Increased Lower Extremity Injury Risk Associated with Player Load and Distance in Collegiate Women’s Soccer

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Financial Disclosures

- None
Introduction

- Over 13 million girls and women playing organized soccer worldwide
- Increased performance expectations -> increased injury risk
- Technological advances in player load tracking using wearable global positioning system (GPS) units may predict injury risk
- Limited research regarding the impact of workload on injury risk specifically to women’s soccer
Purpose

- To examine the relationship between injury risk and workload collected from wearable GPS units in National Collegiate Athletic Association (NCAA) Division I women’s soccer players
Methods

- Retrospective analysis of prospectively collected GPS data from one NCAA Division I women’s soccer team
- 3 seasons (August - December 2017-2019); 65 individual soccer seasons included
- Workload quantified using commercially available GPS units (Catapult OptimEye, Catapult Sports, Melbourne, Australia)
Methods

- Variables collected: Player load (triaxial acceleration), total distance, high-speed distance (> 8 mph)
- All available players required to wear their GPS unit for training sessions and games. 95.3% compliance (7,654 of 8,032 sessions).
- Only time loss-injuries affecting the lower extremity included. Injuries were classified by body part, contact/non-contact, and by time missed: minimal (1-3 days missed), mild (4-7 days missed), moderate (1-4 weeks missed), or severe (4+ weeks missed).

Player load = \( \sqrt{\frac{(a_x(t) - a_x(t-1))^2 + (a_y(t) - a_y(t-1))^2 + (a_z(t) - a_z(t-1))^2}{100}} \)
Methods (Workload Analysis)

• Data categorized into weekly blocks from Monday to Sunday
• Previous 1-weekly, 2-weekly, 3-weekly, and 4-weekly cumulative loads calculated and grouped by z-score
• Acute to Chronic Workload Ratio (ACWR) calculated 2 ways
  – Rolling average: average acute workload (past 7 days) divided by average chronic workload (past 28 days)
  – Exponentially weighted moving average (EWMR): EWMA acute (N = 7 days) divided by EWMA chronic (N = 28 days)

\[
\text{EWMA}_{\text{today}} = \text{Load}_{\text{today}} \times \lambda_a + ((1 - \lambda_a) \times \text{EWMA}_{\text{yesterday}}
\]

\[
\lambda_a = \frac{2}{N + 1}
\]
Statistical Analysis

• Injury incidence, injury risks
• Logistic regression to compare ACWRs between injured and non-injured players for all GPS variables
• Each player injury matched by season and week to uninjured players for that week. Injured and uninjured cohorts were compared using two-sample $t$-tests.
Results

<table>
<thead>
<tr>
<th>Injury Location</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knee</td>
<td>12</td>
</tr>
<tr>
<td>ACL Tear</td>
<td>2</td>
</tr>
<tr>
<td>MCL Sprain</td>
<td>6</td>
</tr>
<tr>
<td>Other ligamentous, meniscal, or chondral injury</td>
<td>4</td>
</tr>
<tr>
<td>Foot and Ankle</td>
<td>19</td>
</tr>
<tr>
<td>Lateral Ankle Sprain</td>
<td>8</td>
</tr>
<tr>
<td>High Ankle Sprain</td>
<td>1</td>
</tr>
<tr>
<td>Ankle Fracture</td>
<td>2</td>
</tr>
<tr>
<td>Foot Ligament Sprain/Plantar Fasciitis</td>
<td>6</td>
</tr>
<tr>
<td>Other Foot Injury</td>
<td>2</td>
</tr>
<tr>
<td>Thigh</td>
<td>19</td>
</tr>
<tr>
<td>Hamstring Strain</td>
<td>5</td>
</tr>
<tr>
<td>Quadriceps Strain</td>
<td>8</td>
</tr>
<tr>
<td>Groin Strain</td>
<td>2</td>
</tr>
<tr>
<td>Contusion</td>
<td>4</td>
</tr>
<tr>
<td>Other hip, leg, or thigh injuries</td>
<td>3</td>
</tr>
</tbody>
</table>

Table 1: Number of injuries by location during the 2017, 2018, and 2019 seasons

<table>
<thead>
<tr>
<th>Daily ACWR Calculation Type</th>
<th>Load Variable</th>
<th>OR (95% CI)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>7:28 EWMA</td>
<td>PL</td>
<td>0.61 (0.12-2.92)</td>
<td>0.54</td>
</tr>
<tr>
<td>7:28 Simple Moving Average</td>
<td>TD</td>
<td>0.83 (0.18-3.85)</td>
<td>0.81</td>
</tr>
<tr>
<td></td>
<td>HSD</td>
<td>1.24 (0.37-4.10)</td>
<td>0.73</td>
</tr>
<tr>
<td></td>
<td>PL</td>
<td>0.53 (0.15-1.87)</td>
<td>0.32</td>
</tr>
<tr>
<td></td>
<td>TD</td>
<td>0.58 (0.17-1.95)</td>
<td>0.38</td>
</tr>
<tr>
<td></td>
<td>HSD</td>
<td>0.69 (0.26-1.87)</td>
<td>0.47</td>
</tr>
</tbody>
</table>

Table 2. Odds of sustaining an injury for each one-unit change of ACWR calculated using an EWMA model or simple moving average model. ACWR-Acute to chronic work ratio; OR-Odds ratio; CI-Confidence interval; EWMA-Exponentially weighted moving average; PL-Player load; TD-Total Distance; HSD-High Speed Distance.
Results

**Figure 1.** Comparison between healthy and injured players for 1, 2, 3, and 4-weekly accumulated (A) player load, (B) total distance, and (C) high speed distance. *P<0.05.
Discussion

- Incidence of lower extremity injury over 3x higher in games compared to practices (11.25/1,000 game hours vs. 3.07/1,000 practice hours).

**Use of absolute load vs. ACWR:**

- High accumulated total distance over four weeks associated with increase in injury risk for male youth soccer players
  - Bowen et al. BJSM 2017

- Increased ACWR -> increased injury risk in youth and professional men’s soccer. Our study showed no association, but when ACWR is between 0.8-1.3, injury risk is lower.
  - Bowen et al. BJSM 2017, 2020
  - Blanch and Gabbett. BJSM 2016
Limitations

- Both contact and noncontact injuries included
- Majority of injuries occurred during games – substitute players may have lower loads and injury risk
- Only external load tracked
- Data from one team – could not calculate position-specific risks
Conclusions

- Higher accumulated player load and total distance, but not ACWR, are associated with injury in women’s soccer players.
References

Thank You