**Metrics Summary & Why:**

- The five selected metrics - Peak Propulsive Power, Jump Height, Peak Velocity, Maximum Sprint Speed, and Total Distance - **present a multifaceted framework** for evaluating athletic performance based on the concepts of RFD[1] and ME&GC[2].
- While Jump Height is well-studied, newer indices like the peak propulsive power (PPP), and peak velocity offer greater sensitivity but are underused across sports and genders[3].
- Workload metrics, including speed max and total distance, are essential for contextualizing performance but are inconsistently reported and rarely integrated with neuromuscular indicators[4].
- Collectively, these five metrics comprehensively assess neuromuscular function, speed-power characteristics, and workload, which provides essential insights for both capacity evaluation and fatigue monitoring in athletes [4].
- Their application is broadly relevant across team and individual sports, and are especially relevant for expanding research among female athletes[5].

**Brief review for each (3-5 key citations per metric):**

1. Peak Propulsive Power (W): Peak propulsive power is the maximum mechanical work output during the concentric phase of a countermovement jump, calculated as force multiplied by velocity at the moment of highest power[6]. It is a key predictor of explosive performance, showing very strong correlations with jump height ($r > 0.90$) and sprint speed ($r = 0.79$), which makes it essential for assessing and monitoring lower-body explosiveness in team sport athletes[7].

2. Jump Height (m): Jump height measures how high an athlete lifts their center of mass during a vertical jump and is the most common way to assess lower-body power[8]. The Countermovement JUmp (CMJ) test is easy, reliable, and strongly linked to sprinting ability ($r = 0.75$-$0.89$) and

strength, making it useful for identifying talent, monitoring fatigue, and evaluating training effects across various sports[9-11]

3. Peak velocity (m/s): Peak velocity is the highest speed reached during movement, such as the take-off speed in jumps, which directly determines how high an athlete flies [12]. It is almost perfectly correlated with jump height (r = 0.96), and in sprinting, peak velocity separates faster athletes from slower ones, with elite male sprinters reaching about 12 m/s[12,13].

4. Speed max (m/s): Speed max is the highest speed an athlete reaches during a straight sprint, measured with GPS, timing gates, or radar[14]. It reflects an athlete's top speed ability, relates closely to jump performance (r = 0.75–0.89), and is critical for success in sports like football and basketball, with differences seen across playing positions[15].

5. Total distance (m): Total distance is the total ground covered by an athlete during training or competition, measured with GPS or local positioning systems[16,17]. It reflects the volume of work done and has a weak correlation with neuromuscular metrics (r = 0.15–0.38), serving as a key marker for managing training load, injury risk, and sport-specific demands when combined with intensity measures [18].

**Research Question:**

Given the 548 unique metrics in the sports database, how can the relationship between rate of force development and movement and gait complexity be best understood through analysis of the five selected metrics: Peak Propulsive Power, Jump Height, Peak Velocity, Maximum Sprint Speed, and Total Distance, and do these relationships differ by sex?

**Brief justification:**

1) Female athlete research gap: Female participation in elite sports is nearly equal to men's, but sports science research remains heavily biased: about 70.7% of studies focus on males, while

only 8.8% focus on females, creating significant gaps in understanding female athlete performance [19,20]. Expanding research with larger female samples and longitudinal monitoring is needed to develop sex-specific training programs and unlock untapped performance potential in women athletes [21].

2) Practical training guidelines: By establishing the correlation structure among all six metrics, this study equips strength and conditioning coaches to identify which capacity metrics best predict performance outcomes, design targeted training interventions, develop position- and sex-specific training protocols, and prioritize assessment batteries based on their predictive validity. These insights enable more individualized and effective training program designs.

3) Evidence base for performance prediction: By establishing the correlation matrix with all six metrics, this study lays the groundwork for developing composite performance indices, creating predictive models for game readiness, and distinguishing between redundant and complementary metrics in assessment batteries, enhancing the efficiency and precision of athlete evaluation and training design.

4) Testing metric cluster empirically: Our correlation and factor analyses will clarify whether Peak Propulsive Power and mRSI group as “capacity” metrics, Jump Height, Peak Velocity, and Sprint Speed cluster as “outcome” metrics, and Total Distance forms a separate “load/volume” cluster. This empirical validation also examines if these clusters differ by sex, providing critical insights for practitioners on how to conceptualize and apply performance testing more effectively.

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