Original Research

The design, development, implementation and evaluation of IRISweb; A rugby-specific web-based injury surveillance system

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ABSTRACT

Objectives: To describe the development, implementation and evaluation of a comprehensive injury surveillance system.
Design: The four phases;
i) A survey of 58 medical professionals working in amateur rugby.
ii) The design of a web-based injury surveillance system (IRISweb).
iii) Recruitment of 21 of the top 58 amateur clubs to use IRISweb.
iv) An evaluation survey of the 21 participating clubs.
Setting: Irish amateur rugby clubs.
Participants: Medical professionals working in amateur rugby.
Main outcome measures: Phase one investigated the injury monitoring practices in operation prior to the IRIS project. Phase four investigated the effectiveness and usefulness of IRISweb.
Results: Twenty-one clubs were recruited, however 2 clubs failed to provide a full season of data (10% dropout rate). Eighty-two percent of the remaining 19 clubs rated IRISweb as 'good' or 'very good'. Facilitators of injury surveillance were; increased player adherence (65%) and notifications to update the system (59%), however, poor player adherence (71%) and medical staff availability (24%) were the main barriers.
Conclusions: The IRIS project is the first prospective long-term injury surveillance system in Irish amateur rugby, effectively tracking injuries to guide future evidence-based injury prevention strategies. This study highlights facilitators and barriers to injury surveillance within amateur sport.

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1. Introduction

Participating in sport, at both amateur and professional levels, may result in injury and associated healthcare costs (Finch, Valuri, & Oanne-Smith, 1999; Hickey, Shield, Williams, & Opar, 2014). However, sport-related injury risk, and the subsequent healthcare costs, may be reduced through the effective implementation of

targeted injury prevention strategies, examples of which are the FIFA11 + in soccer (Barengo et al., 2014) and neuromuscular control exercises in Australian Football (Finch, Lloyd, & Elliott, 2009; Finch et al., 2016; Marshall, Lopatina, Lacny, & Emery, 2016; Swart et al., 2014). However, to develop successful injury prevention strategies, the incidence, nature and severity of injuries must first be established by conducting comprehensive long-term injury surveillance (Holder and World Health Organisation Staff, 2002), through the collection of valid and interpretable data. For injury surveillance data to aid the development of targeted injury prevention strategies it must be of high quality, representative of the target cohort

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and collected continually over time (Centers for Disease Control and Prevention, 2001). While epidemiological data on sports injuries are widely reported in the literature, the majority of these data have been collected in professional or elite populations and may not be representative of the amateur cohorts (Finch, 2012). Therefore, high quality comprehensive injury surveillance strategies designed for the amateur level sporting populations are required. However, amateur cohorts often have limited resources and infrequent access to medical professionals, thus the implementation of such strategies present additional challenges over the elite game (Donaldson & Finch, 2012; Donaldson, Leggett, & Finch, 2012; Emery, Meeuwisse, & Hartmann, 2005, Van Beijsterveldt, Stubbe, Schmikli, Van De Port, & Backx, 2015).

Rugby Union, hereafter rugby, has approximately 9.1 million amateur and professional players currently registered across 133 rugby unions (World Rugby, 2018b). Rugby is growing in popularity with record numbers of 'Get Into Rugby' participants seen in 2017 (World Rugby, 2018b). Due to the physical nature of rugby, there is an inherent risk of injury, with pooled incidence rates of 26.7/1000 player hours (Freitag, Kirkwood, Scharer, Ofori-Asenso, & Pollock, 2015b), 46.8/1000 player hours (Yeomans et al., 2018b) and 81/1000 player hours (Williams, Trewartha, Kemp, & Stokes, 2013) reported in meta-analyses conducted in youth, amateur and professional cohorts respectively. While it has been shown that community-led injury prevention strategies may reduce injury risk in rugby (Gianotti, Quarrie, & Hume, 2009; Quarrie, Gianotti, Hopkins, & Hume, 2007) there is currently a distinct lack of long-term injury surveillance strategies within the amateur rugby code (Freitag, Kirkwood, & Pollock, 2015a). The RFU CRISP Project (Roberts, Trewartha, England, Shaddick, & Stokes, 2013) is a long-running amateur rugby injury surveillance study, using a paper-based system and a 'missed match' time-loss injury definition. It has reported injury incidence rates of 17.8/1000 player hours, lower than the incidence rate calculated in the meta-analysis on amateur rugby, which may be due to the 'missed-match' injury definition used (University of Bath, 2016; Yeomans et al., 2018b).

In Ireland there is an estimated 195,700 players currently registered across 224 amateur clubs and 246 school teams (World Rugby, 2018a). Within the professional setting, the Irish international men and women's teams are ranked in the top three and the top ten respectively, of the World Rugby Rankings (World Rugby, 2018b). Despite the popularity of rugby in Ireland, there is a paucity of literature regarding the incidence and severity of injuries within Irish amateur rugby. Many studies on injuries in Irish amateur rugby are restrospective case series, which are at risk of recall bias (Maclean & Hutchison, 2012; Baker, Devitt, Green, & McCarthy, 2013; O'Rourke et al., 2007) or prospective studies taken over a short duration, such as three months, which may lack seasonal variation (Farnan, Mahony, Wilson, & Gissane, 2013).

The aim of this study is twofold: Firstly, to describe the design, development and implementation of the IRIS project web-based surveillance platform (IRISweb) and secondly, to subsequently evaluate the operation of the IRISweb system.

The IRIS project intends to develop and implement a comprehensive rugby-specific injury surveillance study, to prospectively monitor the incidence, nature and severity of injuries across the amateur game in Ireland. The data collected by the IRIS project will guide the development of future evidence based injury prevention strategies aimed at reducing injury risk and enhancing player welfare. Further development of the system may be aided by evaluating the IRISweb system and highlighting barriers or facilitators to conducting injury surveillance within the amateur game. By openly describing and discussing the processes, issues and benefits of reviewing, developing and implementing high quality injury surveillance systems in rugby, this study serves to inform the international community and help develop high quality approaches to injury surveillance.

2. Methods

Within the 224 amateur rugby clubs in Ireland, there is a national league of 58 senior clubs that represent the highest level of amateur rugby in the country. Fifty of these clubs participate in the men's All Ireland League (AIL) comprising of five divisions, while eight clubs participate in the women's AIL. These 58 amateur clubs were the intended cohort to initially implement an injury surveillance system. The design and subsequent implementation of a comprehensive rugby-specific injury surveillance system for the amateur game requires a systematic approach, as outlined by the WHO Injury Surveillance Guidelines in Fig. 1 (Holder and World Health Organisation Staff, 2002). Using these guidelines, the IRIS project implemented a step-wise approach to conducting injury surveillance in Irish amateur rugby (Fig. 2).

2.1. Current injury surveillance practices

The current injury surveillance practices in operation in Ireland were established, using a survey that was designed and disseminated to 58 medical professionals and coaches working with the highest level amateur rugby clubs in Ireland. The initial questionnaire was developed as an online survey and piloted by two medical professionals with experience in team sport and injury reporting prior to dissemination. The 27-question survey also investigated the level of staffing and resources available within these clubs. Using a cross-sectional survey design, the
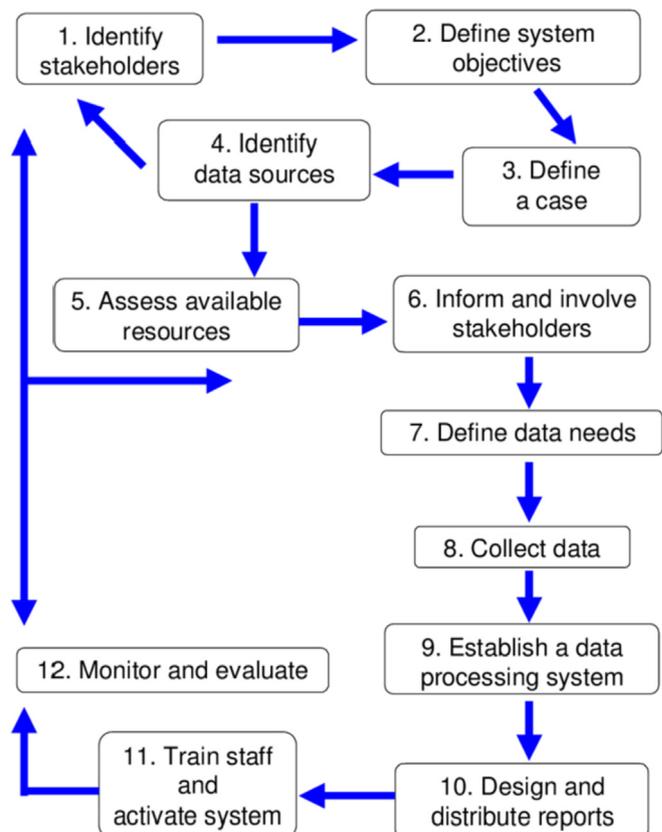

Fig. 1. WHO Injury Surveillance Guidelines 'Steps for Injury Surveillance'. (With permission) (Holder and World Health Organisation Staff, 2002, p. 18).
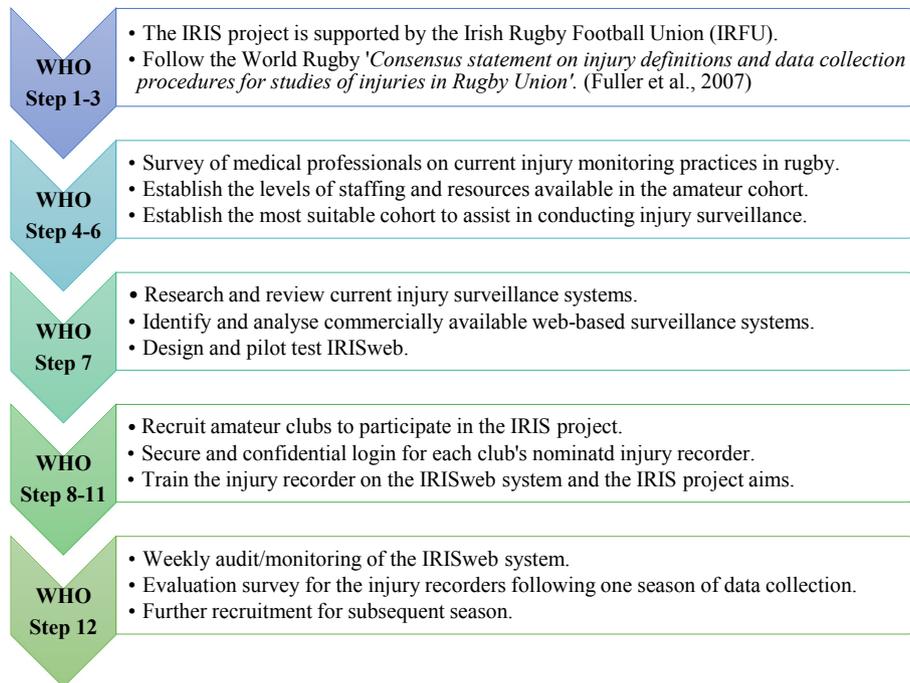
Fig. 2. The phases of the IRIS project, aligned with the WHO Injury Surveillance Guidelines 'Steps for Injury Surveillance'. (Holder and World Health Organisation Staff, 2002).

questionnaire was distributed via SurveyMonkey (SurveyMonkey, Palo Alto, CA, USA) cloud based software. The design and results of this survey have previously been described in detail (Yeomans et al., 2018a).

2.2. The design and development of IRISweb

Once the current injury surveillance practices in Irish amateur rugby were established, a thorough review of the literature on current injury surveillance systems in operation globally and in various sporting codes and competitive levels, was conducted. Web-based surveillance systems were identified and analyzed following the steps outlined in the WHO Injury Surveillance Guidelines (Holder and World Health Organisation Staff, 2002). These guidelines highlight nine attributes associated with good injury surveillance systems, including; simplicity, flexibility, acceptability, reliability, utility, sustainability, timeliness, security and confidentiality. Injury surveillance systems have been evaluated in the literature under three specific characteristics; i) data quality characteristics, ii) operational characteristics and iii) practical characteristics (Mitchell, Williamson, & O'Connor, 2009). Following the review of current injury surveillance systems and commercially available web-based surveillance systems, the IRIS project began designing a bespoke comprehensive rugby-specific system, called IRISweb, with respect to these three characteristics.

i) Data quality characteristics: This refers to the quality of the information received, including the completeness, specificity and sensitivity of the data collected (Mitchell et al., 2009). It also refers to how representative the data are of the target population. To obtain these quality data, a comprehensive injury report form was designed, including questions around injury nature, body location, mechanism of injury, timing of injury and pitch surface, as shown in Fig. 3. The injury definition used, followed the World Rugby 'Consensus statement on injury definitions and data collection procedures for studies of injuries in Rugby Union' (Fuller et al., 2007), therefore;

"Any physical complaint, which was caused by a transfer of energy that exceeded the body's ability to maintain its structural and/or functional integrity, that was sustained by a player during a rugby match or rugby training, irrespective of the need for medical attention or time-loss from rugby activities. An injury that results in a player receiving medical attention is referred to as a 'medical-attention' injury and an injury that results in a

Fig. 3. The IRISweb injury report form.

player being unable to take a full part in future rugby training/match as a 'time-loss' injury." (Fuller et al., 2007, p. 329 p. 329).

To calculate injury severity (i.e. number of days that elapsed from the date of injury to the date of return to play), a player's return to full rugby training and/or availability for match selection was also recorded. Any injury that resulted in more than a 24 hour absence, from rugby match or training activities was classed as a 'time-loss injury' during data analysis, whereas any injury that required less than a 24 hour absence from rugby match or training activities was classed as a 'slight injury', as per the consensus guidelines definition (Fuller et al., 2007). Any injury that required medical attention and no absence from rugby was classed as a 'medical attention injury'. Any injury recurrences or exacerbations were recorded, with a recurrent injury defined as one of the same site and type as the original injury, occurring after the player has made a full return to match play following the original injury (Fuller et al., 2007).

ii) Operational characteristics: This refers to the key processes involved in collecting injury data, namely simplicity, timeliness and flexibility (Mitchell et al., 2009). Time commitment has been reported as a barrier to the implementation of injury surveillance systems (Ekegren, Donaldson, Gabbe, & Finch, 2014), therefore, to maximize adherence and compliance, the injury report form was designed to facilitate simple and concise completion. For an implementation strategy to be effective, consideration of the intended user is vital (Fixsen, Blase, Naoom, & Wallace, 2009). The IRISweb system was designed to be used by the primary medical professional, namely the doctor or physiotherapist, working with the senior rugby team of each participating club. While robust, high quality information was required, the system aimed to balance ease of use and practicality, to require minimal time commitment.

iii) Practical characteristics: This refers to the functional capabilities and practical elements of the surveillance system (Mitchell et al., 2009). For a surveillance system to be successfully implemented it must be accepted by the intended user and useful. The IRISweb system was designed to be used on any internet web browser and device (i.e.: mobile phones of different operating systems, laptops, tablets, desktop computers) so that the injury recorders may document injuries in a convenient manner. Each participating club received monthly and end-of-season reports summarizing their club's data and the overall AIL data. Compliance and adherence to an implementation strategy may be increased when there is a belief in the importance or value of the system (Ekegren et al., 2014; McCall, Dupont, & Ekstrand, 2016), therefore the IRIS project was designed to aid sharing of information and maintain compliance throughout the season.

A beta-version of IRISweb was piloted by four medical professionals with experience in injury reporting and surveillance in team sports, including rugby. The expert panel group was asked to provide feedback on the question content, the ease of use of the IRISweb system and detail any recommendations for improvement. The expert panel provided specific recommendations with regard the separation of 'Head' and 'Face' injuries on the body location of injury, the inclusion of questions around the playing surface at the time of injury and the final diagnosis at the time of return to play (RTP). The beta-version of the system was subsequently piloted by 15 medical professionals and post-graduate researchers in a

university sport sciences department to ensure the system would work effectively when large volumes of data were being recorded simultaneously, and were also asked to test the system on various internet web-browsers and devices.

Following the development and pilot testing of the IRISweb system, each of the 21 IRIS clubs were allocated a bespoke secure and confidential homepage, where the individual profiles of every player involved with the senior first squad were visible (Fig. 4). Once an injury occurred during the season, the injury recorder completed an injury report form for the injured player and provided a provisional diagnosis and expected return to play date. The injured player would be highlighted as 'injured' until the injury recorder cleared the player as fit for RTP, providing a final diagnosis and RTP date.

2.3. IRIS project recruitment

At the end of the 2016–2017 rugby season, the researchers contacted the 50 men's AIL and eight women's AIL teams to recruit clubs for participation in the IRIS project, beginning in the 2017–2018 season. The clubs were advised that the IRIS project would be collecting data for two full seasons. The IRIS project aimed to recruit 20 clubs for the first season of data collection, with a view to further expansion for the second season. An introductory email was sent to each club, for the attention of the club secretary, outlining the aims of the IRIS project, the commitment required from the club, players and medical staff and the incentives for participating. These incentives for the injury recorder included an invitation to attend an Ireland international rugby match, monthly continual professional development (CPD) literature and reports, regular invitations to CPD workshops and seminars. The incentives for the club included summary reports of their club's data and the overall AIL data. This email also indicated that the IRIS project was supported by the Irish Rugby Football Union (IRFU), to encourage participation. This email was followed by a letter sent to each club to maximize dissemination.

In clubs where a medical professional was listed with contact details made available, an email was also sent directly to that medical professional. If no response was received to the email a follow up phone-call was conducted.

Any clubs that expressed an interest in participating in the IRIS project, were asked to nominate an injury recorder to act as the

Fig. 4. IRISweb club homepage.

main contact point for the IRIS project. The injury recorder was the primary medical professional working with the senior first team in the majority of cases, however in some clubs where one regular medical professional was not available the club nominated an alternative injury recorder who collected the injury data from the match day physiotherapist or doctor.

Every participating club was visited in person at least once during pre-season to set up the IRISweb system and/or in-season to discuss any queries that arose during the season. During pre-season training for the 2017—2018 season, meetings between the IRIS team and the injury recorders were conducted in person or via Skype. The injury recorder was given an instructional narrated video about the IRISweb system and the IRIS project. They were also given a beta-version of the IRISweb system in order to practice recording injuries and were advised to contact the IRIS research team with any questions or issues via email or phone. Once the injury recorder was confident in using the IRISweb system, they were given a secure and confidential login to their own club's homepage on the IRISweb system. The injury recorder was asked to disseminate a short questionnaire to all players involved with the senior first team via SurveyMonkey or paper form, so that the players could be registered on the IRISweb system. This player questionnaire contained 16 questions including; player name, date of birth, mass, height, past medical history, medications, past injury history (within the preceding 12 months), playing position and number of years playing rugby. Informed consent was indicated by the subsequent completion of the questionnaire.

The injury recorder was asked to document any rugby match or training injury occurring to the senior first squad throughout the season, following the World Rugby definition of an injury (Fuller et al., 2007). During the season, the IRIS team conducted a weekly audit of the data collected on the IRISweb system in order to ensure accuracy and completeness. If any incorrect or missing data were recorded, the injury recorder was contacted directly via email, with a follow-up text message sent if no response was received. If no new injuries had been recorded in the preceding two match weeks or if players had passed their expected return to play date without being cleared as fit for RTP, a reminder email and/or text was sent to the injury recorder. The injury recorders were informed that all injuries must be recorded on the IRISweb system within 30 days after the last match of the season in order to give sufficient time to record and clear injuries as necessary.

2.4. Evaluation of IRISweb

The final stage of the development of the IRISweb system was the evaluation of the system following the first season of data collection, to determine the effectiveness and functionality of IRISweb. This stage utilized a cross-sectional survey design. Data regarding the overall experience, compliance, barriers and facilitators to the IRISweb system were collected using an online questionnaire distributed by SurveyMonkey.

The survey was designed to be completed by the nominated IRIS injury recorder working with the senior first team in each IRISclub. The injury recorder had been tasked with reporting any injuries occurring to the senior first team on the IRISweb system for the 2017—2018 rugby season, therefore they were deemed the most suitable participants to complete the evaluation survey.

At the end of the 2017—2018 rugby season an email thanking the injury recorder and rugby club for participating in the IRIS project was sent to each IRIS injury recorder. The email also provided a web link to access the evaluation survey. The purpose of the email was to explain the survey, the time commitment and confidentiality of all collected information. Informed consent was indicated by the subsequent completion of the survey. Participants were informed

that they may exit the survey at any time without an implication. Participants were given 40 days to complete the survey from the date the email was distributed. A reminder text and/or email containing the survey link was sent 10 days, 21 days and 30 days after the initial email. After 40 days all responses were downloaded from the SurveyMonkey site and collated for statistical analysis.

The initial questionnaire was developed as an online survey and piloted by two medical professionals with experience in the IRISweb system and injury reporting, prior to dissemination. Specific recommendations with regard the inclusion of questions around the accuracy of the data recorded on the IRISweb system and the injury recorder's level of compliance with the IRIS project, were provided. The final amended survey consisted of 18 questions (17 closed, 1 open), with three main sections:

1) Club demographics: The questions in this section ascertained the provincial branch of the club and the role of the injury recorder within the club.
2) Injury surveillance practices prior to the IRISweb system: The questions in this section sought to gather data on whether injuries were monitored in the club prior to participating in the IRIS project. It included questions on how injuries were monitored, what information was recorded and who was responsible for this.
3) The IRISweb system: This section contained questions regarding barriers and facilitators to using the IRISweb system, the time commitment and whether the injury recorder intends to continue monitoring injuries using the IRISweb system. It also asked the participants to rate the IRISweb system, their overall compliance, accuracy and engagement with the IRIS project using five-point Likert Scales.

All responses were extracted from SurveyMonkey and exported to Microsoft Excel™ for analysis. The responses were analyzed descriptively by calculating and reporting percentages and frequencies of responses.

3. Results

3.1. Current injury surveillance practices

The results of the current injury surveillance practices survey have already been discussed in detail (Yeomans et al., 2018a). While it was found that 91% of amateur rugby clubs in Ireland were monitoring injuries, the person responsible for this and the methods used varied widely and lacked a systematic and standardized approach, resulting in difficulties tracking injury trends across the amateur game. The majority of responding clubs had medical professionals, namely physiotherapists and/or doctors, available at matches and to a lesser degree at training also. Therefore, medical professionals were the targeted cohort to implement a comprehensive centralized injury surveillance system in Irish amateur rugby.

3.2. IRIS project recruitment

Twenty-one clubs agreed to participate in the IRIS project for two full seasons beginning in September 2017. The majority of injury recorders were the primary medical professional working with the senior first team, namely physiotherapists or physical therapists (n = 16) and doctors (n = 1). In clubs where no one medical professional was associated with the senior first team, a representative from the club acted as injury recorder and these included the senior team's manager (n = 2), the club's welfare officer (n = 1) or the club's director of rugby (n = 1). These 21 clubs

represented 646 players (mean 30 ± 12 senior first players/club).

Two clubs failed to provide a full season of data for the first season of data collection and were therefore excluded from the analysis of the data stemming from the IRIS project for the 2017−2018 season. This resulted in a 10% dropout rate for the first season of data collection.

3.3. Evaluation of IRISweb

Nineteen injury recorders responded to the end-of-season IRISweb evaluation survey, giving an overall response rate of 90%. The majority of the responding injury recorders were physiotherapists or physical therapists (n = 15), with the senior first team manager (n = 2), the club's director of rugby (n = 1) and the club's welfare officer (n = 1) also acting as injury recorder.

The survey asked the injury recorders to rate various aspects of the IRISweb system using a Likert Scale from 1 to 5; with 1 being very poor, 2 being poor, 3 being neutral, 4 being good and 5 being very good. The frequency with which each point on the Likert Scale was selected was calculated and shown in Fig. 5. Eighty-two percent of responding injury recorders rated the IRISweb system as 'very good' (24%) or 'good' (58%), while the remaining 18% were neutral about the overall system.

Sixty-five percent of responding injury recorders found the level of contact with the IRIS project team to be 'very good', while 35% found it to be 'good'. Fifty-eight percent of the responding injury recorders found the reminder emails and/or texts to be 'very good', while 42% found the reminders to be 'good'. While only 54% rated the appropriateness of the injury report form as 'good' or 'very good', when asked if IRISweb was gathering sufficient data regarding injuries, the majority (88%) of respondents felt the data were sufficient. The remaining 12% suggested that training load data, pre-injury training load and non-rugby related injuries and/or illnesses should also be collected. The incentives were reported as 'poor' for the club (23%) and the injury recorder (30%).

Thirty-seven percent of the responding injury recorders had an injury surveillance system in place in the club, prior to the IRIS project. Within these clubs, the club physiotherapist was primarily responsible for this (86%), with the director of rugby monitoring injuries in one club (14%). Paper based injury recording was used by 57% of these clubs, with the remaining 43% using an Excel spreadsheet to track injuries. Fig. 6 shows the injury data collected by clubs prior to the IRISweb system. The other 63% of responding injury recorders reported that no injury surveillance system was in place in their club prior to the IRISweb system.

The majority of injury recorders spent 10−20 minutes on average each week recording injuries on the IRISweb system (40%), while 24% spent 0−10 min and 18% spent both 20−30 and > 30 min using the IRISweb system. The main barriers and facilitators to using the IRISweb system are outlined in Table 1.

'Player adherence' was reported as both a barrier and facilitator to injury surveillance and this refers to the players' compliance with completing the registration form at the beginning of the season. Seventy-one percent of the responding injury recorders reported various barriers to the iRISweb system such as the time-commitment, financial constraints of the club and availability of medical professionals at training sessions or between matches, while no barriers or issues with the system were reported by 29% of the responding injury recorders.

The survey contained one open question, regarding the best and worst features of the IRISweb system. Table 2 outlines the three most common responses for both the best and worst features.

Overall, the 94% of injury recorders found using the IRISweb system to be either a 'positive' (53%) or 'somewhat positive' (41%) experience, with only 6% providing a neutral response. No injury recorder reported a 'negative' experience using IRISweb. With regards to the club, 70% of the injury recorders reported that the club found the IRIS web to be a 'positive' (29%) or 'somewhat positive' (41%) experience. Twenty-four percent of the responding injury recorders reported a neutral response from the club towards the IRISweb system and 6% reported a 'somewhat negative' experience. The majority of respondents intended to conduct injury surveillance next season (88%) and 100% reported that they would recommend the IRISweb system to other clubs. Of those people not intending to conduct injury surveillance next season, 6% were stepping down from their role in the club and 6% were unsure.

4. Discussion

4.1. Summary of main findings

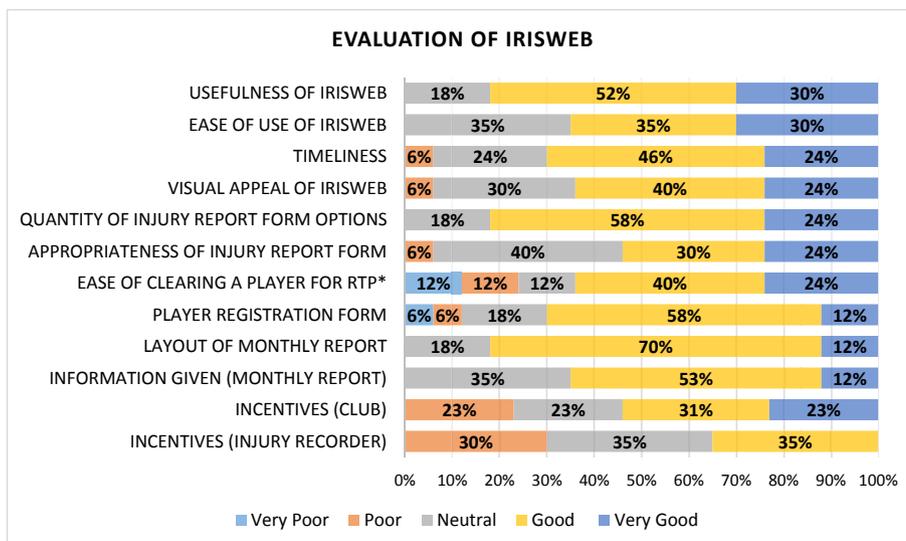The IRIS project is the first comprehensive rugby-specific injury

Fig. 5. Percentage of responses evaluating the IRISweb system.
*RTP − Return to Play
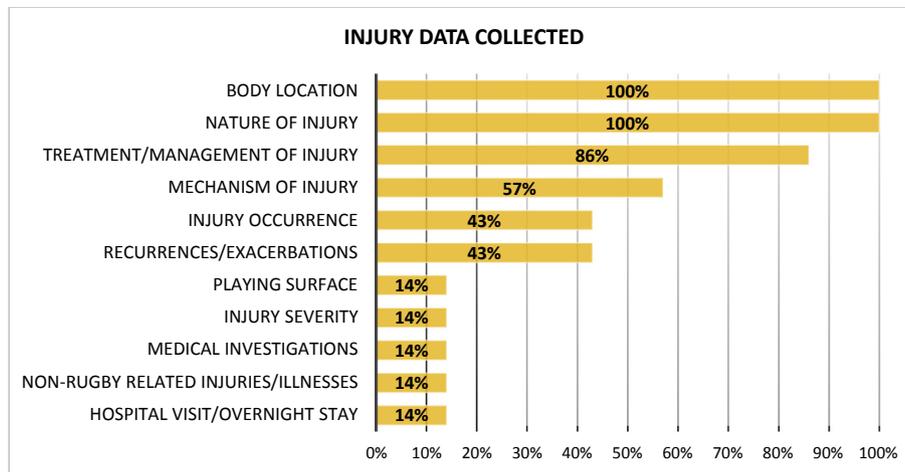
INJURY DATA COLLECTED

Fig. 6. The nature of injury data collected by clubs prior to the IRISweb system.

Table 1
Barriers and facilitators to conducting injury surveillance (RR %[a]).

Barriers	Facilitators
Player adherence (71%)	Player adherence (65%)
Availability of medical professionals at matches and/or training (24%)	Notifications on IRISweb to clear a player for RTP (59%)
Login issues (18%)	Weekly email and/or text reminders (29%)
Lack of options on report forms (12%)	More options on report forms (24%)
Access to internet (6%)	Less options on report forms (12%)

[a] RR – Response Rate.

Table 2
The top three most reported best and worst features of IRISweb (RR %[a]).

Best Features	Worst Features
Keeping an injury record (35%)	Player adherence to register details (41%)
Ease of use (29%)	Insufficient detail/lack of reporting options (18%)
Quality of information (24%)	Access to previously saved reports (12%)

[a] RR – Response Rate.

surveillance strategy to be implemented within the amateur male and female game in Ireland, with the aim of prospectively gathering data on the incidence, nature and severity of injuries occurring, to monitor injury trends. This study describes the design, development and implementation of the IRIS Project and subsequently evaluated the IRISweb system. The main facilitators to the IRISweb system were; increased player adherence (65%) and notifications to update the system (59%). In contrast, poor player adherence (71%) and medical staff availability (24%) were the main barriers to injury surveillance.

In amateur sport, the lack of standardized injury surveillance strategies may result in under-reported or missed injuries when compared to the comprehensive systems in place in the corresponding professional settings (Van Beijsterveldt et al., 2015). To date, no long-term prospective injury surveillance system exists in Irish amateur rugby and while many Irish amateur clubs reported that injuries were monitored within the club, the methods used and the staff responsible for this varied (Yeomans et al., 2018a). Therefore, it is difficult to establish the true incidence and etiology of rugby-related injury occurring across the game. The RFU CRISP Project (Roberts et al., 2013) is a long-running injury surveillance study, and has reported on the incidence and etiology of 'missed-match' time-loss injuries in senior male amateur rugby since 2009 (University of Bath, 2016). The IRIS Project seeks to add to this literature, while also investigating injuries in female amateur rugby

players, training injuries and the validity of a web-based surveillance system tailored for amateur cohorts. By providing information regarding the trends in injury incidence, nature and severity, future evidence-based injury prevention strategies may be designed and effectively implemented, to reduce injury risk and enhance player welfare and well-being.

The aim of any injury prevention strategies is to minimize injury risk and reduce the incidence of injuries occurring, therefore having a reliable method of monitoring the incidence of injury over time is required (Chalmers, Simpson, & Depree, 2004). While injury prevention strategies like BokSmart and RugbgySmart in rugby (Brown, Verhagen, Knol, Van Mechelen, & Lambert, 2016; Gianotti et al., 2009) and FIFA11 + in soccer (Barengo et al., 2014) are often evaluated, there is a lack of evidence evaluating the various aspects of injury surveillance strategies (Ekegren, Gabbe, & Finch, 2016). Many injury surveillance strategies are described in detail (Hagglund, Walden, Bahr, & Ekstrand, 2005; Junge et al., 2008; Waller, Feehan, Marshall, & Chalmers, 1994) or evaluated for complete and accurate data (Emery et al., 2005; Yard, Collins, & Comstock, 2009), however only one study in Australian football implemented a web-based injury surveillance strategy in an amateur setting and subsequently investigated barriers and facilitators to implementing the strategy using semi-structured interviews with the participants (Ekegren et al., 2014). The process of implementing a phone-call based injury surveillance strategy in

rugby has been described in detail, and while the implementation process and subsequent injury prevention strategies were evaluated for effectiveness, the usability of the strategy according to the participants was not reported (Chalmers et al., 2004). This study is the first study to openly describe the development and implementation of a web-based injury surveillance strategy and then evaluate all aspects of the system, to help develop uniform high quality approaches to injury surveillance.

Twenty-one clubs agreed to participate in the IRIS project, with only two clubs (10% dropout rate) failing to provide a full season of data during the first year of the project. A number of facilitators and barriers to injury surveillance in amateur cohorts were highlighted throughout the development, implementation and evaluation of the IRIS project, and are outlined below.

4.2. Facilitators to injury surveillance

'Simplicity' has been highlighted as a key attribute associated with good injury surveillance practices (Holder and World Health Organisation Staff, 2002). It has also been shown that 'ease of use' is a facilitator to effective injury surveillance within amateur cohorts (Ekegren et al., 2014). During the design and development of IRISweb, attention was given to the layout and structure of the web system and report forms to ensure ease of use. Sixty-five percent of the injury recorders reported that the IRISweb system was 'good' or 'very good' with regards ease of use, while 29% reported ease of use as one of the best features of IRISweb. Based on feedback related to the appropriateness of the injury report form further investigation into the suitability of the form and the relevance of the questions should be conducted. Fourteen percent of the injury recorders that monitored injuries prior to the IRISweb system, also monitored non-rugby related injuries and/or illnesses. Future development of the IRIS Project should look to include these variables, alongside training load data and pre-injury training load, while maintaining the simplicity of the system. There is often a reliance on volunteer staff to fulfil injury surveillance or prevention strategies within amateur cohorts (Donaldson et al., 2012) and therefore designing a system that is easy to use and adjust to is vital to maintain compliance with the strategy.

Communication, between medical staff and players, and also between club staff, is an important feature of injury surveillance (McCall et al., 2016). Every club was visited at least once during pre-season and/or in-season by the IRIS research team to address any queries that arose during the season. The IRIS project also contacted each IRIS club regularly throughout the season to maintain compliance and interest in the injury surveillance strategy. Sixty-five percent of responding injury recorders found the level of contact with the IRIS team 'very good'. The IRIS Project research team monitored the injury records each week and if any inactivity longer than two match-weeks was observed, the injury recorder was contacted with a reminder to update the system if needed and 59% of the injury recorders found this to be 'very good'. Belief in the importance of the implementation strategy has been shown to be important in the uptake and success of injury surveillance systems (Ekegren et al., 2014; McCall et al., 2016). Every month, the injury recorder was provided with a monthly summary of their club's injury data and an anonymized summary of their division's injury data and 65% of the injury recorders found the quality of these monthly reports to be 'good' or 'very good'. Also, 24% of the injury recorders found the quality of information given to be one of the best features of the strategy.

4.3. Barriers to injury surveillance

Player adherence with injury prevention strategies has been

shown to influence the effectiveness of the strategy (Steffen et al., 2013). The IRISweb system was to be used by the injury recorders only and the club's players were asked to complete a registration form during pre-season and then to report injuries to the injury recorder during the season. Player adherence was highlighted as the main barrier to conducting injury surveillance by 71% of the IRIS injury recorders, reporting difficulties in getting players to register on the IRISweb system and also in following-up after an injury had occurred. It has been shown that the success, or otherwise, of implementing injury surveillance and prevention strategies is reliant on adherence, from both the players and the coaching or medical staff in an elite setting (McCall et al., 2016). This may also be true within amateur settings where lack of support or belief in the system may lead to under-reporting of injuries (Ekegren et al., 2014; McKay, Steffen, Romiti, Finch, & Emery, 2014). However, it has been shown that both players and clubs will participate in implementation strategies if they are educated regarding the intervention (Finch, 2006; Orr et al., 2013). Sixty-five percent of the IRIS injury recorders reported that improved player adherence would be a facilitator to successful implementation of the IRISweb system, therefore education strategies aimed at players on the importance of injury surveillance and prevention may increase compliance and adherence (McCall et al., 2016; Orr et al., 2013). Also, all incentives offered as part of the IRIS Project were for the club and/or injury recorder, with no incentives delivered to the players. Future development of the IRIS Project could include player incentives as a way of increasing player adherence. The incentives for the club and injury recorder were offered prior to the club agreeing to participate and these incentives were poorly received. While the injury recorders were consulted during the season about what additional incentives, such as CPD events and/or educational resources, may be of most benefit only 35% found these incentives to be 'good'. Consulting the injury recorders, the clubs and the players regarding the incentives prior to commencing data collection may improve compliance from all parties involved.

While the intended cohort to implement the IRISweb system in each club was the primary medical professional (doctor, physiotherapist, physical therapist), this was not possible in 20% of the IRIS clubs as no one regular medical professional was associated with the senior first team. These clubs nominated a member of the club staff to act as injury recorder and this person collected the injury report forms from the match-day medical professional and recorded the injuries on the IRISweb system once a week. The accuracy of injury monitoring from multiple observers has been highlighted as a concern within the literature (Hagglund et al., 2005, Van Beijsterveldt et al., 2015), therefore the IRIS project employed a clear definition of a reportable injury following the World Rugby consensus guidelines (Fuller et al., 2007). The IRIS project also standardized the methods by which injuries are reported in order to maximize accuracy in cases where multiple injury recorders may be operating (Bjorneboe, Florenes, Bahr, & Andersen, 2011). To ensure validity and accuracy of the data, the IRIS Project employed a two-tiered system, whereby the initial inputting of the injury could be completed by a non-medical professional, with a 'provisional diagnosis' given. In order to complete the injury record, a 'final diagnosis' is required before the player is cleared to RTP. This allows time for the player to be assessed by a medical professional prior to the final diagnosis being recorded. Twenty-four percent of the IRIS injury recorders reported that availibility of medical professionals at matches and/or training acted as another barrier to conducting injury surveillance, whereby follow-up after an injury was difficult. Therefore, future studies aiming to implement surveillance and/or prevention strategies should first establish the level of staffing and resources available and subsequently tailor the strategy depending on these factors.

The time taken to record injuries has been highlighted as a barrier to injury surveillance (Ekegren et al., 2014). While the majority of injury recorders spent 10–20 minutes on average each week using the IRISweb system, the time commitment was still reported as a barrier to the system. To streamline the injury recording process, the injury recorders were able to use the IRIS-web system on various web-browsers and devices so that injuries may be recorded at the most convenient time. However, 6% reported that access to the internet acted as a barrier to using the IRISweb system and 18% reported some login/technical issues during the season.

5. Study limitations

While the IRISweb system was designed to be used by the primary healthcare professional working with the senior first team, in some clubs the injury recorder was a club representative. This may have resulted in delays recording the information as the injury recorder waited for all the required information from the match-day medical professional. Also, this may account for the larger time commitment from some of the responding injury recorders in completing the injury report forms as the form was designed to be used by a medical professional.

6. Conclusion

The IRIS project is the first comprehensive rugby-specific injury surveillance strategy to be implemented within amateur rugby in Ireland, with the aim of prospectively gathering data on the incidence and severity of injuries occurring. Ultimately this information will be used to track injuries across the amateur game, with a view to guiding future evidence-based injury prevention strategies. By establishing the current injury monitoring practices in operation within the amateur game in Ireland, it not only highlighted that the implementation of one centralized system would be feasible but also indicated the target cohort to act as the injury recorder. Therefore the IRISweb system was designed to be primarily used by the medical professional involved with the senior first rugby team. The IRIS project aims to expand recruitment across various competitive levels and age groups and must be conscious of the staffing and resources available to ensure successful wider implementation of the IRISweb system, particularly in clubs where multiple medical professionals may be working, or where alternative club staff may be the with ultimate user of the system. During this planned expansion, maintaining regular contact with the clubs will be vital to ensure accurate data is gathered. The development of targeted, effective injury prevention strategies, is reliant on comprehensive and robust data on the incidence, nature and severity of injury. However, the methods by which these data are collected must be simple and require minimal time commitment to ensure successful implementation of the surveillance strategy. Improved player adherence with an injury surveillance strategy is vital, therefore delivering player incentives and designing educational workshops on the importance of injury surveillance and prevention may increase compliance from players and ultimately enhance player welfare and well-being.

Conflicts of interest

The authors have no conflict of interest to declare.

Ethical approval

Ethical approval for this study was granted by the institution's Research Ethics Committee in compliance with the Declaration of Helsinki. Subjects gave informed consent in order to participate.

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