Evidence-based injury prevention for repetitive microtrauma injuries: The cricket example

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University of Ballarat
Adopting injury prevention research into the management of cricket fast bowlers

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Physiotherapist
Cricket NSW
Overview of presentation

- The research student “journey” - developing a partnership with sport
- Development of a research plan
- Injury to cricket players
- Previous injury risk factor research
- Overview of the research projects completed
- How this research has been adopted into the cricket “real world”
- Research directions for the future
Overview of presentation

• Tips and hints for researchers and sporting practitioners
• How researchers can get funding
• Ideas for administrators on what research is likely to work and what they should be looking for in a funding application
The start of the research adventure...
The research student journey

- Honours research
- Identification of priority areas
- Cricket - one of Australia’s most popular sports
- Nearly 500,000 people participate in organised programs each year
The research student journey

- Contacted several people associated with cricket
- Discussion of ideas with Patrick – original plan “rubbish”!
- Identified fast bowling injury as a priority area
- Developed a plan for the research
Injury in Australian elite cricket

Wicket keepers 1%
Spin bowlers 4%
Batsmen 4%
Fast bowlers 16%

This clearly establishes fast bowlers as the priority group for continued injury risk factor research

Orchard et al., 2005, Sport Health
Why are back injuries to fast bowlers so concerning?

- Injuries to lumbar vertebrae may not heal properly
- Can lead to spondylolisthesis – forward slippage of vertebrae
- Long term consequences:
  - Disc problems
  - Nerve root compression
  - Early degeneration of lumbar spine
Repetitive microtrauma (overuse) injuries

- Repetitive microtrauma - a number of forces combine to produce a fatigue effect over time
- Load involved with bowling one delivery might not exceed critical limit of tissues
- Cumulative effect might result in mechanical degradation of tissues
Stages of fast bowling
Overview of previous research

- High injury rates to fast bowlers were identified in an injury surveillance study conducted by Cricket Australia.
- Three risk factors for injury to fast bowlers have been proposed:
  
  - Technique
  - Physical preparation
  - Bowling workload

A plan was developed to quantify bowling workload in an objective, meaningful and reliable manner.
Why investigate bowling workload?

- Lack of prospective monitoring
- Training workload rarely monitored
- Guidelines proposed - however these are arbitrary
- A need for scientific evidence to inform injury prevention initiatives and policy
- Development of a pilot study with NSW Blues
The pilot study...will this research work?
Pilot study conducted with NSW Blues

- 1999/00 (a season later than planned…)
- 12 fast bowlers
- Mean age 25.4 years (range 22 - 34)
- Bowling workload prospectively monitored for match and training sessions
- Video training sessions 2 times per week
- A range of ideas considered – counter in bowling marker, hand-held counters
- Needed to develop a protocol that was acceptable and useful to players
Methods

Analysing workload

Uninjured

Workload for entire season

Injured

Workload prior to injury
First injury only
Summary of pilot study results

• 7 players (58%) sustained a total of 9 injuries

• Frequency of sessions
  – injured = 1.9 days
  – uninjured = 3.2 days

• Deliveries per week
  – mean = 203
  – RR = 6 for bowling above mean

• Match deliveries per month
  – mean = 522
  – RR = ? All bowlers above mean sustained injury
Reporting results back to the sport

• Opportunity to present at the Cricket Australia Sports Science and Medicine Forum
• Provided information that was meaningful to sports medical staff, coaches, administrators and players
Tips and hints

• Make the presentation meaningful
• Have a clear take home message
• Describe the implications for the sport
• Propose how the problem be investigated and how solutions can be generated
• As much as possible, fit in with existing practices
• Have a “champion” for the research
Converting a pilot study into a national project
Conducting a national bowling workload study

- Funding received to continue study on a national scale
- Primary objective to identify a “safe” fast bowling threshold and develop workload guidelines
Why this research was possible

- Based on the design and reporting of a very well performed (and unfunded) pilot study with the NSW senior squad
- Coaching staff and players were informed
  - that there would be minimal disruption to training sessions
  - that the results could serve as a reference tool for quantifying fast bowling workload each training session
- Use of Brett Lee to “market the research”
Barriers to conducting and implementing research

• Tradition
• Female research staff
• Why change something that isn’t broken?
• Funding
Methods

- 90 fast bowlers from state or Australian teams
- 2000-01 and/or 2001-02 seasons
- Research assistant appointed in each state to attend training sessions
- This involved collaboration with state cricket associations – both RD and PF
- Also collaboration with Dr John Orchard – injury data
- Scorer collected training information for Australian national squads
- Use of fixture scorecards for matches recorded on a daily basis
Effects and benefits of fast bowling workload research

- Player awareness of workload monitoring
- Seeking of workload information by players, medical and coaching staff
- Reduction in training workloads in seasons subsequent to pilot study and between first and second seasons of national study
# Results

Total number of bowling sessions for season

<table>
<thead>
<tr>
<th>Season</th>
<th>Match</th>
<th>Training</th>
<th>Combined</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999-00</td>
<td>41</td>
<td>43</td>
<td>83</td>
</tr>
<tr>
<td>2000-01</td>
<td>42</td>
<td>27</td>
<td>69</td>
</tr>
<tr>
<td>2001-02</td>
<td>35</td>
<td>25</td>
<td>60</td>
</tr>
</tbody>
</table>

- 14% for 1999-00
- 41% for 2000-01
- 28% for 2001-02
# Results

**Average deliveries per session**

<table>
<thead>
<tr>
<th></th>
<th>Match</th>
<th>Training</th>
<th>Combined</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999-00</td>
<td>74</td>
<td>57</td>
<td>65</td>
</tr>
<tr>
<td>2000-01</td>
<td>69</td>
<td>43</td>
<td>59</td>
</tr>
<tr>
<td>2001-02</td>
<td>70</td>
<td>39</td>
<td>57</td>
</tr>
</tbody>
</table>

- 5% decrease in Match deliveries
- 31% decrease in Training deliveries
- 12% decrease in Combined deliveries
Results

Total number of deliveries for season

Match
- 1999-00: 3000
- 2000-01: 2000
- 2001-02: 1000

Training
- 1999-00: 2000
- 2000-01: 1000
- 2001-02: 500
# Results

*Injuries sustained*

<table>
<thead>
<tr>
<th>Season</th>
<th>Total bowlers</th>
<th>Injured bowlers</th>
<th>% of group</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000-01</td>
<td>65</td>
<td>38</td>
<td>58</td>
</tr>
<tr>
<td>2001-02</td>
<td>76</td>
<td>46</td>
<td>61</td>
</tr>
</tbody>
</table>
Summary of results

U-curve for risk of injury vs. workload
Results

Frequency of bowling sessions

- **< 2 days**
  - RR = 2.4*
  - 100%

- **2 – 2.99 days**
  - RR = 1.4
  - 58%

- **4 – 4.99 days**
  - RR = 1.3
  - 53%

- **≥ 5 days**
  - RR = 1.8*
  - 73%
Results

Frequency of training sessions

≥ 6 days rest → < 6 days rest

RR = 2.0*

*Indicates statistical significance.
Results

No of sessions per week

≤ 2 sessions  $\rightarrow$  2 – 3 sessions  $\rightarrow$  > 3 sessions

RR = 1.7*  $\rightarrow$  RR = 1.5*
Results

$N^o$ of deliveries per week

< 123 deliveries

RR = 1.4

123 – 188 deliveries

RR = 1.4

> 188 deliveries
**Recommendations**

**Session frequency**
- 2 – 5 days rest

**Training frequency**
- $\geq 6$ days rest

**Sessions per week**
- 2 – 3 sessions

**Deliveries per week**
- 123 – 188 deliveries
The process of translating research findings into cricket “real world” practices

- Slow process – information was delivered to sports medicine personnel and administrators
- Guidelines distributed from the top down
- “Selling” the injury prevention message – what’s the bottom line for administrators?
- Performance benefits as well as IP
- How can these guidelines be implemented?
• Reported soreness (not injury) during weeks 6, 9 & 11
• Followed 3 of the 4 weeks in which workload > 190 deliveries
• Weekly workload monitored for the rest of the season
• Average weekly workload for the season was 180 deliveries.
Implementation of fast bowling workload guidelines - Australian cricket team World Cup 2007

- Week One Average - 64 Balls - 2 Sessions
- Week Two Average - 122 Balls - 3 Sessions
- Week Three Average - 159 Balls - 4 Sessions
- Week Four Average - 134 Balls - 3 Sessions
- Week Five Average - 120 Balls - 4 Sessions
- Week Six Average - 148 Balls - 3 Sessions
- Week Seven Average - 78 Balls - 2 Sessions
- Week Eight Average - 136 Balls - 3 Sessions
- Week Nine Average - 142 Balls - 3 sessions
- Based on recommendations of 2.0 to 3.5 rest days between bowling sessions and 120 to 190 balls per week
Feedback at the World Congress

• Anecdotal evidence of a reduction of injury in several cricket nations
• Difficult to formally evaluate, because it is not realistic to conduct an intervention study, such as a RCT
Future research

• Develop partnerships with sport – what do the sports medicine personnel need? What is meaningful to administrators?
• Spell length investigation
• Spinal shrinkage
• Impact on match bowling performance
• Consideration of a range of potential risk factors
• Junior fast bowlers
Identifying a priority group...junior athletes
Concerns for junior fast bowlers

Given the results of research with adult bowlers – how suitable are the current bowling workload guidelines for junior fast bowlers?
Workload guidelines for junior fast bowlers

<table>
<thead>
<tr>
<th>Age group (years)</th>
<th>Training sessions per week</th>
<th>Deliveries per training session</th>
<th>Maximum sessions per week</th>
<th>Maximum deliveries per week</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adults</td>
<td>1</td>
<td>40</td>
<td>3</td>
<td>188</td>
</tr>
<tr>
<td>Under 13</td>
<td>2</td>
<td>30</td>
<td>3</td>
<td>108</td>
</tr>
<tr>
<td>Under 15</td>
<td>2</td>
<td>36</td>
<td>3</td>
<td>132</td>
</tr>
<tr>
<td>Under 17</td>
<td>3</td>
<td>36</td>
<td>4</td>
<td>204</td>
</tr>
<tr>
<td>Under 19</td>
<td>3</td>
<td>42</td>
<td>4</td>
<td>246</td>
</tr>
</tbody>
</table>

Cricket Australia, 2004.  Dennis et al., 2003, JSMS
The vulnerability of the adolescent musculoskeletal system

- Younger bowlers may be more prone to overuse-type injuries due to immature musculoskeletal system
- Particularly lumbar spine
- Not fully developed until late teens / early 20’s
Methods

Participants
- 47 male fast bowlers average age 14.7 years (range 12 – 17 years)

Monitoring workload
- Workload diaries completed daily for the 2002-03 season
- Recorded all match and training sessions for the season and deliveries bowled

Injury data
- Any concerns reported in workload diaries
- Bowlers contacted by physiotherapist
Injuries sustained

11 bowlers (25%) injured

7 bowlers (64% of injured group) sustained a bony or soft tissue back injury

23 of the 44 bowlers reported back pain at some stage during the season

(Adults 59%)

(Adults 14%)
Average number of rest days between sessions

< 3.5 days

Injured:
64%

Uninjured:
27%

RR = 3.1
(1.1 – 8.9)
**Recommendations**

**Session frequency**
- \( \geq 3.5 \) days rest
- (no current guideline)

**Deliveries per session**
- 50 deliveries
- (currently 30 - 42)

**Sessions per week**
- 2.5 sessions
- (currently 3 - 4)

**Deliveries per week**
- No trend
- (currently 108-246)
Discussion

- Relationship between high workload and injury
- Average of <3.5 rest days at 3 times risk of injury
- Rest days should be added to guidelines
- Large number of injuries to lower back and bowlers reporting back pain
Adoption of research findings into policy

- Combined with results of research with adults, suggests that current guidelines may not be appropriate
- Discussion with administrators and policymakers
- As a result, the Australian Junior Cricket Policy will be changed
- Rest days added to guidelines
- Other workload allowances reduced
Future research

• Age stratification guidelines
  – Chronological vs skeletal age
• Consideration of a range of potential risk factors
Investigating a range of potential injury risk factors concurrently
Overview of the project

• Prospective cohort field-based study conducted in 2003-04 season
• Funded by Cricket Australia as part of the SPOT injury prevention program

Identify the risk factors for repetitive microtrauma injury to adult and adolescent fast bowlers
Methods

- 91 male fast bowlers
- NSW and Qld Cricket Associations
- Aged 12 – 33 years (mean 19 years)

- **Baseline screening:**
  - Two dimensional multiple plane analysis of bowling technique
  - Fitness and anthropometric assessment
  - Musculoskeletal assessment

- **During season:**
  - Workload
  - Injuries
Injuries sustained

- 41% of bowlers injured
- 92% of injuries were trunk, back and lower limb
- Including:
  - Lumbar musculoligamentous strains
  - Side and abdominal strains
  - Groin injuries
  - Heel and achilles injuries
Independent predictors of injury

- **reduced** hip internal rotation on the bowling side of the body was associated with a significantly decreased risk of injury

- **reduced** ankle dorsiflexion on the non-bowling side of the body was associated with a significantly increased risk of injury
Ankle lunge test and injury

• Lunge test also identified as an extremely reliable and valid test to measure ankle dorsiflexion range in standing

• Bowlers with a non-bowling ankle dorsiflexion lunge < 14cm significantly more likely to get injured
Implications of lunge test results

- 14 cm is now our target in rehabilitation from any ankle or lower limb injury to reduce subsequent problems along the lower limb kinetic chain.
- We also measure ankle dorsiflexion lunge of our fast bowlers each month and those who drop below 14 cm on non-bowling side undergo physiotherapy intervention to improve this.
Continued research

• Biomechanical research to investigate how these factors are responsible for internal loading and increasing injury risk
• How do these tests relate to dynamic movement?
  – 3D motion analysis of running and bowling
• Can the procedures for the current field-based tests be improved?
• Are there other field-based tests that can be used?
• Does improving ankle dorsiflexion range and gluteus medius function assist in reducing injury risk?
Researchers and practitioners – establishing a strong and successful team
Why conduct research?

• The primary objective of this research, through collaboration with cricket sports medical staff, coaches, players and administrators, is to contribute to fast bowlers enjoying participation in the game injury free.... well, almost!
Our ideas for conducting successful sports injury research

• Identify an area of concern in consultation with coaching and support staff
• Original project
• Non disruptive to training programs, coaching staff and players
• Use of elite sports people to market the research
• Results that can be reported in plain English and that are applicable in the real world
• Work with existing support staff and players
• Field based
• Perhaps pitch it at the elite level initially when being funded by sport? Increases profile and funding? And then expand the research to juniors and community level
Acknowledgments

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