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Artigo Original

Atletas de voleibol de elite: padrão do Functional Movement Screen

Elite volleyball athletes: Functional Movement Screen pattern

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Resumo: Objetivo: Analisar o efeito da alta demanda inspiratória sobre o equilíbrio e o risco de queda em idosos. Métodos: Os participantes realizaram o Modified Clinical Test of Sensory Interaction and Balance (m-CTSIB) na plataforma Biodex Balance System (BBS) com aumento da demanda respiratória e imediatamente após o teste. O m-CTSIB foi realizado em três condições: avaliação basal com respiração livre; com aumento da demanda inspiratória; e após o término do teste. A análise dos dados foi realizada por meio do teste de Shapiro-Wilk, utilizando o teste de Levene e Análise de Variância para medidas repetidas (ANOVA). Resultados: Treze homens idosos (73 ± 7,25 anos) foram selecionados nos quais a pressão inspiratória máxima (PImáx) foi avaliada. No protocolo m-CTSIB, a comparação pré e durante mostrou diferenças significativas em Olhos Abertos em superfície firme e instável e em Risco de Queda. Quando essas condições foram comparadas durante e após os testes, houve diferenças significativas em todas as condições. Quando comparados pré e pós, apenas a superfície instável Olhos Fechados mostrou diferença significativa. Conclusão: A sobrecarga na demanda inspiratória foi capaz de causar alterações em variáveis do equilíbrio, principalmente quando o voluntário é exposto à sobrecarga.

Palavras-chaves: Respiração; Biodex Balance System; Idoso; Biomecânica.

Abstract: *Objective*: Analyze the effect of high inspiratory demand on balance and risk of falling in the elderly. *Methods*: The participants performed the Modified Clinical Test of Sensory Interaction and Balance (m-CTSIB) on the Biodex Balance System (BBS) platform with increased respiratory demand and immediately after the test. m-CTSIB was performed under three conditions: baseline assessment with free breathing; with an increase in the inspiratory demand and after the end of the test. For data analysis, the Shapiro-Wilk test was performed using the Levene test, and Analysis of Variance for repeated measures (ANOVA). *Results*: Thirteen elderly men (73 ± 7.25 years) were selected in whom the maximum inspiratory pressure (PImax) was evaluated. In the m- CTSIB protocol, pre and during comparison showed significant differences in Eyes Open in firm and unstable surface and in Fall Risk. When these conditions were compared during and after the tests, there were significant differences in all conditions. When pre and after were compared, only the Eyes Closed unstable surface showed a significant difference. *Conclusion*: The overload in the inspiratory demand was able to cause changes in the balance variables, especially when the volunteer is exposed to overload.

Key-words: Breathing; Biodex Balance System; Elderly; Biomechanics.

1. Introduction

Volleyball is a collective sport characterized by technically complex movements[1], including short and explosive movement patterns, quick and agile positioning, jumps and blocks[2]. These motor actions compose the main attack, blocks and serve moves, demanding high physical capacity of the players, which are decisive in the games[3]. In addition, the execution of continuous volleyball actions induces muscle imbalances and joint instability that require special attention. In this context, the motor action of jumping is presented as the most important sporting movement for volleyball[4].

It is extremely important for the technical commission of high-performance teams to evaluate the athletes' individual movements to analyze the athlete's current conditioning and identify possible deficits to be improved[5]. In general, performance tests provide more objective information and normative values for comparison, however, most tests do not assess the effectiveness that the individual performs a certain movement. In many cases, it is not possible to identify imbalances in flexibility and muscle strength[6,7]. Such alterations may be associated with compensatory movement patterns that tend to decrease performance[8] and increase the risk of injury[9].

Aiming to evaluate functional movement patterns, the Functional Movement Screen (FMS) is a protocol composed of seven fundamental movement patterns that help to identify functional deficits (or biomarkers) related to proprioceptive, mobility and stability deficiencies, serving as an observable performance of basic locomotor, manipulative and stabilizing movements, besides being a low-cost tool[6]. FMS has a good reliability[10-13] and good ability to prevent injuries in collective sports[9], despite the cut-off point (total score ≤14) for an increased risk of injury in athletes is still hotly debated[14,15].

Asymmetries are related to an increased risk of injury[16], derived from inappropriate movement patterns that can limit performance[14,17]. In addition, a greater number of injuries and asymmetries are observed in the beginning of the season[17]. In volleyball athletes, a greater number of asymmetries were observed in the shoulder mobility test in first and second division players, a joint that is very required in the modality. Several studies have described FMS results in team sports, comparing athletes from different sports[17-19] and assessments of collegiate or national level volleyball athletes[17,20]. Evaluating elite female athletes from Turkey, Azerbaijan and Kazakhstan, Aka et al.[21] showed that the scores obtained were greater than 14 points, presenting low risk of injuries[21], whereas Toselli & Campa[22] evaluated 69 elite athletes of the Italian men's volleyball team and showed that about 33% of athletes presented dysfunctional movements, with a prevalence of asymmetrical movements in the shoulder mobility test, highlighting the importance of individual analyses[22].

Thus, evaluation using the FMS seems to be an important strategy for identifying possible asymmetries, and thus, prescribing injury prevention exercises[22], especially in pre-season assessments. Considering the different demands that high-level sport requires and seeking to know the profile of functional movement patterns of young adult athletes in the beginning of their careers, in the Brazilian volleyball elite, the leading country in the

FIVB ranking of the men's volleyball teams, the present study aimed to analyze the profile of movement patterns evaluated through the FMS in world volleyball elite athletes at the beginning of the pre-season. Trying to understand the general functionality in this group can be important in order to suggest possible interventions aimed at prophylaxis and optimization of training.

2. Methods

Experimental Approach

The evaluations took place at the end of May 2019, on the day of the pre-season presentation. The participants attended the training center of the Brazilian Volleyball Confederation (CBV) to perform the anthropometric assessment and the FMS protocol during the morning. The protocol was carried out by the team's physical trainer, who has extensive experience with the procedure and has performed many evaluations.

Subjects

The study included 22 volleyball athletes from the Brazilian under-19 men's volleyball team (age 17.6 ± 0.57 years, body mass 88 ± 9.58 kg, height 194.9 ± 6.23 cm), selected for the 2019 volleyball world championship, hosted in Tunisia. Athletes who, by orientation of the team's medical department, were not able to perform the tests proposed, did not participate in the data collection. All athletes were familiarized with the protocols of the evaluations performed.

Prior to their participation in the study, the athletes read and signed a free and informed consent form, which included all the information relevant to the study. This study was conducted in accordance with the World Medical Association's code of ethics (Declaration of Helsinki), printed in the British Medical Journal (July 18, 1964)

Procedures

Functional Movement Screen

The seven movement patterns that comprise the FMS protocol were evaluated: Deep Squat, Hurdle Step, Forward Lunge, Shoulder Mobility, Active Straight Leg Raise, Push Up and Body Rotation Stability[6,7].

Each movement pattern was qualitatively evaluated and received a score ranging from 0 to 3. A score of 0 was assigned when the athlete reported pain while performing the movement. A score of 1 was given when the individual was unable to complete the movement pattern or assume the position to perform the movement. A score of 2 was assigned if the athlete was able to complete the movement, but with some kind of compensation. A score of 3 was given when the individual correctly performed the movement without any compensation.

Of the seven movements evaluated, five (Hurdle Step, Forward Lunge, Shoulder Mobility, Active Straight Leg Raise and Body Rotation Stability) present scores assigned to the right and left sides. Different scores between the two sides were considered asymmetries.

To calculate the total FMS score, the worst score reported between the two evaluated sides was used. The procedures were performed with the equipment recommended by the protocol (Functional Movement Systems Inc., Virginia, USA).

Statistical analysis

The results are described in frequencies, means, standard deviation and 95% confidence interval (95% CI). Pearson's chi-square test was used to compare the differences in frequency distribution between the left and right sides for the movement patterns: Hurdle Step, Forward Lunge, Shoulder Mobility, Active Straight-leg Raise and Body Rotation Stability.

The significance level adopted was $\alpha < 0.05$. All analyses were performed using SPSS software (IBM SPSS Statistics 20.0).

3. Results

The mean total FMS score was 16.09 ± 1.97 (95% CI: 15.22 – 16.97). All participants performed the evaluation tests and there were no reports of pain. The frequency distribution of each movement, as well as the means, standard deviation and 95% CI are described in table 1.

Table 1: Distribution of frequencies, means, standard deviation and 95% CI of the seven movements evaluated in the FMS.

FMS	Side	Mean SD	IC 95%		Score	Score	Score	Score	p
			Lower	Upper	0	1	2	3	
Deep Squat	-	2.09 ± 0.53	1.86	2.32	0	2	16	4	
Hurdle Step	Left	2.23 ± 0.53	1.96	2.46	0	1	15	6	0.597
Hurdle Step	Right	2.27 ± 0.46	2.07	2.47	0	0	16	6	
Hurdle Step TOTAL		2.23 ± 0.53	1.99	2.46	0	1	15	6	
Forward Lunge	Left	2.32 ± 0.48	2.1	2.53	0	0	15	7	0.499
Forward Lunge	Right	2.23 ± 0.43	2.04	2.42	0	0	17	5	
Forward Lunge TOTAL	-	2.23 ± 0.43	2.04	2.42	0	0	17	5	
Shoulder Mobility	Left	2.5 ± 0.6	2.23	2.76	0	1	9	12	0.045
Shoulder Mobility	Right	2.77 ± 0.69	2.47	3.08	1	0	2*	19*	

Shoulder Mobility TOTAL	-	2.45 ± 0.74	2.13	2.78	1	0	9	12	
Active Straight Leg Raise	Left	2.64 ± 0.58	2.38	2.89	0	1	6	15	0.940
Active Straight Leg Raise	Right	2.68 ± 0.57	2.43	2.93	0	1	5	16	
Active Straight Leg Raise TOTAL	-	2.55 ± 0.60	2.28	2.81	0	1	8	13	
Trunk Stability Push-up	-	2.5 ± 0.67	2.2	2.8	0	2	7	13	
Rotator Stability	Left	2.05 ± 0.21	1.95	2.14	0	0	21	1	1,000
Rotator Stability	Right	2.05 ± 0.21	1.95	2.14	0	0	21	1	
Rotator Stability TOTAL	-	2.05 ± 0.21	1.95	2.14	0	0	21	1	

* Indicates a significant difference in the distribution of frequencies between the left and right sides of the same movement pattern.

Four athletes (≅18%) had a total score ≤14. Only one athlete (≅4%) scored 0 on the Shoulder mobility movement on the right side.

Overall, 13 athletes (≅59%) had some type of asymmetry (different scores between left and right sides) in the five movement patterns analyzed by the FMS. Individually analyzing, only one athlete (≅4%) presented asymmetry in the Hurdle Step movement. In the Forward Lunge movement, two athletes (≅9%) had asymmetry. Eight athletes (≅36%) showed asymmetry in the Shoulder Mobility movement. Five athletes (≅23%) presented asymmetry for the Active Straight-leg Raise movement and no athlete presented asymmetry in the Body Rotation Stability movement.

Chi-square analysis revealed a significant difference in the distribution of frequencies between the two sides of the Shoulder Mobility movement (X^2= 8.03; p= 0.02). After verifying the adjusted residuals, a lower frequency of Score 2 was found in the right side when compared to the left side (2 x 9, respectively) and a higher frequency of Score 3 on the right side when compared to the left side (19 x 12, respectively). There was no difference in the frequency distribution between the different sides in the other movements (Hurdle Step, Forward Lunge, Active Straight-leg Raise and Body Rotation Stability, $p > 0.05$).

4. Discussion

The present study aimed to analyze the profile of movement patterns evaluated through the FMS in elite world volleyball athletes at the beginning of the pre-season. Among the main findings, it is highlighted that 82% of athletes obtained a score ≥ 14, characterizing a good general movement pattern, and only 4 athletes showed values below or equal to 14. It was also possible to observe that 13 athletes presented some type of asymmetry in the five bilateral movement patterns evaluated, which are associated with risk of injury. In particular, shoulder mobility had a significant difference between right and left sides, in which shoulder mobility on the right side was greater than the left side.

The present study showed a total FMS value of 16.09 ± 1.97. Other sports modalities such as rugby, men's football and women's football, values of 13.10 ± 1.97 were found in rugby[18], in men's football, these values ranged from 13.88 ± 1.83[19] for the under-15 category up to 16.47 ± 1.35 for the professional category, while in women's soccer, the reported value was 16.48 ± 2.10[17]. Among the movement patterns that assess asymmetries, Campa et al.[18] showed that for rugby, football and volleyball, the highest percentages were demonstrated in the shoulder mobility[18].

Evaluating volleyball athletes, Toselli & Campa[22], compared Italian first and second division players, and although there were no significant differences between the divisions, the first division players had a mean of 15.28 ± 1.73, while the second division players presented 14.83 ± 2.26[22]. Aka et al.[21], evaluating female athletes from the national teams of Turkey, Azerbaijan and Kazakhstan, demonstrated means of 14.77 ± 2.23, 14,25 ± 2,46 and 15.77 ± 1.39, respectively[21]. Both studies found values lower than those demonstrated in the present study (16.09 ± 1.97), which may be related to the evaluation period of the study of Toselli & Campa[22], which was were carried out in the competitive period while the present study evaluated the pre-season, and also the fact that the study by Aka et al.[21] be composed of female athletes[21,22].

The phase of assessments has extreme importance for volleyball players, in which Berriel et al.[23] showed that, in the pre-season, there is a need to improve basic physical abilities to tolerate well the training loads[23]. In addition, these results seem to indicate that FMS is not a physical performance predictor, but it may be related to the specific requirements of the modality in which it is being evaluated.

Linek et al.[20] evaluated adolescent volleyball players in two moments and dit not find significant differences (16.3 and 16.1), however, an intervention with specific stability exercises for volleyball was carried out, and the mean FMS score increased to 18.1[20]. The results of this study suggest that specific exercises are effective in increasing the movement pattern scores of adolescent players.

Other important finding showed a significant asymmetry in the shoulder mobility of 36% of athletes (eight athletes). This result is close to the percentage of 29% observed by

Toselli & Campa[22], who also observed that most of the asymmetric movements and score 0 (pain when performing the movement) measured in FMS were registered in the shoulder mobility test[22]. This may be due to the extensive use of this joint during movements required in the modality, which can lead to proprioceptive and shoulder strength deficits in volleyball players[22,24]. These results corroborate the findings of the present study and highlight the importance of working on muscle reinforcement, strength balance and proprioception for the shoulder joint. According to Linek et al.[20] specific stabilization exercises can be an interesting strategy to be developed with athletes of this modality[20].

It is assumed that asymmetries can limit health and performance, due to inappropriate muscle contractions and body twisting that culminate in poor movement patterns[25,26]. Sprague et al.[17] observed a greater frequency of movement asymmetries at the beginning of the seasons, which shows an area to be explored, if analyzed together with the frequency of injuries in athletes during the same period[17]. Due to the proposed relationship between neuromuscular asymmetries and risk of injury, the FMS seems to be able to demonstrate this risk[6,7].

The present study presents as limitations the lack of knowledge of the training programs that the athletes carried out in their respective teams before being selected for the national teams, mainly involving aspects related to flexibility and joint mobility, therefore, the results of the present investigation may present a certain degree of heterogeneity. Nevertheless, it is important to point out that the selection of players evaluated constitutes an important category that formed a leader team of the FIVB ranking in recent years, which is considered a high-level sample in the world volleyball scenario. Future studies should investigate possible intervention effects on the FMS results, in addition to performing more than one assessment throughout the season, to observe the behavior of movement patterns during competition periods. Another suggested line of investigation would be to observe the incidence of injuries in athletes and investigate the relationships with the FMS score.

5. Conclusion

It was found that almost all athletes from the Brazilian under-19 volleyball team at the beginning of the pre-season had a score ≥ 14 in the FMS, showing good patterns of basic locomotor and stabilizing movements. In addition, approximately 59% of the athletes had some type of asymmetry in bilateral movement patterns, especially shoulder mobility, which presented a significant difference between the right and left sides, where shoulder mobility on the right side was greater than the left side. left. Thus, it is understood that carrying out this assessment in the pre-season can be an important parameter for identifying preventive exercises to be prescribed throughout the season, in order to correct asymmetries and possible injury prevention.

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Conflict of interest: The authors declare there are no competing interests.

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