

Article

Reliability and Validity of the Portable KForce Plates for Measuring Countermovement Jump (CMJ)

George Plakoutsis ^{*}, Dimitrios Zapantis, Eirini-Maria Panagiotopoulou, Eleftherios Paraskevopoulos , Maria Moutzouri , George A. Koumantakis  and Maria Papandreou

Department of Physiotherapy, University of West Attica, 12243 Athens, Greece

* Correspondence: gplakoutsis@uniwa.gr

Abstract: Physical fitness is of great significance to athletes in both single-player and team sports. The countermovement jump (CMJ) is one of the most commonly applied jump tests for assessing the mechanical capacities of the lower extremities. The KForce Plates system is a portable force platform that sends action-time audio and visual biofeedback to a smartphone or tablet through the KForce application, making it a suitable instrument for assessing the CMJ. The aim of the present study was to evaluate the test–retest reliability and validity of the portable force platform (KForce Plates) in the evaluation of the CMJ in collegiate athletes compared to a validated application, My Jump 2. Thirty-four collegiate professional athletes, deriving from various sports backgrounds, participated in the present study. The CMJs were reported with the portable KForce Plates and the simultaneous use of the ‘My Jump 2’ application using an iPhone 13 between days 1 and 7. Our findings revealed high test–retest reliability (ICC = 1.00 and ICC = 0.99) in-between measurements. High correlations were monitored amongst the portable KForce plates and the My Jump 2 application for measuring the CMJ ($r = 0.999$, $p = 0.001$). The Bland–Altman plot exhibits the limits of agreement amongst the portable KForce plates and the My Jump 2 application, where the bulk of the data are within the 95% CIs with an agreement of ≈ 1 cm. Our findings suggest that the portable KForce Plates system is a reliable and valid instrument and, therefore, can be used by experts in the sports field.

Keywords: reliability; validity; KForce plates; My Jump 2; countermovement jump



Citation: Plakoutsis, G.; Zapantis, D.; Panagiotopoulou, E.-M.; Paraskevopoulos, E.; Moutzouri, M.; Koumantakis, G.A.; Papandreou, M. Reliability and Validity of the Portable KForce Plates for Measuring Countermovement Jump (CMJ). *Appl. Sci.* **2023**, *13*, 11200. <https://doi.org/10.3390/app132011200>

Academic Editor: Alessandro Ruggiero

Received: 5 September 2023

Revised: 7 October 2023

Accepted: 10 October 2023

Published: 12 October 2023



Copyright: © 2023 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

1. Introduction

Health-related attributes, including flexibility, muscle strength and power, cardiorespiratory endurance, and body composition, are strongly associated with physical fitness [1]. Physical fitness is of great significance to athletes both in single-player and team sports [2,3]. Numerous training techniques (e.g., plyometric jump training) are commonly used by athletes in order to promote physical fitness parameters [3,4].

Jump tasks such as vertical jump tests (VJ) are widely used to examine the complexity of motor coordination, including aspects of sprinting (acceleration–deceleration), throwing, and changes of direction [1,5–7]. Moreover, the evaluation of lower limb muscular strength and the plethora of outcome information regarding physical fitness parameters led health care professionals, coaches, and conditional professionals to the wide use of VJ tests as a performance predictor [1]. The countermovement jump (CMJ) and the squat jump (SJ) are two sub-variants of VJ, and they both derive from the Sargent jump [1,8,9].

The CMJ is one of the most commonly applied methodological procedures for assessing the mechanical capacities of the lower extremities [10]. It has been mainly implemented for investigating sports performance [11,12], neuromuscular fatigue [12], limb asymmetries [13], and the efficacy of various training protocols [10,14]. The CMJ is described as an initial countermovement (CM) before the toe-off phase and also provides information regarding the reactive strength of the lower limbs [1]. CMJ performance components include the monitoring of various kinematic and kinetic parameters (e.g., jump height, flight

time, mean power, peak power, etc.) [10,12]. Jump height is the mainstay of performance factors, as it has a direct association with performance in sports-specific tasks and athletes' mobility [10,13,15].

Several different methods exist for measuring jump height due to the simplicity of the testing procedure and the eco-friendly nature of the impact in comparison to other conventional methods (e.g., isokinetic tests) [10]. However, despite the technological advancements for measuring biomechanics and sports performance, force platforms are still deemed the gold standard for measuring CMJ performance [10,11,13,15,16]. They provide sports practitioners with highly reliable equipment, helping them to assess a profound number of variables. Force platforms are typically stabilized on the ground, thus preventing any unrelated vibrations from raw force assessments [17]. One obvious limitation of the in-ground force platforms is that they are not portable, and therefore, measurements can only take place in a laboratory environment. However, several instruments provide a valid and reliable jump height evaluation, such as camera-based methods [15], accelerometers [18], and infrared platforms [19].

Nowadays, a number of portable force platforms (e.g., Kinvent, Kistler, and Biodex) are on the market, giving clinicians new opportunities to explore aspects and variables of the applications of CMJ. The KForce Plates system (by Kinvent) is a portable force platform that is composed of a unidirectional strain gauge (vertical axis) and an electronic pressure transducer that connects through Bluetooth to a smartphone or tablet application (KForce, Kinvent, Montpellier, France) and, therefore, is an interesting substitute for the in-ground force platforms [20]. Validation of portable devices such as KForce plates is limited. Serrano, Mottet, and Caillaud [20] found in their study that plates were valid and reliable for assessing unipodal static and dynamic balance in the laboratory or in the sports field, suggesting that CMJ measurements and their factors (e.g., jump height and flight time) will also prove the KForce plates' reliability and validity. Nevertheless, due to their high cost and the need for specialized software programs to analyze the data, Apple Inc. (Cupertino, CA, USA) recently launched the My Jump 2 application, which was developed by Carlos Balsalobre [15]. It calculates jump height by recording a high-speed video using smartphones' and tablets' ability to record a high image resolution, and therefore, the flight time of a jump exercise could be manually evaluated via the video frames of take-off and landing positions [16,21]. The app has been proven valid for different sports populations, such as sports science students and young recreational athletes [22,23], the elderly [24], and trained athletes [25].

The aim of the present study was to test the reliability and validity of a portable force platform (the KForce Plates system by Kinvent) for the evaluation of CMJ in collegiate professional athletes compared to the validated application My Jump 2 [16,21]. The portable Kforce plates have recently been confirmed to be valid and reliable only for assessing single-leg and dynamic balance and not for measuring CMJ. Our thesis was that CMJ assessment in the sports field could be the best option to observe sports performance, limp asymmetries, neuromuscular fatigue, and the efficacy of training protocols. We hypothesized that the CMJ measurements (jump height and flight time) via the portable lightweight Kforce plates would be reliable and valid in the laboratory environment and also in the sports field. A group of collegiate professional athletes performed a CMJ on the Kforce plates and the My Jump 2 application concurrently between days 1 and 7.

2. Materials and Methods

2.1. Participants

A total of thirty-four collegiate athletes aged 18 to 27 (mean age = 21.6 ± 5.7) volunteered to participate to test the reliability and validity of the study. Twenty-two were males (64.7%) and twelve were females (35.3%). The anthropometric characteristics of the athletes were as follows: mean height was (171.0 ± 9.8), mean weight was (69.6 ± 13.1), mean leg length was (99.8 ± 6.4), height at 90° was (60.5 ± 8.9), and mean BMI was (23.7 ± 2.9). All athletes were volunteers from several sports, such as football, basketball, volleyball,

running, swimming, tennis, martial arts, dance, and gymnastics. Participants were recruited from the Physiotherapy Department of the University of West Attica. All athletes were formally informed that they could withdraw at any time from the study without any consequences. Written informed consent was obtained from all participants. The study was accepted by the Ethics Committee of the University of West Attica (No. 18030).

The inclusion criteria of the study were (a) age ≥ 18 years old, (b) active athletic training in various sports activities > 5 years (professional level), (c) > 6 h of training per week, and (d) injury-free during the last 2 years. The exclusion criteria of the study were (a) amateur athletes, (b) recent surgery (last 1 year), and (c) age > 35 years old.

2.2. Procedures

Before testing, all participants were made familiar with the CMJ. An experienced sports physiotherapist briefed them one week in advance with a live presentation and explanation of the optimal technique. Prior to the testing procedure, they performed a standard 10 min warm-up consisting of 8 min of jogging on a treadmill (40–50% of maximal heart rate) and 2 min of VJs with moderate intensity (continuously at their own pace). Their body mass was measured to the nearest 0.1 kg using the electronic scale Mi Body Composition Scale 2 (Xiaomi Inc., Beijing, China), and their height was measured on a portable stadiometer SECA 213 (SECA Instruments Ltd., Hamburg, Germany) to the nearest 1 cm [16]. During each session, participants performed 3 CMJs, and they were instructed to perform the highest possible jump. The highest CMJ was then taken into statistical analysis, and there was a one-minute rest between trials. CMJs were recorded with the validated My Jump 2 application [16,21] through an iPhone 13 (Apple Inc., Cupertino, CA, USA) and also using the KForce Plates system application (Kinvent, Montpellier, France) on a Samsung tablet (Samsung Electronics Co., Ltd., Suwon, Republic of Korea) concurrently. In order to avoid any errors during recordings, the experienced sports physiotherapist used a portable photo stand in order to secure the stability of the iPhone 13, and, simultaneously, he also used the default automated procedure for measuring CMJ with the KForce plates application. To initiate the recording, KForce plates need to detect the CMJ performance of the athlete, whereas in the My Jump 2 app, the recording begins by pressing the recording button. The testing procedure took place on the 1st and 7th days for all participants at the Laboratory of Advanced Physiotherapy of the University of West Attica in order to evaluate the test–retest reliability of the assessments (jump height and flight time). The timeframe was determined based on previous research in order to ensure that neuromuscular fatigue could not alter movement strategies [26].

2.3. Countermovement Jump Performance

All participants were asked to step on the previously calibrated (according to the manufacturer's guidelines) KForce Plates system during both sessions, and they were asked to stay in an upright position with a straight trunk, knees extended, and feet shoulder-width apart. They were instructed to jump as high as possible after the 'go' (online timer) instruction by the sports physiotherapist and land as close to the designated spot on the KForce Plates system as possible. During the testing procedure, participants had to keep their hands on the hips and execute a quick downward movement at an estimated 90° knee flexion and then a quick upward movement in order to perform the highest possible jump [10,21].

2.4. Main Outcome Measures

2.4.1. KForce Plates System

The KForce Plates system (Kinvent) is a portable force platform that includes an electronic pressure transducer. It sends actual-time audio and visual biofeedback to a smartphone or tablet through the KForce application. It weighs 1.6 kg, the dimensions per plate are $30 \times 320 \times 160$ mm, the radio range is up to 20 m, the max weight is 300 kg per plate with an accuracy of 500 gr, the acquisition frequency is up to 75 Hz, and the wireless

transmission frequency is 2.4 GHz band (Figure 1). We used the default settings of the KForce plate for measuring CMJ (jump height and jump time), and we exported raw data for analysis from the KForce application (Figure 2).



Figure 1. The KForce plates from different perspectives.

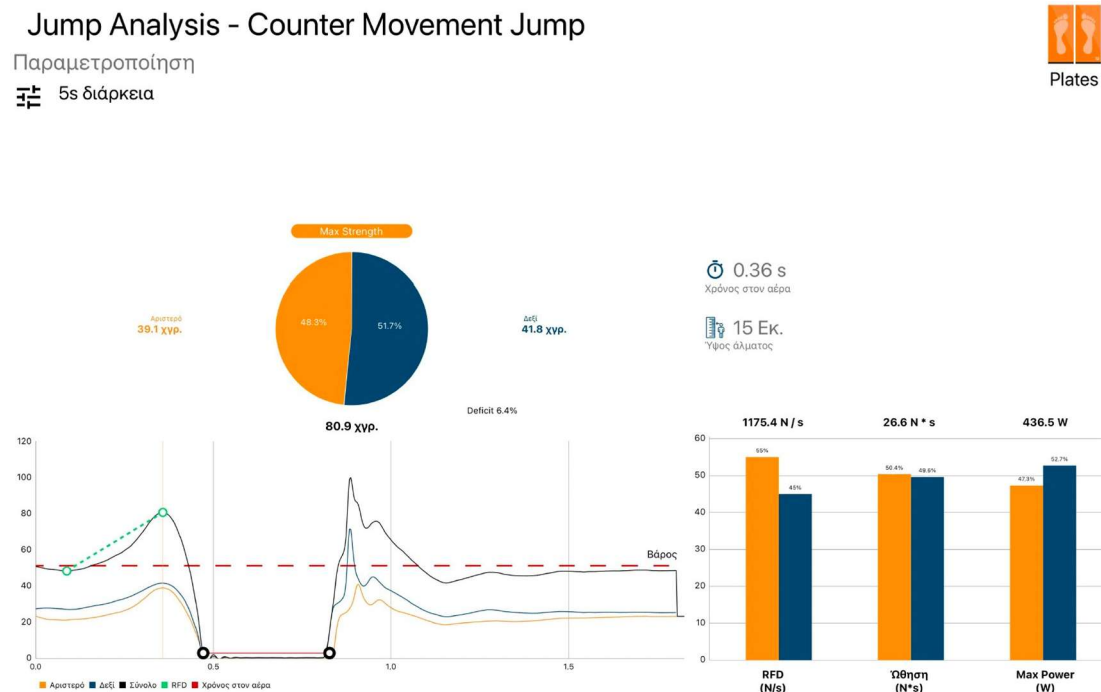


Figure 2. The report analysis from the KForce application for measuring CMJ, (Explanations; Αριστερό: Left, Δεξί: Right, Σύνολο: Total, Χρόνος στον αέρα: Flight time, Ύψος άλματος: Jump Height, Όθηση: Impetus, εκ.: cm., Παραμετροποίηση: Adjustments, Διάρκεια: Duration.

2.4.2. My Jump 2 Application

We used the My Jump 2 application through an iPhone 13 in order to record videos of the procedure and, therefore, to compute the jump height with the manual selection of the take-off video frame and the landing video frame. In their study, Bosco et al. [27] introduced the equation $h = t^2 \times 1.22625$, where h stands for the jump height (in meters) and t for flight time (in seconds). The My Jump 2 app utilizes this equation in order to determine jump height. All evaluations were made by the same researcher with the same iPhone 13, and the recordings were made from the same position at a distance of 1.5 m from the participants, as stated by the manufacturer's instructions [25] (Figure 3a,b).

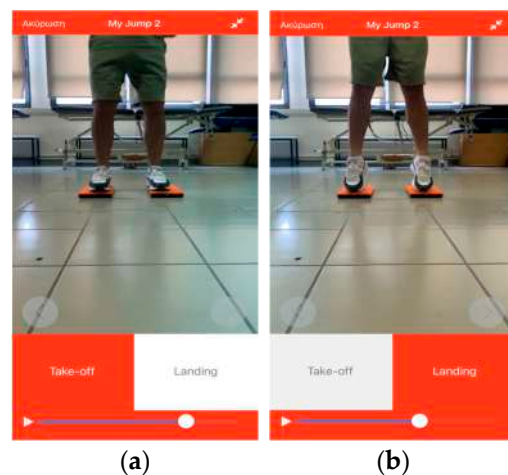


Figure 3. Take-off (a) and landing (b) captures on the portable KForce Plates with the concurrent use of the My Jump 2 app, (Explanations; Ακύρωση: Cancel).

2.5. Statistical Analysis

Descriptive statistics were used, with means and standard deviations. A Kolmogorov-Smirnov test was used in order to check the normality of the data. A paired *t*-test was used for the evaluation of systematic bias between the 2 sessions (1st and 7th days). The intraclass correlation coefficient (ICC) was performed in order to assess the test–retest reliability of the KForce Plates system. ICC values indicate the level of reliability as follows: less than 0.5 = poor, between 0.5 and 0.75 = moderate, between 0.75 and 0.9 = good, and greater than 0.90 = excellent ICC [28]. The ICC between the two methods (the portable KForce Plates and the My Jump 2 applications) for evaluating the CMJ was calculated in both measurements (1st and 7th days) [28]. In addition, the Bland–Altman plot evaluated the limits of agreement for jump height and jump time for the two methods of measurement. Moreover, the lower and upper limits of the 95% confidence interval for the Bland–Altman plot were also computed [29]. To assess the concurrent validity, the Pearson correlation coefficients (*r*) were calculated between the two methods (the portable KForce Plates and the My Jump 2 application) of measurement. Pearson correlation coefficients (*r*) range in magnitude from -1.00 to 1.00 [28]. The statistical significance was set at the $p \leq 0.05$ level. All analysis was performed using the SPSS v. 26 statistical package (Statistical Package for the social sciences, SPSS Inc., Chicago, IL, USA).

3. Results

3.1. Reliability

The results for testing reliability with the ICC between repeated measurements by the same examiner on the 1st and 7th days and between the two instruments for the dependent variables (jump height and flight time) were excellent for both variables (Table 1).

Table 1. ICC on the 1st and 7th days between the 2 instruments, the portable KForce Plates and the My Jump 2 application, for measuring CMJ variables.

CMJ KForce Plates—My Jump 2 App N = 34	1st Day		7th Day	
	ICC	95% CI	ICC	95% CI
Jump height (cm)	1.000	1.000–1.000	1.000	1.000–1.000
Flight time (s)	0.999	0.998–1.000	0.999	0.998–1.000

ICC: intraclass correlation coefficient; CI: confidence interval.

The ICCs and the mean difference for the CMJ variables (jump height and flight time) of the 1st and 7th days between the two instruments (the KForce Plates and the My Jump 2) are presented in Table 2.

Table 2. ICCs of the mean difference for the CMJ measurements for the variables jump height and flight time between the 2 instruments of the KForce Plates and the My Jump 2 app.

CMJ	KForce Plates and My Jump 2 Measurements	
	ICC (95% CI)	MD (95% CI)
N = 34		
Jump height (cm)	0.872 (0.744; 0.936)	−4.06 (−6.20; −1.91)
Flight time (s)	0.877 (0.755; 0.939)	−0.04 (−0.06; −0.02)

ICC: intraclass correlation coefficient; CI: confidence interval.

To compare the limits of agreement of CMJ measurements for the jump height variable between the 1st and 7th days and also between the two instruments (the portable KForce Plates and the My Jump 2 application), we used the Bland–Altman plots (Figure 4). The mean difference (MD = 0.004) was not statistically significant ($t = 0.187$, $p = 0.853$). The lower bound of the 95% confidence interval was −0.265, and the upper bound was 0.274 (± 1.96 standard deviations). There was a strong relationship between the measurements of the two instruments (the portable KForce Plates and the My Jump 2 application) and an agreement of ≈ 1 cm.

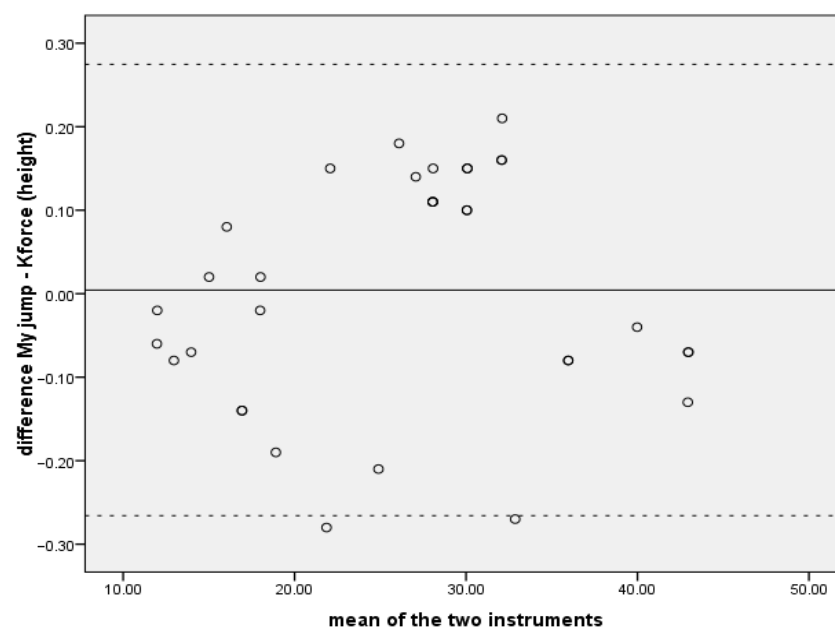


Figure 4. Bland–Altman plots illustrating the limits of agreement of the 2 measurements (the portable KForce Plates and the My Jump 2 application) for jump height between the 1st and 7th days.

Furthermore, in order to compare the limits of agreement of CMJ measurements for the flight time variable between the 1st and 7th days and also between the two instruments (the portable KForce Plates and the My Jump 2 application), we used the Bland–Altman plots (Figure 5). The mean difference (MD = 0.00) was not statistically significant ($t = -1.193$, $p = 0.242$). The lower bound of the 95% confidence interval was −0.007, and the upper bound was 0.006 (± 1.96 standard deviations).

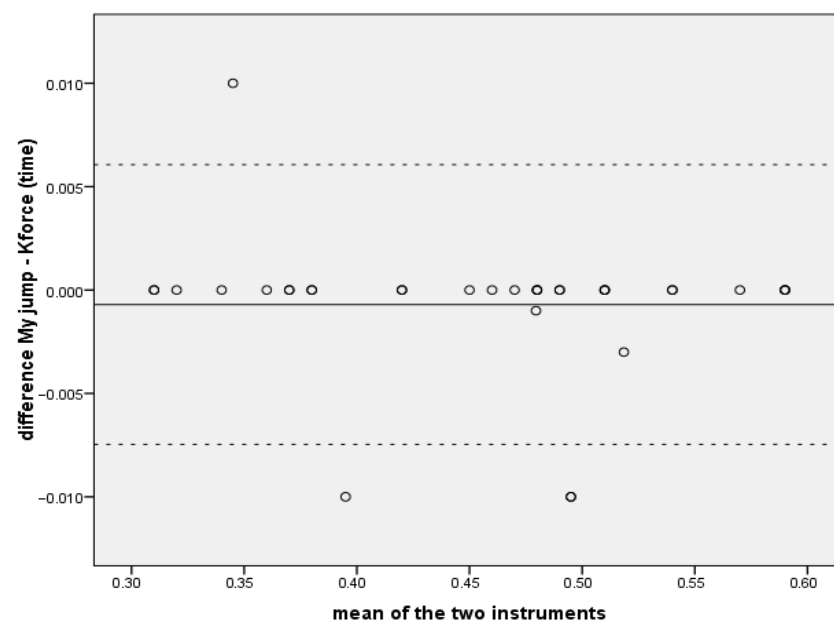


Figure 5. Bland–Altman plots illustrating the limits of agreement of the 2 measurements (the portable KForce Plates and the My Jump 2 application) for flight time between the 1st and 7th days.

3.2. Concurrent Validity

The My Jump 2 application was used as a valid and reliable instrument in order to evaluate the concurrent validity of the portable KForce Plates for measuring CMJ variables (jump height and flight time) between the 1st and 7th days. The Pearson correlation coefficients depicted high reliability between the two instruments on the 1st and 7th days, respectively ($r = 1.000$ jump height, $r = 0.999$ jump time, and $p < 0.001$), as presented in Table 3.

Table 3. Pearson correlation coefficients (PCC) of the 2 measurements (the portable KForce Plates and the My Jump 2 application) for CMJ variables (jump height and flight time) between the 1st and 7th days.

CMJ KForce Plates—My Jump 2 App	1st Day	7th Day
N = 34	PCC	PCC
Jump height (cm)	1.000	1.000
Flight time (s)	0.999	0.999

4. Discussion

The present study evaluated the test–retest reliability and the concurrent validity of the portable KForce Plates compared to the validated My Jump 2 application installed on an iPhone 13 for measuring CMJ in collegiate athletes. The KForce Plates system was found to be highly reliable and valid for measuring jump height and flight time variables in CMJ in comparison to the My Jump 2 application. Furthermore, the data illustrated in the Bland–Altman plots (Figures 3 and 4) demonstrate that most of the values are close to the mean of differences between the two tools, therefore depicting a high level of agreement [29]. The CMJ is a simple method to identify athletes’ strengths and weaknesses and also to monitor training progress [26,30]. There are a variety of methods and devices for evaluating jump height and flight time variables; however, most of them are restricted to a clinical laboratory environment.

In our study, test–retest reliability revealed that jump height and flight time for measuring CMJ appeared to be reliable assessment outcomes (jump height: ICC = 1.000; CI = 1.000;

1.000, p value < 0.001; and flight time: ICC = 0.999; CI = 0.998; 1.000, p value < 0.001). A number of reliability studies for the My Jump application used these guidelines for interpreting ICC values: less than 0.5 = poor, between 0.5 and 0.75 = moderate, between 0.75 and 0.9 = good, and greater than 0.90 = excellent ICC [21,22,29,31–33]. Thus, the results of the current study indicate excellent reliability. The portable KForce Plates measurements showed that there was a mean difference of 4.06 cm for jump height and 0.04 ms for flight time. These findings are not in agreement with the study of Stanton et al. [34], who conducted a reliability study with recreational athletes using the My Jump application. In that case, the mean jump height was 0.43 cm, and flight time was not evaluated. However, our study was conducted among collegiate athletes using the My Jump 2 application on an iPhone 13. We observed a high correlation between the portable KForce Plates and the My Jump 2 application in both jump height ($r = 1.000$; p value < 0.001) and flight time ($r = 1.000$; p value < 0.001), which indicated the concurrent validity of the KForce Plates system for assessing CMJ in collegiate athletes.

Previous studies compared various technologies for measuring CMJ with force platforms [21,22]. The My Jump and My Jump 2 applications have been compared to force platforms in a number of different jumps [22,25,31] and have shown a high correlation ($r = 0.97$ – 0.99) for CMJ and SJ in athletes [25,31] and for drop jumps ($r = 0.94$ – 0.97) in students [22]. The rapid evolution of new technologies suggests that a contemporary smartphone includes a high-speed camera with high-speed frequency, thus reducing the measurement error of the My Jump 2 application. Several research papers have compared portable instruments with unportable force plates, with a mean difference between -1.06 and 11.7 cm for CMJ performance (jump height) [18,19,35], which is in agreement with our study. Differences between portable instruments and force plates could be attributed to the fact that the sampling rate and athletic performance vary in many study designs.

In our study, athletes derived from various sports backgrounds (such as football, volleyball, gymnastics, etc.) implicated physiological and biomechanical variables such as muscle force and flexibility, anaerobic characteristics, and optimal neuromuscular control. Therefore, CMJ performance might also involve the stimulation of these mechanisms related to sports performance [25,36,37]. As a matter of fact, an improvement in the jump height variable is directly associated with greater sports performance, mainly in athletes with explosive activities [38]. Furthermore, CMJ training protocols are progressively used in various types of sports [39,40]. Thus, the portable KForce plates might be useful in evaluating athletes competing in explosive-type sports and also for athletes deriving from other types of sports.

The reasons to choose the KForce Plates system are that it is portable, lightweight, and low-cost for use by sports coaches and sports practitioners. Its small size allows the assessment of a plethora of variables, such as external forces exerted by each limb separately when using instrumented systems with more than one force plate [20]. Our findings provide a reliable and valid perspective for using the KForce plates in sports and clinical biomechanics, such as in the analysis of functional tests and plyometric jump training. Moreover, the portability of the instrument allows practitioners to evaluate complex parameters, such as jumping height, leg stiffness, velocity, power, and ground reaction forces in either professional or amateur athletes with accuracy, thus allowing the possibility to improve sports performance, reduce the risk of injury, and manage reliable assessments either in a laboratory environment or in the sports field [3–6]. The use of the portable KForce plates might help to implement improved training-induced performance adaptations, providing accurate feedback to practitioners and athletes, respectively.

The main limitation of our study is that participants were collegiate professional athletes deriving from various sports backgrounds (e.g., football, basketball, and tennis), possibly affecting our results. Future research could explore the reliability and validity parameters in amateur athletes or in a specific sports activity (e.g., basketball). Another possible limitation of our study is the dimensions of the KForce plates. Athletes with a larger foot imprint compared to the size of the KForce plates would need an extension of

the surface of the portable plates. This alteration could affect athletes' comfort and their execution of the CMJ and, therefore, the results of the study. Moreover, professional athletes frequently experience alterations to their training schedule due to training decisions or competitions. These parameters could affect the availability for testing and the athletic fitness of each athlete, especially when they come from different sports backgrounds. In our study, we applied the standardized execution of CMJ (athletes had to keep their hands on the hips, and they had to execute a quick downward movement at an estimated 90° knee flexion and then a quick upward movement in order to perform the highest possible jump) in order to analyze the test—retest reliability. Future studies could apply a variation of CMJ, including arm swing, in order to explore if the jump technique affects the reliability and validity variables of the instruments.

Furthermore, the main limitation of our study is that the My Jump 2 application requires the precise manual selection of the video frames in which the athlete executes the take-off and the landing action and, therefore, makes the procedure challenging and subjective. Future studies could include in their methodology design a pilot study prior to the actual execution of CMJ in order to overcome the obstacles of the familiarization procedure for both athletes and researchers.

5. Conclusions

The aim of our study was to test the reliability and validity of the portable KForce plates for measuring CMJ in collegiate athletes deriving from various sports backgrounds.

Our findings suggest that the KForce Plates system is a reliable and valid tool that can be used by experts in the sports field. Although the portable KForce Plates system and the My Jump 2 application were found to be comparable tools for assessing CMJ, the portability, ease of use, and assessing parameters make the KForce Plates system the best option for clinical practitioners when evaluating either professional or amateur athletes.

In conclusion, technological advancement has facilitated the automatic calculation of the data, the portability of the platforms, and the affordability of the accompanying equipment. Future studies could explore the reliability and validity of the portable KForce plates on other jump tests with the concurrent use of the gold standard in-ground force platforms. They could also test the reliability and validity of athletes deriving from different sports backgrounds (e.g., elite or amateur athletes) or specific sports (e.g., football) in order to reduce the risk of injuries and improve sports performance.

Author Contributions: Conceptualization, G.P. and M.P.; methodology, G.P., M.P., M.M. and G.A.K.; software, G.P., D.Z., E.-M.P. and E.P.; validation, G.P., E.P., M.M., G.A.K. and M.P.; formal analysis, G.P. and M.P.; investigation, G.P., D.Z. and E.-M.P.; resources, G.P.; data curation, G.P. and M.P.; writing—original draft preparation, G.P.; writing—review and editing, G.P., D.Z., E.-M.P., E.P., M.M., G.A.K. and M.P.; visualization, G.P., D.Z., E.-M.P., E.P., M.M., G.A.K. and M.P.; supervision, M.P.; project administration, G.P. and M.P. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: This study was accepted by the Ethics Committee of the University of West Attica (No. 18030).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data presented in this study are available on request from the corresponding author. The data are not publicly available due to ethical restrictions.

Acknowledgments: The authors thank the Department of Physiotherapy of the University of West Attica for its services.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Petrigna, L.; Karsten, B.; Marcolin, G.; Paoli, A.; D'Antona, G.; Palma, A.; Bianco, A. A Review of Countermovement and Squat Jump Testing Methods in the Context of Public Health Examination in Adolescence: Reliability and Feasibility of Current Testing Procedures. *Front. Physiol.* **2019**, *10*, 1384.
2. Aughey, R.J.; Buchheit, M.; Garvican-Lewis, L.A.; Roach, G.D.; Sargent, C.; Billaut, F.; Varley, M.C.; Bourdon, P.C.; Gore, C.J. Yin and yang, or peas in a pod? Individual-sport versus team-sport athletes and altitude training. *Br. J. Sport. Med.* **2013**, *47*, 1150–1154. [\[CrossRef\]](#)
3. Sole, S.; Ramírez-Campillo, R.; Andrade, D.C.; Sanchez-Sanchez, J. Plyometric jump training effects on the physical fitness of individual-sport athletes: A systematic review with meta-analysis. *PeerJ* **2021**, *9*, e11004. [\[PubMed\]](#)
4. Bazyler, C.D.; Abbott, H.A.; Bellon, C.R.; Taber, C.B.; Stone, M.H. Strength training for endurance athletes: Theory to practice. *Strength Cond. J.* **2015**, *37*, 1–12.
5. Suchomel, T.J.; Nimphius, S.; Stone, M.H. The Importance of Muscular Strength in Athletic Performance. *Sport. Med.* **2016**, *46*, 1419–1449.
6. Seitz, L.B.; Reyes, A.; Tran, T.T.; de Villarreal, E.S.; Haff, G.G. Increases in Lower-Body Strength Transfer Positively to Sprint Performance: A Systematic Review with Meta-Analysis. *Sport. Med.* **2014**, *44*, 1693–1702.
7. Comfort, P.; Stewart, A.; Bloom, L.; Clarkson, B. Relationships between strength, sprint, and jump performance in well-trained youth soccer players. *J. Strength Cond. Res.* **2014**, *28*, 173–177. [\[PubMed\]](#)
8. Sargent, D.A. The Physical Test of a Man. *Am. Phys. Educ. Rev.* **1921**, *26*, 188–194. [\[CrossRef\]](#)
9. Sargent, L.W. Some Observations on the Sargent Test of Neuromuscular Efficiency. *Am. Phys. Educ. Rev.* **1924**, *29*, 47–56. [\[CrossRef\]](#)
10. Anicic, Z.; Janicijevic, D.; Knezevic, O.M.; Garcia-Ramos, A.; Petrovic, M.R.; Cabarkapa, D.; Mirkov, D.M. Assessment of Countermovement Jump: What Should We Report? *Life* **2023**, *13*, 190.
11. McMahon, J.J.; Murphy, S.; Rej, S.J.E.; Comfort, P. Countermovement-Jump-Phase Characteristics of Senior and Academy Rugby League Players. *Int. J. Sport. Physiol. Perform.* **2017**, *12*, 803–811. [\[CrossRef\]](#) [\[PubMed\]](#)
12. Claudino, J.G.; Cronin, J.; Mezêncio, B.; McMaster, D.T.; McGuigan, M.; Tricoli, V.; Amadio, A.C.; Serrão, J.C. The countermovement jump to monitor neuromuscular status: A meta-analysis. *J. Sci. Med. Sport* **2017**, *20*, 397–402. [\[CrossRef\]](#)
13. Lake, J.P.; Mundy, P.D.; Comfort, P.; Suchomel, T.J. Do the peak and mean force methods of assessing vertical jump force asymmetry agree? *Sport. Biomech.* **2020**, *19*, 227–234. [\[CrossRef\]](#) [\[PubMed\]](#)
14. Berton, R.; Lixandrão, M.E.; Pinto e Silva, C.M.; Tricoli, V. Effects of weightlifting exercise, traditional resistance and plyometric training on countermovement jump performance: A meta-analysis. *J. Sport. Sci.* **2018**, *36*, 2038–2044. [\[CrossRef\]](#)
15. Balsalobre-Fernández, C.; Glaister, M.; Lockey, R.A. The validity and reliability of an iPhone app for measuring vertical jump performance. *J. Sport. Sci.* **2015**, *33*, 1574–1579. [\[CrossRef\]](#)
16. Bogataj, Š.; Pajek, M.; Hadžić, V.; Andrašić, S.; Padulo, J.; Trajković, N. Validity, reliability, and usefulness of my jump 2 app for measuring vertical jump in primary school children. *Int. J. Environ. Res. Public Health* **2020**, *17*, 3708. [\[CrossRef\]](#) [\[PubMed\]](#)
17. Walsh, M.; Church, C.; Hoffmeister, A.; Smith, D.; Haworth, J. Validation of a Portable Force Plate for Evaluating Postural Sway. *Percept. Mot. Skills* **2021**, *128*, 191–199. [\[CrossRef\]](#) [\[PubMed\]](#)
18. Choukou, M.A.; Laffaye, G.; Taiar, R. Reliability and validity of an accele-rometric system for assessing vertical jumping performance. *Biol. Sport* **2014**, *31*, 55–62. [\[CrossRef\]](#)
19. Glatthorn, J.F.; Gouge, S.; Nussbaumer, S.; Stauffacher, S.; Impellizzeri, F.M.; Maffiuletti, N.A. Validity and reliability of optojump photoelectric cells for estimating vertical jump height. *J. Strength Cond. Res.* **2011**, *25*, 556–560. [\[CrossRef\]](#) [\[PubMed\]](#)
20. Meras Serrano, H.; Mottet, D.; Caillaud, K. Validity and Reliability of Kinvent Plates for Assessing Single Leg Static and Dynamic Balance in the Field. *Sensors* **2023**, *23*, 2354. [\[CrossRef\]](#) [\[PubMed\]](#)
21. Jimenez-Olmedo, J.M.; Pueo, B.; Mossi, J.M.; Villalon-Gasch, L. Reliability of My Jump 2 Derived from Crouching and Standing Observation Heights. *Int. J. Environ. Res. Public Health* **2022**, *19*, 9854. [\[CrossRef\]](#) [\[PubMed\]](#)
22. Haynes, T.; Bishop, C.; Antrobus, M.; Brazier, J. The validity and reliability of the My Jump 2 app for measuring the reactive strength index and drop jump performance. *J. Sport. Med. Phys. Fitness* **2019**, *59*, 253–258. [\[CrossRef\]](#) [\[PubMed\]](#)
23. Driller, M.; Tavares, F.; McMaster, D.; O'Donnell, S. Assessing a smartphone application to measure counter-movement jumps in recreational athletes. *Int. J. Sport. Sci. Coach.* **2017**, *12*, 661–664. [\[CrossRef\]](#)
24. Cruvinel-Cabral, R.M.; Oliveira-Silva, I.; Medeiros, A.R.; Claudino, J.G.; Jiménez-Reyes, P.; Boullosa, D.A. The validity and reliability of the “My Jump App” for measuring jump height of the elderly. *PeerJ* **2018**, *2018*, e5804. [\[CrossRef\]](#)
25. Gallardo-Fuentes, F.; Gallardo-Fuentes, J.; Ramírez-Campillo, R.; Balsalobre-Fernández, C.; Martínez, C.; Caniuqueo, A.; Cañas, R.; Banzer, W.; Loturco, I.; Nakamura, F.Y.; et al. Intersession and intrasession reliability and validity of the my jump app for measuring different jump actions in trained male and female athletes. *J. Strength Cond. Res.* **2016**, *30*, 2049–2056. [\[CrossRef\]](#)
26. Gahercole, R.; Sporer, B.; Stellingwerff, T. Countermovement Jump Performance with Increased Training Loads in Elite Female Rugby Athletes. *Int. J. Sport. Med.* **2015**, *36*, 722–728.
27. Bosco, C.; Luhtanen, P.; Komi, P.V. A simple method for measurement of mechanical power in jumping. *Eur. J. Appl. Physiol. Occup. Physiol.* **1983**, *50*, 273–282. [\[CrossRef\]](#)
28. Koo, T.K.; Li, M.Y. A Guideline of Selecting and Reporting Intraclass Correlation Coefficients for Reliability Research. *J. Chiropr. Med.* **2016**, *15*, 155–163. [\[CrossRef\]](#) [\[PubMed\]](#)

29. Bland, J.M.; Altman, D. Statistical Methods for Assessing Agreement between Two Methods of Clinical Measurement. *Lancet* **1986**, *327*, 307–310. [[CrossRef](#)]
30. Sha, Z.; Zhou, Z.; Dai, B. Analyses of Countermovement Jump Performance in Time and Frequency Domains. *J. Hum. Kin.* **2021**, *78*, 41–48. [[CrossRef](#)] [[PubMed](#)]
31. Rogers, S.A.; Hassmén, P.; Hunter, A.; Alcock, A.; Crewe, S.T.; Strauts, J.A.; Gilleard, W.L.; Weissensteiner, J.R. The Validity and Reliability of the MyJump2 Application to Assess Vertical Jumps in Trained Junior Athletes. *Meas. Phys. Educ. Exerc. Sci.* **2019**, *23*, 69–77. [[CrossRef](#)]
32. Yingling, V.R.; Castro, D.A.; Duong, J.T.; Malpartida, F.J.; Usher, J.R.; Jenny, O. The reliability of vertical jump tests between the Vertec and My Jump phone application. *PeerJ* **2018**, *6*, e4669. [[CrossRef](#)]
33. Rago, V.; Brito, J.; Figueiredo, P.; Carvalho, T.; Fernandes, T.; Fonseca, P.; Rebelo, A. Countermovement jump analysis using different portable devices: Implications for field testing. *Sports* **2018**, *6*, 91. [[CrossRef](#)] [[PubMed](#)]
34. Staton, R.; Wintour, S.A.; Kean, C.O. Validity and intra-rater reliability of MyJump app on iPhone 6s in jump performance. *J. Sci. Med. Sport* **2017**, *20*, 518–523. [[CrossRef](#)]
35. Buckthorpe, M.; Morris, J.; Folland, J.P. Validity of vertical jump measurement devices. *J. Sci. Med. Sport* **2012**, *30*, 63–69. [[CrossRef](#)]
36. Homard, J.A.; Costill, D.L.; Mitchell, J.B.; Park, S.H.; Chenier, T.C. The role of anaerobic ability in middle distance running performance. *Eur. J. Appl. Physiol. Occup. Physiol.* **1991**, *62*, 40–43. [[CrossRef](#)]
37. Noakes, T.D. Implications of exercise testing for prediction of athletic performance: A contemporary perspective. *Med. Sci. Sport. Exerc.* **1988**, *20*, 319–330. [[CrossRef](#)]
38. Rairez-Campillo, R.; Alvarez, C.; Henriquez-Olguin, C.; Baez, E.B.; Martinez, C.; Adrade, D.C.; Izquierdo, M. Effects of plyometric training on endurance and explosive strength performance in competitive middle- and long-distance runners. *J. Strength Cond. Res.* **2014**, *28*, 97–104. [[CrossRef](#)]
39. Petrsen, K.; Hansen, C.B.; Aagaard, P.; Madsen, K. Muscle mechanical characteristics in fatigue and recovery from a marathon race in highly trained runners. *Eur. J. Appl. Physiol.* **2007**, *101*, 385–396. [[CrossRef](#)]
40. Bollosa, D.A.; Tuimil, J.L.; Alegre, L.M.; Iglesias, E.; Lusquinos, F. Concurrent fatigue and potentiation in endurance athletes. *Int. J. Sport. Physiol. Perform.* **2011**, *6*, 82–93. [[CrossRef](#)] [[PubMed](#)]

Disclaimer/Publisher’s Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.