

FMS SCREENING AS A REVOLUTIONARY - REHABILITATIVE MEASURING INSTRUMENT IN SPORTS AND RECREATION

¹Armin Zećirović,
²Dragama Rodić,
³Ilma Čaprić,
³Mila Manić,
⁴Konstantinos Stratakis,
³Adem Mavrić,
³Samir Hačković,
³Raid Mekić,

DOI 10.7251/SIZEN2001153Z
ISSN 1840-152X
UDK 796.012.1
<http://sportizdravlje.rs.ba/>
<https://doisrpska.nub.rs/index.php/SIZ>

¹Faculty of Physical Education and Sport, university of East Sarajevo
²IST-Hochschule University of Applied Sciences
³ Faculty of Sport and Physical Educytion, University of Niš
⁴ Faculty of Sport and Physical Educytion, University, Singidunum

SCIENTIFIC CRITISM

Apstrakt: International sports programs have established FMS screening procedures as an essential component for identifying students, recreational and professional athletes who are at a high risk of injury. The aim of this paper is to establish the use of the Functional Movement Screening (FMS), as a system which deals with the analysis of the functional patterns of movement and their components and determines the efficiency of the locomotor system through the evaluation of one's mobility, motor control and stability. This research included thirteen original research papers. Each paper handled the issue and was able to meet the requirements of the set goal. A selection of works from 2010 to 2015 was taken as the method for this paper.

Key words: diagnosis, mobility, stability, correction, athletes

1. Introduction

There is an increasing number of youth who are actively involved in sports and partake in both individual and team sports. In the earlier stages, sports are supposed to serve the needs of the children and be fun, creative and innovative. Meanwhile, we are witnessing a large increase of early specialization of young people as well as an increasing number of injuries in their youth. As an unwanted, but inevitable consequence of inappropriate work-outs and early specialization which is not biologically characteristic of the child's body, we are seeing a result in more frequent visits to physiatrists, orthopedists and sudden remitting of physical activities due to injury and inadequate treatment. A report on high school sports seasons from 1995 to 1997 indicates that there were more than two million injuries, which required 500,000 physician visits and 30,000 hospitalizations in the United States (Powell J, &

Barber-Foss K, 1999). This extent of reported injuries, together with the fact that many significant sports-related injuries can lead to long-term physical impairment, justifies the research into the possibility of using pre-participation methods which are able to identify young athletes that are at a higher risk of injury (Micheli J , et al, 2000). In an attempt to create functional assessment, Gray Cook and Lee Burton developed FMS screening in 2001, FMS (Functional Movement Screening). This screening tool consists of a multitude of tests for assessing the mobility and stability of the joints simultaneously through a series of seven movements, ie. seven tests. Although none of the tests are specific to any particular sport, these FMS tests challenge both upper and lower extremities as well as the torso in functional tasks, unlike some other types of athletic performance testing, which are unable to test these aspects. (Cook G, & Burton L, 2019).

As predetermined, the evaluation is practical because the desired movements can be tested within five to ten minutes, allowing the instructor to quickly evaluate the deficiencies that may require a more in-depth assessment and can be rehabilitated in order to reduce the risk of injury (Chapman R, at al, 2014). If a professional or a recreational athlete is often injured, FMS testing helps us find the cause of their injuries and eliminates them with specific functional exercises. The FMS test system shows us the state of motor control, mobility and asymmetry of the left and right as well as the upper and lower sides of the body.

These parameters are acquired by placing the participant in positions where they exhibit the greatest asymmetries, imbalances, weaknesses, and limitations in these movements (Abraham A, et al., 2015).

More focus is increasingly being put on the muscle and not on the movement, because many exercise strength before the dysfunction, which is a completely wrong algorithm. Numerous

professional and recreational athletes perform at a higher level, despite not being effective in their basic movements; in this way, without knowing it, they try to add form to the dysfunction. Many individuals work out around the already existing problem or simply do not work on their weaknesses during a strength and fitness session. In today's development of the training and rehabilitation market, athletes and medical professionals have access to a vast arsenal of equipment and exercise programs; however, even the best programs and equipment cannot improve form and health if fundamental weaknesses are not being revealed and nurtured (Boyle M, 2018).

The goal is to individualize each exercise program based on a poor connection between the physical or functional limitations of the client. In order to pinpoint the weak connection, basic patterns of body movement should be taken into account. Most people do not start strength and conditioning or rehabilitation programs by determining if they have the adequate movement patterns. Therefore, it is very

important to review the basic movements of an individual before starting a rehabilitation or strength and conditioning program (Boyle M, et al., 2016). Improvement of the dysfunctions can have a positive effect and improve performance in athletes, without forcing strength exercises before correction, e.g. give preference to the mobility of the thoracic part of the spine and increase the amplitude of movement before doing a deep squat with weights.

The aim of this paper is to present FMS screening as a revolutionary diagnostic - rehabilitation method and as a measuring instrument that shows us the state of motor control, stability, mobility and asymmetry of the left and right, upper and lower sides and helps instructors design programs by systematically using corrective exercises for normalization or for improving basic movement patterns in clients. It provides us with a systematic tool to monitor progress and development of movement patterns in the presence of a variable injury status or levels of form, and confirms the fact that it is one of the key tools and factors in injury prevention and functionality in professional and recreational athletes.

2. Method

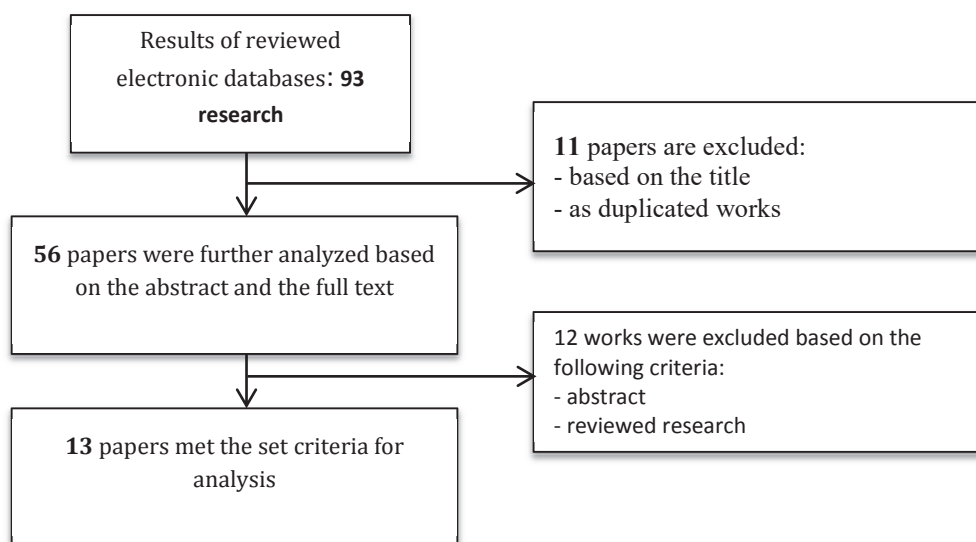
Research data for the purposes of this paper was collected through electronic databases: PubMed, Google Scholar, DOAJ, as well as through the bibliography: Functional Movement Screen Pro trainer Manual (Cook & Burton 2016), Certified Functional Strength & Conditioning Manual (Boyle M, 2016) and EXOS Performance Manual Trainer (Verstegen M, 2016). This research was conducted in the period from 2010 to 2015. The following key words were used in the database research: diagnostics, mobility, stability, correction, athletes. The obtained research titles, abstracts and complete texts were then read and analyzed. In order for the research to be accepted for final analysis, it had to meet two criteria: the first criterion refers to the review of the selected measuring instrument, in this case the FMS screening test, while the second criterion is the analysis of works in the selected period. The research that met the set criteria was then analyzed and presented on the basis of the following parameters: reference (first letter of the author and year of publication of the research, a sample of participants, applied instrument of tested value and finally, the results of the research).

3. Research results

The approach used for collecting, analyzing and eliminating the obtained works is given in Figure 1. Based on the key words, 93 works were identified. The number of studies that were immediately excluded based on the title as well as the number of duplicate papers is 11, while 56 papers were included in the analysis. Further

analysis of 56 papers excluded 12 papers based on several criteria: abstract, because it was a systematic review research, as well as the absence of a control research group as well as a review research and the topic was not fully adequate. The remaining 13 works which met the set criteria are: works published in the period from 2010 to 2015, are shown in Table 1.

Figure 1. The approach for collection, analysis and elimination of obtained works:



4. Discussion

This discussion includes thirteen original papers and literature from the most distinguished experts in the field of sports, fitness, recreation and rehabilitation (Boyle M, Cook G, Burton L, & Versteegen M).

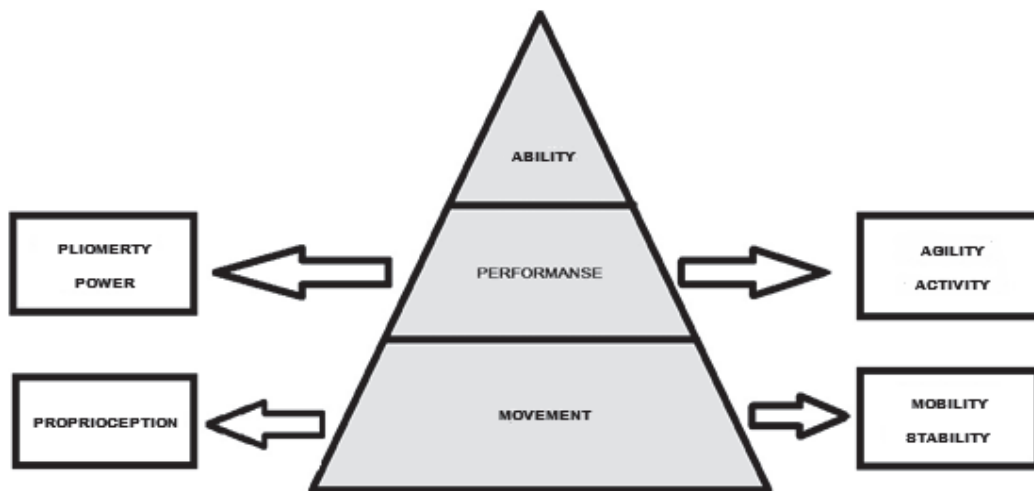
The aim of this paper is to present FMS screening as an instrument that shows us the state of motor control, stability, mobility and asymmetry of the left and right as well as the upper and lower sides, helps instructors design programs by systematically using corrective exercises to normalize or improve basic movement patterns in clients, it provides us with a systematic tool for monitoring the progress and development of movement patterns in the presence of variable injury status or different levels of form, and confirms the fact that it is one of the key tools and factors in injury prevention and improving functionality in professional and recreational athletes.

FMS screening is an array of seven tests that assesses the subject's competence in performing basic functional movements. It is a standardized, reliable, and highly applicable tool that allows the detection of major areas of deficiency or poor movement control and the indication of limitations or asymmetries (Bonazza N, et al., 2016). In order to better understand

this, basic movements are those movements (not specific types of sport) that every active individual should be able to perform - mobility management, stability, proprioception, and coordination.

If we consider the FMS performance pyramid (Figure 2), we mean the lowest part - MOVEMENT. The greater the competence in this area, the greater the efficiency of workouts intended for the athletic part (performance) and the specific sports part (skill), reducing the risk of injuries and overload. Unlike most muscle tests, FMS screening does not assess individual areas, but involves sequences of movements that also involve limited parts of the body.

Figure 2. FMS performance pyramid:



Based on the results of numerous scientific studies, it is determined that FMS is an excellent tool for improving performance and athletic longevity, movement economy, recognizing dysfunctions, reducing the risk of injuries, of overload and muscle injuries on tendons and ligaments, as well as an excellent diagnostic - rehabilitation method and an excellent guide for personalized corrective work. The steps in the injury control process are as follows: to determine the existence of the problem, to determine the causes of the problem, to determine what prevents the

problem, to implement prevention strategies and programs and to continue monitoring and effectiveness of preventive efforts. (Bruce A, Bruce H, et al., 2010).

With FMS screening, we examine clients for an injury risk and either a dysfunctional or restrictive movement pattern (Cook G, Burton L, et al., 2006), and it allows us to identify the so-called "red flags" or movement patterns that are risky for clients. It allows us to quickly see the quality of basic movement patterns and to work on a direct way to correct the dysfunction (Verstegen M, 2014).

Why do we do FMS testing? Because health is our number one priority and because we want to find and identify the weakest links in the kinetic chain of clients through FMS screening in order to correct and improve them in time, because the correction itself improves the movement pattern, which largely avoids and reduces the risk of injury. In addition to prevention, FMS also offers key information for planning and programming workouts. (Cook G, Burton L, 2019).

FMS screening is made up of seven tests (**Picture 1**):

1. Deep Squat
2. Hurdle Step
3. In-Line Lunge
4. Shoulder Mobility
5. Active Straight Leg Raise
6. Trunk Stability Push Up
7. Rotary Stability.



Picture1. *FMS screening (seven tests)*

There are also three *clearing* - additional tests, after shoulder mobility, stabilization push-ups, and rotational stability, which push the joint to its limits, in an attempt to reproduce the symptoms. If the range of motion is normal, the joint is removed as the cause of the musculoskeletal system disorder.

Deep Squat Testing – Establishes total body mechanics and neuromuscular control. We use it to test bilateral, symmetrical, functional mobility and stability of the hips, knees and ankles.

The Hurdle Step testing - is an integral part of movement and acceleration. This movement puts into question the step mechanic, and at the same time testing stability and control in the one-legged position. The test also determines the stability and control of the pelvis and cortex (core - represents a set of muscles whose main function is the stability of the lumbo-pelvic region and connecting the upper and lower extremities. When we say strong torso, we mean a stable and strong core that does not allow the dissipation of energy while it is transferred from foot to hand and vice versa).

The In-Line Lunge - puts the body in a position to simulate pressure during rotation, deceleration and hip movements. This test also determines the mobility and stability of the hips, knees, ankles and feet.

Shoulder Mobility Test - shows the natural complementary rhythm of the scapular-thoracic region, the thoracic spine and the ribbed tissue during reciprocal movements of the upper extremities.

Active Straight Leg Raise - not only identifies the active mobility of the hips, but also the stability of the cortex. This pattern causes the ability to dissociate the lower extremities while maintaining stability in the pelvis and cortex.

Trunk Stability Push Up - This test is used as a basic observation of cortex stabilization and is not a test or a measure of upper body strength and firmness. The movement tests the ability to stabilize the spine in the sagittal plane during a closed kinetic chain, a symmetrical movement of the upper body part.

The Rotary Stability Test - is a complex one, it requires proper neuromuscular coordination and energy transfer through the torso. This pattern observes the stability of the pelvis in several planes, cortex and shoulder girdle during the combined movement of the upper and lower extremities.

In a study conducted by (Teyhen D, et al., 2012) in a high school in the United States, in sports such as athletics, football, tennis and volleyball, with the help of FMS screening, they proved that the greatest injury risk factor is the retention of a previous injury, so older athletes would play longer than the younger athletes who had more chances of injury. In addition, they

have proven that individual corrective exercises can improve performance and reduce the risk of injury in athletes who have been tested and monitored for their progress.

The FMS serves as a screen to identify individuals with a functional movement deficit which could indicate an increased risk of injury. The use in the bibliography varies from young, active individuals to middle-aged individuals to elite and professional athletes, as well as soldiers and firefighters. It has been observed that

lower FMS scores are associated with increased BMI, increased age, and decreased activity levels (Mitchell U, et al., 2016).

A score of <14 on the FMS is used as the highest score. Individuals who score less than 14 points on the FMS screening possess nonfunctional movement patterns that may correlate with a higher risk of injury (Minick, et al., 2010).

There are currently 13 reliability studies (Table 1) for FMS screening which indicate that it has excellent reliability. Systematic reviews show that reliability is better when the one testing Table 1. Studies which indicate the reliability of FMS screening: the client has more experience. *Studies were published after the systematic review. For the composite score, the measurement standard is 1.0 and the minimum detective change is 2.1 - 2.5.*

Studies	Method	Interrater	Intrarater	Training level	Comments
Minick et al., 2010	Cap - individual test	Significant / Excellent	on the	Professionally Certified News	Videocassette testing FMS
Schneiders et al., 2011	ICC - composite, individual test	ICC 0.97 (Excellent), Cap = Substantial / Excellent	on the	FMS meter with experience	Live FMS testing
Frohm et al., 2012	ICC	Good / Excellent	Good / Excellent = 0.8	PT 2-4 years	
Onate et al., 2012	ICC	Good / Excellent = 0.98	Good / Excellent = 0.8	Certified and without certified CSCS & AT experts	Real time FMS testing
Teihen et al., 2012	ICC	Good / Excellent = 0.76	Moderate = 0.74	Without certificate - PT students	20 hours of FMS training
Butler et al., 2012	ICC	Excellent = 0.99	on the	FMS certified	Videocassette testing
Shultz and associates, 2013	K alpha	Poor = 0.38	Moderate = 0.6	TC students and professionals	Experience but not certified <1 year of experience = postal reliability <2 years of experience = poor reliability
Smith and associates, 2013	ICC	Good / Excellent = 0.87 - 0.89	Good / Excellent = 0.81 - 0.91	AT&T professionals	Real / real time FMS tested with different educational background
Gribble and associates, 2013	ICC	on the	Good / Excellent = 0.94 (6 months experience)	ATC students and professionals	Videocassette testing FMS

Elias, 2013.	ICC	Good / Excellent = 0.90	on the	PT 2-10 years	Untrained / untrained meters
Parentea u-G and associates, 2014	ICC	Good / Excellent = 0.96	Excellent = 0.96		
Gulgin and associates, 2014	ICC	Good / Excellent = 0.88	on the	Newbie certified PT students and certified experts	Certified experts - 3 years of FMS experience
Stobierski and associates, 2015	ICC	Good / Excellent = 0.76 - 0.98	Good / Excellent = 0.74 - 0.92		Real / real time FMS tested is more reliable

Legend: The studies are papers that have been engaged in research and validation of FMS screening; The method represents "applications" that have made it easier to diagnose testing; Interrater refers to the extent to which variables agree; The intrarater represents the meter and its accuracy; The level of training represents the educational qualification of the meter; The comment is a part of how and in what way it performs the measurement.

Although there is preliminary research (Kiesel K, Phillip Plisky J, et al., 2007) on the subject of whether serious injuries on professional football could be predicted with pre-season FMS screening? Concerns remain about the validity of the FMS. Also, the occurrence of pain during FMS screening in a certain body segment can be a stronger indicator of injury risk than a low composite score and provides a simpler method of assessing injury risk.

Previous studies that have used FMS as a screening tool have investigated whether FMS had some predictive validity for injuries and found that FMS has benefits in recognizing deficiencies in certain movements and detecting deficit.

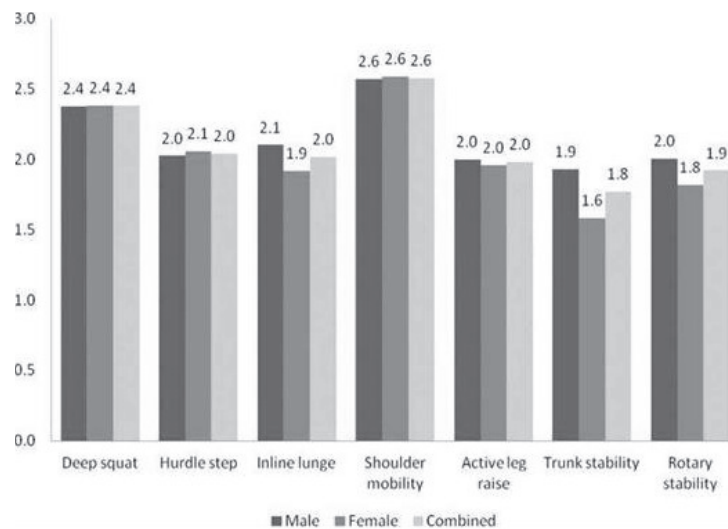


Diagram 1. Distribution of mean scores on different FMS tests

The importance of FMS as an injury screening tool was determined using cut-off evidence-based results. Three studies used screening statistics to determine scoring <14 as appropriate for identification of individuals who were more likely to sustain injury. In a study conducted by (Abraham A, et al., 2015) it was found that 46.5% (465 out of 1005) of participants had an overall score of 14 or less which may indicate a potentially higher risk of injury. This is 89% compared to 22% of professional football players in the study (Kiesel K, Phillip Plisky J, et al., 2007).

A study by (Peate W, Bates G, et al., 2007) conducted on firefighters suggests that an end result <16 is strongly associated with injury. Detection of a significant difference in FMS scores in those with previous injury was not observed in active adults.

The difference between these studies is probably related to the difference in the total size of injuries with firefighters or professional athletes as opposed to the general population. Moreover, the absence of any study to determine cut-off scores in the school-age adolescent population limited the clinical benefit of FMS to understand which individual characteristics may be associated with FMS composite scores in this population.

There is also a study by (Abraham A, et al., 2015), which provided a comprehensive descriptive profile of the participants and a large sample of the school population, primarily adolescents (Diagram 1). They found that providing a normative data set with narrow assurance intervals could improve the use of the FMS screening test to detect biomechanical deficiencies in basic movements that may limit human performance. The clinical utility of the FMS test is currently limited by the lack of normative reference values of this population. The aim of this research is to fill this gap by providing normative reference values for the school population of adolescents..

5. Conclusion

With the occurrence of increased injuries in children, the general population and professional and recreational athletes, it is crucial to introduce a pre-series procedure before any sports activity and training process which will be useful to determine potential injury risks. As scientists have confirmed, FMS is an excellent, practical screening tool, easily portable, efficient, reliable, easy to practice and execute and can be used in both the sports and general community. The normative values given for FMS in these studies can be useful for identifying abnormal overall results in the world of sports, recreation and fitness, and present FMS as a specific revolutionary - rehabilitation diagnostic tool that will avoid and prevent injuries, overcome client dysfunction, fix deficient movement patterns and preserve the client's health, because – health is above all else.

REFERENCES

- Agresta C., Slobodinsky M., Tucker C. (2014). Functional Movement Screen, Normative values in healthy distance runners.
- Abraham A., Rajasekar S., Rohit N. (2015). Normative values for the Functional Movement Screen in adolescent school aged children.
- Beach T., Frost D., Callaghan J. (2014). FMS scores and low-back loading during lifting whole-body movement screening as an ergonomic tool.
- Boyle M. (2018). *BodyByBoyle*, Certified Functional Strength Coach Trainer Manual.
- Boyle M., Butler R., Queen R. (2016). Functional Movement Competency and dynamic balance after anterior cruciate ligament reconstruction in adolescent patients.
- Bodden J., Needham R., Chockalingam N. (2015). The effect of an intervention program on Functional Movement Screen test scores in mixed martial arts athletes.
- Bonazza N., Smuin D., Onks C., Silvis M., Dhawan A. (2016). Reliability, validity, and injury predictive value of the Functional Movement Screen: A systematic review and meta-analysis.
- Bradley H., & Esformes J. (2014). Breathing pattern disorders and functional movement.
- Bruce A., Bruce H., Steven H., Bullock H. (2010). A public health approach to injury prevention: The U.S. military experience.
- Butler R., Contreras M., Burton L., Plisky P., Goode A., Kiesel K. (2013). Modifiable risk factors predict injuries in firefighters during training academies.
- Butler R., Plisky P., Southers C., Scoma C., Kiesel K. (2010). Biomechanical analysis of the different classifications of the Functional Movement Screen deep squat test.
- Chapman R., Laymon A., Arnold T. (2014). Functional Movement Scores and longitudinal performance outcomes in elite track and field athletes.
- Chimera N., Smith C., Warren M. (2015). Injury history, sex, and performance on the Functional Movement Screen and Y balance test.
- Clifton D., Harrison B., Hertel J., Hart J. (2013). Relationship between functional assessments and exercise-related changes during static balance.
- Cook, G., & Burton, L. (2019). FMS Certification, Pro Trainer Manual.
- Cook, G., Burton, L., Hoogenboom B. (2006). Pre-participation screening: *The use of fundamental movements as an assessment of function – Part 1*.
- Cook G., Burton L., Hoogenboom B., Voight M. (2014). Functional movement screening: *The use of fundamental movements as an assessment of function – Part 2*.
- Dossa K., Cashman G., Howitt S., West B., Murray N. (2014). Can injury in major junior hockey players be predicted by a pre-season Functional Movement Screen – *a prospective cohort study*.
- Heather G., & Hoogenboom B. (2014). A nine-test screening battery for athletes: *A reliability study. The Functional Movement Screenng (FMS): An inter-rater reliability study between raters of varied experience*.
- Kiesel K., Phillip Plisky J., Michael Voight L. (2007). Functional Movement Screen normative values and validity in High school athletes: *can the FMS used as a*

- predictor of injury. Can serious injury in professional football be predicted by a preseason Functional Movement Screen.*
- Micheli, J., R. Glassman, K., Michelle. (2000). The prevention of Sports injuries in children.
- Minick K., Kiesel K., Burton L., Taylor A., Plisky P., Butler R. (2010). Interrater reliability of the Functional Movement Screen.
- Mitchell U., Johnson A., Vehrs P., Feland J., Hilton S. (2016). Performance on the Functional Movement Screen in older active adults.
- Powell, J., & Barber Foss, K. (1999). Traumatic brain injury in high school athletes.
- Teyhen D., Shaffer S., Lorenson C., Halfpap J., Donofry D., Walker M., Dugan J., Childs D. (2012). The Functional Movement Screen: a reliability study.
- Verstegen M. (2014). EXOS performance specialist certification; *Trainer manual*.
- Peate W., Bates G., Lunda K., Francis S., Bellamy K. (2007). Core strength: *A new model for injury prediction*.
-

Received: 04.11.2020.
Approved: 15.12.2020.

Correspondence:

Armin Zećirović
Faculty of Physical Education and Sport, university of East Sarajevo
71420 Pale, BiH
Tel: +381 62 11 69 199
e-mail: armin.zecirovic@gmail.com