Routledge
Taylor & Francis Group

Measurement in Physical Education and Exercise Science

ISSN: 1091-367X (Print) 1532-7841 (Online) Journal homepage: www.tandfonline.com/journals/hmpe20

Assessing the Gymaware RS Linear Position Transducer Reliability and Validity in Measuring Countermovement Jump Height

Zeki Akyildiz & Deniz Şentürk

To cite this article: Zeki Akyildiz & Deniz Şentürk (06 Jul 2026): Assessing the Gymaware RS Linear Position Transducer Reliability and Validity in Measuring Countermovement Jump Height, Measurement in Physical Education and Exercise Science, DOI: 10.1080/1091367X.2026.2699718

To link to this article: https://doi.org/10.1080/1091367X.2026.2699718

Published online: 06 Jul 2026.

MEASUREMENT IN PHYSICAL EDUCATION AND EXERCISE SCIENCE
https://doi.org/10.1080/1091367X.2026.2699718

Assessing the Gymaware RS Linear Position Transducer Reliability and Validity in Measuring Countermovement Jump Height

Zeki Akyildiz [a] and Deniz Şentürk [b]

[a]Sports Science Faculty, Department of Coaching Education, Afyon Kocatepe University, Afyonkarahisar, Türkiye; [b]Sports Science Faculty, Department of Coaching Education, Gelisim University, Istanbul, Türkiye

ABSTRACT
This study evaluated the concurrent validity and intra-device reliability of a linear position transducer (LPT) for counter-movement jump (CMJ) height. Twenty-six subjects (22.21 ± 5.3 years) performed five CMJs using a force plate (Forcedecks) concurrently with the LPT to test validity. A statistically significant difference was found between the force plate and Gymaware units. Although there are differences between strength platforms and Gymaware units, there is no difference between the Gymaware units. Bland-Altman analysis for validity revealed that LPT overestimated jump height for CMJ in both units, Gymaware RS unit 1 and Gymaware RS unit 2. Gymaware RS equipment, like the force platform, provides reliable measurement data. The Forcedecks force platform, Gymaware RS unit 1, and Gymaware RS unit 2 provide data below 5% CV. The Gymaware RS overestimates jump height, but it is a reliable tool for tracking changes in jump height to measure performance improvement and monitor fatigue.

KEYWORDS
Countermovement Jump; linear position transducer; measurement; validity; reliability

Introduction

The countermovement jump (CMJ) is the most widely used vertical jump test for evaluating neuromuscular status and monitoring fatigue (Alba-Jiménez et al., 2022). The standardized nature of the CMJ test, combined with its low risk of injury and ease of administration, has facilitated its widespread adoption by coaches and athletes under real-world field conditions (Marrier et al., 2017). CMJ offers a rapid and straightforward assessment method, utilizing numerous scientifically validated techniques. In addition, reliable technologies are available for its implementation, causing minimal additional fatigue (Marrier et al., 2017). The CMJ also offers sustained and high sensitivity in detecting changes in neuromuscular function, with neuromuscular fatigue likely reflecting both the stretch – shortening capability of the lower-limb muscles and the capacity to assess muscular fatigue (Twist & Highton, 2013).

Historically, jump performance has been assessed using expensive, laboratory-based force platforms, which are considered the gold standard (Walsh et al., 2006). The validity of force platforms as a criterion measure is underpinned not only by their hardware precision but also by the mathematical rigor of the numerical methods used to process force-time data. The specific choice of computational algorithm, such as flight-time versus numerical integration, is critical, as it directly influences the accuracy of jump height estimation (Chiu & Dæhlin, 2020). By selecting the force platform as our reference, we ensure that the validity of wearable technologies is evaluated against this highest level of computational precision. However, sports technology advances have made it feasible to perform these measurements with various devices, including accelerometer-based systems (Dragutinovic et al., 2024), video cameras (Şentürk et al., 2024), linear position transducers (LPTs) (Ruiz-Alias et al., 2024), and jump mats (Reeve & Tyler, 2013). The increased utilization of velocity-based resistance training methods by strength and conditioning coaches and sports scientists has also resulted in a concomitant rise in the use of LPT-based devices (Balsalobre-Fernández & Torres-Ronda, 2021). LPTs are practical, portable devices that utilize optical encoding technology to measure the displacement and velocity of an object (Pérez-Castilla et al., 2019). GymAware represents a distinct category of LPT, as it incorporates an angle sensor positioned near the base of the tether where it connects to the spool (Gym-Aware; Kinetic Performance Technologies, Canberra, Australia). The measurement of vertical-only displacement can be achieved with high accuracy, provided that any horizontal movement is corrected for using basic

CONTACT Zeki Akyildiz zekiakyldz@hotmail.com Sports Science Faculty, Department of Coaching Education, Afyon Kocatepe University, Afyonkarahisar, Türkiye

trigonometry (Harris et al., 2010). Although various kinematic variables (e.g., force, power, and velocity) can be derived from CMJ measurements (Crewther et al., 2011; García-Ramos et al., 2017; Hansen et al., 2011a, 2011b; Pérez-Castilla et al., 2017), jump height is the most frequently reported outcome in both research and applied sport settings, making it a logical focus for the present study. However, using these devices to assess CMJ height has been the subject of investigation in only two studies, which reported good to excellent test – retest reliability (ICC = 0.70–0.95) and strong correlations with force plate measurements ($r = 0.90$). Nevertheless, these studies also consistently overestimated jump height by approximately 7–9 cm, indicating that caution is warranted when interpreting absolute values (O'Donnell et al., 2018; Wadhi et al., 2018).

The Gym-Aware RS model, a recent addition to the market, stands out with its unique features, including x-axis correction for angular displacement, 2D bar path tracking, and improved positional resolution (~0.8 mm) with updated data processing algorithms (Gymaware, 2024). To our knowledge, no study has yet investigated the validity and reliability of the new Gym-Aware RS model in measuring CMJ height, nor examined the inter-unit consistency of its measurements. This study aims to fill this gap by evaluating the concurrent validity and test – retest reliability of the Gym-Aware RS device for measuring countermovement jump performance, using a force plate as the criterion reference. A secondary objective is to assess the inter-unit consistency between two Gym-Aware RS devices.

Methods

Subject

Twenty-six physically active males, with an average age of 23.02 ± 2.04 years, willingly enrolled in this research. The participants exhibited a mean body mass of 78.9 ± 25.6 kg and a body height of 172.7 ± 18.58 cm. An a priori power analysis was conducted using G*Power software (version 3.1.9.7; Heinrich-Heine-Universität Düsseldorf, Düsseldorf, Germany) to determine the minimum sample size required to detect a moderate effect size. Based on a repeated mesures design, with an alpha level of 0.05, a statistical power of 0.80, and a Cohen's f effect size of 0.25, the analysis indicated that a minimum of 24 participants was required. Therefore, our final sample of 26 participants was deemed sufficient to provide adequate statistical power for the assessment of both validity and reliability. All subjects demonstrated high proficiency in executing the CMJ during the familiarization session, ensuring proper technique was employed. CMJ testing was a regular component of their training programs. None of the participants exhibited physical limitations or neuromuscular injuries that could impair CMJ performance. Participants were explicitly instructed to refrain from engaging in strenuous lower-body exercise for the study and to arrive at each testing session rested. Before participation, all subjects received a comprehensive verbal explanation of the testing procedures and provided written informed consent, indicating their voluntary agreement to participate in the study. The study protocol adhered to the principles of the Declaration of Helsinki and received approval from the Institutional Review Board.

Study design

The primary objective of this study was to evaluate the concurrent validity and test – retest reliability of the Gym-Aware RS in measuring countermovement jumps CMJ height, utilizing a force plate as the criterion. The force plate was selected as the criterion measure because it is widely recognized as the gold standard in biomechanical research. Unlike mechanical jump-height assessment tools that rely on manual reach or physical contact, the force plate provides superior precision and objective temporal data, ensuring a more robust validation of wearable sensor technologies. The study's secondary objective was to assess the inter-unit consistency between two Gym-Aware RS devices. Participants were required to attend the laboratory on two separate occasions: the fi, ing a familiarization session; the second, an experimental session. During the familiarization session, the participants were informed in detail about the study's purpose, procedures, and potential risks. Following this briefing, the subjects' body mass and stature were measured. To ensure the accuracy of jump height calculations, the stabilization of body weight measurement was strictly controlled, as improper averaging of the quiet standing period can introduce significant systematic errors (Street et al., 2001). In the present study, the automated weighing protocol of the VALD ForceDecks was utilized. Each participant was required to stand motionless for a minimum of 2–3 seconds prior to each jump. The software verified a stable force-time baseline (Standard Deviation < 20 N) and provided an auditory signconfirmingirm that body mass had been accurately determined before the trial commenced. This procedure minimized potential errors in weight-averaging duration and offset determination, as recommended by (Street et al., 2001). Participants then completed a standardized warm-up consisting of five minutes of cycling at a self-selected pace, six repetitions of forward and lateral lunges, forward and lateral leg swings, and bodyweight squats.

Furthermore, the subjects were permitted to perform two self-selected mobilization exercises of their choice. This was followed by CMJs performed progressively at perceived intensities of 80%, 90%, and 100% (two repetitions at each intensity). Subsequently, whilst wearing a belt fitted with two Gym-Aware devices, participants performed five CMJs on a force platform. After a 48-hour interval, the experimental session was conducted, commencing with the identical standardized warm-up protocol. Participants then performed five CMJs on a force platform, with a one-minute recovery period between jumps. The participants were encouraged to exert maximum effort throughout the trials to achieve the highest possible jump height. Trials that did not meet the required technical criteria were repeated following a 1-minute recovery period.

Data acquisition

Participants stood motionless on the force platform (ForceDecks, FDLite V.2, VALD, Brisbane, Australia) until the software accurately measured their body weight (version 2.0.9105) (Collings et al., 2024). The CMJ protocol required participants to start upright with a straight torso, fully extended knees, and feet shoulder-width apart. Before each jump, participants were instructed to remain completely still, after which a standardized "3, 2, 1, go" countdown was given. They were then required to complete the jump in one continuous motion. The movement sequence began with a rapid countermovement, during which participants descended to a self-selected depth, immediately followed by an explosive upward motion to maximize jump height. Throughout the movement, participants were instructed to act as much as possible along a vertical path (Markovic et al., 2004). During all CMJ trials, simultaneous measurements were obtained using two GymAware RS devices (Kinetic Performance Technologies, Canberra, Australia) attached to the same point on a belt worn by the participants and positioned vertically beneath them using Velcro straps (Orange et al., 2019). The test procedure is shown in detail in Figure 1. GymAware measurements were recorded in real-time using the GymAware mobile application (version 5.6.1). For testing, the two Gym-Aware RS units were placed between the plates of the force platform. To ensure stability, each Gym-Aware RS

Figure 1. Illustration of the countermovement jump (CMJ), showing the initial and peak positions. A more detailed demonstration can be found in the video at https://www.youtube.com/shorts/9kyTQYGYjek.

base plate was secured by placing a 5-kg weight plate beneath it, allowing the four magnets on the underside of the Gym-Aware plate to make complete contact with the metallic surface. Each participant performed five CMJ trials, with a 1-minute rest interval between jumps. Trials were repeated if they failed to meet the following technical criteria: (a) maintaining a vertical path for the sensor tether without excessive cord slack, (b) landing cleanly within the force plate boundaries without loss of balance, and (c) adhering to the specified jump technique (e.g., keeping hands on hips throughout the movement). Any trial involving a preparatory movement artifact or an improper landing was excluded and repeated after a 1-minute rest. Jump height was recorded for all trials. For the force platform, jump height was determined using the flight-time method.

Jump height was calculated from the force plate data using the flight-time method to ensure methodological synchronization with the GymAware RS. Although the impulse-momentum method is often cited as the gold standard for force plate analysis (Linthorne, 2001), the flight-time algorithm was specifically selected here to provide a direct "like-for-like" comparison with the LPT technology. By aligning the calculation models, we aimed to isolate the measurement accuracy of the LPT without the confounding influence of differing physical calculation principles. To satisfy the assumption that the center of mass (COM) remained consistent at take-off and landing, a strict protocol was enforced: two researchers visually monitored each trial to ensure participants maintained full leg extension during the flight and landing phases. Any trials involving significant knee or hip flexion ("tucking") were immediately excluded and repeated. All recorded jump height values from both systems were included in the analysis. Jump height data from all devices were transferred in real time to an Excel spreadsheet during the measurement sessions.

Statistical analysis

All statistical analyses were conducted using JASP software (version 0.95.0), developed by the University of Amsterdam, Amsterdam, The Netherlands. Descriptive statistics are presented as mean values and standard deviations (SD) for each device and condition. The normality of the data was verified using the Shapiro – Wilk test. Concurrent validity was further assessed using Bland – Altman analyses, which estimated the mean bias and 95% limits of agreement between measurement systems. These plots provided visual and statistical evaluations of systematic error and device agreement. Reliability analyses were conducted for each measurement system. The standard error of measurement (SEM) was calculated as an absolute index of measurement precision, while the coefficient of variation (CV%) was used as a relative index of within-device consistency. A CV% threshold of ≤5% was considered indicative of excellent reliability. Additionally, the minimal detectable change at 95% confidence (MDC_{95}) was calculated to determine the smallest change that can be interpreted as a genuine difference beyond measurement error.

All statistical analyses were conducted to evaluate the absolute reliability and measurement error of the devices. Absolute reliability was assessed using the SEM, the MDC_{95}, and CV%. The MDC_{95} was calculated as $MDC_{95} = 1.96 \times SEM \times \sqrt{2/5}$ to determine the threshold for true performance changes, accounting for the five repeated measurements (Weir, 2005). The results are presented with exact p-values, 95% confidence intervals (CI), and effect sizes. The results are presented with exact p-values, 95% confidence intervals (CI), and effect sizes where applicable to interpret the findings comprehensively. All statistical tests were performed at the significance level of $p < .05$.

Results

Descriptive values for each jump, highlighting differences in repetitions and equipment, are presented in Figure 2. Across all repetitions, Gymaware RS units consistently reported higher jump heights compared to the Force Plate. However, the two Gymaware RS units yielded similar results throughout all repetitions.

The Bland-Altman plots (Figures 3,4,5) illustrate the level of agreement and the distribution of random error between the measurement systems. Method comparison revealed a systematic bias, with Gymaware Unit 1 reporting higher values than the Force Plate (Mean bias: −6.16 cm; 95% limits of agreement (LoA): −11.84 to −0.48 cm). A similar systematic offset was observed for Gymaware Unit 2 (Mean bias: −6.32 cm; 95% LoA: −11.91 to −0.73 cm). In contrast, the inter-unit agreement between the two Gymaware devices was excellent, demonstrating a negligible mean difference of −0.16 cm (95% LoA: −2.55 to 2.24 cm). These results indicate that while a stable systematic bias exists between the LPT technology and the force plate, the Gymaware RS units demonstrate high internal consistency. While this statistical agreement is strong, the 95% LoA range of approximately 4.8 cm represents a level of random measurement error that cannot be ignored. While these devices are systematically consistent, this inherent "noise" means that in real-world practice, small differences between measurements should be interpreted with caution.

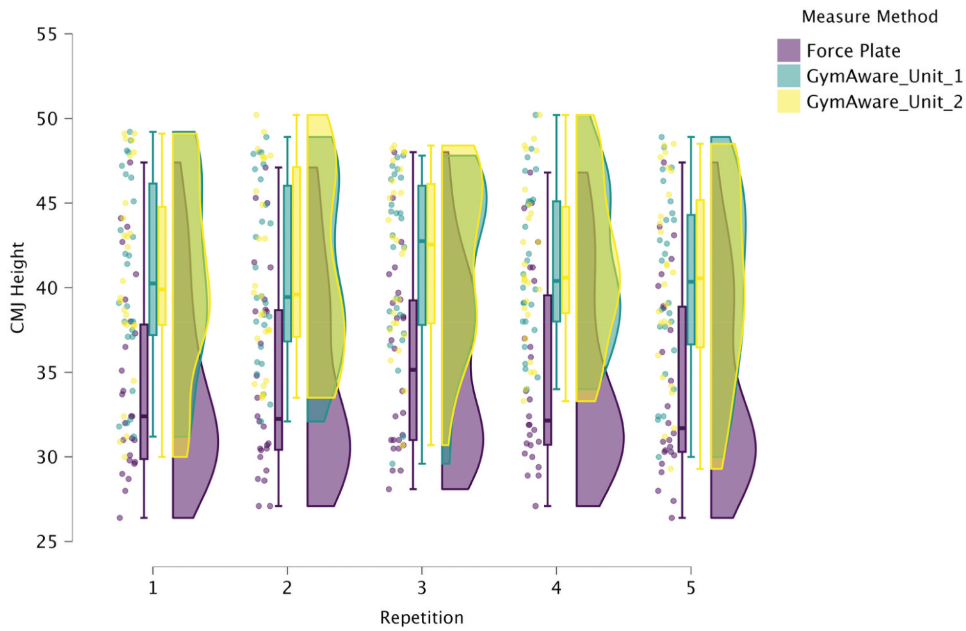

Figure 2. Descriptive values of measurement methods based on repetitions.

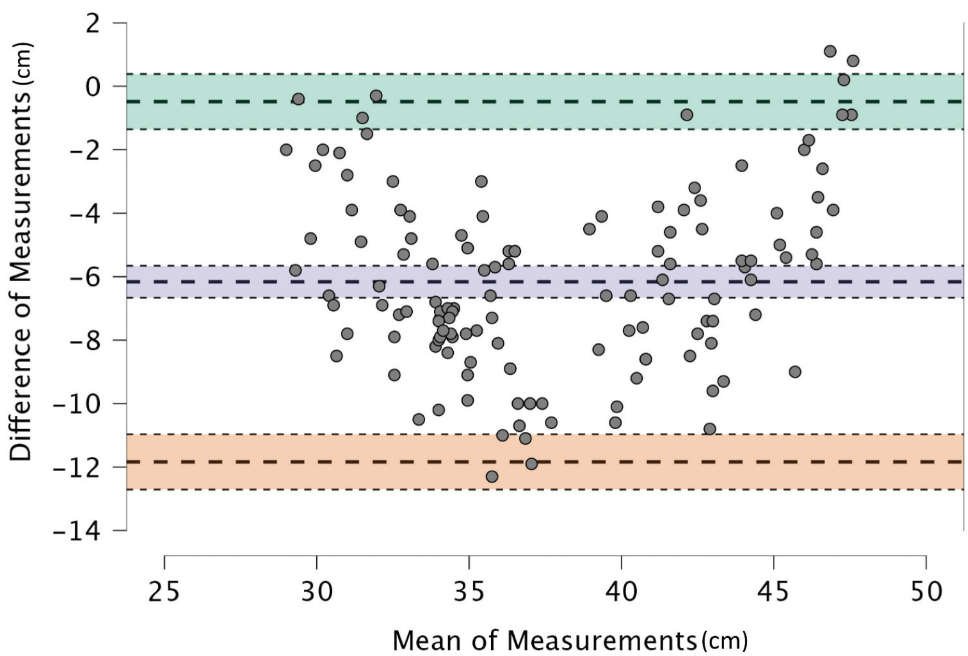

Figure 3. Bland–Altman plot for agreement between the force plate and the GymAware unit 1 in measuring jump height (cm).

Reliability metrics for all devices are displayed in Table 1. All three devices demonstrated high measurement precision, with SEM values ranging from 0.28 to 0.32 cm. CV% values were remarkably low (Force Plate: 0.82% [95% CI: 0.72%–0.96%]; GymAware Unit 1: 0.95% [95% CI: 0.83%–1.11%]; GymAware Unit 2: 0.92% [95% CI: 0.80%–1.07%]), suggesting excellent relative reliability. The minimum detectable change at the 95% confidence level was comparable across devices, ranging from 0.35 cm to 0.40 cm, indicating high sensitivity in detecting true performance changes. These metrics were calculated to account for the five repeated measurements per participant, ensuring consistency with the statistical guidelines proposed by (Weir, 2005).

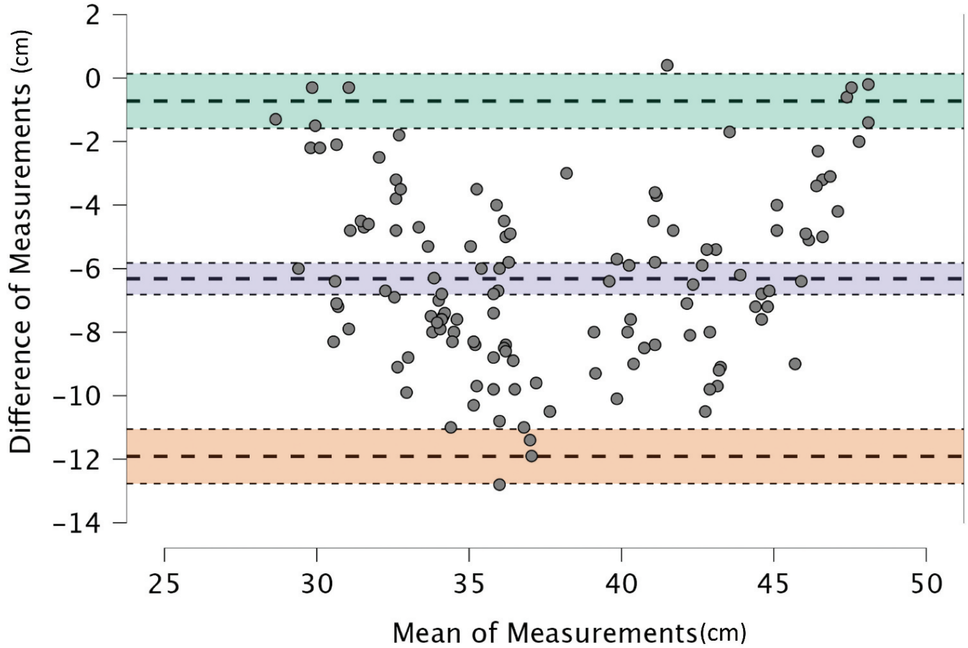

Figure 4. Bland–Altman plot for agreement between the force plate and the GymAware unit 2 in measuring jump height (cm).

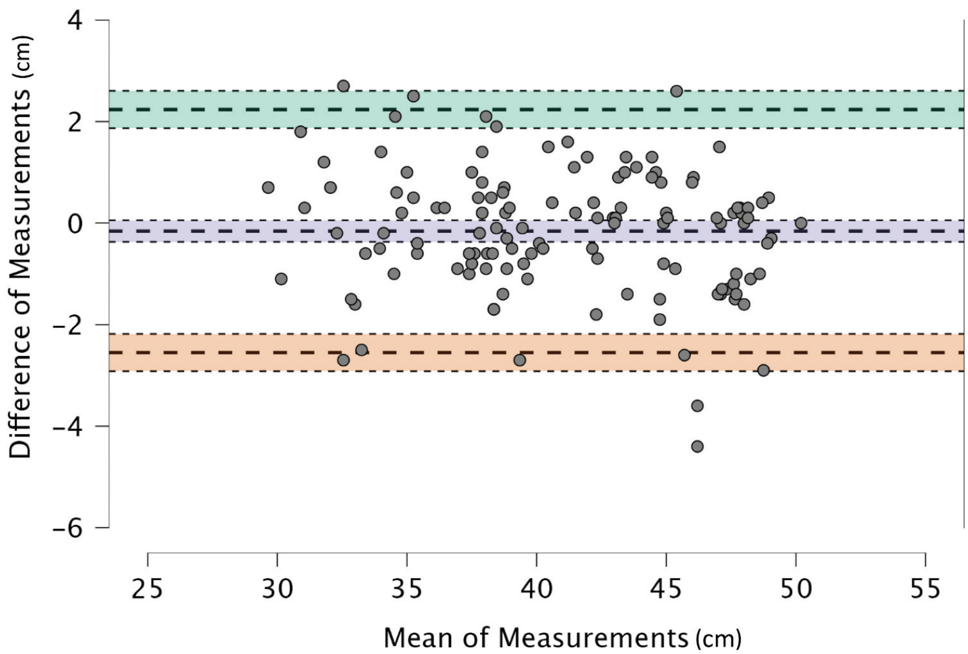

Figure 5. Bland–Altman plot for agreement between the GymAware unit 1 and the GymAware unit 2 in measuring jump height (cm).

Table 1. Reliability analysis.

Device	Mean (SD)	SEM (cm)	CV% (95% CI)	MDC_{95} (cm)
Force Plate	34.75 (5.53)	0.28	0.82 (0.72–0.96)	0.35
GymAware Unit 1	40.91 (5.35)	0.32	0.95 (0.83–1.11)	0.40
GymAware Unit 2	41.06 (5.89)	0.31	0.92 (0.80–1.07)	0.38

Discussion

This study evaluated the concurrent validity and intra-unit reliability of the GymAware RS linear position transducer (LPT) in measuring countermovement jump (CMJ) height. The results revealed a significant overestimation of jump height by the GymAware RS compared to a force plate (Forcedecks), yet demonstrated excellent measurement consistency across trials and between devices.

These findings are consistent with previous studies in the literature (O'Donnell et al., 2018). reported a mean overestimation of 7.0 ± 2.8 cm by the GymAware LPT in female athletes compared to a force plate. Similarly (Wadhi et al., 2018), found 8.68 ± 2.99 cm overestimations in CMJ height. In the present study, the GymAware RS units overestimated CMJ height by 6.16 cm and 6.31 cm (Units 1 and 2, respectively), further reinforcing this trend. These discrepancies are primarily attributable to fundamental methodological differences. In the present study, jump height was estimated using the flight-time method for both devices to ensure methodological parity during comparison. We acknowledge that while force plates or jump height estimation via flight time, the impulse-momentum method is regarded as the gold standard because it directly translates force-time data. The preference for force plates as a criterion measure is supported by their superior ability to acquire kinetic data. The specific choice of computational algorithm – such as flight-time versus numerical integration – is critical, as it directly influences the accuracy of jump height estimation (Chiu & Dæhlin, 2020). However, flight time was intentionally selected here to facilitate a direct comparison between the two technologies under typical field-testing conditions. Furthermore, LPTs derive jump height from cable displacement, which may capture vertical torso movement or slight deviations in the cable's path, inherently differing from the center-of-mass elevation measured by force plates.

Despite these absolute discrepancies, the reliability metrics of the GymAware RS units were highly favorable. Both units demonstrated coefficients of variation (CVs) well below the accepted 5% threshold—1.12% and 1.16%—showing comparable reliability to the force plate (CV = 1.43%). Additionally, the minimal difference between the two GymAware devices (MD = −0.16 cm) underscores strong intra-device consistency. These findings support the use of GymAware RS for tracking longitudinal changes in jump height performance, rather than for absolute measurement comparison against gold-standard equipment.

As noted in our results, while the consistency of the GymAware RS units is statistically robust, the 95% LoA of 4.79 cm warrants practical rather than statistical consideration. In the daily training environment, this range of random error is critical; for instance, a 2–3 cm fluctuation in an individual's jump height might be indistinguishable from the device's internal measurement noise. Therefore, we honestly advise practitioners to avoid swapping devices during an athlete's training block. To ensure that observed changes reflect true physiological adaptations rather than measurement artifacts, we recommend prioritizing longitudinal monitoring with a single, dedicated device per athlete.

It is crucial to emphasize that these results do not suggest that GymAware RS is interchangeable with force plates for performance monitoring or benchmarking. However, in applied settings, particularly where portability and time efficiency are priorities (e.g., team training environments), GymAware offers a practical and reliable alternative for monitoring neuromuscular readiness and fatigue (Akyildiz et al., 2022; Garrett et al., 2019, 2020). One limitation of the present study is the lack of a test – retest reliability assessment across multiple days, which has been evaluated in previous studies, such as those by O'Donnell et al. and Wadhi et al. Future investigations should further assess inter-day reliability to establish the tool's consistency over time. Moreover, the current study's sample comprised individuals at the recreational level, which may limit the generalizability of the results to elite athletic populations or clinical groups. A limitation of the study is that only male athletes were included; therefore, future studies should verify these findings in female populations.

Conclusion

GymAware RS LPT significantly overestimates CMJ height relative to a force plate; it demonstrates excellent intra-unit reliability and consistent measurement output. These findings align with existing literature and affirm GymAware RS as a dependable tool for monitoring performance trends over time. Coaches and sport scientists can confidently use GymAware RS to assess training effects, readiness, and fatigue in field settings, provided systematic overestimation is accounted for and cross-device comparisons are avoided. Future research should expand validation efforts across diverse populations and across multiple sessions to further support the practical deployment of this approach in elite sport contexts.

Acknowledgments

This study was presented as an oral presentation at the 30th Annual Congress of the European College of Sport Sciences (ECSS, 2025) held in Rimini, Italy.

Disclosure statement

No potential conflict of interest was reported by the author(s).

ORCID

Zeki Akyildiz http://orcid.org/0000-0002-1743-5989

References

Akyildiz, Z., Ocak, Y., Clemente, F. M., Birgonul, Y., Günay, M., & Nobari, H. (2022). Monitoring the post-match neuromuscular fatigue of young Turkish football players. *Scientific Reports*, *12*(1), 13835. https://doi.org/10.1038/s41598-022-17831-7

Alba-Jiménez, C., Moreno-Doutres, D., & Peña, J. (2022). Trends assessing neuromuscular fatigue in team sports: A narrative review. *Sports*, *10*(3), 33. https://doi.org/10.3390/sports10030033

Balsalobre-Fernández, C., & Torres-Ronda, L. (2021). The implementation of velocity-based training paradigm for team sports: Framework, technologies, practical recommendations and challenges. *Sports*, *9*(4), 47. https://doi.org/10.3390/sports9040047

Chiu, L. Z. F., & Dæhlin, T. E. (2020). Comparing numerical methods to estimate vertical jump height using a force platform. *Measurement in Physical Education and Exercise Science*, *24*(1), 25–32. https://doi.org/10.1080/1091367X.2019.1650044

Collings, T. J., Lima, Y. L., Dutaillis, B., & Bourne, M. N. (2024). Concurrent validity and test-retest reliability of VALD ForceDecks' strength, balance, and movement assessment tests. *Journal of Science & Medicine in Sport*, *27*(8), 572–580. https://doi.org/10.1016/j.jsams.2024.04.014

Crewther, B. T., Kilduff, L. P., Cunningham, D. J., Cook, C., Owen, N., & Yang, G.-Z. (2011). Validating two systems for estimating force and power. *International Journal of Sports Medicine*, *32*(4), 254–258. https://doi.org/10.1055/s-0030-1270487

Dragutinovic, B., Jacobs, M., Feuerbacher, J., Goldmann, J.-P., Cheng, S., & Schumann, M. (2024). Evaluation of the Vmaxpro sensor for assessing movement velocity and load-velocity variables: Accuracy and implications for practical use. *Biology of Sport*, *41*(1), 41–51. https://doi.org/10.5114/biolsport.2024.125596

García-Ramos, A., Jaric, S., Pérez-Castilla, A., Padial, P., & Feriche, B. (2017). Reliability and magnitude of mechanical variables assessed from unconstrained and constrained loaded countermovement jumps. *Sports Biomechanics*, *16*(4), 514–526. https://doi.org/10.1080/14763141.2016.1246598

Garrett, J., Graham, S. R., Eston, R. G., Burgess, D. J., Garrett, L. J., Jakeman, J., & Norton, K. (2019). A novel method of assessment for monitoring neuromuscular fatigue in Australian rules football players. *International Journal of Sports Physiology and Performance*, *14*(5), 598–605. https://doi.org/10.1123/ijspp.2018-0253

Garrett, J. M., Graham, S. R., Eston, R. G., Burgess, D. J., Garrett, L. J., Jakeman, J., & Norton, K. (2020). Comparison of a countermovement jump test and submaximal run test to quantify the sensitivity for detecting practically important changes within high-performance Australian rules football. *International Journal of Sports Physiology and Performance*, *15*(1), 68–72. https://doi.org/10.1123/ijspp.2019-0150

Gymaware. (2024). Gymaware rs specifications. https://gymaware.zendesk.com/hc/en-us/articles/4414960013199-GymAware-RS-Specifications

Hansen, K. T., Cronin, J. B., & Newton, M. J. (2011a). The reliability of linear position transducer and force plate measurement of explosive force-time variables during a loaded jump squat in elite athletes. *The Journal of Strength and Conditioning Research*, *25*(5), 1447–1456. https://doi.org/10.1519/JSC.0b013e3181d85972

Hansen, K. T., Cronin, J. B., & Newton, M. J. (2011b). The reliability of linear position transducer, force plate and combined measurement of explosive power-time variables during a loaded jump squat in elite athletes. *Sports Biomechanics*, *10*(1), 46–58. https://doi.org/10.1080/14763141.2010.547592

Harris, N. K., Cronin, J., Taylor, K.-L., Boris, J., & Sheppard, J. (2010). Understanding position transducer technology for strength and conditioning practitioners. *Strength & Conditioning Journal*, *32*(4), 66–79. https://doi.org/10.1519/SSC.0b013e3181eb341b

Linthorne, N. P. (2001). Analysis of standing vertical jumps using a force platform. *American Journal of Physics*, *69*(11), 1198–1204. https://doi.org/10.1119/1.1397460

Markovic, G., Dizdar, D., Jukic, I., & Cardinale, M. (2004). Reliability and factorial validity of squat and countermovement jump tests. *The Journal of Strength and Conditioning Research*, *18*(3), 551. https://doi.org/10.1519/1533-4287,(2004)18<551:RAFVOS>2.0.CO;2

Marrier, B., Le Meur, Y., Robineau, J., Lacome, M., Couderc, A., Hausswirth, C., Piscione, J., & Morin, J.-B. (2017). Quantifying neuromuscular fatigue induced by an intense training session in rugby sevens. *International Journal of Sports Physiology and Performance*, *12*(2), 218–223. https://doi.org/10.1123/ijspp.2016-0030

O'Donnell, S., Tavares, F., McMaster, D., Chambers, S., & Driller, M. (2018). The validity and reliability of the GymAware linear position transducer for measuring counter-movement jump performance in female athletes. *Measurement in Physical Education and Exercise Science*, *22*(1), 101–107. https://doi.org/10.1080/1091367X.2017.1399892

Orange, S. T., Metcalfe, J. W., Liefeith, A., Marshall, P., Madden, L. A., Fewster, C. R., & Vince, R. V. (2019). Validity and reliability of a wearable inertial sensor to measure velocity and power in the back squat and bench press. *The Journal of Strength and Conditioning Research*, *33*(9), 2398–2408. https://doi.org/10.1519/JSC.0000000000002574

Pérez-Castilla, A., Feriche, B., Jaric, S., Padial, P., & García-Ramos, A. (2017). Validity of a linear velocity transducer for testing maximum vertical jumps. *Journal of Applied*

Biomechanics, *33*(5), 388–392. https://doi.org/10.1123/jab.2016-0142

Pérez-Castilla, A., Piepoli, A., Delgado-García, G., Garrido-Blanca, G., & García-Ramos, A. (2019). Reliability and concurrent validity of seven commercially available devices for the assessment of movement velocity at different intensities during the bench press. *The Journal of Strength and Conditioning Research*, *33*(5), 1258–1265. https://doi.org/10.1519/JSC.0000000000003118

Reeve, T. C., & Tyler, C. J. (2013). The validity of the SmartJump contact mat. *The Journal of Strength and Conditioning Research*, *27*(6), 1597–1601. https://doi.org/10.1519/JSC.0b013e318269f7f1

Ruiz-Alias, S. A., Şentürk, D., Akyildiz, Z., Çetin, O., Kaya, S., Pérez-Castilla, A., & Jukic, I. (2024). Validity and reliability of velocity and power measures provided by the vitruve linear position transducer. *PLOS ONE*, *19*(10), e0312348. https://doi.org/10.1371/journal.pone.0312348

Şentürk, D., Yüksel, O., & Akyildiz, Z. (2024). The concurrent validity and reliability of the My jump Lab smartphone app for the real-time measurement of vertical jump performance. *Proceedings of the Institution of Mechanical Engineers, Part P: Journal of Sports Engineering and Technology*. https://doi.org/10.1177/17543371241246439

Street, G., McMillan, S., Board, W., Rasmussen, M., & Heneghan, J. M. (2001). Sources of error in determining countermovement jump height with the impulse method. *Journal of Applied Biomechanics*, *17*(1), 43–54. https://doi.org/10.1123/jab.17.1.43

Twist, C., & Highton, J. (2013). Monitoring fatigue and recovery in rugby league players. *International Journal of Sports Physiology and Performance*, *8*(5), 467–474. https://doi.org/10.1123/ijspp.8.5.467

Wadhi, T., Rauch, J., Tamulevicius, N., Andersen, J., & De Souza, E. (2018). Validity and reliability of the GymAware linear position transducer for squat jump and counter-movement jump height. *Sports*, *6*(4), 177. https://doi.org/10.3390/sports6040177

Walsh, M. S., Ford, K. R., Bangen, K. J., Myer, G. D., & Hewett, T. E. (2006). The validation of a portable force plate for measuring force-time data during jumping and landing tasks. *The Journal of Strength and Conditioning Research*, *20*(4), 730. https://doi.org/10.1519/R-18225.1

Weir, J. P. (2005). Quantifying test-retest reliability using the intraclass correlation coefficient and the SEM. *The Journal of Strength and Conditioning Research*, *19*(1), 231. https://doi.org/10.1519/15184.1