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## Negative association between injuries and team success in professional cricket: A 9-year prospective cohort analysis

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### Abstract

**Objectives:** To examine the relationship between injuries and team success in professional cricket.

**Design:** Prospective cohort analysis

**Methods:** A prospective cohort of all match time-loss injuries and County Championship point tallies for nine seasons (from 2010 – 2018 inclusive) for all 18 First-Class County Cricket (FCCC) cricket teams in England and Wales. Two injury measures of match time-loss injury incidence and burden were assessed for within-team (linear mixed model on season-to-season changes) and between-team

(correlation on differences averaged over all seasons) effects. County Championship league points tally was used as the measure of team success.

**Results:** A moderate negative correlation was found between injury burden and team performance ( $r = -0.36$ ; 90% CI  $-0.66$  to  $0.05$ ; *likely negative*,  $P = 0.15$ ). A reduction in match injury incidence of 2 match time-loss injuries per 1,000 days of play (90% CI 1.4 to 2.9,  $P = 0.10$ ) within a team, or a reduction in match injury burden of 75 days per 1,000 days of play (90% CI 50 to 109,  $P = 0.053$ ) in any given season was associated with the smallest worthwhile change in County Championship points (+13 points) for Division 1, but not for Division 2.

**Conclusion:** Moderate reductions in injury burden are associated with potentially worthwhile effects on performance for a domestic cricket team in the County Championship Division 1.

**Keywords:** Epidemiology; performance; injury; incidence; prevalence; sports

## 1. Introduction

It has been proposed that athlete availability (through not being injured) is as significant a factor in team sport success as player skill,<sup>1</sup> with injuries shown to have a negative association with team and individual athletic achievement.<sup>2</sup> Injury epidemiology studies often explore the extent of the injury problem through incidence/prevalence rates, but the extent to which injuries influence team success may be more practically relevant to coaches.<sup>3</sup> The link between injuries and performance also needs to be understood by stakeholders in sports clubs to ensure adequate resource allocation to injury prevention strategies.<sup>4</sup>

A systematic review investigating the association between injuries and team success across different sports found evidence that increased availability of team members/athletes increased the likelihood of success.<sup>2</sup> Though seven of the 14 included studies had low risk of bias, a challenge with synthesising and comparing studies in this subject area is the mix of statistical methodology, injury/success measures, and varying time periods of data collection. These challenges make it difficult to

adequately generalise the findings and to date, no study has explored the relationship between injury and success within the context of cricket. In cricket, bowling has the highest risk of injury<sup>5-7</sup> and yet if an injury occurs, currently a bowling substitute cannot replace this player, which might have a major effect in the context of a team with a limited number of specialists in this role. Furthermore, if high performing players are unavailable for selection because of injury, the strength of the team is compromised.

Several studies investigating the injury-success relationship have used injury incidence rates as an injury measure but examining injury frequency alone does not adequately account for the varying severity of time-loss injuries.<sup>4</sup> Instead, a measure of injury burden ('overall match injury incidence rate x mean absence per match injury'), which incorporates both frequency and severity of injuries, may be more suitable for assessing the impact of injury on team success, as this measure is directly associated with athlete availability.<sup>8</sup> One 24-team football study that explored the association between both injury incidence and injury burden (independently) and team performance over 11 seasons found more significant associations between injury burden and three performance measures (final league ranking, points per league match and a measure that reflects success in European cup competitions). Moderate negative associations between injury burden and success measures were also found in professional Rugby Union.<sup>9</sup> This study utilised linear mixed modelling to examine both within- and between-team effects; a within-team reduction in injury burden of approximately 42 days per 1000 player hours was associated with the smallest worthwhile change in league points tally ( $\pm 3$  league points). Thus, there is growing evidence of a negative association between injury burden and team success.<sup>2</sup> However, there are still only a small number of studies in this area and no studies have explored this relationship in elite cricket.

Providing evidence of an association between injury measures and team success may be useful when attempting to communicate the importance of injury prevention to elite cricket stakeholders, and when striving to implement injury prevention initiatives within this setting. As such, the aim of this study was to examine the association between injury measures and team success in professional cricket teams in England and Wales.

## 2. Methods

A prospective cohort design was used to record all match time loss injuries for all first XI players associated with all 18 First-Class County Cricket (FCCC) clubs (across Divisions 1 and 2) in England and Wales, for nine seasons from April to September from 2010 to 2018 inclusive. All teams were involved in the England and Wales Cricket Board (ECB) injury surveillance programme, which was co-ordinated by a central 'Injury Surveillance Officer' who provided advice and guidance (on matters such as compliance, injury definitions, data collection) to the lead physiotherapists at each club responsible for recording injuries.

All injuries were recorded on purpose built central online medical records system: Profiler (The Profiler Corporation, New Zealand (2010-2016 inclusive), Cricket Squad (The Sports Office, UK) (2017-2018 inclusive), supported by ECB's Injury Surveillance Officer. To help ensure compliance, injury recording was mandatory and enforced through ECB annual Science and Medicine audit on injury and medical records.

Each player registered to one of the 18 First-Class County Cricket (FCCC) clubs was informed of the injury surveillance programme and provided individual consent for their data to be routinely collected and analysed by ECB and a University research partner (mean  $n = 507$  players per season). This was done at the time of annual registration and reviewed if there were any significant process or contractual changes at the start of pre-season. The study was approved by University of Bath, Research Ethics Approval Committee for Health.

In line with cricket injury surveillance guidelines,<sup>10</sup> First-Class County practitioners defined and recorded any injury or illness that were considered to render the player unavailable for match selection during the season, regardless of whether a match was scheduled.

The injury measures used in the current study were match injury incidence (number of match time-loss injuries per 1,000 days of play), and match injury burden ('overall match injury incidence rate x mean absence per match injury'), expressed for each team as number of injury days lost per 1000 days of play to account for both the frequency and severity (days lost from competition and practice) of injuries. The domestic competition structure in England and Wales sees 18 FCCC clubs compete in three competition formats during the domestic season (April to September inclusive). Two formats are tournament competitions with a group and knockout stage played in 'blocks' of single day fixtures (One-Day 50 over and T20 cricket). The County Championship is a league played throughout the season with each fixture scheduled for four days. Injuries from all competition formats were included in the analysis as an injury sustained in another format (e.g. One-Day cup) would still render the player unavailable for selection in a County Championship match. If a team played more days as a result of progressing in one of the two shorter format cup competitions, this was accounted for by use of actual days played for each format each season.

County Championship league points tally (16 points awarded for a win, eight points for each team in a tie and five points apiece if a match is drawn) was the team success measure used in this analysis. Out of the three domestic cricket competitions each season, the County Championship is the only format with fixtures that run the entire season and a league points tally. The other two competitions (One-Day 50 over and T20) are shorter cup competitions and thus performance in these competitions is difficult to quantify.

The analyses were based on the statistical methods developed to investigate the association between performance indicators and match outcomes in Rugby Sevens<sup>11</sup> and injury and success in Rugby Union.<sup>9</sup> All estimations were made using the *lme4* package<sup>12</sup> with *R* (V.3.5.2, R Foundation for Statistical Computing, Vienna, Austria). Prior to completing the within-team analysis, both injury measures were standardised by converting to within-team Z-scores.

A linear mixed model determined the association between injury measures and performance *within* each team (across the multiple seasons). The fixed effects included were injury measures (match incidence rate or match injury burden, vis separate models) and the division a team was competing in

during a given season, with team success (County Championship league points tally) the dependent variable and a random effect for team to account for repeated measurements. Team squad size (number of registered players for each squad each season) was included in the model to control for its possible effect. Effects were evaluated as the change in team performance associated with a two within-team SD increase in the injury measures, representing a change from a typically low (-1SD) to typically high (+1 SD) value.<sup>13</sup>

Inferences regarding the effect of the injury variables were assessed using the smallest worthwhile difference in team success and magnitude-based inferences.<sup>13</sup> The smallest worthwhile difference was given by 0.3 of the typical variation in the team success measures between seasons.<sup>14</sup> This difference was calculated as the SD of the average season-to-season change in each team success measure, multiplied by 0.3.<sup>11</sup> Following this method, the threshold for smallest worthwhile change in County Championship points tally was calculated to be 13 points. In the County Championship, 16 points are awarded for a win and throughout the study period the average points differential between teams finishing 7th versus 8th in Division 1 (relegation to Division 2) was 11, providing support for its use as a practically meaningful points difference.

Between-team effects were analysed to determine how injury measures of teams that were on average more successful over the study period (higher average points tally) compared to those less successful, by averaging the injury and team success measures for each team across the nine seasons. Spearman and Pearson correlation coefficients were used (depending on significance of Shapiro Wilks test for normality) to assess between-team associations. A correlation of  $\pm 0.3$  (moderate) was adopted as the smallest worthwhile effect for between-team Pearson correlations.<sup>15</sup>

A significance level of  $p < 0.05$  was always used. In addition, magnitude-based inferences were used as a complementary analysis to evaluate and interpret the effects in terms of practical relevance.<sup>16</sup> Effects were classified as *unclear* if the  $\pm 90\%$  confidence limits crossed thresholds for both positive and negative effects by  $>5\%$ . Otherwise, the effect was clear and considered to have the magnitude of the largest observed likelihood value; positive if associated with superior team performance in a higher points tally, negative if associated with a poorer team performance, and trivial if associated



with a non-substantial (below the smallest worthwhile change threshold) change in team performance. The effects were then qualified with a probabilistic term to provide more informative inferential assertions about the magnitude of the effect,<sup>13</sup> using the following scale: <0.5%, *most unlikely*; 0.5-5%, *very unlikely*; 5-25%, *unlikely*; 25-75%, *possible*; 75-95%, *likely*; 95-99.5%, *very likely*; >99.5%, *most likely*.<sup>17</sup>

### 3. Results

In total, 14,163 team days of play, 1,343 match time-loss injuries and 40,863 seasonal days lost were recorded during the study period. This resulted in a match time-loss injury incidence rate of 94.8 injuries per 1,000 days of play (90% CI 83.3 to 107.9). The mean severity of all recorded match time-loss injuries was  $25 \pm 11$  days, with a further breakdown of team means (in any given season) for success and injury measures provided in Table 1.

The within-team effect of a 2 SD increase in each injury measure (incidence and match burden) on performance (County Championship points tally) is shown in Figure 1, along with the effect within each division. Additional interaction effects between squad size and injury measures were explored and removed from the model as they did not improve model fit and explained no additional variance in team success. Both injury measures showed *possibly negative* (probabilistic term) associations with team success (25-75% possible likelihood) in Division 1, but effects were *trivial* in Division 2. Based on the average within-team effect in Division 1, a reduction in match injury incidence of 2 match time-loss injuries per 1,000 days of play per club (90% CI 1.4 to 2.9,  $p = 0.10$ ), or a reduction in match injury burden of 75 days per 1,000 days of play (90% CI 50.2 to 109.0,  $p = 0.053$ ) in any given season was associated with the smallest worthwhile change in County Championship points ( $\pm 13$  points) as illustrated in Figure 1.

As the Shapiro Wilks test for normality was significant for match injury incidence ( $W = 0.79$ ,  $p < 0.01$ ) but not significant for match burden ( $W = 0.93$ ,  $p = 0.12$ ), Spearman and Pearson correlation were used to assess between-team associations of injury measures on performance, respectively. The

correlation between match injury burden and performance met the adopted moderate correlation ( $\pm 0.3$ ) threshold for the smallest worthwhile effect for between-team correlations ( $r = -0.36$ ; 90% CI -0.66 to 0.05; *likely negative*,  $p = 0.15$ ) and is displayed in Figure 2. The Spearman correlation between team success and match injury incidence ( $r = -0.25$ ; 90% CI -0.59 to 0.17,  $p = 0.32$ ) was *unclear* (Figure 2).

#### 4. Discussion

This study aimed to examine the association between injury measures (match injury incidence and burden) and team success in professional cricket teams in England and Wales. Both injury measures demonstrated *possibly negative* associations with County Championship points tally, with two SD decreases in injury burden associated with substantial (worthwhile) improvements within team success when teams were in Division 1, but not when they were in Division 2. Between-team differences in match injury burden were also moderately associated with the team success measure, with teams that had low injury burden values typically accumulating more County Championship points across both County Championship Divisions.

These results provide some support for the growing evidence of the negative association between injury and team success.<sup>2,4,9</sup> Proposed mechanisms for this effect include reduced ability to select the best players, disruption to match and training preparations through player unavailability, as well as potential negative physical and psychological effects associated with injury that can still affect performance after a player has returned.<sup>18,19</sup> When the strongest team is often selected to play and with athlete availability suggested to be as important a factor in team success as player skill,<sup>1</sup> any injury can weaken a squad in any team sport. Due to the dynamic and complex nature of both injuries and performance in sport, only moderate associations between injury and team success were expected in this study. However, these findings still provide further empirical support for the importance of injury prevention efforts and effective injury treatments as a worthwhile part in the overall aim of improving

team success that should be understood by stakeholders in sports clubs involved with resource allocation to injury prevention and treatment.

An average within-team change in injury burden of approximately 75 days per 1000 days of play per team per season was associated with the smallest worthwhile change in County Championship points ( $\pm 13$  points) in Division 1. Although this negative association was only found when teams were in Division 1, perhaps reflecting the different competitive standard between the two divisions. Injuries sustained in Division 1 may be more detrimental to a team's overall performance in relation to other teams in the division. As injury burden accounts for frequency and severity of injuries, there are several possible ways a team could achieve a reduction in this area. For example, one way would be for a typical club to reduce their total time-loss match injuries by two injuries per season (in the context of a mean eight match time-loss injuries per team per season during the nine season study period), alongside a four-day reduction in severity of all injuries (in the context of a mean match injury severity of 25 days across the 18 clubs during the study period). However, suggesting exact recommendations for how a team would reduce injury burden can be difficult, as the aetiology and mechanisms of injury as well as individual risk factors need to be considered before any injury prevention strategy is recommended. Based on the evidence of the association between injuries and team success, future research to enhance understanding of such risk factors to inform the development of injury prevention strategies would be worthwhile.

The exact way injuries influence team performance remains unclear from this study, as the analysis explored an association between injury and team success and thus causality cannot be directly inferred. Indeed, it may be that successful teams incur fewer time-loss injuries as a result of being successful. Bowling is an important factor in a cricket team's success and has consistently been found to be the main cause of time-loss injuries.<sup>5-7</sup> Winning teams who have efficient bowlers may take wickets quicker, resulting in bowlers with less exposure than a team who must bowl and field for longer periods. In addition, it may be that successful teams have greater budgets available for medical, rehabilitation and strength and conditioning staff.<sup>9</sup> A larger overall squad size is considered to be favourable as it can accommodate any time-loss injuries better than a smaller squad. However, the

interaction effects between squad size and injury measures were removed from this study as they did not improve model fit or explain any additional variance in team success, as was the case with a similar analysis in rugby union.<sup>9</sup>

A methodological consideration with this current study is the lack of adjustment for the relative importance of an injured player within the team. An injury to a highly valued player is likely to have a greater impact on team success. A study in Australian Football League (AFL) has attempted to adjust for this using player weighting based on both a club-based rating system (obtained from the AFL) and league-wide 'Brownlow Medal votes' (sourced from publicly available data), which is a '3-2-1' voting system used by field umpires at the conclusion of an AFL match, with three votes awarded to the best player of either team.<sup>20</sup> This study found that when the 'value' of injured players was accounted for, injury was more strongly associated with team performance than when it was not, with weighted injury burden explaining up to 12% of the variation in final table position.<sup>20</sup> Finalists were more likely to have a higher player match availability than teams that were non-finalists. Future research on the association between injury and team success should consider including a weighting for players based on their importance within a team. This is especially pertinent to cricket, which (to a greater extent than most team sports) is effectively an individual sport within a team context, with much of the game focused on one bowler against one batsman. With this mind, losing specialist players to injury is likely to have a bigger effect in cricket than in other sports.

Future research in this area should also consider including non-time loss as well as time loss injuries in their analysis. Only including those injuries that resulted in time loss may bias the findings and is a limitation of the current study. A player with a non-time loss injury will be available for selection, with (or without) modified activity that can compromise their ability to perform at their usual standard, which could influence team success.

## **5. Conclusion**

This study found negative associations between injury burden and team success, with the implication being that moderate reductions in injury burden could have a worthwhile effect on the performance of a domestic cricket team in the County Championship Division 1, but not Division 2. Such findings highlight the link between injuries and team success that need to be understood by stakeholders in cricket and emphasises the importance of injury prevention efforts.

### **Practical implications**

- These findings emphasise the importance of injury prevention efforts and highlight the role that science and medicine staff have in ensuring player availability and how this contributes to team success.
- Knowledge of the negative association between injuries and team success may be useful when communicating the value of injury prevention initiatives within this setting.

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## Graphic legends

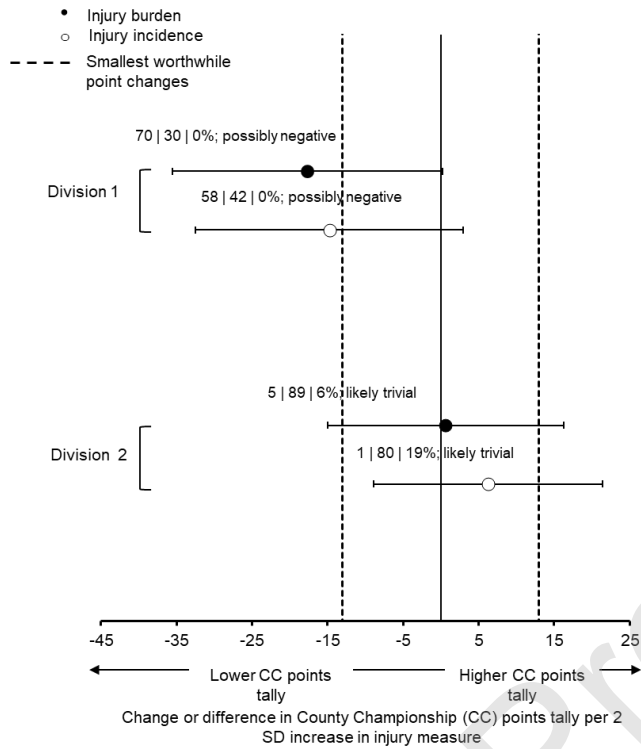


Figure 1: Plot for within-team changes of injury measures on Country Championship league points tally for each division.

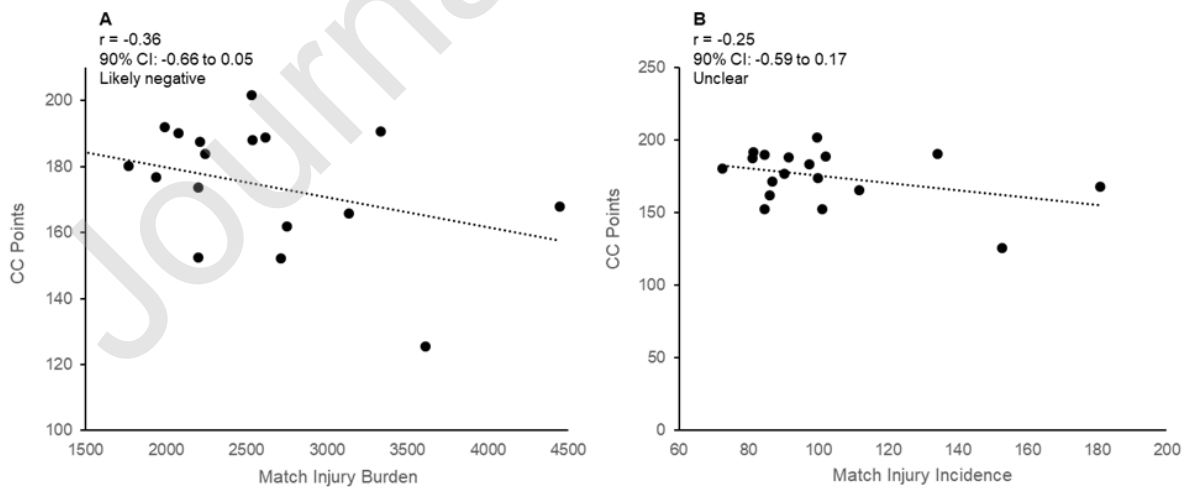


Figure 2: Pearson and Spearman correlation for (A) match injury burden and (B) match injury incidence and team success (County Championship league points tally).

**Table legends**

Table 1: Team means (90% CI) for any given season over the nine-year study period

<b>Performance/Injury Measure</b>	<b>Mean (90% CI)</b>
Days played	81 (71.2, 92.2)
Squad size	28 (24.6, 31.9)
County Championship points	175.0 (153.8, 199.1)
Match time-loss injuries	8.3 (7.3, 9.4)
Match injury severity	25.1 (22.1, 28.6)
Match injury burden (per 1,000 days of play)	2541.1 (2233.0, 2891.7)
Match injury incidence (per 1,000 days play)	102.2 (89.8, 116.3)