Literature review

Please refer to Project.md Part 1.4.1 for full discussion.

Introduction: This literature review examines five athletic performance metrics commonly used in both male and female basketball team performance assessment and monitoring. These metrics were selected to represent two fundamental constructs: Rate of Force Development (RFD) metrics that reflect an athlete's ability to generate force rapidly, and Movement Efficiency/Gait Complexity metrics that capture how effectively athletes translate force production into functional movement outcomes during dynamic basketball-specific tasks.

Construct 1: Rate of Force Development (RFD) Metrics

- Peak Propulsive Power (W) reflects maximal mechanical output during the concentric phase of a jump and is sensitive to fatigue, providing utility for tracking explosive strength.
- Jump Height (m): is the most frequently studied neuromuscular metric in collegiate sports, particularly in basketball. Derived from countermovement jumps, it reflects lower-limb power output.

These 2 metrics reflect an athlete's explosive strength capacity, i.e., the ability to generate high levels of force in minimal time and convert that force into vertical displacement. Research confirms that RFD is an expression of explosive strength that seems to be better related to most performances of both sport-specific and functional daily tasks compared to pure maximal voluntary contraction strength[1]. Jump height is included as an RFD metric because it represents the direct outcome of rapid force application during the propulsive phase, with research showing very strong correlations between peak power and jump height, suggesting they measure the same underlying explosive capacity[2,3].

Construct 2: Movement Efficiency/Gait Complexity Metrics

- Peak Velocity (m/s) serves as a reliable indicator of explosive output and limb symmetry.
- Maximum Sprint Speed or Speed Max (m/s) is defined as the highest sprint velocity achieved, and is critical for workload monitoring.
- Total Distance (m) quantifies cumulative movement load and is central to workload monitoring.

These 3 metrics reflect movement efficiency and gait complexity during dynamic basketball tasks. Peak Velocity and Maximum Sprint Speed reflect the efficiency of translating force into horizontal and vertical speed[4,5]. Total Distance captures gait complexity and movement economy across accumulated locomotor patterns[6].

Together, these 5 metrics represent how efficiently and adaptively athletes move during sustained and varied locomotor tasks.

Why these metrics:

Based on the dataset, Hawkins and Kenxion metrics, only these 5 stood-out for availability, quality, and cross-sport coverage:

1. Jump Height (in top 10 Hawkins metrics by count)

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2. Peak Propulsive Power (in top 10 Hawkins metrics by count)
3. Peak Velocity (in top 10 Hawkins metrics by count)
4. Speed Max (top Kinexon metric tested for Women's Basketball)
5. Distance total (in top 10 Kinexon metrics by count)

These five metrics also:

1. Meet the force-outcome relationship where RFD metrics (raw force capacity) may predict ME&GC metrics (how well force translates to movement)
2. Are feasibly measured using common equipment (force plates, GPS devices)
3. Have established validity in team sport contexts
4. Address research gaps particularly for female athletes and basketball-specific populations
5. Enable practical applications for determining whether to train force production or movement efficiency

Brief review for each with 3-5 key citations per metric)

1) Peak propulsive power: Represents the maximum mechanical work output during the concentric phase of a countermovement jump, calculated as force × velocity at the instant of highest power generation. It is one of the strongest predictors of explosive athletic performance, with research consistently demonstrating very strong correlations with jump height ($r > 0.90$) and sprint performance ($r = 0.79$). Peak power serves as a fundamental metric for assessing lower-body explosiveness and monitoring training adaptations in team sport athletes. (Please see Appendix 1 for references)

2) Jump height: It quantifies vertical displacement of the center of mass during vertical jumps and is the most widely used measure of lower-body power. It is simple, practical, valid, and very reliable compared to other jump tests, demonstrating strong relationships with sprint performance, maximal strength, and explosive-strength tests. Jump height has direct basketball-specific relevance for rebounding, blocking, and shooting performance. (Please see Appendix 1 for references

3) Peak velocity: It represents maximum instantaneous speed during movement, the take-off velocity in jumps (which directly determines jump height) or maximum running velocity during sprints. It is the ultimate expression of explosive power, with larger net impulse during propulsion leading to greater take-off velocity and higher jumps. Maximum velocity during sprinting shows near-perfect correlations with sprint performance and is the most important variable distinguishing faster from slower elite sprinters (ES = 3.69). Peak velocity captures an athlete's ability to maximize force output in minimal time, critical for basketball's rapid accelerations. (Please see Appendix 1 for references)

4) Speed Max: It represents the highest velocity achieved during linear sprinting, typically measured via GPS, timing gates, radar guns, or laser systems. It is directly related to decisive game actions in basketball and team sports. Sprint performance depends on trainable determinants including power, technique, and sprint-specific endurance, though genetic traits play a significant role. Maximum velocity shows near-perfect correlations with all 20m sections of 100m sprints and is the most distinguishing variable between performance levels in elite athletes. (Please see Appendix 1 for references)

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5) Total distance: It represents cumulative distance traveled during training sessions or matches, measured via GPS or Local Positioning Systems. It quantifies overall locomotor work volume and serves as the primary marker of external training/match load. GPS devices combined with physiological measurements have become reliable tools for characterizing movement patterns and assessing external load, internal load, fatigue, and performance. Total distance is essential for managing training periodization, preventing overtraining, and understanding sport-specific demands, though it shows weak correlations with neuromuscular capacity metrics. (Please see Appendix 1 for references)

Potential research question or hypothesis based on identified gaps

What are the most important metrics for Rate of Force Development (RFD) and Movement-Efficiency & Gait-Complexity (ME&GC), and how do female and male athletes perform in these metrics?

Justification for why your analysis will be valuable

1. Identifies Critical Female Athlete Research Gap: In recent decades, women's participation in sports has grown significantly, reaching near parity with men in major competitions such as the 2024 Paris Olympics. However, this progress has not been mirrored in sports science research, where women remain underrepresented both as research subjects and academic leaders[7]. Research emphasizes that individual requirements in women's sports have been included too little (or partly not at all) for too long and that therefore an enormous performance potential still lies dormant in the teams[8].

2. Provides Practical Training Guidance: The CMJ has been directly linked with 0-30m sprint performances and relative strength during dynamic 1RM squat and power clean. This suggests those who perform better in the CMJ, also perform better during sprint performances and 1RM tests[9]. Research shows these findings may help practitioners obtain a better insight into position-specific differences with regards to CVJ force-time characteristics as well as aid with individually tailored training regimen design[10].

3. Recommends Enhanced Fatigue Monitoring: Concentric impulse, peak velocity, mean force, mean power, and peak power experienced significant decreases post-practice, alongside lower vertical jump height and reactive strength index-modified values[11].Understanding how Total Distance correlates with these changes informs load management.

4. Supports Performance Prediction: Performance was quantified at the player level using the reactive strength index modified (RSImod), and models could predict RSI and game score with greater than 90% accuracy and a 0.9 F1 score[12] . Peak power derived from a countermovement jump provides insights into which athletes are better prepared each week, and maximum speed depicts high-intensity moments in competitions[12].

5. Tests Metric Clustering Empirically: It can help determine whether the six metrics cluster as hypothesized (capacity vs. outcomes vs. load) and whether these patterns differ by sex, something not previously established in collegiate basketball.

Conclusion: This literature review gives a strong basis for the research question and line of inquiry that leads to a focused and meaningful research effort.

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References *support the two constructs and justification*

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Appendix 1 *lists references for 5 Metrics.*

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