



## Original research

# Female rugby union injuries in New Zealand: A review of five years (2013–2017) of Accident Compensation Corporation moderate to severe claims and costs



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## ABSTRACT

**Objectives:** To provide epidemiological data and related costs for moderate-to-serious and serious injury claims for women's rugby union in New Zealand.

**Design:** A retrospective analytical review of injury entitlement claims for women's rugby from 2013 to 2017.

**Methods:** Data were analysed by year of competition, age, body site and injury type for total and moderate-to-severe (MSC) Accident Compensation Corporation (ACC) claims and costs.

**Results:** Over 2013 to 2017 there were 26,070 total claims for female rugby union costing \$18,440,812 [AD\$16,956,998]. The 15–19-year age group recorded 40% (n = 1,009) of the total female rugby union Moderate-to-serious and serious (MSC) claims and 41% (\$5,419,157 [AD\$4,983,112]) of the total female rugby union MSC costs. The knee was the most commonly recorded injury site accounting for 40.3% (n = 1,007) of MSC claims and 46.9% (\$6,229,714 [AD\$5,728,732]) of MSC costs with an average cost of \$1,245,943 ± \$217,796 [AD\$595,351 ± AD\$104,070] per-year for female rugby union.

**Conclusions:** This is the first study to report the nature and related costs for moderate-to-serious and serious injury claims for women's rugby union in New Zealand. A total of 26,070 injury claims were lodged over the duration of the study but only 9.6% (n = 2,501) of these were classified as MSC injury entitlement claims. Participants 25 years and older accounted for 31% of the female rugby union player claims. Females in the over 35-year age groups compete against younger participants which may account for the higher mean cost per-claim seen as the age groups increase in years until they retire from the game.

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## Practical implications

- Women's rugby union moderate-to-serious injury entitlement claims, total costs and mean cost per-claim increased over a five-year period. In addition, the percentage increase in costs (13%)

was greater than the rate of inflation (4%) over the same reporting period.

- Women's rugby union participants in the over 35-year age group recorded less than a tenth of total moderate-to-serious injury entitlement claims (10%) but almost a quarter of the total costs (24%). Considerations are warranted to enabling a modified version of women's rugby union for this cohort of players similar to the President's grade of rugby union for males to assist in the reduction of injuries.

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- Further research is warranted specifically focusing on female rugby union to identify the etiological factors and mechanisms in these injuries for sex specific injury prevention strategies to be developed. A further review of the number and costs of injuries is warranted to identify changes that occur.
- The medical care of female rugby union players is needed at all levels of participation to assist in providing timely implementation of appropriate first aid care of women rugby union players.

## 1. Introduction

The New Zealand women's rugby team, also known as the Black Ferns, have dominated at the international level of competition for much of the past 20 years.<sup>1</sup> Even though women's rugby has received much more attention over recent years, it still falls behind Men's rugby in terms of support and interest. Traditionally seen as amateur sports for females, participation in these sports has necessitated that players partake in their sporting activities while still maintaining their normal lives either at work and/or with their families. As rugby union is a full contact collision sport, the players are at a high risk of sustaining injuries.<sup>2</sup> These injuries may result in loss of income, financial costs for medical related care and employment limitations depending on the injury type and severity that occurred.

Worldwide there are limited studies specifically reporting on women's rugby union<sup>3–5</sup> match injuries with the reported injury incidence ranging from 4<sup>4</sup> to 36 per 1000 match hours. However, this can be influenced by the participation level and the injury definition used. A few epidemiological studies<sup>6,7</sup> have reported on aspects of female sports participation injury costs but no paper to date has reported specifically on female rugby union injury costs. To enable identification of the effects from participating in sports such as rugby union, epidemiological studies are required to assist with injury prevention target planning and for future reviews to be conducted. Therefore, this paper was undertaken to provide an epidemiological overview of the types of injuries and the related costs for moderate-to-serious and serious injury claims (termed MSC) for women's rugby union in New Zealand over a five-year period from 2013 to 2017.

## 2. Methods

The methods undertaken in this study are identical to previous studies<sup>6,8</sup> reporting on injuries recorded through the national health provider, Accident Compensation Corporation (ACC). The ACC database was utilised to provide descriptive epidemiological data including the costs associated with treatment for injuries occurring in female rugby union activities. 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. 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>8</sup> ACC injury entitlement claims are categorised as minor (medical treatment only), moderate-to-serious<sup>8</sup> or serious.<sup>9,10</sup> The terms are defined under the Injury Prevention, Rehabilitation and Compensation (IPRC) Act, 2001 with the ACC responsible for meeting the costs of these injuries.<sup>11</sup> Minor claims are lodged following an accident and generate a payment for the period reported to the registered licenced practitioner (e.g., physiotherapist, General Practitioner) for the medical treatment provided.<sup>11</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>11</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>8,11</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>9,10</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>8,11,12</sup>

This study focused on moderate-to-serious and serious-injury entitlement claims that occurred from 1st January 2013 to 31st December 2017 resulting from participating in female rugby union activities. The definition utilised for this study was “any injury (minor, moderate-to-serious and serious injury) that had been assessed and reported by a registered health practitioner as a result of sports participation”.<sup>7</sup> 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 adjutor (<https://www.rbnz.govt.nz/monetary-policy/inflation-calculator>) to reflect all costs at 2017 rates with a mean inflation of  $3.7 \pm 1.0\%$  per-year.

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.

All data collected were entered into a Microsoft Excel spreadsheet and analysed with SPSS (IBM Corp, Released 2017. IBM SPSS Statistics for Windows, Version 25.0 Armonk, NY: IBM Corp). Data are reported as means and standard deviations ( $\pm$ SD).<sup>13</sup> Comparisons of the number of claims and 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 and between 2013 and 2017. These years were chosen as they were the start and the end of the study duration. 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 Australian Dollars (AD\$) unless otherwise indicated.

## 3. Results

Over 2013–2017 there were a total of 26,070 claims identified for female rugby union costing \$18,440,812 [AD\$16,957,399] were identified. This resulted in an average of  $5214 \pm 452$  total claims per-year costing \$705  $\pm$  \$49 [AD\$648  $\pm$  AD\$45] per-claim per-year. Total costs increased by an average of 13%  $\pm$  6% per reporting year over the duration of the study. The MSC claims accounted for 10% ( $n = 2501$ ) of the total female rugby union claims but 76% (\$13,289,442 [AD\$12,839,596]) of the total costs. Female rugby union recorded an average of  $504.0 \pm 78.1$  MSC claims per-year costing \$2,657,888  $\pm$  \$474,008 [AD\$2,442,411  $\pm$  AD\$435,906].

There were more MSC claims recorded in 2015 ( $n = 508$ ) for female rugby union when compared with 2014 ( $n = 439$ ;  $\chi^2_{(1)} = 5.0$ ;  $p = 0.0249$ ) and 2013 ( $n = 406$ ;  $\chi^2_{(1)} = 11.4$ ;  $p = 0.0007$ ) (see Table 1). There were differences in the total costs for female rugby union in 2013 (\$2,095,132 [AD\$1,926,654]) when compared with 2014 (\$2,283,404 [AD\$2,099,832];  $\chi^2_{(1)} = 8095.5$ ;  $p < 0.0001$ ), 2015 (\$2,694,115 [AD\$1,806,212];  $\chi^2_{(1)} = 74913.8$ ;  $p < 0.0001$ ), 2016 (\$2,976,915 [AD\$2,731,008];  $\chi^2_{(1)} = 153299.3$ ;  $p < 0.0001$ ) and 2017 (\$3,239,876 [AD\$2,972,247];  $\chi^2_{(1)} = 245630.2$ ;  $p < 0.0001$ ).

The 15–19-year age group recorded 40% ( $n = 1,009$ ) of the total female rugby union MSC claims and 41% (\$5,419,157 [AD\$4,982,862]) of the total female rugby union MSC costs (see Table 1). The 45–49-year age group recorded the highest

**Table 1**  
Years of injury and age group reported as total number, average per-year, total costs, average costs per-year and average costs per MSC injury claim in New Zealand Dollars (\$) with 95% standard deviations for female rugby union by reporting years from 2013 to 2017.

Year	Injury claims		Injury costs		
	Total n=(%)	Average per year Mean ± SD	Total costs NZD\$ (%)	Average cost per year (NZD\$) Mean ± SD	Mean cost per year (NZD\$) Mean ± SD
2013	406 (16.2)	23.8 ± 24.5	\$2,095,132 (15.8)	\$123,243 ± \$156,186	\$3965 ± \$2331
2014	439 (17.6)	27.7 ± 27.6	\$2,283,404 (17.2) <sup>ab</sup>	\$142,713 ± \$156,075	\$5851 ± \$2966
2015	508 (20.3) <sup>ab</sup>	31.5 ± 35.9	\$2,694,115 (20.3) <sup>ab</sup>	\$168,382 ± \$247,470	\$4537 ± \$2547
2016	567 (22.7) <sup>b</sup>	35.4 ± 37.5	\$2,976,915 (22.4) <sup>ab</sup>	\$186,057 ± \$208,039	\$5391 ± \$2235
2017	581 (23.2) <sup>b</sup>	34.4 ± 41.5	\$3,239,876 (24.4) <sup>ab</sup>	\$202,398 ± \$256,358	\$6,846 ± \$5,332
Total	2501* (100.0) <sup>ab</sup>	504.0 ± 78.1	\$13,289,442* (100.0) <sup>ab</sup>	\$2,657,888 ± \$474,008	\$5259 ± \$162
Age group					
00–04	6 (0.2)	3–	\$3684 (0.0)	\$737 ± \$1590	\$614 ± \$820
05–09	9 (0.4)	3–	\$12,098 (0.1) <sup>b</sup>	\$2420 ± \$3172	\$1344 ± \$1073
10–14	254 (10.2) <sup>ab</sup>	50.8 ± 15.3	\$806,987 (6.1) <sup>ab</sup>	\$161,397 ± \$69,710	\$3,157 ± \$834
15k19	1009 (40.3) <sup>ab</sup>	201.8 ± 26.2	\$5,419,157 (40.8) <sup>ab</sup>	\$1,083,831 ± \$154,928	\$5,387 ± \$499
20–24	483 (19.3) <sup>ab</sup>	96.6 ± 12.1	\$2,361,412 (17.8) <sup>ab</sup>	\$472,282 ± \$84,742	\$4863 ± \$359
25–29	332 (13.3) <sup>ab</sup>	66.4 ± 16.0	\$1,915,280 (14.4) <sup>ab</sup>	\$383,056 ± \$135,288	\$5659 ± \$846
30–34	197 (7.9) <sup>ab</sup>	39.4 ± 12.2	\$975,031 (7.3) <sup>ab</sup>	\$195,006 ± \$81,414	\$4,835 ± \$567
35–39	129 (5.2) <sup>a</sup>	25.8 ± 6.5	\$927,108 (7.0) <sup>ab</sup>	\$185,422 ± \$88,864	\$6918 ± \$2155
40–44	49 (2.0) <sup>a</sup>	9.8 ± 1.9	\$222,171 (1.7) <sup>ab</sup>	\$44,434 ± \$15,672	\$4445 ± \$699
45–49	24 (1.0) <sup>a</sup>	4.8 ± 2.5	\$501,211 (3.8) <sup>ab</sup>	\$100,242 ± \$28,102	\$23,270 ± \$8,096
50–54	12 (0.5)	2.4 ± 1.3	\$66,465 (0.5) <sup>ab</sup>	\$13,293 ± \$16,130	\$5539 ± \$5510
55–59	9 (0.4)	1.8 ± 1.6	\$24,113 (0.2) <sup>b</sup>	\$4823 ± \$8927	\$2679 ± \$3661
60–64	12 (0.5)	2.4 ± 1.3	\$46,447 (0.3) <sup>b</sup>	\$9289 ± \$10,634	\$3465 ± \$3981
65–69	3 (0.1)	3–	\$1861 (0.0) <sup>b</sup>	\$372 ± \$832	\$620 ± \$0
80–84	0–	0–	\$0–	\$0–	\$0–
Total	2501* (100.0)	504.0 ± 78.07	\$13,289,442* (100.0)	\$2,657,888 ± \$474,008	\$5259 ± \$162

SD = standard deviation; (%) = percentage; NZD = New Zealand Dollars; \* = due to data rounding and confidentiality requirements, numbers do not add to the total number of total injury claims and costs reported; significant difference ( $p < 0.05$ ) than (a) = difference from previous year; (b) = difference from 2013.

(\$23,270 ± \$8096 [AD\$21,367 ± AD\$7444]) while the 00–04-year age group recorded the lowest (\$614 ± \$820 [AD\$565 ± AD\$754]) female rugby union mean cost per-claim per-year. There were differences identified in the number of MSC claims and costs for female rugby union over the duration of the study for the 20–24 year age group (claims:  $t_{(4)} = 17.9$ ;  $p = 0.0001$ ; costs:  $t_{(4)} = 12.5$ ;  $p = 0.0002$ ) and 40–44 year group (claims:  $t_{(4)} = 11.4$ ;  $p = 0.0003$ ; costs:  $t_{(4)} = 4.7$ ;  $p = 0.0095$ ).

There were more MSC claims for the lower limb ( $n = 1577$ ) than head/neck ( $n = 248$ ;  $t_{(4)} = -15.2$ ;  $p = 0.0001$ ), upper limb ( $n = 576$ ;  $t_{(4)} = -14.3$ ;  $p = 0.0001$ ) and chest/back/other ( $n = 74$ ;  $t_{(4)} = -15.3$ ;  $p = 0.0001$ ) for female rugby union (see Table 2). The knee was the most commonly recorded injury site accounting for 40% ( $n = 1,007$ ) of MSC claims and 47% (\$6,229,714 [AD\$5,728,689]) of MSC costs with an average cost of \$1,245,943 ± \$217,796 [AD\$1,145,738 ± AD\$200,280] per-year for female rugby union. There was a notable increase in the number of MSC claims ( $\chi^2_{(1)} = 14.1$ ;  $p = 0.0002$ ) and costs ( $\chi^2_{(1)} = 21827.6$ ;  $p < 0.0001$ ) for the head between 2013 and 2017. The upper and lower arm recorded the highest cost per MSC claim (\$12,338 ± \$5148 [AD\$11,346 ± AD\$4734]) for female rugby union.

Soft tissue injuries were the most commonly recorded MSC injury claim ( $n = 1581$ , 63%) and cost (\$8,887,847 [AD\$8,172,188]) for female rugby union (see Table 3). There were notable differences in the number of MSC claims ( $t_{(4)} = 20.4$ ;  $p < 0.0001$ ) for fracture/dislocations for female rugby union over the duration of the study. Recording only 5% ( $n = 126$ ) of female rugby union MSC claims, concussions recorded an average cost of \$94,337 ± \$37,598 [AD\$86,741 ± AD\$34,571] or \$3901 ± 726 [AD\$3587 ± AD\$668] per-claim per-year.

#### 4. Discussion

This is the first study to report on the number of ACC claims lodged, and the associated costs of sports-related injuries that occur in female rugby union over a five-year period. As shown there

were 26,070 injury claims lodged over the duration of the study but only 10% ( $n = 2501$ ) of these were classified as moderate-to-serious and serious injury (MSC) injury entitlement claims. Most of the ACC claims (23,569; 90%) reflect the number of sports related injuries that did not require further additional rehabilitation assistance. The numbers reported in this study are not a reflection of how many injuries were occurring<sup>6</sup> but how many injuries were recorded by the individual participants as a result of participating in that sport. The results of this study could be biased as they exclude those female rugby union participants that did not lodge an ACC injury entitlement form for injuries dealt with by themselves. Consequently, there may be an under-reporting of the actual number and costs of these injuries. The term MSC is an accounting term utilised by ACC and is not a reflection of the severity classification of the injury recorded. All the injuries recorded in this study required additional assistance beyond medical treatment alone.<sup>11</sup>

Previous epidemiological studies reporting on the costs of sports related injuries<sup>6,7</sup> reported that there were more male than female MSC claims and costs. It was suggested<sup>14</sup> that this may be due to the differences in how males participate in sport when compared with females in contact sports where females reportedly have slower speed and agility, lower muscular power, lower estimated maximal aerobic power and a greater body mass and skinfold thickness than males. Although previous studies<sup>15–17</sup> have reported that females participating in sports such as rugby union have increased risk factors, when compared male participants this may not be the case. These risk factors include smaller stature, weaker neck muscles,<sup>18–20</sup> lower head/neck mass<sup>15–17</sup> and a greater acceleration of their head and neck with a lower ability to protect their heads from unanticipated impacts.<sup>21</sup> It has also been suggested<sup>22</sup> that females partake in sport in a less aggressive manner than males and this would result in a lower injury rate being reported. Despite this, it has been reported that females have similar attitudes to males in terms of sports participation in areas such as aggression, physical danger and injury.<sup>23</sup> When comparing the results of this study to previous studies,<sup>6,7</sup> the differences in the MSC claims reported

**Table 2**

Injured body part reported as total number, average per-year, total costs and average costs per-year in New Zealand Dollars (\$) with 95% standard deviations of MSC injury claims for female rugby union from 2013 to 2017.

	Injury claims		Injury costs		
	Total n=(%)	Average per year Mean ± SD	Total costs NZD\$ (%)	Average cost per year (NZD\$) Mean ± SD	Mean cost per year (NZD\$) Mean ± SD
Head/neck	248 (9.9) <sup>ab</sup>	49.6 ± 13.9	\$846,257 (6.4) <sup>ab</sup>	\$169,251 ± \$42,602	\$3433 ± \$380
Head (except face)	146 (5.8) <sup>ab</sup>	29.2 ± 11.3	\$509,527 (3.8) <sup>ab</sup>	\$101,905 ± \$28,798	\$3611 ± \$503
Face	24 (1.0) <sup>a</sup>	4.8 ± 1.5	\$66,359 (0.5) <sup>ab</sup>	\$13,272 ± \$7149	\$2591 ± \$1144
Eye	9 (0.4)	1.8 ± 1.6	\$18,578 (0.1) <sup>b</sup>	\$3716 ± \$3496	\$2064 ± \$399
Nose	30 (1.2) <sup>a</sup>	6.0 ± 2.0	\$115,857 (0.9) <sup>ab</sup>	\$23,171 ± \$12,114	\$3709 ± \$1599
Ear	6 (0.2)	1.2 ± 1.6	\$24,592 (0.2) <sup>b</sup>	\$4918 ± \$9471	\$4099 ± \$4440
Neck/back of head	33 (1.3) <sup>ab</sup>	6.6 ± 2.6	\$111,344 (0.8) <sup>a</sup>	\$22,269 ± \$7776	\$3905 ± \$2150
Upper limb	576 (23.0) <sup>ab</sup>	115.2 ± 15.5	\$2,951,597 (22.2) <sup>ab</sup>	\$590,319 ± \$85,729	\$5136 ± \$418
Shoulder	324 (13.0) <sup>a</sup>	64.8 ± 4.0	\$1,823,749 (13.7) <sup>ab</sup>	\$364,750 ± \$20,846	\$5637 ± \$318
Upper and lower arm	41 (1.6) <sup>a</sup>	8.2 ± 4.1	\$430,328 (3.2) <sup>ab</sup>	\$86,066 ± \$18,773	\$12,338 ± \$5148
Elbow	23 (0.9) <sup>ad</sup>	4.6 ± 1.8	\$60,132 (0.5) <sup>ab</sup>	\$12,026 ± \$6362	\$2576 ± \$784
Hand/wrist	71 (2.8) <sup>a</sup>	14.2 ± 4.0	\$287,299 (2.2) <sup>ab</sup>	\$57,460 ± \$40,310	\$4125 ± \$2616
Finger/thumb	117 (4.7) <sup>a</sup>	23.4 ± 5.9	\$350,089 (2.6) <sup>ab</sup>	\$70,018 ± \$26,679	\$2912 ± \$627
Lower limb	1557 (62.3) <sup>ab</sup>	311.4 ± 45.2	\$8,527,695 (64.2) <sup>ab</sup>	\$1,705,539 ± \$287,767	\$5467 ± \$330
Hip/upper leg/thigh	27 (1.1) <sup>a</sup>	5.4 ± 2.9	\$126,696 (1.0) <sup>b</sup>	\$25,339 ± \$32,650	\$3425 ± \$3781
Knee	1007 (40.3) <sup>a</sup>	201.4 ± 24.2	\$6,229,714 (46.9) <sup>ab</sup>	\$1,245,943 ± \$217,796	\$6162 ± \$539
Lower leg	140 (5.6) <sup>a</sup>	28.0 ± 5.0	\$1,082,068 (8.1) <sup>ab</sup>	\$216,414 ± \$24,963	\$7803 ± \$600
Ankle	313 (12.5) <sup>ab</sup>	62.6 ± 16.3	\$958,267 (7.2) <sup>ab</sup>	\$191,653 ± \$35,055	\$3,125 ± \$364
Foot	58 (2.3) <sup>a</sup>	11.6 ± 1.9	\$117,971 (0.9) <sup>ab</sup>	\$23,594 ± \$10,962	\$2025 ± \$916
Toe	12 (0.5) <sup>d</sup>	2.4 ± 1.3	\$12,979 (0.1) <sup>b</sup>	\$2596 ± \$3446	\$1082 ± \$1203
Chest/back/other	74 (3.0) <sup>a</sup>	14.8 ± 2.5	\$963,894 (7.3) <sup>ab</sup>	\$192,779 ± \$87,148	\$12,753 ± \$4592
Chest	15 (0.6)	3.0–	\$19,820 (0.1) <sup>ab</sup>	\$3964 ± \$3031	\$1321 ± \$1010
Back/spine	38 (1.5) <sup>a</sup>	7.6 ± 2.9	\$189,537 (1.4) <sup>b</sup>	\$37,907 ± \$33,037	\$4443 ± \$2944
Abdomen/pelvis	12 (0.5) <sup>a</sup>	2.4 ± 1.3	\$53,844 (0.4) <sup>b</sup>	\$10,769 ± \$10,628	\$4487 ± \$3371
Multiple locations	6 (0.2)	1.2 ± 1.6	\$11,579 (0.1) <sup>b</sup>	\$2316 ± \$3224	\$1930 ± \$386
Unknown	3 (0.1)	0.6 ± 1.3	\$689,114 (5.2) <sup>ab</sup>	\$137,823 ± \$63,116	\$66,003 ± \$0
Total	2501* (100.0)	504.0 ± 78.1	\$13,289,442* (100.0)	\$2,657,888 ± \$474,008	\$5259 ± \$162

SD = standard deviation; (%) = percentage; NZD = New Zealand Dollars; \* = due to data rounding and confidentiality requirements, numbers do not add to the total number of total injury claims and costs reported; significant difference ( $p < 0.05$ ) than (a) = difference from previous year; (b) = difference from 2013

**Table 3**

Injury type reported as total number, average per-year, total costs and average costs per-year in New Zealand Dollars (\$) with 95% standard deviations of MSC injury claims for female rugby union from 2013 to 2017.

	Injury claims		Injury costs		
	Total n=(%)	Average per year Mean ± SD	Total costs NZD\$ (%)	Average cost per year (NZD\$) Mean ± SD	Mean cost per year (NZD\$) Mean ± SD
Soft tissue injury	1581 (63.2) <sup>ab</sup>	316.2 ± 53.5	\$8,887,847 (66.9) <sup>ab</sup>	\$1,777,569 ± \$307,601	\$5621 ± \$282
Fracture/dislocation	691 (27.6) <sup>a</sup>	138.2 ± 15.16	\$3,175,345 (23.9) <sup>ab</sup>	\$635,069 ± \$111,849	\$4,606 ± \$700
Other	80 (3.2) <sup>ab</sup>	16.0 ± 5.6	\$678,246 (5.1) <sup>ab</sup>	\$135,649 ± \$64,323	\$8220 ± \$1720
Concussion/brain injury	126 (5.0) <sup>ab</sup>	25.2 ± 10.0	\$471,686 (3.5) <sup>ab</sup>	\$94,337 ± \$27,598	\$3901 ± \$726
Wounds	21 (0.8) <sup>a</sup>	4.2 ± 2.2	\$57,293 (0.4) <sup>b</sup>	\$11,459 ± \$9409	\$2656 ± \$1374
Unknown	9 (0.4) <sup>b</sup>	1.8 ± 1.6	\$6097 (0.0) <sup>b</sup>	\$2032 ± \$2799	\$677 ± \$933
Gradual onset	9 (0.4)	1.8 ± 1.6	\$7652 (0.1)	\$1530 ± \$2762	\$850 ± \$1123
Foreign body	3 (0.1)	0.6 ± 1.3	\$5131 (0.0) <sup>b</sup>	\$5131 ± \$0	\$1710 ± \$0

SD = standard deviation; (%) = percentage; NZD = New Zealand Dollars; significant difference ( $p < 0.05$ ) than (a) = difference from previous year; (b) = difference from 2013.

would be related to the lower number of females participating in the sport, not the lack of aggression.

As shown by Table 1, the number of injuries increased as the age-groups increased peaking at age 15–19 in female rugby union. It has been reported for rugby league<sup>24</sup> that there is a sudden change in the injury rate at the 11–12 year age group and this may be reflective of physiological changes occurring and/or increasing numbers of people participating in these sports. Participants 25 years and older accounted for 31% of the female rugby union player claims. There are many possible reasons for the decline in players after this age including change in family situation, occupation or loss from the sport due to other factors. What was unexpected was the finding that the mean cost per-claim peaked in the 45–49-year group at \$23,270 [AD\$21,396]. Males participate in a restricted version of the game in rugby union (Presidents) for players over the age of 35 years old but there are no similar modifications of the respective sports codes for female participants. As such females in the over 35-year age groups who wish to play rugby union must compete in the

full version of the game against younger participants and this may account for the higher mean cost per-claim seen as the age groups increase in years until they retire from the game. Another possible explanation for the older adult's being recorded in this study is that they may have been a spectator at a game and were injured there. This is a limitation to utilising the ACC database as in lodging the claim the venue and the sporting activity are recorded, not if the claimant was a player, team management or spectator.

More than half of the MSC claims for female rugby union (62%) over the duration of the study were associated with the lower limb. This was unexpected as the nature of rugby union require tackling, being tackled, acceleration, deceleration and change of direction at all levels of participation.<sup>25</sup> The percentage of lower limb injuries recorded in this study are similar to previous studies reporting on rugby union (44%,<sup>5</sup> 46%,<sup>3</sup> 52%<sup>26</sup> and 66%<sup>4</sup>). The most commonly injured anatomical site was the knee for rugby union (40%) and again this was expected. This is similar to a previous studies of male rugby union<sup>2,27,28</sup> participation where the knee and lower

limb where more commonly injured during match participation. Although research is being undertaken in female rugby union, further research is warranted specifically focusing on female rugby union to identify the etiological factors and mechanisms in these injuries for sex specific injury prevention strategies to be developed.

In reporting<sup>6</sup> on the costs of concussions over a 10-year period (2001–2011), it was identified that the mean cost per MSC claim for rugby union was \$9078 [AD\$8347]. When compared with the current study, the mean cost of a concussion for rugby union has decreased over the duration of the study to \$3901 [AD\$3587] per claim. This was unexpected, and a possible reason for this finding is that female athletes may be more honest in reporting concussion symptoms enabling prompt medical management and not being placed at exposure to subsequent concussions when compared to male athletes.<sup>16</sup> Although rugby union team management must undertake yearly training in the form of RugbySmart,<sup>12</sup> this is not a mandatory yearly coaching requirement for all levels of rugby union, particularly school based competition. In addition, as female rugby union are deemed to be less important<sup>29</sup> when compared with the male version, there may not be the medical infrastructure available for the identification and management of these injuries. Further research is warranted to identify the medical training and support provided for female rugby union match and training activities.

Although the majority of ACC claims (23,569; 90%) reflect the number of injuries that resolved without further medical assistance, the data recorded through ACC should not be reflective of the total incidence of the injuries that occurred through participation in women's rugby union in New Zealand.<sup>6</sup> The results reported in this study exclude those participants that did not make an injury entitlement claim for more minor injuries.<sup>6</sup> Although the injuries recorded through the ACC database identify the sporting activity, it does not identify whether the injuries recorded were from participation in the sport, just that they occurred at a rugby union activity. Additionally, the terminology of 'moderate-to-serious' and 'serious' are not a reflection of the severity classification of the injury but are the accounting terms applied by ACC to the costs involved with the rehabilitation of the injury. The moderate-to-serious claims recorded in this study 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. As such, there was no indication as to whether the injury claims recorded were for new, recurrent or exacerbation of previous injuries within these sporting activities.

## 5. Conclusion

This study reports for the first-time epidemiological data and related costs for moderate-to-serious and serious injury claims for women's rugby union in New Zealand. The number of female rugby union injuries increased as the age-groups increased peaking at age 15–19. The lower limb recorded more than half of the MSC claims (62%) over the five years of the study. Females in the over 35-year age groups compete against younger people which may account for the higher mean cost per-claim seen as the age groups increase in years until they retire from the game. The reasons for this may include decrease in fitness when compared with younger players and previously unmanaged injuries. Further research is warranted specifically focusing on female rugby union to identify the etiological factors and mechanisms for the injuries that occur to enable sex specific injury prevention strategies to be developed.

## 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, TC, AP, CG]; and/or
- (iv) Participated in drafting of the manuscript [DK, PH, NH, CC, TC, AP, CG]; and/or
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