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Effect of Nationwide Injury Prevention Programme on Serious Spinal Injuries in New Zealand Rugby Union: Ecological Study

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## Effect of nationwide injury prevention programme on serious spinal injuries in New Zealand rugby union: ecological study

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### ABSTRACT

**Objective** To investigate the effect of RugbySmart, a nationwide educational injury prevention programme, on the frequency of spinal cord injuries.

**Design** Ecological study.

**Setting** New Zealand rugby union.

**Participants** Population at risk of injury comprised all New Zealand rugby union players.

**Intervention** From 2001, all New Zealand rugby coaches and referees have been required to complete RugbySmart, which focuses on educating rugby participants about physical conditioning, injury management, and safe techniques in the contact phases of rugby.

**Main outcome measures** Numbers of all spinal injuries due to participation in rugby union resulting in permanent disablement in 1976-2005, grouped into five year periods; observed compared with predicted number of spinal injuries in 2001-5.

**Results** Eight spinal injuries occurred in 2001-5, whereas the predicted number was 18.9 (relative rate=0.46, 95% confidence interval 0.19 to 1.14). Only one spinal injury resulted from scrums over the period; the predicted number was 9.0 (relative rate=0.11, 0.02 to 0.74). Corresponding observed and predicted rates for spinal injuries resulting from other phases of play (tackle, ruck, and maul) were 7 and 9.0 (relative rate=0.83, 0.29 to 2.36).

**Conclusions** The introduction of the RugbySmart programme coincided with a reduction in the rate of disabling spinal injuries arising from scrums in rugby union. This study exemplifies the benefit of educational initiatives in injury prevention and the need for

comprehensive injury surveillance systems for evaluating injury prevention initiatives in sport.

### INTRODUCTION

Rugby union is a type of full contact football most commonly played between two teams of 15 players. Spinal cord injuries, although rare on the basis of exposure per player, are a major cause of serious morbidity and mortality in rugby.<sup>1</sup> During the 1970s and 1980s an increase in the reported frequency of catastrophic spinal injuries associated with rugby was documented in medical journals from several countries in which rugby is a popular sport. Since the 1980s and 1990s measures to prevent injury have included changes to laws on scrum procedures, stricter application of existing laws, and educational initiatives.<sup>2,3</sup>

A review of papers published up to 2001 reported that 40% of spinal injuries occurring in rugby were the result of the scrum, 36% were from the tackle, and 18% from the ruck/maul (see bmj.com for a glossary of terms). The definition of injury used in the studies reviewed, however, varied from admissions to spinal units through to tetraplegia.<sup>1</sup>

Ascertaining the numbers of spinal injuries occurring in rugby and the risks faced by players both in the scrum and in other facets of the game has been hampered by the relative rarity of the events and a lack of standardised procedures for collecting data.<sup>1,3,4</sup> A further impediment to evaluating the risks of spinal injuries in rugby has been a lack of reliable "denominator" data—the number and exposure of participants from which the cases result over a specified period.<sup>4</sup>

A recent call by a consultant general surgeon in the United Kingdom to ban the rugby scrum generated a

flurry of correspondence in the *BMJ*.<sup>5</sup> The article cited evidence from an Australian survey that reported the elimination of scrum related spinal cord injuries in rugby league after the adoption of non-contested scrums in 1996.<sup>6</sup>

Our study had two aims. The first was to document the number of permanently disabling spinal injuries in New Zealand rugby union from 1976 to 2005. The second was to investigate whether the incidence of spinal injuries in New Zealand rugby union changed after the introduction in 2001 of RugbySmart, a nationwide injury prevention programme.

## METHODS

### Number of spinal injuries

We collated and analysed data from 1976 to 2005 on the frequency and circumstances of rugby related spinal injuries in New Zealand. We extracted incidence data from the Accident Compensation Corporation database for serious rugby related spinal injury claims. This corporation is a no fault insurance system, which provides personal injury cover for all New Zealand citizens, residents, and temporary visitors. Any serious injury that requires medical assistance automatically generates an Accident Compensation Corporation claim.

In addition to Accident Compensation Corporation data, we cross checked files from the New Zealand Rugby Foundation to provide information about the phase of play in which the injury occurred. For the purposes of modelling injury rates, we categorised the phase of play as scrum and other (tackle, ruck, and maul).

### Spinal injury rates

We used records of numbers of players, available from the New Zealand Rugby Union from 1998 onwards, to estimate the average incidence of spinal injury per 100 000 players per year for the periods 1996-2000 and 2001-5 (table). We estimated the player numbers in 1998-2000 by using a combination of player registrations and evaluation of competition draws. To

calculate the rate in 1996-2000, we used the average number of players from 1998-2000 as the denominator for the entire period.

### RugbySmart programme

Since January 2001, RugbySmart ([www.rugbysmart.co.nz](http://www.rugbysmart.co.nz)) has been the vehicle for delivering information on injury prevention to rugby coaches, referees, and players in New Zealand. The RugbySmart programme derives its approach from van Mechelen's sequence of prevention model.<sup>7</sup>

RugbySmart is a multifaceted injury prevention programme and has developed over time as new information about risks has emerged. Both players and coaches in New Zealand have identified rugby coaches as having a key role in communicating information on injury prevention and attitudes to players' safety.<sup>8</sup> All coaches must complete RugbySmart on an annual basis. Because completing RugbySmart is compulsory, the reach of the programme to coaches and referees is close to 100%.

Information and resources have been made available through compulsory seminars, the production of DVDs, a dedicated website, and provision of injury prevention "tools," such as a sideline concussion check card, to coaches and referees. The principles espoused in RugbySmart with respect to safety in contact have been integrated throughout New Zealand Rugby Union coaching courses. Key messages on injury prevention, such as the relation between injury prevention and performance, techniques to minimise injury risk in the contact situations of rugby, the importance of progressive physical conditioning (especially with respect to building up to contact during the pre-season period), and management of acute injuries, have been heavily marketed so that they will be acceptable to participants.

### Statistical analysis

To examine the effect of the RugbySmart programme, we calculated changes in numbers of scrum related and other spinal injuries before and after the introduction

Player numbers and injury rate per year

Year	No of players (thousands)	Change from previous year (%)	Scrum injuries	Other injuries	Injury rate (per 100 000 players per year)
1996	NA	NA	3	1	NA
1997	NA	NA	0	1	NA
1998	122	NA	0	2	1.6
1999	130	6	4	1	3.9
2000	129	-1	2	3	3.9
2001	120	-7	0	2	1.7
2002	122	1	0	1	0.8
2003	121	-1	0	2	1.7
2004	129	6	1	1	1.6
2005	138	6	0	1	0.7

NA=not available.

of RugbySmart. The aim of the modelling was to estimate the linear effect of time period on the number of injuries per five year period. We did not build participation level (number of players) into the model, because accurate estimates of numbers of players were not available before 1998.

To estimate the minimum clinically important difference, we calculated the typical number of spinal injuries occurring from scrums per five year period. A factor decrease of 1.2 equated to one person not being permanently disabled through a scrum related spinal injury per five year period, which we believed was a worthwhile clinical outcome.

## RESULTS

Seventy seven permanently disabling injuries were recorded in 1976-2005. In 1976-2000 the scrum accounted for 48% (33/69) of spinal injuries; in 2001-5 the percentage was 12.5 (1/8). Tackles accounted for 36% (25/69) of spinal injuries in 1976-2000 and 87.5% (7/8) in 2001-5. The remaining 11 injuries resulted from the ruck or maul. The figure shows the frequency of permanently disabling spinal cord injuries in New Zealand rugby grouped by five year period from 1976.

In 2001-5 eight spinal injuries occurred in New Zealand rugby, whereas the predicted number based on the rate from the previous periods was 18.9 (relative rate=0.46, 95% confidence interval 0.19 to 1.14). Only one scrum related spinal injury occurred in 2001-5, which was clearly less than the predicted number of 9.0 (relative rate=0.11, 0.02 to 0.74). Seven spinal injuries occurred as a result of tackles, rucks, and mauls in 2001-5; the predicted number was 9.0. The difference in the number of observed spinal injuries resulting from tackles, rucks, and mauls relative to the predicted number was rated unclear (relative rate=0.83, 0.29 to 2.36).

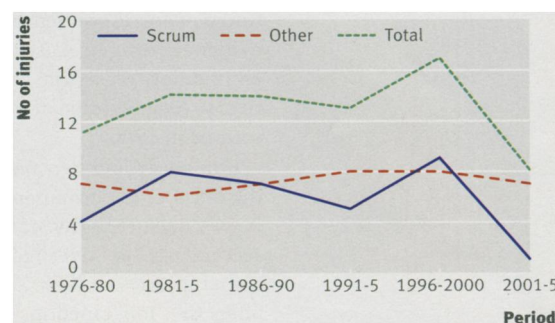
The average annual number of players registered was 126 800 in 1996-2000 and 125 900 in 2001-5. The rates of spinal injuries from scrums and from other phases of play per 100 000 players per year were therefore 1.4 and 1.3 in 1996-2000 and 0.2 and 1.1 in 2001-5.

## DISCUSSION

### RugbySmart and spinal injury numbers

A major goal of the New Zealand Rugby Union and the Accident Compensation Corporation in establishing RugbySmart was "to eliminate spinal injuries within the context of a contact sport." The results are consistent with a decrease in spinal cord injuries in New Zealand rugby since 2000, primarily owing to a reduction in injuries occurring in scrums. This decrease coincides with the introduction of the RugbySmart programme.

If the true rate of scrum related spinal injury was the observed average rate of 6-7 per five years, the chance of observing one or zero scrum related spinal injuries in 2001-5 if the underlying rate of injury to players had not changed and the total exposure of players to rugby



Permanently disabling spinal injuries (American Spinal Injuries Association scale A to D) in New Zealand rugby union, 1976 to 2005

had remained constant was only 1%. Thus a small chance exists that the decrease observed in this study reflects expected statistical variation, but a real decrease in the rate of spinal injuries from scrums occurred in New Zealand over the period 2001-5 is much more probable.

One of the weaknesses of this study is the lack of a control group. Because the New Zealand Rugby Union wanted to implement a nationwide injury prevention programme from the beginning, we were unable to create a control group to which RugbySmart was not delivered.

Changes in law are a means of altering behaviour that have the potential to decrease the risk of injury. In 1992, the International Rugby Board introduced a change that altered the sequence of events in scrum engagement. Little evidence suggests that any decrease in scrum related spinal injuries in New Zealand that followed this change was sustained through the subsequent five year period (see figure). No substantive changes occurred to the law relating to the scrum, ruck, maul, or tackle through the period of the RugbySmart intervention (2001-5) that would have been expected to affect players' risk of sustaining a spinal injury.

### Players' exposure to scrums, tackles, and rucks

A decrease in exposure to scrums could have contributed to the decrease in the number of scrum related spinal injuries seen in 2001-5 compared with previous periods. Such a decrease in exposure to scrums could have resulted from fewer players participating in rugby, fewer matches a year for those who did participate, fewer scrums per match, or some combination of the three. Over the long term, we have little evidence on which to base any conjecture of the possible impact of numbers of players on numbers of injury. Across all levels, the number of competitions and the number of matches played per competition have not, to our knowledge, changed substantially in New Zealand over the past decade.

At least part of the decrease in scrum related spinal injury numbers is probably due to a decrease in the



**WHAT IS ALREADY KNOWN ON THIS TOPIC**

Spinal cord injuries, although rare on the basis of exposure per player, are a major cause of serious morbidity and mortality in rugby

**WHAT THIS STUDY ADDS**

The number of permanently disabling spinal injuries in New Zealand rugby has markedly decreased following the introduction in 2001 of RugbySmart, a nationwide injury prevention programme

This study exemplifies the benefit of educational initiatives in injury prevention and the need for comprehensive injury surveillance systems for evaluating such initiatives in sport

number of scrums per match. Evidence from international matches indicates a long term decrease in the number of scrums per match. A comparative analysis by the International Rugby Board of international matches played in the early 1980s and the early years of the 21st century found that the average number of scrums per match had dropped from 31 to 19.<sup>9</sup> International Rugby Board statistics indicate that the numbers of scrums per 80 minutes of match play at international level in 2003 for seniors and in 2004 for under 21 and under 19 grades were 21, 22, and 22.<sup>10</sup> Given the above, we can attribute approximately 8-10% of the decrease in scrum related spinal injuries to a decrease in exposure as a result of fewer scrums per match in the 2001-5 period than occurred in 1996-2000.

Although the effect is not clear, the RugbySmart programme seems to have been unsuccessful in reducing the number of spinal injuries unrelated to the scrum. Compared with the relatively controlled environment of the scrum, the direction and size of forces applied to players' bodies in the tackle, ruck, and maul are much less predictable. Whether the underlying risk to players (as opposed to the number of injuries observed) has changed in the tackle, ruck, and maul is difficult to determine. For example, the injury data do not take into account possible changes in the frequency of tackles and rucks in rugby. Substantial increases in both of these phases of play have been noted in professional rugby.<sup>9</sup> We do not know whether or to what extent such increases have been reflected in lower grades.

**Injury prevention in rugby**

Several avenues for injury prevention are available to rugby administrators, including changes in law and educational programmes. We believe that research into the probable effects of changes in law on patterns of match activity and the overall risk of injury to participants should be done before their introduction. Historical evidence shows that changes in law have resulted in changes in the relative frequency and nature of match activities, characteristics of players, and epidemiology of injuries that were not foreseen when the changes were introduced.<sup>9,11</sup>

The results presented here provide evidence that educational programmes are a viable option for decreasing the rate of serious spinal injuries in rugby union scrums. In the absence of evidence that other factors have had a major role, we believe that the RugbySmart programme has probably played a positive part in decreasing the risks to players in New Zealand of sustaining serious spinal injuries through participation in rugby.

**Conclusion**

The introduction of the RugbySmart injury prevention programme in New Zealand has coincided with a drop in the number of spinal injuries over the past five years. A decrease in injuries from scrums has been the major contributor to this reduction. Whether the programme has had an effect on injuries from other phases of play is unclear. Educational initiatives seem to represent a viable option for decreasing the rate of serious spinal injuries in rugby union scrums.

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**Competing interests:** KLQ and SMG are responsible for the production of the RugbySmart programme on behalf of the New Zealand Rugby Union and Accident Compensation Corporation respectively. WGH and PAH: none declared.

**Ethical approval:** AUT University ethics board.

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