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COMPARISON OF EXPLOSIVE FORCE ASSESSMENT WITH DESMOTEC AND JUSTJUMP IN ADOLESCENTS

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Abstract: *We analyzed the comparison between two pieces of equipment that evaluates leg strength. 27 girls and 18 boys (15-19 years) from the N-E area of Romania performed vertical jumps after the squat jump (SJ), countermovement jump (CMJ) and CMJ with arms swing (CMJ-AS) procedures. We used JustJump and Desmotec. There were found differences between the two devices among the values obtained from all three jumps for both boys (SJ=9.1 cm, CMJ=9.8 cm, CMJ-AS=11 cm) and girls (SJ=4.3 cm, CMJ=4.7 cm, CMJ-AS=5.5 cm). There weren't big differences between the evaluation of girls with Desmotec and boys with JustJump in all jumps. Desmotec generated considerably higher values compared to JustJump.*

Key words: *leg force, power, vertical jump, teenagers, JustJump.*

1. Introduction

The JustJump system was developed and used in assessing the explosive force of the lower train based on the speed-force ratio, specifying the height of the vertical jump [28].

There are numerous methods for assessing the height of the vertical jump, but some specialists suggest the use of a video technique [11] to be used as a reference criterion, although it requires expensive equipment and specialized people. There are two accessible and valid methods for assessing vertical jumping: a. jumping vertically and reaching the highest possible point, b. platform/contact mat. Regarding the first method, the most widely used device is Vertec (Vertec, Sports Imports, Hilliard, OH) [2, 3], [14], [25]. Contact mat uses a cinematic equation based on which flight time is measured. A common example of a mat is the JustJump system (Probotics, Huntsville, AL) [3], [7], [9], [16], [19], [21], [22], [25], [27, 28], whose micro-switches built into the mat (68x68 cm) measure the interval between the subject's beating phase on the mat and its landing [18].

There is research indicating that eccentric training has the potential to induce superior neuromuscular adaptations [27]. Several studies have found that eccentric training is superior to

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traditional strength training for increasing functional performance [26].

Desmotec is a relatively new device (2012) and is based on the collaboration between world-class trainers and experts, doctors, performance athletes, physiotherapists, researchers and entrepreneurs who trust their device.

In the literature, the Desmotec E.Board platform is rarely used, but rather the D.Sport [15] and D.Full [1] Desmotec E.Board has integrated D.Soft and E.Load cells favouring the assessment of balance, explosive force and isometric. The D.Soft software is designed to provide real-time feedback and recorded performance reports, which can be saved and stored.

Some specialists have measured the height of the CMJ vertical jump performed according to the Bosco protocol, using the JustJump system also used in our research [27].

The JustJump system was used to determine the reliability of the device. Two test sessions were conducted, during which they performed 3 vertical jumps on three devices (JustJump, Vertec and Myotest). It was concluded that for girls, the JustJump system is much more reliable than Vertec [22].

The validity of the JustJump system in measuring flight time and jump height in rugby players was determined by comparison with a force platform. JustJump achieved significantly different results from the platform in measuring flight time and jump height ($p < 0.05$). However, strong associations were found between the two for the flight time and height of CMJ and CMJ-AS [8].

Waller [28] followed the measurement of explosive force using JustJump, characterizing it as a valid device in testing the explosion force and power of the lower limbs. The author provided for test-retest reliability and a reduced validity of the muscle strength assessment of the lower limb extensors.

Measuring explosive force using vertical jumps is one of the most widely used assessments included in an optimal multi-sport test battery [10].

Methods for assessing the height of the vertical jump and the explosive power are numerous. The standard method is the force platform, but there are other instruments that are more affordable and easier to carry, such as matte electrical contact systems (e.g.: Chronojump) or infrared mat and inertial sensors. (ex.: OptoJump Next, BeastSensor, Gyko) [10].

Validation of portable vertical jump assessment systems is increasingly common, especially because it allows sports professionals as well as scientists to obtain information on the practical use of these methods [4].

The reliability of the mat contact system, compared to the motion-capture system, was significantly [23].

Compared with the Kistler laboratory force platform, the validity of the force platform Quattro Jump, Belt mat Sports Contact mat Eleiko Sport and Vertec Vertical Jump Meter was investigated. The force platform and mat belt were found to be valid, while Vertec and mat contact were not [2].

SportJump System Pro and ErgoJump Plus were compared with a standardized 600 M Dinascan force platform, to validate the two equipment's. Of the two devices, reliable and valid was the SportJump System Pro [12].

Heredia-Jimenez and Orantes-Gonzalez [13] analyzed the differences in the height of the vertical jump of a wearable 3D inertial measurement unit (IMU), the

Kistler force platform and the SportJump System Pro photocell system. Given the flight time of the CMJ, the 3 aircraft were correlated.

Köklü et al. [17] compared three methods of measuring the height of the vertical jump: the Bertec force platform, the motion analysis system (SIMI Motion 7.5, GER) and the My Jump 2 app. The force platform was the gold standard of this evaluation, but also the motion analysis system has been labeled as such [4, 12-13, 18-20, 23]. My Jump 2 is a valid method of assessing the height of the vertical jump [17]. The reliability and validity of the My JUMP 2 has also been evaluated by other specialists, who have also used HomeCourt and Takei Vertical Jump Meter in their studies [6].

There are significant differences between the Vertec and Just Jump systems, but without practical relevance, so the JustJump system is a viable alternative for measuring the height of the vertical jump [3], [14]

JustJump is a reliable method, but the results obtained are much higher compared to the force platform, specialists suggesting the use of the data correction equation [19].

Literature has considered numerous methods of assessment of the explosive force of the lower limbs, among them the JustJump system and less the Desmotec platform, being a new apparatus. Therefore, thanks to the validation of the detention assessment with the JustJump system, by comparison with standardized platforms, the aim of our research is to establish the differences between the measurement of the explosive force of adolescents in northeastern Romania using the two devices: Desmotec (Biella, Italy) and JustJump (Probotics, Huntsville, Alabama, USA).

We assume that the performance of the 3 types of jumps will be rendered similarly by the two methods.

2. Material and Methods

This research aims to determine the differences in the evaluation of the vertical jump performed by a group of teenagers on two devices: the Desmotec V.12 platform and the JustJump system.

Due to the favorable period of manifestation of conditional force quality, 45 adolescents (27 girls, 16.54 ± 0.9 years, 162.8 ± 7.1 cm, 57.26 ± 9.4 kg and 18 boys, 16.39 ± 1.0 years, 175.2 ± 7.0 cm, 67.20 ± 7.4 kg) were selected to attend high school studies in the northeastern part of Romania to take part in the research (Table 1). None of them followed any other physical activity, except the physical education classes at the school.

Their participation in the study was approved by their legal representatives by signing the parental agreement.

Antropometry

The anthropometric data considered height, measured using an electronic level Handy and the Bosch GLM80 Professional telemetry, body mass determined by the Tanita BC-601 CG analyzer and body mass index rendered by calculating the ratio between weight and square height.

The explosive force was assessed by performing the Squat Jump (SJ), Coutermovement Jump (CMJ) and CountermovementJump with Arm swing (CMJ-A) jumps on the JustJump system (Probotics, Huntsville, Alabama, USA), subsequently on the Desmotec E.Board platform. (Biella, Italy). Between each

jump there was a break of 5 minutes, and between devices 10 minutes.

Each test was explained and demonstrated in advance by a team of trained students from the Centre for Selection and Sports Counselling of the Faculty of Physical Education and Sports in Iași.

SJ was performed from the standing position with the knees bent at 90°, after holding the position for 3 seconds a vertical jump was made as high as possible. ***CMJ*** provided a protocol like SJ, except that the teenagers performed from a standing position. During the flight of both tests, the knees had to be stretched, and the hands on the hips throughout the jump. ***CMJ-AS*** was performed from standing apart with arm swing. All the jumps landed on both legs.

The protocol for each jump was followed in the same way as in the assessment with the Desmotec platform, except that the subjects started the trial after the type of jump was selected from the equipment tablet, and they performed the jump after a sound signal. Each jump was performed twice on both devices, recording the best value.

Subjects anthropometrics Table 1

	N	Age (years) Mean ± SD	Heigh (cm) Mean ± SD	Weight (kg) Mean ± SD	BMI (kg/m2) Mean ± SD
Girls	27	16.54 ± 0.9	162.8 ± 7.1	57.26 ± 9.4	21.57 ± 3.15
Boys	18	16.39 ± 1	175.2 ± 7	67.20 ± 7.4	21.96 ± 2.58
Overall	45	16.53 ± 1.01	167.8 ± 9.33	61.23 ± 9.95	21.73 ± 2.91

Statistical analysis

The obtained data are presented in tables as mean and standard deviation. Using GraphPad Prism 9.3.0 (GraphPad Software Inc.), the results were calculated. Prior to the descriptive statistical processing, the extreme values (outliers) were searched for, subsequently applying the ROUT method (Q=1). By using the Pearson r coefficient, the links between the results of the analyzed variables were expressed, their strength being given by the value in the mode (insignificant - < 0.29; moderate - 0.30-0.49; strong - 0.50-0.69; very strong - 0.70-0.89; almost perfect - > 0.90. The threshold for determining statistical significance was 0.05.

3. Results

The collected data were used to establish the differences between the vertical jump performance measured with the JustJump system and that evaluated with the Desmotec platform, performing the 3 protocols (SJ, CMJ, CMJ-AS). Values are presented as mean and standard deviation for all 3 types of jumps performed on both systems (Table 2).

Gender-related, there are differences between the detent of girls and boys, with the latter performing better. Also, the values rendered by Desmotec are higher than those recorded by the JustJump system for all protocols.

Descriptive statistics of variables by gender Table 2

	Girls (N=27) Mean ± SD *(CV%)*	Boys (N=18) Mean ± SD *(CV%)*	t test (girls - boys)	Overall (N=45) Mean ± SD *(CV%)*
SJ – JJ (cm)	11.52 ± 1.9 *(16.22%)*	17.6 ± 2.7 *(15.22%)*	t=9.020, df=43, p<0.0001	13.96 ± 3.74 *(26.80%)*
CMJ – JJ (cm)	12.01 ± 1.98 *(16.44%)*	18.51 ± 2.35 *(12.67%)*	t=10.02, df=43, p<0.0001	14.61 ± 3.84 *(26.31%)*
CMJ-AS – JJ (cm)	13.4 ± 2.04 *(15.23%)*	20.76 ± 2.73 *(13.15%)*	t=10.35, df=43, p<0.0001	16.34 ± 4.32 *(26.42%)*
SJ – Desmotec (cm)	15.9 ± 3.77 *(23.73%)*	26.78 ± 5.33 *(19.92%)*	t=8.022, df=43, p<0.0001	20.26 ± 6.96 *(34.37%)*
CMJ – Desmotec (cm)	16.77 ± 4.3 *(25.65%)*	28.32 ± 5.27 *(18.61%)*	t=8.067, df=43, p<0.0001	21.39 ± 7.38 *(34.49%)*
CMJ-AS – Desmotec (cm)	18.9 ± 4.97 *(26.27%)*	31.80 ± 6.1 *(19.18%)*	t=7.775, df=43, p<0.0001	24.07 ± 8.35 *(34.68%)*

CV – coefficient of variation; JJ – JustJump; SJ – squat jump; CMJ – countermovement jump; CMJ-AS – countermovement jump with arm swing.

Comparison of girls, boys and sample results for each sample Table 3

	F	p
SJ (cm)	F (5, 174) = 31.59	<0.0001
CMJ (cm)	F (5, 174) = 32.90	<0.0001
CMJ-AS (cm)	F (5, 174) = 32.68	<0.0001

SJ – squat jump; CMJ – countermovement jump; CMJ-AS – countermovement jump with arm swing

Given the results of the three gender-related protocols, there are differences in performance between the group of girls and boys in SJ (F (5, 174) = 31.59, p < 0.0001), CMJ (F (5, 174) = 32.90, p < 0.0001) and CMJ-AS (F (5, 174) = 32.68, p < 0.0001) (Table 3).

The statistical analysis supports a number of significant differences between the results obtained by boys and girls at SJ evaluated with the JustJump system (9.1 cm vs. 4.3 cm). Also, the same situation is observed between JustJump and Desmotec, the values recorded by them having a significant value of 0.0093 in the case of girls, less than 0.0001 in the boys, and on the sample the p value is lower than 0,0001 (Figure 1).

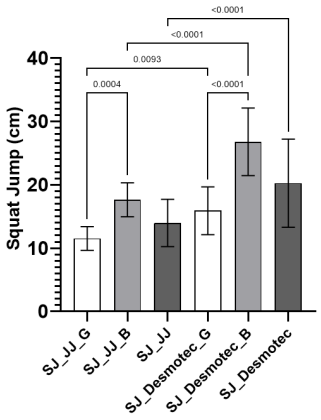

Fig. 1. *Squat Jump height by gender and testing equipment (SJ_JJ_G, SJ_JJ_B, SJ_JJ – Girls/boys/overall SJ on Just Jump; SJ_Desmotec_G, SJ_Desmotec_B, SJ_Desmotec – Girls/boys/overall SJ on Desmotec)*

The same situation is observed in the case of the CMJ protocol, the differences between the results of girls and boys at the device level are relevant (JustJump: p =0.0003; Desmotec: p<0.0001). Comparing data on devices (JustJump vs. Desmotec), the p value is significant for the girls' group (p=0.0063), boys (p<0.0001) and the sample (p<0.0001) (Figure 2).

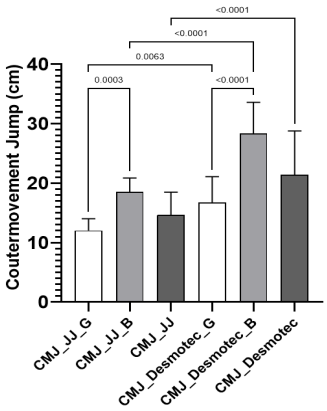

Fig. 2. *Countermovement Jump height by gender and testing equipment (CMJ_JJ_G, CMJ_JJ_B, CMJ_JJ – Girls/boys/overall CMJ on Just Jump; CMJ_Desmotec_G, CMJ_Desmotec_B, CMJ_Desmotec – Girls/boys/overall CMJ on Desmotec)*

The situation of the statistical analysis is similar in the case of CMJ-AS (Figure 3). The differences between genders in the values recorded by JustJump and between devices in the case of boys are significantly higher than in the case of the other protocols. At sample level, the performance rendered by JustJump is statistically very different from that recorded by Desmotec ($p < 0.0001$). The same value of the significance of the differences is also between the boys' activities at the device level ($p < 0.0001$), for girls it is $p = 0.0047$. Relative to the gender of the subject, the values rendered by Desmotec are significantly different from those obtained by JustJump (girls: $p = 0.0047$; boys: $p < 0.0001$).

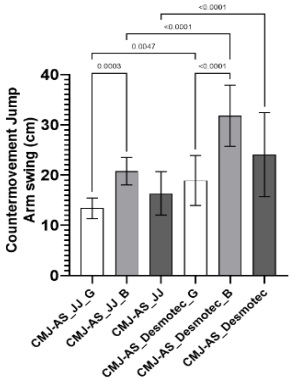

Fig. 3. *Countermovement Jump with Arm swing height by gender and testing equipment (CMJ-AS_JJ_G, CMJ-AS_JJ_B, CMJ-AS_JJ – Girls/boys/overall CMJ-AS on Just Jump; CMJ-AS_Desmotec_G, CMJ-AS_Desmotec_B, CMJ-AS_Desmotec – Girls/boys/overall CMJ-AS on Desmotec)*

4. Discussion

The most frequently used methods of assessing the height of the vertical jump in the literature are those with reaching the highest point during the jump and with the contact mat system.

The correlations between the JustJump system and the Vertec device were studied in a 2018 study involving 76 students and professors from a Florida university aged 18 to 66. The correlation between the two devices was significant for each variable ($p < 0.01$) [25].

Regarding Vertec (Vertec, Sports Imports, Hilliard, OH) and JustJump (Probotics, Huntsville, AL), the latter was found to be a valid measure. These were compared with a benchmark, the 3-camera motion analysis system. Leard et al. (2007) noted any differences between the standard method

and JustJump (44.17±10.29 cm, p=0.972), the recorded values were close [18].

Burr et al. [3] found differences between the JustJump system and the Vertec equipment. The results recorded from 95 rugby players were 5213 ± 485 watts (JustJump) and 5631 ± 527 Watts (Vertec) at CMJ, and 5149 ± 485 watts at SJ, respectively. The higher results were recorded by Vertec, the argument being that it offers extrinsic motivation, more precisely reaching the highest palettes.

Isaacs [14] analyzed CMJ in 480 children 7-11 years old (248 boys and 232 girls) with two methods. Following his analysis, the Just Jump system represents a viable, convenient and effective alternative for assessing the height of a vertical jump by young children.

The JJ system was used, along with Vertec and Myotest, to determine the reliability of vertical jump height measurement methods in a group of 40 boys and 39 girls. For girls, JustJump was much more reliable than Vertec [22].

JustJump was used in a study to measure the explosive force of 24 rugby players aged 18.70 ± 0.90 years. The athletes performed 3 repetitions of the CMJ protocol, and the best result was noted. Values were recorded on playing positions forwards (50.58 ± 7.06 cm) and backs 50.6 ± 5.02 cm) [16].

In another study, the JustJump system was used to evaluate the vertical jump in order to establish links between it and the sprint performance and strength of 34 players (17.2 ± 0.6 years) [7].

Contact mat JJ was used on a sample of 35 girls (21 ± 2.06 years) and 34 boys (21.5 ± 2.3 years) to determine its reliability. Having performed 4 test sessions, the girls had the same values in the 1, 2 and 4 sessions (32 ± 6 cm), and in the 3rd they had a lower score (31 ± 5 cm). In boys, regarding the average of the 3 values in each session, it was noted that in the 2nd test session they had significantly lower result than in the first week of evaluation (47 ± 8 cm vs. 48 ± 7 cm). It is recommended that the value of the highest be taken into account when the height of the vertical jump is measured with mat contact [21].

Several researchers wanted to validate vertical jump assessment methods, comparing them with a validated and standardized system, including Heredia-Jimenez and Orantes-Gonzalez [13] who wanted to validate OptoJump and Myotest to allow sports professionals to have instructions in the practical use of these methods.

García-L et al. [11] sought to create a new vertical jump assessment system, using the SportJumpv-1.0 software, to which they adapted a contact mat. SportJumpv-1.0 was correlated with High-Speed Camera, Led and Dinascan 600 M force plate, with its value r being between 0.982-0.994, and p being less than 0.001.

Based on the designed system, the authors traced the differences between the photocell system SportJump System Pro and the contact mat SportsJump-v1.0. A small difference was demonstrated between the platform and SportJump System Pro (1.3 ± 0.2 cm), thus rendering a significant correlation ($p < 0.001$). SportJump System Pro is a valid and reliable device [12].

Between two mat contact systems, Chronojump and Globus, a high reliability was found, providing precise measurements of the height of vertical jumps among athletes [23].

Heredia-Jimenez and Orantes-Gonzalez [13] analyzed the differences between the Kistler force platform, the SportJump

System Pro photocell system and a wearable 3D inertial measurement unit (IMU). Measuring the flight time, the jump heights were 37±5 cm (Kistler and 3D IMU) and 0.35 ± 0.05 m (SportJump System Pro).

The My Jump 2, HomeCourt and Takei Vertical Jump Meter (TVJM) devices were compared. The results showing significant differences between the three systems ($p < 0.01$), but the test-retest reliability was significant (ICC3,1 = 0.80–0.96) [6].

Compared to the Bertec 4060-10 force platform, My Jump 2 and SIMI Motion 7.5 were analyzed to determine their validity. Of the two, My Jump 2 stands out as an effective alternative for assessing the height of vertical jumps instead of standard methods. My Jump 2 can be recommended as a practical and valid method, both in the lab and in the field of sports specialists, for measuring CMJ [17].

4. Conclusions

Vertical jump performance, regardless of the method used and the jump protocol performed, was higher among boys. Aspect also supported by existing literature.

Compared to the JustJump system, Desmotec produced higher vertical jump height values for all three protocols (SJ, CMJ, and CMJ-AS) and for both genders, with significant differences between the two devices. The hypothesis launched is not supported by the obtained results, so it is not recommended to interchange the two methods of measuring SJ, CMJ and CMJ-AS height.

We suggest studying the reliability and validity of the two on a larger sample as well as comparing the relatively new Desmotec platform with a standardized device.

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