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Position-based anthropometric characteristics and general physiological performance of national level, U18 ice hockey players

Características antropométricas basadas en la posición y el rendimiento fisiológico general de jugadores de hockey sobre hielo de nivel nacional, sub-18

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Abstract

Identifying talented players requires subjective, as well as objective assessments of playing ability and performance. The assessment of anthropometric characteristics, as well as general physiological performance can be used for player selection. The primary purpose of this study was to determine whether positional profiling is possible for national level ice hockey players by examining anthropometric characteristics and physiological performance. The study involved two ice-hockey teams, U18 and U23, in total of 49 athletes (32 forwards and 17 defensemen), members of the "Székelyföldi" Ice Hockey Academy (SZJA). Data collection was conducted in May 2020, at the SZJAs Medical and Methodological Center. Body height was determined including barefoot height (± 0.1 cm) using a wall mounted stadiometer. Body weight was measured with a standard scale. A standard incremental maximal oxygen uptake test was conducted in the laboratory by means of open-circuit spirometry and computerized instrumentation (CPET Cosmed, Italy) following the Bruce protocol. With the use of the descriptive statistics, we found no differences at the anthropometric characteristics between forwards and defensemen. Regarding the physiological characteristics, some possible differences were found for maximal- and absolute oxygen uptake rate. While our results from descriptive statistics show no significant differences between the two studied ice hockey position, based on the Mann-Whitney U test, considering all parameter values, we found that there were significant differences between the two groups within this sample number.

Keywords
VO2 max; spiroergometry; ice hockey; playing position.

Resumen

La identificación de jugadores talentosos requiere evaluaciones subjetivas y objetivas de la capacidad y el rendimiento de juego. La evaluación de las características antropométricas, así como el rendimiento fisiológico general, pueden utilizarse para la selección de jugadores. El objetivo principal de este estudio fue determinar si el perfil posicional es posible para los jugadores de hockey sobre hielo de nivel nacional mediante el examen de las características antropométricas y el rendimiento fisiológico. El estudio involucró a dos equipos de hockey sobre hielo, U18 y U23, en un total de 49 atletas (32 delanteros y 17 defensas), miembros de la Academia de Hockey sobre Hielo "Székelyföldi" (SZJA). La recolección de datos se realizó en mayo de 2020, en el Centro Médico y Metodológico SZJAS. La altura del cuerpo se determinó incluyendo la altura de los pies descalzos (±0,1 cm) utilizando un estadiómetro montado en la pared. El peso corporal se midió con una balanza estándar. Se realizó una prueba de consumo de oxígeno máximo incremental estándar en el laboratorio mediante espirometría de circuito abierto e instrumentación computarizada (CPET Cosmed, Italia) siguiendo el protocolo de Bruce. Con el uso de la estadística descriptiva, no encontramos diferencias en las características antropométricas entre delanteros y defensas. En cuanto a las características fisiológicas, se encontraron algunas posibles diferencias para la tasa de consumo de oxígeno máxima y absoluta. Si bien nuestros resultados de las estadísticas

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descriptivas no muestran diferencias significativas entre las dos posiciones de hockey sobre hielo estudiadas, con base en la prueba U de Mann-Whitney, considerando todos los valores de los parámetros, encontramos que hubo diferencias significativas entre los dos grupos dentro de este número de muestra.

Palabras clave
VO2 máx; espirometría; hockey sobre hielo; posición de juego.

Introduction

Identifying an athlete's physiological characteristics in a particular sport helps in the player's recruitment process and in identifying the athlete's strengths and weaknesses; and leads to the development of sport-specific training and testing (Roczinok, et al., 2015).

Ice hockey is played under special conditions, i.e. on a low-friction surface, so it requires a unique set of skills different from other team sports. Hockey skills include the general movement patterns of skating, stick handling, and checking. (Pearsall, Turcotte , & Murphy, 2000)

Ice hockey is high-intensity, intermittent, body contact, winter team sport. Hockey is widely considered an aerobic activity accentuated with several repeated bouts of anaerobic exercise. Given the intermittent nature of the sport, its practicants have to perform in shifts, namely an anaerobic sprint-based shift (69% anaerobic glycolysis) followed by relatively short recovery period (31% aerobic metabolism). (Stanula & Roczinok, 2014; Roczinok, Adam, Przemysław, Stanula, & Gołaś, 2014; Delisle-Houde, Chiarlitti, Reid, & Andersen, 2019; Burr, et al., 2008; Nightingale, Miller, & Turner, 2013; Lowery, Tomkinson, Peterson, & Fitzgerald, 2018; Stanula & Roczinok, 2014).

The player's ability to repeatedly withstand fatigue with high work intensity, leads to an advantage, which can contribute to the success of the game. Ice hockey requires the development of a number of physical skills, such as speed, agility and flexibility, in order to properly perform technical elements on a high level and a well-coordinated series of activities. (Stanula & Roczinok, 2014; Nightingale, Miller, & Turner, 2013; Burr, et al., 2008; Delisle-Houde, Chiarlitti, Reid, & Andersen, 2019).

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Based on literature sources, between 2009 and 2014, the average height of NHL Combine hockey players (n = 592) was 1.86 ± 0.05, their average body weight was 86.79 kg ± 6.36 kg, and the average the maximum oxygen consumption was: VO2max 56.6 ml/min/kg ± 4.6 ml/min/kg. (Ong, et al., 2017)

According to some research groups, there are significant differences between the physiological profiles of offensive players, defensive players, and goalkeepers. Interestingly, offensive players have significantly higher aerobic abilities and lower body fat percentages than defensive players or goalkeepers. Defenders have an absolute aerobic capacity significantly higher than offensive players and goalkeepers. (Burr, et al., 2008)

Physical condition and anthropometric data play a valuable role in predicting the potential of hockey players (Burr, et al., 2008), thus it could be a valuable tool in setting up selection criteria for elite ice hockey teams.

According to (Vescovi, Murray, & VanHeest, 2006) identifying talented players requires subjective as well as objective evaluation. Subjective assessments are valuable in characterizing the skills needed to play hockey; however, such assessments vary among coaches. In contrast, the assessment of anthropometric characteristics as well as physiological performance diagnostics, with standard tests, is suitable for targeted and personalized training for players, monitoring of training interventions, and the observation of normal growth and development patterns. Nowadays, there is a valid need to apply multidimensional analyzes in sports sciences, as these are becoming especially important in the selection process. (Vescovi, Murray, & VanHeest, 2006; Roczinok, et al., 2015)

Determining an athlete's potential in team sports requires a critical analysis of the skills and abilities deemed important in that sport, and then selecting and performing appropriate tests to evaluate those qualities. In order to provide an accurate assessment, appropriate methodologies and statistical tools are also required. (Roczinok, et al., 2015)

The possibilities for using statistical analysis tools are wide, from the simplest taxonomic studies to multidimensional exploration techniques to optimize the selection

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process. Many mathematical models or even artificial neural networks can be used to optimize selection at certain stages of athletic development. (Roczinok, et al., 2015)

Some research has shown that several attributes provide position-specific profiles for a variety of sports. For example, research examining soccer players has shown physical (eg, height and body mass) and physiological (eg, aerobic power, speed, vertical jump) differences among forwards, midfielders, defenders, and keepers. (Vescovi, Murray, & VanHeest, 2006). The authors (Vescovi, Murray, & VanHeest, 2006) claim that positional profiling in ice hockey is also possible, but the limited research has provided conflicting results.

In line with initiatives from elite teams in several countries (Lemoyne J., et. Al, 2022), there is an increased interest in providing precision athlete selection methodologies, based on specific anthropometric, and, more recently, physiological data. Accordingly, throughout this research, we proposed to investigate the possibility to use anthropometric and general physiological performance values in order to create position specific profiles for successful national level ice hockey players, in the age groups U18 and U23.

Materials and methods

Research design

The experiment involved two ice- hockey teams, U18 and U23, in total of 49 athletes (32 forwards and 17 defensemen), members of the SZJA academy. Data collection was conducted in May 2020, at the SZJAs Medical and Methodological Center (informed concern from all participants was collected). Body height was determined in barefoot height (± 0.1cm) using a wall mounted stadiometer. All measurements were performed by authorized personnel. Body weight was measured morning, two hours after a light breakfast. Participants did not train or take medications prior to the measurements.

A standard incremental maximal oxygen uptake test was conducted in the laboratory by means of open-circuit spirometry and computerized instrumentation. Each subject performed the test until voluntary exhaustion on a treadmill ergometer platform.

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Prior to each trial, the portable gas analyzer (CPET Cosmed, Italy) was calibrated, and each subject was fitted for the gas analyzer and the portable heart rate monitor. The subjects were instructed on the testing protocol for each modality and procedures that would be followed throughout the exercise test. Once this was completed, the exercise test began.

A standard Bruce protocol was performed (Józsa, Atlasz , Tékus , & Wilhelm , 2015), exhaled air was continuously sampled by the gas analyzer (CPET Cosmed, Italy) and the rate of oxygen uptake (V̇O2), carbon dioxide production (V̇CO2), minute ventilation (V̇E), and the respiratory exchange ratio (RER) were recorded breath by breath, by an on-line computer system (Omnia Cosmed, Italy). The gas analyzer was calibrated in accordance with the manufacturer's specifications at the beginning of each test day.

The vita-maximum test is stopped by the exercise performer himself, due to subjective fatigue (influenced by subjective factors motivation, perseverance), thus validation criteria for the maxima test were used:

- RER greater than 1.10 at test termination,
- oxygen uptake reaching a plateau or starting to fall even though the work rate kept increasing,
- maximal age-specific heart rate was reached.

Statistical analysis

In order to decipher the differences between the studied groups descriptive statistic methods were used, as follows:

For the 95% Confidence Interval calculation the following equation was used:

$$\bar{x} - t * \frac{s}{\sqrt{n}} \leq \mu \leq \bar{x} + t * \frac{s}{\sqrt{n}} \quad \text{(Equation 1.)}$$

Where: $\bar{x}$ represents the average, t-Student T, s- standard deviation, n-sample size

For the box plot analysis, the minimum, 25 Percentile, Medium, Average, 75 Percentile and maximum data were calculated and based on these values the box plot analysis were carried out using *Microsoft Excel* program. The box plot used the median, the Q1 and

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Q3 quartiles, and the minimum and maximum data points to convey the level, spread, and symmetry of a distribution of data values.

For the hypothesis analysis, the Mann Whitney U test on parametric test was applied, using the SPSS statistical program.

Results

The primary purpose of this study was to determine whether positional profiling is possible for national level ice hockey players by examining anthropometric characteristics and physiological performance, among two national level ice-hockey teams, U18 and U23, in total of 49 athletes (32 forwards and 17 defensemen), members of the "Székelyföldi" Ice Hockey Academy (SZJA). Goalkeepers were not included in the study, based on relevant literature data, which back up the assumption that the physical characteristics of goalkeepers are different from those of fielders, and data obtained from goalies would hinder detection of reference parameters for defenseman and forward by shifting the statistical results.

For our study, general anthropometric measurements were carried out, body height and body weight were determined as stated in the Methods section. Ergospirometry was performed based on the Bruce protocol with open-circuit spirometry, as stated in the Methods section. Collected data were firstly analyzed by descriptive statistics in order to determine confidence intervals of our data categorized based on player position and age group (U23 or U18).

Based on data shown in Table 1. we can state that all measured values fit in the 95% Confidence Interval.

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Table 1.

Confidence Interval calculation for all measured data

Team		Age	Weight (kg)	Height (cm)	VO2Max (ml/min/kg)	VO2 (ml/min)	HR max (bpm)	VE (l/min)
U23 Forward	Count	16	16	16	16	16	16	16
	Average	***19.63***	***77.50***	***179.25***	***55.96***	***4301.81***	***195.94***	***136.34***
	95%CI-	18.90	71.66	176.28	52.82	4033.98	192.21	120.81
	95%CI+	20.35	83.34	182.22	59.10	4569.64	199.67	151.86
U23 Defenceman	Count	9	9	9	9	9	9	9
	Average	***18.78***	***77.11***	***179.67***	***55.22***	***4247.78***	***195.56***	***139.94***
	95%CI-	18.03	72.69	176.82	51.55	3977.92	190.94	117.99
	95%CI+	19.52	81.53	182.52	58.89	4517.64	200.17	161.90
U18 Forward	Count	16	16	16	16	16	16	16
	Average	**16.50**	**69.31**	**176.38**	**55.65**	**3843.38**	**198.69**	**126.66**
	95%CI-	16.23	65.59	172.96	52.83	3627.44	194.76	112.60
	95%CI+	16.77	73.03	179.79	58.47	4059.31	202.61	140.71
U18 Defenceman	Count	8	8	8	8	8	8	8
	Average	**16.25**	**67.88**	**174.25**	**52.39**	**3607.88**	**197.25**	**123.28**
	95%CI-	15.86	59.42	168.16	48.86	3066.04	191.06	92.39
	95%CI+	16.64	76.33	180.34	55.91	4149.71	203.44	154.16

As we could not identify significant differences among player positions, by descriptive statistics, we further examined the datasets by distribution and standard deviation of parameters (Table 2). Obtained data were visualized by box plot analysis in order to assess distribution of parameter values between quartiles and to try to assess trends in values distribution (Figures 1-3.)

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Table 2.

Anthropometric and physiological characteristics of the examined population

Team		Weight (kg)	Height (cm)	VO2Max (ml/min/kg)	VO2 (ml/min)	HR max (bpm)	VE (l/min)
U23 Forwards	min	64	169	47,5	3464	185	81,9
	25P	66,75	176	51,45	3932,25	191,5	121,2
	Med	74,5	178,5	55,2	4386,5	194	143,05
	Average	**77,50**	**179,25**	**55,96**	**4301,81**	**195,94**	**136,34**
	75P	85	180	59,425	4514,5	202,25	154,125
	Max	96	191	67,3	5234	207	180,4
	stdev	10,97	5,58	5,9	502,97	7,01	29,15
U23 Defensemen	min	71	173	48,6	3583	185	102,4
	25P	73	178	49,6	4120	192	117,2
	Med	76	180	57,3	4329	195	138
	Average	**77,11**	**179,67**	**55,22**	**4247,78**	**195,56**	**139,94**
	75P	79	182	58	4374	200	167,1
	Max	90	184	61,4	4792	205	178,7
	stdev	5,75	3,71	4,78	351,07	6	28,56
U18 Forwards	min	55	166	45,6	3098	182	69,5
	25P	63,5	172,5	52,2	3656,25	193,75	113,8
	Med	70,5	177	56,35	3955	199,5	127,95
	Average	**69,31**	**176,38**	**55,65**	**3843,38**	**198,69**	**126,66**
	75P	73	179	57,375	4039	203,25	139,1
	Max	80	190	66,9	4384	212	177,1
	stdev	6,98	6,42	5,29	405,52	7,37	26,39
U18 Defensemen	min	51	164	45,5	2667	184	71,9
	25P	61,75	169,75	50,35	3269,5	194,25	95,475
	Med	68,5	173	51,6	3598,5	197	128,35
	Average	67,875	174,25	52,3875	3607,875	197,25	123,275
	75P	73,5	178,5	55,725	4173,5	201,75	152,7
	Max	84	185	58,3	4373	208	166,5
	stdev	10,12	7,29	4,22	648,29	7,4	36,95

In the case of U23 forwards, ages varied between 18 and 22 years, the body weight was between 64 kg and 93 kg, the height was between 169 cm and 191 cm. Physiological parameters: VO2max between 47.5 - 67.3 ml/min/kg, absolute oxygen consumption between 3467 - 5234 ml/min, maximal heart rate - HRmax between 185-207 bpm, minute ventilation VE between 81.9 - 168.4 l/min.

The U23 defender players were 18 to 21 years old, they had body mass from 71 kg to 90 kg, the height was from 173 cm to 184 cm. The physiological parameters was: VO2max

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between 49.1 - 61.4 ml/min/kg, absolute oxygen uptake VO2 between 3583 - 4544 ml/min, maximum heart rate - HRmax between 185-201 bpm, minute ventilation between 102.4 - 178.7 l / min.

At the U18 team the forwards were between 16 and 17 years old. They had body masses between 60 kg - 76 kg, body height between 166 cm - 190 cm. The physiological characteristics of the mentioned group was: VO2max between 45,6 - 66,9 ml/min /kg, absolute oxygen uptake VO2 between 3149 - 4384 ml/min, maximum heart rate - HRmax between 182 - 212 bpm, minute ventilation between 81,9 - 168,4 l/min.

The measured dates show us that in the case of U23 defenders, the ages between 16-17 years, the body weight was between 61 kg-84 kg, the height was between 164 cm - 185 cm. Physiological parameters: VO2max between 45,5 - 58,3 ml/min/kg, absolute oxygen consumption between 2667 - 4373 ml/min, maximal heart rate-HRmax between 184 - 208 bpm, minute ventilation VE between 71,9 - 166,5 l/min. The average age values range from 19.63 in case of U23 forwards, 18.78 for U23 defensemen, 16.50 for U18 forwards, and 16.25 for U18 defensemen. Surprisingly, weight average values are quite similar among the studied groups, 77.55 for U23 forwards and 77.11 for defensemen of the same team and 69.31 for U18 forwards, and 67.88 for U18 defenseman. Considering physiological performance parameters, there is a relatively small difference in averages of VO2Max values, ranging from 52.39 ml/min/kg in case of U18 defensemen and 55.96 for U23 forwards. There is an evident difference in average values of VO2 and VE between the two age groups.

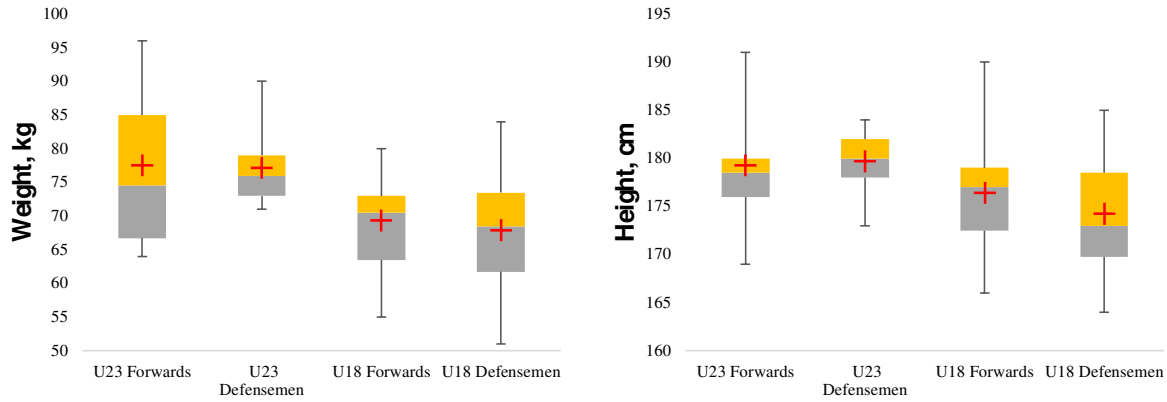

Figure 1. Box plot representation of height and body weight of the measured population

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As shown in Table 2. and illustrated in Figure 1. there are no major differences in body weight between forwards and defenders on either of the studied teams, the average values being 77.5kg ± 11kg for forwards and 77.11kg ± 5.8kg for defenders from the U23 team. Members of the U18 team had an average weight of 69.3 kg ± 7.0 kg in case of the forwards, respectively 67.9 kg ± 10.1 kg among defenders. Regarding body weight, there is no evident difference in body height between U23 and U18 defenders and forwards. In the U23 team, the forwards had an average height of 179.3 cm ± 5.6 cm and the defenders 179.7 cm ± 3.7. In the U18 team, the forwards had an average height of 176.4 cm ± 6.4 cm and the defenders 174.3 cm ± 7.3.

On the Figure 1. we can clearly observe a pattern in body height, this shows us that the U23 defenders are slightly taller than the defenders, but at the players of the U18 team we can see a contrary trend, where the forwards are taller than the defenders. Interestingly, only in case of U23 defensemen, weight and height values show a narrow distribution.

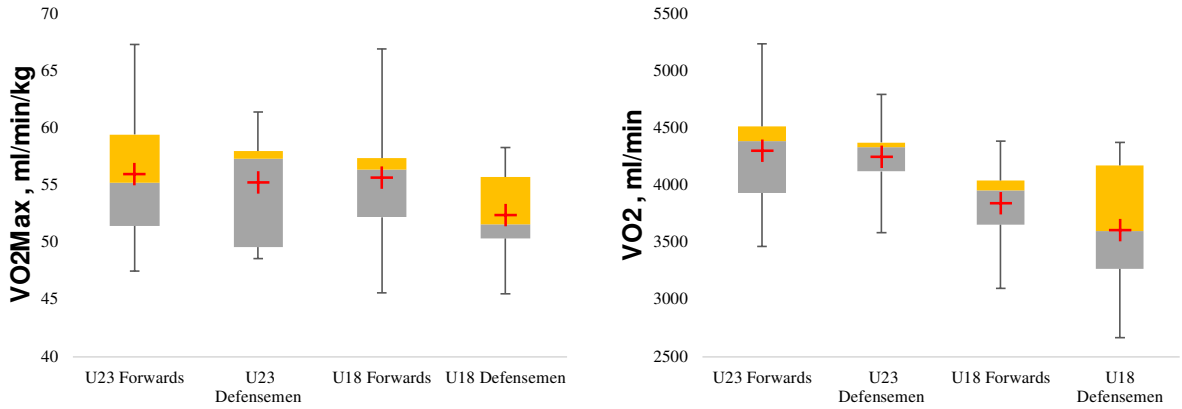

Figure 2. Box plot representation of VO2Max and VO2 of the measured population

According to the data in Table 2 there is a small difference in the maximum oxygen uptake (VO2max) between defenders and forwards at both teams. The maximum oxygen consumption was 55.9 ± 5.9 ml / min / kg for the attacking players and 55.2 ± 4.78 ml / min / kg for the defenders of the U23 team. In the other team, the forwards had a maximum oxygen

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uptake of 55.65 ± 5.29 ml / min / kg, and in the team's defenders an average of 52.39 ± 4.22 ml/min/kg.

A small difference can be seen in the absolute oxygen consumption between defenders and forwards at both teams. The average values of absolute oxygen uptake were 4301.8 ± 502.9 ml/min for the forwards and 4247 ± 351 ml/min for the defenders of the U23 team. In the other team, the forwards had an absolute oxygen consumption of 3843.3 ± 405.5 ml/min, and in the team's defenders an average of 3607.8 ± 648.2 ml/min. Regarding at the averages, we can observe that the forwards had a greater relative and absolute oxygen uptake.

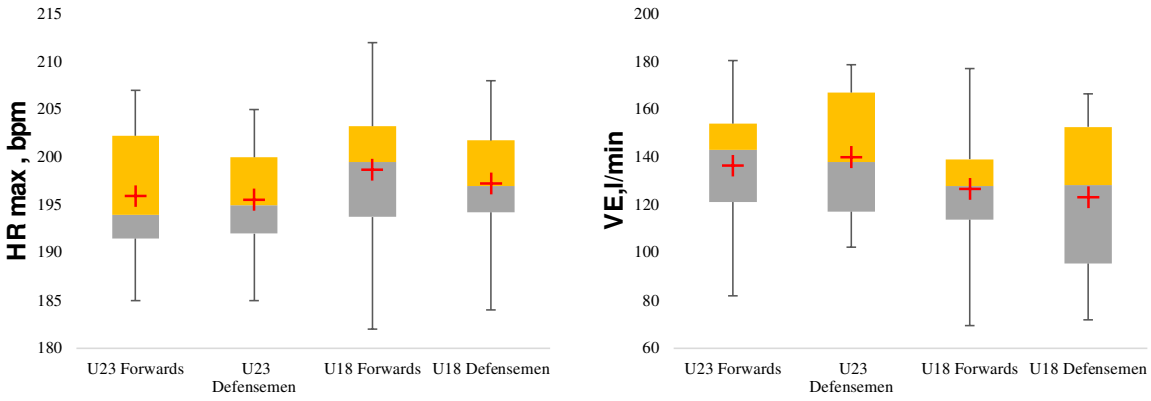

Figure 3. Box plot representation of HR max and VE of the measured population

Looking at anthropometric measurements, there is no evident difference in maximum heart rate between U23 and U18 defenders and forwards. In the U23 team, the forwards had an average maximum heart rate of 195.9 ± 7 bpm and the defenders 195.5 ± 6 bpm, while in the U18 team, the forwards had an average maximum heart rate of 199.5 ± 7.3 bpm and the defenders 197.7 ± 7.4 bpm. Regarding the minute ventilation, no major difference was observed between defenders and forwards in both teams. The average values being 136.3 ± 29.1 l / min for strikers and 139.9 ± 28.56 l / min for defenders of the U23 team. And the members of the U18 team had an average weight of 126.6 ± 26.3 l / min for the attackers, respectively 123.2 ± 36.9 l / min for the defenders. Concerning general physiological characteristics, the box plot visualization reveals a wide interval distribution of the data in case of all registered parameters (VO2Max, Vo2, HRMax and VE, Figures 2. and 3.)

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Table 3.
Mann-Whitney U test non parametric 2 independent samples

F-Test Two-Sample for Variances				F-Test Two-Sample for Variances			
U23 F&D				U18 F&D			
Parameters	U	Ucrit	Decision	Parameters	U	Ucrit	Decision
Weight	67.0	31	Different	Weight	70.0	31	Different
Height	61.5	31	Different	Height	51.0	31	Different
VO2Max	65.0	31	Different	VO2Max	53.0	31	Different
VO2	66.0	31	Different	VO2	52.0	31	Different
HR max	70.5	31	Different	HR max	59.5	31	Different
VE	71.0	31	Different	VE	62.5	31	Different

(SPSS) At 0.05 P, n=16, m=8, critical U=31

Our hypothesis being the existence of position-based reference values for the examined anthropometric and physiological characteristics, which was not evidently seen in the first set of statistical analysis, we performed a hypothesis testing by the Mann-Whitney U test, which takes into consideration all parameter values. For the non-parametric Mann-Whitney U test for 2 independent samples, with this sample number, the significance criterion was 31. Considering our results, (Table3.), the recorded data does show significant differences in all examined parameters according to game positions.

Discussion

The present research focuses on identifying talented hockey players from U18 teams. In the presented paper, we aimed to create game position-dependent profiles based on anthropometric and physiological measurements, focusing on U18 junior team in order to select/categorize young hockey players with the help of objective evaluations. The results of the descriptive statistics show no significant differences between parameters of the players from the two hockey teams we studied, but based on the Mann-Whitney U test, considering all parameter values, there were significant differences found between the two groups with this sample number.

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According to other works in the field of study, position profiling was assessed including goalies among the studied athletes (Vescovi, Murray, & VanHeest, 2006), however, there would be evident differences highlighted between game positions, as usually, goalkeepers tend to present smaller values in body weight, and they usually have lower aerobic capacity. But according to (Burr, et al., 2008) removal of the goalies' data increased predictive capacity, suggesting that talent identification using physical fitness testing of this sort may be more appropriate for field players.

Research in other team sports also shows similar results to our hypothesis testing Mann-Whitney U test results. In a recent work, authors (Waqas, et al., 2021), found significant differences in the playing positions of football players in terms of aerobic capacity. Field players have a much greater endurance capacity than goalkeepers.

According to another research on football (Bernal-Orozco, et al., 2020), who profiled players according to body composition, significant differences were found between playing positions. The study concludes, that the goalkeepers were taller, heavier, and obtained the highest values for adipose mass, whereas forwards presented higher percentages of muscle mass.

Other authors, who conducted studies on ice hockey players (Burr, et al., 2008) found that the body index, which is a composite score of height, lean mass, and muscular development, was relevant using several statistical models, with a differentiating influence by position. They also found positional differences in the relative importance of anthropometric and fitness parameters of off-ice hockey tests in relation to the draft order. Finally, they described significant differences between the physiological profiles of players based on playing position.

Regarding our results, we must state that the number of athletes participating in the study was relatively lower (Burr, et al., 2008; Lamoyne, Brunelle, Pelletier, Glaude-Roy, & Martini, 2022), or similar (Waqas, et al., 2021; Bernal-Orozco, et al., 2020) to other works in the field. As we could not identify significant differences among player positions by descriptive statistics, we further examined the datasets by distribution and standard deviation

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of parameters and the obtained data were visualized by box plot analysis in order to assess distribution of parameter values. Regarding anthropometric parameters, in case of U23 defensemen, weight and height values show a narrow distribution, which can be used as reference values for selection of athletes from junior teams. Moreover, hypothesis testing by the Mann-Whitney U test, which takes into consideration all parameter values and not just the averages, showed that a position-based differentiation can be carried out in case of the studied population.

An older study (Vescovi, Murray, & VanHeest, 2006) found no significant predictive capacity of any testing variables to predict playing position. These differing results may be attributable to the fact that his study population was smaller than the population examined by Burr, as such, had no smaller power to detect smaller differences.

Conclusion

Finally, the results we have obtained suggest that there is some difference between the offensive and defensive players of Romanian national hockey players. At this time, we found significant differences between the two game positions, with this sample number. Our perspectives for this work, however, suggest that in order to apply profiling at a younger age, a larger number of samples is needed.

Regarding anthropometric parameters, in case of U23 defensemen, weight and height values show a narrow distribution, which could be used as reference values for selection of athletes from junior teams. However, we didn't find the same pattern in case of U18 players. Furthermore, we hypothesize, that with a larger data population, ergo spirometry results could also show a profile of these athletes.

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