Original Article

Lateralization value of functional movement rating in volleyball players' injury prevention

JOANNA PIECH¹, WOJCIECH BAJOREK², ARTUR PŁONKA³, MACIEJ KUCHCIAK⁴, GABRIEL BOBULA⁵

^{1, 2, 3, 4, 5}Institute of Physical Culture Sciences, Medical College of Rzeszów University, Rzeszów University, POLAND

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Abstract:

The Game variability and asymmetry of volleyball movements often lead to overloads affecting the mobility system. Premature specialization limits versatility and motor preparation, which increases the risk of injury. Therefore, systematic comprehensive control becomes very important. Functional Movement Screen (FMS) is one of the tools used for the functional assessment of an athlete. The Functional Movement Screen (FMS) test applied in the presented research allows assessment of players' movement abilities as well as assessing their susceptibility to injury which can be caused by asymmetry volleyball. The set of preformed activities in the test is based on global movement patterns, it is used in both physiotherapy and sports. A revision of scientific research confirms the high repetitiveness of this research tool (ICC = 0,98) while being applied to functional assessment of sportspeople. The aim of the study was to assess the influence of lateralization of functional muscle efficiency of volleyball players in the first league. The FMS test allows one to determine the motor skills of a player and check his susceptibility to injury due to asymmetry appearing in this sport. The research showed a number of irregularities in movement patterns in the group of volleyball players. More than half of the assessed sportspeople gained less than 18 points in the FMS test, which shows the presence of additional compensation movement during the test. The predisposition for higher injury risk within volleyball players may be a consequence of the fact. The largest disorders during the tests were observed during by the SM test (1.9/3), while the smallest disorders during the ASLR test (2.6/3 and 2.7/3). The average score obtained by players practising professional volleyball was 16.5/21 points. The lowest average result was obtained in the shoulder mobility test. Some players felt pain during the test which prevented them from performing the task correctly. According to FMS assumptions, a result between 18-14 points suggests the presence of certain motor disorders that increase the incidence of injury by about 25-35%. Disproportions that occur in the subjects are caused by greater exploitation of a given muscle group. In the case of volleyball players, a slight asymmetry in the individual trials of FMS has also been observed. Asymmetry often leads to muscular dystonia which can cause serious injury. Asymmetry was observed in the majority of players in the research.

Key Words: pain, avoidance, health, improvement, asymmetry

Introduction

Volleyball is a game which is characterized by movement in all directions and areas. The changeability of the game pace, the dynamics and asymmetry of movements may affect the overload of the movement apparatus. Ankles, knees and shoulder joints as well as the lower part of spinal cord are mainly exposed to overloads (Giglia et al., 2011; Czarny et al. 2014; Bajorek, & Piech, 2016; Gadula, 2018; Numata et al., 2018).

Early specialization of players limits the optimal preparation of all-round players, which increases the risk of injury. Therefore, a systematic comprehensive control becomes the most reasonable and important method of optimizing the training process. It applies not only to the training methods used to achieve the best sport results, but also to a health oriented control in the training process. This is important because of the constantly increasing traumatism in sport at all levels of sport advancement. In science today there are many means and methods for analysing all these factors. One of the options is to use the system called Functional Movement Screen (FMS). The FMS rating is part of an athlete's work system; it is a tool and an open system of impact in which you can change training measures and methods that are individually customized to the needs and requirements a specific person. It is a package of seven very simple and easy motion tests. FMS assessment is a system for functional assessment of movement quality. It is based on global movement patterns and is used in physiotherapy and sport. The FMS evaluation system was created by Gray Cook and Lee Burton as an element of comprehensive interaction serving motor preparation and physiotherapeutic treatment in specific musculoskeletal disorders. FMS allows assessing dysfunction or asymmetry occurring in global movement patterns (Cook, Burton, Hoogenboom, & Voight, 2014; Koczański et al., 2015; Boichuk et al., 2019).

Individual motor aspects, such as neuromuscular coordination, mobility and stability are subjected to individual assessment in order to create a program of corrective exercises that will be customized to the individual needs of the athlete. After the evaluation, the algorithm of individual correction exercises is established, which allows to achieve the planned goal. The corrective algorithm includes the hierarchy of human motor development; in consequence the selected corrective exercises are effective and effective in their operation (Duff, & Sainburg, 2007; Olex-Zarychta, & Raczek, 2008; Toselli, & Campa, 2018).

The FMS test assesses the subject of functional fitness and susceptibility to injury. Performing a given exercise in a natural way for you but in an inappropriate way to the pattern often leads to weakening the body's structures. Tools such as a measuring board, long pole, two short poles, a crossbar and a measuring cup are necessary to carry out the test. The attire of the examined person must not restrain his/her movements (Rzepka, & Mikołajec, 2009; Orr, Pope, Stierli, & Hinton, 2016).

Material & Methods

The aim of the study was to assess the functional efficiency of volleyball players using the FMS test. The FMS test allowed determining the motor skills of every volleyball player in a professional club and checking their susceptibility to injury. The research involved 14 players representing the colours of TSV Transgaz Travel Mansard Sanok, taking part in volleyball matches at the first league level. The research was carried out during the preparatory period in 2017. Each competitor was informed about the purpose of the test and its course. The entire research process consisted of tests: DS - test Deep Squat, HS - test Hurdle Step, ILL - test In-Line Lunge, SM - test Shoulder Mobility, ASLR - test Active Straight Leg Raise, TSPU - test Trunk Stability Push Up, RS - test Rotational Stability. Each part of FMS test is evaluated from 0 points (pain during movement) to 3 points (perfect movement pattern). A three point result was obtained by volleyball players who performed the given task in a stable position and without feeling pain. The lowest amount of points was given to players who felt pain during the test. Points obtained in all categories classify the subjects into three groups. Players who scored between 18 and 21 points have correct movement patterns and the risk of overload injury is minimal. The ones who obtained between 14 and 18 points during tests have disorders in movement patterns and the threat of injury varies between 25-35%. Risk of injury for athletes who scored 14 points or less increases to more than 50% (Cook et al. 2014). The collected research data was statistically calculated in Statistica software. Test product-moment and partial correlations with extended precision calculations were used. Results are presented in the detailed table. For calculations there was p-value set at 0,05. The authors have the approval with signatures from the ethics committee number 3/11/2017 and approval of the TSV Transgaz Travel Mansard Sanok to publish the experimental data. The research was conducted according to ethical standards of committee on the rights of experiments of Helsinki declaration (WMA Declaration of Helsinki, 2013).

Results

Selected results obtained by the tested competitors in individual tests are presented in the Table 1. Table 1. Statistical characteristic of significant FMS results (N = 14).

	Mean	Variance	Std.Dev.	Confidence SD	Standard	Kurtosis
HSR	2,2857	0,2198	0,4688	0,3399	0,1253	-1,0341
HSL	2,2143	0,1813	0,4258	0,3087	0,1138	0,5014
ILLR	2,1429	0,1319	0,3631	0,2633	0,0971	3,7917
ILLL	2,2857	0,2198	0,4688	0,3399	0,1253	-1,0341
SMR	1,9144	0,7967	0,8923	0,6471	0,2416	-1,6386
SML	1,9143	0,8021	0,8976	0,6745	0,2386	-1,6467
ASLRR	2,7143	0,2198	0,4688	0,3399	0,1253	-1,0341
ASLRL	2,6429	0,2473	0,4972	0,3605	0,1329	-1,8384
RSR	2,2429	0,1619	0,3433	0,2532	0,0962	3,4882
RSL	2,3643	0,2813	0,5258	0,3087	0,1438	0,4014

Note: last letter in test shortcuts means side: R – right, L – left.

According to the research it was found that most of the results oscillate around the value of number two. In the case of statistically significant ten correlations, six parameters of the distribution curve are left-side and four are right-side. The standard error oscillates between the 10th and 90th percentile. On average, the largest disorders during the tests were found in the SM test (1.9). Four players during the SM test, were found to feel pain that caused them to achieve the lowest results. All single-limb tests carried out on competitors showed slight motor asymmetry which is related to the nature of the discipline.

Figure 1. The average results obtained in single-limb tests.

The analysis of average values of points obtained in individual trials by the examined players shows the occurrence of irregularities in the basic movement patterns of the assessed volleyball players (Figure 1). The average values close to a score of two points show that competitors are not able to make the correct pattern, and incorrect movement occurs during movement.

The occurrence of the lowest value in four examined players in the SM test indicates the occurrence of pain during the attempted test. According to FMS assumptions, each result should be consulted with a physician or a physiotherapist.

Table 2. Results of test product-moment and partial correlations with extended precision calculations between right and left (N=14).

	Constant	Slope	Constant	Slope	r(X,Y)	r ²	t	p
HS	0,5000	0,7500	0,2727	0,9091	0,8257	0,6818	5,0709	0,0003
ILL	0,5000	0,8333	1,0000	0,5000	0,6455	0,4167	2,9277	0,0127
ASLR	0,2000	0,9000	0,6000	0,8000	0,8485	0,7200	5,5549	0,0001
RS	0,2500	0,9167	0,6667	0,6667	0,7817	0,6111	4,3425	0,0010

The statistical analysis in Table 2 showed a very strong correlation in particular tests for left and right limb movements. It follows that all volleyball players should be focused on improving motor skills both for nominal and opposing limbs, as this affects the final result and minimizes the possibility of injury. None of the athletes participating in our study managed to get the maximum score (21 points) in the FMS test. Distribution of the results of FMS test is presented in the table below:

Table 3. FMS total score (N=14).

	13 pts.	14 pts.	15 pts.	16 pts.	17 pts.	18 pts.	19 pts.
N	2	1	2	0	4	2	3
%	14,3%	7,1%	14,3%	0%	28,6%	14,3%	21,4%

Average FMS total score in the group of volleyball players was 16,5. According to FMS assumptions, a score between 14–18 points indicates the presence of some movement disorders, which increase injury risk by 25%-35%.

As described in Table 3 a group 21,4% of subjects got 14 points or less, which may suggest an increased risk of injury (up to 50%) during training. In the study group, players whose total FMS score was 18 or more points were also identified (Figure 2). These subjects presented more correct functional movement patterns and less movement compensation during the test.

Figure 2. FMS total score graphical presentation (N=14).

Discussion

The high repeatability and reliability of FMS test (ICC= 0,98) presented in scientific research, indicates the opportunity to use it in complex, functional assessment of athletes. (Kochański et al., 2015; Sungcheol, Hyungjun, & Jooyoung, 2019). FMS Test was applied in many sport disciplines such as: soccer, basketball, football, boxing and athletics. It is carried out to obtain primary movement patterns and define injury risk in active professional groups such as: fire-fighters and soldiers (Bock, Stierli, Hinton, & Orr, 2016; Davis, Orr, Knapik, & Harris, 2019; Kochański et al., 2015). Results of our study, conducted on volleyball players showed that most of the players presented incorrect movement patterns. Similar results were obtained by Siedlaczek in the group of volleyball players from the II league (Siedlaczek et al., 2015). Other research that used the FMS test in a group of volleyball players was conducted by Schneiders. The results showed that gender does not determine the final test result (Schneiders, Davidsson, Hörman, & Sullivan, 2011).

Over half of the assessed athletes obtained less than 18 points in the FMS test which indicates the presence of the additional, compensatory movements during the test. It could lead to higher injury risk among volleyball players. In this group special training should be introduced including corrective exercise and improvement of movement patterns. One third of the volleyball players in our study group have correct movement patterns, but it is important to remember about functional, strength and conditioning training, especially stabilizing exercises. Due to the fact that core stability in volleyball is a major element in the presented study the volleyball players obtained the best results in the TSPU test. A study performed on national volleyball teams gives a different result to our work. It is due to a higher level of specialisation in national teams. (Aka, Yilmaz, Aktug, Akarçesme, & Altundag, 2019). Studies presented by two others researchers teams are confirmation of research presented in our article (R. Chorba, D. Chorba, Bouillon, Overmyer, & Landis, 2010; Schneiders et al., 2011). TSPU test execution requires an appropriate level of strength and core stability. Scientific research confirmed that functional stability is very important in team sports, due to dynamic acts such as running, jumping or changing direction. Research shows that the objective indicators of stability may be useful in evaluating the chance of injuries caused by impaired neuromuscular control (Vrbanić T, Ravlić-Gulan, Gulan, & Matovinović, 2007). The stability of the body, strongly affects the performance of the correct movement patterns in such volleyball tasks as overhead and forearm passes, serving and attacking. Volleyball players also received good results in ASLR tests (ASLRR – 2,7, ASLRL – 2,6). Aka and his co-researchers received a similar results to his research (Aka, Yilmaz, Aktug, Akarçesme, & Altundag, 2019). When performing this test, you can check the proper functioning of the sciatic-shin muscle group. Similar results were obtained in the Deep Squat Test which can present the stability level of the ankle. The last element (DS) is significant and provides an important role for volleyball players. The sciatic-shin muscle group is also responsible for knee stability. Volleyball exercises, such as quickly reaching a block or performing a service or attack, overloads the ankle and knee joints. They play a very important role during these movements. They maintain stability of the lower limb both when moving and when landing from an attack or from a service. Volleyball players are often faced with a lot of asymmetric movements (in services, attacks). For example in attack, usually one shoulder joint works and the jump force is not always evenly distributed on both lower limbs. Asymmetries often lead to muscle dystonia, which can cause serious injuries. In this study the asymmetries were observed in the majority of players. The lowest average score was obtained in the Shoulder Mobility Test. Some players felt pain during the test, which prevented them from properly performing it. The obtained result does not coincide with the test result obtained in the women group of volleyball players. This may be due to the fact that female players are more probable to exhibit joint laxity than male players (R. Chorba et al., 2010; Gürkan, 2016; Reeser et al., 2010). The shoulder girdle of volleyball players has a very important role during the match and

practice. During the attack, serving or blocking the joints are overloaded. Players who felt pain during this test should perform corrective exercises that will strengthen a particular muscle group.

Conclusions

The study found a number of irregularities in the performance of motor patterns by the test group of volleyball players. The FMS test allowed us to determine in which movement patterns compensatory movements and asymmetries occur the most often. This made it possible to construct individual sets of exercises that will reduce the negative effects during the movements and strengthen the muscles and joints most vulnerable to injury in volleyball. The research also showed that both sides of the body are correlated, which means the need to strengthen right and left side muscles during training in order to minimize the injuries to players.

Conflicts of interest. The authors declare that there is no conflict of interest.

References:

- Aka, H., Yilmaz, G., Aktug, Z. B., Akarçesme, C., & Altundag, E. (2019). The Comparison of the Functional Movement Screen Test Results of Volleyball National Team Players in Different Countries. *Journal of Education and Learning*, 8(1), 138-142.
- Bajorek, W., & Piech, J. (2016). Strength as a factor of effectiveness offensive plays in volleyball. *Scientific Review of Physical Culture*, 6(4), 172-183.
- Bock, C., Stierli, M., Hinton, B., & Orr, R. (2016). The functional movement screen as a predictor of police recruit occupational task performance. *Journal of Bodywork and Movement Therapies*, 20(2), 310-315.
- Boichuk, R., Iermakov, S., Kovtsun, V., Levkiv, V., Karatnyk, I., & Kovtsun V. (2019). Significance of typological features of the nervous system for the effective implementation of motor coordination processes in 16-18-year-old female volleyball players. *Journal of Physical Education and Sport*, 19(3), 1519 - 1525.
- Chorba R., S., Chorba, D. J., Bouillon, L. E., Overmyer, C. A., & Landis, J. A. (2010). Use of a Functional Movement Screening Tool to Determine Injury Risk in Female Collegiate Athletes. *North American Journal of Sports Physical Therapy*, 5(2), 47-54.
- Cook, G., Burton, L., Hoogenboom, B. J., & Voight, M. (2014). Functional movement screening: the use of fundamental movements as an assessment of function - part 1. *International journal of sports physical therapy*, 9(3), 396-409.
- Czarny, W., Bajorek, W., Król, P., Rzepko, M., Bobula, G., & Hałoń, P. (2014). Effect of strength on serving effectiveness in volleyball. *Scientific Review of Physical Culture*, 4(1), 31-37.
- Davis, J. D., Orr R., Knapik J. J., & Harris D. (2019). Functional Movement Screen (FMS™) Scores and Demographics of US Army Pre-Ranger Candidates. *Military Medicine*, 0(1), 1-7.
- Duff, S.V., & Sainburg, R.L. (2007). Lateralization of motor adaptation reveals independence in control of trajectory and steady-state position. *Experimental Brain Research*, 179, 551-561.
- Gadula, D. (2018). Master's foundations - professional motor preparation in volleyball. Kielce, 289-295.
- Giglia, G., Brighina, F., Zangla, D., Bianco, A., Chiavetta, E., Palma, A., & Fierro, B. (2011). Visuospatial Attention Lateralization in Volleyball Players and in Rowers. *Perceptual and Motor Skills*, 112(3), 915-925.
- Gürkan, A. C. (2016). Comparison of Right- and Left-Leg Balance Points in Female Volleyball Players and Sedentary Controls. *The Anthropologist*, 24(3), 746-750.
- Khudik, S., Chikurov, A., Petrova, M., Burmistrov, A. (2018). Functional asymmetry and the sports result. *Journal of Physical Education and Sport*, 18(1), 408-415.
- Kochański, B., Kałużna, A., Kałużny, K., Wołowicz, Ł., Leoniuk, J., Hagner-Derengowska, M., Zukow, W., & Hagner, W. (2015). Functional evaluation of competitors practicing boxing using the Functional Movement Screen (FMS). *Journal of Education, Health and Sport*, 5(10), 19-28.
- Kochański, B., Plaskiewicz, A., Kałużny, K., Dylewska, M., Płoszaj, O., Hagner-Derengowska, M., & Żukow W. (2015). Functional Movement Screen (FMS) - comprehensive patient functional assessment system. *Journal of Education, Health and Sport*, 5(4), 90-101.
- Numata, H., Nakase, J., Kitaoka, K., Shima, Y., Oshima, T., Takata, Y., Shimozaaki, K., & Tsuchiya, H. (2018). Two-dimensional motion analysis of dynamic knee valgus identifies female high school athletes at risk of non-contact anterior cruciate ligament injury. *Knee Surgery Sports Traumatology Arthroscopy*, 26, 442-447.
- Olex-Zarychta, D., & Raczek, J. (2008). The relationship of movement time to hand-foot laterality patterns, *Laterality*, 13(5), 439-455.
- Orr, R., Pope, R., Stierli, M., & Hinton, B. (2016). A functional movement screen profile of an Australian state police force: a retrospective cohort study. *BMC Musculoskeletal Disorders*, 17, 296.
- Reeser, J.C., Joy, E.A., Porucznik, C.A., Berg, R.L., Colliver, E.B. & Willick, S.E. (2010). Risk Factors for Volleyball-Related Shoulder Pain and Dysfunction. *PM&R*, 2(1), 27-36.
- Rzepka, R., & Mikołajec, K. (2009). *The use of functional training in motor preparation. Modern muscle strength training*. Katowice, AWF.
- Schneiders, A.G., Davidsson, A., Hörmann, E., & Sullivan, S.J. (2011). Functional Movement Screen™ normative values in a young, active population. *International Journal of Sports Physical Therapy*, 6(2), 75-82.

- Siedlaczek, M., Srokowski, G., Łukasiewicz, H., Srokowska, A., Kowalik, T., Piekorz, Z., & Zukow W. (2015). The compliance between the results of the FMS test and the frequency of injury in volleyball players on the example of the 2nd league team. *Journal of Education, Health and Sport*, 5(8), 529-539.
- Sungcheol, L., Hyungjun, K., & Jooyoung, K. (2019). The Functional Movement Screen total score and physical performance in elite male collegiate soccer players. *Journal of Exercise Rehabilitation*, 15(5), 657–662.
- Toselli, S., & Campa, F. (2018) Anthropometry and Functional Movement Patterns in Elite Male Volleyball Players of Different Competitive Levels. *The Journal of Strength & Conditioning Research*, 32(9), 2601–2611.
- Vrbanić, T.S., Ravlić-Gulan, J., Gulan, G., & Matovinović, D. (2007). Balance index score as a predictive factor for lower sports results or anterior cruciate ligament knee injuries in Croatian female athletes--preliminary study Collegium Antropologicum. *Collegium Antropologicum*, 31(1), 253-8.
- WMA Declaration of Helsinki – Ethical Principles for Medical Research Involving Human Subjects. (2013). Retrieved from <https://www.wma.net/policies-post/wma-declaration-of-helsinki-ethical-principles-for-medical-research-involving-human-subjects/>