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Epidemiology of University American Football Injuries in the United Kingdom
ABSTRACT

Background
College level American football injury data are routinely collected, however data relating to UK university American football injuries has never been reported.

Purpose
To describe the epidemiology of UK university American football injuries.

Study Design
Descriptive epidemiology study.

Methods
An online survey tool was used to collect injury data of 410 players from 56 UK university American football teams who participated in the 2014-2015 British Universities and College Sports American football season. Survey data were collected from January to February 2016 and analysed to determine the incidence and patterns of injury.

Results
710 injuries and 204 concussions were self-reported among the 410 participants, of which 334 (81.5%) were injured and 131 (32.0%) experienced concussion symptoms. The rate of injury per 100 athlete-seasons was greater in defensive players (195.3) than offensive players (155.1). The most common injuries were knee and ankle ligament injuries. The most common time loss for an injury was >4 weeks.

Conclusion
UK university American football injuries differ markedly from those reported for US colleges. UK university players appear to have less playing experience, greater
concussion risks, more severe injuries and a greater proportion of injuries to
defensive players.

**Key Terms**
Football (American), Head injuries/concussion, General sports trauma, Epidemiology

**What is known about this subject**
College level American football injury data is routinely collected to a high standard by
the NCAA. Data for UK university American football players has never been
collected.

**What this study adds to existing knowledge**
This is the first study to describe UK university American football injury data and
highlight a worryingly high injury rate compared to US college football. Player
experience seems to be linked to injury rate.
INTRODUCTION

American football is the most popular collegiate sport in America. 72,788 players from 670 teams participated in the 2014-15 season\textsuperscript{31} and Division I games attracted an average attendance of 44,603.\textsuperscript{28} The game is less popular, but growing, in the UK university system. American football was first played between UK universities in 1985 as a 4-team league. This league has since been accepted under the British University and Colleges Sport (BUCS) governing body and had expanded to encompass an 80-team league by the 2015-16 season.\textsuperscript{4}

Within the US, players are brought up through age-grade systems playing American football and need to perform at a high level to move from high school to college teams.\textsuperscript{29} In countries such as Japan or the UK, a large proportion of players first play American football at university\textsuperscript{21} as at the youth level other sports are predominantly played.\textsuperscript{18,32} College players outside of the US therefore start with less experience, and higher practice injury rates suggest coaches put a greater emphasis on full-contact scrimmages.\textsuperscript{19,21} Lack of player experience in combination with an increased exposure to contact may lead to a higher injury rate,\textsuperscript{19} however later sports specialisation may actually reduce injury risk.\textsuperscript{27} In Japanese collegiate football, the practice injury rate is over twice that in US colleges, suggesting these factors in combination increase injury risk.\textsuperscript{10,19} Differences in training facilities, medical and rehabilitation facilities, officiating, playing equipment and coaching quality due to funding disparities further separate US college teams from those in other countries. Distinct playing populations and environments may mean that injury patterns in UK university American football differ from those observed in US colleges.
Injuries in US collegiate American football are recorded by the NCAA Injury Surveillance Program. There is no such data collection system in place the UK and there is no literature available describing injuries in the UK American football playing population. This study therefore aims to characterise the incidence and patterns of injury in UK university American football during the 2014-15 season to set the foundation for future research aimed at developing injury prevention strategies that make the sport safer to play in the UK.

**MATERIALS AND METHODS**

**Study design**

Injury data and player information was retrospectively collected from a voluntarily recruited sample using an anonymised online survey platform. Players who participated in the 2014-2015 BUCS American football season and were at least 18 years old were eligible, regardless of whether they acquired an injury during the season. The 2014-15 BUCS American football season consisted of seven regular season games and up to two playoff games per team, running from September 2014 to March 2015. Teams practiced on average one to two times per week depending on their fixtures. 78 teams were identified via the BUCS website⁴ and contact made via corresponding email addresses and Facebook pages. Facebook was then used as the primary distribution platform of the survey access link as it is considered the most popular social network among university students and an effective communication platform.⁷ The survey was distributed to teams from January to February 2016 for voluntary completion by players. Mass survey sendouts took
place when the survey opened and 3 weeks after opening, and teams were
individually followed up multiple times throughout the survey period to improve
response rate.

Survey tool

The Bristol Online Surveys questionnaire tool was used to design and distribute the
survey.\textsuperscript{5} The questionnaire was distributed electronically instead of using paper-
based methods, since response rates are higher for electronic surveys.\textsuperscript{2} The
questionnaire was developed based on data collected by previous injury studies\textsuperscript{9,15,19}
and consensus statements on injury data collection.\textsuperscript{12,13} Anatomical location and
injury type categories from previous research were used.\textsuperscript{12} Prior to filling out the
questionnaire, players were required to accept a statement to confirm their
consent. All responses were anonymous. Questions asked in the questionnaire are
summarised in Table 1 and shown in full in Appendix 1.

Table 1. Summary of topics and questions asked in the questionnaire.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Player profile</td>
<td>Age, gender, team, number of injuries, playing position, playing experience</td>
</tr>
<tr>
<td>Injury characteristics</td>
<td>Body site injured, injury type, recurrence of injury, mechanism of injury, type of athletic exposure (game or practice), position played, time loss of injury</td>
</tr>
<tr>
<td>Concussion information</td>
<td>Number of concussions, history of concussion</td>
</tr>
</tbody>
</table>

The questionnaire was validated prior to distribution with an internal pilot test. The
primary feedback was that the survey was unfeasibly long, thus the format was
condensed. This reduced data entry time to help improve response rate.\textsuperscript{17} Ethical
approval was obtained from the [affiliation removed] Ethics Committee.

Operational definitions
For the purposes of this study, an injury was defined as a physical complaint that occurred as a direct result of participation in an organised training session or match from the 2014-15 BUCS American Football season and resulted in time missed from training or matches. This definition was used to include all time-loss injuries, and adapted from a previous definition. Absences due to illness and non-sport-related medical conditions were not included in the study. Injuries were classified into four categories of severity: slight (time loss 1-3 days), minor (time loss 4-7 days), moderate (time loss 1-4 weeks) and severe (time loss >4 weeks). These injury severity categories have been previously used in the literature. Concussion diagnosis requires a full assessment by a medical professional. Due to lack of athletic trainers in BUCS American football teams and under-diagnosis of concussions in sport, participants were presented with a lay concussion description drawn from the Scottish Sports Concussion Guidance to aid them in determining the number of concussions they had acquired over the course of the season. This description notes the various symptoms indicative of concussion following a direct blow to the head (detail in appendix 1). One athlete participating in one BUCS American football season was defined as one athlete-season. Each participant was considered to have played for one athlete-season.

### Statistical analysis

Required survey sample size was estimated using the Creative Research Systems online survey sample size calculator. Assuming a total sample population of 3900 (78 teams with an assumed roster of 50 players per team) we required a return rate of at least 350 players to offer a reflective sample base on a confidence level of 95% and a confidence interval of 5%. In practice we aimed for the largest response rate
possible. Players were grouped by position (quarterback, running back, wide receiver, tight end, offensive lineman, defensive lineman, linebacker, defensive back and special teams) and by playing experience in years (0, 1, 2, 3, ≥4). All data were non-parametric and arranged into either scale variables or nominal groups by frequency counts. Incidence rates, incidence proportions, rate differences, rate ratios and risk ratios for injuries and concussions were calculated using formulas described in the literature.\(^{20}\) 95% confidence intervals (CIs) were calculated for incidence rates, incidence proportions, rate ratios, and risk ratios. Incidence rates were calculated per 100 athlete-seasons. Players' injuries were categorised by the injury characteristics in Table 1 and are reported as numbers and percentages. Chi-square (\(\chi^2\)) cross tabulation and one-sample tests were conducted to determine statistically significant associations between injury characteristics and player groups. Strength of association was quantified using phi (\(\phi\)) for \(\chi^2\) cross tabulation tests. Statistical significance for \(\chi^2\) tests with expected cell frequencies less than five used either Fisher's Exact test (\(\chi^2\) cross tabulation tests) or an exact test of goodness-of-fit (\(\chi^2\) one-sample tests). The \(\alpha\) value was set at \(p<.05\). Risk and rate ratios with CIs not including 1.00 were considered statistically significant. Analysis was carried out using SPSS, version 22.

**RESULTS**

**Demographic**

422 players responded from 56 of 78 UK university American football teams. 12 players were excluded from analysis due to inadequate completion of the survey, or not meeting eligibility criteria, leaving 410 player responders (11% of the estimated
population) for analysis. The mean age of participants was 21.3 years (range 18-37 years). 95.6% of participants were 18-25 years old. 99.3% of participants were male (407 male; 3 female). 341 participants (83.2%) started playing American football at university and 162 (39.5%) had never played American football prior to the 2014-2015 season.

**Injury and concussion rates**

A total of 710 injuries and 204 concussions were reported among the 410 participants, of which 334 (81.5%) were injured and 131 (32.0%) were concussed during the 2014-15 season. In total, the injury and concussion rates were 173.2 injuries per 100 athlete-seasons, 95% CI [160.7, 186.4] and 49.8 concussions per 100 athlete-seasons, 95% CI [43.2, 57.1]. Injury and concussion rates by player position and playing experience are shown in Figure 1, Figure 2 and Table 2.

![Injury rates by player position. *p < .05, based on 95% confidence intervals, compared to another mutually exclusive group within the same category.](image-url)
Figure 2. Concussion rates by player position. *p < .05, based on 95% confidence intervals, compared to another mutually exclusive group within the same category.
Table 2. Numbers of injuries and concussions acquired by players and incidence rates by player position and playing experience.

<table>
<thead>
<tr>
<th>Player position</th>
<th>No. of Exposures (athlete-seasons)</th>
<th>No. of injuries</th>
<th>Incidence rate(^a) (95% CI)</th>
<th>No. of concussions</th>
<th>Incidence rate(^a) (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Offence overall</td>
<td>216</td>
<td>335</td>
<td>155.1 (138.9-172.6)</td>
<td>105</td>
<td>48.6 (39.8-58.8)</td>
</tr>
<tr>
<td>Quarterback</td>
<td>20</td>
<td>23</td>
<td>115.0 (72.9-172.6)</td>
<td>9</td>
<td>45.0 (27.1-68.6)</td>
</tr>
<tr>
<td>Running back</td>
<td>42</td>
<td>74</td>
<td>176.2 (138.3-221.2)</td>
<td>32</td>
<td>76.2 (52.1-107.6)*</td>
</tr>
<tr>
<td>Wide receiver</td>
<td>66</td>
<td>90</td>
<td>136.4 (109.7-167.6)</td>
<td>18</td>
<td>27.3 (16.2-43.1)</td>
</tr>
<tr>
<td>Tight end</td>
<td>9</td>
<td>17</td>
<td>188.9 (110.0-302.4)</td>
<td>1</td>
<td>11.1 (0.3-61.9)</td>
</tr>
<tr>
<td>Offensive lineman</td>
<td>79</td>
<td>131</td>
<td>165.8 (138.6-196.8)</td>
<td>45</td>
<td>57.0 (41.5-76.2)</td>
</tr>
<tr>
<td>Defence overall</td>
<td>191</td>
<td>373</td>
<td>195.3 (176.0-216.1)*</td>
<td>99</td>
<td>51.8 (42.1-63.1)</td>
</tr>
<tr>
<td>Defensive lineman</td>
<td>48</td>
<td>117</td>
<td>243.8 (201.6-292.1)*</td>
<td>31</td>
<td>64.6 (43.9-91.7)*</td>
</tr>
<tr>
<td>Defensive back</td>
<td>73</td>
<td>116</td>
<td>158.9 (131.3-190.6)</td>
<td>34</td>
<td>46.6 (32.2-65.1)</td>
</tr>
<tr>
<td>Linebacker</td>
<td>70</td>
<td>140</td>
<td>200.0 (168.2-238.0)*</td>
<td>32</td>
<td>45.7 (31.3-64.5)</td>
</tr>
<tr>
<td>Special teams</td>
<td>3</td>
<td>2</td>
<td>66.7 (8.1-240.8)</td>
<td>2</td>
<td>66.7 (8.1-240.8)</td>
</tr>
<tr>
<td>Playing experience, y</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>162</td>
<td>277</td>
<td>171.0 (151.4-192.4)</td>
<td>54</td>
<td>33.3 (25.0-43.5)</td>
</tr>
<tr>
<td>1</td>
<td>106</td>
<td>199</td>
<td>187.7 (162.6-215.7)</td>
<td>56</td>
<td>52.8 (39.9-68.6)</td>
</tr>
<tr>
<td>2</td>
<td>65</td>
<td>102</td>
<td>156.9 (128.0-190.5)</td>
<td>34</td>
<td>52.3 (36.2-73.1)</td>
</tr>
<tr>
<td>3</td>
<td>30</td>
<td>52</td>
<td>173.3 (129.5-227.3)</td>
<td>30</td>
<td>100.0 (67.5-142.8)</td>
</tr>
<tr>
<td>≥4</td>
<td>47</td>
<td>80</td>
<td>170.2 (135.0-211.8)</td>
<td>30</td>
<td>63.8 (43.1-91.1)</td>
</tr>
</tbody>
</table>

\(^a\)Total exposures = 410 athlete-seasons.
\(^b\)Per 100 athlete-seasons.
\(^*\)\(p < .05\), based on 95% confidence intervals, compared to another mutually exclusive group within the same category.

There were no significant differences in injury or concussion rates by playing experience. Overall, defensive players had a significantly higher injury rate than offensive players (rate ratio = 1.26, 95% CI [1.11, 1.40]) acquiring 40.2 more injuries per 100 athlete-seasons. Defensive and offensive players had a roughly equal concussion rate (rate ratio = 1.07, 95% CI [0.79, 1.34]). Defensive linemen had the highest injury rate, which was significantly higher than that of offensive linemen, defensive backs, wide receivers and quarterbacks, \(p<.05\). Linebackers had the second highest injury rate, which was significantly higher than that of wide receivers.
Running backs and defensive linemen had the highest concussion rates, which were significantly higher than that of wide receivers, $p<.05$.

**Risk of injury and concussion**

The risks that a player would sustain at least one injury over the course of the season was 81%, 95% CI [77.7%, 85.2%], and the risk that a player would sustain at least one concussion over the course of the season was 32%, 95% CI [27.6%, 36.6%]. Injury and concussion incidence proportions and risks by player position and playing experience are shown in Table 3.

<table>
<thead>
<tr>
<th>Player Position</th>
<th>Total players</th>
<th>No. of players injured</th>
<th>Incidence proportion (95% CI)</th>
<th>Risk of acquiring ≥1 injuries</th>
<th>No. of players concussed</th>
<th>Incidence proportion (95% CI)</th>
<th>Risk of acquiring ≥1 concussions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Offence overall</strong></td>
<td>216</td>
<td>174</td>
<td>0.806 (0.749-0.853)</td>
<td>81%</td>
<td>66</td>
<td>0.306 (0.249-0.370)</td>
<td>31%</td>
</tr>
<tr>
<td>Quarterback</td>
<td>20</td>
<td>15</td>
<td>0.750 (0.531-0.888)</td>
<td>75%</td>
<td>6</td>
<td>0.300 (0.145-0.519)</td>
<td>30%</td>
</tr>
<tr>
<td>Running Back</td>
<td>42</td>
<td>37</td>
<td>0.881 (0.750-0.948)</td>
<td>88%</td>
<td>18</td>
<td>0.429 (0.291-0.578)</td>
<td>43%</td>
</tr>
<tr>
<td>Wide Receiver</td>
<td>66</td>
<td>51</td>
<td>0.773 (0.658-0.857)</td>
<td>77%</td>
<td>12</td>
<td>0.182 (0.107-0.291)</td>
<td>18%</td>
</tr>
<tr>
<td>Tight End</td>
<td>9</td>
<td>7</td>
<td>0.778 (0.453-0.937)</td>
<td>78%</td>
<td>1</td>
<td>0.111 (0.020-0.435)</td>
<td>11%</td>
</tr>
<tr>
<td><strong>Defence overall</strong></td>
<td>191</td>
<td>158</td>
<td>0.810 (0.710-0.881)</td>
<td>81%</td>
<td>29</td>
<td>0.367 (0.269-0.477)</td>
<td>37%</td>
</tr>
<tr>
<td>Offensive Lineman</td>
<td>79</td>
<td>64</td>
<td>0.827 (0.767-0.874)</td>
<td>83%</td>
<td>64</td>
<td>0.335 (0.272-0.405)</td>
<td>34%</td>
</tr>
<tr>
<td><strong>Defensive Lineman</strong></td>
<td>48</td>
<td>45</td>
<td>0.938 (0.832-0.979)</td>
<td>94%</td>
<td>17</td>
<td>0.354 (0.234-0.496)</td>
<td>35%</td>
</tr>
<tr>
<td>Defensive Back</td>
<td>73</td>
<td>52</td>
<td>0.712 (0.600-0.803)</td>
<td>71%</td>
<td>21</td>
<td>0.288 (0.197-0.400)</td>
<td>29%</td>
</tr>
</tbody>
</table>
### Table 1: Player Characteristics

<table>
<thead>
<tr>
<th>Category</th>
<th>Number</th>
<th>Concussion History</th>
<th>Risk</th>
<th>Playing Experience</th>
<th>Risk</th>
<th>Playing Experience by Concussion History</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linebacker</td>
<td>70</td>
<td>61</td>
<td>0.871 (0.773-0.931)</td>
<td>87%</td>
<td>26</td>
<td>0.371 (0.268-0.489)</td>
</tr>
<tr>
<td>Special Teams</td>
<td>3</td>
<td>2</td>
<td>0.667 (0.208-0.939)</td>
<td>67%</td>
<td>1</td>
<td>0.333 (0.061-0.792)</td>
</tr>
<tr>
<td>Playing experience, y</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>162</td>
<td>131</td>
<td>0.809 (0.741-0.862)</td>
<td>81%</td>
<td>36</td>
<td>0.222 (0.165-0.292)</td>
</tr>
<tr>
<td>1</td>
<td>106</td>
<td>96</td>
<td>0.906 (0.835-0.948)</td>
<td>91%</td>
<td>37</td>
<td>0.349 (0.265-0.444)</td>
</tr>
<tr>
<td>2</td>
<td>65</td>
<td>51</td>
<td>0.785 (0.670-0.867)</td>
<td>79%</td>
<td>24</td>
<td>0.369 (0.262-0.491)</td>
</tr>
<tr>
<td>3</td>
<td>30</td>
<td>21</td>
<td>0.700 (0.521-0.833)</td>
<td>70%</td>
<td>15</td>
<td>0.500 (0.332-0.668)</td>
</tr>
<tr>
<td>≥4</td>
<td>47</td>
<td>35</td>
<td>0.745 (0.605-0.847)</td>
<td>75%</td>
<td>19</td>
<td>0.404 (0.276-0.547)</td>
</tr>
</tbody>
</table>

*Risks rounded to zero decimal places and calculated as risk over the course of 1 season.

168 (41.0%) players had acquired a concussion prior to the season, of which 76 (45.2%) acquired a concussion during the season. Only 55 (22.7%) of 242 players with no concussion history acquired a concussion during the season. There was a statistically significant association between having a concussion prior to the season and acquiring a concussion during the season, $\chi^2(1) = 23.111, p<.001$. The association had a small-to-moderate effect size, $\phi = 0.237, p<.001$, risk ratio = 1.99, 95% CI [1.50, 2.65]. Player numbers by concussion history prior to the season and if they received a concussion during the season are shown in Figure 3.

**Figure 3. Number of players by if they had been concussed prior to the season and if they received a concussion during the season.**
Injuries by body part and injury type

The most commonly injured body parts were the knee (20%), shoulder (17%), and hand (13%). Head injuries occurred significantly more in games (90.9%) compared to other body parts, \( p<.001 \). Hand and upper leg injuries occurred significantly more in practices (67.4%, 76.9%) compared to other body parts, \( p=.015, .026 \). Significantly more knee injuries were severe (50.0%) compared to other body parts, \( p=.002 \).

The most common injury types were ligament injuries (28%), muscle strains (19%) and bone fractures (15%). Concussions occurred significantly more in games (91.3%) compared to other injury types, \( p<.001 \). Significantly less muscle strains were severe (17.5%) compared to other injury types, \( p=.015 \). The most commonly injured body part and injury type combinations, their proportions of all severe injuries, most common type of athletic exposure and their most common injury mechanisms are shown in Table 4.

Table 4. Most common body part and injury type combinations with percentages of all injuries, all severe injuries, most common type of athletic exposure and most common injury mechanisms.

<table>
<thead>
<tr>
<th>Body Part</th>
<th>Injury Type</th>
<th>Frequency</th>
<th>Percentage of all injuries</th>
<th>Percentage of all severe injuries</th>
<th>Most common type of athletic exposure (%)</th>
<th>Most common injury mechanism (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knee</td>
<td>Ligament injury</td>
<td>34</td>
<td>10.2%</td>
<td>24.6%</td>
<td>Game (65%)</td>
<td>Impact (85%)</td>
</tr>
<tr>
<td>Ankle</td>
<td>Ligament injury</td>
<td>28</td>
<td>8.4%</td>
<td>10.1%</td>
<td>Equal(^a) (50%)</td>
<td>Impact (79%)</td>
</tr>
<tr>
<td>Hand</td>
<td>Bone fracture</td>
<td>23</td>
<td>6.9%</td>
<td>7.2%</td>
<td>Practice (70%)</td>
<td>Impact (100%)</td>
</tr>
<tr>
<td>Head</td>
<td>Concussion</td>
<td>22</td>
<td>6.6%</td>
<td>5.8%</td>
<td>Game (91%)</td>
<td>Impact (100%)</td>
</tr>
<tr>
<td>Shoulder</td>
<td>Dislocation/subluxation</td>
<td>17</td>
<td>5.1%</td>
<td>11.6%</td>
<td>Practice (53%)</td>
<td>Impact (94%)</td>
</tr>
<tr>
<td>Shoulder</td>
<td>Ligament injury</td>
<td>13</td>
<td>3.9%</td>
<td>7.2%</td>
<td>Practice (54%)</td>
<td>Impact (92%)</td>
</tr>
<tr>
<td>Upper leg</td>
<td>Muscle-tendon strain</td>
<td>12</td>
<td>3.6%</td>
<td>5.8%</td>
<td>Practice (75%)</td>
<td>Overuse (67%)</td>
</tr>
<tr>
<td>Shoulder</td>
<td>Muscle-tendon strain</td>
<td>11</td>
<td>3.3%</td>
<td>2.9%</td>
<td>Game (55%)</td>
<td>Impact (91%)</td>
</tr>
<tr>
<td>Lower back/pelvis</td>
<td>Muscle-tendon strain</td>
<td>10</td>
<td>3.0%</td>
<td>1.4%</td>
<td>Practice (60%)</td>
<td>Impact (80%)</td>
</tr>
</tbody>
</table>

Note: Only injuries with a frequency count >10 are included. \(^a\)Percentages are rounded to zero decimal places. \(^b\)Numbers of game and practice injuries were equal.
Injury characteristics

Of injuries reported, 101 (30.2%) were recurrent, 266 (79.6%) were caused by an impact, and 66 (19.8%) occurred from overuse. 172 (51.5%) of injuries occurred in games and 162 (48.5%) occurred in practices. The type of exposure during which injury occurred by player position is shown in Figure 4.

Wide receivers were injured significantly more in practices (63.8%) compared to other positions, $p=0.041$. Cornerbacks had significantly more overuse injuries (33.3%) compared to other positions, $p=.048$.

The most common time loss for an injury was >4 weeks (31.1%). No significant differences in injury severity or recurrence of injury were found between positions.
DISCUSSION

This is the first study to document university American football injuries in the UK.

Compared to US players, UK university players had less playing experience, greater concussion risks, more severe injuries and a greater proportion of injuries was seen in defensive players. We highlight a very different, more amateur setup for American football in UK universities compared to US colleges, with substantial differences in player experience, strength and conditioning, funding, coaching, officiating, and medical facilities.

Almost two in five players had no experience prior to the 2014-15 season and over four in five played American football for the first time at university. This is entirely different to the competitive situation in the US, where only 6.5% of high school players make it on to college teams and organised football starts at the grade school level. Less experienced players, such as those in the UK, are less likely to have developed good tackling technique compared to more experienced players as it requires proper training and consolidated practice. This may explain why defensive players were found to have higher injury rates than offensive players, which is in marked contrast to the US and Japan where offensive players have the higher injury rates. Defensive and offensive players in the UK had a roughly equal concussion rate overall, which is consistent with findings in the US. Similar to previous studies, running backs and linebackers were among the positions with the highest injury rates. These positions are often injured due to their involvement in high-speed tackles. Injury rates in offensive and defensive linemen
were proportionally higher than in US colleges.\textsuperscript{33} This is likely due to teams in the UK having small roster sizes (similar to US high schools) and linemen having to play for entire games, unlike in US colleges where second and third string substitutes are available.\textsuperscript{1,11}

Approximately one in three UK university players (32\%) acquired at least one concussion over the course of the season, which is over three times the risk reported in US American football (4-10\%).\textsuperscript{11} The high concussion risk reported by this study should be interpreted with caution due to the self-diagnosed and self-reported data it is based on, however the high number of players reporting concussion symptoms is extremely concerning, especially in light of the second-impact syndrome\textsuperscript{24} and potential long-term neurodegenerative effects.\textsuperscript{25} UK Players with a history of concussion had almost twice the risk of acquiring a concussion during the season compared to those with no history, which is consistent with findings in US American football.\textsuperscript{15} There is no enforced return-to-activity protocol following concussion in the UK. It is at the discretion of players to return to activity safely if advised to do so by match-day medical staff, who have no affiliation or continuity with teams. By contrast, NCAA players in the US are started on a detailed return-to-activity protocol by their medical teams and monitored to ensure compliance.\textsuperscript{30}

Knee, shoulder and hand injuries made up a greater proportion of injuries compared to US high school and college injuries.\textsuperscript{33} The knee was the most common injury site among offensive players in the UK and makes up a similar proportion of injuries to offensive players in the US.\textsuperscript{33} Defensive players in the UK were most injured at the shoulder, whereas US defensive players most commonly had head injuries. More
shoulder injuries in defensive players could be another indication of poor tackling technique in the UK, with players failing to protect their shoulders when tackling.\textsuperscript{33}

Consistent with US high school and college injuries,\textsuperscript{33} ligament injuries and muscle strains were the most common injury types. Also in keeping with findings in the US,\textsuperscript{10} knee and ankle ligament injuries were the most common injuries, and made up a similar proportion of all severe injuries. Hand fractures made up a much larger proportion of UK injuries (6.9\%) than they did US injuries (1\%), many of which occurred in practices (70\%). This may be due to more contact in practices in the UK, similar to in Japan.\textsuperscript{19,21}

The time loss spread by position is similar to that shown in US high schools.\textsuperscript{1} However, the most common time loss (>4 weeks) was much longer than that in US colleges and high schools (≤6 days).\textsuperscript{1,33} This may be due to underreporting of minor injuries, as is common in self-reported retrospective injury data.\textsuperscript{14} More severe injuries may also be a result lack of formal player strength and conditioning or match officials who are less experienced at policing illegal contact.

The implementation of an injury surveillance programme similar to that used in the NCAA\textsuperscript{9} or BUCS Super Rugby\textsuperscript{6} would allow for a more comprehensive description of injuries from which targeted injury prevention strategies could be recommended. Since we lack higher resolution data at present, broad injury prevention strategies should be considered based on the findings of this study. These could include designated team personnel to monitor injuries and concussion protocols, limited contact at practices, improved coach and referee training, strength and conditioning
programmes and a period of technique development before participation in
competitive contact.

Limitations
The primary limitations of this study are the retrospective survey design, the lack of
exposure data and the non-responder rate. Survey data have well established
responder biases which may over-represent the true injury incidence and under-
represent minor injuries. We place particular caution on the concussion response
data as this was a self-report of concussion symptoms as opposed to a specific
medical diagnosis. The response rate accounted for only 11% of the estimated
population, however this is a reasonable response rate for a population survey tool.²
The wider representativeness of the data is unknown as this is the first survey
reported in a UK university football population, but the injury rates reported seem
broadly credible in comparison to wider literature.

Future surveys, ideally on an annual basis, are vital to evaluate the validity and
reliability of this initial data report. More detailed collection of exposure data would
have allowed for the calculation of injury rates using athlete-exposures, which are
more comparable to the literature than athlete-seasons and this should also be a
focus of future research. Additionally, collection of data on the factors that separate
UK and US football will aid in comparison of injury data and identification of
contributors to injury. Once an injury surveillance system has been established data
on other factors known to affect injury rates, such as player size,³²² playing
surfaces,¹⁵ time of year,¹⁰ and type of play³³ can be collected to enhance
understanding of the contributors to injury in the UK.
Conclusion

This is the first study to document and analyse American football injuries in UK university players. UK university players appear to have less playing experience, greater concussion risks, more severe injuries and a greater proportion of injuries to defensive players than their US counterparts. These results suggest that injury rate and type may be related to skill and tackling technique. The introduction of a national injury surveillance system in UK university American football would be a sensible first step to developing a comprehensive injury mitigation strategy.

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APPENDIX 1 – PLAYER QUESTIONNAIRE

Player profile

1. What is your date of birth?

2. What is your gender?
   a. Male
   b. Female
   c. Other

3. What team did you play for in the 2014/15 season?

4. How many injuries did you acquire playing American football during the 2014/15 season? For the purposes of this survey, this is the definition of injury:
   “A physical complaint that occurred as a direct result of participation in an organised American Football training session or match and resulted in time missed from training or matches.”
   a. 0
   b. 1
   c. 2
   d. 3
   e. 4
   f. 5+
5. What was the main position you played during the 2014/15 season? (most time spent playing)
   a. Quarterback
   b. Running back
   c. Wide receiver
   d. Tight end
   e. Centre
   f. Offensive guard
   g. Offensive tackle
   h. Linebacker
   i. Defensive tackle
   j. Defensive end
   k. Safety
   l. Cornerback
   m. Kicker
   n. Special Teams

6. For how many complete seasons have you played American Football?
   (Including the 2014/15 Season, but NOT including the current 15/16 season)
   a. 1
   b. 2
   c. 3
   d. 4
   e. 5+
7. For how many years had you played American football prior to University?

   a. 0  
   b. 1  
   c. 2  
   d. 3  
   e. 4  
   f. 5+  

Injury characteristics

1. What body part did you injure?

   a. Head  
   b. Neck  
   c. Sternum/ribs  
   d. Upper back  
   e. Abdomen  
   f. Lower back/pelvis  
   g. Shoulder  
   h. Upper arm  
   i. Elbow  
   j. Forearm  
   k. Wrist  
   l. Hand  
   m. Upper leg  
   n. Knee  
   o. Lower leg
2. What type of injury was it? (If you do not think your injury fits in to any of these categories, do your best to describe your injury in as much detail as possible after selecting "Other").

a. Concussion
b. Bone fracture (broken bone)
c. Dislocation/subluxation
d. Ligament injury/sprain/tear
e. Meniscus tear
f. Cartilage damage
g. Muscle rupture/strain/tear/cramps
h. Tendon rupture/tendinosis/bursitis
i. Bruise
j. Abrasion (graze/light cut)
k. Laceration (deep cut)
l. Nerve injury
m. Dental injury
n. Other

3. Prior to your injury, had you experienced the same injury at the same site before?

a. Yes
b. No
4. Was the injury due to an impact (e.g. a tackle) or non-impact/overuse (e.g. cramp) event?
   a. Impact
   b. Non-impact/overuse

5. Did the injury occur in training or during a match?
   a. Training
   b. Match

6. What position were you playing when you were injured?
   a. Quarterback
   b. Running back
   c. Wide receiver
   d. Tight end
   e. Centre
   f. Offensive guard
   g. Offensive tackle
   h. Linebacker
   i. Defensive tackle
   j. Defensive end
   k. Safety
   l. Cornerback
   m. Kicker
   n. Special Teams
766  7. How much time did you miss from full-contact training/matches as a result of the injury?
769  a. 1 to 3 days
770  b. 4 to 7 days
771  c. 1 to 4 weeks
772  d. >4 weeks
773
774  **Concussion information**
775  1. How many concussions did you get from playing American football during the 2014/15 season?
777  Presence of any of the following symptoms as a result of a direct blow to the head or to other parts of the body resulting in rapid movement of the head may suggest concussion:
778      - Headache
779      - Dizziness
780      - Mental Clouding, confusion, or feeling slowed down
781      - Visual Problems
782      - Nausea or vomiting
783      - Fatigue
784      - Drowsiness/Feeling like “in a fog”/difficulty concentrating
785      - “Pressure in the head”
786      - Sensitivity to light or noise
787  And/or a diagnosis of concussion by a medical professional.
789  a. 0
2. Had you ever had a concussion (from any activity) prior to the 2014/15 season?

a. Yes
b. No