

# Title: Sports-related injuries in New Zealand: National Insurance (Accident Compensation Corporation) claims for five sporting codes from 2012 to 2016

Running title: ACC sports injuries

Authors: King, D,<sup>a,b</sup> Hume, P,<sup>a,c</sup> Hardaker, N,<sup>a,d</sup> Cummins, C,<sup>b</sup> Gissane, C,<sup>e</sup> Clark, T<sup>f</sup>

- a. Sports Performance Research Institute New Zealand (SPRINZ),  
Faculty of Health and Environmental Science  
Auckland University of Technology, Auckland, New Zealand
- b. School of Science and Technology,  
University of New England,  
Armidale, NSW, Australia
- c. National Institute of Stroke and Applied Neuroscience (NISAN)  
Faculty of Health and Environmental Science  
Auckland University of Technology, Auckland, New Zealand
- d. Accident Compensation Corporation,  
Wellington, New Zealand
- e. School of Sport Health and Applied Science  
St Mary's University,  
Twickenham, Middlesex, United Kingdom
- f. Australian College of Physical Education  
Department of Sport Performance  
Sydney Olympic Park NSW, Australia

## Correspondence to:

Doug King  
Emergency Department  
Hutt Valley District Health Board  
Private Bag 31-907  
Lower Hutt  
New Zealand

Email: [dking@aut.ac.nz](mailto:dking@aut.ac.nz)

Keywords: Sport-related injury; Costs; Injury; Rugby League; Rugby Union; Netball; Football; Cricket

Submitted to: *British Journal of Sports Medicine*

Abstract: 254/250 words  
Manuscript: 3,243/3,000 words  
References: 32  
Tables: 4 + 3 supplemental  
Figures: 1

## Competing interests

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

### **Funding**

No source of funding was utilised in the conducting of this study.

**Contributor statement:** According to the definition given by the International Committee of Medical Journal Editors (ICMJE), the authors listed above qualify for authorship based on making one or more of the substantial contributions to the intellectual content of:

- (i) Conception and design [DK; PH; NH]; and/or,
- (ii) Acquisition of data [NH; DK; PH]; and/or
- (iii) Analysis and interpretation of data [DK, PH, NH, CC, CG, TC]; and/or
- (iv) Participated in drafting of the manuscript [DK, PH, NH, CC, CG, TC]; and/or
- (v) Critical revision of the manuscript for important intellectual content [DK, PH, NH, CC, CG, TC].

### **Exclusive License**

"The Corresponding Author has the right to grant on behalf of all authors and does grant on behalf of all authors, an exclusive licence (or non-exclusive for government employees) on a worldwide basis to the BMJ Publishing Group Ltd and its Licensees to permit this article (if accepted) to be published in Journal (British Journal of Sports Medicine) editions and any other BMJPG products to exploit all subsidiary rights, as set out in our licence (<http://bjsm.bmjournals.com/misc/ifora/licenceform.shtml>)."

**Title: Sports-related injuries in New Zealand: National Insurance (Accident Compensation Corporation) claims for five sporting codes from 2012 to 2016**

Running title: ACC sports injuries

## ABSTRACT

**Objectives:** To provide epidemiological data and related costs for sport-related injuries of five sporting codes (cricket, netball, rugby league, rugby union and football) in New Zealand for moderate-to-serious and serious injury claims.

**Methods:** A retrospective analytical review utilising detailed descriptive epidemiological data obtained from the Accident Compensation Corporation (ACC) for 2012-2016.

**Results:** Over the five years of study data, rugby union recorded the most moderate-to-serious injury entitlement claims (25,226) and costs (NZD\$267,359,440 [£139,084,749]) resulting in the highest mean cost (\$10,484 [£5,454]) per moderate-to-serious injury entitlement claim. Rugby union recorded more serious injury entitlement claims ( $n=454$ ) than cricket ( $t_{(4)}=-66.6$ ;  $p<0.0001$ ); netball ( $t_{(4)}=-45.1$ ;  $p<0.0001$ ); rugby league ( $t_{(4)}=-61.4$ ;  $p<0.0001$ ); and football ( $t_{(4)}=66.6$ ;  $p<0.0001$ ) for 2012-2016. There was a two-fold increase in the number of female moderate-to-serious injury entitlement claims for football (RR: 2.6 [95% CI: 2.2 to 2.9];  $p<0.0001$ ) compared with cricket, and a three-fold increase when compared with rugby union (RR: 3.1 [95% CI: 2.9 to 3.3];  $p<0.0001$ ). Moderate-to-serious concussion claims increased between 2012 and 2016 for netball (RR: 3.7 [95% CI: 1.9 to 7.1];  $p<0.0001$ ), rugby union (RR: 2.0 [1.6 to 2.4];  $p<0.0001$ ) and football (RR: 2.3 [95% CI: 1.6 to 3.2];  $p<0.0001$ ). Nearly a quarter of moderate-to-serious entitlement claims (23%) and costs (24%) were to participants aged 35 years or older.

**Conclusions:** Rugby union and rugby league have the highest total number and costs associated with injury. Accurate sport exposure data are needed to enable injury risk calculations.

## WHAT ARE THE NEW FINDINGS

- Rugby union and rugby league have the most moderate-to-serious injury entitlement claims, total costs, and highest mean cost for sporting injury in New Zealand.
- The mean cost per claims has increased from NZD\$7,206 [£3,749] (2002-2007) to NZD\$8,248 (95% CI: NZD\$6,013 to NZD\$10,483) [£4,490 (95% CI: £3,127 to £5,460)] (2012-2016); this percentage increase was 12% greater than the rate of inflation
- The average cost per moderate-to-serious injury entitlement claims were similar in most sporting codes for male and female participants.

- Concussion injury entitlement claims provided the highest average cost of moderate-to-serious injuries recorded.
- Participants in the over 35 yr. age group recorded nearly a quarter of the total moderate-to-serious injury entitlement claims (23%) and costs (24%).

## INTRODUCTION

People in New Zealand participate in sporting activities for reasons such as health, fitness, pleasure, relaxation or for the team environment.<sup>1</sup> Although sports participation can have healthy influences and assist with reducing risk factors such as cardiovascular disease,<sup>1</sup> injuries are a risk of sports participation.<sup>2</sup> Studies have reported the incidence of injuries during sports participation endeavouring to better understand what is occurring.<sup>3</sup> All sports injuries are a concern and organisations are constantly striving to improve the management and prevention of injuries to make their sports safer.<sup>4</sup> Injuries are one of the main reasons why individuals drop out from sports participation.<sup>5</sup> One way to assist with identification of the extent of the sport injury problem, and the development of injury prevention programmes, is through injury epidemiology data analyses.<sup>1, 6</sup> A source for injury data is the national insurance company in New Zealand, the Accident Compensation Corporation (ACC). Utilising data obtained from the ACC, studies have reported on rugby union,<sup>7-12</sup> rugby league,<sup>13-18</sup> cricket,<sup>12</sup> netball,<sup>6, 12</sup> sports-related concussion,<sup>19, 20</sup> dental injuries<sup>21, 22</sup> and the effects of injury prevention strategies.<sup>8, 9, 20, 23-25</sup> Most, but not all,<sup>14-16</sup> of these studies reported specific injuries<sup>6, 7, 10, 11, 13, 18, 20, 25</sup> or injury prevention strategies.<sup>9, 23, 24</sup> Some studies<sup>14-16</sup> reported directly on the number and associated costs of rugby league injuries over a 10 year period. Caldwell<sup>26</sup> highlighted that the cost of sports-related injuries in New Zealand has risen to NZD\$542 million [£281,970,524] and that the top sports codes by total injury costs in 2016 were rugby union (NZD\$78,242,505 [£40,704,945]), football (NZD\$38,295,109 [£19,922,679]), netball (NZD\$27,639,333 [£14,380,659]) and rugby league (NZD\$19,871,754 [£10,339,212]). The costs of sports injuries are increasing but there is a paucity of studies reporting on all injuries and the related costs. It has been previously been reported<sup>15</sup> that for 42,754 ACC injury entitlement claims over an eight-year period the total costs were NZD\$48,704,704 [£25,342,015]. Moderate-to-serious claims represented 13.9% (5,493) of the total number of claims but 87.9% (NZD\$42,822,048 [£22,281,153]) of the total costs. Although minor claims accounted for the majority (86.1%) of claims they only accounted for 12.1% of the total costs. Therefore, the aim of this study was to provide a retrospective analytical review on the moderate-to-serious and serious injury claims and related costs for five sporting codes (cricket, netball, rugby league, rugby union and football) in New Zealand.

## METHODS

### *The quality of the New Zealand ACC injury reporting system and data*

As there are no reliable data capturing systems for injuries within national sports organisations in New Zealand, the ACC database was utilised to provide detailed descriptive epidemiological data including the costs associated with treatment for injuries occurring in sporting activities. The ACC records, and reports, on different types of acute personal injury claims.<sup>20</sup> The database records the number of injury claims but is unable to report length of hospital stay, missed match or loss of training time, and participation level. The terms minor, moderate-to-serious and serious entitlement claims are defined under the Injury Prevention, Rehabilitation and Compensation (IPRC) Act, 2001 with the ACC responsible for meeting the costs of these injuries.<sup>20</sup> People qualify for cover when they present with a personal acute injury as a result of an accident to any of the 30,000 ACC registered medical practitioner's throughout New Zealand.<sup>20</sup> When making a claim, injury information is collected using a standard ACC 45 injury reporting form to ensure levels of consistency for data recording and analyses.<sup>15</sup> The injured person (unless impaired) completes information relating to the activity surrounding the injury (e.g. location, activity prior, cause, narrative), and personal details (e.g. age, gender, ethnicity, contact details). The registered health professional completes the form by providing information regarding initial diagnosis and other relevant medical information (e.g. surgical procedure). The claim is filed with the ACC and details are entered into a central database. The ACC covers compensation for the injury (sporting or other) including medical treatment, income replacement, social and vocational rehabilitation and ancillary services (transportation and accommodation) as part of the rehabilitation.

Epidemiological studies are dependent on data quality for any analysis to be undertaken.<sup>23</sup> There is no disincentive by ACC for making claims, nor are people risk-rated or penalised for the amount of claims they make.<sup>23</sup> Coverage is guaranteed by ACC, but this is offset by the restriction to sue for personal injury except in rare circumstances for exemplary damages.<sup>23</sup> ACC injury entitlement claims are categorised as minor (medical treatment only), moderate-to-serious<sup>23</sup> or serious.<sup>11, 27</sup> Minor claims are lodged following an accident and generate a payment for the period reported to the registered medical practitioner (e.g., Physiotherapist, General Practitioner) for the medical treatment provided.<sup>20</sup> Typically minor claims do not require loss of time from employment, where the claimant does not require additional medical support and involves a few treatments with the ACC meeting most of the costs.<sup>20</sup> Moderate-to-serious injury entitlement claims occur following an accident, generate a payment for the

period reported and require additional financial support for treatment, loss of earnings and related medical costs.<sup>20,</sup>

<sup>23</sup> Serious injury entitlement claims require a prolonged period of financial support, loss of earnings and related medical support and are monitored by the Serious Injury Claim Unit, typically over a long period of time.<sup>11, 27</sup>

Moderate-to-serious and serious injury entitlement claims account for approximately 8% of total claims recorded, but can account for 80% of total costs.<sup>9, 20, 23</sup>

This study focused on moderate-to-serious and serious-injury entitlement claims that occurred from 1<sup>st</sup> January 2012 to 31<sup>st</sup> December 2016 resulting from participating in five sporting activities. The definition utilised 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 also had to have been accepted as an ACC claim during the study period to be recorded in the study dataset. All costs were inflation adjusted using the Reserve Bank inflation adjustor (<https://www.rbnz.govt.nz/monetary-policy/inflation-calculator>) to reflect all costs at 2016 rates with a mean inflation of 2.8 ±1.3% per year.

### ***Ethical consent***

Ethical consent was sought from the central region Health and Disability Ethics Committee (HDEC) but was not required. Informed consent from the injured participants was not obtained as de-identified data were collected from the ACC database without individual participant identification or follow-up.

### ***Statistical Analysis***

All data collected were entered into a Microsoft Excel spreadsheet and analysed with SPSS (IBM Corp, Released 2017. IBM SPSS Statistics for Windows, Version 24.0 Armonk, NY: IBM Corp). Data are reported as means and standard deviations (±SD) with 95% confidence intervals (CI) where appropriate.<sup>28</sup> Comparisons of the costs over the reporting years were calculated using an independent *t*-test. A one-sample chi-squared ( $\chi^2$ ) test was utilised for comparison between reporting years for the number of claims recorded. Injury incidence was not calculated for the study as the sporting codes participation rates were not available as part of the data analysis. All costs are reported in NZ Dollars (\$) and Great Britain Pounds (£) unless otherwise indicated.



## RESULTS

Throughout 2012-2016 there were 853,824 total claims costing ACC NZD\$777,939,840 New Zealand Dollars (NZD) (equivalent to £404,805,406) with an average cost per year of NZD\$155,587,968 (95% CI: \$12,462,949 to \$311,238,885) (£80,961,081 [95% CI: £6,484,816 to £161,946,176]). The moderate-to-serious and serious injury entitlement claims represented 7.2% (61,412) of total claims for the five sports codes, but 78.6% (NZD\$611,456,567 [£318,207,349]) of the total injury entitlement costs with a mean cost per year of NZD\$122,291,313 (95% CI: NZD\$31,025,952 to NZD\$275,608,579) (£63,659,340 [95% CI: £16,150,711 to £143,521,314]). Minor injuries accounted for 7.2% of the total claims and 21.4% of the total costs (NZD\$166,483,148 [£86,603,122]) with a mean cost per year of NZD\$33,296,629 (95% CI: NZD\$30,632,006 to NZD\$35,961,253) (£17,318,733 [95% CI: £15,932,899 to £18,703,803]). As a result, minor injuries had a mean cost of NZD\$210 (95% CI: NZD\$205 to NZD\$215) (£109 [95% CI: £107 to £112]) per claim.

### ***Total, moderate-to-serious and serious Accident Compensation Corporation injury entitlement claims***

Over the 2012-2016 period there were 60,803 moderate-to-serious and 597 serious injury entitlement claims recorded for five sports (see Table 1). Moderate-to-serious injury entitlement claims recorded the highest total costs (NZD\$529,358,883 [£275,682,788]) resulting in an average cost of NZD\$8,248 (95% CI: NZD\$6,013 to NZD\$10,483) (£4,296 [95% CI: £3,131 to £5,460]) per injury entitlement claim. There were 2,432 ±1,570 moderate-to-serious injury entitlement claims per year costing an average of NZD\$104,928,473 (95% CI: NZD\$11,027,826 to NZD\$220,884,773) (£54,625,125 [95% CI: £5,741,019 to £114,991,269]). per year. Serious injury entitlement claims were less (NZD\$86,862,544 [£45,227,843]) but had the highest average cost (NZD\$142,584 (95% CI: NZD\$132,467 to NZD\$152,700) [£74,241 (95% CI: £68,973 to £79,508)]) per claim. Rugby union recorded the most moderate-to-serious injury entitlement claims (25,226) and costs (NZD\$267,359,440 [£139,220,573]) and, as a result, had the highest mean cost (NZD\$10,484 (95% CI: NZD\$10,018 to NZD\$10,951) [£5,459 (95% CI: £5,217 to £5,702)]) per moderate-to-serious injury entitlement claim. Rugby union also recorded more serious injury entitlement claims ( $n=454$ ) than cricket ( $t_{(4)}=-66.6$ ;  $p<0.0001$ ); netball ( $t_{(4)}=-45.1$ ;  $p<0.0001$ ); rugby league ( $t_{(4)}=-61.4$ ;  $p<0.0001$ ); and football ( $t_{(4)}=66.6$ ;  $p<0.0001$ ) during the study.

### ***Reporting years moderate-to-serious and serious injury entitlement claims***

Figure 1 illustrates the mean cost per year for moderate-to-serious claims and serious claims for the five sports. The two rugby codes had the highest mean costs per claim (a surrogate measure of severity of the injury) for the moderate-to-serious claims and the serious claims. All sports showed an increase in the mean cost per year over the five years for the moderate-to-serious claims. The same trend of increasing mean cost per year was seen for the serious claims over the years for the sports. There was a four-fold increase in mean cost in 2013 for cricket and a large increase for netball from prior years for the 2015 mean claims costs for serious claims. Details of the yearly numbers and costs for the claims per sport are available in supplementary Table S1.

### ***Gender moderate-to-serious and serious injury entitlement claims***

There were differences in the number of moderate-to-serious injury entitlement claims for females between 2012 and 2016 for netball (RR: 1.2 [95% CI: 1.1 to 1.3];  $p < 0.0001$ ), rugby league (RR: 2.0 [95% CI: 1.5 to 2.7];  $p < 0.0001$ ), rugby union (RR: 1.9 [95% CI: 1.6 to 2.2];  $p < 0.0001$ ) and football (RR: 1.4 [95% CI: 1.3 to 1.6];  $p < 0.0001$ ) (see Table 3). The mean costs per moderate-to-serious injury entitlement claim varied from NZD\$6,330 (95% CI: NZD\$5,664 to NZD\$6,995) (£3,297 [95% CI: £2,950 to £3,643]) for netball to NZD\$10,582 (95% CI: NZD\$10,142 to NZD\$11,022) (£5,647 [95% CI: £5,278 to £5,736]) for rugby union. The costs of moderate-to-serious injury entitlement claims for females (NZD\$14,339,203 to NZD\$21,797,582 [£7,7463,351 to £11,345,666];  $t_{(4)}=12.6$ ;  $p=0.0002$ ) and males (NZD\$74,964,427 to NZD\$98,571,975 [£39,041,592 to £51,336,440];  $t_{(4)}=18.8$ ;  $p=0.0001$ ) increased during the study. Females recorded the highest mean cost per serious injury entitlement claim (NZD\$43,373 (95% CI: NZD\$39,548 to NZD\$47,197) [£22,587 (95% CI: £20,595 to £24,579)]) in rugby union. There was a two-fold increase in the number of female moderate-to-serious injury entitlement claims for football (RR: 2.6 [95% CI: 2.2 to 2.9];  $p < 0.0001$ ) when compared with cricket, and a three-fold increase when compared with rugby union (RR: 3.1 [95% CI: 2.9 to 3.3];  $p < 0.0001$ ).

### ***Injury site moderate-to-serious and serious injury entitlement claims***

The number of moderate-to-serious injury entitlement claims increased for lower limb injuries over 2012-2016 for cricket ( $\chi^2_{(4)}=12.8$ ;  $p=0.0123$ ), netball ( $\chi^2_{(4)}=32.5$ ;  $p < 0.0001$ ), rugby league ( $\chi^2_{(4)}=10.6$ ;  $p=0.0310$ ), rugby union ( $\chi^2_{(4)}=18.8$ ;  $p=0.0009$ ) and football ( $\chi^2_{(4)}=101.3$ ;  $p < 0.0001$ ) (see Table 4). Rugby union ( $n=2,779$ ) recorded more

head/neck injuries than cricket ( $n=212$ ;  $t_{(4)}=-2.6$ ;  $p=0.0456$ ) during the study. The costs of moderate-to-serious injury entitlement claims increased during the study for injuries to the head and neck for rugby union ( $t_{(4)}=30.0$ ;  $p<0.0001$ ), netball ( $t_{(4)}=8.7$ ;  $p=0.0010$ ); and rugby league ( $t_{(4)}=36.1$ ;  $p<0.0001$ ). Rugby union recorded the highest average cost per moderate-to-serious (NZD\$25,237 (95% CI: NZD\$22,733 to NZD\$27,741) [£13,138 (95% CI: £11,834 to £14,437)]) and serious (NZD\$179,513 (95% CI: NZD\$166,410 to NZD\$192,616) [£93,424 (95% CI: £86,605 to £100,234)]) injury entitlement claim for the head/neck during 2012-2016. The knee recorded the most moderate-to-serious injury entitlement claims ( $n=19,026$ ) and costs (NZD\$172,178,936 [£89,598,967]) but the neck, back of head vertebrae recorded the highest mean cost per moderate-to-serious injury entitlement claim (NZD\$77,428 (95% CI: NZD\$26,732 to NZD\$128,123) [£40,293 (95% CI: £13,911 to £66,675)]) (see Supplemental Table S2).

### ***Injury type moderate-to-serious and serious injury entitlement claims***

The number of moderate-to-serious injury entitlement claims for fracture/dislocations increased over 2012-2016 for cricket ( $\chi^2_{(4)}=25.5$ ;  $p<0.0001$ ), rugby union ( $\chi^2_{(4)}=17.8$ ;  $p=0.0014$ ) and football ( $\chi^2_{(4)}=37.5$ ;  $p<0.0001$ ) (see Table 5). Moderate-to-serious concussion claims increased between 2012 and 2016 for netball (RR: 3.7 [95% CI: 1.9 to 7.1];  $p<0.0001$ ), rugby union (RR: 2.0 [1.6 to 2.4];  $p<0.0001$ ) and football (RR: 2.3 [95% CI: 1.6 to 3.2];  $p<0.0001$ ). Rugby union recorded the highest total costs for moderate-to-serious injury entitlement claims for soft tissue injuries (NZD\$140,783,951 [£73,273,813]) and football recorded the highest average cost per moderate-to-serious injury entitlement claim for gradual onset (NZD\$14,964 (95% CI: NZD\$4,014 to NZD\$25,911) [£7,790 (95% CI: £2,090 to £13,490)]). Although rugby union recorded a higher total cost for moderate-to-serious injury entitlement concussion claims (NZD\$6,796,172 [£3,538,987]) than rugby league (NZD\$3,606,561 [£1,878,053];  $t_{(4)}=-6.7$ ;  $p=0.0026$ ), rugby league recorded a higher average cost per moderate-to-serious injury entitlement claim (NZD\$15,925 (95% CI: NZD\$14,121 to NZD\$17,730) vs. NZD\$6,611 (95% CI: NZD\$5,769 to NZD\$7,454) [£8,294 (95% CI: £7,355 to £9,235) vs. £3,444 (95% CI: £3,005 to £3,883)];  $t_{(4)}=12.1$ ;  $p=0.0003$ ). Serious injury entitlement claims costs differed by sport for fracture dislocations (rugby union:  $t_{(4)}=21.7$ ;  $p<0.0001$ ; rugby league:  $t_{(4)}=11.5$ ;  $p=0.0003$ ), concussions (rugby union:  $t_{(4)}=22.4$ ;  $p<0.0001$ ; rugby league:  $t_{(4)}=13.2$ ;  $p=0.0002$ ) and soft tissue injuries (rugby union:  $t_{(4)}=46.8$ ;  $p<0.0001$ ; rugby league:  $t_{(4)}=11.2$ ;  $p=0.0004$ ).

### **Age group moderate-to-serious and serious injury entitlement claims**

The 20-24 yr. old age group recorded 23.7% (n=14,401) of the total moderate-to-serious injury entitlement claims and 22.4% (NZD\$118,335,586 [£61,641,914]) of the total moderate-to-serious injury entitlement costs (see Supplemental Table S3). Nearly a quarter of the moderate-to-serious entitlements claims (22.9%) and costs (23.7%) were to participants 35 yr. or older. Participants 50-54 yr. old recorded 2.1% of the total moderate-to-serious injury entitlement claims, 2.5% of the total moderate-to-serious injury entitlement costs but had the highest mean cost (NZD\$10,038 (95% CI: NZD\$9,533 to NZD\$10,543) [£5,229 (95% CI: £4,966 to £5,491)]) per moderate-to-serious injury entitlement claims. The age groups differed by sport for the highest moderate-to-serious injury entitlement claims and costs. There were more moderate-to-serious injury entitlement claims for participants 20-24 yr. playing rugby union than football ( $t_{(4)}=37.6$ ;  $p<0.0001$ ), netball ( $t_{(4)}=-25.3$ ;  $p<0.0001$ ), rugby league ( $t_{(4)}=-24.1$ ;  $p<0.0001$ ) and cricket ( $t_{(4)}=-31.4$ ;  $p<0.0001$ ).

### **DISCUSSION**

This retrospective analytical review utilised detailed descriptive epidemiological data obtained from the ACC for 2012-2016 for rugby union, rugby league, cricket, netball, and football. The information on injury claims and costs added to prior reports of ACC sport data such as the 2002-2007 analysis for rugby league injuries.<sup>13-18</sup> The total number of claims, and therefore total costs, are somewhat dependent upon exposure. Therefore, the focus of our analysis was on the average cost per claim type, and the differences between sports, gender and years. The average cost per moderate-to-serious claim was NZD\$8,248 (95% CI: NZD\$6,013 to NZD\$10,483) [£4,296 (95% CI: £3,132 to £5,460)] which was higher than the mean cost-per-claim (NZD\$7,206 [£3,753]) from a previous study.<sup>15</sup> This difference may be related to the inclusion of five compared with one sports code (rugby league) and/or the increased costs of medical care between the two studies (2002-2007 vs. 2012-2016). However, the cost percentage increase was greater than the rate of inflation over the same period.

The mean cost per moderate-to-serious injury entitlement claim was similar for males and females across most of the sporting codes in the study. It was not unexpected that males recorded more injuries than females across most of the sporting codes as males represent the largest cohort of participants in cricket, football, rugby league and rugby union, whereas females represent the largest cohort of participants in netball.

Although concussions accounted for an average of  $2.5 \pm 1.5\%$  of the moderate-to-serious injury entitlement claims and  $3.0 \pm 2.2\%$  of costs, the average mean cost per claim (NZD\$7,691 (95% CI: NZD\$6,943 to NZD\$8,439) [£4,006 (95% CI: £3,616 to £4,395)]) was among the highest mean costs per injury. The number of concussions increased when compared to previous work<sup>19</sup> on sports-related concussion, and the mean cost per moderate-to-serious and serious concussion injury entitlement claim was more (NZD\$11,651 vs. NZD\$9,804 [£6,068 vs. £5,106]) when compared for the respective sporting codes. The mean costs per moderate-to-serious and serious concussion injury entitlement claim decreased over the reporting period (2012 vs. 2016) for some (rugby union: NZD\$11,653 to NZD\$9,033 [£6,069 vs. £4,704]; netball: NZD\$13,065 vs. NZD\$6,516 [£6,803 vs. £3,393]) but not all (football: NZD\$2,929 vs. 3,466 [£1,525 vs. £1,822]; rugby league: NZD\$25,868 vs. NZD\$30,073 [£13,470 vs. £15,657]; cricket: NZD\$14,333 vs. NZD\$23,325 [£7,462 vs. £12,144]) of the sports codes included in the study. Future research should investigate whether the change in mean costs per concussion is reflective of the increased awareness of concussion in sports and efforts of sporting codes in addressing these injuries.

Increasing numbers of people older than 35 years, train for, and compete in, team and individual sporting activities.<sup>29, 30</sup> It is accepted<sup>31</sup> that exercise can assist with preventing, or reducing, changes in structure and function of the body associated with aging. Injuries to sports participants over 35 yr. can present a unique challenge to the sports medicine community with the injuries occurring alongside age-related changes and underlying pathologies.<sup>32</sup> The introduction of the masters' level of sporting activities for those over 35 yr. has enabled people to continue on within their sporting activities. The finding that those over 35 yr. age recorded 22.9% of the total moderate-to-serious injury entitlement claims and 23.7% of costs is similar to a previous study<sup>15</sup> and may be reflective of this participation level in these sports. Although there are increasing numbers of participants competing in older age level sport, there is a paucity of studies detailing the incidence of injuries specifically to masters or president's participation level in sports. Research into this participation level in all sports is warranted to identify the risks and injury incidence that occur.

### *Limitations*

Most claims (792,424; 92.8%) reflected the number of injuries that resolved without further medical assistance. Data gathered through the ACC system should not be seen as being reflective of the total incidence of injuries from participation in these sporting codes in New Zealand.<sup>17</sup> The results exclude participants in these sporting

codes who do not make an injury entitlement claim for more minor injuries.<sup>17</sup> Despite this, the results do highlight the number of injuries and their associated costs over a 5-year recording period that required medical assistance. There was no indication as to whether the injury claims recorded were for new, recurrent or exacerbation of previous injuries within the different sporting codes. The terms 'moderate-to-serious' and 'serious' are not a reflection of the severity classification of the injury, more the accounting terms applied by ACC to the costs involved with the rehabilitation of the injury. The moderate-to-serious claims recorded may not necessarily have been lodged or the accident have occurred, during the same period reported. Moderate-to-serious claims are recorded if there has been any entitlement received during the life of the claim and they are backdated to the day the claim was lodged. If there were to be future entitlements, then the data reported here would change accordingly.

## **CONCLUSION**

Rugby union featured prominently as the highest total number and costs associated with injury, likely due to the popularity of the sport, as well as the impact nature of the sport. Accurate sport exposure data are needed to enable injury risk calculations. It is clear that an injury recorded by a healthcare provider when an injury is seen in New Zealand, and captured by the ACC recording system, does not fully describe the true cost of such injuries. However, it does identify the number of injuries that are moderate-to-serious, or serious, enough to warrant medical assistance.

## TABLE AND FIGURE LEGENDS

**Table 1:** Sports code summary of ACC moderate-to-serious and serious injury entitlement claims and costs, for total number of claims, total costs, mean costs per claim and per reporting year with 95% Confidence Intervals, for five sports from 2012 to 2016 in New Zealand.

**Table 2:** Sports code summary of ACC moderate-to-serious and serious injury entitlement claims and costs of female and males by total number of claims, total costs, mean costs per claim and per reporting year with 95% Confidence Intervals, for five sports in New Zealand from 2012 to 2016.

**Table 3:** Sports code summary of ACC moderate-to-serious and serious injury entitlement claims and costs of anatomical group by total number of claims, total costs, mean costs per claim and per reporting year with 95% Confidence Intervals, for five sports in New Zealand from 2012 to 2016.

**Table 4:** Sports code summary of ACC moderate-to-serious and serious injury entitlement claims and costs, of injury type by total number of claims, total costs, mean costs per claim and per reporting year with 95% Confidence Intervals, for five sports in New Zealand from 2012 to 2016.

## FIGURE

**Figure 1:** Mean cost per year for (A) moderate-to-serious, and (B) serious injury entitlement claims, for rugby union, football, netball, rugby league and cricket

## SUPPLEMENTARY TABLES

**S-Table 1:** Sports code summary of ACC moderate-to-serious and serious injury entitlement claims and costs, for total number of claims, total costs, mean costs per claim and per reporting year with 95% Confidence Intervals, by reporting year from 2012 to 2016 for five sports in New Zealand.

**S-Table 2:** Sports code summary of ACC moderate-to-serious and serious injury entitlement claims and costs of anatomical location by total number of claims, total costs, mean costs per claim and per reporting year with 95% Confidence Intervals, for five sports in New Zealand from 2012 to 2016.

**S-Table 3:** Sports code summary of ACC moderate-to-serious and serious injury entitlement claims and costs by total number of claims, total costs, mean costs per claim and per reporting year with 95% Confidence Intervals by age groups for five sports in New Zealand from 2012 to 2016.



## REFERENCES

1. van Mechelen W, Hlobil H, Kemper H. Incidence, severity, aetiology and prevention of sports injuries: A review of concepts. *Sports Med.* 1992; **14**(2):82-99.
2. Hurley O, Moran A, Guerin S. Exploring athletes' experience of their injuries: A qualitative investigation. *Sport Exerc Psychol Rev.* 2007;**3**:14-23.
3. Finch C. A new framework for research leading to sports injury prevention. *J Sci Med Sport* 2006; **9**(1):3-9.
4. Leung F, Franettovich Smith M, Hides J. Injuries in Australian school-level rugby union. *J Sports Sci.* 2017;**35**(21):2088-92.
5. Finch C, Cassell E. The public health impact of injury during sport and active recreation. *J Sci Med Sport.* 2006;**9**(6):490-7.
6. Reeves J, Hume P, Gianotti S, Wilson B, Ikeda E. A retrospective review from 2006 to 2011 of lower extremity injuries in badminton in New Zealand. *Sports.* 2015;**3**(2):77-86.
7. Gianotti S, Hume PA, Hopkins WG, Harawira J, Truman R. Interim evaluation 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.
8. Gianotti S, Quarrie K, Hopkins W. The prevention of serious injuries in rugby union. *Br J Sports Med.* 2008;**39**(6):386.
9. Gianotti S, Quarrie K, Hume P. Evaluation of RugbySmart: A rugby union community injury prevention programme. *J Sci Med Sport* 2009;**12**(3):371-5.
10. Quarrie K, Gianotti S, Chalmers D, Hopkins W. An evaluation of mouthguard requirements and dental injuries in New Zealand rugby union. *Br J Sports Med* 2005;**39**(9):650-4.
11. Quarrie K, Gianotti S, Hopkins W, Hume P. Effect of nationwide injury prevention programme on serious spinal injuries in New Zealand rugby union: Ecological study. *BMJ.* 2007;**334**(7604):1150-3.
12. Hume P, Marshall S. Sports injuries in New Zealand: Exploratory analysis. *NZ J Sports Med.* 1994;**22**(2):18-22.
13. King D, Hume P, Gianotti S, Clark T. Neck back and spine injuries in amateur rugby league: A review of nine years of Accident Compensation Corporation injury entitlement claims and costs. *J Sci Med Sport.* 2011;**14**(2):126-9.
14. King D, Hume P, Milburn P, Gianotti S. Rugby league injuries in New Zealand: Variations in injury claims and costs by ethnicity, gender, age, district, body site, injury type and occupation. *NZ J Sports Med* 2009;**36**(2):48-55.
15. King D, Hume P, Milburn P, Gianotti S. Rugby league injuries in New Zealand: A review of 8 years of Accident Compensation Corporation injury entitlement claims and costs. *Br J Sports Med.* 2009;**43**(8):595-602.
16. King D, Hume P, Milburn P, Gianotti S. Women's rugby league injury claims and costs in New Zealand. *Br J Sports Med.* 2010;**44**(14):1016-23.

17. Lythe M, Norton R. Rugby league injuries in New Zealand. *NZ J Sports Med* 1992; **20**:6-7.
18. King D, Hume P, Gianotti S, Clark T. A Retrospective Review Over 1999 to 2007 of Head, Shoulder and Knee Soft Tissue and Fracture Dislocation Injuries and Associated Costs for Rugby League in New Zealand. *Int J Sports Med*. 2011;**32**(4):287-91.
19. King D, Gissane C, Brughelli M, Hume P, Harawira J. Sport-related concussions in New Zealand: A review of 10 years of Accident Compensation Corporation moderate to severe claims and costs. *J Sci Med Sport*. 2014;**17**(3):250-5.
20. Gianotti S, Hume P. Concussion sideline management intervention for rugby union leads to reduced concussion entitlement claims. *Neuro Rehab*. 2007;**22**(3):181-9.
21. Welch C, Thomson W, Kennedy R. ACC claims for sports-related dental trauma from 1999 to 2008: A retrospective analysis. *NZ Dent J*. 2010;**106**(4):137-42.
22. Love R, Carman N, Carmichael S, MacFayden E. Sport-related dental injury claims to the New Zealand Accident Rehabilitation and Compensations Insurance Corporation, 1993-1996; Analysis of the 10 most common sports, excluding rugby union. *NZ Dent J*. 1998;**94**(418):146-9.
23. Gianotti S, Hume P. A cost-outcome approach to pre and post-implementation of national sports injury prevention programmes. *J Sci Med Sport* 2007;**10**(6):436-46.
24. Gianotti S, Hume P, Tunstall H. Efficacy of injury prevention related coach education within netball and soccer. *J Sci Med Sport* 2009;**13**(1):32-5.
25. Gianotti S, Marshall S, Hume P, Bunt L. Incidence of anterior cruciate ligament injury and other knee ligament injuries: A national population-based study. *J Sci Sport Med* 2009;**12**(6):622-7.
26. Caldwell O. Sport injury costs soar to \$542m - that's more to ACC than road crashes. Dominion Post. 2017 20th July 2017.
27. Gianotti S, Quarrie K, Hopkins W. The prevention of serious injuries in New Zealand rugby union. *Br J Sports Med*. 2005;**39**(6):386.
28. Twellaar M, Verstappen F, Huson A. Is prevention of sports injuries a realistic goal? A four-year prospective investigation of sports injuries among physical education students. *Am J Sports Med* 1996; **24**(4):528-34.
29. McPherson B. Sport participation across the life cycle: A review of the literature and suggestions for future research. *Sociol Sport J*. 1984;**1**(3):213-30.
30. O'Brien S, Burgess C. Perspectives on older adults in physical activity and sports. *Educ Gerontol*. 1992 1992/01/01;**18**(5):461-81.
31. Chodzko-Zajko W, Proctor D, Fiatarone Singh M, Minson C, Nigg C, Salem G, et al. Exercise and physical activity for older adults. *Med Sci Sport Exerc*. 2009;**41**(7):1510-30.
32. Newsham-West R, Button C, Milburn P, Mündermann A, Sole G, Schneiders A, et al. Training habits and injuries of masters' level football players: A preliminary report. *Phys Ther Sport*. 2009 2009/05/01;**10**(2):63-6.

**Table 1:** Sports code summary of ACC moderate-to-serious and serious injury entitlement claims and costs, for total number of claims, total costs, mean costs per claim and per reporting year with 95% Confidence Intervals, for five sports from 2012 to 2016 in New Zealand.

Sports Code	Total	Claims		Total cost	%*	Costs NZD\$		Mean cost per claim (95% CI)
		%*	Mean $\pm$ SD per yr.			%**	Mean cost per yr. (95% CI)	
<b>Moderate-to-Serious Injury Claims</b>								
Rugby union	25,226 <sup>acdef</sup>	3	5,045 $\pm$ 360	\$267,359,440 <sup>acdef</sup>	34.4	\$52,990,715 (\$46,211,711-\$59,769,719)	\$10,484 (\$10,018-\$10,951)	
Football	14,240 <sup>abdef</sup>	1.7	2,848 $\pm$ 357	\$99,237,392 <sup>abdef</sup>	12.8	\$19,672,411 (\$15,522,575-\$23,822,306)	\$6,438 (\$6,438-\$7,315)	
Netball	11,748 <sup>abcef</sup>	1.4	2,350 $\pm$ 167	\$74,706,089 <sup>abcef</sup>	9.6	\$14,808,594 (\$11,933,591-\$17,683,596)	\$6,272 (\$5,593-\$6,951)	
Rugby league	6,517 <sup>abcdf</sup>	0.8	1,303 $\pm$ 105	\$63,797,127 <sup>abcdf</sup>	8.2	\$12,674,465 (\$10,559,203-\$14,735,727)	\$9,681 (\$8,871-\$10,490)	
Cricket	3,072 <sup>abcde</sup>	0.4	614 $\pm$ 88	\$24,258,835 <sup>abcde</sup>	3.1	\$4,809,257 (\$3,614,679-\$6,003,835)	\$7,802 (\$6,623-\$8,981)	
<b>Total</b>	<b>60,803<sup>a</sup></b>	<b>7.1</b>	<b>2,432 <math>\pm</math>1,570</b>	<b>\$529,358,883<sup>a</sup></b>	<b>68</b>	<b>\$104,928,473 (\$11,027,826-\$220,884,773)</b>	<b>\$8,248 (\$6,013-\$10,483)</b>	
<b>Serious Injury Claims</b>								
Rugby union	454 <sup>cdef</sup>	0.1	91 $\pm$ 3	\$72,795,782 <sup>acde</sup>	9.4	\$14,888,363 (\$13,612,130-\$16,164,596)	\$161,109 (\$139,958-\$186,259)	
Football	15 <sup>be</sup>	0	3 $\pm$ 0	\$608,175 <sup>abe</sup>	0.1	\$143,623 (\$113,398-\$173,849)	\$48,177 (\$2,971-\$99,281)	
Netball	9 <sup>be</sup>	0	3 $\pm$ 0	\$320,399 <sup>be</sup>	0	\$106,766 (\$25,548-\$539,080)	\$2,111 (\$203-\$24,226)	
Rugby league	104 <sup>bcd</sup>	0	21 $\pm$ 1	\$12,691,174 <sup>abcd</sup>	1.6	\$2,565,153 (\$1,731,574-\$3,398,732)	\$118,957 (\$27,479-\$210,435)	
Cricket	15 <sup>be</sup>	0	3 $\pm$ 0	\$447,014 <sup>e</sup>	0.1	\$53,566 (\$25,827-\$81,305)	\$9,371 (\$166-\$30,908)	
<b>Total</b>	<b>597</b>	<b>0.1</b>	<b>26 <math>\pm</math>36</b>	<b>\$86,862,544<sup>a</sup></b>	<b>11.2</b>	<b>\$17,362,840 (\$16,161,224-\$18,564,456)</b>	<b>\$142,584 (\$132,467-\$152,700)</b>	

CI: Confidence Interval; % = Percentage of \* total claims and \*\* total costs; NZD = New Zealand dollars (\$); All costs are inflation adjusted to 2016 values; Significant difference ( $p < 0.05$ ) than (a) = across reporting years (2012 to 2016); (b) = rugby union; (c) = football; (d) = netball; (e) = rugby league; (f) = cricket

**Table 2:** Sports code summary of ACC moderate-to-serious and serious injury entitlement claims and costs of female and males by total number of claims, total costs, mean costs per claim and per reporting year with 95% Confidence Intervals, for five sports in New Zealand from 2012 to 2016.

	Claims (n=)	Moderate-to-Serious Claims		Claims (n=)	Serious Claims	
		Total	Costs in NZD\$ Mean (95% CI) per claim		Total	Costs in NZD\$ Mean (95% CI) per claim
<b>Rugby union</b>						
Female	1,396 <sup>adf</sup>	\$11,076,670 <sup>acdef</sup>	\$6,950 (\$6,750-\$7,158)	15 <sup>cf</sup>	\$646,285 <sup>a</sup>	\$43,373 (\$39,548-\$47,197)
Male	23,830 <sup>adf</sup>	\$256,282,770 <sup>acdef</sup>	\$10,694 (\$10,151-\$11,236)	439	\$72,149,497 <sup>acef</sup>	\$160,592 (\$147,199-\$173,986)
<b>Total</b>	<b>25,226<sup>acdef</sup></b>	<b>\$267,359,440<sup>acdef</sup></b>	<b>\$10,582 (\$10,142-\$11,022)</b>	<b>454<sup>cdf</sup></b>	<b>\$72,795,782<sup>acde</sup></b>	<b>\$167,353 (\$148,539-\$186,168)</b>
<b>Football</b>						
Female	2,468 <sup>abdef</sup>	\$14,785,722 <sup>abdef</sup>	\$5,813 (\$5,427-\$6,199)	0	-	-
Male	11,772 <sup>abdef</sup>	\$84,451,670 <sup>abdef</sup>	\$7,100 (\$6,631-\$7,568)	15	\$608,175 <sup>abe</sup>	\$47,875 (\$37,799-\$57,950)
<b>Total</b>	<b>14,240<sup>abdef</sup></b>	<b>\$99,237,392<sup>abdef</sup></b>	<b>\$6,940 (\$6,526-\$7,032)</b>	<b>15<sup>be</sup></b>	<b>\$608,175<sup>abe</sup></b>	<b>\$47,875 (\$37,799-\$57,950)</b>
<b>Netball</b>						
Female	10,061 <sup>abcef</sup>	\$62,709,324 <sup>abcef</sup>	\$6,197 (\$5,490-\$6,902)	9 <sup>bcef</sup>	\$320,399 <sup>be</sup>	\$35,589 (\$10,851-\$179,694)
Male	1,687 <sup>bcef</sup>	\$11,996,765 <sup>abcef</sup>	\$6,720 (\$5,938-\$7,503)	0	-	-
<b>Total</b>	<b>11,748<sup>abcef</sup></b>	<b>\$74,706,089<sup>abcef</sup></b>	<b>\$6,330 (\$5,664-\$6,995)</b>	<b>9<sup>be</sup></b>	<b>\$320,399<sup>be</sup></b>	<b>\$35,589 (\$10,851-\$179,694)</b>
<b>Rugby league</b>						
Female	365 <sup>acdf</sup>	\$2,934,902 <sup>abcd</sup>	\$7,101 (\$5,481-\$8,720)	6 <sup>d</sup>	\$194,434 <sup>a</sup>	\$32,405 (\$24,775-\$40,036)
Male	6,152 <sup>acf</sup>	\$60,862,225 <sup>abcd</sup>	\$9,834 (\$8,975-\$10,691)	98 <sup>d</sup>	\$12,496,740 <sup>abcf</sup>	\$121,954 (\$98,621-\$145,288)
<b>Total</b>	<b>6,517<sup>abcd</sup></b>	<b>\$63,797,127<sup>abcd</sup></b>	<b>\$9,769 (\$8,991-\$10,547)</b>	<b>104<sup>bcd</sup></b>	<b>\$12,691,174<sup>abcd</sup></b>	<b>\$126,155 (\$90,393-\$161,917)</b>
<b>Cricket</b>						
Female	208 <sup>bcde</sup>	\$1,645,796 <sup>abcd</sup>	\$7,470 (\$4,801-\$10,138)	3 <sup>bd</sup>	\$164,382	\$27,231 (\$11,618-\$56,080)
Male	2,864 <sup>abd</sup>	\$22,613,039 <sup>abcde</sup>	\$7,835 (\$6,414-\$9,256)	12	\$282,632 <sup>abe</sup>	\$19,532 (\$14,340-\$24,724)
<b>Total</b>	<b>3,072<sup>abce</sup></b>	<b>\$24,258,835<sup>abcde</sup></b>	<b>\$7,875 (\$6,685-\$9,066)</b>	<b>15<sup>be</sup></b>	<b>\$447,014<sup>e</sup></b>	<b>\$17,856 (\$8,609-\$21,102)</b>

CI: Confidence Interval; NZD = New Zealand dollars (\$); All costs are inflation adjusted to 2016 values; Significant difference ( $p < 0.05$ ) than (a) = across reporting years (2012 to 2016); (b) = rugby union; (c) = football; (d) = netball; (e) = rugby league; (f) = cricket

**Table 3:** Sports code summary of ACC moderate-to-serious and serious injury entitlement claims and costs of anatomical group by total number of claims, total costs, mean costs per claim and per reporting year with 95% Confidence Intervals, for five sports in New Zealand from 2012 to 2016.

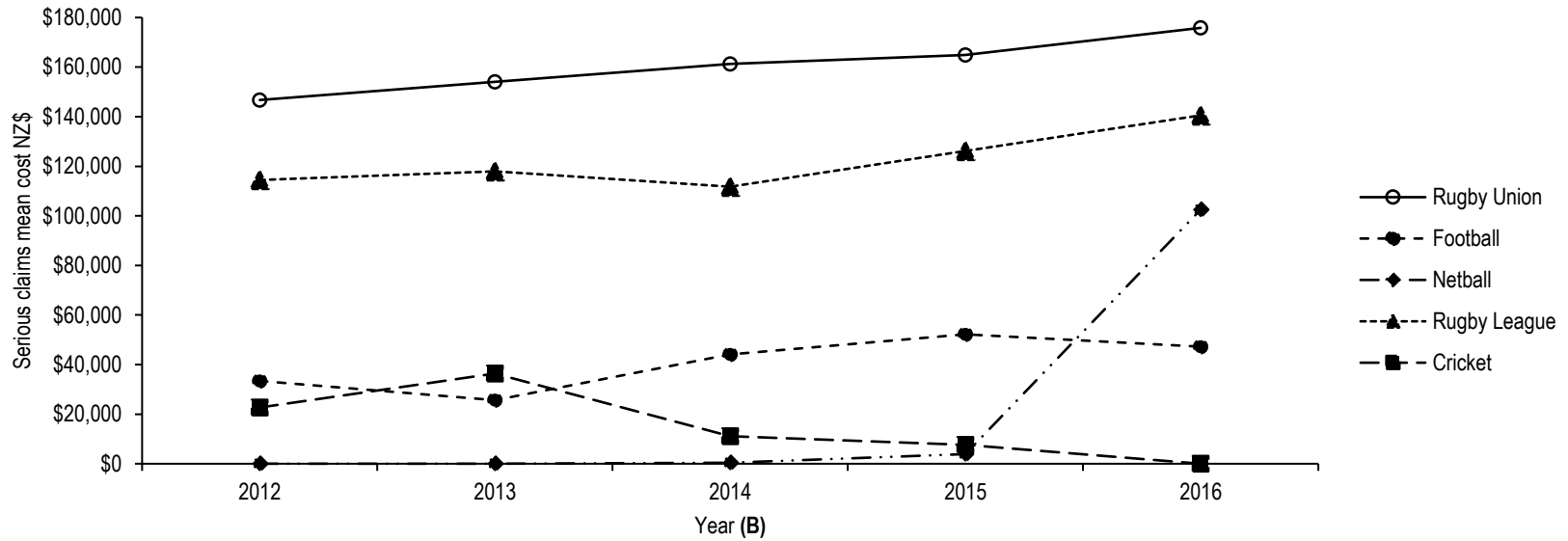
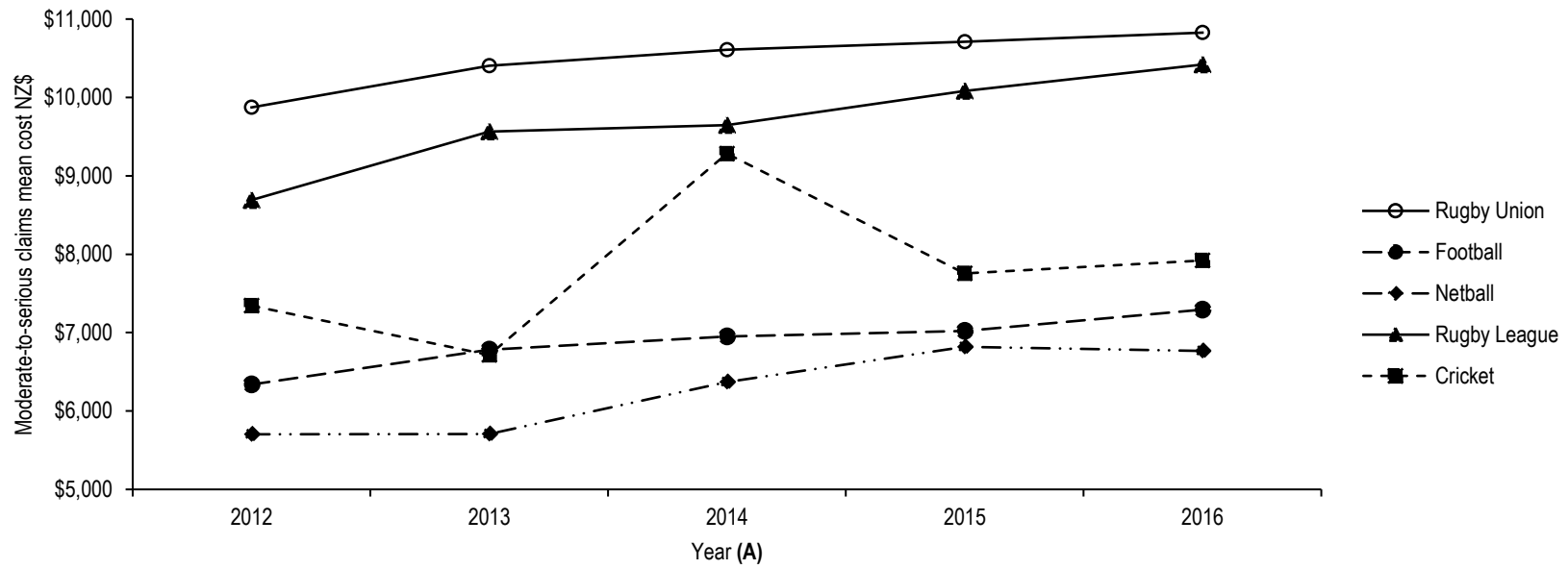
	Moderate-to-serious claims			Serious claims		
	Claims (n=)	Costs in NZD\$ Total	Costs in NZD\$ Mean (95% CI) per claim	Claims (n=)	Costs in NZD\$ Total	Costs in NZD\$ Mean (95% CI) per claim
<b>Rugby union</b>						
Head/Neck	2,779 <sup>a</sup>	\$75,027,020 <sup>acdef</sup>	\$25,237 (\$22,733-\$27,741)	348	\$62,980,144 <sup>acef</sup>	\$179,513 (\$166,410-192,616)
Upper Limb	8,996 <sup>a</sup>	\$78,414,146 <sup>acdef</sup>	\$8,113 (\$7,556-\$8,670)	15	\$1,098,531 <sup>a</sup>	\$72,969 (\$58,617-\$87,320)
Lower Limb	11,219 <sup>a</sup>	\$95,899,475 <sup>acdef</sup>	\$7,988 (\$7,247-\$8,730)	15	\$656,286 <sup>af</sup>	\$43,089 (\$40,488-\$45,691)
Chest/Back/Other	602	\$18,018,799 <sup>acdef</sup>	\$11,805 (\$11,245-\$12,365)	50	\$8,060,821 <sup>ade</sup>	\$102,708 (70,891-\$134,525)
<b>Total</b>	<b>25,226<sup>acdef</sup></b>	<b>\$267,359,440<sup>acdef</sup></b>	<b>\$10,582 (\$10,142-\$11,022)</b>	<b>454<sup>cdf</sup></b>	<b>\$72,795,782<sup>acde</sup></b>	<b>\$167,353 (\$148,539-\$186,168)</b>
<b>Football</b>						
Head/Neck	773 <sup>a</sup>	\$16,474,290 <sup>abdef</sup>	\$28,947 (\$7,729-\$95,623)	9	\$178,012 <sup>be</sup>	\$19,552 (\$1,660-\$40,764)
Upper Limb	2,146 <sup>a</sup>	\$13,961,754 <sup>abdef</sup>	\$7,373 (\$6,304-\$8,442)	0	\$0	-
Lower Limb	10,295 <sup>a</sup>	\$66,472,381 <sup>abdef</sup>	\$8,799 (\$2,754-\$14,843)	0	\$0	-
Chest/Back/Other	232	\$2,328,967 <sup>abdef</sup>	\$6,999 (\$4,384-\$9,614)	15	\$430,163 <sup>abe</sup>	\$28,322 (\$5,684-\$50,960)
<b>Total</b>	<b>14,240<sup>abdef</sup></b>	<b>\$99,237,392<sup>abdef</sup></b>	<b>\$6,940 (\$6,526-\$7,032)</b>	<b>15<sup>ef</sup></b>	<b>\$608,175<sup>abe</sup></b>	<b>\$47,875 (\$37,799-\$57,950)</b>
<b>Netball</b>						
Head/Neck	282 <sup>a</sup>	\$2,263,039 <sup>abce</sup>	\$8,042 (\$6,991-\$9,093)	0	\$0	-
Upper Limb	1,217	\$7,090,408 <sup>abcef</sup>	\$5,551 (\$4,003-\$7,098)	0	\$0	-
Lower Limb	9,631 <sup>a</sup>	\$62,985,236 <sup>abcef</sup>	\$6,218 (\$5,457-\$9,798)	0	\$0	-
Chest/Back/Other	67	\$2,367,406 <sup>abce</sup>	\$7,327 (\$4,472-\$10,183)	9	\$320,399 <sup>be</sup>	\$35,589 (\$10,851-\$179,694)
<b>Total</b>	<b>11,748<sup>abcef</sup></b>	<b>\$74,706,089<sup>abce</sup></b>	<b>\$6,330 (\$5,664-\$6,995)</b>	<b>9<sup>be</sup></b>	<b>\$320,399<sup>be</sup></b>	<b>\$35,589 (\$10,851-\$179,694)</b>
<b>Rugby league</b>						
Head/Neck	577	\$10,097,516 <sup>abcdf</sup>	\$14,639 (\$13,103-\$16,175)	66	\$8,650,534 <sup>abcdf</sup>	\$90,965 (\$77,405-104,525)
Upper Limb	2,489 <sup>a</sup>	\$21,853,578 <sup>abcdf</sup>	\$8,074 (\$7,222-\$8,926)	0	\$0	-
Lower Limb	2,902 <sup>a</sup>	\$27,137,436 <sup>abcdf</sup>	\$8,188 (\$7,372-\$9,003)	0	\$0	-
Chest/Back/Other	209	\$4,708,597 <sup>abcdf</sup>	\$15,676 (\$12,492-\$18,859)	30	\$4,040,640 <sup>abd</sup>	\$95,494 (\$71,646-\$119,342)
<b>Total</b>	<b>6,517<sup>abcdf</sup></b>	<b>\$63,797,127<sup>abcdf</sup></b>	<b>\$9,769 (\$8,991-\$10,547)</b>	<b>104<sup>bcd</sup></b>	<b>\$12,691,174<sup>abcdf</sup></b>	<b>\$126,155 (\$90,393-\$161,917)</b>
<b>Cricket</b>						
Head/Neck	212	\$3,450,788 <sup>abce</sup>	\$13,510 (\$2,251-\$29,273)	15	\$282,600 <sup>abd</sup>	\$11,934 (\$4,719-\$38,588)
Upper Limb	1,086 <sup>a</sup>	\$7,839,018 <sup>abcde</sup>	\$6,679 (\$6,142-\$7,215)	0	\$0	-
Lower Limb	1,394 <sup>a</sup>	\$10,062,669 <sup>abcde</sup>	\$6,810 (\$6,631-\$6,990)	12	\$164,414	\$13,707 (\$8,104-\$55,518)
Chest/Back/Other	72	\$2,906,360 <sup>abce</sup>	\$9,633 (\$6,779-\$12,487)	0	\$0	-
<b>Total</b>	<b>3,072<sup>abce</sup></b>	<b>\$24,258,835<sup>abcde</sup></b>	<b>\$7,875 (\$6,685-\$9,066)</b>	<b>15<sup>be</sup></b>	<b>\$447,014<sup>abd</sup></b>	<b>\$17,856 (\$8,609-\$21,102)</b>

CI: Confidence Interval; NZD = New Zealand dollars (\$); All costs are inflation adjusted to 2016 values; Significant difference ( $p < 0.05$ ) than (a) = across reporting years (2012 to 2016); (b) = rugby union; (c) = football; (d) = netball; (e) = rugby league; (f) = cricket

**Table 4:** Sports code summary of ACC moderate-to-serious and serious injury entitlement claims and costs, of injury type by total number of claims, total costs, mean costs per claim and per reporting year with 95% Confidence Intervals, for five sports in New Zealand from 2012 to 2016.

	Rugby union			Football			Netball			Rugby league			Cricket			
	Claims	Costs NZD		Claims	Costs		Claims	Costs		Claims	Costs		Claims	Costs		
	Total	Total	Mean (95% CI) per claim	Total	Total	Mean (95% CI) per claim	Total	Total	Mean (95% CI) per claim	Total	Total	Mean (95% CI) per claim	Total	Total	Mean (95% CI) per claim	
<b>Moderate-to-serious Claims</b>																
Soft Tissue Injury	14,300 <sup>a</sup>	\$140,783,951 <sup>abcd</sup>	\$8,529 (\$8046-\$9,012)	9,818 <sup>a</sup>	\$74,001,659 <sup>abcd</sup>	\$7,162 (6,686-\$7,639)	9,593 <sup>a</sup>	\$61,767,002 <sup>abcd</sup>	\$6,272 (\$5,567-\$6,976)	3,453 <sup>a</sup>	\$34,379,950 <sup>abcd</sup>	\$8,731 (\$8,066-\$9,396)	1,980 <sup>a</sup>	\$18,204,326 <sup>abcd</sup>	\$8,459 (\$6,638-\$10,280)	
Fracture/ Dislocation	9,419 <sup>a</sup>	\$116,655,870 <sup>abcd</sup>	\$12,634 (\$11,789-\$13,481)	3,880 <sup>a</sup>	\$23,054,232 <sup>abcd</sup>	\$5,956 (\$5,465-\$6,447)	1,965	\$11,929,929 <sup>abcd</sup>	\$5,460 (\$4,406-\$6,515)	2,636	\$24,960,469 <sup>abcd</sup>	\$8,953 (\$8,033-\$9,874)	948 <sup>a</sup>	\$4,856,390 <sup>abcd</sup>	\$5,333 (4,883-\$5,783)	
Concussion/ Brain Injury	991 <sup>a</sup>	\$6,796,172 <sup>abcd</sup>	\$6,611 (\$5,769-\$7,454)	285 <sup>a</sup>	\$894,575 <sup>abc</sup>	\$3,239 (\$2,145-\$4,334)	105 <sup>a</sup>	\$825,419 <sup>abc</sup>	\$9,158 (\$5,066-\$13,251)	284	\$3,606,561 <sup>abcd</sup>	\$15,925 (\$14,121-\$17,730)	44	\$748,966 <sup>abcd</sup>	\$15,567 (\$5,818-\$25,316)	
Laceration, Wound	322	\$1,414,811 <sup>abcde</sup>	\$4,556 (\$3,763-\$5,349)	165	\$687,255 <sup>abcd</sup>	\$4,978 (\$2,587-\$7,370)	50	\$143,552 <sup>abc</sup>	\$3,372 (\$5,859-\$3,264)	85	\$369,029 <sup>abc</sup>	\$4,570 (\$2,430-\$6,711)	59	\$160,648 <sup>abcd</sup>	\$3,372 (\$886-\$5,859)	
Gradual Onset	111	\$1,444,475 <sup>abcd</sup>	\$12,204 (\$9,375-\$15,033)	18	\$319,163 <sup>abcd</sup>	\$14,964 (\$4,017-\$25,911)	15	\$13,623 <sup>abc</sup>	\$1,135 (\$124-\$2,394)	17	\$367,389 <sup>abcd</sup>	\$21,904 (\$6,792-\$37,016)	14	\$260,190 <sup>a</sup>	\$16,809 (\$1,532-\$44,151)	
Deafness	20	\$48,054 <sup>a</sup>	\$2,517 (\$479-\$4,555)	17	\$50,110 <sup>a</sup>	\$2,960 (\$958-\$4,422)	0	\$0	-	15	\$16,753	\$1,396 (\$275-\$3,067)	15	\$8,474	\$698 (\$371-\$2,766)	
Dental Injuries	17	\$76,279	\$5,070 (\$457-\$22,598)	15	\$28,995 <sup>a</sup>	\$1,867 (\$338-\$11,073)	16	\$22,660 <sup>a</sup>	2,382 (\$139-\$4,904)	12	\$63,390	\$834 (38-\$4,285)	6	\$12,099 <sup>a</sup>	\$2,017 (\$1,629-\$2,404)	
Hernia	12	\$48,045 <sup>abc</sup>	\$4,004 (1,200-\$6,807)	21	\$138,528 <sup>abc</sup>	\$6,909 (\$5,582-\$8,234)	4 <sup>a</sup>	\$3,904	\$1,301 -	3 <sup>a</sup>	\$5,124	\$1,708 -	6	\$7,742	\$2,581 -	
Amputation/ Enucleation	16	\$76,586 <sup>a</sup>	\$4,381 (\$548-\$24,311)	15	\$55,299 <sup>a</sup>	\$1,916 (\$224-\$9,059)	0	\$0	-	6	\$10,535	\$1,756 (\$119-\$5,631)	0	\$0	-	
Non-Occupational	9	\$5,973 <sup>a</sup>	\$663 (\$22-\$1,304)	3 <sup>a</sup>	\$3,789	\$1,263 -	0	\$0	-	0	\$0	-	0	\$0	-	
Foreign Body	9	\$9,224	\$1,024 (\$484-\$1,564)	3 <sup>a</sup>	\$3,787	\$1,262 -	0	\$0	-	6	\$17,927	\$2,988 (\$489-\$6,465)	0	\$0	-	
<b>All</b>	<b>25,226<sup>abcd</sup></b>	<b>\$267,359,440<sup>abcd</sup></b>	<b>\$10,582 (\$10,142-\$11,022)</b>	<b>14,240<sup>abcd</sup></b>	<b>\$99,237,392<sup>abcd</sup></b>	<b>\$6,940 (\$6,526-\$7,032)</b>	<b>11,748<sup>abcd</sup></b>	<b>\$74,706,089<sup>abcd</sup></b>	<b>\$6,330 (\$5,664-\$6,995)</b>	<b>6,517<sup>abcd</sup></b>	<b>\$63,797,127<sup>abcd</sup></b>	<b>\$9,769 (\$8,991-\$10,547)</b>	<b>3,072<sup>abcd</sup></b>	<b>\$24,258,835<sup>abcd</sup></b>	<b>\$7,875 (\$6,685-\$9,066)</b>	
<b>Serious Injury Claims</b>																
Fracture/ Dislocation	325	\$64,313,383 <sup>abcd</sup>	\$209,876 (\$201,451-\$218,271)	0	\$0	-	9	\$320,399 <sup>abc</sup>	\$35,589 (\$10,851-\$179,694)	36	\$7,734,525 <sup>abcd</sup>	\$222,350 (\$45,294-\$399,405)	6	\$164,414 <sup>abc</sup>	\$568 (\$144-\$2,280)	
Soft Tissue Injury	66	\$4,598,256 <sup>abc</sup>	\$136,271 (\$122,821-\$149,721)	15	\$608,175 <sup>abc</sup>	\$47,875 (\$37,799-\$57,950)	0	\$0	-	20	\$1,470,389 <sup>abc</sup>	\$92,568 (68,327-\$116,810)	0	\$0	-	
Concussion/ Brain Injury	31	\$3,176,880 <sup>cd</sup>	\$181,868 (\$125,174-\$238,563)	0	\$0	-	0	\$0	-	34	\$3,413,723 <sup>cd</sup>	\$170,686 (\$134,903-\$206,469)	9	\$282,600 <sup>abc</sup>	\$18,840 (\$14,839-\$22,840)	
Laceration, Wound	17	\$188,753 <sup>a</sup>	\$12,583 (\$3,506-\$21,660)	0	\$0	-	0	\$0	-	0	\$0	-	0	\$0	-	
Gradual Onset	15	\$518,510 <sup>a</sup>	\$34,568 (\$19,939-\$49,197)	0	\$0	-	0	\$0	-	0	\$0	-	0	\$0	-	
Dental Injuries	0	\$0	-	0	\$0	-	0	\$0	-	14	\$72,537 <sup>a</sup>	\$8,060 (\$893-\$8,013)	0	\$0	-	
<b>All</b>	<b>454<sup>cd</sup></b>	<b>\$72,795,782<sup>abcde</sup></b>	<b>\$167,353 (\$148,539-\$186,168)</b>	<b>15<sup>cd</sup></b>	<b>\$608,175<sup>abc</sup></b>	<b>\$47,875 (\$37,799-\$57,950)</b>	<b>9<sup>abc</sup></b>	<b>\$320,399<sup>abc</sup></b>	<b>\$35,589 (\$10,851-\$179,694)</b>	<b>104<sup>abcd</sup></b>	<b>\$12,691,174<sup>abcd</sup></b>	<b>\$126,155 (\$90,393-\$161,917)</b>	<b>15<sup>abc</sup></b>	<b>\$447,014<sup>abcd</sup></b>	<b>\$17,856 (\$8,609-\$21,102)</b>	

\* = Age groups with no serious injury claims across all five sports codes excluded; CI: Confidence Interval; NZD = New Zealand dollars (\$); All costs are inflation adjusted to 2016 values; Significant difference ( $p < 0.05$ ) than (a) = across reporting years (2012 to 2016); (b) = rugby union; (c) = football; (d) = netball; (e) = rugby league; (f) = cricket



**Figure 1:** Mean cost per year for (A) moderate-to-serious, and (B) serious injury entitlement claims, for rugby union, football, netball, rugby league and cricket