Functional Movement Screen (FMS) predicts severe injuries in professional rugby union players

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The Functional Movement Screen

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Professional Rugby Union – High Injury Risk

- Full contact sport defined by repetitive bouts of short duration high intensity work during which players collide, sometimes while running at full speed.

- 81 injuries per 1000 match hours and 3 injuries per 1000 practice hours (Williams et al., Sports Med 2013)

Need strategies that reduce injury risk

Screen to determine “high-risk” players
Functional Movement Screen

Tests balance, strength and range of motion simultaneously; providing a holistic, integrative assessment of the players’ quality of movement.
FMS as an injury predictor

FMS predicts injury in
• American football players (Kiesel et al., N Am J Sports Phys Ther 2007)
• Female collegiate athletes (Chorba et al., N Am J Sports Phys Ther 2010)
• Military recruits (Lisman et al., Med Sci Sports Exerc 2013)
• General population (Letafatkar et al., Int J Sports Phys Ther 2014)

Review - “moderate scientific evidence” to support the use of FMS as a predictor of injury (Kraus et al., J Strength Cond Res, 2014)

Research Questions
• Can FMS predict severe injury in professional rugby players?
• What FMS score is the best predictor of injury risk?
• Is any individual or combination of component tests a better predictor of injury than the FMS composite score?
• Does FMS predict contact/non-contact injuries?
Methods

- Professional rugby players (Stature 1.87 ± 0.08m, body mass 103.1 ± 13.1kg) completed FMS tests prior to the start of competition.
- 62 players completed 90 FMS tests over 4 preseason periods between 2011 and 2013.
- Injuries were recorded by team medical staff for 6 months (180 days) after each FMS test classified contact/non-contact.
- **Severe Injury** – exclusion >28 days (IRB Consensus Statement on Injury definitions, 2007)
- A receiver operated characteristic (ROC) curve and 2x2 contingency table were used to calculate odds and likelihood ratios, sensitivity and specificity.
- Survival analysis
Results

Figure 1 - Composite FMS scores of players not injured and players who suffered severe injury >28 days.
Results – Distribution of component test scores

Not-injured group

Injured group

Frequency (%)

Not-injured group

Injured group

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Results - FMS component tests

Differences in FMS scores between injured and not-injured players appear to be due to differences in ASLR and ILL scores.
Results

Figure 2 - ROC curves for the FMS composite test relating to injured or non-injured status.
## Results – All injuries

### 2 x 2 contingency table for FMS score of ≤ 13

<table>
<thead>
<tr>
<th></th>
<th>Severe Injured</th>
<th>Non-Severe Injured</th>
</tr>
</thead>
<tbody>
<tr>
<td>FMS ≤ 13</td>
<td>16 True Positives</td>
<td>15 False Positives</td>
</tr>
<tr>
<td>FMS ≥ 14</td>
<td>10 False Negatives</td>
<td>49 True Negatives</td>
</tr>
</tbody>
</table>

**Sensitivity 0.61**  
(95% CI = 0.41 to 0.80)  
61% of players with FMS ≤ 13 will sustain severe injury

**Specificity 0.77**  
(95% CI = 0.64 to 0.86)  
77% of players with FMS > 13 will not sustain severe injury

**Odds Ratio = 5.2**  
(95% CI = 2.0-13.9)  
Players with FMS ≤ 13 are 5.2 times more likely to sustain a severe injury

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Figure 3 - ROC curves for the FMS composite test relating to injured or non-injured status.

Other component tests “no better than chance” at predicting severe injury.
Results – Active straight leg raise and in-line lunge

ASLR score ≤ 2 predicts injuries

Sensitivity 0.96 96% (95% CI = 0.92 to 0.93)
Specificity 0.29 29% (95% CI = 0.18 to 0.43)
Odds ratio 9.4 (95% CI = 1.2 to 76)

ILL + ASLR score ≤ 4 predicts injuries

Sensitivity 0.83 83% (95% CI = 0.63 to 0.95)
Specificity 0.53 53% (95% CI = 0.39 to 0.66)
Odds ratio 5.6 (95% CI = 1.7 to 18)

<table>
<thead>
<tr>
<th></th>
<th>Severe Injured</th>
<th>Non-Severe Injured</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASLR ≤ 2</td>
<td>23 True Positives</td>
<td>39 False Positives</td>
</tr>
<tr>
<td>ASLR ≥ 3</td>
<td>1 False Negatives</td>
<td>16 True Negatives</td>
</tr>
</tbody>
</table>
### Non-Contact and Contact Injuries

<table>
<thead>
<tr>
<th></th>
<th>Contact Injuries</th>
<th></th>
<th></th>
<th>Non-contact injuries</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Injured</td>
<td>Not injured</td>
<td>Effect size</td>
<td>Injured</td>
<td>Not injured</td>
<td>Effect size</td>
</tr>
<tr>
<td>N=14</td>
<td>N=76</td>
<td></td>
<td></td>
<td>N=12</td>
<td>N=78</td>
<td></td>
</tr>
<tr>
<td><strong>FMS Composite Score</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>13.1 ± 2.0</strong>*</td>
<td><strong>14.3 ± 1.5</strong></td>
<td>medium</td>
<td><strong>13.3 ± 1.4</strong></td>
<td><strong>14.3 ± 1.7</strong></td>
<td>medium</td>
</tr>
<tr>
<td>Deep Squat</td>
<td><strong>1.6 ± 0.8</strong>*</td>
<td><strong>2.1 ± 0.4</strong></td>
<td>large</td>
<td>2.1 ± 0.5</td>
<td>2.0 ± 0.5</td>
<td>small</td>
</tr>
<tr>
<td>Hurdle Step</td>
<td>2.1 ± 0.3</td>
<td>2.1 ± 0.4</td>
<td>trivial</td>
<td>1.9 ± 0.5</td>
<td>2.1 ± 0.4</td>
<td>small</td>
</tr>
<tr>
<td>In-Line Lunge</td>
<td><strong>1.8 ± 0.7</strong>*</td>
<td><strong>2.3 ± 0.5</strong></td>
<td>large</td>
<td>2.1 ± 0.7</td>
<td>2.2 ± 0.5</td>
<td>trivial</td>
</tr>
<tr>
<td>Shoulder Mobility</td>
<td>1.5 ± 0.7</td>
<td>1.6 ± 0.7</td>
<td>trivial</td>
<td>1.4 ± 0.5</td>
<td>1.7 ± 0.7</td>
<td>small</td>
</tr>
<tr>
<td>Active Straight Leg Raise</td>
<td><strong>1.8 ± 0.6</strong>*</td>
<td><strong>2.1 ± 0.6</strong></td>
<td>medium</td>
<td><strong>1.8 ± 0.5</strong>*</td>
<td><strong>2.1 ± 0.6</strong></td>
<td>medium</td>
</tr>
<tr>
<td>Trunk Stability Push Up</td>
<td>2.2 ± 0.4</td>
<td>2.4 ± 0.6</td>
<td>small</td>
<td>2.4 ± 0.5</td>
<td>2.4 ± 0.6</td>
<td>trivial</td>
</tr>
<tr>
<td>Rotary Stability</td>
<td>1.9 ± 0.5</td>
<td>1.8 ± 0.5</td>
<td>small</td>
<td>1.6 ± 0.5</td>
<td>1.8 ± 0.5</td>
<td>medium</td>
</tr>
</tbody>
</table>

*Significant difference.

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Results – Non-contact injuries

FMS composite score $\leq 14$ predicts non-contact injuries

Sensitivity 0.83 83%
(95%CI = 0.52 to 0.98)

Specificity 0.46 46%
(95%CI = 0.35 to 0.58)

Odds ratio 4.3
(95% CI = 0.9 to 21)

ASLR was “no better than chance” at predicting severe non-contact injury
# Results – Contact Injuries

<table>
<thead>
<tr>
<th></th>
<th>FMS Composite Score ≤ 13</th>
<th>Deep Squat + In-line lunge</th>
<th>Deep Squat + In-line lunge + Active straight leg raise</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sensitivity</strong></td>
<td>0.71</td>
<td>0.92</td>
<td>0.83 (0.52 to 0.98)</td>
</tr>
<tr>
<td>(95%CI)</td>
<td>(0.42 to 0.92)</td>
<td>(0.62 to 1.0)</td>
<td></td>
</tr>
<tr>
<td><strong>Specificity</strong></td>
<td>0.72</td>
<td>0.37</td>
<td>0.52</td>
</tr>
<tr>
<td>(95%CI)</td>
<td>(0.61 to 0.82)</td>
<td>(0.26 to 0.50)</td>
<td>(0.40 to 0.65)</td>
</tr>
<tr>
<td><strong>Odds Ratio</strong></td>
<td>6.5</td>
<td>6.5</td>
<td>5.5</td>
</tr>
<tr>
<td>(95%CI)</td>
<td>(1.8 to 23.0)</td>
<td>(0.8 to 54)</td>
<td>(1.1 to 27)</td>
</tr>
<tr>
<td><strong>X² Test</strong></td>
<td>p = 0.003</td>
<td>P = 0.049</td>
<td>p = 0.023</td>
</tr>
</tbody>
</table>

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How does FMS predict contact injuries?

Model 1: Disadvantageous tackle positions

Poor tackle technique = ↑ Risk of injury (Burger et al., 2015)

Dysfunctional movement patterns (low-FMS) may make it more difficult for players to get into the “ideal” tackle position
How does FMS predict contact injuries?

**Model 2: Fatigue**

Fatigue is a risk factor for injury

- Well-developed physical characteristics prevent injury

Dysfunctional movement patterns (Low-FMS) may be inefficient, and ↑ rate of fatigue

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Survival analysis

High-FMS (≥14) vs. Low-FMS (≤13)

Mean survival time is **31 days** greater for High-FMS vs. Low-FMS groups (160 ± 6 vs. 129 ± 11 days)

Significant difference in survival time for **contact**, but not for **non-contact** injuries
Conclusion

FMS is a predictor of severe contact and non-contact injury in professional rugby union players.

ASLR \leq 2 \text{ predicts injury with a sensitivity of 96\%}

An FMS score of \leq 13 \text{ predicts severe injury with the highest specificity.}

FMS will assist in the management of players, improving team performance and reducing cost of injury.

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Implications

• Professional rugby union players should perform regular FMS screens.
• Players who attain low FMS scores should be placed on exercise programs to correct their movement dysfunction.

Future research

FMS scores can be improved by corrective training programs (Kiesel et al., Scand J Med Sci Sports 2011)

Determine whether corrective training programs improve player’s resilience and reduces the time spent off the field due to injury
Thank you for listening!

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