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A Review of Rugby Union and League Australian Spinal Cord Injury Datasets – A Look at the Past and Future Expectations

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Abstract: This review identifies Australian datasets that report spinal cord injuries [SCI] in rugby union [RU] and rugby league [RL]. SCIs are catastrophic injuries with lifelong consequences. The Australian literature report rates of injury in football codes occurring in various phases of play over several decades. In 2007 the International Rugby Football Board [IRFB] introduced a new law governing the scrum rule sequence. The review objective is to enhance the understanding of the consequences of scrum rule changes and other contributing factors to SCI along with providing an overview of the rates of injuries in the codes over several decades. Database and literature searching for manuscripts, reports and thesis that reported SCI where RU to RL injury rates were compared was performed. Search terms included; 'NSW claims data, Australian SCI Register and spinal unit data'. The reported rate or odds ratios as reported in manuscripts were identified and tabulated with the rates verified using the Toronto Center for Evidence Based Medicine [CEBM] toolbox EBM Statistical Calculator. If not originally calculated incidence rates and numbers of participants were utilized to equate the statistic. Tabulation of reported odds ratios was done and these varied from 1.3-4.0. Calculation of rates in two additional datasets where rates were not reported was also done including an Australian SCI unit dataset [1.8-2.5], while the other was an Australian Institute of Health and Welfare [AIHW] dataset [2.1]. This review, collation and tabulation of data enhanced the comparison of injury rates enabling viewing of injury trends over several decades.

I. INTRODUCTION

The costs, burden and repercussions of a person sustaining a SCI are lifelong, devastating, catastrophic, and costly. The cost burden to the person and the family are great, but there are also immense repercussions, costs and implications in terms of hospital resources and rehabilitation units and there is often in many cases insurance company payouts and the requirement for pharmaceuticals, community resources [home help] and equipment [rehabilitation aides].

Estimates from Yeo in the late 1990s as cited in the manuscript by Berry and colleagues state that the cost of caring for a person with paraplegia are in the order of $1 million, while it rises to a staggering $5 million when you consider the care for a tetraplegia casualty. [1] In addition to this is the fact that in many cases insurance cover provided for casualties is insufficient. [2]

The Australian SCI Register was established in 1995 by the National Injury Surveillance Unit of the AIHW. [1] Recorded are incident cases of SCI where patient consent is given. Data on cases is collected from six Australian SCI units and includes information that relates to the patient history, the demographics, injury specifics and the medical and clinical assessment.

According to data presented in an AIHW document on SCI that summarizes data from 2007-8, cause of injury is documented for 50% of cases of SCI and of the SCIs due to sporting

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activities the major football codes accounted for 25% of such injuries. [3]

In the late 1990s Yeo and colleagues as cited by Carmody et al reported that 15% of admissions to SCI units are a result of sport and recreation. [2]

The AIHW in a SCI statistical document that analysed and reported on data from 2005-6 it was reported that approximately 12% of these traumatic type injuries occur during sport. [4] A further publication in 2009 being an analysis of data from 2006-7 report that 8% of injury cases were as a result of sport. [5]

RU and RL are sports where the risk of SCI is one of the most catastrophic types of injury or repercussions that unfortunately can occur which is as a result of these sports being contact / collision sports. Carmody and colleagues report that from years 1960 to 2002, playing football in Australia resulted in 239 acute SCIs. [2]

Berry and colleagues from the Research Centre for Injury Studies in South Australia published a manuscript in 2006 that analyzed trends in incidence rates of rugby code-related severe cervical SCIs in NSW from 1986-2003 using Poisson regression modeling. [1] They state that the greatest hazard in RU is the scrum with 35% of SCIs attributable to scrums, while the greatest hazard in RL is the tackle causing 78% of such injuries.

Not quite a decade ago it was stated that there was an urgent need to revise the rules of scrum engagement in RU while in RL the rules relating to multiple tacklers needed amendment. [2]

Initiatives and steps to minimize risk which have been instigated over several decades include education, injury prevention programs, identifying and monitoring risks and hazards, careful player selection, rule modification and making illegal extremely hazardous manoeuvres. One example of a rule modification and change is when scrums were no longer contested in RL, and Carmody and colleague's manuscript published in 2005 reported that there has been an absence of scrum injuries in RL since 1996. [2] Lastly there was the establishment of injury registers to monitor the rate of injury changes in the football codes in the 1980s and 1990s.

Various manuscripts published in the literature over the last few decades have reported the rate of injuries in the different codes of football. Wilson and colleagues manuscript published in 1996 [6] reported on data analyzed from the 1980s and early 1990s that assessed the incidence of SCIs in RU and RL based upon NSW government insurance scheme claims data. The incidence of SCI in RL in NSW in the decade commencing 1984 was 0.18/10 000 registered participants/ year while the figure for RU was 0.53/10 000. Taylor and Coolican's publication at a similar time, (1987) reviewed 107 SCIs, finding that the force related to scrum engagement as opposed to scrum collapse mostly was the causal factor for injury sustainment [7].

In the decade following 1984 SCIs in RU lessened significantly and this could be possibly due to rule changes that include the "phased sequence of scrum engagement" and the collapse of scrums. [8]

There was a scrum engagement law sequence change in 1988 relating to the instructions called by the referee; "crouch — touch — pause — engage". Following this in the early 1990s the touch instruction was eliminated and the referee instead became responsible for ensuring the proximity of opposing front rows before engagement. [2] Various other rules changes during this time were recommended but were not as such specifically adopted.

In 1986 new rules were agreed upon after pressure from medical representatives in several countries influenced the IRFB. These rule changes included collapse of the scrum, prolonged rucks or mauls, and the banning of spear or high tackles to ensure

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safety. [9] Despite various rule changes during this time there was a gradual return to the forceful scrum engagement. [2]

During the late 1980s and early 1990s however the decrease in the rate of SCI was only minimal in RU and this decrease was not noted in RL in NSW. [1] However this decrease in RU injuries during that time frame came after the previous worldwide increase during the 1970s and early 1980s [10].

Carmody and colleagues in a manuscript published in the Medical Journal of Australia analyzed the rate of injuries that occurred in RU, RL, Australian Rules Football [ARF] and soccer from the years 1997-2002. [2] They compared this with data that had been previously reported for the years 1986-96. This involved a data collection process that included information from patients [n=52] admitted to any of the six SCI units within Australia. The finding was that the rate of injuries in RU and RL had changed minimally if the 1997-2002 time block was compared to the earlier 1986-96 period were data was also collected. Aside from this conclusion however was one positive finding, being that the severity of injuries in the latter time period was less as determined by the Frankel grade. [2]

In January 2007 the IRFB implemented a new law for scrum engagement after extensive review of the safety of the scrum. [8] This new law aimed to decrease injuries by decreasing scrum impact force and the likelihood of scrum collapse. [11]

II. METHODS

A review of the Australia literature was performed. Database and literature searching for manuscripts, reports and thesis that reported SCIs in which RU to RL injury rates were compared was done using the 'snowball strategy'. This included searching online databases such as Medline and PubMed using search terms such as; 'NSW claims data', 'Australian SCI Register' and 'spinal unit data'. The data from the identified studies was tabulated and the information extracted included the study sample [location and data source], author, year of publication and the age range of patients which comprise the basic study details.

The reported rate or odds ratios as reported in manuscripts were identified and tabulated with the rates subsequently verified using the CEBM Statistical Calculator. [12]

If not originally calculated incidence rates and numbers of participants were utilized to equate the statistic using this calculator [Figure 1, Table 1]. The manuscript by Berry and colleagues [1] was utilized as an example to show how to calculate injury cases in the respective football codes and the number of participants for various years reported [Figure 2]. Exposed arbitrarily are the injury cases in RU given the rate is higher in this sport while not-exposed are the injury cases in RL. The figure below shows how to calculate the odds ratio using the free share-ware web-based online calculator tool. Controls are the number of players averaged over the years for which the calculation equates to for each respective code reported. The average for each code is then entered into the calculator tool and in this case the average for years 1995-2003 for RU was 29 431, while the average for RL was 79 200. Finally the get results key is hit in order to have an instantaneous result produced along with confidence interval estimates and in this case it equated to an OR of 4.0 [95% CI 1.9 – 8.4].

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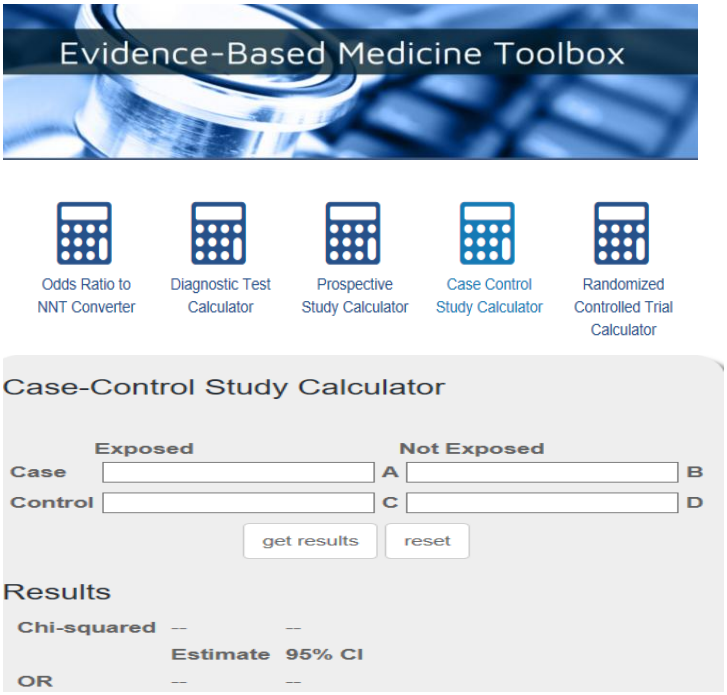

Figure 1. Center for Evidence Based Medicine [Toronto] toolbox EBM calculator [12]. https://ebm-tools.knowledgetranslation.net/calculator/case-control/ [accessed 26/11/17].

Table 1. Extracts from Table 1 as reported in the manuscript by Berry and colleagues [1]. Tetraplegia [complete and incomplete] incurred in rugby union and rugby league in NSW (1986-2003).

	Australian Spinal Cord Injury Register (ASCIR)			
	Rugby union		Rugby league	
Year	Cases[c]	Participants	Cases[c]	Participants
1986	4	24,600	1	80,219
1987	5	22,020	3	81,515
1988	1	23,510	3	79,966
1989	2	23,510	1	79,974
1990	1	22,964	2	78,627
1991	0	25,150	1	80,762
1992	0	26,584	1	83,656
1993	1	26,366[a]	0	81,923
1994	0	26,366[a]	0	84810
Sub-total	14	—	12	—
1995	1	26,366[a]	1	82,420
1996	4	26,148	1	84,138
1997	0	26,250	1	84,697
1998	1	26,207	2	76,417
1999	0	27,425	2	75,793
2000	2	30,180	0	78,223
2001	2	30,922	2	77,931
2002	4	35,471	1	76,928
2003	4	35,917	2	76,258
Sub-total	18	—	12	—
Total	32	—	24	—

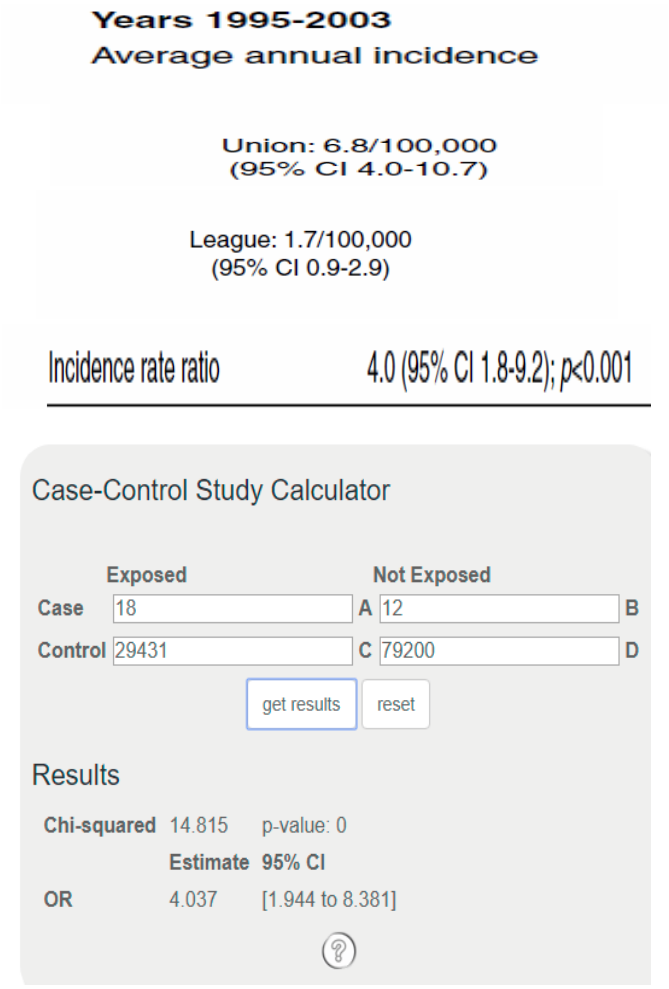

Figure 2. Center for Evidence Based Medicine [Toronto] toolbox EBM calculator [12]. Data from Berry [latter time block] is entered into the calculator tool as per details in the methodology [1].

III. RESULTS

Six studies were identified that are included in table 2 [1, 2, 4, 6, 13, 14] and the last had a 2nd reference that related to that which was reported in the study. [15]

Three of these studies reported odds ratios in the manuscripts as calculated by the study authors.[1, 6, 14]

The methodology being utilization of the CEBM toolbox EBM statistical calculator that enabled re-analysis reproduced the statistics. [12]

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Two of the references/ manuscripts included in the table below did not initially report odds or rate ratios in the respective publications, however this analysis has enabled statistical estimates and calculations. [2, 13]

In one manuscript there were two time blocks and the initial time block when analyzed had a resultant odds ratio of 1.8, while the latter time block resulted in a greater odds ratio of 2.5 being the comparison of RU to RL rates. [2]

The AIHW dataset estimate was 2.1 being again the odds ratio comparison of RU to RL. [13] The sixth reference included in the table below did not report a statistic nor was this able to be calculated as there were too few patient numbers. [4]

The odds ratios varied from a low of 1.3 to a high of 4.0. While these estimates vary somewhat over time and between datasets, the consensus is that RU has a higher rate then RL [approximately double to fourfold]. This table format allows easy viewing of multiple publications and datasets for comparison purposes. The new analysis done in this review resulted in statistics reasonably consistent with other previously reported statistics. This has provided several more statistical comparisons for readers. This enhances and verifies the findings previously reported.

Table 2: Australian datasets that summarize spinal injury rates in rugby union and rugby league.

Author	Year	Age	Location	RU/RL odds ratio or rate ratio reported	CEBM verification
Wilson et al 1996	1984-94	Senior and junior	NSW [government and private claims insurance data]	2.98 (95% CI 0.28 to 32.27)	2.98 (95% CI 0.8 to 32.25)
Berry et al 2006	1986-1991	≥15 years	NSW Australian Spinal Cord Injury Register	4.0 (95% CI 1.7 to 9.9)	4.0 (95% CI 1.8 to 9.0)
	1995-2003			4.0 (95% CI 1.8 to 9.2)	4.0 (95% CI 1.9 to 8.4)
Carmody et al 2005	1986-96	Adults and schoolboys	Six Australian spinal cord injury units	Not reported	1.8 (95% CI 1.0 to 2.9)
	1997–2002	n=45 adults n=7 (< 18 years old).		Not reported	2.5 (95% CI 1.2 to 5.3)
Flood & Harrison 2006	2002-3	Children and Adults	Australian Institute of Health and Welfare (AIHW) data	Not reported	2.1 (95% CI 0.8 to 5.6)
Cripps 2007	2005-6	≥15 years	(AIHW) data	Not reported [a]	- [b]
Rotem 2007	1984-99	Abstract did not report the age range.	Masters thesis with NSW datasets	1.34 (95% CI 1.0 to 1.7)	1. 27 (95% CI 0.66 to 2.4)[c] [Prospective]

a Only 5 cases occurred n=2 [RU]; n=3 [RL]. b – too small numbers permitting analysis

c Abstract only available online and prospective option chosen to reproduce rate ratio. Case control option as was per used in the other analyses produced a ratio of 1.7.

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IV. DISCUSSION

While only a small segment of this abstract involves additional analysis to that reported by the authors in the original manuscripts with the additional analysis done here being calculation of an OR as a result of further analyzing data reported by Carmody [2] and colleagues and that reported by the AIHW [13], the comparative analysis is interesting. The additional analysis of the Australian data supports the fact that the RL scrum law change may have influenced the rate of injuries in this sport as is evidenced by the difference in the ratios in the two blocks of time as less injuries in RL would have occurred after the change in 1996, which may equate with the higher OR in the latter time block showing hence that there were more injuries in RU. However maybe these findings are circumstantial and in fact this compilation of information has not shed much light on existing knowledge nor added much to the body of knowledge.

It must be remembered that a major limitation to compilation of data such as this comparison table is that there is tremendous heterogeneity between the included studies and hence this is an obvious limitation to interpretation of trends between datasets or over time. Some studies are state based data, while others are Australian data and hence this makes comparisons difficult and awkward.

Aside from this retrospective review though, prospective and forthcoming studies will be monitored by many individuals and groups whom will 'stay tuned' to ongoing developments. The toll of injury resulting from sports such as RU has serious public health, societal and economic consequences and given that rates of spinal injury in RU vary from double [2, 13] to fourfold [1] that of RL thus far the ramifications of the new law introduced by the IRFB in 2007 that aims to improve scrum safety in RU will be eagerly anticipated by many [8].

Continued comparisons such as these will be interesting and will be subsequently reviewed by statisticians, sporting bodies and boards, coaches, physiotherapists, other clinicians and interested persons. Monitoring of these trends as injury statistics continue to be collected progressively during the sporting season and in the following years is crucial for injury prevention programs. RU authorities' responsibilities must include establishing and maintaining national and international spinal injury registers so that researchers have access to current information that allows them to develop and enhance existing measures of prevention [15].

In New Zealand after the implementation of the new scrum law in 2007 a publication by Gianotti and colleagues found a decrease in the injury rate during the first year of data collection and this was a comparison of injuries occurring in 2007 compared with the rate for 2002-6 collective [11]. This beneficial effect of the new law in the first year is promising and no doubt continued data collection will substantiate the ongoing positive outcomes that are expected as a result.

If you consider that the lifetime cost of care for someone with spinal cord injuries, while estimated in the 1990s as previously mentioned in the introduction has now escalated to cost estimates in 2009 being $5 million for a person whom sustains paraplegia and up to $9.5 million for someone whom has quadriplegia, these prevention and education programs are crucial, urgent and necessary[16].

Prevention is paramount, not only to prevent the life changing repercussions of injury for the person and family that involve personal, physical and emotional strain and disability, but financial

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loss and hardship, and it is estimated that 40% of the cost burden is on the individual [16].

Given that there is also a mammoth financial burden borne by government, insurance companies and the community, prevention hence becomes not only a personal issue for individuals but it remains high priority on the prevention agenda in terms of public health and sports injuries.

In New Zealand the new law was included in Rugby Smart, whom organize an annual compulsory workshop for coaches and referees [17]. Smart Rugby has now been operational in Australia for over ten years and has been updated annually to reflect any changes in the way the game is played and refereed [18]. Incorporating law changes into training and education programs is essential and necessary given the implications of these injuries. A manoeuvre in sport done haphazardly can have life changing repercussions, and prevention can reduce or mitigate consequences. An old fashioned quote that persons long ago were heard to say, but so true; 'an ounce of prevention is worth a pound of cure'.

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V. REFERENCES

1. Berry JG, Harrison JE, Yeo JD, Cripps RA, Stephenson SC. Cervical spinal cord injury in rugby union and rugby league: are incidence rates declining in NSW? Aust N Z J Public Health. 2006; 30 (3): 268-74.
2. Carmody DJ, Taylor TK, Parker DA, Coolican MR, Cumming RG. Spinal cord injuries in Australian footballers 1997–2002. Med J Aust. 2005; 182 (11): 561–4.
3. Norton L. Australian Institute of Health and Welfare. 2010. Spinal Cord Injury, Australia 2007-8. ISSN 1444-3791; ISBN 978 1 74024 957 7; Cat. No. INJCAT 128; 44 pages. http://aihw.gov.au/publication-detail/?id=6442468335
4. Cripps R. Australian Institute of Health and Welfare. 2007. Spinal cord injury, Australia 2005–06. ISSN: 1444-3791. ISBN: 978 1 74024 733 7. Cat. No. INJCAT 102; 50 pages. https://www.aihw.gov.au/reports/injury/spinal-cord-injury-australia-200506/contents/table-of-contents
5. Cripps R. Australian Institute of Health and Welfare. 2009. Spinal cord injury, Australia, 2006-07. ISSN: 1444-3791. ISBN: 978 1 74024 818 1. Cat. No. INJCAT 119; 44 pages. https://www.aihw.gov.au/reports/injury/spinal-cord-injury-australia-2006-07/formats
6. Wilson SP, Atkin PA, Rotem T, Lawson J. Spinal cord injuries have fallen in rugby union players in New South Wales. Br Med J. 1996; 313: 1550.
7. Taylor TK, Coolican MR. Spinal cord injuries in Australian footballers, 1960–1985. Med J Aust. 1987; 147 (3): 112-3, 116-8.
8. International Rugby Football Board. Australian Rugby Football Union handbook 1995. Laws of the game of rugby football. Sydney: Australian Rugby Football Union, 1995:131 (law 20(2)).
9. Edgar M. Tackling rugby injuries. Lancet. 1995; 345 (8963): 1452-3.
10. Haylen PT. Spinal injuries in rugby union, 1970-2003: lessons and responsibilities. Med J Aust. 2004; 181 (1): 48-50.
11. Gianotti S, Hume PA, Hopkins W, Harawira J, Truman R. Interim evaluation

RA Journal of Applied Research
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||Volume||4||Issue||02||Pages-1399-1406||February-2018||
Index Copernicus ICV: 74.25, DOI: 10.18535/rajar/v4i2.02

of the effect of a new scrum law on neck and back injuries in rugby union. Br J Sports Med. 2008; 42(6):427-30.

12. Toronto Centre for Evidence Based Medicine Toolbox – EBM Calculators. https://ebmtools.knowledgetranslation.net/calculator [accessed 15/11/17].
13. Flood L and Harrison JE 2006 Hospitalised sports injury, Australia 2002–03. ISSN 1444-3791. ISBN 1 74024 549 0. Injury Research and Statistics Series Number 27. (AIHW cat no. INJCAT 79) Adelaide: AIHW. https://www.aihw.gov.au/getmedia/3ad6f1c8-0ba3-4435-a4cd480754fc7d30/injcat79.pdf.aspx?inline=true
14. Rotem T. 2007. Epidemiology of Catastrophic rugby football injuries in New South Wales. Masters Dissertation. Faculty of Medicine. University of New South Wales.
15. Rotem TR, Lawson JS, Wilson SF, Engel S, Rutkowski SB, Aisbett CW. Severe cervical spinal cord injuries related to rugby union and league football in New South Wales, 1984-1996. Med J Aust. 1998; 168 (8): 379-81.
16. The economic cost of spinal cord injury and traumatic brain injury in Australia, The Victorian Neurotrauma Initiative, Report by Access Economics Pty Limited, Australia, June 2009.
17. New Zealand Rugby. Rugby Smart. http://www.nzru.co.nz/rugbysmart
18. Australian Government, Australian Sports Commission. Smart Rugby 2017. http://www.rugbyaustralia.com.au/coaching/SmartRugby/ProgramFeatures.aspx