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Effect of the MobilityWOD training program on functional movement patterns related to the risk of injury in CrossFit practitioners

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Background: CrossFit is an increasingly popular form of physical activity. However, due to its specificity and high intensity, it carries with it a considerable risk of injuries. So it is important to know if some specific training including exercises derived from physiotherapy and functional training (MobilityWOD) can reduce the risk of injury. **Objective:** The aim of the study is to assess the effect of MobilityWOD training program on functional movement patterns related to the risk of injury in adult male CrossFit practitioners. **Methods:** The study included 30 men aged 20–35 years old who practice CrossFit training five timeper week. Initially, a functional evaluation was performed using the Functional Movement Screen (FMS) test including a qualitative assessment of Deep Squat, Hurdle Step, In-Line Lunge, Shoulder Mobility, Active Straight-Leg Raise, Trunk Stability Push-Up, Rotational Stability. Then, for 8 weeks, the participants performed an additional MobilityWOD unit once a week. This training lasted 45 minutes. During MobilityWOD training, athletes performed the self-myofascial release technique, with foam rollers, lacrosse balls and resistance band exercises. After this time the evaluation was carried out using the FMS test. **Results:** After the MobilityWOD training program, the participants obtained significantly increased scores for the FMS test, scoring 17.3 ± 1.79 points compared to 15.9 ± 2.39 points before the program (medium effect size). The number of athletes scoring equal to or less than 14 points in the FMS test, which is associated higher injury risk, decreased (from 26% before MobilityWOD training to 6% after training). In the case of the specific test components Deep Squat, Shoulder Mobility, Active Straight-Leg Raise, results improved significantly. **Conclusions:** After MobilityWOD training, the FMS test result for CrossFit athletes improved significantly. The MobilityWOD training in the study group improved the quality of movements patterns and reduced risk of injury.

Keywords: physical activity, FMS test, mobility, physical fitness

Introduction

Keeping physically active is important from both cultural and social perspectives. In developed societies, physical fitness is perceived as contributing to the common good and can be achieved in various ways. Physical activity is a key element of a healthy lifestyle and a positive way of spending free time (Kosiba, Bogacz-Walancik, Gacek, Wojtowicz, & Majer, 2019).

Physical fitness has been increasing in popularity in recent years. With this increase has come more modern, intense and more strenuous forms of physical activity, such as CrossFit, which are similarly becoming more popular (Bastug, Ozcan, Gultekin, & Gunay, 2016). CrossFit training has its positive and negative effects. On one hand, it contributes to an improvement in physical fitness that comes from regular, systematic work (Eather, Morgan, & Lubans, 2016; M. M. Smith, Sommer, Starkoff, & Devor, 2013), but on the other hand, it can lead to injury (Hopkins et al., 2019; Weisenthal, Beck, Maloney, DeHaven, & Giordano, 2014). Therefore, it can be concluded that such high-intensity physical activity is not appropriate for all.

What distinguishes CrossFit from other forms of physical activity is primarily the lack of routine, along with its variability and very high intensity of training. In motor training, the fundamentals of CrossFit training, based on the concept of functional training, is so-called basic motility, which depends on the coordination of the neuromuscular system, and the stabilization and mobility of the musculoskeletal system. This is the starting point for shaping a person's targeted mobility

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and technical abilities (Cook, Burton, & Hoogenboom, 2014a, 2014b).

CrossFit is an intense form of exercise, and therefore pattern overload is common at levels nearly unheard of in other forms of movement. For this reason, exercises that improve mobility of the subjects has a very important role in injury prevention during CrossFit training (Cook, 2003; Moran, Booker, Staines, & Williams, 2017).

The most common injuries in CrossFit training relate to damage to the joints and muscles. This damage was predominantly found in the shoulders, knees, lumbar spine, elbows and wrists. In addition, a shorter training time (less than six months and fewer than three workouts per week) increases the risk of injury (Feito, Burrows, & Tabb, 2018; Mehrab, de Vos, Kraan, & Mathijssen, 2017; Minghelli & Vicente, 2019).

CrossFit is emerging as a popular form of competitive exercise. As participation in CrossFit grows, injuries associated with it will likely grow gradually. It was shown that the increasing involvement of CrossFit trainers in coaching participants corresponds with a decreased injury rate (Weisenthal et al., 2014). So it seems that specific functional training should be desirable.

To improve practitioner mobility, an individual training unit was developed – MobilityWOD. It was a new part of CrossFit training comprising exercises derived from physiotherapy and functional training. The goals of MobilityWOD training are supporting the improvement and healing process, reducing existing post-workout tension, as well as counteracting other possible harmful consequences of CrossFit training (Weisenthal et al., 2014). During MobilityWOD training, athletes performed the myofascial release technique, with foam rollers, lacrosse balls and resistance band exercises.

There is not much scientific research on CrossFit training. No research has yet been found on the effect of MobilityWOD training on functional movement patterns and the risk of injury in athletes.

An important element of injury prevention in sport is a comprehensive functional assessment that allows one to identify any restrictions on athletes. The aim of the study is to assess the effect of the MobilityWOD training program on functional movement patterns related to the risk of injury in adult male CrossFit practitioners.

Methods

Participants

The research included 30 men aged between 20 and 35 years who practiced CrossFit five times a week at Cross Training Racibórz. The inclusion criterion was a minimum CrossFit training experience of 1 year and not having previously performed MobilityWOD training. The exclusion criterion was a disease or injury in the previous two months, impeding a proper functional assessment and a break in training over one week in the last four weeks. A full list of the participants' characteristics is displayed in Table 1.

Participants trained CrossFit five days a week, according to the assumptions. They trained other WOD (workout of the day) units, that shape efficiency, endurance, strength, power, speed and coordination. They did not do MobilityWOD training before.

The study was carried out in accordance with the guidelines of the Declaration of Helsinki and Good Clinical Practice. Prior to the study, all subjects were informed of the principles and purpose of the study and gave written consent to participate. The Bioethical Commission at the Opole Medical School approved of the study (permission no. KB/13/FI/2017).

Measures and procedures

The research took place in a Cross Training sports club in Racibórz in 2018. The researchers made basic anthropometric measurements. Body height was measured with an anthropometer to an accuracy of 0.1 cm, body mass was measured on an electronic scale with an accuracy of 0.1 kg, and body mass index was computed.

Researchers then performed a functional assessment using the Functional Movement Screen (FMS) test. FMS test is a pre-participation screening tool designed to identify compensatory movement patterns that are indicative of increased injury risk and inefficient movement that causes reduced performance (Cook, Burton, & Hoogenboom, 2006a, 2006b). The reliability of the FMS test was assessed, among others, by C. A. Smith, Chimera, Wright, and Warren (2013). The test exhibits the reliability of measurements between the subject (inter-rater intraclass correlation coefficient .87–.89) and by the same examiner taking them (intra-rater intraclass correlation coefficient .81–.91). Excellent interrater and intrarater reliability was also demonstrated by Bonazza, Smuin, Onks, Silvis, and Dhawan (2017). A study by Minick et

Table 1
Demographics of the study participants

Variable	$M \pm SD$	Range
Age (years)	28.1 ± 3.5	20.0–35.0
Body height (cm)	180.1 ± 5.7	168.8–190.1
Body mass (kg)	86.6 ± 7.8	72.1–101.0
Body mass index (kg/m^2)	26.7 ± 1.8	22.5–30.9

al. (2010) showed that the FMS test can confidently be applied by trained individuals.

FMS is used to detect existing functional limitations and expose asymmetries between the left and right sides in relation to a given task. In asymmetrical tests (Hurdle Step, In-Line Lunge, Shoulder Mobility, Active Straight-Leg Raise and Rotational Stability) the left and right sides can be assessed independently. Positions in which the subject is forced to move during exercise allow for a smooth and accurate indication of weak links and any irregularities during the task. The FMS test consists of seven fundamental movement component tests (Cook et al., 2014a, 2014b): (1) Deep Squat (DS), (2) Hurdle Step (HS), (3) In-Line Lunge (ILL), (4) Shoulder Mobility (SM), (5) Active Straight-Leg Raise (ASLR), (6) Trunk Stability Push-Up (TSPU), (7) Rotational Stability (RS).

The FMS test is scored on a scale of 0 to 3 (Cook et al., 2014a, 2014b): 0 – movement was painful, requiring a referral to a healthcare professional; 1 – inability to perform or complete a functional movement pattern; 2 – ability to perform a functional pattern, but with some degree of compensation; 3 – unquestioned ability to perform the functional movement pattern.

The maximum score a person can achieve is 21 points. Obtaining 14 points or less on the test shows that there are dysfunctional movement patterns and the probability of injury is significantly increased (Adamczyk, Pepłowski, Boguszewski, & Białoszewski, 2012; Chorba, Chorba, Bouillon, Overmyer, & Landis, 2010; Kiesel, Plisky, & Voight, 2007).

In order to minimize external factors, all motor tasks were performed in a well-lit and soundproofed room. Each subject performed seven tasks three times, taking into account the test where he obtained a lower score.

The research was carried out by the two authors of the article, who are trained in how to perform the FMS test, one of whom is an experienced sports physiotherapist. Original, certified FMS equipment was used. Measurements were conducted at the same time of day to minimize the effect of diurnal variations on the selected variables.

In the beginning, participants were examined using the FMS test. Then, they performed an additional unit of MobilityWOD training for eight weeks. This training was done once a week and lasted 45 minutes. During MobilityWOD training, athletes performed the self-myofascial release technique, with foam rollers, lacrosse balls and resistance band exercises. Foam roller and lacrosse ball are pieces of equipment that work on the principle of self-myofascial release. This means that the person performing the exercise can use it to relax muscles and fascia. The exercise involves pressing the bodyweight on specific muscles (most often quadriceps femoris, gastrocnemius, erector spinae). As a result, micro-damage to the muscle occurs in addition to relaxation. The body then receives a signal for faster regeneration of a specific area. Already damaged muscles are not rolled this way. The resistance band helps increase the range of motion in joints that naturally cling to each other. "Resistance" with the bands causes separation in the joint cavity and allows for freer, "unblocked" movements. Mobilization techniques were used in the areas of the head and neck, back, chest, shoulders, arms, elbow joints, forearms, wrists, buttocks, hip flexors, adductors, hamstrings, knee joints, calves, ankles, feet and fingers. A duration of about 1–2 minutes was used for each body part, separately for each limb.

The MobilityWOD training program was explained and supervised by a trainer. After this time, they were re-examined using the FMS test.

Statistical analysis

Statistical processing was performed using Statistica software (Version 13.1; StatSoft, Tulsa, OK, USA). Descriptive statistics were calculated, including mean, standard deviation, median, minimum and maximum. The Wilcoxon test was used to examine the significance of differences before and after the MobilityWOD training. The effect size was evaluated by coefficient *r*, where .1–.3 represents small effect, .3–.5 medium effect, and > .5 large effect. A statistical significance level of .05 was used.

Results

After the MobilityWOD training program, the participants obtained significantly higher values of the FMS test, scoring 17.3 ± 1.79 points compared to 15.9 ± 2.39 points before the program (a medium effect size; Table 2).

Before MobilityWOD training, 26% of the group achieved an equal or lower score (14 points), thus indicating an increased risk of injury. After performing the exercises according to the MobilityWOD training methodology, only 6% of the respondents achieved results 14 points or below.

In the case of the specific test components, DS, SM and ASLR, results improved significantly. A medium effect was found for DS, SM, ASLR. For other variables, a small effect of training was found. Table 2 shows the participants' results.

Table 2
Result of the Functional Movement Screen test and the specific test components before and after MobilityWOD training

Test	Before $M \pm SD$	Before Range	After $M \pm SD$	After Range	Z	p	r
DS	2.0 ± 0.950	0–3	2.3 ± 0.760	0–3	2.691	**.007**	.347
HS	2.4 ± 0.568	0–3	2.6 ± 0.563	0–3	1.690	.091	.218
ILL	2.5 ± 0.508	0–3	2.5 ± 0.504	0–3	1.342	.180	.173
SM	2.1 ± 0.698	0–3	2.5 ± 0.626	0–3	3.059	**.002**	.395
ASLR	2.1 ± 0.402	0–3	2.5 ± 0.507	0–3	3.180	**.001**	.411
TPSU	2.7 ± 0.490	0–3	2.8 ± 0.406	0–3	1.342	.180	.173
RS	1.9 ± 0.182	0–3	2.0 ± 0.000	0–3	1.342	.180	.173
Total FMS	15.8 ± 2.389	0–21	17.3 ± 0.788	0–21	3.800	**.001**	.491

Note. Before = results before the MobilityWOD training program; After = results after the MobilityWOD training program; Z = Wilcoxon test result; r = effect size; DS = Deep Squat; HS = Hurdle Step; ILL = In-Line Lunge; SM = Shoulder Mobility; ASLR = Active Straight-Leg Raise; TPSU = Trunk Stability Push-Up; RS = Rotational Stability; Total FMS = total score of Functional Movement Screen. Statistically significant p values are in boldface.

Discussion

The main finding of our study was significantly increased score of FMS test after MobilityWOD training. The increased score obtained by the competitors in the FMS test indicates a reduced risk of injury. Improving the results may be a consequence of using mobility training exercises that increase the range of motion in the joints. Bradley and Portas (2007) investigated the effect of lower limb motion range on the risk of injury in football. Their results show that players with a smaller pre-season range have a statistically higher risk of muscle damage in the season.

The result of the FMS test before the MobilityWOD program and the results of the individual tasks indicate the occurrence of certain irregularities. A score of 15.9 ± 2.39 points means that the participants were not able to perform the movement patterns correctly, and as a result, there was movement compensation during the tasks.

After the MobilityWOD program, the number of participants who scored less than or equal to 14 points, implying an increased risk of injury, also decreased. Only 6% of participants, compared to 26% before training, achieved scores less than or equal to 14 points. MobilityWOD training in the study group improved movement patterns and reduced risk of injury.

In CrossFit training, MobilityWOD exercises are designed to minimize the risk of injury by optimally preparing the movement system for effort using well-known physiotherapy methods and exercise techniques. Current literature does not indicate unambiguously which of the methods used is the most effective (Mahrová, Hráský, Zahálka, & Požárek, 2014; Page, 2012). Mahrová, Hráský, Zahálka, and Požárek (2014) studied the effect of static and dynamic stretching on the range of motion in selected joints in footballers. There were no differences between the effects of both stretching programs on ROM. Both types of stretching can improve the range of motion in selected joints and protect against lower limb injuries.

Adding new training programs for participants can improve functional assessment and reduce the risk of injury. Lago-Fuentes et al. (2018) presented improved the results of the FMS test after the addition of the new training program. They tested professional female futsal players with the FMS test before and after a 6-week core strength training performed on stable and unstable surfaces. The studied players obtained similar average FMS results of 15.85 and 16.00 points before training and 17.42 and 17.70 after training.

Driller, Mackay, Mills, and Tavares (2017) tested the effect of tissue flossing on the ankle on range of motion, jump and sprint performance in recreational athletes. Participants performed tests pre and up to 45 minutes post-application of a floss band to both ankles. After performing tissue flossing on both cubes, participants obtained significant weight-bearing lunge test results than without tissue flossing. These results were associated with trivial to small effect sizes at all time points.

According to the findings of the study, participants obtained the weakest results in the Rotational Stability test. The rotary stability pattern observes multi-plane pelvis, core and shoulder girdle stability during a combined upper- and lower-extremity movement (Cook et al., 2014b). Core muscle activity is best understood as the pre-programmed integration of local, single-joint muscles and multi-joint muscles to provide stability and produce motion (Kiblar, Press, & Sciascia, 2006).

Disturbance in the work of these muscles causes the activation of compensatory mechanisms, where the role of stabilization is taken over by the muscles responsible for movement. Poor movement patterns then appear (Akuthota, Ferreiro, Moore, & Fredericson, 2008). Functioning in compensatory movement patterns leads to a disturbance of central nervous system modulation, and, paradoxically, in the case of physically active people, deterioration of their physical fitness (Page, Frank, & Lardner, 2010).

Another test representing the motor control-focused patterns is the Trunk Stability Push-Up. In this test, participants received the highest scores. It can be assumed that the positive results are related to the nature of the movements performed in the test. While the Rotational Stability test required the subjects to maintain core stability with additional limb work on all planes, the Trunk Stability Push-Up test concerned only the sagittal plane. In addition, it can be assumed that the strength of the participants' arms was enough to complete the task and compensated for any deficiencies in the functionality of the deep muscles.

There is a correlation between deep torso muscles and functions of the upper and lower extremities. Central stabilization is the basis for effective movement in distal parts (Shirley et al., 2012). It is now known that all existing disorders of the musculoskeletal system lead to changes in the functioning of areas distant from the place of primary dysfunction (Bradley & Portas, 2007). Incorrect work of the ilio-pelvic-lumbar complex during physical activity results in the generated loads often being discharged within the iliotibial band, which was also observed in the results of participants in the Active Straight Leg Raise test (Page et al., 2010).

This study also has limitations. Some authors question the prognostic validity of the FMS test (Bardenett et al., 2015; Dorrel, Long, Shaffer, & Myer, 2015). These studies suggest that the FMS test may be useful for recognizing deficiency in certain movements, however, should not be used to the overall prediction of injury. The second limitation of the study is the absence of a control group which was not created due to the small number of CrossFit participants in the club. Future research among a larger number of people and with a control group will produce a more accurate assessment of the functional state of participants.

Conclusions

Eight weeks of MobilityWOD training in the study group has improved the quality of functional movements patterns and reduced the risk of injury. A higher FMS test result, after MobilityWOD training, still indicates the 6% trainees are predisposed to injury and indicates some deficiencies in their basic motor skills.

Conflict of interest

There were no conflicts of interest.

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