Ulewski Damian, Weber–Nowakowska Katarzyna, Gębska Magdalena, Zyżniewska–Banaszak Ewelina, Kołodziej Łukasz. The relationship between the result of FMS research and risk of sports injuries. Journal of Education, Health and Sport. 2019;9(9):271-287. eISSN 2391-8306. DOI http://dx.doi.org/10.5281/zenodo.3402123
http://ojs.ukw.edu.pl/index.php/johs/article/view/7399

The journal has had 5 points in Ministry of Science and Higher Education parametric evaluation. § 8. 2) and § 12. 1. 2) 22.02.2019.

Received: 25.08.2019. Revised: 30.08.2019. Accepted: 07.09.2019.

The relationship between the result of FMS research and risk of sports injuries

Damian Ulewski[1], Katarzyna Weber–Nowakowska[2], Gębska Magdalena[2], EwelinaZyżniewska–Banaszak[2], Łukasz Kołodziej[2]

[1] Physiotherapist, Fizjo – Pomoc Medical Center Szczecin

[2] Department of Rehabilitation Musculoskeletal System, Pomeranian Medical Univeristy in Szczecin

Corresponding author:
Katarzyna Weber-Nowakowska, e-mail: katarzyna.weber@pum.edu.pl

Abstract

Physical effort is undoubtedly linked to human functioning. Daily activities, professional

work and locomotion are basic signs of physical exercises. Civilization development has caused many changes in the lives of the population and the main reason for these changes is sedentary life. Hypokinesis leads to the general weakening of the body. Professional athletes belong to the group of people who are not exposed to changes related to sedentary lifestyle. However, they are more exposed to the occurrence of musculoskeletal injuries which are called sports injuries. Despite conducting regular periodic examinations and screening among athletes, the problem of prevention and the occurrence of the injuries has not been appropriately described.

The objectives of the study were to assess physical fitness of a selected group of athletes using the Functional Movement Screen, to examine the correlation and statistical significance between the FMS score and the number of past injuries and to determine the need for prevention of sports injuries for athletes.

The study involved 25 handball players from the Pogoń Szczecin team in the years 2015 - 2017. The study consisted of two parts: author's questionnaire survey and FMS test.

Statistical analysis of the results did not show any significant effect of FMS on the number of injuries in handball (r = -0,19). The main factor that affects the number of injuries is the long-term practice of players on handball courts (r = 0,54). Commonly known phenomenon among the players is participating in trainings despite damages and pain that results from the past injuries.
Key words: physical activity, handball, FMS, sports injuries, injury prevention

Introduction

It is well known that properly adapted physical activity has a number of positive effects for all human organism. Often changing the lifestyle, introducing more recreational forms of sport allows you to overcome ailments of the circulatory system, digestive system or locomotor system. A sedentary lifestyle and lack of exercise is associated with a limitation of physical activity. Hypokinesia leads to a general reduction in body function [1, 2]. It causes a decrease in muscle mass, an increase in body fat, slows down metabolism and decreases bone density, and reduces adaptation to temperature changes. In extreme situations, inactivity can trigger emotional or intellectual changes (depression, memory impairment, speech fluency) [3]. Long-term physical inactivity has an impact on the development of lifestyle diseases, diabetes, obesity or disorders related to the circulatory system [1, 2]. According to the Chen-

Lin Lin analysis [4], limited physical activity is the fourth most common factor responsible for the level of mortality in society.

In the 1990s, the concept of physical fitness was developed with health - H-RF (health-related fitness) [1]. Efficiency has been described in the category of preventive healthcare as an activity aimed at minimizing the risk of health problems. It is associated with the total well-being of the body covering every aspect of health [1, 2]. Adequate physical exertion has an impact on the circulatory system and the occurrence of diseases associated with it. It lowers arterial pressure, improves lipid profile and glucose tolerance, reduces body weight, has an impact on coagulation processes of hormone levels [5].

Professional sport is another type of effort. It is based on full competition in which people with the highest degree of talents participate [6]. In competitive sport, physical capacity is defined as the ability to perform long-term or short-term efforts with maximum intensity and involvement of large groups muscle, without a significant effect on the homeostasis of the body [7]. This feature increases in direct proportion to the duration and intensity of physical exertion. Sports training is defined as a unit which aims to improve physical performance and specific functional skills necessary to achieve the intended sport result [7]. People practicing sports are subject to adaptive changes in the functioning of the musculoskeletal, cardiovascular and endocrine systems [7, 8]. The athlete's body is subjected to a large amount of load associated with the need to develop, improve movement and fitness during the competition period [9]. For competitors it is often a very difficult period during which they are exposed to injuries as a result of overloading of many structures. The situation occurs as a result of insufficient recovery time and adaptation to training loads.

Regardless of the type of activity for recreational and professional sports, the definition of injury is the same. One of the most general is: "A sports injury is an injury that arose while playing sports or recreation" [10]. If we add to the definition the reason that is characteristic of the selected sport, we present the definition of injuries identical to a specific sport. In the literature, the basic division of injuries is based on the distinction between acute and chronic injuries [8, 9, 11].

Injuries in sport are a multi-faceted issue that requires comprehensive and targeted analysis. A properly structured training plan and periodic check-up plan should result in continuous improvement of motor preparation, improvement of athletic performance, and a reduction in the risk of injury. An important element is the individualized functional training,

which is designed to shape the correct functioning of the musculoskeletal system and maintain proper movement patterns. A particularly important element of the research is a comprehensive functional assessment of players to prevent new injuries and limitations.

Aim

The main aim of the study is to assess the physical fitness of Pogoń Szczecin players using the Functional Movement Screen method.

The specific aims are:

1. To examine the correlation between the results of the FMS test and the number of injuries occurring in competitors.
2. To investigate the relationship between the subjective assessment of functional status and the FMS result.
3. Determining the need to introduce an educational program in the field of motor system prevention among competitors

Material and methods:

The study was conducted on a group of 25 men, players of the Pogoń Szczecin handball team in the 2015/2016 and 2016/2017 seasons. 22 of them were reported to the PGNiG Superleague men - the highest level of competition in Poland. The remaining 3 people belonged to the group of players tested in the club. Four players from the described group perform equally in the junior teams of another Szczecin club (KS CKS SMS Szczecin). A list of anthropometric features is presented in Table 1.

Tab. 1 List of anthropometric characteristics of the subjects

n = 25	Min.	Max.	Average $\overline{\quad}$	(max-min)	Mediana	SD
Age [years]	18	40	25	22	24	6,24
Weight [kg]	68	116	93,4	48	92	12,47
Heigh [m]	1,75	1,98	1,89	0,23	1,92	6,95

The study included performing the FMS test and supplementing the author's questionnaire. The questionnaire consisted of three parts. In the first of these players were asked about a subjective assessment of health, including physical fitness, as well as about cooperation with other specialists, including dietitian, sports psychologist, physiotherapist, masseur. The second part consisted of 4 questions and assessed knowledge of the FMS method. The last part, the most extensive, containing 11 questions, referred to the players' injuries and health behaviors in the period after being injured until the injury was fully healed.

The Functional Movement Screen test was performed in a sports hall before the participants entered the training. The original diagnostic equipment consisting of a 5x15x150cm beam, two crossbars with graduations, a rod with a scale and elastic rubber was used for the assessment.

A comprehensive FMS test consists of 7 trials [12]: deep squat (DS), leg over bar (HS), in-line lunge (ILL), shoulder girdle mobility (SM) shoulder mobility, active straight leg raise (ASLR), pump stability (TSPU), trunk rotational stability (RS).

The test was performed without warming up. The best sample of three repetitions was assessed, while in case of doubt a lower score was awarded [13, 14, 15]. All tests were evaluated on a four-point scale (0-3 points). The condition of receiving 3 points was to make the test run smoothly without any compensation element. The correct performance of the exercise but with visible compensation is 2 points. Failure to perform the test, in the absence of information from the participant about the occurring pain is 1 point. The occurrence of pain preventing the test from being performed is 0 points [13, 14, 15]. The maximum number of points that can be obtained is 21.

During qualification for the study, the following inclusion and exclusion criteria were used:

Criteria for inclusion in the study: training internship minimum 1 year in the senior team at the highest level of competition in Poland, training internship minimum 3 years with specialization in handball, regular participation of the player in training of the first team, expressed written consent to participate in the study. Exclusion criteria are: injury excluding training, players in the course of rehabilitation after an injury or surgery, players without adequate handball experience, no written consent to participate in the study.

The obtained results were ordered in a spreadsheet and subjected to statistical analysis in

the Libre Office Calc program. To examine the relationship between two variables due to the qualitative nature of the variables, the Pearson r-correlation coefficient was used. The level of statistical significance was assumed to be p = 0.05

Results:

The study involved 25 men, players of the Pogoń Szczecin handball team in the 2015/2016 and 2016/2017 seasons. 22 of them were reported to the PGNiG Superleague men - the highest level of competition in Poland. The remaining 3 people belonged to the group of players tested in the club. Four players from the described group perform equally in the junior teams of another Szczecin club (KS CKS SMS Szczecin).

The longest training experience in the team was 30 years, of which 24 years in the senior team. The shortest training internship was respectively 4 years of total training internship including a year in the senior team. The average period of practicing this discipline is 14 years. The average seniority in a senior team is 7.5 years. The standard deviation for the total training placement is 6.65, while for the senior team placement is 6.09.

Figure 1 presents a graph of dependence of cooperation between players and various specialists. 11 people (44%) work only with a physiotherapist and masseur in club conditions. Lack of cooperation with other medical units is declared by 4 respondents (16%). The average FMS score for people who do not cooperate with other entities is 14 points. Despite this, they are characterized by a small number of sport injuries (the average number of injuries is 4).

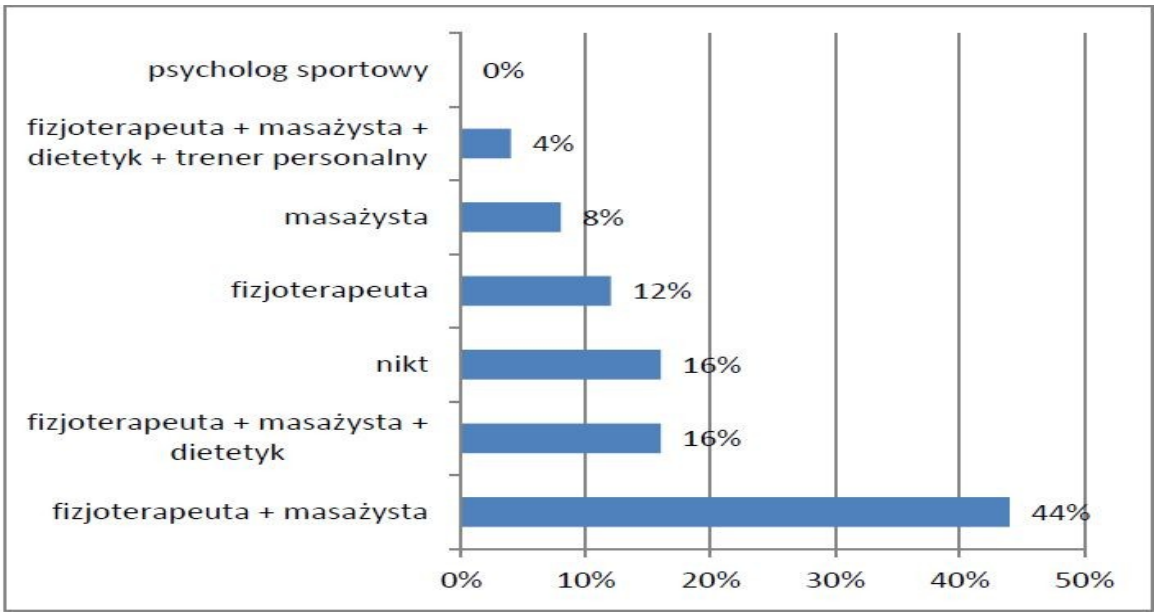

Fig.. 1. Cooperation of players with medical entities

Figure 2 shows the total number of player injuries. The highest number of injuries sustained while practicing the discipline is 20 injuries. Only one player has not been injured in his career. The average number of injuries excluding from participation in handball training is 6. The standard deviation for the number of injuries is 4.52. 83 injuries related to the lower limb and 60 injuries related to the upper limb were noted in the examined group of players. The highest number of injuries recorded in one player for these areas is 10 lower limb injuries and 8 upper limb injuries.

Fig. 2. The number of injuries during the career.

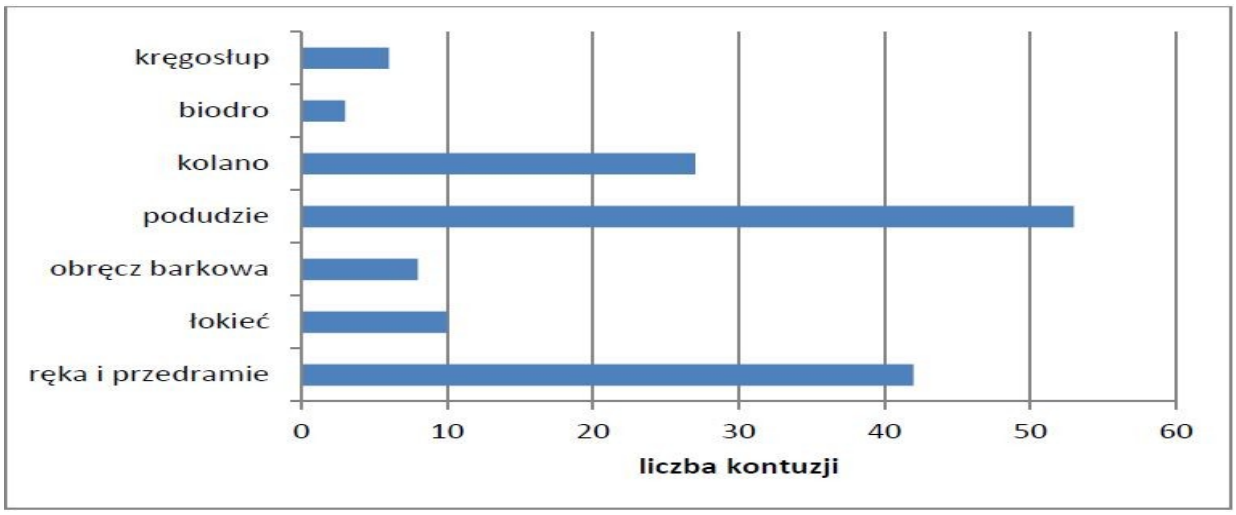

Figure 3 shows the average number of injuries per player after division into individual groups. Statistical analysis did not show a significant relationship between the selected FMS score groups and the number of sports injuries noted.

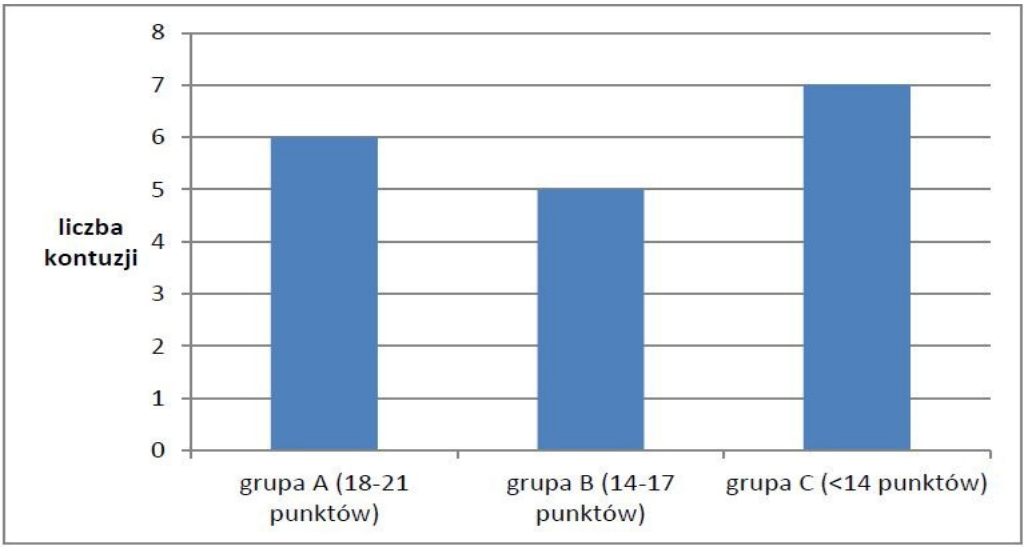

Fig. 3. Average number of injuries per player The average FMS test score in the examined group of handball players was 15 points. This indicates the asymmetries and potential exposure of group members to sports injuries. The examined people were divided into 3 groups according to the FMS result (Fig. 4). Group A includes players with a score of 18-21 points, group B people with a score of 14-17 points, and group C people who have a score below 14 points. As a result of statistical analysis, a correlation coefficient was obtained for the FMS result in groups and the total number of injuries with a value of -0.19 (p = 0.536).

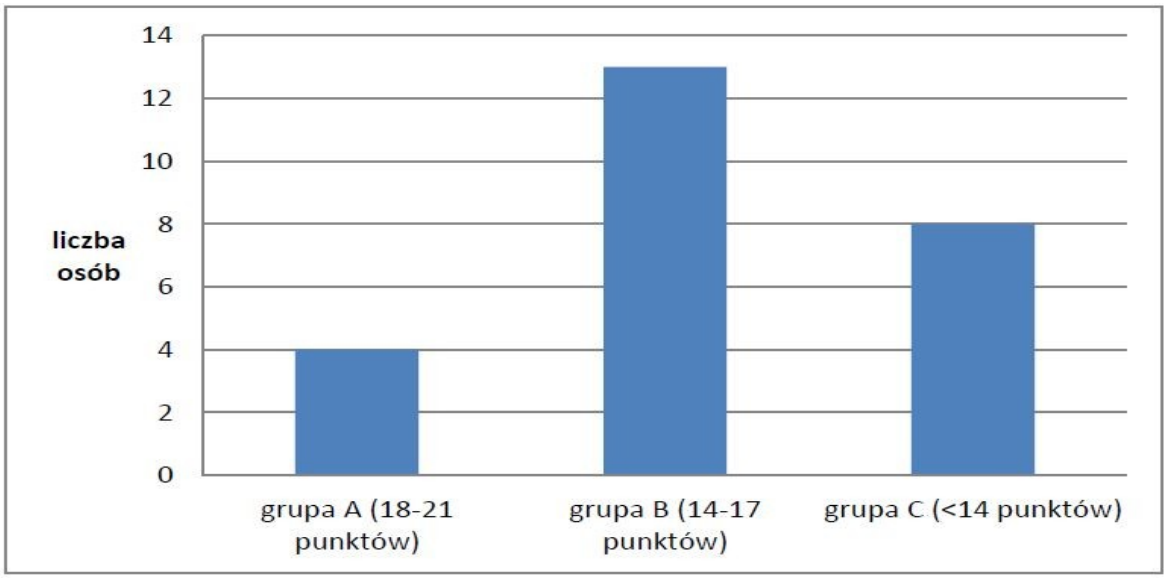

Fig 4. FMS results – number of players

Based on the questionnaire information was obtained about the subjective assessment of physical fitness. Figure 5 shows the relationship between the FMS test result and the subjective assessment of physical fitness. The correlation coefficient of players divided into groups was 0.68 ($p < 0.001$). The obtained result indicates a strong relationship between the FMS result and the subjective assessment of physical fitness.

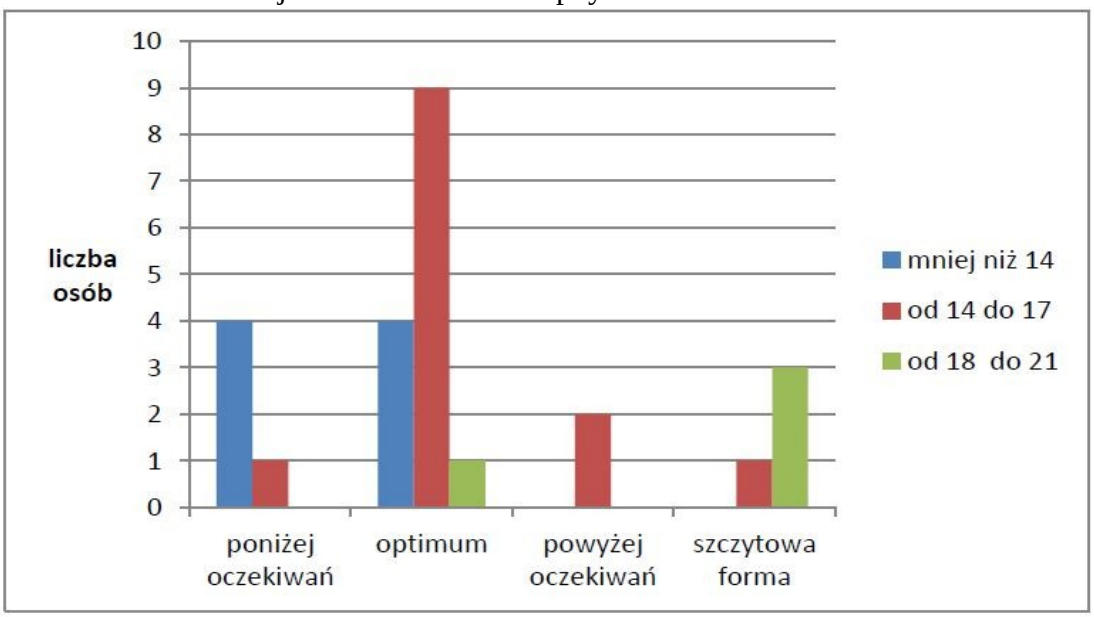

Fig. 5. Correlation of the FMS score to the subjective assessment of physical fitness

Table 2 presents the results of the FMS test. The most frequently obtained grade was 2 points. Only one test showed pain. The TSPU test (pump in the support) turned out to be the most diverse in terms of the result.

Tab. 2 Summary of FMS results.

test FMS	Max (pkt)	Min (pkt)	Średnia ($\overline{x}$)
DS	3	1	1,96
HS	3	2	2,32
ILL	3	2	2,36
SM	3	1	2
ASLR	3	1	1,96
TSPU	3	0	2,28
RS	2	1	1,96

Conducted studies showed no relationship between age and the FMS result. A moderate relationship exists between the age of the player and the total number of injuries he has suffered. The lower the SM test result, the greater the number of shoulder girdle injuries.

Based on the questionnaires, information was obtained about the state of knowledge of the players about the FMS test, as well as previous participation in the study. 15 people know the basic information about how to use the Functional Movement Screen test in practice. 13 competitors have previously participated in the FMS survey. For 12 subjects this was the first test performance. 32% of respondents believe that regular FMS examination in sport is an important element of injury prevention. However, only 6 people (24%) believe that training using the assumptions of the FMS method brings better results than a normal training unit.

When asked whether after trauma players participate in team training as many as 17 people (68%) answered yes. Only 8 people (32%) after injuries are excluded from training. Figure 6 shows what type of injury players take part in in the first team training. 17 people answered yes to the question about participation in trauma training. At least 3 people trained only with an injury that did not require additional medical treatment. Most athletes (8 people) from this group participated in training with an injury that required control and medical treatment. Injuries of six players from the trauma training group required orthopedic surgery.

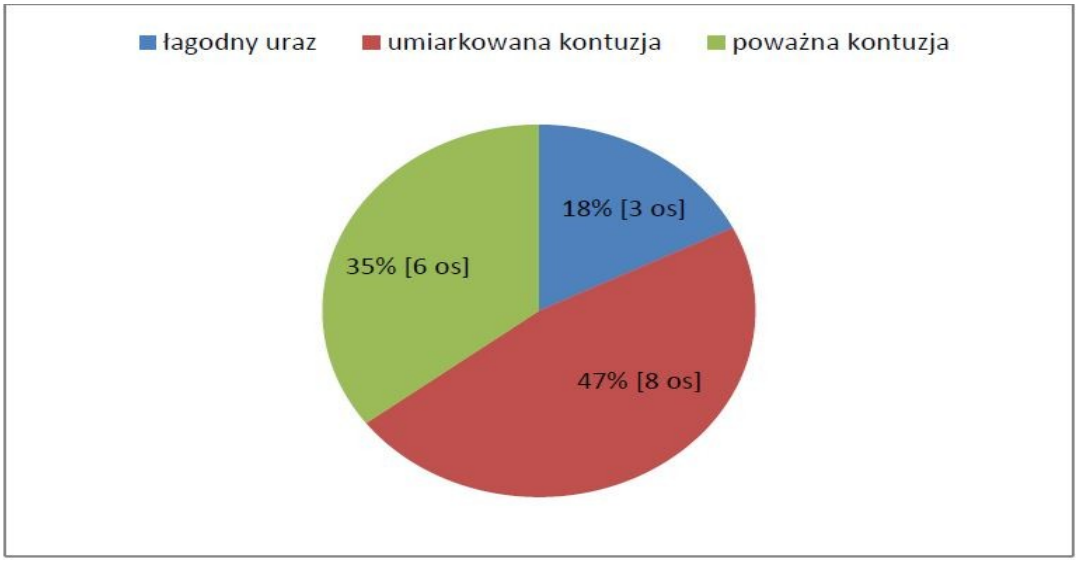

Fig. 6 The type of injury with which players participate in training. The very quick introduction of young players to senior teams is associated with increased exploitation of their body. Due to the lack of physical preparation, they are more likely to experience injury. Competitors who showed limitations of movement in the joints (knee, shoulder and elbow) obtained a similar FMS score to unlimited players. Due to restrictions, two out of three players are more susceptible to body fatigue. A player with limitation of extension in the elbow joint does not indicate greater susceptibility to fatigue. In response to the FMS study, the players reacted with interest about the prevention of the shown locomotor system restrictions.

Summary of results:

1. The average training period of a handball player is 14 years, including 7.5 years in the senior team.

2. The most common sports injuries in the group of handball players are injuries to the ankle and lower leg (36%) as well as the arm and forearm (28%). The average number of injuries excluding a handball player from training is 6.

3. 19 people (76%) declare cooperation with a physiotherapist, 2 people (8%) declare cooperation only with a masseur, while 4 people (16%) are not associated with cooperation with any medical entity.

4. The highest FMS score obtained is 20 points (8% of the group) and the lowest is 11 points

(8%). The median for the FMS result is 15 points.

5. During the FMS examination, 1 person (4%) reported pain as a factor preventing the test (TSPU) from being performed.

6. A strong relationship was shown between the subjective assessment of health status and the FMS test result (r = 0.68).

7. A relationship between age and occurrence of injury in Pogoń Szczecin players was demonstrated regardless of their level of physical fitness (r = 0.54).

8. Familiarity with the FMS survey was declared by 15 persons, while only 13 of them participated in FMS diagnostics before taking measurements for the current survey.

9. Over half of the people (68%) have ever participated in training while being an injured player.

10. There was no significant statistical relationship between the FMS test result and the number of injuries recorded in the study group.

Discussion:

The Functional Movement Screen study is an important element supporting the diagnostic process of the human body. It allows a very broad look at the body, its movement pattern and level of functioning. According to Gray Cook, the FMS test was never just a diagnostic tool. It was created for the basic assessment of traffic quality as well as for use as a screening test [16].

The occurrence of injury is undoubtedly associated with motor preparation of athletes. After analyzing the available literature and based on the results of the research, it can be concluded that the FMS test itself has little to do with predicting injury. The occurrence of injuries is affected by many more factors than the individual ability to perform a specific test under the weight of their own body. Some factors are reduced endurance and endurance, and limitation of agility and muscle strength. Still, FMS has as many supporters as opponents. Studies conducted by Kyle Kiesel et al. [17] (n = 46) show diagnostic possibilities for athletes playing football professionally. 51% of players with a score equal to or less than 14 ended the season with injuries whose treatment lasted more than 3 months. Sean M. Bardenett [18] examining a diverse group of athletes (n = 185), among others volleyballers, swimmers, footballers and footballers showed no link between the FMS

test and injury prevention. Studies have shown that the most important risk factor is the earlier occurrence of injuries, as well as the exploitation of the athlete during the full sports season (about 5 months). Finally, the FMS test was recognized as an inappropriate tool to predict sports injuries [18].

The analyzed literature, as well as the results of own research on handball players, show no relationship between the FMS result and the occurrence of injury. Considering the aforementioned risk factors, it can be concluded that the FMS test only allows to show the occurring functional disorders of the musculoskeletal system. A higher FMS result, and therefore also better physical ability, makes it easier for athletes to function in a sport discipline, and thus better regeneration ability and less susceptibility to fatigue than competitors with visible limitations.

The basic seven tests of the FMS test are too few exercises to assess the possibility of sports injuries well enough [19, 20]. Due to the variety and severity of risk factors for sports injuries, a complete diagnostic examination should consist of individualized assessment of mobility, proprioception, muscle strength and additionally basic movement patterns such as deep squat, in-line lunge [19]. According to the results of research carried out by R.G. Lockie [20] elements of the FMS study, such as deep squat, hurdle step, in-line lunge, active straight leg raise and trunk stability push-up are not able to examine the dynamic stability of the musculoskeletal system, making them not a reliable test suitable for athletes.

Own research has shown a large correlation between the FMS test result and the subjective assessment of physical fitness. Higher result obtained in the test was characterized by better self-esteem of the player. This may indicate that the players are well prepared for the season. According to the research of S. Tafuri [21] and M. Garrison [22], people with a score above 15 points are characterized by a better adaptation of the body to physical effort, which results in faster development of motor skills than competitors with a lower FMS score (<11 points).

To date, the most frequently studied groups of athletes are football, baseball and volleyball players. These studies were conducted on a larger scale than their handball counterparts. This may be due to the lower popularity of this sport and its general lack in the sports structures of the United States and Great Britain. The average group analyzed in selected handball tests is 25 players [23.24]. Studies conducted on a small group of handball players are characterized by low statistical significance. Despite this, the variety

of activities undertaken by the players or the total lack of them tend to reflect on this selected group. The results obtained in this work incline to continue research on a larger group of competitors. This would allow for a stronger relationship between the parameters tested.

The analysis of literature presented above, as well as the results of own research show how difficult a correct functional assessment of athletes is. Despite the development of science and medicine, no suitable tool has yet been invented to prevent injury in sport. The players themselves also do not facilitate this task in situations when they sometimes participate in training and sports competitions while being an injured person. Thus, they increase the chance of a new injury at least twice [16, 23]. The FMS test in classified sports conditions is slowly replaced by another method, i.e. Selective Functional Movement Assessment (SFMA). It is a modification of the FMS test, whose task is to evaluate the functioning of the human body (FMS assesses selected movement patterns) [16, 25]. In its assumptions, SFMA refers to the clinical presentation of the patient's image. This method includes in its assessment all publicly available clinical tests necessary to accurately locate the dysfunction. Only as a result of comprehensively conducted examination is an appropriate diagnosis presented [16, 25]. Modifications to many years of proven test methods testify to the complexity of the problem and the continuous development of sports medicine.

Conclusions:

1. The physical fitness of a group of handball players does not differ from the fitness of an average person.
2. No relationship was found between the low FMS score and the greater number of injuries among competitors.
3. A large relationship has been demonstrated between the subjective assessment of functional status and the FMS result.

There is an indication to supplement the current training methods in the Pogoń Szczecin team for further education and prevention of sports injuries.

References:

1. Knapik A., Saulicz E., Plinta R., Miętkiewicz-Ciepły E.: Wpływ systematycznej aktywności ruchowej na sprawność funkcjonalną kręgosłupa na podstawie trójpłaszczyznowego pomiaru zakresu gibkości. *Ann. Acad. Med. Siles.* 2005;59:6.
2. Jodkowska M., Mazur J., Oblacińska A.: Perceived bariers to physical activity among polish adolescents. *Przegl Epidemiol.* 2015;69:73-78.
3. Borowicz K.: Aspekty biochemiczne i patofizjologiczne aktywności fizycznej. *Zeszyty naukowe WSSP* 2013;17:137-148.
4. Lin C., Lee W., Ou C., Hsiao J., Huang C., Huang J. i wsp.: Regular recreational physical activity and risk of head and neck cancer. *BMC Cancer* 2017;17:286.
5. Makowiec-Dąbrowska T.: Wpływ aktywności fizycznej w pracy i życiu codziennym na układ krążenia. *Forum Med Rodz.* 2012;6(3):130-136
6. Panfil Ł., Seweryniak T.: Wybrane uwarunkowania rozwoju talentów sportowych. *Prace Naukowe Uniwersytetu Ekonomicznego we Wrocławiu* 2014;349:295-307.
7. Plinta R., Olszanecka-Glinianowicz M., Chudek J., Skrzypulec-Plinta V.: Trening sportowy a stężenia krążących adipokin. *Postepy Hig Med. Dosw* 2013;67:35-42
8. Cheron Ch., Le Scanff Ch., Leboeuf-Yde Ch.: Association between sports type and overuse injuries of extermities in children and adolescents: a systematic review. *Chiropr Man Therap* 2016;24:41.
9. Dziak A., Tayara S.: Urazy i uszkodzenia w sporcie. *wyd. Kasper, Kraków* 2000;s.17-54 ISBN 83-910437-0-3.
10. Ogorevc M.: Medycyna alterntywna w sporcie. *wyd. KOS, Katowice,* 2011;s.28-33, ISBN 978-83-7649-038-0.
11. Złotowska R., Skiba M., Mroczek A., Bilewicz-Wyrozumska T.: Negatywne skutki aktywności fizycznej oraz uprawiania sportu. *Hygeia Public Health* 2015;50(1):41-46.
12. Chimera J. N., Warren M.: Use of clinical movement screening tests to predict injury in sport. *World J Orthop*. 2016;7(4):202-217.
13. Szymczyk D., Oleksy Ł., Wróbel K., Opaliński G.: Możliwości oceny funkcjonalnej piłkarzy nożnych z wykorzystaniem testu FMS™ (Functional Movement Screen™) – doniesienia wstępne. Instytut Fizjoterapii/Sportiva.pl 2012.06.19 dostęp internetowy

14. Kochański B., Plaskiewicz A., Kałużny K., Dylewska M., Płoszaj A., Hagner-Derengowska M., Zukow W.: Functional Movement Screen (FMS) – kompleksowy system oceny funkcjonalnej pacjenta. *Journal of Education Health and Sport*. 2015;5(4):90-101.
15. Lemiesz G., Iwańczyk K., Biernat R., Godlewski J., Szymański M., Biernat U., Tajchman L., Sieklucka E.: Zastosowanie testu funkcjonalnej oceny w praktyce. *PFiR.* 2013;39:4-11.
16. Cook G., Burton L., Hoogenboom BJ., Voight M.: Functional movement screening: the use of fundamental movements as an assessment of function – part 2. *Int J Sports Phys Ther.* 2014;9(4):549-563.
17. Kiesel K.,Plisky P., Voight M..: Can serious injury in professional football be predicted by a preseason functional movement screen? *N Am J Sports Phys Ther.* 2007;2(3):147-158.
18. Bardenett S.M., Micca J.J., DeNoyelles J.T., Miller S.D., Jenk D.T., Brooks G.S.: Functonal movement screen normative values and validity in high school athletes: can the FMS be used as a predictor of injury? *Int J Sports Phys Ther.* 2015;10(3):303-308.
19. Yeung J., Cleves A., Griffiths H., Nokes L.: Mobility, proprioception, strength and FMS as predictors of injury in professional footballers. *BMJ Open Sport Exerc Med*. 2016;2(1).
20. Lockie R.G., Callaghan S.J., Jordan C.A., Luczo T.M., Jeffriess M.D., Jalilvand F. i wsp.: Certain actions from the Functional Movement Screen do not provide and indication of dynamic stability. *J Hum Kinet.* 2015;14:19-29.
21. Tafuri S., Notarnicola A., Monno A., Ferretti F., Moretti B.: Crossfit athletes exhibit high symmetry of fundamental movement patterns. A cross-sectional study. *Muscles Ligaments Tendons J*. 2016;6(1):157-160.
22. Garrison M., Westrick R., Johnson M.R., Beneson J.: Association between the functional movement screen and injury development in college athletes. *Int J Sports Phys Ther*. 2015;10(1):21-28.
23. Nuño A., Chirosa I.J., van den Tillar R., Guisado R., Martín I., Martinez I.: Effects of fatigue on Throwing Performance in Experienced Team Handball Players. *J Hum Kinet* 2016;54:103-113

24. Manchado C., Garcia-Ruiz J., Cortell-Tormo J.M., Tortosa-Martinez J.: Effect of core training on male handball players' throwing velocity. *J Hum Kinet*. 2017:56;177-185.
25. Goshtigian G.R., Swanson B.T.: Using the selective functional movement assessment and regional interdependence theory to guide treatment of an athlete with back pain: a case report. *Int J Sports Phys Ther.* 2016;11(4):575-595.