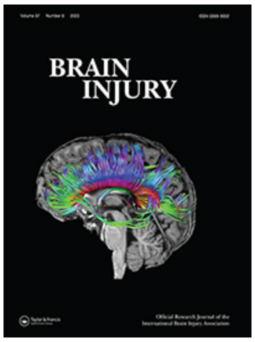

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An exploratory study into the relationship between playing at home or away and concussion

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ABSTRACT

Primary Objective: To investigate the effect of home and away game travel on risk of concussion across different levels of rugby union.

Research Design: Exploration study across school, university, and professional rugby teams.

Methods and Procedures: Retrospective analysis of concussion incidence and symptomology of surveillance data and prospective data collection for potential concussions via surveys. Data was collected from school rugby teams (n = 344 matches, over 2 years), a university rugby (n = 6 matches), and a professional rugby team (n = 64 matches, over two seasons).

Main Outcomes and Results: School level rugby had an increased prevalence of concussions in away matches (p = 0.02). Likewise, there was a significant increase ($p < 0.05$) in concussions at away matches in university rugby. In addition, the professional rug by team had significant differences in recovery times and symptoms with away fixtures, including longer recovery times ($p < 0.01$), more initial symptoms ($p < 0.01$), as well as greater and more severe symptoms at 48 hours ($p < 0.05$).

Conclusions: This research highlights an increased prevalence of concussion in school and university-aged rugby players away from home, as well as increased symptoms, symptom severity, and recovery times in professional rugby players.

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Concussion; travel; rugby union; injury; recovery

Introduction

Short- and long-distance travel is common in professional sport, with teams often traveling across different states and/ or time zones (1). However, while recent evidence suggests that short-haul flights in the United States do not impact concussion symptoms (2), longer distance international air travel is associated with an increased risk of thromboembolic disorders (3), jet lag and fatigue, sleep disruption, headaches, and dietary disturbance (4). These effects of long-distance air travel (5) can impact athletic performance and the likelihood of injury (6), with recent consensus statements highlighting the need to further examine the impact of travel on injury (7), especially in relation to concussion. This is even more prudent given that 8, observed greater frequency head impacts when Rugby Union players competed in away games.

Indeed, whilst general, physiological factors associated with travel (e.g., altitude, fitness, loading, fatigue) have been found to impact the likelihood of injury (9–11), the effect of travel (regardless of modality) on brain injuries (specifically) has largely been overlooked (2). Yet, this is an important area of further study, as concussions can have a profound impact on an individual, and even lifelong consequences (3, 12–14). Adequate recovery from concussion is also very important and may be affected by several factors [e.g., food, sleep, exercise) that can be complicated by long-distance travel.

When players travel long distances, even without crossing time zones or using aircrafts, they experience social jetlag, a form of lagging behind their rhythms of normality, often referred to as travel fatigue. 15,has previously discussed travel fatigue as the shifting of clocks and the moving of everyday events, imposed by travel, resulting in fatigue. 16, further argued that social jetlag occurs when events disrupt everyday lives and functions (e.g., the desire for sleep, food], regulated by circadian rhythms, induced by entrained circuits of routine and environmental triggers (e.g., zeitgebers, such as sunlight and temperature). Yet, in a recent systematic literature review of athletes travel fatigue and jetlag management (Janse van Ransburg *et al*., 2020), a lack of research on the impact of domestic travel and coach travel (in particular) on fatigue and injury was highlighted.

The absence of research on coach travel fatigue in sport is surprising, especially as athletes experience the coach transit like that of an airplane. Although not pressurized and not incorporating travel across time zones, the 'body tacitly inhabits the vehicle space' [17: 1019], with embodied displacement (18) occurring during coach travel. 19, also claims that time is *wasted* during movement from place to place, particularly 'when [players are] forced to be seated' [17: 1021, I], like travel to and from sporting fixtures. While player experiences of travel are not uniformly negative, when travel is obligated (20), travel-related experiences can be physically and emotionally demanding (20–22). The demands on the players, whether jetlag or social jetlag, might explain the significant difference in results away from home in Rugby Union (4,23) and the decrease in performance exhibited in international soccer matches (24).

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As the most common and reported injury in professional Rugby Union (hereon rugby) players, concussion is a significant concern for rugby teams and governing bodies (25). In England, the prevalence of concussion in rugby varies by level, yet remains the most frequent injury. The Rugby Football Union in 2019/2020 seasons reported 9.0 concussions per 1,000 playing hours in youth teams (26), 17.4 in university teams (27) and 19.8 in professional teams (28) in injury surveillance projects. Concussions are induced through direct or indirect forces to the brain, which result in axon augmentation and the release of a neurometabolic cascade, causing inflammation and a variety of symptoms (e.g., headaches, emotional dysfunction, memory loss, loss of consciousness) (29, 30). Reported symptoms and observed signs are the most effective mechanism of diagnosing and monitoring a concussion. Rest, recovery, and graduated return to activity with early exposure to low intensity aerobic exercise is currently the most appropriate management for a concussion (31).

Yet, travel fatigue has the potential to delay adequate and timely rest, with disruption to sleep patterns and an overall loss of sleep likely impacting concussion recovery (15, 16). Thus, the aim of this research was to investigate whether there was an effect of home and away game travel in relation to risk of concussion, across different levels of rugby. The three rugby levels were split across junior, adult, and professional rugby. Two seasons of concussion surveillance were analyzed for rugby players at a school, across multiple teams, as well as a professional rugby team. In addition, a university rugby team was surveyed during the second half of the BUCS season across three home and three away matches.

Method

Participants

The sample for this study was derived from school rugby teams, a university rugby team, and a professional rugby team. The school teams comprised of male athletes from between 14 and 18 years of age, while the university rugby team included 48 males aged between 18 and 25 years of age. The elite rugby team included male players from between 18 to 34 years of age.

Procedure

School-level, rugby teams undertook their own (internal) injury surveillance programme that included information about concussions. Specifically, internal records included information about diagnosed concussions from across two seasons of match play, as well as information about the location and date of each match. No personal, demographic, or other identifiable data was shared between the team, the medical staff who collated the data, or the authors of this article. The games played by the school rugby teams were publicly available and accessed online to determine the number of games played and the location of the matches.

The university rugby team volunteered to participate in a cross-sectional, prospective concussion-monitoring programme. Specifically, players were asked to complete an online questionnaire that assessed whether they had experienced a concussion, the location and date of games, as well as any symptoms or signs of a concussion (see Appendix). This programme included six matches in the final quarter of the season, three of which were at home and three were away games. The selection of included games was systematic, incorporating the scheduled fixtures for the team, with the six games played over a six-week period. All players in the club participating in the game were invited to participate each week.

Data from the professional rugby team was also collected via (internal) injury surveillance from medical staff. Specifically, the professional rugby team used the Third Head Injury Assessment Form (HIA3) as part of the assessment process for concussions. The HIA3 captures information about the symptoms experienced during the first 48-hours after a head injury and includes information about concussion exclusion or diagnosis. The HIA3 forms examined in the present study included data from two seasons of match play, before COVID-19 disruption. HIA3 forms provide a formalized, quasi-injury surveillance tool for diagnosed concussions in rugby players. Like the school rugby teams, no other personal, demographic or identifiable data was shared with the authors. Also, like the school rugby teams, the games played by the professional rugby team were publicly available and were accessed online to determine the matches played at home and away.

Matches

Data from the school rugby teams included 344 games from different teams (n = 22), across different age groups and two seasons (2016–2018), while six-matches were included from the university team from the 2018–2019 season. In addition, the professional rugby team provided data from 64 matches over two-seasons (2018–2020).

Statistics

Chi-square analysis was performed to determine the associations between home and away games, with an alpha of $p < 0.05$ taken to be statistically significant. A weighted method employed the split to home and away matches (Table 1). T-tests were used to compare symptom severity between the locations of the matches (home or away), with $p < 0.05$ taken to be statistically (significantly) different.

Table 1. Shows the total number of matches, number of home matches, number of away matches, and level of play for the different teams.

Club	Matches	Home	Away	Time	Type of Club
1	344	176	168	2016–2018	School
2	6	3	3	2018–2019	University
3	64	32	32	2018–2020	Professional

Table 2. Shows the home and away ratio used to weight the expected concussive and non-concussive events for the different teams. Results from the observed concussions and the expected concussions are also presented.

Club	Home and Away Games (H: A)	Observed Home	Observed Away	Expected Home	Expected Away	Significance
School	176: 168	30	48	39.9	38.1	$p < 0.05$
University	3: 3	7	32	11	28	$p < 0.05$
Professional	32: 32	6	13	9.5	9.5	$p = 0.08$

Table 3. Presents differences in the number of symptoms and severity of concussion symptoms between home and away games, before and at the point of the HIA3 assessment process for the professional rugby team.

HIA3		Significance
Prior to HIA3 Assessment	Number of Symptoms	$p < 0.01$
	Severity of Symptoms	$p = 0.07$
At the Point of HIA3 Assessment	Number of Symptoms	$p < 0.05$
	Severity of Symptoms	$p < 0.01$

Ethics

Approval was granted by the Geography Department Ethics Committee at Durham University in 2018.

Results

School team

Over the two seasons of public-school boy rugby, there were 78 diagnosed concussions, including 30 at home matches (38.5%) and 48 (61.5%) away from home (Table 2). Chi-square analysis revealed a significant ($p < 0.05$) association between the expected number of concussions (40) at home (176 matches of 334 multiplied by 78) and away (38) from home (168 matches of 334 multiplied by 78) and those observed (30 at home and 48 away). Surveillance of the games calculated the number of playing opportunities based upon the total number of matches (n = 344) multiplied by the players on the pitch (n = 15), totaling 5,160 playing opportunities. Home playing opportunities (including n = 176 home matches) equaled 2,640, less the 30 concussions, giving 2,610 non-concussed playing opportunities. Away games totaled 2,520 playing opportunities, less the 48 concussions, giving 2,472 non-concussive playing opportunities. Chi-squared analysis examined for an association between playing opportunities, location, and concussions compared to the expected playing opportunities, location, and concussions. The number of expected concussions were weighted by games played and concussive events, which included 40 at home and 38 away from home. These taken from the split of playing opportunities gives 2,600 non-concussive home playing opportunities and 2,582 non-concussive away playing opportunities. The association in observed concussions and expected concussions was significant at the 95% confidence level ($p = 0.02$).

University team

Of the 78 questionnaires returned, 22 (28.2%) were from home fixtures and 56 (71.8%) away from home. Across the six weeks – which included three home games (50%) and three away games (50%) – 39 (50%) responses suggested symptoms of concussion. 7 of these responses were reported at home, and 32 at away fixtures, giving 39 potential concussions. With the split of responses at home (28%) and away (72%), the expected number of concussions were predicted as 28% of 39, or 11 expected concussions at home, and 72% of 39, or 28 expected away concussions. Chi-squared analysis of the difference in observed and expected concussive events was significant at the 95% confidence level ($p < 0.05$).

Professional Team

Between 2018–2020, the professional rugby team reported 19 concussions, six at home (31.59%) and 13 away (68.41%) from home (Table 2). The 64 matches totaled 960 playing opportunities (15 players multiplied by the games), split into 480 both at home and away. The observed number of non-concussive events was 474 at home (480 less 6 concussions) compared to 467 away (480 less 13 concussions). The expected split with home and away games (50:50) means 9.5 concussions were expected at both home and away fixtures, along with 470.5 non-concussive events. Concussions observed and expected between home and away fixtures was not significant ($p = 0.10$). The comparison between observed and expected non-concussive playing opportunities and concussions was also not significant ($p = 0.08$)

Across the two seasons of professional rugby, the team saw 10 from 19 concussions being asymptomatic at the 48-hour HIA3 assessment stage. In addition, 52.6% of those concussed had not recovered within six days. Of those who failed to recover at the HIA3 stage, two (20%) concussions were from home fixtures and eight (80%) were from away games. If the split in concussions being symptomatic during the HIA3 was expected to be even across home and away games, then 5 concussions would be expected to be symptomatic and 4.5 asymptomatic for both home and away fixtures. The resulting difference was significant at the 99% confidence level ($p < 0.01$).

Analysis of the professional team's data from the HIA process details the difference in the severity and number of symptoms of the 19 concussions (see Table 3). Specifically, paired t-tests between initial symptom severity highlighted a significant difference at the 95% confidence level ($p = 0.01$) between concussion symptoms following home and away fixtures. While the initial number of symptoms at away games compared to home games was not significantly different ($p = 0.07$), there were differences in the number and severity of symptoms 48 hours after the injury. Here, the severity of symptoms was significantly higher at the 95% confidence level ($p = 0.02$) for away games compared to home games. Additionally, the number of symptoms was significantly higher at the 99% confidence level at away fixtures compared to home fixtures ($p < 0.01$).

Discussion

International or long distance away fixtures in sport can disrupt preparations for competition, impacting performance and match outcomes. 23, found that across the Super Rugby competition in Australia, New Zealand, and South Africa, and more recently Argentina and Japan, long distance travel can have a detrimental impact on performance (4]. 8, also examined collisions in community rugby in New Zealand, with greater head impacts observed in away matches. Away from rugby, international travel for soccer has also been shown to be detrimental to performance and wellness (24). This study, although restricted to national travel within the United Kingdom, has extended this work exploring the impact of home and away travel on concussion prevalence and recovery. Specifically, this research found an increase in the incidence of concussion away from home in younger players and professional players. Amongst professional players, these concussions also resulted in longer recovery times, potentially through disruption and travel experiences.

In the context of travel, the impact of, and recovery from, concussion has [like many injuries) yet to be explored in depth. Indeed, 2, have to date offered the only study to consider the acute impact of short-haul air-travel immediately after a concussion. Analyzing the return travel of military collegiate athletes suffering from concussion, they concluded that short-haul flights did not cause a differentiation in concussion symptoms compared to when they began to travel. However, this study only assessed concussion symptoms at one point in time (immediately after the flight]; thereby monitoring changes in concussion symptoms over a maximum of six hours only, with the first recording before the flight and the second after landing. Yet, concussion symptoms may take longer to present, with changes in biochemistry following a neurometabolic cascade (29).

Unfortunately, 2, also failed to consider how jet lag and circadian disruption from travel extends beyond the immediate arrival at a destination. This exploration has been limited in time points and is something future work in this area should consider. Thus, both the effects of concussion (32) and travel (33) might be delayed. Therefore, it cannot be concluded that travel does not impact concussion recovery. On the contrary, the results of this study indicate that travel is a component of recovery from concussion, as well as risk, in the context of coach travel.

In line with the arguments above, coach travel for sports teams, like flights, must be further examined for potential impacts on athletes via circadian disruption. Although jet lag is exclusively associated with flight and time zone differences, coach travel within the same country might be as long, if not longer, than some long-haul flights. Additionally, circadian disruption exists when a day or several hours are spent in the same space, or sitting (34). Coaches form a social lag and loss of freedom with time being experienced differently from what would be expected (16). Thus, work with both sports teams and individual competitors must recognize the impact of players traveling (long) distance by coaches.

Like circadian rhythm, sleep plays a key role in physical and mental rest and recovery (7), but plays a particularly important role in the initial stages of recovery from concussion (31). Yet, the impact of coach travel induced fatigue, exhaustion, and delaying, on the quantity and quality of sleep and subsequent recovery from concussion requires further investigation (15, 16, 22). Examining travel related experiences, whether that be sensory exposure (20), being fixed in a sit (17), having time stretched out (22), or having no personal space to relax (21) or begin to recover from a concussion, could also offer a chance to explain the elongation of symptoms of concussion at away fixtures. At the same time, the efficacy of interventions (e.g., delaying travel, bypassing lengthy coach journeys) that may address the impacts of sleep loss through travel and circadian disruption could be explored.

Beyond the injury itself, recovery remains a critical aspect of injuries such as concussion, with players keen to return to play as soon as possible. The increased symptoms of concussion, as well as recovery times from concussion at away fixtures amongst professional players in this study highlights the need to further examine current practices in relation to recovery when teams travel via coach back home. In addition, future studies with athletes and sports teams should explore the ways in which social jetlag and the impact of travel continues to effect injuries, training, and performance long after returning home. Moreover, the impact of travel and being away from home could add elements to longitudinal studies that have explored training loads and injuries; strengthening work that examines injuries over time [see 35]. The addition of travel and fatigue, both as social jetlag and bodily experiences, could serve to further research around performance and athlete welfare.

Limitations

Although this study includes teams from across different levels of rugby, data collection was disrupted due to COVID-19, resulting in an incomplete data set for the season for the professional team. The identified teams are also not necessarily a representation of all rugby played. In addition, data for the university team and potential concussions are from surveys and only symptoms that could be related to concussions and, as such, are not necessarily representative of concussions experienced by players. Nevertheless, the approach taken allowed for an exploration into home and away differences in concussion incidence and recovery, an area that requires further examination. Unfortunately, however, demographic data is also absent for the school and professional teams due to restrictions in data from injury surveillance.

Conclusion

This research compared concussion incidence and recovery for rugby players from school, university and professional teams. In doing so, it found that playing away from home, a proxy for travel, increased the incidence of concussion and prolonged the recovery time following a concussion, sometimes termed concussion severity. As a result, teams, at various levels of sport, should consider the implications of travel on the management of concussions. This may include delaying return travel for those who sustain a concussion, allowing them more time to recover before returning home (where possible).

Further research should also examine a variety of travel scenarios to establish which are most effective for both performance purposes, but also in the prevention and recovery from injuries such as concussion.

Disclosure statement

NH works for the Concussion Legacy Foundation UK and received funding from Erasmus+ strategic partnerships program (2019-1-IE01-KA202-051555). AJW received funding from Erasmus+ strategic partnerships program (2019-1-IE01-KA202-051555). AJP currently receives partial research salary funding from Erasmus+ strategic partnerships program (2019-1-IE01-KA202-051555). JB has no disclosures. AJP has previously received partial research funding from the Sports Health Check Charity (Australia), Australian Football League, Impact Technologies Inc., and Samsung Corporation, and is remunerated for expert advice to medico-legal practices. MM has no disclosures.

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Appendix

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Symptoms check

	none	mild		moderate		severe	
Headache	0	1	2	3	4	5	6
"Pressure in head"	0	1	2	3	4	5	6
Neck Pain	0	1	2	3	4	5	6
Nausea or vomiting	0	1	2	3	4	5	6
Dizziness	0	1	2	3	4	5	6
Blurred vision	0	1	2	3	4	5	6
Balance problems	0	1	2	3	4	5	6
Sensitivity to light	0	1	2	3	4	5	6
Sensitivity to noise	0	1	2	3	4	5	6
Feeling slowed down	0	1	2	3	4	5	6
Feeling like "in a fog"	0	1	2	3	4	5	6
"Don't feel right"	0	1	2	3	4	5	6
Difficulty concentrating	0	1	2	3	4	5	6
Difficulty remembering	0	1	2	3	4	5	6
Fatigue or low energy	0	1	2	3	4	5	6
Confusion	0	1	2	3	4	5	6
Drowsiness	0	1	2	3	4	5	6
More emotional	0	1	2	3	4	5	6
Irritability	0	1	2	3	4	5	6
Sadness	0	1	2	3	4	5	6
Nervous or Anxious	0	1	2	3	4	5	6

From the table above do you have any symptoms, if so which and how bad? (State None if none) *

Long-answer text