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Estimation of injury costs: financial damage of English Premier League teams' underachievement due to injuries

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ABSTRACT

Background In individual sports, the effect that injuries have on an athlete's performance, success and financial profit is implicit. In contrast, the effect of a single player's injury or one player's absence in team sports is much more difficult to quantify, both from the performance perspective and the financial perspective.

Objectives In this study, we attempted to estimate the effect of injuries on the performance of football teams from the English Premier League (EPL), and the financial implications derived from this effect.

Methods Our analysis is based on data regarding game results, injuries and estimations of the players' financial value for the 2012–2013 through the 2016–2017 seasons.

Results We found a statistically significant relationship (r=−0.46, 95% CI −0.6 to −0.28, p=0.001) between the number of days out due to injuries suffered by team members during a season and the place difference between their actual and expected finish in the EPL table (according to overall player value). Moreover, we can interpolate that approximately 136 days out due to injury causes a team the loss of one league point, and that approximately 271 days out due to injury costs a team one place in the table. This interpolation formula is used as a heuristic model, and given the relationship specified above accounts for a significant portion of the variance in league placement (21%), the remaining variance is related to other factors. Calculating the costs of wage bills and prize money, we estimate that an EPL team loses an average of £45 million sterling due to injury-related decrement in performance per season.

Conclusion Professional football clubs have a strong economic incentive to invest in injury prevention and rehabilitation programmes.

What are new findings?

- A comprehensive estimation of costs of injuries based on five seasons of data from the English Premier League (EPL) was undertaken.
- An average EPL team lost approximately £45 million per season due to injury-related decrements in performance.
- This estimation is based on the assessment of the team's underachievement due to injured players (£36 million) and on a direct calculation of salaries paid to injured players (£9 million).

How might it impact on clinical practice in the near future?

- The underachievement caused by injuries found in this study emphasises the need to better understand, predict and prevent injuries.
- Current results reveal that injuries impose a considerable financial burden, which could be reduced by increasing investments in specialised medical and analytical units.

INTRODUCTION

Decision-makers in both the private (eg, stakeholders, CEOs, managers) and public (eg, officials in the Ministry of Health, Social Security analysts) sectors are interested in the overall financial loss caused by injuries, and also in the potential cost savings resulting from injury prevention.[1] Financial loss is an outcome measure that enables quick comparisons among different types of injuries across a variety of industries. In this regard, the industry of professional sports requires its employees to perform at high intensities and at the highest limit of their physical capacity. As a consequence, professional athletes often suffer from injuries of various types and diverse severity.[2]

Football (soccer) is a team contact sport which requires intense physical demands (high speed running, jumping, tackling, changing directions), and as such its players are prone to both contact (eg, concussion) and non-contact (eg, hamstring strain) injuries.[3 4] The assessment of the overall effect of a single player's absence caused by injury in team sports is not an obvious pursuit, however, in recent years, attempts have been made to examine this issue. The most straightforward approach for assessment of the financial burden of injuries is to record

time-loss injuries and to count the total number of days lost due to these injuries. The literature commonly defines time-loss injury as any physical complaint which was sustained during a competitive match or in training that resulted in a player being unable to take part in, at a minimum, the player's next practice or official match.[4]

For example, Mosler *et al*[5] reported that a professional football club can expect 6.6 groin injuries per season, resulting in a total of 85 days lost. Roe *et al*,[6] in a longitudinal study of hamstring injury rates, found that Gaelic teams typically sustained 9.0 hamstring injuries per season, resulting in 299 time-loss days.

A more comprehensive approach would be to account not only for time loss by injured players but also for team performance, as reflected by accumulated wins and by annual ranking. Applying this approach, Hägglund *et al*[7] showed that lower injury incidence and higher match availability were associated with higher final league ranking and with increased points per match in European football. Similar findings were reported by Williams *et al*,[8] who recorded all time-loss injuries incurred by English Premiership rugby players during seven consecutive seasons.

A number of researchers went beyond the assessment of time loss and wins 'left on the table' due to injuries, and were able to assess the financial impact of injuries on the organisation. Hickey *et al*[9] reported on the significant increase of financial costs due to hamstring strains, after combining the athletes' annual salary for the 2003–2012 seasons with publicly available information on injuries in the Australian Football League (not the common association football also known as soccer). Donaldson *et al*[10] performed a retrospective analysis of publicly available media sources to collect injury and salary data and to assess the amount of salary paid by clubs to injured players.

Similar cost analyses have also been published by various media outlets for the English Premier League (EPL) teams. For example, according to the 2016–2017 seasonal injury report published by 'Physioroom' (https://www.physioroom.com/), Premier League clubs suffered an average of 1410 days lost (SD=554) and 58 injuries (SD=16). Combining days out due to injury with the injured players' annual salaries enabled the analysts to measure the teams' injury-related wage bill. As reported by 'Physioroom', the total EPL injury-related wage bill for the 2016–2017 season was £181 million, meaning an average of £9 million per team in one season.

In the current article, we attempt to go one step further—beyond the existing measurements of the salary paid to injured players. Our aim is to estimate the effect of injuries on the performance of teams in the EPL, and to account for detrimental influences of injuries on the teams' income. The EPL is one of the most popular football leagues globally. Live matches are aired in more than 212 countries and territories, reaching approximately 4.7 billion viewers.[11] The EPL restricts access to the television (TV) market by not allowing broadcasters to negotiate with individual clubs, and instead forcing them to buy a package from the central negotiating body. To estimate the financial impact of injuries on team performance in the EPL, we used a prize money breakdown by season-end ranking (TV rights included), alongside deficits in prize money between the bottom three places in the Premier League and the top three places in the English Football League (EFL) Championship (one tier lower), as an assessment of the financial impact that relegation has on a club. Furthermore, we also considered the prize money for achievements in European competitions.

METHODS

Data collection

A retrospective cross-sectional study was performed on five seasons of the EPL: 2012–2013 to 2016–2017. Full rosters and the number of games in which each player participated were obtained from the EPL website (https://www.premierleague.com/). Injury data were obtained from publicly available sources such as 'Physioroom' and official team injury reports. Annual team worth assessments were obtained from 'Transfermarkt' (https://www.transfermarkt.com/). 'Transfermarkt' provides a constantly updated estimation of each player's financial worth in the top European leagues—meaning the transfer fee that should be paid by a team aiming to buy that player at a certain point in time. In our analysis, we used the most updated estimations up to the end of the summer transfer window (1 September) for each season included in the analysis.

Injury influence on team ranking

Using the 'Physioroom' website, injury analysis reports for the 2012–2013 to 2016–2017 seasons and the corresponding financial team worth assessments, we attempted to quantify the effect that injuries have on a team's expected performance according to its financial squad worth. A team's expected league position at the end of each season was determined by the rank of its squad worth. The expected position was then compared with the team's actual league position; this allowed us to generate a place-difference estimation. Additionally, a points-difference estimation was generated for each team (eg, 'team A') by comparing the actual points collected by team A with the number of points collected by the team that finished the season in team A's expected place.

Due to differences in the distribution of days out due to injury and the point differences between the seasons examined, these values have been scaled per season. Finally, linear regression models were fitted to model the relationship between days out due to injury and the difference between the team's actual and expected seasonal outcome.

Influence of team rank on team income

The League's revenues are distributed to the clubs. The amount is made up of (1) merit money, (2) facility

fees and (3) Domestic TV, international TV and central commercialisation. Additionally, a number of EPL teams participate in, and make revenues from, (4) Union of European Football Associations (UEFA) Champions League and (5) UEFA Europa League. At the bottom of the table, the three lowest-placed teams are relegated to a lower league, and therefore will sustain heavy losses in the following season due to the significant differences in prize money between the EPL and the EFL Championship divisions.

More specifically: (1) Merit money is based solely on each club's final position in the league. For instance, in the 2016–2017 season, the bottom-of-the-table Sunderland received £1.9 million in merit money, while every other club received an extra £1.9 million for every position higher that they finished; (2) Facility fees are based on how many of each club's games were selected and aired on live TV. In 2016–2017, every team received a guaranteed £13.6 million, even if fewer than 10 of their games were chosen for live TV, and an additional £0.94 million for each game over 10 games; (3) Domestic TV, international TV and central commercialisation are all equally shared and summed up to £84.4 million per club; (4) and (5) In order to create a model that accounts for the expected losses of Champions League and Europa League prize money (qualification grants with performance bonuses), as well as for the financial effects of relegation from the Premier League, we consulted a professional football analyst with more than a decade of experience both on a national and an international level. We use an example to illustrate the logic on which our estimation is based. A team that finished fourth in the EPL is guaranteed a minimum payment of £12.7 million for participating in the group stage of the 2016–2017 season of the Champions League. Additionally, a fourth-place EPL team will on average achieve eight points during the group stage and thus will be paid £4 million in performance bonuses. A team that finished fifth in the EPL will participate in the Europa League (€2.6 million award for participation), and is expected to achieve 12 points during the group stage (€1.44 million), finish first in the group (€0.6 million) and reach the semifinals (€1.6 million). This adds up to a €10.46 million difference in income between the fourth (€16.7 million) and fifth (€6.24 million) place. On average, the financial deficit caused by losing one place in the final EPL table is approximately £6.9 million.

Patient and public involvement

Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

RESULTS

Examples of the impact of injuries on team performance based on the difference between expected and actual season-end rank are presented in table 1.

The data presented in table 1 serve as an example for the analysis performed for each season in order to determine the difference between a team's expected and actual seasonal outcome. We proceed to assess the explanatory power of days lost due to injuries on the difference between a team's expected and actual finishing rank.

In figure 1, a statistically significant relationship (r=−0.46, 95% CI −0.6 to −0.28, p<0.0001) can be seen between the number of days out due to injury that a team suffers per season and the place difference between its expected and actual rank. Using a linear regression model, we can interpolate that approximately 271 days out due to injury may cost a team one place in the table. Taking into account, for example, that in the 2016–2017 season Premier League clubs suffered an average of 1410 days out due to injury, and given the statistical model described above which translates to 271 days out to a loss of one league place, we can estimate that a Premier League club drops an average of six places in the table, in comparison to their expected finish according to the squad's worth. This six-place drop translates to an estimated average of £36 million.

A similar procedure was applied to assess the explanatory power of days lost due to injuries on the difference between the expected number of annual points based on the team squad's worth and the actual number of points collected.

Figure 2 displays the statistically significant relationship (r=−0.38, 95% CI −0.54 to −0.2, p=0.001) between the amount of days out due to injuries a team suffers during a season, and the point difference between their actual and expected (according to the overall players' worth) finishing place in the EPL. Based on the linear regression model, we can interpolate that approximately 136 days lost due to injury causes a team the loss of one league point.

DISCUSSION AND CONCLUSION

In line with the existing literature, the current analysis suggests that player injuries impose a major impact on team performance. This impact can also generate substantial financial damages, some of which we tried to estimate in our current investigation. Based on the relationships we found in our study between injuries and a team's performance, we estimate that an average EPL team lost approximately £45 million per season due to injury-related decrements in performance. This estimation is based on the assessment of the team's underachievement due to injured players (£36 million) and on a direct calculation of salaries paid to injured players (£9 million). Losses associated with transfer fees and a drop in the players' worth due to injuries were not taken into account in the current study, but are expected to be substantial as well. Therefore, professional football clubs are increasingly investing in injury-prevention programmes and enhanced return-to-play protocols.[12]

The club's investment in injury prevention and rehabilitation is reflected by the establishment of extensive

Table 1 Injuries' impact on team achievements in the 2016–2017 season of the EPL

Club	No of injuries	Days lost	Team worth (in millions of Pounds Sterling)	Expected rank	Actual rank	Rank difference	Expected points	Actual points	League points lost
Man United	75	1262	481	1	6	-5	93	69	–24
Chelsea	46	877	466	2	1	1	86	93	7
Man City	51	1153	466	3	3	0	78	78	–8
Arsenal	71	1573	422	4	5	-1	76	75	–1
Liverpool	81	1840	348	5	4	1	75	76	1
Tottenham	55	1029	329	6	2	4	69	86	17
West Ham	82	2191	217	7	11	-4	61	45	–16
Everton	41	1618	215	8	7	1	46	61	15
Leicester	44	885	189	9	12	-3	46	44	–2
Southampton	52	1655	179	10	8	2	45	46	1
Stoke	60	1624	155	11	13	-2	45	44	–1
Crystal Palace	67	1857	142	12	14	-2	44	41	–3
Watford	77	1852	117	13	17	-4	44	40	–4
Bournemouth	52	1163	110	14	9	5	41	46	5
West Brom	36	203	97	15	10	5	41	45	4
Swansea	44	991	95	16	15	1	40	41	1
Middlesborough	48	1055	95	17	19	-2	40	28	–12
Sunderland	85	2265	83	18	20	-2	34	24	–10
Hull City	49	2289	70	19	18	1	28	34	6
Burnley	35	822	60	20	16	4	26	40	16

sports science departments, and the hiring of scientific experts in various domains, such as physiology, biomechanics, sport medicine and nutrition. Hence, alongside a growing investment in technology that monitors various aspects of player performance and well-being (eg, Global Positioning System (GPS) tracking, camera-based tracking, biomechanical screening, isokinetic testing), analytical tools are being used to enable the gathering of insights from the collected data.

However, as illustrated by the data presented in our study, the current methods used in professional football seem to be insufficient when attempting to reduce injury rates and magnitude. As can be observed from our data, the increased volume of injuries in the EPL was a visible

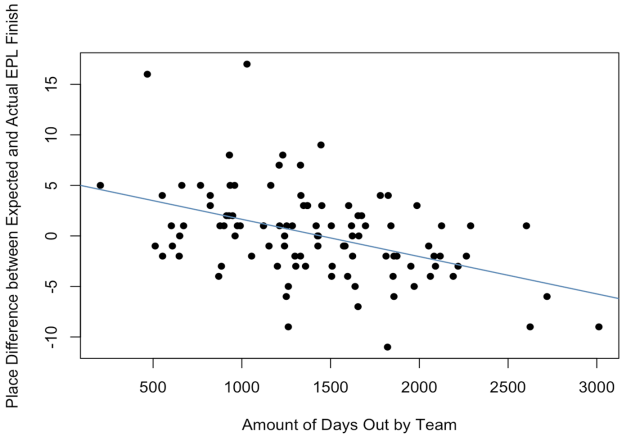

Figure 1 The relationship between days out due to injuries and the difference between expected and actual rank by the end of the season. Based on data from seasons 2012–2013 to 2016–2017. EPL, English Premier League.

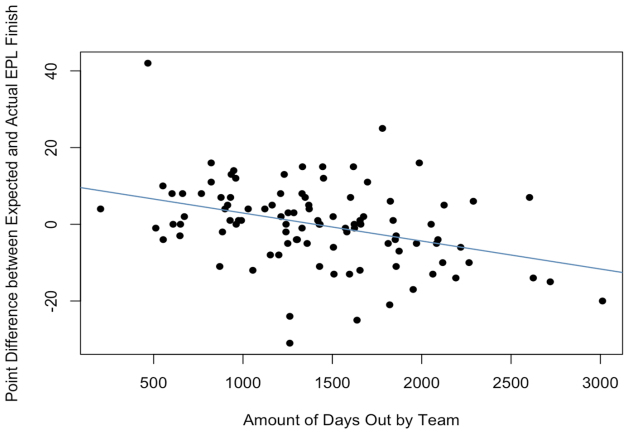

Figure 2 The relationship between days out due to injuries and the difference between expected and actual points by the end of the season. Based on data from seasons 2012–2013 to 2016–2017. EPL, English Premier League.

trend throughout the period examined in the current study. However, formidable scientific teams are at work on the clubs' behalf to reduce injury rates.[13] Although football clubs have been spending substantial portions of their budget on technology aimed at improving injury prevention and return-to-play protocols, it seems that there are still missing links in the effort to better mitigate this problem.

There are various possible assumptions as to what these missing links might be. One could consist of additional data sources that are not currently being collected which are highly correlated with injury occurrence and risk, or perhaps there is a need for improvement in the measurement accuracy of the current technology. Additionally, due to the multifactorial nature of injuries in professional football, a missing link might be the need to use powerful analytical tools, such as machine learning and artificial intelligence, which are frequently used in other industries but as of yet not in professional sport performance (eg, in basketball or football).

LIMITATIONS

Our calculations in this study can be used to form an interesting estimation of the impact that injuries may have on a team's performance and the financial effect this impact may imply. However, the correlation coefficients found in the current study showed that days out due to injury accounted for 21% of the variance in place in the EPL table, and for 14% of the variance in points achieved. This is to say that the remaining portion of variance was associated with other factors.

Contributors EE and RL designed the study. EE and EM analysed the data. EE and EM wrote the manuscript. RL and YM assisted in the manuscript preparation.

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Competing interests None declared.

Patient consent for publication Not required.

Ethics approval This study is based on information freely available in the public domain.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available in a public, open access repository. Injury data were obtained from publicly available sources such as 'Physioroom' and official team injury reports. Annual team worth assessments were obtained from 'Transfermarkt' (https://www.transfermarkt.com/).

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Correction: Estimation of injury costs: financial damage of English Premier League teams' underachievement due to injuries

Eliakim E, Morgulev E, Lidor R, *et al*. Estimation of injury costs: financial damage of English Premier League teams' underachievement due to injuries. *BMJ Open Sport & Exercise Medicine* 2020;6:e000675. doi:10.1136/bmjsem-2019-000675.

The article has been corrected since it was published online. The authors want to alert the readers to the following errors identified in the published version. The "Competing interests" statement has been updated as well.

In the Results section of the abstract, the first sentence should read "We found a statistically significant relationship (r=−0.46, 95% CI −0.6 to −0.28, p=0.001)…"

In the "Results" section at page 3, the first sentences of the third and fifth paragraph should read as

"In figure 1, a statistically significant relationship (r=−0.46, 95% CI −0.6 to −0.28, p<0.0001)…"

"Figure 2 displays the statistically significant relationship (r=−0.38, 95% CI −0.54 to −0.2, p=0.001)…"

Competing interests EE is the current CTO and co-founder of "Zone7", a company that uses artificial intelligence to develop injury prevention solutions. EM, RL and YM declare that they have no conflict of interest.

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