The Validity & Reliability of the Danu System for Countermovement Jumps

Introduction

Vertical jump performance, specifically Jump Height (JH), is considered a crucial functional parameter for athletic populations [1]. The Countermovement Jump (CMJ) is instrumental in assessing vertical jump capabilities as it offers insights into an athlete's stretch-shortening cycle [2] enables effective monitoring of neuromuscular fatigue [3], evaluates interlimb asymmetries [4], and identifies differences between distinct populations [5]. Traditionally, practitioners have employed force plates to assess CMJ height, which are widely regarded as the gold standard [6] [7] [8]. Recently, however, there has been a shift towards more cost-effective and practical alternatives that can be integrated into natural sporting environments, facilitated by advances in wearable technology [9]. This study aims to investigate the concurrent validity and reliability of the Danu Sports system in measuring Countermovement Jump height and flight time, comparing its performance against that of a force plate (ForceDecks Dual Force Plate System, VALD Performance PTY LTD, Queensland, Australia).

Method

Forty team sport players (21 males, 19 females) volunteered for this study. Participants were asked to perform three countermovement jumps (CMJs) while wearing Danu socks (figure 1a) and using their own footwear on Vald ForceDecks (figure 1b).

Both Flight Time and Jump Height was calculated by identifying final contact and initial contact, through custom algorithms developed to process the raw sensor data collected from the Danu socks. Jump height is derived from flight time [10] as shown in equation 1. Vald automatically outputs both flight time and jump height through their software.

$$\text{Jump height (cm)} = \frac{t^2 \cdot g}{8} \qquad (1)$$

A total of 117 CMJs were recorded, with 3 CMJs being missed on the Vald system. The data analysis included Intraclass Correlation Coefficient, Pearson Correlation Coefficient, Bland-Altman Analysis, Adjusted R^2, Mean Absolute Error (MAE), and Root Mean Square Error (RMSE), selected for their robustness in assessing measurement accuracy and agreement between the Danu system and Vald ForceDecks.

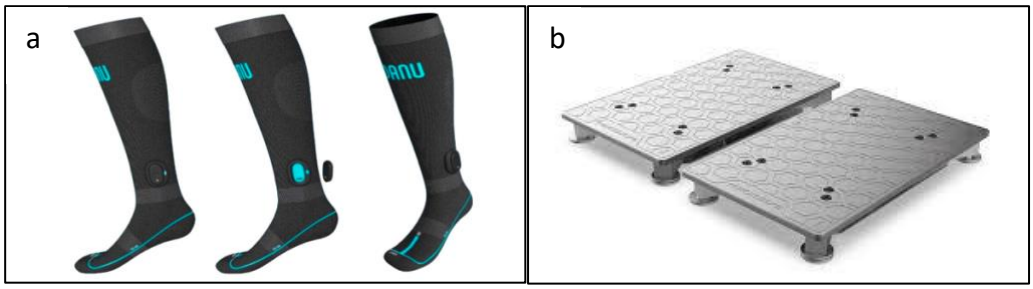

Figure 1. (a) Danu Sports Smart Sock. (b) Vald ForceDecks Force Plates.

Results

The Intraclass Correlation Coefficient (ICC) values derived from comparisons between the Danu system and the Vald force plates were consistently > 0.9 (0.96-0.97), indicating an exceptional level of agreement between the two measurement systems [11]. The results highlight the reliability and accuracy of the Danu system in replicating measurements obtained from the force plates with the Bland-Altman analysis mean difference sat at 0s for flight time and -0.02cm for jump height with no significant systematic bias, and the Pearson R^2 values of 0.95 for both metrics. For a detailed breakdown of the results for each metric along with the statistical analyses conducted, refer to table 1.

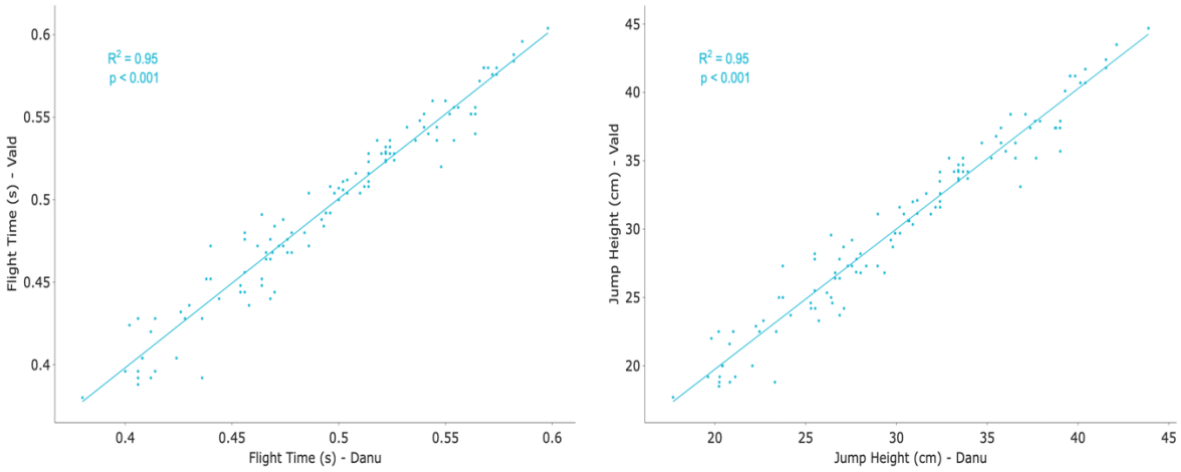

Figure 2. Scatter plot comparison for flight time (s) and jump height (cm), Danu Vs. Vald

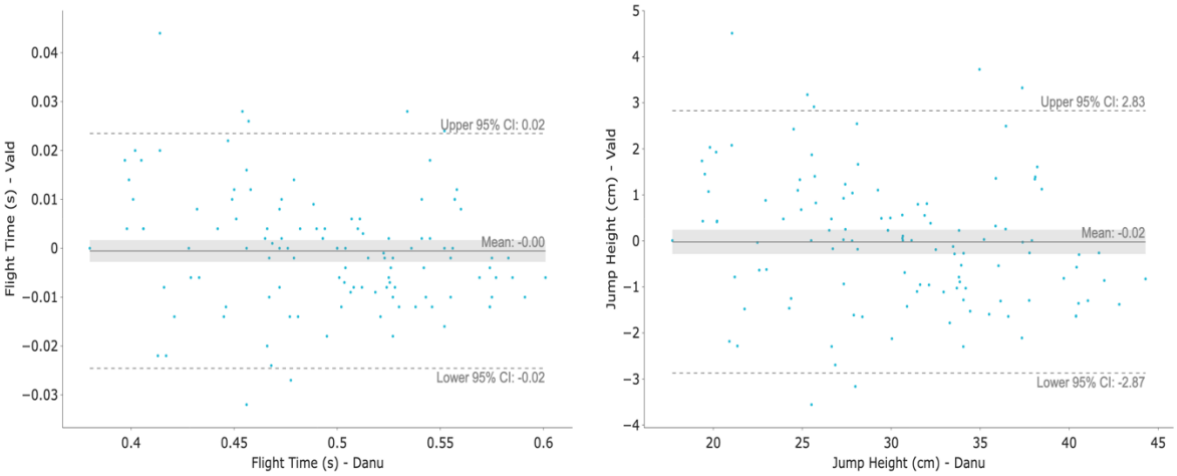

Figure 3. Bland-Altman plot for comparison between Danu and Vald for flight time (s) and jump height (cm).

Table 1. Statistical analysis outcomes.

Metric	*MAE*	*ICC (2,1)*	*Pearson r*	*Adj. R^2*	*Pearson p*	*RMSE*	*Bland-Altman (Mean, upper, & lower limits)*
Flight Time (s) (n = 117)	0.01	0.97	0.98	0.95	<0.001	0.013	0.00, +0.02, -0.02
Jump Height (cm) (n=117)	1.34	0.96	0.98	0.95	<0.001	1.83	0.02, +2.83, -2.87

Mean Absolute Error (MAE), ICC(2,1), Root Mean Square Error (RMSE), Pearson Correlation, Adjusted R^2, Bland-Altman (Mean difference, Upper 95% CI, lower 95% CI)

Conclusion

The results demonstrate a strong correlation and excellent agreement between the Danu system and Vald force plates, underscoring the high validity and reliability of the Danu system in measuring biomechanical metrics comparable to those captured by the force plates, similar to previous studies conducted on wearable technology [12] [13] [9]. Therefore, the Danu system is a valid and reliable product that can be used for precise biomechanical assessments applicable in both research and clinical settings. Future independent studies could help to verify these findings.

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