1.4 Brief Review of Literature & Metric Selection

Summary of Selected Metrics and Justification

The following metrics were selected because they are important for injury assessment and performance optimization.

- **Total Distance (TD) & Accumulated Acceleration Load (AAL):** These are time-based, external workload metrics that quantify the total volume and intensity of an athlete's movement during practice and competition (Prudholme et al., 2022). They are crucial for calculating the workload ratio, which is a primary tool for predicting non-contact soft tissue injuries (Xiao et al., 2021).
- **Max Force & Torque:** These are measures of muscular strength and rotational capacity (Ashworth et al., 2025). Strength deficits and strength imbalances are well-established, modifiable risk factors for injuries in athletes (Tavares et al., 2025).

Review of Selected Metrics

Total Distance

The metric of total distance (TD) is a measure that tracks the entire distance a player travels during a competition or training session, typically measured by GPS or LPS wearables (Junior et al., 2021). This metric is crucial for athletic performance because it quantifies the physical demands placed on an athlete, which is essential for prescribing appropriate training loads, optimizing performance, and monitoring cumulative load to assess and potentially reduce injury risk (Xiao et al., 2021). Normal and elite values vary by sport and position: for NCAA Division I women's soccer players, the average distance traveled per game in quartiles was 3.9 km, 5.6 km, and 7.4 km per game respectively (Junior et al., 2021). Elite players are commonly reported as covering 9.1 km/match for full-game starters (Junior et al., 2021). Existing research highlights that higher accumulated total distances over periods of 2 to 4 weeks are associated with an increased risk of lower extremity injuries in collegiate women's soccer (García et al., 2021).

Max Force

Max Force measures the absolute maximum force a muscle or muscle group can produce (Ashworth et al., 2025). This can be measured via an isometric contraction (MVIC), which is a pushing action, or a holding capacity (Adaptive Force), where the muscle resists an increasing external load (Schaefer et al., 2023). Maximal strength is vital because it reflects an athlete's physical capabilities in relation to their sport's demands (Nakatani et al., 2021). Assessing maximal holding capacity is also highly relevant, as an impaired ability to resist external loads is assumed to be a major factor in injury mechanisms and the development of musculoskeletal pain (Schaefer et al., 2023). Values for this metric are highly specific to the muscle group and measurement type. For example, the mean theoretical maximum force (F_0) for the elbow flexors of male gymnasts ranged from 44.7 N to 225.1 N, (Nakatani et al., 2021). Existing research consistently identifies traditional heavy resistance exercise as a primary stimulus for increasing maximal strength (Spiering et al., 2023). Maximal strength assessments, such as those derived from the F-V relationship, are used to help categorize dynamic

muscle function and assess injury risk based on strength differences at various joint angles (Nakatani et al., 2021).

Torque

The metric of torque measures the rotational force produced by a muscle group acting around a joint (Ashworth et al., 2025). Specifically, it is the product of the force applied and the distance from the axis of rotation (Şahbat et al., 2022). This metric is crucial for athletic performance because it directly reflects joint strength and muscular balance, which are necessary for generating powerful, rotational movements and is highly important for injury assessment (Ashworth et al., 2025). Torque is highly important for injury assessment because research uses torque measurements to determine the strength balance between opposing muscle groups, such as the internal and external rotators of the shoulder, where an imbalance ratio is considered a risk factor for injuries like Swimmer's Shoulder (Tavares et al., 2025). Normal and elite values are highly dependent on the joint, joint angle, and movement speed: for instance, hip external rotation isometric torque in competitive athletes ranges from approximately 0.29 Nm/kg in female volleyball players to 0.46 Nm/kg in male soccer players (Ashworth et al., 2025). Existing research focuses on using torque to evaluate the effectiveness of preventive exercise programs in correcting strength deficits and improving muscle balance to reduce injury risk (Tavares et al., 2025).

Accumulated Acceleration Load

The metric of Accumulated Acceleration Load (AAL) is a measure of external workload that quantifies the accumulated intensity of a player's movements over time, typically tracked using accelerometers within wearable microtechnology units (Koyama et al., 2024). It is often expressed in arbitrary units (AU) and represents the total physical stress imposed by repeated changes in velocity (accelerations and decelerations) during training and match-play (Koyama et al., 2024). This metric is important for athletic performance as it helps coaches monitor and regulate training load, which is crucial for prescribing appropriate training intensity and managing fatigue (Prudholme et al., 2022). AAL is related to injury assessment because the physical stress from these repeated, high-intensity movements is a component of the overall workload that, if poorly managed, contributes to injury risk (Ruiz-Rios et al., 2024). Normal or elite values are highly dependent on the sport and context. For example, men's college basketball players AAL is approximately 13.5 a.u. (Koyama et al., 2024). Existing research shows that the accumulated acceleration load, alongside other metrics like sprint count, is highly related to overall Player Load, making it a key variable that coaches can manipulate to regulate practice intensity in sports like collegiate women's soccer (Prudholme et al., 2022).

Hypothesis: Would players with higher asymmetry differences between both sides for torque and max force affect acceleration load and distance total results?

Research Question: Could these key indicators be used to determine players' risk of injury?

Justification for Analysis

This analysis is valuable because we can identify trends that are predictive.

The ability to isolate these trends in a real-world collegiate database is crucial for:

1. Informing Injury Prevention: that can be used to modify training interventions before an injury occurs.
2. Optimizing Performance: Ensuring that training volume and intensity are appropriately balanced to maximize athletic performance while minimizing the associated injury risk.
3. Application into health: evaluation and application of findings have potential to be applied into fields such as physical therapy and rehabilitation.

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