Reliability of the four series 15-second vertical jumping test

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ABSTRACT

Purpose: The purpose of this study was to check the reliability of the vertical jumping test and re-test in four series of the 15-seconds test (IVJT). **Method:** Eighteen male volunteer athletes participated in this study, and they were divided as follows: eleven handball players (25.74 ± 4.71 years; 85.84 ± 7.63 kg; 182.14 ± 3.46 cm), and seven basketball players (18.60 ± 0.77 years; 83.82 ± 10.02 kg; 188.14 ± 5.76 cm). The assessed variables for the test and re-test were: power peak (PP), mean power (MP), and fatigue index (FI). The performances attained by them in these variables were measured through the vertical jumping test in four series of the 15-seconds test with 10 seconds recovery between series. The statistical treatment was performed through the descriptive technique and the intraclass correlation coefficient (ICC). **Results:** The results have shown a high ICC in the repeated measurements performed in different days for every variable: PP (r = 0.992; p = 0.0360); MP (r = 0.993; p = 0.0107); and FI (r = 0.981; p = 0.0556). Added to this, it was found high correlation coefficients between the test and re-test as to the quality indicators in the measurements of the vertical jumping technique with counter-movement without the help of the upper limbs (CMJ) (r = 0.991; p = 0.0800), for the amount of jumps together with a 15 and 60 seconds work (AVJ15s, r = 0.936; p = 0.0062, and AVJ60s, r = 0.978; p = 0.0139) and in the jumped height, in a 15 and 60 seconds work (VJ15s, r = 0.993; p = 0.0467, and VJ60s, r = 0.988; p = 0.0014). **Conclusion:** The data analysis pointed out the existence of a reliable measurement of the IVJT when assessing the explosive strength resistance through the MP and FI variables.

Keywords: Assessment. Collective sports. Vertical jumping test.

INTRODUCTION

The physiological demands during a soccer, basketball, handball and volleyball game are characterized by repetitive strength with intermittent contexts[1-4]. Several studies have shown that such strength poses short-endurance works[1-9], alternating maximal, high, and submaximal intensities and an interval between works[1-4,6]. In such context, the work is characterized by a great amount of actions such as: changes in the direction, short-distance displacement and vertical jumping, and these actions are repeated several times along a match[1-6].

Based on these indicatives, the explosive strength is justified for being a variable that is manifested during maximal actions and intensities in these sports. Furthermore, another factor that must be considered is the amount of actions, and this explains the importance of the performance upon the explosive strength resistance (ESR), resulting in a successful performance of the athlete. This has been suggested in the specialized literature that points out the muscular fatigue as one of the factors responsible by the players' performance during a game situation[3,4,6,10], which is interpreted through the decrease in the strength performance, velocity and power[11-17].

The muscular fatigue is understood as a reversible process[11,12] which is manifested by the corporal responses to external conditions in performing works upon repeated and prolonged situations for a given period of time[11,13-15], and having as consequence the expression of a transitory decrease in the results of the functional capability, evidenced by a failure in keeping the performance in certain variables such as the strength, velocity and power[11-17].

Some of the studies have approached different ways to assess the performance on the explosive strength resistance (ESR), whose capability allows to players to retard the muscular fatigue process[18-20]. Nevertheless, considering the tests with higher verification applicability on the performance, the specialized literature indicates that the vertical jumping test is considered more specific than those performed on ergonomic cycles[16,18,19,21].

However, basketball, soccer, handball, and volleyball are considered intermittent context strengths, and therefore, the results of the ESR performance measurements are differentiated from the continuous contexts[1,22,23].

So, maybe the vertical jumping tests with continuous context may have underestimated the ESR results for intermittent context sports, as the interval between strengths allow a recovery between a motor action to another, and as consequence, they produce a greater amount of useful works during a physical strength.

Nevertheless, it is verified in the literature that the assigned measurements are focused on the continuous context vertical jumping that proved to be reliable measurements[18,19]. Recently, Harley, and Doust[24] reported in studies with volleyball and basketball players that intermittent context tests are reliable. Even so, there is scarcity of studies aiming to check the ESR assessed through vertical jumping tests in the intermittent context and to demonstrate whether there is reliability or not in the repeated measurements. With this, it arisen some questionings on the reliability of the four series of the 15-seconds vertical jumping test with 10 seconds recovery to assess the ESR from the amount of useful work produced and of the decrease in the performance of the explosive strength.

Therefore, the purpose of this study consisted in verifying the reliability of the repeated measurements of the test and re-test applied in four series of the 15-seconds vertical jumping test with 10-seconds recovery.

METHODOLOGY

Characteristic of the individuals

The sampling was composed by male handball and basketball players of clubs from the metropolitan region of the Campinas city, São Paulo State, Brazil, who were performing daily trainings to participate in the 2003 State Championship.

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All players were in their training period preparing to the competition, and in a certain extent, this allowed the data collection, but it was impossible to do the same with volleyball and soccer players, as they were in a competition period. Every individual signed a consent term to participate as volunteers in the study proposed, which was approved by the Ethics Committee of the institution, and they performed an adaptation process to the vertical jumping test.

It participated in this study 18 volunteers: 11 handball players (aged 25.74 ± 4.71 years; height 182.14 ± 3.46 cm; body mass 85.84 ± 7.63 kg) and seven basketball players (aged 18.60 ± 0.77 years; height 188.14 ± 5.76 cm; body mass 83.32 ± 10.02 kg).

Assessed variables:

The anthropometric measurements of the height (HEI) and body mass (BM) were used to characterize the individuals in the assessment. Such measurements were performed according to the standardization prescribed by Lohman *et al.*[25]. The motor variables were: power peak (PP), mean power (MP), and fatigue index (FI) in repeated measurements performed in different test and re-test days.

The PP was the mean power produced in the first of four series of the 15-seconds test; the intermittent context MP was assessed by the amount of work produced along a 60-second strength performed in four series of the 15-seconds test with 10-seconds intervals.

The result was expressed in watts/kg ($W.kg^{-1}$) according to equations to assess the PP and MP in the vertical jumping test described by Bosco *et al.*[19]. The FI assessed from the relationship between the peak power (first series) and the mean power generated in the last series (fourth series) was determined through the equation described by Bosco *et al.*[19], and the result was expressed in percentage (%).

Equipment:

The variables pertained to the ESR performance upon intermittent strength was assessed through the use of the JUMP TEST contact carpet, equipment that have the same principle than the Ergojump[26] to inform the flight time (m/sec) and the contact time (m/sec). In order to perform the ESR measurements, it was employed a wooden stadiometer, and the Plena Lithium Digital electronic scale BM was used to measure the BM.

Four series of the 15-second vertical jumping test (IVJT)

For both vertical jumping tests with intermittent context (IVJT), it was employed the vertical jumping technique with counter-movement without the help of the upper limbs (CMJ), a procedure described by Komi; Bosco[27]; Bosco[28]. All participants performed an approximately 110º angle knee flexion justified as the optimum angle to apply the strength[29]. All participants were instructed to perform continuous vertical jumps in a work performed at maximal strength with no pause between jumps during the tests. Athletes were asked to remain with their trunk in the vertical positioning with no excessive forward move, and having their knees extended during the flight phase, in order to avoid influencing the results.

The VJTI was performed in four series of 15-seconds of vertical jumping with 10-seconds interval between each series. The continuous 15-seconds jumping test procedure had as basis the description made by Bosco *et al.*[19], whose reliability for the continuous 15-seconds vertical jumping test has been reported as high, r = 0.95[19].

Data collection:

Athletes were asked to perform no extenuating activity 24 hours prior to the data collection. The information collection related to the data on the anthropometric measurements and the explosive strength resistance was performed at the sportive gymnasium of each Club. It was allowed a seven days recovery gap between the test and re-test data collection. The individuals performed a 15-seconds warming performing the following actions: stretching, running, coordinative exercises, and exercises for the neural-muscular activation aimed to the jumping test.

In the tests and re-tests, all participants performed the jumping action with the counter-movement technique, without the help of the upper limbs (VJT) after 60 seconds after the warming. Three tries with maximal strength with a 10-seconds pause in each jump were performed. From these results, it was chosen the highest, in order to check the maximal strength intensity to be applied to the VJTI, and consequently, to the controlling of the strength intensity. Whenever the athlete did not reach 95% of the maximal intensity in the three first vertical jumps, the test was interrupted, and a second try re-started after 60 seconds.

The participants were stimulated to jump as much as possible within the foreseen time in both tests. The researchers validated one try in each test, according to the individual's action: flexion of the knees, forwarding movement of the trunk, decreasing size of the knee flexion during consecutive jumps, and use of the upper limbs.

Statistical treatment:

Initially, it was used descriptive statistical techniques to describe the results: for the investigation on the reliability of the result in repeated measurements of the VJTI, it was employed the interclass correlation statistics technique. The significance level was $p < 0.05$.

RESULTS

Table 1 describes the mean values attained in the test and re-test administration, as well as the correlation coefficients between repeated measurements in different days of the vertical jumping test (four series of the 15-seconds test).

TABLE 1
Descriptive and correlation coefficient of four series of the 15-seconds vertical jumping test measurements

Variables	Teste			Re-Teste			R	p
	n	Mean	SD	n	Mean	SD		
PP *($w.kg^{-1}$)*	18	24.68	2.70	18	24.95	2.70	0.992	0.0360
MP *($w.kg^{-1}$)*	18	18.79	2.23	18	18.94	2.16	0.993	0.0107
FI *(%)*	18	57.50	9.51	18	57.83	9.56	0.981	0.0556

PP: power peak; MP: mean power; FI: fatigue index.

The results found in this study showed the existence of high correlations in every variable of the test and re-test. The results of the correlation coefficients between repeated measurements (test and re-test) were: r = 0.992 (p = 0.0360) for the power peak, and r = 0.993 (p = 0.107) for the MP; for the FI it was verified r = 0.981; however, that FI correlation revealed to be not statistically significant (p = 0.0556).

In the test and re-test, it was found mean power peak values estimated in 24.68 ± 2.70 $W.kg^{-1}$ and 24.95 ± 2.70 $W.kg^{-1}$, respectively.

For the mean power, the results found in the VJTI were 18.79 68 ± 2.22 $W.kg^{-1}$, respectively for the test and re-test. As to the fatigue index, it was found mean values of 57.50 ± 9.51 and 57.83 ± 9.56, respectively for the test and re-test.

Table 2 presents the correlation coefficients (r) of the quality indicators found in the results of the 15-seconds test. The indicators indicated interclass correlation coefficients for the VJT technique of r = 0.991 (p = 0.080); for the amount of vertical jumping in the 15s and 60s works, it was verified: r = 0.936 (p = 0.0062), and r = 0.978 (p = 0.0139), respectively, since the jumped height in the 15s and 60s works were: r = 0.993 (p = 0.0467), and r = p = 0.988 (p = 0.0014), respectively.

TABLE 2
Quality indicators of four series of the 15-seconds vertical jumping test measurements

Variables	Teste			Re-Teste			R	p
	n	Mean	SD	n	Mean	SD		
VJT *(cm)*	18	39.26	3.19	18	39.66	3.60	0.991	0.0080
AVJ60s	18	56.50	3.69	18	56.33	3.83	0.978	0.0139
AVJ15s	18	14.22	0.65	18	14.11	0.67	0.936	0.0062
VJ15s *(cm)*	18	33.86	3.43	18	34.16	3.45	0.993	0.0467
VJ60s *(cm)*	18	25.73	2.49	18	25.78	2.36	0.988	0.0014

VJT: vertical jumping with counter-movement with no contributions from the upper limbs; AVJ60s: amount of vertical jumping in a 60 second work; AVJ15s: amount of vertical jumping in a 15 second work; VJ15s: height of the vertical jumping in a 15 second work; VJ60s: height of the vertical jumping in a 60 second work.

DISCUSSION

This study has shown that the expression of the power peak (PP), the mean power (MP) and the fatigue index (FI) are reliable measurements to the repeated measurements for the VJTI test, in which it was used a simple and accessible equipment to be applied in a training place.

Such reliability indicates a high consciousness grade in the results, reinforced by the quality indicators found in the VJTI test, in which it is observed a strengthening of the test and re-test measurements; this is due to the high correlation index presented in the results of the VJTI related to the VJT in the mean height jumped in the 15 seconds work (SV15s), in the mean jumped height in the 60 seconds work (SV60s) in the amount of the 15-seconds jump (NSV15s) and in the amount of the 60 seconds vertical jumping (NSV50S).

Thus, in the accuracy of the VJTI measurements there must be a control to those indicators, since they may be considerably influences in the test results.

Upon the comparison of the results found in this study with the ones found by Harley and Doust[24], it is verified that the VJTI measurements for test and re-test of the variables PP and FI presented higher correlation coefficients than those found in the 5 series of 10 vertical jumping of the Harley Doust test[24] (r = 0.73, and r = 0.866), respectively for the PP and FI). However, the care with the learning effect can explain the lower reliability found in the Harley and Doust study[24] than the VJTI for the PP and FI, since this study performed a procedure before the vertical jumping tests that consisted of the individual's adaptation to the tests. Such element that tried to minimize the effect can also be explained by the Elvira *et al.* study[30] that showed a lower variation coefficient (1.7%) in the VJT technique in the second day of the vertical jumping test than the value found in the first day (2.94%). However, in the MP measurements, it was observed some similarity in the reliability of the measurements, presenting correlation coefficients r = 0.935.

The result found in this study upon the measurement of the mean PP values has shown a similarity to the results found in the Harley and Doust study[24] comprising basketball and volleyball players (25.8 ± 2.1 $W.kg^{-1}$), as well as in the results found with basketball players in studies performed by Bosco; Luhtanen and Komi[19] (24.7 ± 2.6 $W.kg^{-1}$) and Bosco *et al.*[31] (26.2 ± 3.8 $W.kg^{-1}$). However, as to the MP in the intermittent context, it was impossible to set comparisons to other studies due to the scarcity of references to such extent on vertical jumping of that nature, and consequently, it was observed only the continuous tests.

As to the values of the vertical jumping technique (VJT) related to other studies, it was observed a similarity in the mean values of this study (r = 0.991) to the studies performed by Ugrinowitsch[32], Elvira *et al.*[30], Hoffman and Kang[18] and to the correlation coefficients for the test and re-test measurements of r = 0.99 (p < 0.05); r = 0.99 (p < 0.05), and r = 0.97 (p < 0.05), respectively.

Thus, the results prove the reliability of the repeated measurements of the PP, MP, and FI variables in the four series of 15-seconds tests, because it can be perceived that such reliability is reinforced by the indicators of the test quality. In such sense, the MP and the FI are reliable variables to the interpretation of the useful quality of work performed in strengths through vertical jumping in the intermittent context.

However, as to the FI, it is presumed that it must be used a certain care when interpreting the results, since it must be considered the analysis on the PP production related to the effects of learning the vertical jumping technique (VJT); this is due to the fact that the FI and the VJT did not present statistically significant correlation. Nevertheless, further investigations are still needed for these indicators using a higher amount of participants, and a higher amount of analysis in different sports, in order to allow possible comparisons to assess the explosive strength resistance, and these determinations were not possible to set in our study.

The data used in this study show that the VJTI is a reliable measurement to assess the decrease in the performance of the explosive strength and the amount of useful work performed by handball and basketball players, as well as for volleyball and soccer players. Thus, these results suggest that the MP and the FI can be used to assess the ESR in athletes from these sports.

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