Jump performance is crucial to measure in sports such as basketball, soccer, and volleyball as this correlates with athletic success due to the power needed for quick movements (Ma et al., 2025). Vertical jump height measures how high one can jump upward using only the muscle force of the lower extremities (Coviello, 2023). This requires a combination of technique and physical strength to increase force and velocity. In volleyball, vertical jump height correlates with spiking, blocking, and serving, in basketball, it favors shooting and rebounding, and in soccer, jump height is critical for physical testing and talent selection (Ma et al., 2025). In the NBA, vertical jump records that are considered to be elite are usually forty-six inches or higher (Coviello, 2023). Even though jump height is crucial in analyzing optimal performance, there are multiple ways to measure jump height, leading to different values from the same jump (Eythorsdottir et al., 2024). Therefore, it is important to determine which equation should be used for each sport or even each jump height (countermovement jumps, squat jumps, drop jumps, and loaded jumps) as this could affect player stats and their chance to play on a professional level. In order to maximize an athlete's jump height data, there are other metrics that need to be taken into consideration as well. The average braking force, average propulsive force, the propulsive phase, and the braking phase should all be studied in relation to jump height to gain a broader understanding.

Average braking force reflects an athlete's ability to decelerate and absorb force during landing and change of direction tasks, making it a meaningful indicator of lower body neuromuscular control. In basketball, athletes frequently perform rapid stops, cuts, and jump landings that require high eccentric force production to safely slow the body before reaccelerating. Research has shown that braking related force time characteristics during countermovement jumps are associated with performance qualities relevant to deceleration and movement control (Harper et al., 2022). Athletes who can tolerate and apply greater braking forces tend to demonstrate more efficient deceleration strategies, which may translate to improved on court performance. Beyond performance, braking force is also useful for injury risk monitoring. Deceleration and landing phases impose substantial eccentric loads on the lower extremities, particularly at the knee and ankle joints. Previous research has demonstrated that reduced eccentric strength and poor force absorption capacity are associated with altered landing mechanics and increased lower extremity loading, which may elevate injury risk during sport specific movements (Dos'Santos et al., 2018). Because average braking force captures an athlete's ability to manage these loads, it is commonly used in applied sports science settings to monitor readiness and guide training interventions. Braking force is modifiable through targeted strength and plyometric training, making it a practical metric for ongoing performance monitoring and athlete development.

Closely related to the braking force, the braking phase measures the deceleration of an athlete as they continue a downward movement before changing direction, providing key insight into how efficiently and safely an athlete can slow down during dynamic actions. This metric is important for athletic performance because decelerating too quickly can increase the risk of injury, while slowing down too slowly can reduce performance during critical game moments

(Harper et al. 2020). Research also shows that the braking phase offers valuable information about an athlete's neuromuscular potential, helping trainers design individualized training programs (McMahon, 2024). Although there are no universally established normal or elite values for the braking phase, a study by Beattie et al. (2020) comparing elite and sub-elite athletes found significant differences in three of the four braking-related metrics, with elite athletes demonstrating faster and more powerful reaction patterns. Existing literature commonly refers to the braking phase as the deceleration phase and emphasizes not only the timing but also the force and power produced during this movement (Harper et al., 2020). While a substantial amount of research already exists, particularly in sports involving jumping and sprinting, there are still opportunities to expand understanding across different sports and competitive levels to identify better ideal braking characteristics, injury-prevention strategies, and performance indicators. Comparisons across teams, positions, or roles may also offer novel insights; for example, examining braking-phase differences between offensive and defensive players could help determine how deceleration abilities influence overall team performance.

In contrast to deceleration-focused metrics, Average Propulsive Force captures the magnitude of force an athlete produces during the upward acceleration phase of a vertical jump. In terms of athletic performance, it is a key contributor to the explosive capabilities of the lower body. In this phase, ground reaction force drives upward acceleration of the center of mass and sets the takeoff velocity. Sports such as basketball, volleyball, and soccer are heavily reliant on this ability, especially in actions like rebounding, blocking, and jumping. While typical values for propulsive force differ by sex, training experience, and sport, athletes generally fall within predictable ranges, with higher trained and more explosive athletes producing substantially greater outputs (Cormie et al., 2009). Although there is no single universal reference chart for propulsive force, previous research provides supporting evidence that trained athletes produce substantially higher propulsive outputs than untrained individuals.

Comparative studies show that collegiate and elite athletes produce markedly higher propulsive force, highlighting their enhanced capacity for rapid and forceful upward acceleration (Cormie et al., 2009; Hori et al., 2008). Research on force time curve phases supports this emphasis on propulsion, describing it as the moment when athletes extend the hips, knees, and ankles to drive the center of mass upward and achieve vertical takeoff (McMahon et al., 2018). Because the greatest force and velocity occur simultaneously during this phase, it is also where the highest power outputs are produced. Additional evidence demonstrates that propulsive force variables are associated with explosive movement performance, especially when athletes complete power training interventions. Average Propulsive Force is therefore not only associated with current explosive performance, but is also highly sensitive to changes in training (Cormie et al., 2009; Hori et al., 2008). Together, these studies show that propulsive force varies meaningfully across performance levels and that higher propulsive force reflects superior neuromuscular ability to accelerate upward, contributing to greater jump height.

Jump performance is commonly assessed using the countermovement jump (CMJ) performed on a force plate, which provides insight into neuromuscular function and readiness to train. Many components are measured during the jump, all of which collectively tell a story (Bishop et al., 2022). These metrics can be divided into the two main phases of the CMJ prior to flight, being the braking (eccentric) and propulsive (concentric) phases. Within the concentric phase, there are several metrics to look at regarding the quality of the rep. One such metric is the length of the phase, which affects the power and velocity of the jump (Merrigan et al., 2020). Though it is not the only metric to show an increase between elite and sub-elite athletes, the duration of the concentric phase did see an increase alongside jump height (Beattie et al., 2020). This research was done on a small group of male sprinters which limited the relevance of these results in other sports. Differences in propulsive phase duration were seen between athletes of different sports (Donahue et al., 2023). The duration of the propulsive phase in volleyball players was generally longer than basketball, and even more so in beach volleyball. However, the highest jump height was seen in volleyball players, suggesting a lack of correlation between propulsion length and jump height.

Overall, the literature supports a multifactorial approach to jump performance assessment, in which outcome measures such as jump height are interpreted alongside force, power, and temporal variables. Evaluating braking and propulsive characteristics together provides a more complete understanding of athletic performance, neuromuscular function, and injury risk, reinforcing the value of integrated force plate analysis in both research and applied sport settings.

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