

The purpose of this brief literature review is to contextualize the five performance metrics selected from our collegiate athletics database for the remainder of this project. Based on the metric discovery in Part 1.3, our group identified System Weight, Peak Velocity, Average Propulsive Force, Jump Height, and Peak Propulsive Force as metrics that were well-represented in the dataset across multiple teams and sports. These variables contain fundamental elements of mechanical force production, neuromuscular output, and explosive performance. To support why we selected these metrics, we reviewed sports-science research that describes what each metric measures, why it matters for athletic performance, what typical values look like, and where current research is still lacking, which helps show how our dataset can contribute.

### *System Weight*

System Weight refers to the total load acting on the athlete during a force-plate assessment, calculated as body weight plus any external mass. System weight is essential for evaluating all force-plate-based measurements since raw force outputs must be normalized in relation to the load being moved, even though it is not usually viewed as a standalone performance variable. Foundational physiology research emphasizes the central role of body mass in regulating energy expenditure, movement efficiency, and force generation (Keesey, 1993). Similarly, early work in sports physiology demonstrates that accurate system-weight measurements are required to derive center-of-mass displacement, impulse, and relative force production (Wilmore & Costill, 1994). To establish meaningful comparisons among athletes and sports, it is crucial to adjust those numbers to system weight because bigger individuals inherently produce more total force. Despite the widespread usage of this modification, relatively little research has been done that explicitly compares system-weight-normalized force outputs across other sports. The literature primarily addresses body mass conceptually rather than analyzing system-weight differences using large, real-world, multi-team datasets—a gap our dataset is uniquely positioned to address.

### *Peak Velocity*

Peak velocity is the highest speed an athlete reaches during a movement, whether they're sprinting, jumping, or performing a loaded exercise. It is frequently used to evaluate training adaptations, explosive capacity, and neuromuscular efficiency. In soccer, peak velocity has strong relevance to maximal sprinting performance and match demands; recent work demonstrates that accurate measurement tools are essential for determining true peak sprint speed in field-based environments (Baena-Rodríguez et al., 2022). Resistance-training research similarly shows that peak velocity responds sensitively to load manipulation and athlete readiness (Cormie et al., 2012). Device-comparison research has also highlighted differences in the validity of mean and peak velocity outputs across linear transducers, force plates, and wearable sensors, emphasizing the importance of selecting appropriate measurement tools (García-Ramos et al., 2018). Sports have different normative ranges; collegiate soccer players usually reach peak speeds of 7 to 9

m/s. Nevertheless, the majority of velocity-based research focuses on a single sport, which leaves a void in cross-sport comparisons utilizing standardized measuring techniques—a feature that our dataset fills.

### *Average Propulsive Force*

Average Propulsive Force quantifies the mean force generated during the upward, propulsive phase of a vertical jump or similar movement. This metric reflects an athlete's ability to apply high levels of force efficiently during explosive tasks. Research in sport biomechanics demonstrates that propulsive force strongly predicts jump height, sprint acceleration, and overall lower-body power (Bobbert et al., 1992). Modern force-plate and sensor-based methodologies have validated the detection of propulsive phases with strong reliability, supporting their use in athlete monitoring (Sensors, 2023). Propulsive force also increases systematically with jump intensity and external load, confirming its sensitivity to training and effort manipulation (Bobbert et al., 1992). Even though propulsive force is an important measure, most research looks at it in single sports or in very controlled lab settings. There is very little work comparing propulsive-force patterns across different collegiate teams using real-world, integrated datasets, which is a gap our analysis can help fill.

### *Jump Height*

Jump Height is one of the most widely used indicators of lower-body power and neuromuscular function. It reflects the vertical displacement of the center of mass during a jump and is influenced by stretch-shortening cycle efficiency, leg stiffness, and muscular strength. Numerous studies validate the use of force plates to calculate jump height and highlight differences in calculation methods such as impulse-momentum, flight time, and optical tracking (Taylor et al., 2021). Normative data suggest that collegiate male athletes typically achieve jump heights of 0.45–0.60 m, while collegiate female athletes reach 0.30–0.45 m (Topend Sports, n.d.). Research also demonstrates that optimal drop-jump height occurs at roughly 75% of an athlete's maximal vertical jump, indicating sport- and ability-specific adaptations (Peng et al., 2017). Jump height is a reliable indicator of neuromuscular fatigue, as reductions in height commonly appear following intensive training or competitive play (Alba-Jiménez et al., 2022). Although jump height has been widely researched, much of the work is confined to single sports or controlled laboratory environments. There remains a noticeable lack of long-term, multi-sport analyses using real collegiate testing data.

### *Peak Propulsive Force*

Peak Propulsive Force refers to the maximum force produced during the propulsive phase of a jump. It is closely linked to explosive performance qualities such as sprint acceleration, jump

takeoff velocity, and rapid force development. Sports biomechanics literature highlights peak propulsive force as a key determinant of explosive strength and a sensitive indicator of neuromuscular fatigue or adaptation (Reiser et al., 2000). Textbook-level analyses confirm its relevance for evaluating mechanical output in high-performance athletes (Knudson & Morrison, 2002). Methodological research also supports the validity and reliability of force-plate-derived propulsive-force metrics across repeated testing (Sensors, 2023). Even so, only a small number of studies have looked at how peak propulsive force varies across different collegiate sports or how it changes over time in real training settings. This leaves meaningful opportunities for exploration within our dataset.

### *Conclusion*

Across all five metrics, a clear research gap emerges. Single-sport analysis, lab-based research, and elite male athlete cohorts predominate in the body of current literature. Research utilizing large, integrated, multi-team collegiate datasets with both force-plate and GPS parameters is conspicuously lacking. Few studies have looked at the relationship between explosive performance in various sports and system weight normalized outputs, and even fewer have compared these associations across time. The strengths of our dataset, which includes repeated measurements across teams, sports, and testing methods, are clearly aligned with these gaps.

### *Research Question:*

How do the five metrics: system weight, peak velocity, jump height, peak propulsive force, and average propulsive force outputs vary across athletes from multiple collegiate sports, and how do these values compare to known normative ranges?

### *Hypothesis:*

1. Athletes who play strength-oriented sports (like basketball or football) will have greater propulsive force and jump height values, while athletes who play sports that emphasize speed and endurance (like soccer) will have higher peak velocity outputs.
2. System-weight normalization will improve athlete comparability and lessen variability caused by variations in body mass.

This analysis is useful because it closes the gap between athlete monitoring in the real world and controlled laboratory investigations. We can produce useful insights for coaches, athletic trainers, and sports-performance personnel by basing our metric selection on evidence-based literature and applying it to a multi-team collegiate dataset. The results could help with load-management decisions, enhance athlete readiness monitoring, and reveal sport-specific performance profiles that are missed by conventional study methodologies.