Original Article

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Functional assessment of children practicing ice hockey through Functional Movement Screen test

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C – Statistical Analysis
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Abstract

Introduction. The high requirements in terms of physical fitness of hockey players may be a factor predisposing to injuries. The purpose of the study was to determine the functional limitations of the locomotor system of children practicing ice hockey. Materials and methods. 104 children took part in the study, including 16 girls and 88 boys, divided into two groups. The first group consisted of children practicing hockey (n=38). The second group consisted of children who do not practice hockey (n=66). The research tool was the FMS test consisting of seven movement activities graded on a 0-3 scale. The Mann-Whitney U test was used to evaluate the differences between particular groups, and the Wilcoxon's test was used to evaluate the differences between the sides. The relationships between the variables were established based on the rho Spearmann correlation. The minimal statistical significance was set at p≤0.05. Results. The boys practicing hockey obtained a significantly higher total result than the boys who are not hockey players (p=0.008). The girls practicing hockey obtained a result close to their peers who do not play hockey. A significant positive correlation was observed between the age of the players and the result obtained in the FMS test in the group of hockey players (r=0.77; p<0.001), and between the training experience and the result of the test (r=0.49; p<0.01). Conclusion. The players obtained a significantly statistically higher result in the FMS test, which may indicate a higher level of functional fitness, resulting from a rational training and the acceleration of motor development.

Keywords: ice hockey, injury prevention, functional limitations, fundamental movement patterns

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INTRODUCTION

Ice hockey is the fastest of team sports. This discipline requires a versatile skills training. The game of hockey characterises of varied pace, in which periods of dynamic effort are intertwined with periods of rest (on the bench). Because of the varied intensity of effort, the energy comes from both aerobic and anaerobic metabolism [1, 2]. Apart from the endurance capacity, the sporting level of contestants is determined by their technical preparation. At its basis lies the ability to drive the puck and to handle the stick skillfully. Short and fast dribbling, feints towards forehand and backhand, and feinting the opponent by blocking the puck with the body and free hand are only some examples of the technique. The ability to accomplish these moves in the correct manner with high speed, as well as the accuracy of passes and the precision of strikes, make a model of a complete player [2, 3]. Another important skill of a hockey player is the dynamic balance, that is, maintaining a stable posture while performing a movement activity and being quick to adjust to changing conditions [4].

The constant physical contact with the opponent may lead to bodily damages [1]. A significant percentage of injuries in hockey is related to the specificity of this sport. An additional element increasing the risk of injuries is the surface (ice) and the use of ice skates and sticks [5-7]. The frequency of bodily damage increases with the age and the skills level of players [8-10]. Injuries occur most frequently during matches. The frequency of injuries during a game ranges from 35 to even 77% of all body damage [5]. Soft tissue injuries are the most common types. Depending on the study, they make up from 74 to 88% of all injuries. The most common ones are bruises, cuts, severance or strain of a tendon or a ligament [6, 7]. Muscle damage makes up about 34% of all injuries, joint damage – 24%, and tendon damage – 18%. Most of them are severe injuries occurring in a contact mechanism. Some of the injuries could have been avoided by the proper motoric preparation of the players [11, 12]. In the prevention of injuries, the key role is played by the strength and endurance capacity of postural and core stability muscles, proper layer of muscles surrounding the joints, muscular balance and symmetry. It is necessary to work on the above mentioned elements from the earliest age, as early as during the initial stage of sports training. For this reason, the purpose of the study was to disclose the functional limitations of children practicing ice hockey.

MATERIAL AND METHODS

104 children participated in the study, including 16 girls and 88 boys, divided into two groups. The first group consisted of 38 hockey players (5 girls and 33 boys). The second group (the control group) consisted of children not practicing hockey (11 girls and 55 boys). The average age of the participants was 2.18 years (±1.72), while the training experience was 4.77 years (±1.94) on average. For the purpose of comparison, the participant were also divided according to their age (10-12 years old and 13-15 years old).

Table 1. Characteristic of examined persons

Gender	Group	Number of people	Age [years]	Body height [cm]	Body mass [kg]
Girls	ICE HOCKEY	5	10.6 ± 0.55	143.6 ± 6.35	39.2 ± 2.39
	NON-ACTIVE	11	10.82 ± 0.75	151.82 ± 8.86	40.36 ± 5.29
Boys	ICE HOCKEY	33	12.45 ± 1.79	158.18 ± 13.42	49.85 ± 11.1
	NON-ACTIVE	55	12.42 ± 1.78	160.11 ± 13.48	50.09 ± 12.71

The Functional Movement Screen test (designed by Gray Cook and Lee Burton) was the main research tool. The test was designed for the purpose of an objective analysis of human movement patterns in relation to their functional capacity, and for the purpose of predicting and preventing injuries among the sportsmen. The three-dimensional evaluation of movement brings to light abnormalities in kinematic chains, as well as it allows for a comprehensive assessment revealing the asymmetry and significant functional limitations, resulting from incorrect mobility and stability of musculoskeletal system [13, 14]. The Functional Movement Screen consists of seven exercises testing the basic movement patters: 1. Deep squat, 2. Hurdle step, 3. In-line lunge, 4. Shoulder mobility, 5. ASLR – active straight leg raise, 6. Trunk stability push-up, 7. Trunk rotation stability [13, 14].

Performance of each of the seven exercises mentioned above is graded on a 4-grade scale, in line with the established criteria. Each movement pattern in graded from 0 to 3 points (3 points are awarded to a person who executed a movement pattern in the correct manner, 2 points are awarded to a person who executed a movement pattern with compensation, 1 point is awarded to a person who did not manage to execute a movement pattern, 0 points are given to persons who experience pain during executing a movement pattern or during a provocative test). A participant of the study can obtain 21 points in total [13, 14].

The FMS examination is conducted before the exercises, before a warm-up. The evaluation is made on two planes – sagittal and coronal. A participant performs a given movement exercise three time, and the examiner grades the best performance. If doubts occur about the correctness of execution of a pattern, the participant is given a lower score. Each side is evaluated separately [13, 14]. An original questionnaire, including biometric data and information regarding the training, was used as an additional research tool.

The differences between the groups were established using the Mann-Whitney U test. The differences between the right and the left side (in the case of two-sided FMS) were calculated using the Wilcoxon's signed-rank test. The relationships between particular variables (e.g., the results of the FMS test, training experience) were determined by the means of the Spearman's rho correlation analysis. The minimal statistical significance was set at $p \leq 0.05$.

Because of too few girls, the statistical analysis concerned only the boys. The results obtained by the girls were presented taking into account the arithmetic means, standard deviations and the sums of particular variables.

RESULTS

The boys practicing hockey obtained a significantly higher result in the FMS test than the boys who were not hockey players ($p=0.008$). The highest result (in both groups) was obtained in the shoulder mobility test. Among the hockey players, the lowest result was obtained when performing a push-up (1.97 points on average). The participants belonging to the control group obtained lower results in all exercises than their peers practicing hockey – excluding the second exercise – a hurdle step. Significant differences between the participants not practicing hockey and the hockey players were observed in the case of two out of seven exercises (Table 2).

The girls practicing hockey obtained a result close to the girls who do not practice the discipline. In both groups, the highest result was obtained in the shoulder mobility test, and the lowest one in the trunk stability exercise (a push-up). In all exercises, the hockey players group obtained slightly higher (or equal) results than the participants not practicing sports, with an exception of the straight leg raising test, where the girls playing hockey obtained a slightly lower result (Table 3).

The total results of two-sided exercises shows significant differences between the right and the left side of the hockey players. In the first group, the significant differences were

Table 2. Results of FMS test performed by boys

Groups	Deep squat	Hurdle step	In-line lunge	Shoulder mobility	ASLR	Trunk stability push-up	Rotary stability	Sum
ICE HOCKEY	2.27* ±0.57	2.00 ±0.25	2.15 ±0.57	2.67 ±0.54	2.51 ±0.56	1.97* ±0.91	2.18 ±0.59	15.76** ±2.38
NON-ACTIVE	2.00 ±0.59	2.04 ±0.41	2.02 ±0.64	2.45 ±0.66	2.27 ±0.59	1.55 ±0.72	2.11 ±0.44	14.45 ±2.19

Differences between groups: * p≤0.05; ** p≤0.01

Table 3. Results of FMS test performed by girls

Groups	Deep squat	Hurdle step	In-line lunge	Shoulder mobility	ASLR	Trunk stability push-up	Rotary stability	Sum
ICE HOCKEY	2.40 ±0.55	2.00 ±0.71	2.00 ±0.71	3.00 ±0.00	2.60 ±0.55	1.20 ±0.45	2.00 ±0.00	15.20 ±1.92
NON-ACTIVE	2.18 ±0.75	2.00 ±0.45	2.00 ±0.77	2.73 ±0.47	2.64 ±0.50	1.18 ±0.40	2.00 ±0.45	15.50 ±2.12

Table 4. Results of bilateral tasks performed by boys

Groups	Hurdle step		In-line lunge		Shoulder mobility		ASLR		Rotary stability		Sum	
	left	right	left	right	left	right	left	right	left	right	left	right
ICE HOCKEY	2.00 ±0.25	2.12* ±0.33	2.18 ±0.58	2.27 ±0.57	2.70 ±0.53	2.89** ±0.33	2.58 ±0.50	2.51 ±0.56	2.18 ±0.58	2.27 ±0.63	11.64 ±1.34	12.06** ±1.37
NON-ACTIVE	2.02 ±0.41	2.07 ±0.38	2.09 ±0.62	2.09 ±0.62	2.49 ±0.66	2.60 ±0.56	2.31 ±0.57	2.29 ±0.60	2.13 ±0.43	2.09 ±0.44	11.04 ±1.57	11.14 ±1.51

Differences between right and left side: * p≤0.05; ** p≤0.01

Table 5. Results of bilateral tasks performed by girls

Groups	Hurdle step		In-line lunge		Shoulder mobility		ASLR		Rotary stability		Sum	
	left	right	left	right	left	right	left	right	left	right	left	right
ICE HOCKEY	2.00 ±0.71	2.20 ±0.45	2.00 ±0.71	2.20 ±0.45	3.00 ±0.00	3.00 ±0.00	2.60 ±0.55	2.60 ±0.55	2.00 ±0.00	2.00 ±0.00	11.60 ±1.52	12.00 ±1.22
NON-ACTIVE	2.00 ±0.45	2.00 ±0.45	2.00 ±0.41	2.00 ±0.41	2.73 ±0.47	2.73 ±0.47	2.64 ±0.50	2.64 ±0.50	2.00 ±0.45	2.00 ±0.45	11.36 ±1.29	11.36 ±1.29

observed during two tests (hurdle step and shoulder mobility test). In the control group, no significant asymmetries were noted (Table 4). In the group of the girls playing hockey, there were also significant asymmetries observed. The biggest difference was recorded in the hurdle step and in-line lunge. The remaining two-sided exercises were executed symmetrically (Table 5). A significant positive correlation was observed between the age of the players and the result obtained in the FMS test in the group of hockey players (r=0.77) (Figure 1). A significant positive correlation concerned also the results of the FMS test and training experience (Figure 2). The general result of the FMS test was significantly higher (p<0.001) in the case of the older boys (12-15 years) than in the case of the younger ones (10-12 years) in the hockey players group. The biggest differences concerned the trunk stability test (a push-up). Important differences between older and younger players were observed in the four out of seven tests among the hockey players. Among the participants not practicing hockey, the older boys obtained a significantly higher result only in the push-up test (Table 6).

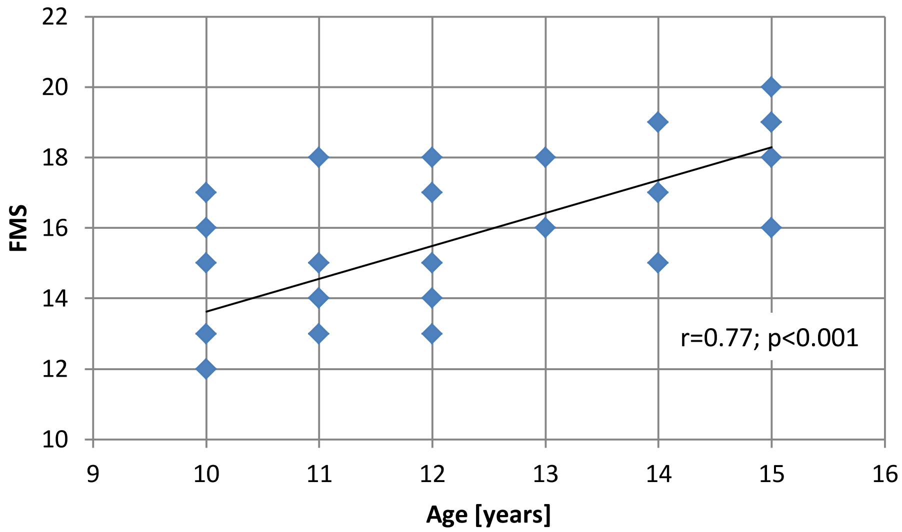

Figure 1. Correlation between results of FMS test and age of hockey players.

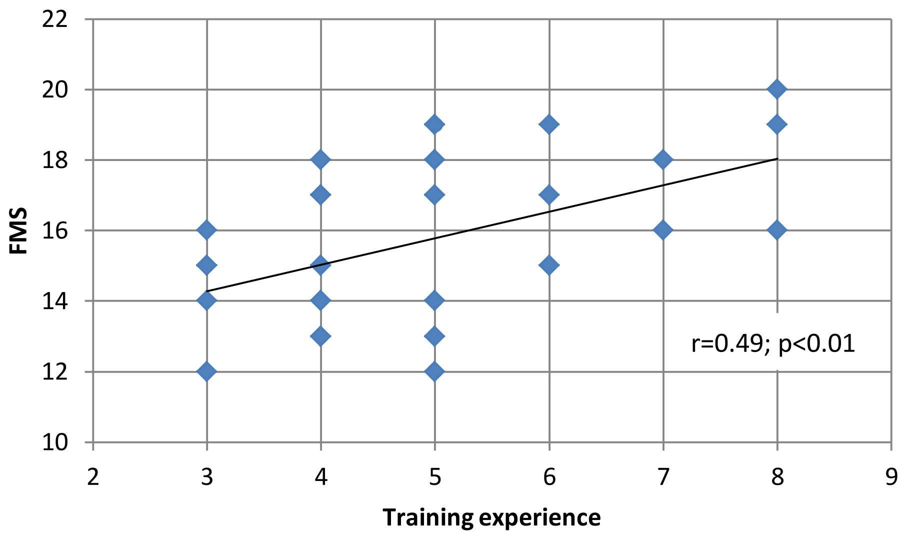

Figure 2. Correlation between results of FMS test and training experience of hockey players.

Table 6. FMS results of boys divided according to age

Groups	Age	Deep squat	Hurdle step	In-line lunge	Shoulder mobility	ASLR	Trunk stability push-up	Rotary stability	Sum
ICE HOCKEY	10-12 years old	2.00 ±0.48	1.94 ±0.24	2.06 ±0.54	2.56 ±0.62	2.28 ±0.57	1.39 ±0.70	2.00 ±0.59	14.22 ±1.77
	13-15 years old	2.60** ±0.51	2.07 ±0.26	2.27 ±0.59	2.80 ±0.41	2.80** ±0.41	2.67*** ±0.62	2.40* ±0.51	17.60*** ±1.59
NON-ACTIVE	10-12 years old	1.96 ±0.64	1.96 ±0.33	2.00 ±0.61	2.43 ±0.69	2.29 ±0.60	1.21 ±0.42	2.07 ±0.38	13.93 ±2.19
	13-15 years old	2.00 ±0.55	2.07 ±0.47	2.00 ±0.68	2.48 ±0.64	2.30 ±0.61	1.85*** ±0.82	2.11 ±0.51	14.81*** ±2.15

Differences between age groups: *p<0.05; **p<0.01; ***p<0.001

DISCUSSION

The FMS test is a simple screening test that allows to determine the functional deficits and asymmetry of studied persons. Currently, it is used not only in professional and amateur sports, but also in many other professions, including soldiers or firefighters [15-18]. High repeatability of the test is one of its benefits. It constitutes a basis for planning a strictly function-oriented rehabilitation. The test also allows for lowering the risk of injury by eliminating risk factors [19-23].

Parenteau et al. [6] used the FMS test in the studies conducted on a group of 30 ice hockey players aged 12-17. The average result obtained by the participants of the study was 12.64 (±3.65). The highest result was obtained in the second test – hurdle step (2.46 ±0.69 on average). The hockey players gained the lowest result in the push-up test (1.21 ±1.37 on average) [6]. The hockey players examined in the course of the present study gained the lowest result in the push-up test as well. This exercise is also the one most strongly correlated with age.

The studies conducted on American football players indicated that those who obtained significantly different results in two-sided FMS tests were in higher risk of injuries than those who obtained similar results for both sides. The study covered 62 healthy players, who had an individual training assigned during a seasons break. It was based on the results obtained during the test and targeted to the improvement of executing asymmetrical exercises. Before the training, there were 31 players not showing an asymmetry, and after there training cycle this number rose to 41. The best evaluation test proved to be the first one, i.e. the deep squat [24]. Asymmetry seems to be the biggest problem in the group of the hockey players examined during the own study. It may predispose to injuries. For this reason, it would be recommended to start an intervention levelling the disproportions mentioned above.

Injuries among children are rare. Frequently, they result from functional limitations. For example, 30-50% of injuries experienced by young athletics trainees result from strain. Severe injuries maintain only 15% of all cases and are caused mostly by a contact with the opponent. The children who practice running suffer most often from a pathology of the knee joint area, i.e. the patellofemoral arthritis, the iliotibial band syndrome and medial tibial stress syndrome [11]. In team sports such as basketball, handball, volleyball, football, or hockey, there may occur a higher risk of severe injury. It results from frequent physical contact between the players [11].

It should be remembered that beside many social, psychological and health benefits of physical activity in young age, there is also an increased risk of injuries and pain that may be experienced by the training youth [11, 12, 25]. A proper functional evaluation of movement patterns with the use of the FMS test or other simple methods may be the first step towards the introduction of a prevention programme [26-30].

The subjective character of the Functional Movement Screen evaluation may be considered as one of the drawbacks of the own study. However, such an impression minimalises the necessity of the evaluation on the sagittal and coronal plane. Besides, the criteria of each evaluation are clearly established and standardised all over the world. The small number of girls may be considered a weak point of the study. This resulted, however, from the fact that the overall number of women playing ice hockey is significantly lower than men.

It is necessary to continue the studies employing the FMS test to examine young athletes practicing various disciplines. It will enable the trainers to plan the trainings in a way that would allow to avoid injuries, which often lead to ending career in young age. The benefits of the test include a low cost of examination and the possibility of a comprehensive movement assessment instead of examining single elements of physical fitness.

CONCLUSIONS

1. The players obtained a significantly statistically higher result in the FMS test, which may indicate a higher level of functional fitness, resulting from a physical activity and the acceleration of motor development.
2. The most important issue that occurred in the studied group of hockey players was a significant asymmetry. This issue requires an appropriate individualised intervention.
3. The players with more training experience obtained significantly higher results. The quality of movement patterns is a result of motor development and sports training.

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