VALIDITY AND RELIABILITY OF DEVICES MEASURING COUNTERMOVEMENT VERTICAL JUMP PERFORMANCE

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ABSTRACT

The countermovement jump (CMJ) test is a standard measure of lower body power. The jump performance in the test can be related to other aspects of athletic performance. With many tools commercially available, it can be difficult for professionals to distinguish which device provides the most accurate results for the best cost. While these devices have been previously validated individually, no past studies have concurrently examined these specific tools. **PURPOSE:** The purpose of this study was to determine the accuracy of four different CMJ measuring devices when compared to the gold standard of a force plate. **METHODS:** 31 physically-active university students were recruited for this study (21 ± 3.3 years; 176 ± 10 cm; 80 ± 17 kg; 9 females, 21 males). The participants were lead through a standardized 10-minute warm-up protocol consisting of dynamic stretching and concluding with instruction of proper jumping technique for the tests. Participants then performed 4 maximal CMJ on the force plate, which served as the gold standard for CMJ measures. Following the gold standard jumps, all participants performed an additional 4 maximal CMJ in an area where 4 other instruments were used to measure CMJ simultaneously: accelerometer-based sensor, a contact mat, a photoelectrical cell system, and a mobile device video app. The researchers measured each CMJ synchronically. A data analysis was conducted using IBM SPSSStatistics and Microsoft Excel. An analysis of variance (ANOVA) and intra-class correlation (ICC) were used to analyze the differences between devices. **RESULTS:** The ANOVA revealed a significant difference in mean CMJ performance between the force plate and the photoelectrical cell system and the mobile device video app ($p < 0.001$). All devices displayed a strong correlation to the force plate with the contact mat displaying the highest ICC (r = 0.899). **CONCLUSION:** All four commercial devices showed strong within-device reliability and strong relationships to the force plate regarding CMJ performance. But, only the contact mat and accelerometer-based sensor measured CMJ performance closest in score to the force plate. In summary, while slightly over-estimating measurements, the commercial devices that seem to agree the closest to the gold standard force plate were the contact mat and accelerometer-based sensor.

INTRODUCTION

The vertical jump test is a standard measure of performance, which measures how high an individual can jump and can be related to other aspects of athletic performance. The force plate is considered the gold standard for measuring counter-movement jumps (CMJ) but force plates are very expensive and technical to use. Nowadays, advanced technology has created devices to measure vertical jump that are much lower in cost and may be beneficial for low-budget programs. However, the accuracy of these devices is unclear. The purposes of this study were to compare four devices (Just Jump mat, My Jump 2 Application, gFlight, and PUSH Band) and their reliability to each other on measuring vertical jumps, as well as their validity to the force plate. The four devices are described below.

- Just Jump Mat: calculates vertical jump height by measuring flight time based on foot contact. It displays the measurement on an attached display system. ($600)
- My Jump 2 Application: an iPhone application used to measure vertical jumps with the use of video analysis. ($8)
- PUSH Band: an accelerometer-based wearable device that estimates jump height based on how far the sensor moves in space. ($350)
- gFlight: a tool that has one floor-level high-density photoelectric beam that can be used to determine jump height through interruption of the beams with your feet. ($400)
- Force Plate: records body weight and force applied to the platform surface over time. ($3,000-$20,000)

PURPOSE & HYPOTHESIS

The purpose of the study was to compare four devices (Just Jump mat, My Jump 2 Application, G-Flight, and PUSH Band) and their validation to the ”gold standard” (force plate) and reliability to each other on accurately measuring vertical jumps.

METHODS

Subjects
- 31 physically active university students
- 22 ± 3.3 years old; 80 ± 17 kg body mass; 176 ± 10 cm height; 9 females, 21 males
- Physically active for at least 3 days a week for 30 minutes a day for the past 6 months
- Read and signed an informed consent approved by institution IRB prior to participation
- Approval of utilizing humans as subjects was approved by the IRB prior to any data collection

Warm-Up
- Ten minutes in length.
- Standardized dynamic movements including jogging, back pedaling, high knee skips, walking lunges, walking knee hugs, walking quadriceps stretch, frankensteins, bodyweight squats, and sub-maximal counter movement jumps
- Familiarization period of proper jumping technique for the tests

Instruments
- Kistler multicomponent force plate with BioWare software (Type 9260AA, Novi, Michigan)
- PUSH strength band 2.0 (Toronto, Canada; Figure 2)
- gFlight (gTech, Sterling, Virginia; Figure 1 & 3)
- Just Jump contact mat (Probotics Inc., Huntsville, Alabama; Figure 1)
- My Jump App 2 (Madrid, Spain; Figure 1)
- Apple iPads (Cupertino, CA; Figure 1)

Jump Tests
- 8 total maximal CMJs (hands on hips) were measured
  - 4 CMJs on the force plate
  - 4 CMJs measured using the 4 other instruments simultaneously.
- 45-seconds of rest between each jump for optimal recovery
- Vertical jump heights were recorded across all devices
- Subjects were instructed to step off and on the platform in preparation for the next jump

Data Analyses
- Intraclass correlation coefficient (ICC): reliability of each instrument for measuring CMJ height (Table 1)
- Coefficient of variation (CV): stability of each instrument during their 4 CMJs (Table 2)
- ANOVA, Tukey post-hoc, Effect sizes: statistical differences between instruments (Figure 4)
- Significance set at $p \leq 0.05$

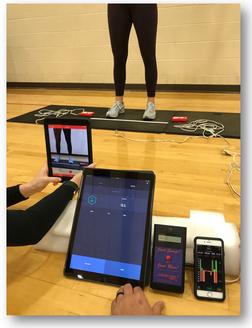

Figure 1: Four of the instruments recording simultaneously during one jump

Figure 2: The correct placement of the PUSH Band sensor for jump testing. Connected via Bluetooth to an iPad.

Figure 3: Proper set-up for using the gFlight for jump testing. Connected via Bluetooth to an iPad.

RESULTS

	JUST JUMP MAT	PUSH BAND	gFLIGHT	MY JUMP APP
JUST JUMP MAT	—	0.979	0.977	0.995
PUSH BAND	0.979	—	0.945	0.971
gFLIGHT	0.977	0.945	—	0.984
MY JUMP APP	0.995	0.971	0.984	—

Table 1: Summary of ICC describing the reliability between instruments

	AVERAGE ± STD. DEV.	CV%
FORCE PLATE	0.4342 ± 0.051	11.8
JUST JUMP MAT	0.4863 ± 0.016	3.4
PUSH BAND	0.4669 ± 0.022	4.8
gFLIGHT	0.3619 ± 0.017	4.9
MY JUMP APP	0.3483 ± 0.014	4.4

Table 2: Vertical jump averages across instruments, including coefficient of variations

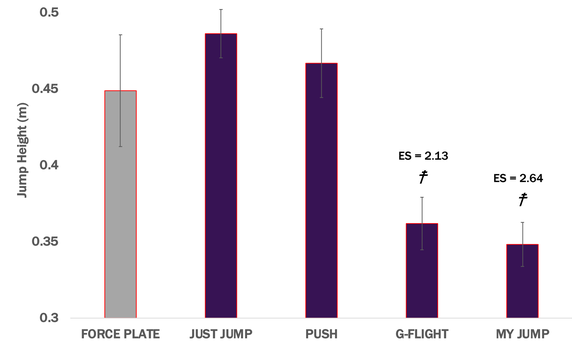

Figure 4: Vertical Jump Height Differences across the Testing Instruments
† represents significantly different than Force Plate ($p < 0.001$)

CONCLUSIONS & PRACTICAL APPLICATIONS

The ability for performance professionals and their athletes to measure CMJs is important for talent identification, athletic progression/performance, and monitoring of neuromuscular readiness for daily training loads. Knowing the reliability and validity of each CMJ measurement device will provide professionals with information on purchasing the correct instrument that fits their budget and testing needs.

All four devices produced very strong ICC between each other, with the lowest correlation being 0.945. Calculating ICC between the force plate and the other four commercial devices was difficult since the recorded jumps did not happen simultaneously. These results provide evidence that all four commercial devices are capable of providing reliable CMJ data for daily use.

When comparing the “accuracy” of CMJ heights to the widely-considered “gold standard” that is the force plate, both the gFlight and My Jump 2 App recorded significantly lower heights. The Just Jump mat and PUSH band recorded CMJ jump heights most similar to the force plate, increasing their validity value when recording CMJ.

REFERENCES

1. Balsalobre-Fernandez, C., Glaister, M., & Lockey, R. A. (2015). The validity and reliability of an iPhone app for measuring vertical jump performance. *Journal of Sports Sciences, 33(15):* 1574-1579.
2. Carlos-Vivas, J., Martin-Martinez, J. P., Hernandez-Mocholi, M. A., & Perez-Gomez, J. (2018). Validation of the iPhone app using the force platform to estimate vertical jump height. *Journal of Sports Medicine and Physical Fitness, 58(3):* 227-232.
3. Garcia-Lopez, J., Peleteiro, J., Rodgriguez-Marroyo, J. A., Morante, J. C., Herrero, J. A., & Villa, J. G. (2005). The validation of a new method that measures contact and flight times during vertical jump. *International Journal of Sports Medicine,* 26: 294-302.
4. Lake, J. P., Augustus, S., Austin, K., Mundy, P. McMahon, J. J., Comfort, P. & Haff, G. G. (2018). The validity of the Push band 2.0 during vertical jump performance. *Sports, 6:* 140.
5. Leard, J. S., Cirillo, M. A., Katsnelson, E., Kimiatek, D. A., Miller, T. M., Trebincevic, K., & Garbalosa, J. C. (2007). Validity of two alternate systems for measuring vertical jump height. *Journal of Strength and Conditioning Research, 21(4):* 1296-1299.
6. Peart, D. J., Balsalobre-Fernandez, C., & Shaw, M. P. (2018). Use of mobile applications to collect data in sport, health, and exercise science: A narrative review. *Journal of Strength and Conditioning Research,* DOI: 10. 1519/JSC.0000000000002344.
7. Yingling, V. R., Castro, D. A., Duong, J. T., Malpartida, F. J., Usher, J. R., & O, J. (2018). The reliability of vertical jump tests between the Vertec and the My Jump phone application. *PeerJ,* DOI 10.7717/peerj.4669.