Original Article

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Functional movement screen proficiency of adolescent female volleyball players

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Abstract

Assessments and testing of young athletes often exclude the fundamental and functional movement capacity, which are critical for healthy motor development of adolescents. The aim of this study was to evaluate functional capacity of young female volleyball players and determine if participation in volleyball leads to development of movement dysfunctions. Two-hundred fifty-eight (258) adolescent female volleyball players (14.3 ± 1.7 yrs) underwent the functional movement screen. Person correlation showed no significant relationship between functional tests and playing experience, while age showed significant, but weak relationship with total functional score ($r = 0.189$; $p < 0.005$). Overall, 44% of participants scored less than 14. Paired sample t-tests show significant bilateral asymmetries in hurdle step, in-line lunge, and shoulder mobility tests. Functional movement screen was useful in identifying functional limitations and asymmetries in young female athletes. However, as neither age nor playing experience were strongly associated with functional score, more attention should be given to the qualitative movement assessment of individual tests, rather than the composite score.

Keywords: FMS™, female athletes, volleyball

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INTRODUCTION

The emphasis of youth participation in sport is shifting from fun-driven activities focused on physical and social development, to the performance-oriented sports with primary focus on playing time and reaching top status. Although athletes that start young and participate in a range of activities show improvements in comprehensive motor development skills and fitness components [1], the concern arises with the injuries occurring due to early sport specialization [1,2]. Consequently, FMS™ and other physical assessments are critical for identifying talented young athletes, their sport-specific predispositions, as well as their abilities to perform fundamental movements that are building blocks to specialized sport-specific skills [3-5]. However, assessments are often focused on performance driven factor such as strength, power, speed, and sport specific skills, without the consideration on functional capacity of young athletes to perform those skills. If functional movement deficiencies are not identified at early specialization, young athletes may be predisposed to injury or limited development of gross motor skills. Therefore, there is a substantial need to provide functional assessment statistics for young athletes across different activities, that may be used by sport practitioners for evaluation of their players.

Female volleyball players, much like their peers in other sports, are also likely to develop sport-specific characteristics that may predispose them to common volleyball injuries [2,6,7]. Although volleyball is a relatively safe sport, acute ankle injuries, knee, and shoulder overuse have been commonly reported [7]. The main risk factors for these injuries have been associated with the functional limitations and imbalances [7], leg muscle strength asymmetries [8], and balance and proprioceptive deficits [9]. Therefore, it is important for sport practitioners to implement comprehensive screening measures of their young athletes and create a baseline profile for their fundamental and functional capacity.

Functional movement screen (FMS™) assesses the fundamental movement patterns and identifies functional limitations and bilateral asymmetries of athletes [10,11], which may be used to create training strategies that improve performance and reduce the risk of athletic injuries. The majority of the FMS™ research has been conducted with the aim to evaluate injury risk and establish normative values in adult athletic populations, although previous research has been equivocal about the use of total FMS™ score as a predictor of sport performance or injury [12,13]. Also, the association between BMI and FMS™ scores is unknown in population of young female volleyball players. Nevertheless, FMS™ can be considered as an effective screening tool to identify gross motor movement restrictions and bilateral asymmetries which may increase the risk of sport related injuries [6,14,15].

Hence, having a functional profile for young female volleyball athletes may be helpful to coaches and trainers to identify the timing of onset of common functional limitations in their athletes and design training protocols that would prevent injuries and prolong their participation in the sport. Considering the paucity of data on young female volleyball athletes and especially on their functional movement capacity, the purpose of this study is to determine the baseline functional movement scores of adolescent female volleyball players, identify any functional deficiencies, determine if participation in volleyball affects their functional performance.

MATERIAL AND METHODS

Participants

Total of 258 female volleyball players between the ages of 12 and 18 and various experience level (Table 1) underwent functional movement assessment as part of a week-long volleyball training camp. Prior to participation, all participants and their parents and/or legal guardians were given an overview of the camp program including testing and assessments procedures and were asked to sign the participation liability waivers and informed consent forms. To be included in the study the participants had to be 1) free of any musculoskeletal injuries at least 6 months prior to the camp, 2) not undergo any rehabilitation at the time of testing, 3) have at least 6 months of continuous volleyball training, and 4) able to physically complete the testing procedures. The research procedures were approved by the University Institutional Review Board.

Procedures

On the day of the testing participants were grouped by age and were asked to complete the standardized questionnaire about their demographics and sport participation. Then, each participant's height and weight were measured, after which they were asked to advance to the functional screen testing station.

Functional Movement Screen (FMS™) was performed by qualified sport scientists with FMS™ certification. Considering FMS™ testing protocol is explained in detail by Cook et al. [10,11] only a brief description will be provided here. The battery of tests included evaluations of deep squat (DS), hurdle step (HS), in-line lunge (ILL), shoulder mobility (SM), active straight leg raise (ASLR), trunk stability push-up (TSPU), and rotary stability (RS). Participants received a score of 3 if they performed the movement task without compensations, 2 if some compensations occurred during the task, and 1 if they were unable to complete the task. Participants were excluded from the study if they expressed any pain during testing.

Statistical analysis

Statistical analysis was performed with SPSS v 26 (IBM, NY, USA). Pearson correlation was used to assess the relationship between the FMS™, anthropometric variables, and playing experience. Paired sample t-test was used to assess the difference between left and right side in bilateral tests. The level of significance for all statistical tests was set at $p < 0.05$.

RESULTS

Of the 400 camp attendees, 258 have met the inclusion criteria and their data has been included in the study (Table 1). The combined mean total FMS® score for female volleyball players was 13.74 ± 2.12 (Table 2), with 44% of participants scoring lower than 14. The participants scored lowest on the trunk stability push up, while the highest functional score for shoulder mobility. Pearson correlation (Table 3) also indicates that FSM™ scores had a significant, but relatively weak association with the age of the athletes. In contrast, the length of participation (i.e., experience) was not related to the total score, nor any of the individual tests.

Table 1. Participants' characteristics

Measure	Mean ± SD
Age [yrs]	14.3 ± 1.7
Height [cm]	168.1 ± 8.4
Body mass [kg]	58.3 ± 10.0
BMI	20.6 ± 2.8
Volleyball playing experience [yrs]	4.0 ± 1.9

SD – standard deviation

Table 2. Functional movement screen test scores

Test	Score (Mean ± SD)
Deep squat	2.04 ± 0.52
Hurdle step	1.68 ± 0.54
In-line lunge	1.74 ± 0.53
Shoulder mobility	2.55 ± 0.66
Active straight leg raise	2.28 ± 0.84
Trunk stability push up	1.33 ± 0.68
Rotary stability	2.14 ± 0.47
FMS total score	13.74 ± 2.12

SD – standard deviation

Table 3. Pearson correlation between age, playing experience, and BMI Functional movement screen test

Indicator	DS	HS	ILL	SM	ASLR	TSPU	RS	FMS
Age	0.01	0.139*	0.073	-0.084	0.220**	0.144*	0.120	0.189**
BMI	-0.123*	-0.109	-0.039	0.005	0.126*	0.141*	0.031	0.036
Playing experience	0.031	0.026	-0.107	-0.034	0.005	0.106	0.032	0.021

DS - battery of tests included evaluations of deep squat, HS - hurdle step, ILL - in-line lunge, SM - shoulder mobility, ASLR - active straight leg raise, TSPU - trunk stability push-up, RS - rotary stability, * $p<0.05$; ** $p<0.005$

Table 4. Assesment of assymetries in participants based on bilateral FMS tests

Indicator	Percentage of athletes with bilateral assymetry	Differences in mean score between left and right side (p)
Hurdle step	22.5%	0.00
In-line lunge	22.9%	0.05
Shoulder mobility	31.4%	0.00
Active straight leg raise	9.7%	0.55
Rotary stability	14.3%	0.34

Further analyses demonstrated significant presence of left-to-right asymmetries in most bilateral tests (Table 4). Active straight leg raise and rotary stability had the lowest occurrence of functional asymmetry, while substantially larger percentage of athletes demonstrated differences in left and right side in shoulder mobility, hurdle step and in-line lunge. Correlation analysis show that these asymmetries were not associated with age nor experience of the athletes.

DISCUSSION

The purpose of this study was to assess the functional capacity of young female volleyball players, identify functional limitations, and determine and age and training duration lead to development of functional movement limitations. The results show that total FMS™ score has weak association with age, while playing experience is not related to any of the functional movement tests. However, individual tests identified significant functional limitations, and show that on average about 20% of young volleyball players are characterized by some bilateral asymmetry which may affect their performance and predispose them to injury.

Considering reported scores on FMS™ vary largely between studies and relative to different sports [16-18] and/or gender [19], the results of this study fall within a range of scores reported for youth athletes [17-20]. However, FMS™ data on volleyball players is scarce, especially in young female athletes. Previous studies have reported total FMS™ score of 15.3 based on only 15 players [18], and 14.9 on female collegiate athletes between ages 18-22 [16]. In that regard, given the sample size and the population sample of this study, these results provide more comprehensive functional capacity reference values for young female volleyball players.

The mean FMS™ score in this study was less than 14, indicating that young volleyball athletes may be predisposed to injuries according to FMS™ standards [10,11]. Although this score interpretation has been challenged [18,20,21], functional movement limitations and bilateral asymmetries in strength, mobility and functional capacity may limit sport performance and lead to sport injuries [14,15]. Based on individual tests, low score was due to limited functionality on trunk stability push up, hurdle step, and in-line lunge, which assess athletes' core strength, general postural stability, and lower limb mobility. These functional and physical characteristics are required in all sports, and in volleyball are particularly critical for movements that generate the most force, such as blocking in defense, and spiking in offense.

Considering that similar functional limitations have been shown before across different activities and in similar age group [17,18,20], these results indicate that total FMS™ score may be affected by the age-related physiological development of young athletes [22]. More specifically, the onset of growth stage in adolescents characterized by peak height velocity (PHV), is a critical period of

young athletes' development that directly affects stability and coordination which is a confounding factor in almost all individual FMS™ tests [4]. Given that the onset of PHV during pubertal stage is characterized by large age variations especially in girls, adolescent athletes are less likely to score above 14 on FMS™ during this stage of development [4]. Similarly, variability in physical development together with the effect of physical training is likely to result in random variability among functional tests. In this study, results show significant, but weak relationship between different functional tests and age and BMI.

Hence, variability in rotary stability, a complex movement requiring proper neuromuscular coordination, shows significant differences between groups that may not have a clear pattern. Whereas a trunk stability push up, an indicator of upper body strength, and shoulder mobility, are likely more affected by sport participation.

Although scores for most individual functional test show restricted functionality, participants scored highest on the shoulder mobility test, which was also the only test that showed significant bilateral asymmetry across the age groups. These are the indicators of sport-specific adaptations which may result from early specialization and training [1,7,16,18,23]. Volleyball players generate great, repetitive forces during serving, spiking and even blocking, which places significant cumulative load on the shoulder girdle. Considering that all of these actions are performed with the dominant hand, explains why right shoulder mobility scored significantly higher than the left side across the age groups. Although coaches are likely to implement some form of preventative strategies such as teaching correct technique, warming up, cooling down and stretching, correction of functional deficits requires a year-long resistance, strength and functional training [7], which is often not provided for adolescent athletes. Although in this study we did not report specific training regimen of all athletes except the experience, from our personal knowledge we can affirm that participants in this study do not participate in organized strength training programs.

CONCLUSIONS

Overall, this study provides a practical baseline for functional competency scores in adolescent volleyball players. However, coaches and practitioners should use caution when using these scores as neither the chronological age nor length of participation in volleyball are a good indicator of functional movement ability particularly in later childhood and early adolescence, which is a crucial period for correctly developing motor skills in young athletes. As young athletes' maturation varies relative to chronological age, coaches and trainers should develop training and skill evaluation strategies that include development and assessment of both, fundamental and functional movement skills as indicators of movement competence and development of young athletes.

CONLICTS OF INTEREST

Authors declare no known conflicts of interest.

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