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RELIABILITY OF A MEDICINE BALL EXPLOSIVE POWER TEST IN YOUNG VOLLEYBALL PLAYERS

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The purpose of the study was to evaluate the reproducibility of the medicine ball explosive power test to assess explosive power in young volleyball players.

Materials and methods. Data were collected using twelve volleyball players (age = 16.5 ± 0.52 years; body mass = 72.05 ± 7.9 kg; height = 182 ± 0.06 cm and body mass index = 21.63 ± 1.85) volunteered for this study. They completed a test and retest of the medicine ball explosive power test on two separate days.

The medicine ball explosive power test was conducted using a 3 kg medicine ball. Testing was carried out in two separated testing session preceded by a standardized warming up protocol. The paired-sample t-test was conducted to determine the differences signification observed between the test and the retest of the medicine-ball explosive power test. The intraclass correlation coefficient ($ICC_{1,1}$) aims to assess relative reliability of the test. The coefficient of variation between test and retest performance was used to check the absolute reproducibility. The Bland and Altman method was used to evaluate the relative and absolute reproducibility of the medicine ball explosive power test.

Results and discussion. Explosive power is often considered as one of the main determinants of a successful high-level performance in many team sports including volleyball. It is frequently measured in different occasion during competitive season using field-based tests. Thus, it is mandatory that strength and conditioning coaches have to use valid and reliable tests to evaluate the power for their athletes. However, contestation regarding test selection still exists grounded upon the particularity of the explosive power evaluation tests in volleyball.

There was no significant difference between medicine ball explosive power test (11.08 ± 0.72 meter) and retest (11.27 ± 0.93 meter) performance. The T-paired Sample test did not show any statistically significant difference (t= 1.035; p =0.393), while the intraclass correlation coefficient aimed to assess relative reliability of the test was of 0.83. The coefficient of variation between test and retest performance was of 5.7% which is near to the 5% confidence interval level. The intraclass correlation coefficient was situated between 0.9 and 0.8 ($ICC_{1,1}$ = 0.83) Thus this study suggests that the medicine ball explosive power test has moderate relative reliability level.

Conclusion. The medicine ball explosive power test is reliable regardless to the age. The Bland and Altman method confirmed our finding suggesting the medicine ball explosive power test is a reliable test.

Keywords: reproducibility, medicine ball backward throw test, field test, explosive power.

Introduction. Volleyball is a complex team sport, which is characterized by specific demands such as athletic, tactical and technical aspects [1, 2, 3]. During a volleyball game players are required to perform different short and explosive movements involving both lower and upper limbs, such as jumping, smashing, serves and spiking [3]. These technics are key preconditions to success in high-level performance [4, 5] reported that a volleyball player perform 40.000 times per year [6]. These statistics shows the importance of the ballistic movements in volleyball. Therefore, a regular assessment of physical fitness allows coaches to prevent injuries [7], to design strength and conditioning program, to administrate an appropriate training load to avoid the detraining or over-training effects and to identify the talented players [8]. Nerveless, it is considerably important to have an easy procedure that can be afforded with minimum logistic requirements. However, the choice of the assessment tool/test should meet some basic criteria such as its reproducibility, sensitivity, validity and its accessibility, which requires a lot of reflexion, in addition for the mentioned criteria. In the same context, the assessment test should be accessible, cost effective and easy to apply for coaches and players, while laboratory tests might be expensive, time consuming and depend on a sophisticated equipment and experts. A field test can be easily deployed into training routines. Thus, a field test can offer a practical application and provide valid and reliable results when performance is assessed.

In the last decades many studies have focused on the evaluation of the power of lower and upper limbs [9, 10, 11, 12]. Among these tests, there is the medicine ball explosive power test described by Stockbrugger et al. [12]. Indeed, the use of this test as a tool to measure the upper and lower limbs power is interesting because of its accessibility compared to other tests that require sophisticated equipment. This leads these studies to suggest it to trainers who do not have access to laboratories.

We believe that the reproducibility of this test in young volleyball players has not yet been proven. It is therefore important to establish the reproducibility of this test and to recommend it to coaches.

Thus, **the purpose of the study** would be to evaluate the reproducibility of the medicine ball explosive power test to assess the explosive power in young volleyball players.

Materials and methods. Participants. Twelve young volleyball players (age = 16.5 ± 0.52 years; body mass = 72.05 ± 7.9 kg; height = 182 ± 0.06 cm and BMI = 21.63 ± 1.85 kg/m^2) were recruited from a national level volleyball team in Tunisia. All players were actively engaged in a regular training schedule consisting of 10 hours per week and a competitive volleyball game each weekend. All participants were exposed to the same training load. All participants and their legal representatives were informed about all testing and training procedures; written informed consent (legal representatives) and assent (children) were obtained before the start of the experiment. The local Institutional Review Committee of the Higher Institute of Sport and Physical Education, Ksar-Saîd, Tunisia approved all procedures. All procedures were in accordance with the latest version of the Declaration.

Experimental procedure. The medicine ball explosive power test was conducted in an in-door gymnasium on three session separated by 24 hours. During first testing session, the following anthropometric characteristics were assessed: body mass, height and body mass index (BMI). The second and third testing sessions consisted of the medicine ball explosive power test. A 15-minute standardized warming up consisted of jogging, dynamic stretching, bounding strides and squat preceded by the evaluation sessions. The test and the retest were conducted in the same conditions in accordance with a rigorous modality.

The medicine ball explosive power test (MBEPT). Participants were instructed to start from the standing position while maintaining their feet at the same level with shoulder and facing backward to the throwing direction. The starting line (zero level) was set at the heel level. Participants have to hold the medicine ball with straight hand. When the starting sign was given, participants should bend their hips and knees in a counter movement motion with a forward trunk inclination. The medicine ball than should be lowered to under the hips level, after the countermovement motion participants start pushing their hip up while extending their knees trying to throw the medicine ball as far as possible to the backward direction. Each participant performed 3 trials with a 5-minute recovery separating the trials. Distance was recorded in metre from the heel level to the impact point. The best performance was considered for further statistical analysis.

Statistical analysis. All statistical analyses were carried out using SPSS 20.0 program for Windows (SPSS, Inc., Chicago, IL, USA) with the level of statistical significance set a priori at 0.05, and MedCalc (version 20.106). All data were presented by mean ± standard deviation. The normality of the distribution was verified using the Kolmogorov-Smirnov test. The matched pair t-test was carried out to test the hypothesis of mean equality. The intraclass correlation and the Bland and Altman (1986) methods were used to evaluate the relative and absolute reproducibility of the MBEPT test.

Results. Table 1 presented the intraclass correlation coefficients between the performances obtained in the test and retest sessions.

We used the paired-sample t-test to determine the significance of the differences observed between the performance of the MBEPT test and retest. The t-test showed no significant difference between the

Table 1 – Intraclass correlation coefficient of the MBEPT test and retest of the volleyball players

	Test Mean ± SD	Retest Mean ± SD	Intraclass correlation	
			ICC (95% CI)	***t-test***
Participants (N=12)	11.08 ± 0.72	11.27 ± 0.93	0.83 (0.393-0.950)	0.323 (NS)

Notes: ICC – Intraclass correlation coefficient; CI – Confidence Interval; NS – Non-Significant.

MBEPT test and retest performances. The intraclass correlation coefficients for young volleyball players are equal to 0.83.

For the MBEPT performance, the data were normally distributed (p = 0.473). The comparison of the mean values of the MBEPT test obtained from the test and retest session was non-significant (t = 1.035; p = 0.393).

Bias values (± ∆SD) as well as the correspondent values of the limit of agreement of 95% (LoA 95%) and the measurement error by the coefficient of variation (CV) of the MBEPT test and retest performances are presented in **Table 2.** The Coefficient of variation (CV) between the test and retest was 5.7%, which is close to the 5% threshold.

Table 2 – Results of the Bland-Altman method for the absolute reproducibility evaluation

	Bias	∆SD	LoA 95%	*CV*
MBEPT	-0.19	0.64	1.26	5.7%

Note: Bias: The mean of the differences between the test and retest performance of the MBEPT

Figure 1 shows the graphic presentation of the Bland and Altman method [13] of the performance of the young volleyball players. Both the zero (null difference between test and retest) and all points are situated in the 95% LoA. In addition, the bias is nearby zero (-0.19).

Discussion. We tend to conclude that the higher the Pearson coefficient between the test and the retest is, the more reproducible the test is. However, the use of this coefficient has its limits. It is important to be aware that the Pearson coefficient represents the degree of correlation between two variables, but not the agreement between these two variables. In the same way, it is possible to have an *r* equal to *1* with a biased measurement. It is therefore essential to always visualize this relationship to judge the adequacy of the value of the correlation coefficient. The reproducibility of MBEPT has been evaluated firstly by the checking of the relative reproducibility using the calculation of the intraclass correlation coefficient ($ICC_{1,1}$) and secondly by the absolute reproducibility using the method of Bland and Altman and the coefficient of variation [13]. These two methods provide complementary information as shown by Atkinson et al. [14].

In order to study the stability of MBEPT performances, a complementary approach was used, as proposed by Bland and Altman [13]. It is a simple approach to implement: it is enough to represent, in each case, the difference between the performances of the two tests in terms of the mean of the performances during the test and retest. On such a graph, the average of the differences corresponds to the average bias between the two tests. If we assume that the differences follow a normal distribution, 95% of the differences will be between this average value: -1.96 x standard deviation of the differences and the average value of +1.96 x standard deviation of the differences. For this reason, these two lines are also repeated on the graph in the studies published in the field of sports science using the method of Bland and Altman [13] to assess the reproducibility of fitness tests such as the studies of some scientists [15, 16, 17, 18, 19].

We believe that a precise study of the reproducibility of MBEPT would be incomplete using only the correlation analysis. Indeed, the graphical representation of Bland and Altman allows a more accurate observation of the differences between test and retest performances. The determination of the limits of concordance at 95% also allows to judge if the variability between the two assessment sessions is acceptable or not.

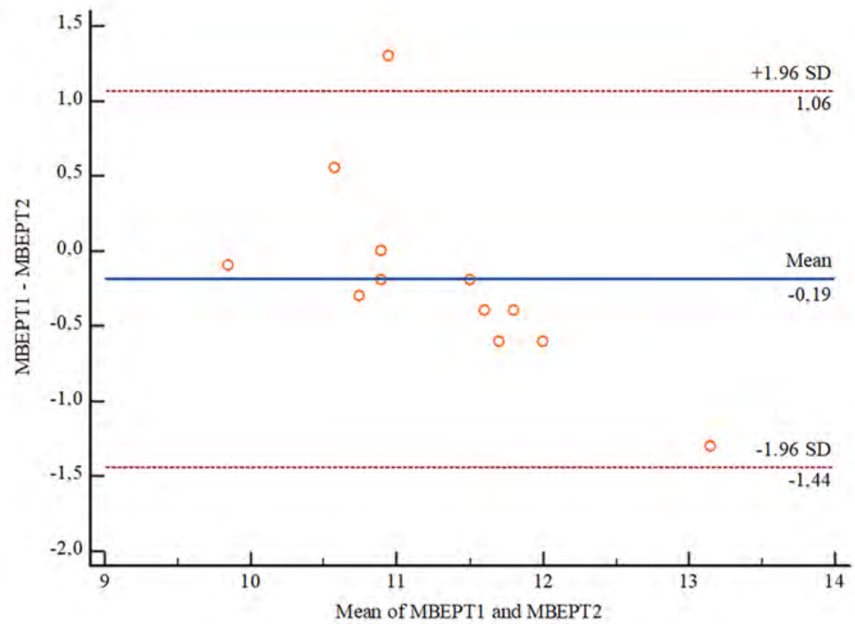

Figure 1 – Graphical presentation of the Bland and Altman method [13] for the absolute reproducibility of the MBEPT test

For the relative reproducibility, the paired-sample Student's t-test showed no significant differences between the test and retest means of the young volleyball players (**Table 1**) regardless of their gender.

The interclass correlation coefficient in young volleyball players is 0.83. In our study the ICC is close to 1. According to scientific research [20, 21] the reproducibility of a test is very good if the ICC is lower than 0.08. We can therefore conclude that our results show a moderate relative reproducibility. For absolute reproducibility, researchers often use the coefficient of variation (CV) to test the variability of performance. In our study the CV is close to the 5% mark. It is equal to 5.7% (**Table 2**). The method of Bland and Altman shows us that in young volleyball players, the bias is equal to -0.19, the standard deviation is 0.64. The values of the differences between the test and retest performances are between bias 1.96 x standard deviation, that is to say that the bias values range is from -1.44 to 1.06. **Figure 1** shows that the majority of the points are located within these intervals represented by the two lines that represent the limits of concordance at 95%. In addition, the zero (zero difference between the test and the retest) is within this interval.

Conclusion. The purpose of this study was to help coaches assess the physical fitness level. Due to the limited duration for training, this study aimed to "bring" an accessible and easy tool allowing the evaluation of the upper limb explosive power. Recently, the MBEPT test is recommended to evaluate the explosive of both upper and lower limbs. This study has proved that the MBEPT test is a reliable test regardless of the age, however the intraclass correlation coefficient, the coefficient of variation and the methods of limit of agreement confirmed that the performance of the MBEPT test are stable for the test and the retest. Thus, the MBEPT test is reliable for volleyball players.

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Conflicts of Interest and Source of Funding

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НАДІЙНІСТЬ ТЕСТУ НА ВИБУХОВУ СИЛУ МЕДИЧНОГО М'ЯЧА У ЮНИХ ВОЛЕЙБОЛІСТІВ

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Резюме. *Метою дослідження* було оцінити відтворюваність тесту «кидок набивного м'яча» при оцінці вибухової сили юних волейболістів.

Матеріали та методи. Дані були отримані за участі дванадцяти волейболістів (вік = 16,5 ± 0,52 років; маса тіла = 72,05 ± 7,9 кг; довжина тіла = 182 ± 0,06 см та індекс маси тіла = 21,63 ± 1,85), які дали згоду на участь у дослідженні. Методика визначення вибухової сили спортсменів передбачала визначення за допомогою виконання тесту «кидок набивного м'яча» та повторне виконання цього ж тесту в різні два дні.

Методика проведення тесту на визначення вибухової сили передбачала використання медичного м'яча вагою 3-кілограми. Тестування проводилося в межах двох окремих сеансів тестування. Перед ними було проведене стандартизоване розминання. Для перевірки гіпотези дослідження щодо відмінностей між тестом і ретестом з визначення вибухової сили шляхом використання кидка набивного м'яча застосовано t-тест для парної вибірки. Також визначено коефіцієнт внутрішньогрупової кореляції, призначений для оцінки відносної надійності тесту. Для перевірки абсолютної відтворюваності використовували коефіцієнт варіації між показниками тесту та ретесту. Для оцінки відносної та абсолютної відтворюваності тесту «кидок набивного м'яча» для визначення вибухової сили використано метод Бленда і Альтмана.

Результати і обговорення. Вибухова сила часто розглядається як один із головних чинників успішної м'язової роботи на високому рівні ефективності в багатьох командних ігрових видах спорту, включаючи волейбол. Її часто вимірюють у різних часових відтинках підготовки та під час змагального сезону за допомогою польових тестів. Таким чином є важливим, щоб тренери з силової (фізичної) підготовки використовували достовірні та надійні тести для оцінки відповідних показників сили своїх спортсменів. Тим не менш, досі існують розбіжності щодо вибору тестів, що базуються на специфіці змісту провів та оцінці вибухової сили у волейболі.

Встановлено, що не було суттєвої різниці між показниками виконанням тесту на вибухову силу з використанням кидка набивного м'яча (11,08 ± 0,72 м) та повторного тесту (11,27 ± 0,93 м). Т-тест парної вибірки не показав статистично значущої різниці (t = 1,035; p = 0,393), а коефіцієнт внутрішньогрупової кореляції, призначений для оцінки відносної надійності тесту, становив 0,83. Коефіцієнт варіації між показниками тесту та ретесту становив 5,7%, що близько до рівня довірчого інтервалу у 5%. Коефіцієнт внутрішньогрупової кореляції знаходився в межах від 0,9 до 0,8 ($ICC_{1,1}$ = 0,83). Проведене дослідження свідчить про те, що тест на вибухову силу за допомогою кидка набивного м'яча має задовільний відносний рівень надійності.

Висновок. Тест кидок набивного м'яча для визначення вибухової сили волейболістів є надійним незалежно від віку спортсменів. Застосування методу Бленда і Альтмана підтвердив припущення про те, що контроль прояву вибухової сили за допомогою тесту «кидок набивного м'яча» є надійним.

Ключові слова: відтворюваність, тест на вибухову силу медичного м'яча, польовий тест, вибухова сила.

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