Original research

Sport-related concussions in New Zealand: A review of 10 years of Accident Compensation Corporation moderate to severe claims and costs

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A R T I C L E  I N F O

Article history:
Received 23 February 2013
Received in revised form 23 April 2013
Accepted 18 May 2013
Available online 17 June 2013

Keywords:
Sport-related concussion
Injury
Ethnicity
Incidence
Costs
Gender

A B S T R A C T

Objectives: This paper provides an overview of the epidemiology of sport-related concussion and associated costs in New Zealand requiring medical treatment from 2001 to 2011 in seven sports codes.

Design: A retrospective review of injury entitlement claims by seven sports from 2001 to 2011.

Methods: Data were analyzed by sporting code, age, ethnicity, gender and year of competition for total and moderate-to-severe (MSC) Accident Compensation Corporation (ACC) claims and costs.

Results: A total of 20,902 claims costing $NZD 16,546,026 were recorded over the study period of which 1330 (6.4%) were MSC claims. The mean yearly number and costs of MSC claims were 133 ± 36 and $1,303,942 ± 378,949. Rugby union had the highest number of MSC claims per year (38; 95% CI 36–41 per 1000 MSC claims). New Zealand Māori recorded the highest total ($6,000,759) and mean cost ($21,120) per MSC claim.

Conclusions: Although MSC injury claims were only 6.4% of total claims, they accounted for 79.1% of total costs indicating that although the majority of sport-related concussions may be minor in severity, the related economic costs associated with more serious sport-related concussion can be high. The finding that rugby union recorded the most MSC claims in the current study was not unexpected. Of concern is that rugby league recorded a low number of MSC claims but the highest mean cost per claim. Due to the high mean cost per concussion, and the high total and mean cost for New Zealand Māori, further investigation is warranted.

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1. Introduction

Sport-related concussions are topical in the sports medicine domain. In the United States of America 1.6–3.8 million sports related concussions occur annually [1] with a cumulative (direct and indirect) cost estimated to be US$56 billion [1]. Most sport-related concussions occur in sports that involve physical contact between participants [2]. However rates are also high for non-contact sports such as baseball and volleyball [3]. Despite the increasing number of international studies on sport-related concussion, there is a paucity of studies describing sport-related concussion in New Zealand sports-participants. To date no published studies have undertaken an epidemiological review of the costs to a nation from sport-related concussion in different sporting activities. To enable appropriate targeting of injury prevention initiatives, we were interested in differences for sport-related concussion incidence and characteristics by age, sports code and gender. Given the ethnic differences in the New Zealand population, it was identified that there may be variance in the ethnic representation of sport-related concussions. With a population of 4.1 million [4] the four largest ethnic groups were New Zealand Europeans (61.2%), New Zealand Māori (13.2%), Pacific Peoples (6.2%), and Asian (8.4%). With this in mind the aim of this study was to provide an epidemiological overview of sport-related concussion and associated costs over 10 years. New Zealand’s national taxpayer funded no-fault injury compensation system administered by the Accident Compensation Corporation (ACC) means that New Zealand is uniquely positioned to provide detailed descriptive epidemiological data including costs associated with treatment. Using these data, comparisons of the incidence and cost of concussions

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http://dx.doi.org/10.1016/j.jsams.2013.05.007
for players in seven sports with comparisons by gender, ethnicity and age over the 2001/2002 to 2010/2011 reporting periods were conducted.

2. Methods

As there is no reliable data capturing system for concussive injuries through national sporting organizations, the ACC database was utilized to provide detailed descriptive epidemiological data including costs associated with treatment for injuries that occur in sporting activities. The database records the number of injury claims but is unable to report missed match and training time, hospitalization duration and level of participation. ACC records, and reports, on two types of acute personal injury claims [5]. These are minor and moderate-to-serious claims (MSC). Both are defined under the Injury Prevention, Rehabilitation and Compensation (IPRC) Act, 2001 with ACC responsible for meeting the costs of the injuries [5]. People qualify for cover when they present with a personal acute injury as a result of an accident to any of the ACC recognized 30,000 registered medical practitioner’s throughout New Zealand [5]. A claim is classified as ‘minor’ when ACC only pays for the registered medical practitioner (e.g., Physiotherapist, General Practitioner) for the medical treatment provided [5]. Typically this involves a few treatments with ACC meeting most of the costs [5]. To be classified as MSC, these injuries usually require assistance beyond medical treatment alone [5]. MSC’s may involve a combination of medical care, rehabilitation costs and income replacement for employment time lost as a result of the injury [5].

For the purpose of the study, we focused on MSC claims that occurred from 1st July 2001 to 30th June 2011 as a result of participating in seven sporting activities. The definition utilized for this study was “any injury that had been assessed and reported by a registered health practitioner as a result of sports participation. The injury had to have been classified and recorded as a concussion utilizing the ACC read code (560...). The injury had to have been accepted as being an ACC claim during the study period to be recorded in the study dataset.”

Epidemiological studies are dependent on data quality for any analysis to be undertaken [6]. Data provided for our analyses was from the ACC database and this is dependent on several factors [7]. This database was utilized as there were no other available databases for collection of player specific data such as numbers participating in the different sports code activities, age of players participating, identification of the ethnicity of players, and number of matches/events/activities completed enabling calculation of match and training exposure hours. A potential identified limitation related to the use of this database is the way the data is retrieved to protect client confidentiality by limiting the access to low level results. As a result any data less than, or equal to, three injury claims was rounded to represent three claims only.

As there were no reliable participation data collected by the different sports-codes, New Zealand population data was obtained from official government data. This data provide estimates of resident populations between each five year census [4]. The population of New Zealand over the study period was ~4.1 million people based on the 2006 census [4].

Ethical consent was sought from the AUT Ethics Committee but was not required. Informed consent from the injured participants was not obtained as de-identified data were collected from the ACC data base without individual participant identification or follow-up.

All data collected were entered into a Microsoft Excel spreadsheet and analyzed with MedCalc for Windows, version 12.0 (MedCalc Software, Mariakerke, Belgium). Injury incidences were calculated as number of injuries per 1000 MSC claims [7]. Data are reported as means and standard deviations (±SD) with 95% confidence intervals (CI) where appropriate [8]. Injury incidences were compared for two selected periods chosen as the start (2001–2002) and end (2010–2011) of the study period (2001–2011). Comparisons between reporting years were calculated using a one sample chi-squared ($\chi^2$ test). Costs are reported in NZ Dollars ($).
Table 2
Sports code and gender concussion injury summary for total number and rate per 1,000 MSC claims with 95% Confidence intervals for total concussion MSC claims, total and mean MSC costs and differences over reporting years for MSC claims.

<table>
<thead>
<tr>
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<tbody>
<tr>
<td></td>
<td>No.</td>
<td>Rate (95% CI)</td>
<td>NZD</td>
<td>Mean NZD</td>
</tr>
<tr>
<td>Rugby union</td>
<td>802</td>
<td>38.4 (35.8–41.1)</td>
<td>$6,252,870</td>
<td>$7797</td>
</tr>
<tr>
<td>Soccer</td>
<td>183</td>
<td>8.8 (7.6–10.1)</td>
<td>$1,143,408</td>
<td>$6248</td>
</tr>
<tr>
<td>Rugby league</td>
<td>179</td>
<td>8.6 (7.4–9.9)</td>
<td>$4,572,625</td>
<td>$25,545</td>
</tr>
<tr>
<td>Netball</td>
<td>74</td>
<td>3.5 (2.8–4.4)</td>
<td>$841,426</td>
<td>$11,371</td>
</tr>
<tr>
<td>Hockey</td>
<td>35</td>
<td>1.7 (1.2–2.3)</td>
<td>$164,661</td>
<td>$4,705</td>
</tr>
<tr>
<td>Touch rugby</td>
<td>34</td>
<td>1.6 (1.2–2.3)</td>
<td>$80,215</td>
<td>$23,595</td>
</tr>
<tr>
<td>Softball/baseball</td>
<td>23</td>
<td>1.1 (0.7–1.7)</td>
<td>$34,211</td>
<td>$14,871</td>
</tr>
</tbody>
</table>

| Female              | No. | Rate (95% CI) | NZD | Mean NZD | $^2 (df=9); p value | $^2 (df=1); p value |
| Netball             | 69  | 3.3 (2.6–4.2) | $833,530 | $12,080 | 18.9 0.026 | 6.3 0.012 |
| Rugby union         | 67  | 3.2 (2.5–4.1) | $608,215 | $9078  | 10.3 0.328 | 1.3 0.248 |
| Soccer              | 51  | 2.4 (1.9–3.2) | $289,080 | $5668  | 14.8 0.097 | 0.5 0.48 |
| Touch rugby         | 27  | 1.3 (0.9–1.9) | $54,099 | $2004  | 3.0 0.564 | 0.0 1.000 |
| Hockey              | 23  | 1.1 (0.7–1.7) | $38,801 | $13,939 | 8.0 0.534 | 3.0 0.083 |
| Rugby league        | 12  | 0.6 (0.3–1.0) | $121,732 | $10,144 | 16.0 0.067 | 0.0 1.000 |
| Softball/baseball   | 9   | 0.4 (0.2–0.8) | $6,220  | $691   | 24.0 <0.001 | 0.0 1.000 |
| Total female        | 258 | 12.3 (10.9–13.9) | $1,943,675 | $7554  | 41.8 <0.001 | 8.0 0.005 |

| Male                | No. | Rate (95% CI) | NZD | Mean NZD | $^2 (df=9); p value | $^2 (df=1); p value |
| Rugby union         | 735 | 35.2 (32.7–37.8) | $5,644,655 | $7680 | 32.8 <0.001 | 6.5 0.011 |
| Rugby league        | 170 | 8.1 (7.0–9.5) | $4,450,893 | $26,182 | 13.3 0.15 | 5.1 0.023 |
| Soccer              | 135 | 6.5 (5.5–7.6) | $854,328 | $6328  | 24.2 0.004 | 1.3 0.248 |
| Touch rugby         | 25  | 1.2 (0.8–1.8) | $26,116  | $1045 | 13.8 0.13 | 0.0 1.000 |
| Hockey              | 21  | 1.0 (0.7–1.5) | $133,860 | $6374  | 9.0 0.437 | 3.0 0.083 |
| Softball/baseball   | 18  | 0.9 (0.5–1.4) | $27,991 | $1555  | 11.0 0.276 | 3.0 0.083 |
| Netball             | 12  | 0.6 (0.3–1.0) | $7,896  | $658  | 16.0 0.067 | 0.0 1.000 |
| Total male          | 1116| 53.4 (50.3–56.6) | $11,145,747 | $9987 | 50.3 <0.001 | 11.5 <0.001 |

Note: CI, Confidence interval.

2001–2011. Rugby league (92.2%; $25,545) and netball ($86.6%; $11,371) recorded the highest percentage of sport code total costs and mean costs per ACC claim. Males recorded significantly more MSC claims than females ($^2=535.8; df=1; p<0.001) (see Table 2). Males participating in rugby union recorded the highest total costs for MSC claims ($5,644,655). Males participating in rugby league recorded the highest mean costs per MSC claim ($26,182). Females participating in netball recorded the highest total ($833,530) and mean costs per female MSC claim ($12,080).

New Zealand European's recorded the highest number of MSC claims (37.6: 35.1–40.3 per 1000 MSC claims; $^2=77.2; df=9; p<0.001) over the duration of the study and this was significant (see Table 3). New Zealand Māori (15.4; 13.8–17.2 per 1000 MSC claims) recorded the highest total ($6,000,759) and mean costs ($21,120) per MSC claims over 2001–11. Over 2001–11 period, New Zealand Māori recorded the highest mean costs per MSC claim for rugby league ($43,604) and rugby union ($14,186) (see Table 3). There were significant differences over the duration of the study for the number of MSC claims for New Zealand Europeans participating in rugby union ($^2=36.0; df=9; p<0.001).

The 20–29 age group recorded the highest MSC costs ($4,820,083) (see Supplementary Table). The 30–39 age group recorded the highest mean costs per MSC claim ($19,910). The number of concussion injury entitlement claims increased over the duration of the study for the 0–9 ($^2=36.3; df=9; p<0.001), 10–19 ($^2=49.0; df=9; p<0.001) and 20–29 ($^2=46.7; df=9; p<0.001) age groups. People participating in rugby league activities in the 30–39 age group recorded the highest total ($2,268,398) and mean cost ($48,211) per MSC claim (see Supplementary Table). Although people participating in rugby union activities in the 20–29 age group recorded the highest total costs ($2,150,341) the 30–39 age group recorded the highest mean cost ($17,376) per MSC claim.

4. Discussion
This study identified the number of ACC claims lodged, and the associated costs of sport-related concussions that occurred from participation in seven sports in New Zealand over a 10-year period (2001–2011). As shown there were 20,962 injury entitlement claims reporting concussions as a result of sports participation but only 6.4% (1,330) of these were classified as MSC injury entitlement claims. The majority of the ACC claims (19,572; 93.6%) reflect the number of sport-related concussions that resolved without further additional assistance. The numbers presented in this study are not a reflection of how many concussions are occurring in the individual sporting codes but how many concussive injuries were recorded by the individual sporting code participants as a result of participating in that sport. As well the term MSC is for the accounting purposes by ACC and does not reflect the severity classification of the head injury itself. All the concussive injuries reported in this study were classified as concussions (S60..) and recorded on the ACC system but required additional assistance beyond mere medical treatment only [5].

MSC claims accounted for 6.4% of the total sport-related concussions for the seven sports surveyed but accounted for 79.1% of total costs. This indicates that although sport-related concussions may be minor in severity, the related economic costs attached to a sport-related concussion with ongoing symptoms can be high. The finding that rugby union recorded the most MSC claims was not unexpected as this is the national game in New Zealand [9]. Previous international studies have identified that ice hockey [10] and the national football league (NFL) [11] have some of the highest incidences of concussion of all sports but these sports have low participation levels in countries such as New Zealand. Denominator data in terms of the number of participants exposed to concussion...
through play, and the hours of exposure to play in these sports is needed to enable an accurate comparison of the risk of concussion in different sports but this data is not available for this study.
costs associated with different ethnic groups in the medical management of concussion? (3) Are the sport-related concussions MSC claims from a single concussive event, a concussive event where the injured player has returned to participation before the concussion has been fully resolved (a repeat concussion)? and (4) Where the original injury was a structural mild Traumatic Brain Injury (sTBI) but has been misdiagnosed as a concussion from sports participation in these sporting codes? The reasons for the mean high cost per concussion, and in particular for New Zealand Māori, are areas that warrant further investigation.

The finding that MSC claims was higher for females (8.5%) than males (6.2%) was similar to previous studies [3,19]. This may be reflective of the identified increased risk factors for female sports participants. These include being of a smaller stature, weaker neck muscles, less head/neck mass than males, increased head mass, greater acceleration of the head and neck and a lower ability to protect their heads compared with male sports-participants [20,21]. In addition, females are more likely to report their injuries, utilize health systems and report symptoms more than males [2]. Consequently, there would be an increase in claim numbers when compared with males. Further studies on the anatomical, mechanical and physiological differences between male and female sports participants recording a sports related concussion are warranted.

The finding that some sporting codes do not have MSCs for players under the age of 9 years or for older age groups does not reflect a limiting of the players by age in that sport. Similarly the recording of MSCs for younger players in other sporting codes does not reflect the risk of a concussion occurring in these sporting codes. The differences recorded between the age groups may be related to several factors. The low number of MSC claims may be reflective of the low sports-participation in this age group in the different sports codes. During Adolescence (10–19 years) sports-participants may have increased risk of concussion due to reduced ability to dissipate forces applied to the head as a result of weaker neck muscles, decreased nerve myelination, greater head-to-body ratio and growth spurts resulting in increases in the body’s weight and mass [22]. The physiological changes that occur to this age group can result in increased forces and momentum during a collision when participating in sports activities [22]. Adolescents and children may also have a protracted recovery after concussion when compared with adults as there may be a more diffuse and prolonged cerebral swelling can occur after an injury to the brain [23]. This suggests that adolescents and children may be more at risk for secondary intracranial hypertension and ischemia.

The reporting of MSCs for sports participants over the age of 39 is not unexpected. Players over this age often participate in modified versions of the sports-code activity in annual events (e.g. Master’s games) or in President or Veteran’s grades. These games are often designed to encourage continued sports activity, team participation and club membership. The 30–39 age group had the highest mean cost per MSC claim. This may be reflective of this age group likely being less compliant with current recommendations for return-to-play procedures. Or more likely the cost of work income replacement (costs were from earnings-related compensations claims) being greater in this age group compared with younger players. Future studies need to explore why this age group has an increased cost per concussion claim than the other age groups.

Given the findings of increased incidence in rugby union, increased cost per claim in male Māori rugby and rugby league players, and increased incidence in female players, injury prevention initiatives should be targeted at these types of players in New Zealand once greater understanding of the risk factors and mechanisms of injury are ascertained. Additional injury prevention initiatives may also include a wider understanding of concussion, the assessment, diagnosis and management education for team medical personnel and coaching staff; more support for the removal from play of players with suspected concussions to enable a complete sideline assessment and the identification of a removal-from-play tool that is usable at all levels of sports participation.

5. Conclusions

The average cost per claim for a moderate to severe concussive injury varied by sports code, ethnicity, gender and age over a 10 year period for seven sporting codes in New Zealand. Māori rugby league males aged between 30 and 39 years, female players and rugby union players need to be targeted for injury prevention initiatives. A wider understanding of concussion identification for team coaches and first aiders and removal from play for assessment at all levels of participation may assist in the identification of concussive injuries. Further longitudinal studies with specific details on injury mechanisms and participation data are warranted to further explore the incidence of sport-related concussion that occurs in New Zealand.

Practical implications

- The costs of sport-related concussions can vary by ethnicity, gender and sporting activity completed.
- The majority of reported sport-related concussions resolve without further ongoing medical assistance.
- More education is required for all sports-team management on identification and management of sport-related concussions.
- Māori sports participants may require a more personalized concussion rehabilitation program for returning to activities.

Contributor statement

DK, PH and CG contributed in the conception and design. JH, DK and PH involved in an acquisition of data. DK, PH, MB, JH and CG contributed in an analysis and interpretation of data. DK, PH, MB, JH and CG involved in the participated in drafting of the manuscript. DK, PH, MB, JH and CG involved in the critical revision of the manuscript for important intellectual content.

Competing interest

The authors declare that there are no competing interests associated with the research contained within this manuscript.

Funding source

No sources of funding or technical assistance were utilized in the conducting of this study.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.jsams.2013.05.007.

References


