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The changing nature of concussion in rugby union: Looking back to look forward

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Abstract

Introduction: Concussion is regularly observed in rugby union and has generated a growing public health concern, yet remains one of the least understood injuries facing the sports medicine community. Evidence suggests that multiple concussions may increase susceptibility to long-term neurological complications that present decades after the initial injury for reasons that remain unclear. We aimed to determine the incidence rate and risk factors for concussion amongst community-level rugby union-15s players active during the 1980s given that it may help to better understand the risks and mechanisms of injury.

Methods: Injury data were collected from clubs by the coach at the time of injury in players using a 15-item questionnaire (1982–1984).

Results: Seventy games were recorded throughout 1982–1983 and 1983–1984 rugby union seasons. Forty-two documented concussions accounted for ~6% of injuries corresponding to an incidence rate of 0.64 per 1000 playing hours, more than a third lower than the 'modern-day' equivalent. Tackling (relative risk 1.60, $p < 0.05$), collisions (relative risk 0.95, $p < 0.05$) and gum shield use (relative risk 1.69, $p < 0.05$) were independently associated with concussion whereas no associations were observed for ground condition, quarter of play or players playing out of position ($p > 0.05$).

Conclusion: Despite limitations due to the retrospective focus and reliance on questionnaire data notwithstanding raised awareness of concussion, the incidence rate of concussion during the 1980s appears to be appreciably lower compared to the present-day game. This is the likely outcome of improvements in the clinical understanding of concussion, data collection tools, reporting methods and clinical management of concussive injuries, including changes to both player and game. However, the findings of this study help better understand the risks and mechanisms of injury once encountered by rugby union players active during the 1980s, of which some of those risks are still apparent.

Keywords

Concussion, traumatic brain injury, incidence, risk factors

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Introduction

Concussive injury has generated a growing public health concern yet remains one of the least understood injuries facing the sports medicine community today. Emerging evidence suggests that multiple concussions sustained during young adulthood may increase susceptibility to long-term neurological complications that typically present decades after the initial injury for reasons that remain unclear.[1] These complications include accelerated cognitive decline, chronic traumatic encephalopathy (CTE), depression, Parkinson's syndrome and Alzheimer's disease.[2,3] Subsequently in recent years, focus has centred towards retired contact sport athletes who may be more susceptible to neurological sequela as a result of recurrent concussion.[1]

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Since the advent of professionalism was introduced to rugby union in 1995, participation throughout the United Kingdom (UK) has risen to 2.5 million players.[4] A recent meta-analysis of community sub-elite rugby union players identified a concussion incidence rate of 2.08/1000 player match hours and speculated this trend would continue to rise with the current reporting methods.[5] Furthermore, professional rugby union players in the UK are more likely than not to sustain a concussion within 25 games,[6] thus generating future health concerns among the medical community and players alike.

A number of intrinsic and extrinsic factors contribute towards concussion risk including: playing position, tackling technique, use of protective head/mouth apparatus, neck strength, warm-up strategy, foul play, quarter of play, ground condition and weather, including various others.[6–10] Given that the majority of the available literature relating to concussion and risk of neurological impairment centres towards retired contact sports athletes aged between 50 and 80,[1] it is seldom supported by injury data from those cohorts, other than individual recall of past events[11] and questions whether today's athletes are exposed to the same risks as once encountered by their senior counterparts. This uncertainty is likely due to the primitive recorded injury data throughout the 'amateur years' of rugby union. However, some rugby union injury data throughout this period in both the adult and schoolboy levels exists. Durkin[12] observed injures in British adult rugby union players over the course of the 1972–1976 seasons and observed that 5.6% of all injures were concussions. Sparks[13] recorded over half a million hours of schoolboy rugby between 1950 and 1980 and observed 9885 injuries, of which 513 (5.2%) were concussion. South African school boy rugby injuries were reported by Nathan et al.[14] and Roux et al.[15] who observed concussion in 22% and 12% of all injuries respectively.

In addition, the understanding of concussion has improved, thus improving the standard of clinical care provided to those with suspected injury and making comparisons between the 'amateur' and present game difficult. For instance, throughout the beginning of the 1980s, a concussion was clinically defined as a loss of consciousness or a loss of awareness following a blow to the head,[16] which was later evolved by Cantu[17] into three categories (mild, moderate or severe). The long-term neurological consequences of concussion were poorly understood and while literature had documented dementia pugilistica[18] among boxing cohorts and later described as CTE,[19] no such evidence existed in rugby union.

Data collection for all injuries in rugby union have improved drastically in the modern day due to the consensus definitions and methodologies to standardise the recording of injuries and reporting of studies which was introduced by the Rugby Injury Consensus Group (RICG) in 2007.[20] This is accompanied by a research determined definition of concussion that is a 'traumatic brain injury induced by biomechanical forces' which is accompanied by a number of symptoms including headache, dizziness, balance/gait abnormalities, confusion, amnesia and various others which can occur without loss of consciousness.[21] Clinical questionnaires specific to concussion including the Sports Concussion Assessment Tool 5th edition and the Head Injury Assessment further allow certified athletic trainers and medical professionals alike to recognise concussion and remove athletes from play, while governing bodies have pre-defined return to play protocols to ensure athletes have recovered adequately before returning to competition.[22] Despite these comparative difficulties, the importance of a detailed injury history has time again been emphasised to be of relevance when diagnosing neurological disorders.[11]

Given the evidence presented, retrospective injury data from the period may be of relevance to retired contact sports athletes and clinicians, to better understand the risks and mechanisms of injuries once encountered. We sought to determine the incidence and corresponding in-game variables and risk factors for concussion among Welsh rugby union players who were active during the 1980s.

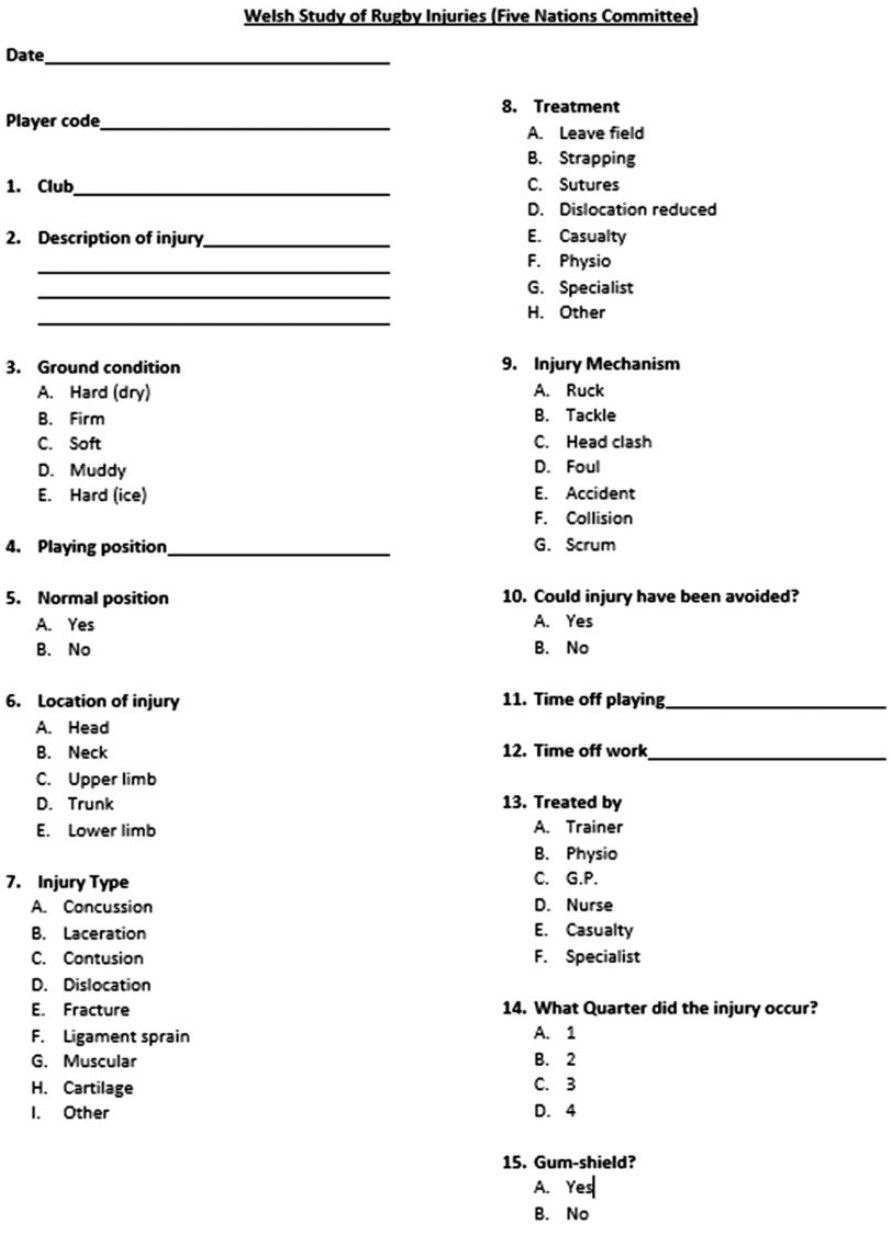
Methods

Participants

Information was obtained from a total of 708 college and senior level rugby union-15s players from clubs across Wales using a 15-item questionnaire (Figure 1) at the time of injury by the team coach between the 1982–1983 and 1983–1984 rugby union seasons. All players and coaches from the selected clubs were invited to participate. All players and coaches who participated provided written and verbal informed consent with data collection overseen by a general practitioner and consultant orthopaedic surgeon-player.

Procedures

Questionnaires included intrinsic and extrinsic factors associated with injuries and each player was assigned an identification code with anonymised datasets subsequently uploaded to a computer database for analysis. Concussion was defined by loss of consciousness or a loss of awareness following a blow to the head,[16] including symptoms of amnesia (personal



Welsh Study of Rugby Injuries (Five Nations Committee)

Date_____

Player code_____

1. **Club**_____
2. **Description of injury**_____
3. **Ground condition**
   A. Hard (dry)
   B. Firm
   C. Soft
   D. Muddy
   E. Hard (ice)
4. **Playing position**_____
5. **Normal position**
   A. Yes
   B. No
6. **Location of injury**
   A. Head
   B. Neck
   C. Upper limb
   D. Trunk
   E. Lower limb
7. **Injury Type**
   A. Concussion
   B. Laceration
   C. Contusion
   D. Dislocation
   E. Fracture
   F. Ligament sprain
   G. Muscular
   H. Cartilage
   I. Other
8. **Treatment**
   A. Leave field
   B. Strapping
   C. Sutures
   D. Dislocation reduced
   E. Casualty
   F. Physio
   G. Specialist
   H. Other
9. **Injury Mechanism**
   A. Ruck
   B. Tackle
   C. Head clash
   D. Foul
   E. Accident
   F. Collision
   G. Scrum
10. **Could injury have been avoided?**
    A. Yes
    B. No
11. **Time off playing**_____
12. **Time off work**_____
13. **Treated by**
    A. Trainer
    B. Physio
    C. G.P.
    D. Nurse
    E. Casualty
    F. Specialist
14. **What Quarter did the injury occur?**
    A. 1
    B. 2
    C. 3
    D. 4
15. **Gum-shield?**
    A. Yes
    B. No

Figure 1. Fifteen-item questionnaire for injury reporting.

communication with general practitioner). The incidence rate was subsequently calculated as

$$\frac{\text{Total number of players with concussion}}{\left\{\begin{array}{l}\text{Exposure (number of matches}\\ \times\text{match duration} \times \text{number of players)}\end{array}\right\}} \times 1000(\text{h})$$

Statistical analysis

Statistical analyses were completed using the Statistics Package for Social Scientists (Version 23.0). Data were first categorised into concussion or other injuries for each category observed via the 15-item questionnaire. To determine association of injury, 2 × 2 Pearson chi square (χ) tests were used however in the event that more than 20% of variables had expected cell counts below five, likelihood ratios (LH) were calculated as a surrogate measure.[23] Throughout association tests, relative risk (RR) of injury were computed simultaneously and incidence rates were calculated for all variables manually. Players with cases of missing data for the observed factor were excluded from the overall analyses.

Results

Seventy games were observed throughout 1982–1983 and 1983–1984 rugby union seasons among 708 players. A total of 178 injuries were classified as head

Table 1. Factors associated with concussion incidence.[a]

	Frequency	Percent	IR	RR	95% CI	*p* value
Playing position						
Front row	4	11	0.06	0.32	0.12–0.84	**0.001**
Lock	6	17	0.09	1.40	0.58–3.41	0.47
Loose forward	4	11	0.06	0.50	0.19–1.36	0.15
Inside back	9	26	0.14	1.73	0.84–3.58	0.14
Midfield back	3	9	0.05	1.09	0.31–3.84	0.89
Outside back	9	26	0.13	1.28	0.65–2.54	0.48
Cause of injury						
Tackle[b]	21	50	0.32	1.60	1.08–2.36	**0.02**
Foul	2	5	0.03	0.18	0.05–0.73	**0.001**
Collision[c]	2	5	0.03	0.95	0.89–1.02	**0.02**
Ruck	11	26	0.16	0.98	0.55–1.74	0.93
Head clash[d]	4	10	0.06	0.91	0.32–2.62	0.86
Accident[e]	1	2	0.02	1.06	0.11–9.96	0.96
Scrum	1	2	0.02	0.80	0.09–6.94	0.83
Gum shield						
Yes	18	69	0.27	1.69	1.12–2.51	**0.02**
No	8	31	0.12	0.52	0.28–0.96	
Ground condition						
Hard	6	16	0.09	0.85	0.37–1.93	0.69
Firm	11	29	0.16	0.70	0.41–1.12	0.17
Soft	15	39	0.23	1.41	0.87–2.30	0.18
Muddy	5	13	0.08	1.09	0.43–2.80	0.86
Icy	1	3	0.02	0.77	0.09–6.68	0.81
Quarter of play						
1	5	16	0.08	0.95	0.37–2.48	0.92
2	10	32	0.15	1.20	0.66–2.18	0.55
3	7	23	0.11	0.70	0.34–1.45	0.32
4	9	29	0.13	1.37	0.68–2.80	0.39
Usual playing position						
Yes	35	92	0.53	1.03	0.93–1.16	0.58
No	3	8	0.05	0.72	0.22–2.38	

IR: incidence rate (per 1000 playing hours); RR: relative risk; CI: confidence interval.
[a]Percentages may not total to 100% due to rounding;
[b]Tackle defined as a collision where opposing player uses arms to ground player in possession of the ball.
[c]Collision, collision where opposing player does not use arms to ground player in possession of the ball.
[d]Head clash, contact of heads when a player was in possession/not in possession of the ball.
[e]Accident, an unintended collision while a player was in possession/not in possession of the ball. The values given in bold highlight the significant findings ($p < 0.05$).

injuries (26% of all injuries). We observed 42 concussions (~6%) corresponding to an incidence rate of 0.64 per 1000 playing hours (~1 concussion every 1.7 games).

Injury data are outlined in Table 1. Tackling ($\chi = 4.84$, $p < 0.05$, RR, 1.60, 95% CI, 1.08–2.36), collisions (LH = 5.81, $p < 0.05$, RR 0.95, 95% CI, 0.89–1.02) and gum shield use ($\chi = 5.82$, $p < 0.05$, RR 1.69, 95% CI, 1.12–2.51) were independently associated with concussion. In contrast, front row players were at lowest risk of injury compared to the backs ($\chi = 7.12$, $p < 0.05$, RR 0.32, 95% CI, 0.12–0.84) and fouling posed the lowest risk of concussion ($\chi = 8.78$, $p < 0.05$, RR 0.18, 95% CI, 0.05–0.73). No associations were observed between concussion and ground condition (LH = 2.27, $p > 0.05$), quarter of play ($\chi = 1.34$, $p > 0.05$) and players playing out of position (LH = 0.31, $p > 0.05$).

Discussion

Our descriptive findings have provided a unique insight into the changing nature of concussion and associated risk factors from rugby union during the 1980s against the modern day game. Notwithstanding the limitations of the current investigation, the incidence rate of concussion nearly four decades ago aligned closely to other injury data available from rugby union players during

the 1980s. Furthermore, this retrospective data have identified risk factors once encountered by past athletes, of which some of those risks are still apparent in the modern era. Comparatively, concussive incidence was seen to be appreciably lower and some risk factors were not entirely consistent with what has been reported in the published literature during the modern era. This is a result of greater clinical management of concussion in modern rugby union, assisted by methods that better recognise and remove an athlete from play safely following injury.

Historical comparisons

In the present study, head injuries were shown to account for approximately one quarter of all injuries corresponding to an incidence rate of 0.64 concussions per 1000 playing hours. We further calculated that concussive injury accounted for 6% of all injures which replicates the earlier findings of Durkin.[12] Additionally, Sparks[13] documented that 16.9% of all injuries recorded were to the head and neck which is appreciably lower than our observations, however the overall percentage of concussive injuries were similar (5%). Our observations of concussion were substantially lower than the 22% and 12% documented by Nathan et al.[14] and Roux et al.[15] in South African school-level rugby union. However, our results align with data from other southern hemisphere regions during that period as Davidson[24] observed 24.5% of injuries to the head and neck among Australian rugby union players.

While data for factors associated with concussion were primitive, previous literature acknowledged that tackling was the primary mechanism for injury[13,15] and front row players were at lower risk of concussion relative to the backs,[15] which corresponds with our findings. However, our observations revealed that hard ground did not increase the risk of concussion, contrary to the findings of others.[13,15] The discrepancies between these studies are likely due to the variation of data collection tools, study sizes, definition of concussion and subsequent clinical management provided following injury, including international differences in health care procedures.

Modern comparisons

Given the inevitable discrepancies in injury definition across studies, our calculated incidence rate is appreciably lower than the 'modern-day' equivalent of 2.08 (range of 1.2–6.9) cited in a recent meta-analysis of players at a similar standard (community, sub-elite 15s) who are at greatest risk of injury.[5] This more than tripling in incidence is the likely consequence of changes to knowledge, identification, reporting and management of concussion within modern day rugby union.[20,21]

Principally, the introduction of the consensus definitions and methodologies to standardise the recording of injuries and reporting of studies[20] has altered injury reporting within rugby union to great effect. Injuries are defined and data are now collected in accordance to whether an injury is: recurrent, non-fatal or catastrophic, and classified by severity, location, type, diagnosis and cause. All injuries are further recorded in relation to training and match exposures, providing detailed medical records for all athletes, thereby allowing qualified health professionals and coaches to better recognise concussive injuries and typical severity characteristics. Moreover, as reporting and recognition of concussion has developed among health professionals and coaching staff, athlete under-reporting of concussive injury has been identified as a key area of improvement.[25] In turn, concussion awareness and education programmes are now utilised to varying degrees from school level onwards, in a bid to enable athletes to better recognise and self-report concussive symptoms.[26]

During the 1980s, no such tools or consensus agreements had been formed, thus highlighting the limitations of this investigation. However (to the best of our knowledge), the 15-item questionnaire utilised throughout the 1982–1984 rugby union seasons in the current investigation was the first of its kind within the United Kingdom and indeed may be of relevance to better understand the mechanisms of previous injuries that may apply to a number of retired athletes. For example, the 15-item questionnaire (Figure 1) shares eight similarities between the Injury Report Form for Rugby Union as constructed by the RICG,[20] which was introduced some 25 years later and still utilised today.

Indeed with the advent of professionalism, training methods have changed such that the 'modern game' now sees players who are more skilful, powerful, conditioned and heavier[27] with increased speed and force of contact events, duration of time the ball is in play and number of tackles/rucks per game[28] that collectively increase concussion risk. In support, tackling was identified as one of the primary risk factors for concussion and continues to prevail in the modern game especially, with the number of tackles seen to quadruple following the advent of professionalism.[28] Front row players were at a lower risk compared to the backs, again consistent with the published literature,[8] likely due to limited opportunity to run with the ball and fewer tacking incidents.[29]

However, some of the risk factors identified in the 1980s were not entirely consistent with what has been reported in the modern game.[5] Fouling has previously

been associated with an increased risk of concussion[30] whereas we observed the contrary. Likewise, we failed to confirm previous reports of an increased incidence of concussion during the third quarter of play (40–60 min) subsequent to insufficient warm up following the half-time break[31] and play on hard ground.[30] Finally, gum shield use that was beginning to be actively encouraged during the 1980s (personal communication personal communication JPR Williams) increased concussion risk in contrast to recent findings.[30] With consideration towards the biomechanics and attendant forces during rugby events, the extent that gum shields could reduce the incidence of brain injury and concussion remains unclear.

Limitations

There are inevitable limitations to this study given its retrospective focus and reliance on questionnaire data. The understanding of concussion from the period of data collection to the modern day has evolved to the extent that the definitions used to diagnosis are different and may highlight the underreporting of such injuries throughout the 'amateur years'. Although medical assessments were carried out by qualified clinicians following injury, data collection forms were populated via the team coach and may subsequently overlook relevant medical information relating to an athlete's injury. Furthermore, we were not in a position to record player demographics including concussion history thus information on concussion severity, residual symptoms from any prior concussions reported and medical clearance to return-to-play were not captured. Finally, we did not assess the long-term functional alterations in these players that would have allowed us to determine to what extent, if indeed any, enduring cumulative cognitive, cerebrovascular and motor function impairments were incurred as a result of concussions sustained decades earlier.

Conclusion

The present findings highlight the changing nature of concussion incidence rates in rugby union since the 1980s. The incidence rate of concussion during the 1980s appears to be appreciably lower compared to that reported in the modern (present-day) game,[5] the likely outcome of improvements in the clinical understanding of concussion, data collection tools, reporting methods and clinical management of concussion,[20] including changes to both player and game.[27] From a clinical perspective, this report allows us to better understand the risks and mechanisms of injury once encountered by rugby union players that were active during the 'amateur period' of the sport, of which some of those risks are still apparent in the modern era and may be priming athletes for future neurological symptoms.

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