows; (1) individual training allows the fitness coach more time to devote to the individual player and (2) the coach can therefore adjust the training to the player's needs, correct potential mistakes in training technique and focus on removing individual player weaknesses.

When comparing specific parameters, we found that the upper and lower limbs velocity had no statistically significant difference between training groups. This is most likely because velocity skills are highly genetically determined and therefore the hardest skills for any training regime to change (Grasgruber and Cacek 2008); especially when the actual physical performance parameters tested in our research are fully considered.

In the body composition assessment, better hydration status was one of the important factors demonstrated in the individually-trained players. Significant difference in intracellular fluid was found at all stages of preparation, and this ICW increase could reflect the body's response to strength training, as it is mentioned in Ribeiro et al. (2014), that muscle hypertrophy is closely connected with intracellular water increase.

Kumar and colleagues' (2012) research also supports our finding that the individual training group attained higher average phase angle and lower resistance values at the end of the training preparation. These indicate a higher proportion of cell mass and higher intracellular fluid values and they reflect the player's basal metabolism, which is significantly higher among players with individual preparation. Since the rate of basal metabolism depends on the amount of body cell mass and muscle mass, it is possible to predict a higher proportion of muscle mass in athletes with individual preparation compared to the collective approach.

One of the most interesting results was the comparison of performance parameters between tests made at the beginning, middle and end of the pre-season preparation, assessed separately for training approach. Here, the individually trained group achieved significant improvement in all parameters of physical performance after each phase of preparation. In contrast, the collectively trained group had only gradual improvement in performance; there were significant differences only in lower limbs power and force after the first phase of preparation but this improved to the four parameters of upper limbs power and velocity and lower limbs power and force after second training phase. These findings indicate that individual approach players achieved earlier and continuous performance improvement during the entire pre-season preparation compared to the collective approach. This confirms the great importance of using the individual approach, because each organism has specific response to training load, and Dovalil (2002) supported our contention that there is no universal or collective training method suitable for every individual.

Changes in body composition followed a totally different pattern when BIA analyzes were compared at the beginning, middle and end of pre-season preparation, separately in each training group. While the collectively trained group responded to training load primarily in the first phase of preparation, with changes in hydration status and fat/fat free mass ratio, there was no significant increase noted over the complete preparation in body cell mass and muscle mass which are closely connected with performance improvement. Our determination are supported by Andreoli and colleagues' (2012) study results showing these parameters as good indicators for performance improvement. These combined findings strongly suggest that poor body response to strength training could be one cause of slower performance improvement. In contrast, the individual training group achieved significant gain in MM, BCM, BMR, ICW and BCMI between admission and output tests, and this correlates with the total performance improvement this group achieved.

The best predictive model for physical performance was revealed in upper and lower limbs force, which reached up to 94.5% and 93.3%, therefore individual training approach, phase of preparation, player's position, FFM, BCMI, BMR, ICW and ECW can be considered the best predictors; because all contributed as best predictors to force improvement. In contrast, poor predictive ability (57.8% and 48.8 %) was provided in upper and lower limbs velocity. This agrees with Grasgruber and Cacek's (2008) research which demonstrated that velocity was the parameter least influenced by training. These authors then stressed that the highly genetically determined nervous system mobility, muscle composition and explosive strength are the physiological factors most influencing every individual's velocity performance.

Study limitation

The small sample size which we eventually had to use to generate regression models limited this study. Here, unexpectedly injured ice hockey players and those who could not complete all admission, middle and output tests were excluded from the survey. These circumstances decreased the sample size to a greater extent than originally anticipated, and this subject loss then increased in the collectively trained players after commencement of the study. The assumption that all ice hockey players put in maximum effort during all the pre-season preparation tests must also be considered.

Conclusion

In conclusion, the individual training approach is confirmed as an important factor in pre-season preparation of young Slovak ice hockey players. We established that the individual training approach, the preparation phase, the player position and body composition parameters of fat free mass, body cell mass index, basal metabolic rate, intra-cellular water and extra-cellular water were the best predictors for force improvement. Finally, the velocity component was established as the biophysical parameter least influenced by ice-hockey pre-season training approach.

A 3-months individual training program during off-season ice-hockey preparation showed significant improvement in all parameters of physical performance after each phase of preparation comparing with the collectively trained group, which achieved only gradual improvement in performance. Our study results indicate the need of individualization in team sport preparation, which included individual training plan modified according to player need during entire preparation, the time training schedule that best fits the criteria for power, force, and velocity development and also the permanent control of body`s reaction to training through the body composition assessment.

Acknowledgments

The authors would like to thank the hockey players for volunteering as participants in this study. This study would not have been possible without the efforts of those involved.

Authors' contributions

VCČ and JČ designed the study and collected the data; VCČ evaluated the body composition parameters and JČ the physical performance parameters. VCČ analyzed data statistically and drafted the manuscript. ZD and DS edited the manuscript. All authors have read and approved the final version of the manuscript, and agree with the order of presentation of the authors.

Conflict of interest

The authors declare that they have no competing financial interests.

Corresponding author

Veronika Candráková Čerňanová, Department of Anthropology, Faculty of Natural Science, Comenius University in Bratislava, Mlynská dolina, Ilkovičová 6, 842 15 Bratislava 4, Slovak Republic
E-mail: cernanova1@uniba.sk

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