Our analysis focuses on five explosive power metrics selected based on their robust representation within the SBU athletics database: Jump Height, Peak Propulsive Force, Peak Velocity, Propulsive Net Impulse, and Modified Reactive Strength Index (mRSI). These metrics were chosen because they demonstrate strong sample sizes across multiple teams with consistent temporal coverage, enabling meaningful longitudinal and comparative analyses.

Jump height, measured through countermovement jumps, represents the most fundamental metric of explosive lower-body power and has become one of the most frequently used tests by coaches and researchers (Markovic, 2007). Research demonstrates that plyometric training produces statistically significant improvements in vertical jump height, with effect sizes ranging from approximately 5% for squat jumps to 9% for countermovement jumps (De Villarreal et al., 2009). In professional basketball, greater vertical jump height has been strongly correlated with playing time in NCAA Division I athletes, highlighting its relevance for competitive selection and performance evaluation (Hoffman et al., 1996). Training interventions demonstrate that improvements in jump performance occur principally through increased countermovement magnitude and maintaining high concentric forces for longer periods (Morris et al., 2022). However, research emphasizes that jump height alone may not be a systematically reliable indicator of power output capacity without contextual analysis of force-time metrics.

Peak propulsive force represents the maximum vertical ground reaction force generated during the concentric phase of a jump, providing direct insight into biomechanical efficiency during explosive movements. This metric demonstrates high reliability with intraclass correlation coefficients of 0.94 (Hori et al., 2009). Athletes demonstrating peak force at the low position of the countermovement show more efficient unweighting and braking phase characteristics compared to those reaching peak force at different movement phases (McHugh et al., 2021). Elite high jumpers generate peak vertical forces ranging from approximately 2,600N to 3,400N during take-off, demonstrating the magnitude of force production in specialized jumping athletes (Linthorne, 2001).

Peak velocity quantifies the maximum upward speed of the center of mass during the propulsive phase of jumping and represents the culmination of force application. This metric demonstrates exceptional reliability with intraclass correlation coefficients of 0.98 in research settings (Hori et al., 2009). The biomechanical relationship between force, velocity, and power makes peak velocity a critical indicator of an athlete’s ability to rapidly accelerate their body mass, with this quality transferring directly to sprint acceleration and change of direction speed (Samozino et al., 2012). Research on force-velocity profiles reveals that individual athletes demonstrate varying characteristics, with some showing force-dominant profiles while others exhibit velocity-dominant patterns, suggesting the value of comprehensive profiling approaches (Samozino et al., 2012).

Propulsive net impulse represents the net vertical impulse applied to the system center of mass during the propulsive phase of a jump, quantifying the total force applied over time according to the impulse-momentum theorem. This metric is mechanically fundamental to jump performance as it represents the cumulative effect of force application over the entire push-off duration

(Linthorne, 2001). Athletes can achieve similar jump heights through different combinations of force magnitude and application time, making impulse analysis valuable for understanding individual neuromuscular strategies (Dowling & Vamos, 1993). Training intervention studies demonstrate improved performance through maintaining high concentric forces for longer periods, with the temporal pattern of force application significantly impacting jumping efficiency (Morris et al., 2022).

The modified reactive strength index has emerged as a critical metric for assessing an athlete's reactive jump capacity and ability to cope with and perform plyometric activities. RSI is calculated by dividing jump height by ground contact time or time to take-off, creating a ratio that captures both performance outcome and movement efficiency in a single value (Young, 1995). This metric describes an individual's capability to quickly transition from eccentric to concentric muscle contraction and can be used to monitor, assess, and reduce injury risk (Flanagan et al., 2008). Research demonstrates that RSI naturally decreases through heavy training cycles and with accumulated load, making it valuable for monitoring fatigue and athlete readiness (Ramirez-Campillo et al., 2022). Unlike output metrics such as jump height or propulsive net impulse that measure performance capacity, mRSI incorporates the temporal efficiency of movement execution, potentially making it more sensitive to neuromuscular fatigue states where athletes may maintain output at the cost of altered movement strategies.

Despite extensive research on individual explosive power metrics, several critical gaps exist in the literature. First, comprehensive comparisons of explosive power metrics across different team sports within the same competitive level remain limited, particularly at the NCAA Division I collegiate level. Second, systematic longitudinal tracking across competitive seasons integrating multiple explosive power metrics is rarely reported in team sport settings. Most intervention studies last between six and sixteen weeks, missing seasonal variation patterns crucial for understanding how athletes respond to periodized training and competition stress. Third, while research demonstrates that mRSI decreases with accumulated load and training stress, direct comparisons of how efficiency-based metrics like mRSI respond to seasonal demands differently than pure output metrics remain underdeveloped. Understanding whether mRSI provides distinct information about neuromuscular fatigue compared to metrics focused solely on performance outcomes represents a valuable area for investigation.

Research Question and Rationale

The primary research question addresses this critical gap: How does mRSI behave as a marker of neuromuscular fatigue compared to output metrics like Jump Height and Propulsive Net Impulse over the competitive season in NCAA athletes? This question distinguishes between efficiency-based metrics (mRSI) and output-based metrics (jump height and propulsive net impulse) to determine whether they provide complementary information about athlete status across a season.

The distinction between these metric types is fundamental to understanding neuromuscular fatigue. Output metrics like jump height and propulsive net impulse quantify what an athlete achieves—the height reached or total force applied—but do not inherently account for how efficiently that output was produced. In contrast, mRSI explicitly incorporates movement efficiency by relating performance outcome to the time required to produce it. An athlete experiencing accumulated fatigue may maintain jump height and impulse values through compensatory strategies such as increased ground contact time or altered movement patterns, but these compensations would manifest as decreased mRSI values. Conversely, mRSI might decline due to changes in movement strategy even when an athlete retains the capacity to generate high outputs.

By tracking these metrics longitudinally across competitive seasons, this analysis will reveal whether mRSI demonstrates different temporal patterns compared to output metrics during periods of high training load, competition density, and recovery. If mRSI declines earlier or more dramatically than output metrics during demanding phases of the season, it could serve as an early warning system for accumulated neuromuscular fatigue before performance capacity measurably deteriorates. Alternatively, if output metrics decline while mRSI remains stable, this might indicate capacity limitations rather than efficiency-based fatigue. Understanding these differential responses will enable coaches to distinguish between athletes who are fatigued but compensating effectively versus those experiencing true performance decline, informing more targeted intervention strategies.

The broader investigation examines how explosive power profiles differ across SBU athletic teams and what longitudinal patterns emerge across competitive seasons. This will provide normative ranges for each metric by sport at the Division I collegiate level, filling a critical gap in published benchmarking data. By tracking athletes across full competitive seasons, the research will characterize how explosive power naturally fluctuates with training periodization, competition schedules, and recovery demands.

This analysis offers value for both scientific and practical applications. Scientifically, it will contribute collegiate-level normative data across multiple sports and advance understanding of how efficiency-based versus output-based metrics respond differently to seasonal demands. Practically, strength and conditioning coaches will gain sport-specific benchmarks, individualized performance tracking, and early warning indicators that distinguish between different types of athlete fatigue states. The development of evidence-based performance monitoring systems, including objective criteria for identifying athletes requiring intervention based on metric-specific patterns, will support proactive load management and injury risk reduction strategies.

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