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LETTER

Validity and Reliability of My Jump 2 App for Jump Performance in Judo Players

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Abstract:

Background:

The height of the jump is an essential factor in judo because through this parameter, coaches can assess the power of the lower limbs, which is essential in the performance of judo techniques. The My Jump 2 (MJ2) application is a validated application to calculate the jump height, however, to the best of our knowledge, no study has tested this smartphone application in judokas.

Objective:

The objective of this study is to analyse the validity and reliability of the app MJ2 for measuring jump height in judokas.

Methods:

Twenty-one judokas were recruited, who performed 2 countermovement jumps on the Chronojump platform (42 jumps). Simultaneously, the videos of the jumps were captured using recommendations in the app and were later processed and analyzed independently by two evaluators.

Results:

The data revealed a good correlation for the calculated jump height with both tools used. In the Bland-Altman analysis, it was observed that the differences between instruments and the inter-evaluator differences were quite low. According to the Pearson correlation (MJ2 *vs* CJ), the value was r=0.97. As for the height of the jump measured using the MJ2 app, an average of 26.38 ± 8.89 cm and 26.25 ± 8.14 was obtained for each evaluator, while the average for the Chronojump platform was 26.69 ± 8.14.

Conclusion:

The concordant data and correlation found indicate that MJ2 application can be used as a method to estimate jump height in judokas.

Keywords: Judo, Countermovement jump, Athletes, Training, Chronojump platform, Jumps.

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1. INTRODUCTION

Vertical jumping (VJ) is a multi-joint movement that requires complex motor coordination, and it has been identified as one of the fundamental movement skills [1]. The maximum height achieved by an athlete in this activity is a functional evaluation parameter frequently used by professionals [2] due to the simplicity and richness of outcome information [3]. Specifically, athletic trainers use the maximum jump height as an indirect parameter for assessing the strength and muscle power of the lower limbs [4]. The significant effect of lower limb exercises in the form of jump squats on the development of explosive strength has also been validated [5].

Judo is a sport characterized by large intensity intervals alternated with periods of low intensity [6]. For judokas, strength in the lower leg, particularly the knee and thigh is of great importance for staying in balance and performing specific techniques in a correct manner [7 - 9]. In competitive judo, the use of techniques that require balance and explosion

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movements to throw your opponent are common practice [10]. In this technique, lower-body muscle groups are essential to success [11], thus suggesting that lower-body muscle strength is paramount to success. Vertical jump tests have been used as assessment tests of lower body strength in judokas, often using force platforms for such evaluation [12 - 14], since a relationship appears to exist between strength-velocity curve and jump tests [11]. Therefore, jump height estimation appears to be important in this sport. Additionally, jump height allows the estimation of lower limb power, which could be essential in the performance of projection techniques (eg.Nage-waza), where the athlete produces a lot of strength during the execution of the technique (this technique can take a while given time to be achieved) [15]. Due to its importance, the analysis of the jump height in judo athletes has been performed previously as part of a physical fitness performance assessment [16].

The Countermovement Jump (CMJ), or vertical jump with countermovement, is one of the jumps mostly used to assess the manifestation of explosive reactive force (power) in the lower limbs [17] and as been used previously for testing judokas [12 - 14]. CMJ consists of a jump based on the stretching-shortening cycle (a mechanism where the function is to provide greater mechanical efficiency of movements that use eccentric muscle actions followed immediately by explosive concentric actions) [18]. The CMJ is an easy-to-apply test, requiring only the jump platform or a mobile application to measure the jump height. Usually, for assessing the jump, contact platforms are used and considered the gold standard [19]. These contact platforms have vertical and pressor sensors to determine when athletes lose contact with the ground and help determine the flight time and the height of the jump. Despite the reliability of the mentioned equipment, they are expensive and often not portable, resulting in difficulties in assessing the athletes in the training field.

In the search for less expensive and more portable solutions, mobile / tablet applications (app) [20 - 22] have been developed to measure vertical jump height. The My Jump 2 (MJ2) application is an app already used to measure the height of the jump, and is an updated version of My Jump application [20]. This application allows the calculation of the jump height, flight time, initial velocity, force and power of vertical jumps. Additionally, provides contact time, vertical stiffness, and reactive force index of the drop jumps and gives Force-Speed profile. The app My jump has already been demonstrated as valid by other authors, such as Gallardo-Fuentes *et al.* [23], in which the recruited sample was 21 athletics athletes (men and women) and Yingling *et al.* [24] whose sample was 21 active sports science students. Additionally, Sharp *et al.* [25] carried out a brief review of studies on the validity and reliability of the My Jump application. Despite stating that the MJ2 appears to have strong evidence supporting its use, it also stated that further studies are needed, particularly with athletic populations [20, 21]. Besides that, none of the previous studies assessed Judo players or athletes in the training field.

Given the importance of determining the height of the jump in Judo athletes, it has an established relationship with lower limb strength, it is also essential to check the validity of the use of an inexpensive and fast application system, that can be used in the training for improving the performance of athletes. Considering that, this study aimed to analyse the validity and reliability of MJ2 for measuring jump height in an athletic population, particularly judo players.

2. MATERIALS AND METHODS

The sample composed of 21 judo players, where six were female and 15 were male (age = 27.41 ± 7.52 years, height = 153.20 ± 21.35 cm, and body mass = 66.13 ± 6.34 kg) recruited for this study. The result of the sample size estimation when setting power at 80%, alpha at 0.05, expected reliability at 0.9 and a drop-out rate of 10% was 20 participants.

Data collection and testing procedures were explained to the athletes and an informed consent was filled for all athletes. All judo players had more than 2 years of practice of the sport. Data collection was carried out adhering the ethical standards for human subjects research and it was approved by the Instituto Piaget Ethics Committee with the number 3/2020.

2.1. Instruments

To measure the athletes' body mass, a SECA 761 professional mechanical scale was used (Bacelar & Irmão Lda, Portugal) and then the standing height was measured with a mobile stadiometer SECA 213 (Bacelar & Irmão Lda, Portugal). To measure jump height, two instruments were used. The first was a contact platform (ChronoJump Boscosys-tem, Spain) associated with the specific software, whose validity has been demonstrated previously [26]. Data from this contact platform was considered the "gold standard" for comparison with MJ2. The second instrument used was an Apple iPad model air A2152 (Apple Distribution International Ltd., Ireland), with the application My Jump 2 installed.

2.2. Protocol

Data collection was carried out at the club before athletes' training. Before data collection, measurements of the basic anthropometric profiles were taken (age, body mass, height, and leg length). Athletes were asked to place both feet on the platform and they were provided information about the test proceedings (Fig. **1**). Athletes were asked to bend knees until 90° with hands on the hips and jump as high as possible without pausing to perform a Counter Movement Jump (CMJ). Additionally, they were instructed to not bend the knees while in the air. Each athlete performed two familiarization trials and two valid trials with 30 seconds of rest between them, totalizing 42 trials for analysis. Simultaneously with the gathering of data on the platform, a video was recorded according to the application's specifications (in slow motion mode, recording in the frontal plane at 120 Hz). The iPad was positioned on a tripod, at 1.5m from the contact platform [20]. Data from the MJ2 app was analysed posteriorly and independently by two evaluators for jump height measurement. Both evaluators (evaluators 1 and 2) proceeded the calculation of the jump through the app using the same video database and in the same iPad, at different times, and in random order of jumps and athletes. Each evaluator recorded the calculated CMJ height and the values were subsequently entered into a file for statistical analysis. For estimation CMJ flight time, both evaluators considered take off as the first frame displaying both feet off the ground and landing the first frame were at least one foot is touching the ground [27]. The difference in these instants is flight time, which can be computed following the equation of Bosco et al, [28] $h = t^2g/8$, where *h* is jump height (m), *t* is flight time (s) and *g* is the gravity acceleration (9.81 m/s^2). MJ2 natively uses this equation to display jump height [29].

2.3. Data Analisys

To analyse the validity of the app MJ2 for measuring the height of the CMJ in comparison with data from the Chronojump, the intraclass correlation coefficient (ICC) was used, and Bland-Altman [30] plots were constructed, as they represent a better agreement between the two instruments [30]. ICC and Bland-Altman plots and complimentary analysis for the mean differences were calculated for each evaluator. To analyse the strength of the correlation between the gold standard and the app, the Pearson correlation test (r) was intended for the Chronojump measurements *vs.* combined evaluators. A linear regression analysis was conducted to determine the relationship between the variables. All calculations and analyses were performed using the SPSS Statistics version 27.0 program (IBM Corporation, New York, USA). The accepted level of significance was $p<0.05$.

3. RESULTS

Regarding the CMJ performance of the subjects, a mean of 26.69 ± 8.14 cm was recorded (Table **1**). When comparing evaluators' measurements to the reference standard no statistical differences were obtained in the measurements (Average comparison $p>0.05$). When using ICC (Intraclass Correlation Index) and the CI (Confidence Interval), we attained an ICC of 0.94 and the 95% CI was 0.88-0.97 ($p<0.001$) for evaluator 1. For evaluator 2, the ICC=0.97 and its 95% CI was 0.94-0.98 ($p<0.001$). Regarding the measurements of the two evaluators (mean of the heights of jumps between 1 and 2), the ICC and the IC were 0.95 and 0.90-0.97 ($p<0.001$), respectively.

Fig. (**2**) shows the level of agreement using the Bland-Altman analysis for both evaluators. For evaluator 1, the dark gray line shows the mean of the differences (1.94 cm) and the light gray lines represent the 95% limits of agreement (9.48 to -5.60 cm). Regarding evaluator 2, the dark gray line shows the mean of the differences (2.19 cm) and the light gray lines represent the 95% limits of agreement (7.38 to -3.00 cm).

Table **2** presents the complimentary analysis for the results obtained in the Balnd Altmann analysis. The results of the t test against the null value (meaning zero as difference) showed that the mean difference between the Standard measures and the Evaulators analysis are not significantly different. The regression analysis between the average and the difference presented values of $R^2=0.12$ and $R^2=0.08$ for each evaluator, respectively, showing that the error is not proportional.

Fig. (**3**) shows the linear regression plot through Pearson's correlation between the height of the jump obtained with the Chronojump and the measurements of both evaluators with the My Jump 2 app, where r=0.97 and $r^2=0.85$ ($p<0.05$).

Fig. (1). CMJ execution (images obtained during data collection).

Table 1. Average comparison, Intraclass correlation and Confidence Interval.

-	Jump Height (cm) (mean ± SD)	Average Comparison (p value)	ICC	CI	% of Agreement
Chronojump	26.69 ± 8.14	-	-	-	-
Evaluator 1	26.38 ± 8.89	-	-	-	-
Evaluator 2	26.25 ± 8.14	-	-	-	-
Evaluator 1 *vs* Chronojump	-	0.26	0.94	(0.88-0.97)*	-
Evaluator 2 *vs* Chronojump	-	0.27	0.97	(0.94-0.98)*	-
Inter-evaluators		0.27	0.95	(0.90-0.97)*	96%

Note:[1] ICC: intraclass correlation; CI: Confidence interval. * $p<0.001$

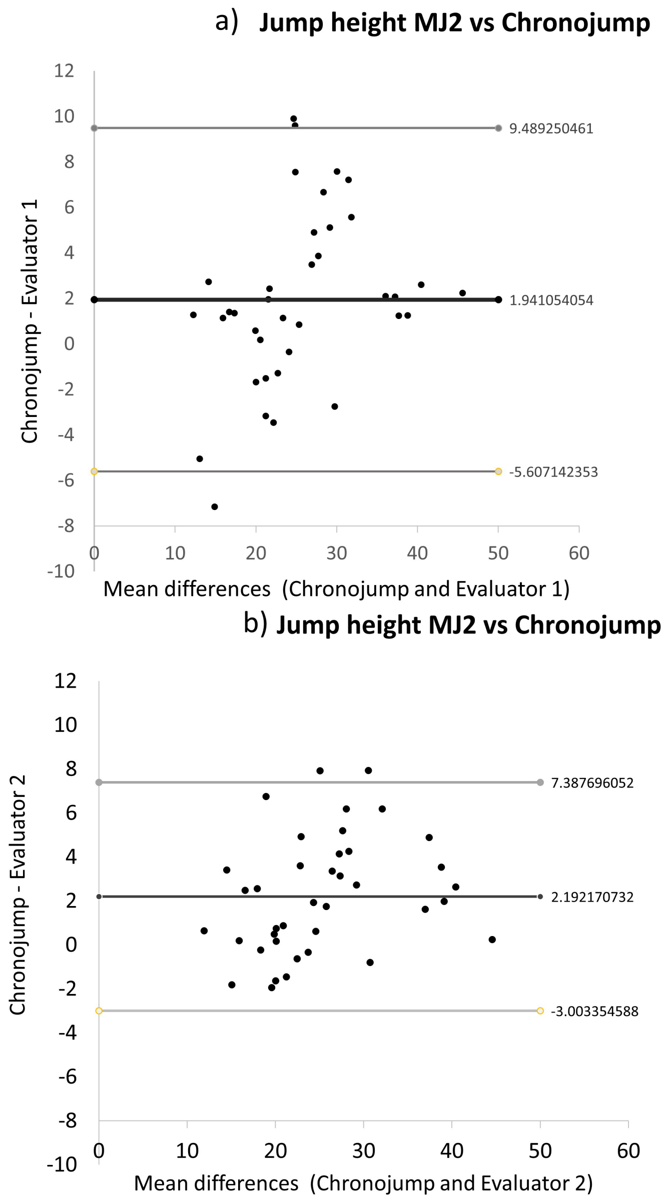

Fig. (2). Level of agreement (Bland-Altman) with 95% limits of agreement (light gray lines) and the mean difference (dark gray line) between MyJump2 and the force platform for CMJ for both evaluators.

Table 2. Bland altmann complimentary analysis. (p<0.05)

-	Evaluator 1	Evaluator 2
Diference mean (evaluator -cronojump)	1.24	1.08
t value calculated	0.85	0.74
Std error	1.46	1.13
Degrees of freedom (dof)	41	41
t value for 41 dof	2.02	2.02
Regression analysis (average *vs* difference)	R^2=0.12	R^2=0.08

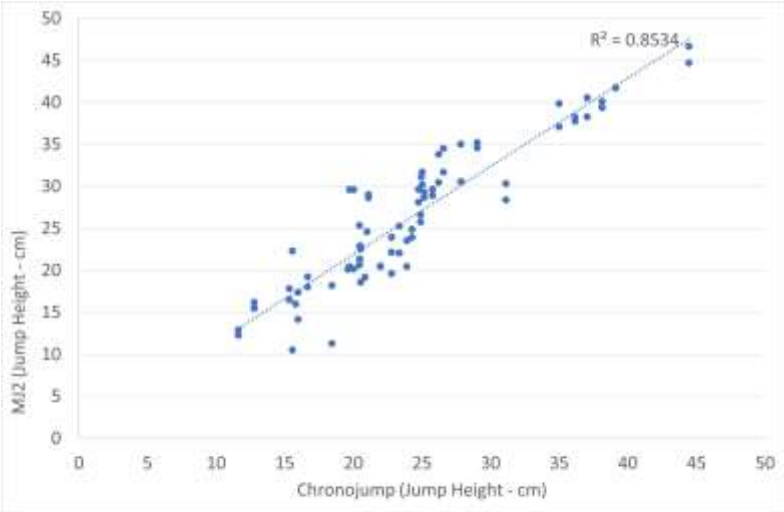

Fig. (3). Linear Regression of the jump height for Chronojump and App MyJump2 with combined evaluators. $p<0.05$.

4. DISCUSSION

The aim of this study was to validate the My Jump 2 application in judo athletes. To this end, the Intraclass Correlation Coefficient (ICC) was calculated between each evaluator and a contact platform that can be considered "the gold standard". According to the literature, if the ICC values are greater than 0.8, they are considered to have a high level of reliability [31, 32]. The values found in this study are 0.94 and 0.97, respectively, demonstrating a high correlation between the values calculated by the app MJ2 and the gold standard for measuring CMJ height. These ICC values are very similar to those obtained by Balsalobre-Férnandez *et al.* [27] (ICC = 0.997, 95% CI: 0.996–0.998, P < 0.001 for both observers) and Carlos-Vivas *et al.* [33] obtained an almost perfect ICC between the MJ app and the force platform (ICC=0.996, 95% CI: 0.998-0.993, p<0.001).

According to the results of the Bland-Altman method (Figs. **2** - **4**), the measurement differences between the instruments were (2.06 ±0.85 cm) and the inter-evaluator differences were (- 0.15 ± 3.77 cm), which suggests that the app MJ2 has acceptable error values in its use. The findings in the study are in agreement with other authors who have found that both MJ2 [34 - 36] and the first version Myjump [21, 37] are valid, reliable tools, despite not assessing judo athletes.

The results of the present investigation are less significant than those reported by Monteiro *et al.* when comparing jump height results with their normative value [38]. There are some reasons for the discrepancy in mean values, such as sample size, different training experiences by athletes, and above all, different procedures, since Monteiro, in his study, used a barbell attached to a linear transducer [38]. Similar differences in jump height can be recounted when comparing the present study with the studies of Detanico *et al.* [39] and Kons *et al.* [40], which can also be explained by the difference in training experience.

This study is not without some limitations., It was possible to demonstrate that the values obtained with the app My Jump 2 are quite reliable, but a larger sample of athletes could be used in future studies, to confirm the results of this study. Besides that, each athlete performed two jumps, which allowed an analysis of 42 jumps. Additional studies should endeavour to use a greater number of jumps per athlete. Another limitation is the level of the athletes, where some were in high competition at the national level, and others were only two years practitioners. Since the purpose of the study is to evaluate the reliability of the app and not the performance of the judokas, the maximum height achieved would not compromise the results obtained.

CONCLUSION

This study adds to the existing literature regarding the validity of a smartphone app to measure jump height, specifically validating the use of this app to measure leg strength in judo athletes. The app MJ2 seems to be an easy and practical tool to use in the context of sports training, and it can be an asset for clubs that do not have the conditions to acquire top-of-the-range equipment to assess their athletes. With this app, the trainer could not only measure the height of the jump but also use other aspects such as asymmetry tests, horizontal jump tests, and even strength speed tests. That said, it is recommended that coaches include the app My Jump 2 in their assessment materials so that athletes achieve better results both in the context of training and competition.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The ethical standards for human subjects research and it was approved by the Instituto Piaget Ethics Committee with the number 3/2020.

HUMAN AND ANIMAL RIGHTS

No animals were used in this research. All procedures performed in studies involving human participants were in accordance with the ethical standards of institutional and/or research committee and with the 1975 Declaration of Helsinki, as revised in 2013.

CONSENT FOR PUBLICATION

Informed consent was filled out for all athletes.

AVAILABILITY OF DATA AND MATERIALS

The data supporting the findings of the article is available in the ZENODO repository at https://zenodo.org/record/8068173, reference number [8068173].

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None.

CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

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