Validation of the AlphaPWR Force Plate Through Force–Time Data Metrics

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Headline
In the contexts of testing, training, and rehabilitation, it is crucial for coaches and clinicians to employ technology that yields valid and reliable results. Force platforms are valuable tools for analyzing the kinetic aspects of human movement, and provide objective measurements of force, speed, and power (1). In field testing, the countermovement jump (CMJ) is widely used for estimating explosive power in the lower body (2) and used for validation of force platform systems (3, 4, 5).

Aim
The aim of this study was to determine the validity of a force platform (AlphaPWR V2.0) using the Force-Time series during countermovement jumps.

Study design
Evaluation study.

Methods
Subjects
Recreational athletes with varying sports backgrounds volunteered to participate in this study (3 males and 2 females, age = 26 ± 3, body mass = 74.0 ± 15.2 kg; height = 175 ± 7 cm). To be eligible, participants had to be healthy and free of injuries in the lower limbs. The study received approval from the ethics committee at the Norwegian School of Sport Sciences, acceptance from the Norwegian Center for Research Data, and was conducted in accordance with the Declaration of Helsinki.

Force Platforms Setup
The portable AlphaPWR force platform was placed on top of an in-ground AMTI force platform in a biomechanics lab to facilitate concurrent jumping performances. The AMTI force platform served as the reference (gold standard). The technical specifications of the platforms are presented in Table 1.

Table 1: Comparison of technical specifications between the in-ground (AMTI) and portable (AlphaPWR) force platforms used in the study.

Testing Procedure
To supplement the hardware comparison, a static test using calibrated weights was performed one day prior to the data collection of CMJs. This test involved concurrent loading of the force platforms with up to 555 kg to measure drift and ensure accuracy. This amount of load was chosen to exceed the expected load during the vertical jumps on the data collection day. The static test is presented in Figure 1.

Figure 1: Force measurements from the static loading test. The figure illustrates the measurement response of the AlphaPWR and AMTI systems under incremental static loads up to 555 kg.

Each participant was scheduled to perform 30 CMJs, for a planned total of 150 jumps. All participants performed warm-up jumps on the force plates to familiarize themselves with the setup. The participants wore their own shoes and used a self-selected countermovement depth for the jumps.

A body weight recording (4 s) was done before and after each jump. All jumps were executed with hands on hips. For the first ten jumps, the participants were instructed to aim for 30% of maximal effort; for the next ten jumps, 60%; and for the final ten jumps, they were instructed to aim for maximal effort. Rest periods of 0.5-2 minutes were allowed between jumps.

Data Collection and Analysis

Data were collected at a sampling frequency of 1000 Hz on the AMTI force platform and 434.027 Hz on the AlphaPWR force platform, with the latter being the standard frequency for that system. A total of four jumps were excluded, two due to outliers (jump height >100 cm) and two due to challenges in matching the files. Additionally, one subject only performed ten jumps. In total, 124 jumps were analyzed further, with jump heights ranging from 13.7 to 48.7 cm. A Butterworth lowpass filter, widely used in biomechanics (6, 7), was applied with a cut-off frequency set to 10 Hz. Jump height was calculated using the takeoff velocity (TOV) method (8), with thresholds for the start of integration set to 20 Newton (N) below body weight.

Statistical Analysis

All statistical analyses were conducted using Python (v3.10) and Visual Studio Code (v 1.92.2). Concurrent validity of the AlphaPWR system against the AMTI platform system was determined using Interclass Correlation Coeficient (ICC). The mean bias and the typical error of the estimate (TEE) were also calculated and interpreted following Hopkins' recommendations (9, 10). Mean bias was evaluated using modified Cohen effect sizes (ES): <0.20 (trivial), 0.2–0.6 (small), 0.6–1.2 (moderate), 1.2–2.0 (large), 2.0–4.0 (very large), >4.0 (extremely large), with Cohen's *d* effect sizes and confidence intervals (CI) calculated to interpret the magnitude and precision of these differences. With AMTI established as the reference, a negative difference would indicate that the Alphatek system underestimate the value compared to AMTI, whereas a positive difference reflects an overestimation. To visualize the agreement between the two platforms, Bland-Altman plots were generated for each parameter to represent bias and 95% level of agreement.

Results

The validity of the measurements was confirmed using ICC. The mean bias and TEE were small with trivial effect sizes for all the metrics assessed. For jump height, the mean bias was -0.06 ± 0.26 cm, corresponding to a percentage bias of -0.22%. The TEE was 0.26 cm, with a Cohen's *d* value of -0.01, and the confidence interval (CI) ranged from -0.11 to -0.02. Regarding the time to push-off, the mean bias was less than 0.001 ± 0.00 seconds (s), representing a 0.01% bias. The TEE was 0.00 s, with a Cohen's *d* of less than 0.001, and the CI was also less than 0.001 in both directions. In the case of mean force, the mean bias was 2.4 ± 1.8 N, which amounted to a 1.1% bias. The TEE for this metric was 2.97 N, with a Cohen's *d* of 0.03, and the CI ranged from 2.03 to 2.67.

For mean acceleration, the mean bias was -0.01 ± 0.02 m.s², reflecting a bias of -0.35%. The TEE was 0.02 m.s², with a Cohen's *d* of -0.01, and the CI was consistent at -0.01 across the range. In terms of Peak Force, a mean bias of 12.24 ± 4.65 N was observed, equating to a 1.17% bias. The TEE was 13.10 N, with a Cohen's *d* of 0.03, and the CI ranged from 11.42 to 13.07.

For peak acceleration, the mean bias was -0.03 ± 0.04 m.s², translating to a -0.19% bias. The TEE was 0.05 m.s², with a Cohen's *d* of -0.01, and the CI spanned from -0.03 to -0.02. Takeoff Velocity showed a mean bias of -0.00 ± 0.01 m.s^{-1}, which corresponded to a -0.15% bias. The TEE was 0.01 m.s^{-1}, with a Cohen's *d* of -0.01, and the CI ranged from -0.01 to -0.00. Finally, for Impulse, the mean bias was 2.20 ± 1.18 N·s, reflecting a bias of 1.24%. The TEE was 2.50 N·s, with a Cohen's *d* of 0.03, and the CI ranged from 1.99 to 2.41.

Table 2. Comparison of measurements between the AMTI and AlphaPWR systems. The table presents intraclass correlation coefficients (ICC), mean bias, percentage bias, 95% confidence intervals (CI), typical error of the estimate (TEE), and Cohen's *d* effect sizes for various performance metrics.

Figure 2: Bland–Altman plots comparing key metrics between the AlphaPWR and AMTI force plate systems, showing mean bias and 95% limits of agreement.

Discussion

The Bland-Altman analysis (Figure 2) reveals that metrics normalized by mass, such as acceleration, show no significant proportional bias, while force-dependent metrics, like mean and peak force, do exhibit this type of bias. In static load tests (Figure 1), the AMTI platform tends to underestimate force as the load increases, particularly for weights up to 200 kg, with a mean underestimation at 1,25 % from the reference. However, since acceleration is calculated as a = F/m, the underestimation of mass effectively cancels out the underestimation of force. This explains why acceleration-related metrics display better agreement between systems. As a result, mass-normalized metrics, such as jump height, remain consistent across platforms.

Jump height was calculated using the TOV method, which directly derives jump height from the measured vertical ground reaction forces by applying the impulse-momentum relationship. This is a recommended approach for vertical jumps on force platforms (11) and provides the most accurate calculation of jump height (8).

The two platforms operate at different sampling frequencies (Table 1). The AlphaPWR platform is capable of sampling at 1000 Hz, however, the default setting of 434.027 Hz was intentionally used in this study to align with the sampling frequency typically employed when the platform is used in real-world applications.

Previous research has indicated that sampling frequencies below 1080 Hz can result in a 4.4% underestimation of jump height, with more specific underestimations ranging from 1.10% to 0.32% observed for frequencies between 300 and 900 Hz (12). Given that the AlphaPWR platform samples at 434.027 Hz, it was anticipated that underestimations within this range might occur. Moreover, the selection of an appropriate take-off threshold, the choice of low-pass filter, and the duration of body weight measurement could further influence accuracy (12). However, in this study, these factors were not of major concern since the primary aim was to compare two systems where these parameters were kept consistent. The only differing factor was the sampling frequency, which is why it was included in the discussion.

Limitations

- Jump height range: the study had a limited range of jump heights, which may have restricted variability and generalizability.
- Single jump type: the study focused exclusively on countermovement jumps, which limits the applicability of the findings to other types of jumps or movements.
- Only the hardware was compared: while all data were analyzed using the same script, which may not reflect potential differences in results that could arise from using different data processing algorithms or software platforms.

Practical applications

- The AlphaPWR force platform offers an accessible method for collecting data on countermovement jumps and other exercises making it a practical tool for coaches, athletes and clinicians who need immediate, valide data.
- Practitioners can confidently use mass-normalized metrics, such as acceleration and jump height, as these show strong agreement across systems. However, it's worth noting that force-dependent metrics (e.g., mean and peak force) exhibit greater variability. While the differences are small, they may still be relevant in high-performance settings where precision is critical.
- Compared to the in-ground reference platform (AMTI), the AlphaPWR platform offers a cost-effective alternative without sacrificing measurement accuracy.

Dataset

Dataset available on SportPerfSci.com

Conflict of interest

The second author holds a position in the Alphatek company. The project received funding.

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