

Surf Lifesaving Injuries in New Zealand between 2009 to 2018 derived from the Surf Life Saving New Zealand Injury Reporting Database: Technical Report #2 to Surf Life Saving New Zealand (SLSNZ)



By research team members for TE HOKAI TAPUWAE – REIMAGINING SPORTS INJURY PREVENTION

Shelley N. Diewald^{1,3}, Patria A. Hume¹, Barry D. Wilson¹, Adam Wooler², Ross Merrett², Daniel T.P. Fong³, Stephen Reay⁴, Valance Smith⁵

¹ Sports Performance Research Institute New Zealand, Auckland University of Technology; ² Surf Life Saving New Zealand; ³ Loughborough University; ⁴ Good Health Design, Auckland University of Technology; ⁵ Te Ara Poutama, Auckland University of Technology

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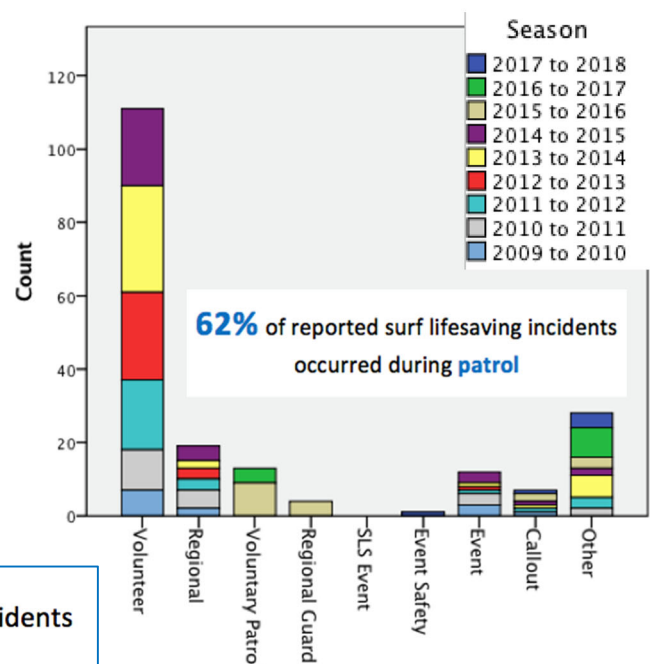
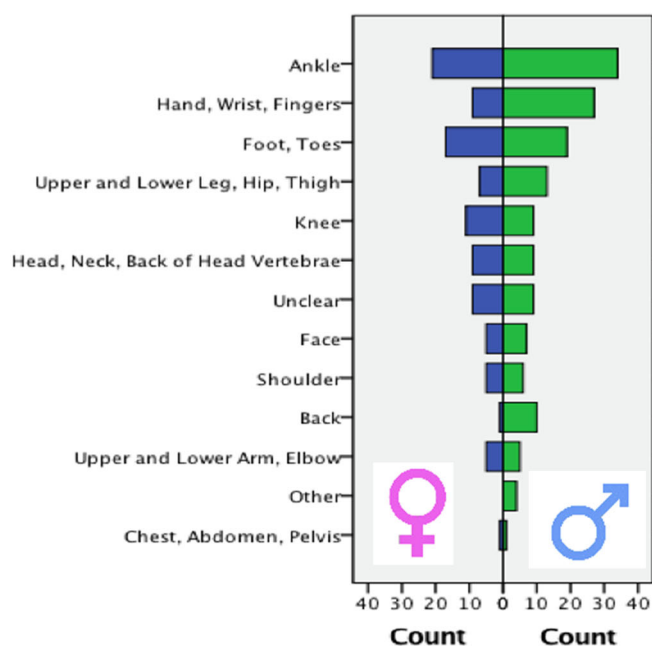
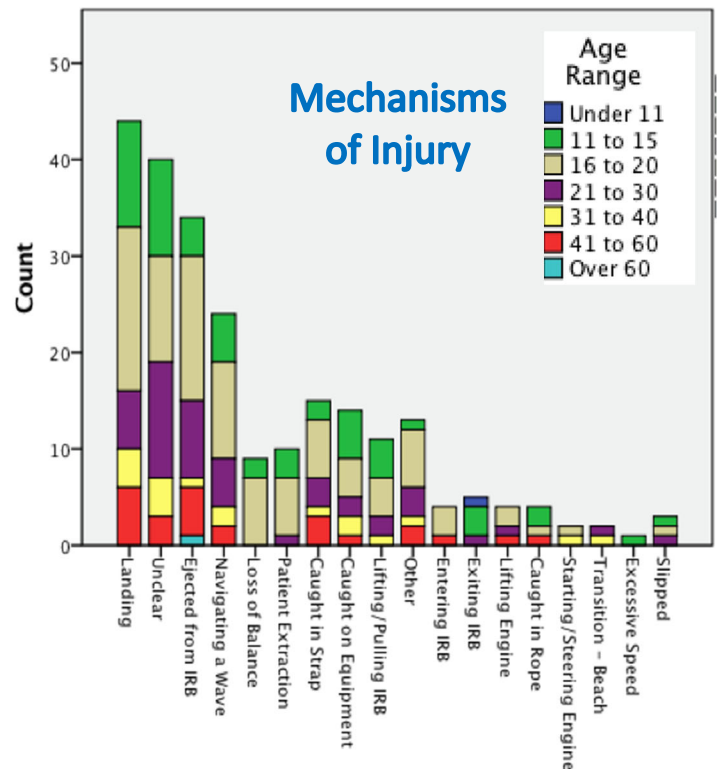
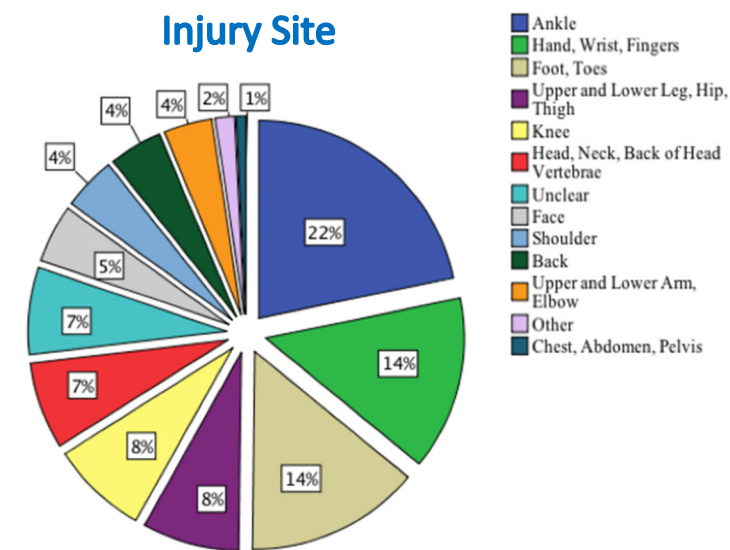
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Surf Life Saving New Zealand injury reporting database

- Fact Sheet



Injury Type was not reported in **34%** of IRB-related incidents

Key Findings

- From 2009 to 2018, there was an average 28 IRB-related incidents reported each season
- Lower extremity injuries were most frequent (131/253, 51.8%)
- SLSNZ should modify the current injury reporting form to include injury site, injury type and mechanism of injury, and remove unnecessary fields to ensure relevant information

ABSTRACT

Background: Incident Report Forms (IRFs) are routinely completed by lifeguard patrols and include all incidents attended to by lifeguards in their supervision of beaches including rescue, search, and first aid activity. According to SLSNZ internal injury reports, increased use of IRBs in New Zealand may have resulted in an increase in injury incidences. However, the details surrounding these injuries were not provided in the internal reports.

Purpose: To analyse the SLSNZ database from 2009 to 2018 to identify injury sites, types, and mechanisms of IRB-related injuries occurring to surf life savers and reported to SLSNZ.

Methods: A retrospective analysis of the SLSNZ injury database for 2009 to 2018 was conducted.

Results: In total, there were 253 (female: 100/253, 39.5%; male: 153/253, 60.5%) IRB-related injury cases reported to SLSNZ from 2009 to 2018. More reported surf lifesaving incidents occurred during patrol (155/253) than competition (12/253). Overall, most injuries to surf lifesavers were lower extremity injuries (131/253, 51.8%). The most reported injury types from 2009 to 2018 were “unclear” (86/253, 34.0%) followed by lacerations (65/253, 25.7%). Overall, the most reported injury mechanism from treatment note free text analysis was “landing” (females: 21/100, 21.0%; males: 25/153, 16.3%) defined by the authors as “landing inside the IRB after going airborne while the IRB was in the water”.

Discussion: Injury prevention initiatives should be focused on areas of high injury frequency such as the landings after becoming airborne. The mechanisms for the lower extremity injuries needs to be clearly identified. As lacerations were most frequent the first aid kits will need adequate supplies such as steristrips. Staff first aid training should focus on lower limb fracture, ankle sprain, and laceration, first response treatment. SLSNZ would benefit from investigating the reporting rates of surf life savers and member mindset surrounding incident reporting, particularly in cases involving IRBs, as there was clear underreporting of injuries given feedback from SLSNZ staff on the results in this report.

Conclusions: The SLSNZ injury database likely provides an underestimation of the number of injuries resulting from the use of IRBs during patrol and competition. Lower limb and back injuries were frequent. Landing after becoming airborne while the IRB was in the water was a common cause of injury.

Recommendations:

1. Provide fact sheets with key information on injury numbers and risk factors to show why data collection is important and how it is useful for SLSNZ to help inform decisions on injury prevention strategies.

INTRODUCTION

Swimming and surfing are an integral part of daily life in New Zealand, with over 14,000 kilometres of coast line extending across two major oceans [1, 2]. Surf life savers play an important role in keeping the public safe, and recently have come to rely less on traditional non-powered rescue aids and more heavily on powered watercrafts; such as the inflatable rescue boat (IRB) to complete open water rescues. Due to their speed and manoeuvrability, IRBs are ideal for beach patrol and surveillance. IRBs consist of two rigid inflatable pontoons supported by a removable fibreglass laminate floor, fitted with an outboard motor and additional crewing equipment (e.g. foot straps, ropes, etc.). New Zealand surf life savers utilise IRBs in over 50% of all rescues per year [3].

Surf Life Saving New Zealand (SLSNZ) is a governmental agency in New Zealand which coordinates the surf lifesaving activities of all the clubs in the nation. This includes the oversight of lifeguard certifications, equipment standards, and member training. The operation of an IRB typically involves two lifeguards; a driver in the rear and a crew member at front, racing through the surf simulating or performing a rescue. The crew member is responsible for keeping the IRB balanced through the surf by utilising their body weight and additional equipment to stay safely inside the boat (e.g. bow ropes, foot straps). The driver is responsible for navigating the IRB in such a way as to ensure the crews' safety. Surf life savers participate in regular training to prepare for IRB operation during both patrol and competition.

Incident Report Forms (IRFs) are routinely completed by lifeguard patrols and include all incidents attended to by lifeguards in their supervision of beaches including rescue, search, and first aid activity. In addition, cases include all reported incidents while training or competing for SLSNZ. Data from the IRFs are subsequently collated at a regional level and then submitted to the national organisation (SLSNZ) for entry onto their countrywide database. This data form the evidence base to illustrate lifeguard activity and are reported in brief in its website and annual reports [1, 2].

The pattern of injuries that occur during sport and recreational activities are often examined to identify the number, circumstances, and causal factors associated with injurious events to quantify the injury burden and to identify potential injury prevention strategies. According to SLSNZ internal injury reports, increased use of IRBs in New Zealand may have resulted in an increase in injury incidences [4-8]. However, the details surrounding these injuries were not provided in the internal reports. Thus, the aim of this study was to analyse the SLSNZ database from 2009 to 2018 to identify injury sites, types, and mechanisms of IRB-related injuries occurring to surf life savers and reported to SLSNZ.

Erby, Heard [9] piloted a trial reporting system for surf life savers in Queensland, and identified areas for improvement. The injury reporting form was found to be an effective tool to describe injuries and calculate injury incidence. Following minor revisions, this form has been used in Australia since 2001. Items identified to be included in future reporting formats included: years of experience, type of competition, full description of incident, nature of injury, contributing factors (mechanisms), and a detailed record of what occurred. Consequently, it may be beneficial for SLSNZ to develop a similar approach in order to improve reporting rates, and quality of data. Therefore, another aim of this study was to analyse the findings to identify areas of improvement in the SLSNZ reporting process and recommend potential improvement strategies.

METHODS

Ethical consent

Permission to access the national database was approved by SLSNZ subject to the database being cleaned of any personal details of the patient to ensure confidentiality and anonymity. Ethical consent was obtained from the Auckland University of Technology (AUT) Ethics Committee (#18380) and Loughborough University Ethics Committee (#R18-P233).

Data collection

A retrospective analysis of the SLSNZ injury database for 2009 to 2018 was conducted. The database includes information recorded by SLSNZ staff and volunteers on incidents that involve: (i) rescue (where a person requires immediate help to return to shore (or place of safety) and who without intervention would have suffered distress, injury or drowning – unable to remove themselves from the situation), (ii) patient assistance (an incident where a person would most likely be able to get themselves out of a danger), (iii) major first aid (Any incident where a victim is administered some form of medical treatment), (iv) a search (any organized search for a missing person or group either at sea or on land), or a (v) a near miss (incident that did not cause harm but had the potential to). Both SLSNZ member and citizen incidents were recorded in the same database. Further, incidents include any of the above that occurred during a surf club competition, patrol, training, or during other SLSNZ endorsed activities. Minor incidents were not reported (where a victim is administered some form of minor medical treatment (e.g. minor cut, bluebottle sting, sand in the eye, minor strain or sprains). The SLSNZ Incident Reporting Form is in paper format and include details regarding the incident and team (e.g. date, time, workplace incident, etc.), incident analysis, activities involved (e.g. swimming, surfing, boat, walking/running, fishing, attempted rescue, etc.), incident conditions (e.g. weather, surf, wind), resources used (e.g. IRB, Radios, rescue tube/board/vehicle, first aid equipment), and patient and SLSNZ details.

Data were extracted and obtained from the SLSNZ Internal Incidence Reporting Database from 2009-2010 to 2017-2018 season. Only incidents occurring to surf life savers were included in the analysis (n=3067). Free text analysis on the description and treatment notes were completed to separate IRB-related incidents from other surf lifesaving incidents. A text search was completed using the Boolean (“IRB” OR “inflatable” OR “rescue boat” OR “IR*”) of the treatment notes field (n=232). Database field “IRB equipment utilised” was analysed finding all positive answers (n=248); free text analysis eliminated incidents that did not occur in the IRB (n=81) or were unclear (n=152). A further 11 incidents were found in which a negative response was given (n=345), however treatment notes indicated otherwise. In total, there 253 IRB-related incidents occurring to surf life savers in New Zealand from 2009-2010 season to 2017-2018 season.

Data analysis and categorising decisions

Categories of fields on the IRFs include incident and team details, police tasking information, incident analysis, incident type, activities involved, and resources used (Appendix A). Not all fields were completed for every incident. In order to compare to previous literature, incidents were categorized by activity type: patrol (“Volunteer”, “Regional”, “Voluntary Patrol”, “Regional Guard”, “Event Safety”, and “Callout”), competition (“SLS Event”, and “Event”), and training (“Other”). If known, severity of injury was also identified by the immediate treatment actions; “Referred to Doctor”, “Ambulance to Hospital”, “Assisted from Beach”.

Incidents were categorised by season of accident, gender, age group at the time of injury, region, severity, and/or activity type. Age groups were defined by SLSNZ for consistency. ‘Seasons’ were defined as 1st October to 30th September of the following year, to align with the active surf lifesaving patrol season and associated participation rates supplied by SLSNZ. The SLSNZ competition season runs from 1st July to 30th June, however the active club patrol season does not start until 1st October. Active, certified lifesavers can be added to the SLSNZ registry as of 1st July each season. Further free text categorisation was made by injury body site, injury type, and mechanism of injury. Body sites were grouped together based on location: “Lower Extremity”, “Upper Extremity”, and “Other” (head, torso, back, neck).

Statistical analysis

Statistical analysis was performed using IBM SPSS Statistics (IBM Corp. Released 2016. IBM SPSS Statistics for Macintosh 24.0. Armonk, NY: IBM Corp). Specific injury types and sites are presented as absolute numbers and percentages, separated by season, age, activity type, and gender. To assess differences between genders, age groups,

and activity, risk relationships were analysed using chi-squared tests for independence ($p < 0.05$), and 95% confidence intervals were constructed, where appropriate.

RESULTS

In total, there were 253 (female: 100/253, 39.5%; male: 153/253, 60.5%) IRB-related injury cases reported to SLSNZ from 2009 to 2018. On average, there were 28.1 IRB-related incidences reported occurring to surf life savers. First aid occurred in 90.5% (229/253) of cases. The most cases occurred during the 2013 - 2014 season (39/253, 15.4%). Of the 39 cases, 21 (53.8%) occurred in the Northern Region of New Zealand. From 2009 to 2018, there was an average increase of 2.2 ± 6.2 IRB-related cases each season. There was a decrease in IRB-related incidents from 2013-2014 to 2014-2015 season (-20.5%) and from 2015-2016 to 2016-2017 season (-17.1%). Over the entire study period, surf life savers aged 16-20 years were the most reported cases (female: 41/253, 16.2%; male: 53/253, 20.9%).

Activity type

The most reported surf lifesaving incidents occurred during patrol (155/253) rather than competition (12/253). Of patrol type services, volunteer services accounted for the most IRB-related cases (111/253, 43.9%). There was a total of 22.9% of IRB-related cases that did not indicate the type of activity prior to the incident ("unknown"). There were zero "unknown" cases prior to the 2015-2016 season.

Injury site

Overall, the most injuries reported occurring to surf life savers were to the lower extremities (131/253, 51.8%). The ankle was the most injured site (55/253, 21.7%), followed by the foot/toes (36/253, 14.2%), and the hand/wrist/fingers (36/253, 14.2%). Out of 253 cases, 7.1% did not indicate where on the body the injury occurred. Male surf lifesaving injuries occurred most at the ankle (34/153, 22.2%) and hand/wrist/fingers (27/153, 17.6%). From 2013-2014 to 2014-2015 season, there was a 72.7% decrease in ankle injury incidences. From 2012-2013 to 2013-2014 season, there was an 80.0% and 45.5% increase in foot and ankle IRB-related cases, respectively. Lower extremity injuries accounted for 56.0% of female and 49.0% of male cases from 2009-2018. Female surf lifesaving injuries occurred mostly at the ankle (21/100, 21.0%) and foot (17/100, 17.0%). Out of 11 back injuries reported, 10 (90.9%) occurred to males. Out of 21 incidents to male surf life savers over the age of 40, 4 (19.0%) were to the lower and upper leg, hip, and thigh.

Table 1: SLSNZ Injury Reporting Database IRB-related incidents occurring to surf life savers from 2009 to 2018 by location.

		Region												Total	
		Central Region		Eastern Region		Northern Region		Southern Region		Unknown		Other ^b			
		Cases (n)	(%)	Cases (n)	(%)	Cases (n)	(%)	Cases (n)	(%)	Cases (n)	(%)	Cases (n)	(%)	Cases (n)	(%)
Season ^c	2009 to 2010	2	3.8	4	7.4	6	5.9	1	2.6	0	0.0	0	0.0	13	5.1
	2010 to 2011	8	15.1	2	3.7	7	6.9	4	10.3	0	0.0	0	0.0	21	8.3
	2011 to 2012	4	7.5	4	7.4	15	14.7	4	10.3	0	0.0	0	0.0	27	10.7
	2012 to 2013	5	9.4	6	11.1	17	16.7	0	0.0	0	0.0	0	0.0	28	11.1
	2013 to 2014	5	9.4	9	16.7	21	20.6	4	10.3	0	0.0	0	0.0	39	15.4
	2014 to 2015	6	11.3	6	11.1	12	11.8	7	17.9	0	0.0	0	0.0	31	12.3
	2015 to 2016	9	17.0	7	13.0	8	7.8	6	15.4	4	100	1	100	35	13.8
	2016 to 2017	10	18.9	8	14.8	7	6.9	4	10.3	0	0.0	0	0.0	29	11.5
	2017 to 2018	4	7.5	8	14.8	9	8.8	9	23.1	0	0.0	0	0.0	30	11.9
Total		53	100	54	100	102	100	39	100	4	100	1	100	253	100

a. Surf Life Saving New Zealand (n=1)

b. The active surf lifesaving season in New Zealand runs from 1 October - 30 April the following year. For the purposes of this study, the inactive season ran from 1 May to 30 September. Incidence rates and total were calculated based on this season (e.g. 1 October 2013 - 30 September 2014). Population was determined as all active surf life savers in New Zealand that were surf lifeguard certified and active during that season. Population data were obtained from SLSNZ. Incidence rates were calculated and reported per 1000 active surf lifesaving members

Table 2: SLSNZ Injury Reporting Database IRB-related incidents occurring to surf life savers from 2009 to 2018 – Activity Type.

		Season ^a																		Total	
		2009 to 2010		2010 to 2011		2011 to 2012		2012 to 2013		2013 to 2014		2014 to 2015		2015 to 2016		2016 to 2017		2017 to 2018			
		Cases (n)	(%)	Cases (n)	(%)	Cases (n)	(%)	Cases (n)	(%)	Cases (n)	(%)	Cases (n)	(%)	Cases (n)	(%)	Cases (n)	(%)	Cases (n)	(%)	Cases (n)	(%)
Volunteer	7	53.8	11	52.4	19	70.4	24	85.7	29	74.4	21	67.7	0	0.0	0	0.0	0	0.0	111	43.9	
Voluntary Patrol	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	9	25.7	4	13.8	0	0.0	13	5.1	
Event Safety	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	3.3	1	0.4	
Regional	2	15.4	5	23.8	3	11.1	3	10.7	2	5.1	4	12.9	0	0.0	0	0.0	0	0.0	19	7.5	
Regional Guard	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	4	11.4	0	0.0	0	0.0	4	1.6	
Callout	1	7.7	0	0.0	1	3.7	0	0.0	1	2.6	1	3.2	2	5.7	0	0.0	1	3.3	7	2.8	
Total Patrol	10	76.9	16	76.2	23	85.2	27	96.4	32	82.1	26	83.9	15	42.9	4	13.8	2	6.7	155	61.3	
SLS Event	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	
Event	3	23.1	3	14.3	1	3.7	1	3.6	1	2.6	3	9.7	0	0.0	0	0.0	0	0.0	12	4.7	
Total Competition	3	23.1	3	14.3	1	3.7	1	3.6	1	2.6	3	9.7	0	0.0	0	0.0	0	0.0	12	4.7	
Other	0	0.0	2	9.5	3	11.1	0	0.0	6	15.4	2	6.5	3	8.6	8	27.6	4	13.3	28	11.1	
Unknown ^b	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	17	48.6	17	58.6	24	80.0	58	22.9	
Total	13	100	21	100	27	100	28	100	39	100	31	100	35	100	29	100	30	100	253	100	

- a. The active surf lifesaving season in New Zealand runs from 1 October - 30 April the following year. For the purposes of this study, the inactive season ran from 1 May to 30 September. Incidence rates and total were calculated based on this season (e.g. 1 October 2013 - 30 September 2014). Population was determined as all active surf life savers in New Zealand that were surf lifeguard certified and active during that season. Population data were obtained from SLSNZ. Incidence rates were calculated and reported per 1000 active surf lifesaving members
- b. Unknown includes all cases in which the type of service was not indicated

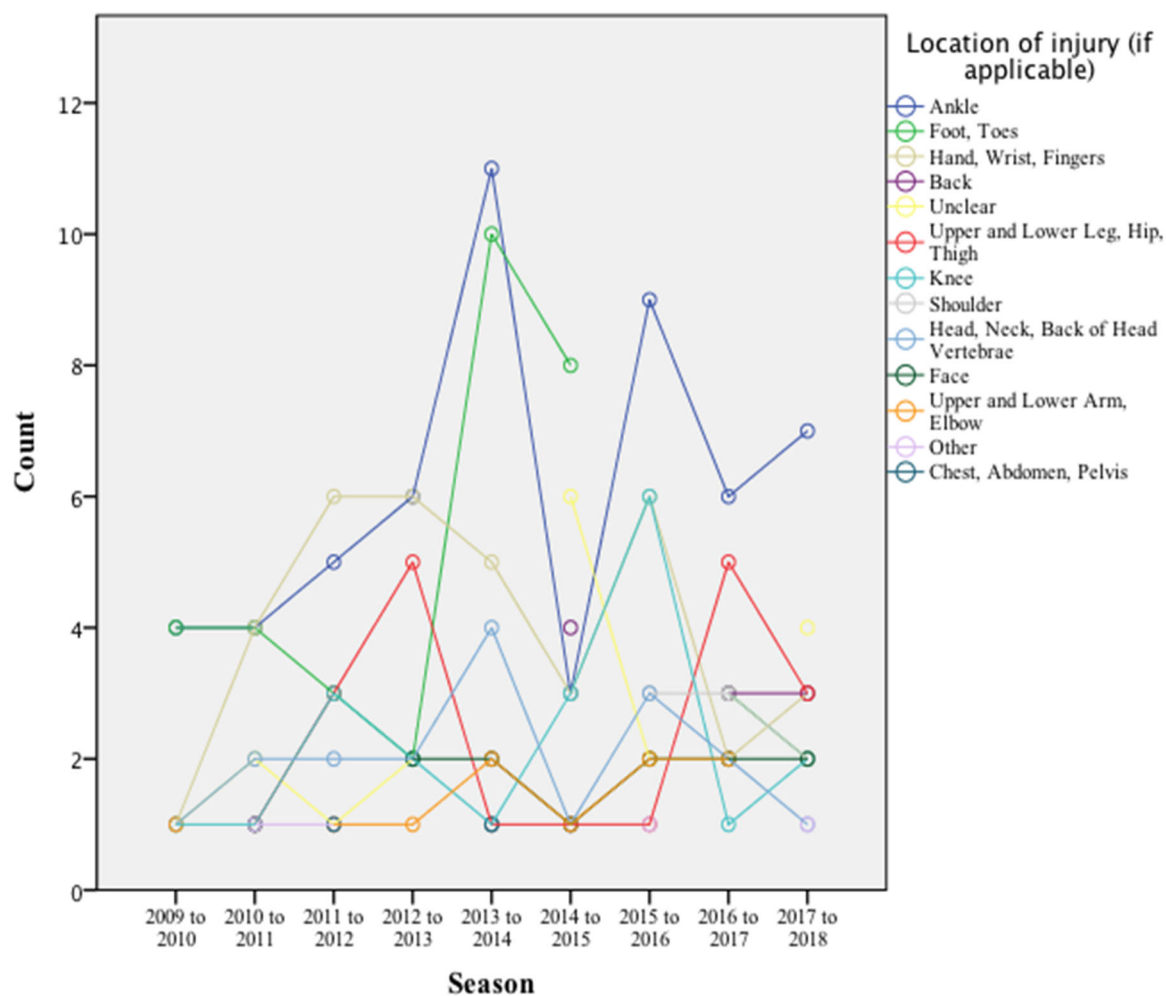


Figure 1: SLSNZ Injury Reporting Database IRB-related incidents occurring to surf life savers from 2009 to 2018 – Injury Site

Table 3: SLSNZ Injury Reporting Database IRB-related incidents occurring to surf life savers from 2009 to 2018 – Injury site

		Season ^a																		Total	
		2009 to 2010		2010 to 2011		2011 to 2012		2012 to 2013		2013 to 2014		2014 to 2015		2015 to 2016		2016 to 2017		2017 to 2018			
		Cases (n)	Total Cases (%)	Cases (n)	Total Cases (%)	Cases (n)	Total Cases (%)	Cases (n)	Total Cases (%)	Cases (n)	Total Cases (%)	Cases (n)	Total Cases (%)	Cases (n)	Total Cases (%)	Cases (n)	Total Cases (%)	Cases (n)	Total Cases (%)	Cases (n)	Total Cases (%)
Upper and Lower Leg, Hip, Thigh	Ankle	4	30.8	4	19.0	5	18.5	6	21.4	11	28.2	3	9.7	9	25.7	6	20.7	7	23.3	55	21.7
	Knee	1	7.7	1	4.8	3	11.1	2	7.1	1	2.6	3	9.7	6	17.1	1	3.4	2	6.7	20	7.9
	Foot, Toes	4	30.8	4	19.0	3	11.1	2	7.1	10	25.6	8	25.8	0	0.0	3	10.3	2	6.7	36	14.2
		0	0.0	1	4.8	3	11.1	5	17.9	1	2.6	1	3.2	1	2.9	5	17.2	3	10.0	20	7.9
Lower Extremity		9	69.2	10	47.6	14	51.9	15	53.6	23	59.0	15	48.4	16	45.7	15	51.7	14	46.7	131	51.8
Upper and Lower Arm, Elbow	Hand, Wrist, Fingers	1	7.7	4	19.0	6	22.2	6	21.4	5	12.8	3	9.7	6	17.1	2	6.9	3	10.0	36	14.2
		1	7.7	0	0.0	1	3.7	1	3.6	2	5.1	1	3.2	2	5.7	2	6.9	0	0.0	10	4.0
	Shoulder	0	0.0	0	0.0	1	3.7	0	0.0	2	5.1	0	0.0	3	8.6	3	10.3	2	6.7	11	4.3
Upper Extremity		2	15.4	4	19.0	8	29.6	7	25.0	9	23.1	4	12.9	11	31.4	7	24.1	5	16.7	57	22.5
Other	Back	0	0.0	1	4.8	0	0.0	0	0.0	0	0.0	4	12.9	0	0.0	3	10.3	3	10.0	11	4.3
	Head, Neck, Back of Head	1	7.7	2	9.5	2	7.4	2	7.1	4	10.3	1	3.2	3	8.6	2	6.9	1	3.3	18	7.1
	Vertebrae																				
	Face	0	0.0	1	4.8	0	0.0	2	7.1	2	5.1	1	3.2	2	5.7	2	6.9	2	6.7	12	4.7
	Chest, Abdomen, Pelvis	0	0.0	0	0.0	1	3.7	0	0.0	1	2.6	0	0.0	0	0.0	0	0.0	0	0.0	2	0.8
Other	Other	0	0.0	1	4.8	1	3.7	0	0.0	0	0.0	0	0.0	1	2.9	0	0.0	1	3.3	4	1.6
	Other	1	7.7	5	23.8	4	14.8	4	14.3	7	17.9	6	19.4	6	17.1	7	24.1	7	23.3	47	18.6
Unclear ^b		1	7.7	2	9.5	1	3.7	2	7.1	0	0.0	6	19.4	2	5.7	0	0.0	4	13.3	18	7.1
Total		13	100	21	100	27	100	28	100	39	100	31	100	35	100	29	100	30	100	253	100

a. The active surf lifesaving season in New Zealand runs from 1 October - 30 April the following year. For the purposes of this study, the inactive season ran from 1 May to 30 September. Incidence rates and total were calculated based on this season (e.g. 1 October 2013 - 30 September 2014). Population was determined as all active surf life savers in New Zealand that were surf lifeguard certified and active during that season. Population data were obtained from SLSNZ. Incidence rates were calculated and reported per 1000 active surf lifesaving members

b. Body site was categorised from free text analysis of treatment notes (as supplied by SLSNZ PAM Database). 'Unclear' includes all reports in which injury location was not specified, or could not be determined from the available information

Injury type

The most reported injury types from 2009 to 2018 were “unclear” (86/253, 34.0%) followed by lacerations (65/253, 25.7%). Soft tissue injuries and suspected soft tissue injuries were indicated in 40 (15.8%) of IRB-related incident reports. In 2016-2017, there were 8 reported fractures; 30.8% of all known fractures over the entirety of the study period. Soft tissue injuries (known and suspected) accounted for 19/94 (20.2%) cases occurring to surf life savers aged 16 to 20 years. Surf life savers over the age of 40 reported fractures and dislocations in 19.2% of reports. From 2009 to 2018, there were 20/55 (36.4%) ankle soft tissue (known or suspected) injuries. Of all lacerations, 27.7% (18/65) occurred to the hand/wrist/ and fingers, and 26.2% (17/65) occurred to the foot/toes. From 2012-2013 to 2017-2018, there was an average decrease in laceration injuries of 2.0 ± 1.7 cases per season.

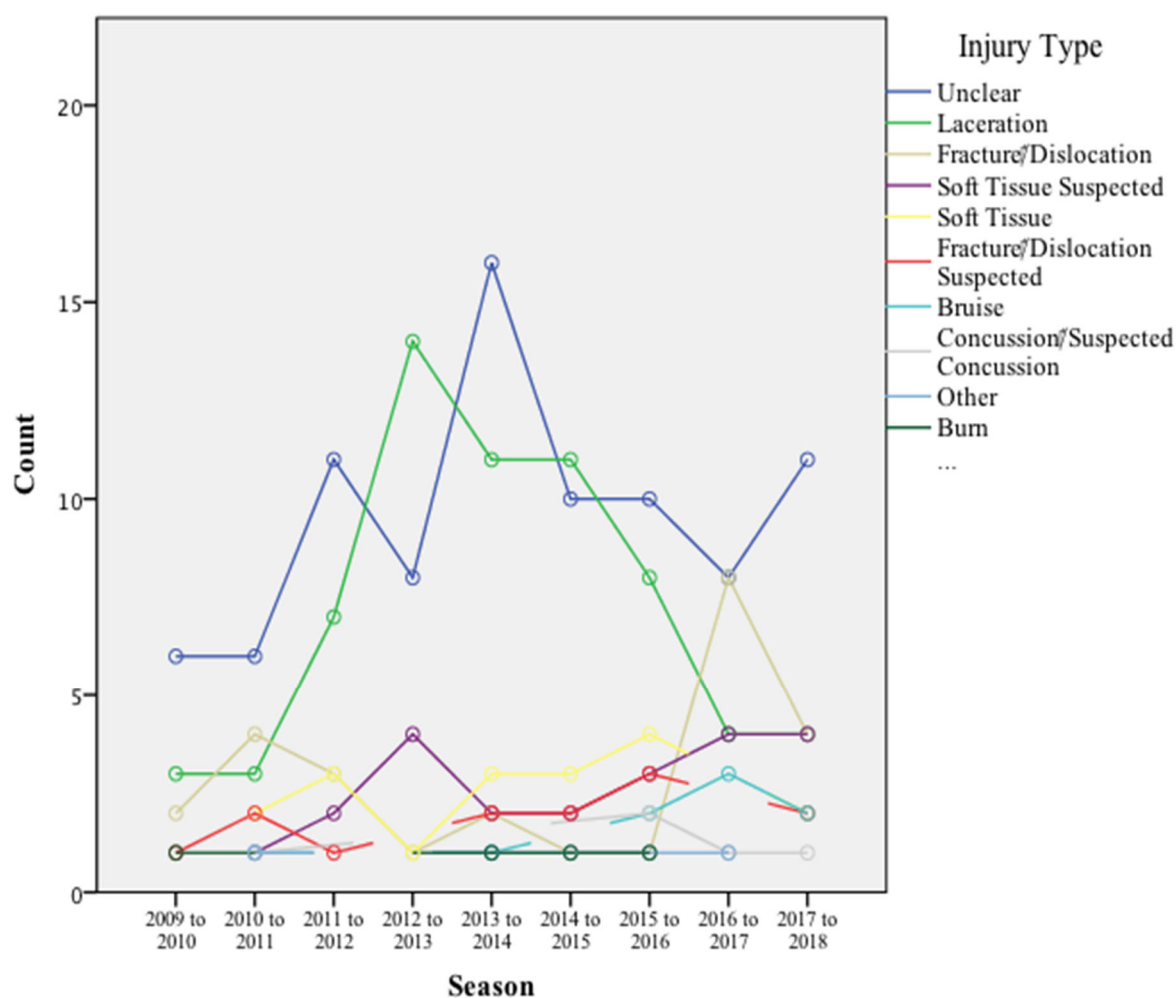


Figure 2: SLSNZ Injury Reporting Database IRB-related incidents occurring to surf life savers from 2009 to 2018 – Injury Type

Table 4: SLSNZ Injury Reporting Database IRB-related incidents occurring to surf life savers from 2009 to 2018 – Injury Type

		Season ^a																			Total	
		2009 to 2010		2010 to 2011		2011 to 2012		2012 to 2013		2013 to 2014		2014 to 2015		2015 to 2016		2016 to 2017		2017 to 2018				
		Cases (n)	Total (%)	Cases (n)	Total (%)	Cases (n)	Total (%)	Cases (n)	Total (%)	Cases (n)	Total (%)	Cases (n)	Total (%)	Cases (n)	Total (%)	Cases (n)	Total (%)	Cases (n)	Total (%)	Cases (n)	Total (%)	
Soft Tissue	0	0.0	2	9.5	3	11.1	1	3.6	3	7.7	3	9.7	4	11.4	0	0.0	2	6.7	18	7.1		
Soft Tissue Suspected ^b	0	0.0	1	4.8	2	7.4	4	14.3	2	5.1	2	6.5	3	8.6	4	13.8	4	13.3	22	8.7		
Fracture/Dislocation	2	15.4	4	19.0	3	11.1	1	3.6	2	5.1	1	3.2	1	2.9	8	27.6	4	13.3	26	10.3		
Fracture/Dislocation Suspected ^c	1	7.7	2	9.5	1	3.7	0	0.0	2	5.1	2	6.5	3	8.6	0	0.0	2	6.7	13	5.1		
Concussion/Suspected Concussion ^d	0	0.0	1	4.8	0	0.0	0	0.0	0	0.0	0	0.0	2	5.7	1	3.4	1	3.3	5	2.0		
Laceration	3	23.1	3	14.3	7	25.9	14	50.0	11	28.2	11	35.5	8	22.9	4	13.8	4	13.3	65	25.7		
Bruise	0	0.0	1	4.8	0	0.0	0	0.0	1	2.6	0	0.0	2	5.7	3	10.3	2	6.7	9	3.6		
Burn	1	7.7	0	0.0	0	0.0	0	0.0	1	2.6	1	3.2	1	2.9	0	0.0	0	0.0	4	1.6		
Unclear ^e	6	46.2	6	28.6	11	40.7	8	28.6	16	41.0	10	32.3	10	28.6	8	27.6	11	36.7	86	34.0		
Other	0	0.0	1	4.8	0	0.0	0	0.0	1	2.6	1	3.2	1	2.9	1	3.4	0	0.0	5	2.0		

- The active surf lifesaving season in New Zealand runs from 1 October - 30 April the following year. For the purposes of this study, the inactive season ran from 1 May to 30 September. Incidence rates and total were calculated based on this season (e.g. 1 October 2013 - 30 September 2014). Population was determined as all active surf life savers in New Zealand that were surf lifeguard certified and active during that season. Population data were obtained from SLSNZ. Incidence rates were calculated and reported per 1000 active surf lifesaving members
- Soft tissue suspected includes all suspected soft tissue injuries as specified in the "treatment notes" field from the database. This is speculation based on the surf lifesaver completing the IRF, and is no medical diagnosis was provided.
- Fracture/Dislocation suspected includes all suspected fracture/dislocation injuries as specified in the "treatment notes" field from the database. This is speculation based on the surf lifesaver completing the IRF, and is no medical diagnosis was provided.
- Concussion/Suspected Concussion includes all suspected head injuries as specified in the "treatment notes" field from the database (medical diagnosis or speculation)
- Injury Type was categorised from free text analysis of treatment notes (as supplied by SLSNZ PAM Database). 'Unclear' includes all reports in which injury location was not specified, or could not be determined from the available information

Injury mechanism

Overall, the most reported injury mechanism from treatment note free text analysis was “landing” (females: 21/100, 21.0%; males: 25/153, 16.3%), defined by the authors as landing inside the IRB after going airborne while the IRB is in the water. The next most occurring mechanisms were “unclear” (42/253, 16.6%) and “ejected from the IRB” (35/253, 13.8%). From 2015-2016 to 2016-2017 season, there was a 133% increase in injuries due to being ejected from the IRB; there was also a 133% increase from 2015-2016 to 2017-2018 season. Out of 55 ankle injury cases, 30.9% (17/55) occurred during landing, and 16.4% (9/55) indicated being caught in the foot strap. All 7 head, neck, and back of head vertebrae cases (100%) occurred while being ejected from the IRB. The lead mechanism of injury among surf life savers aged 16 to 20 years was landing (17/94, 18.1%), and ejection from the IRB (15/94, 16.0%). Getting caught in the strap occurred to 10/100 (10.0%) female surf life savers whom reported the incident, compared to 6/153 males (3.9%).

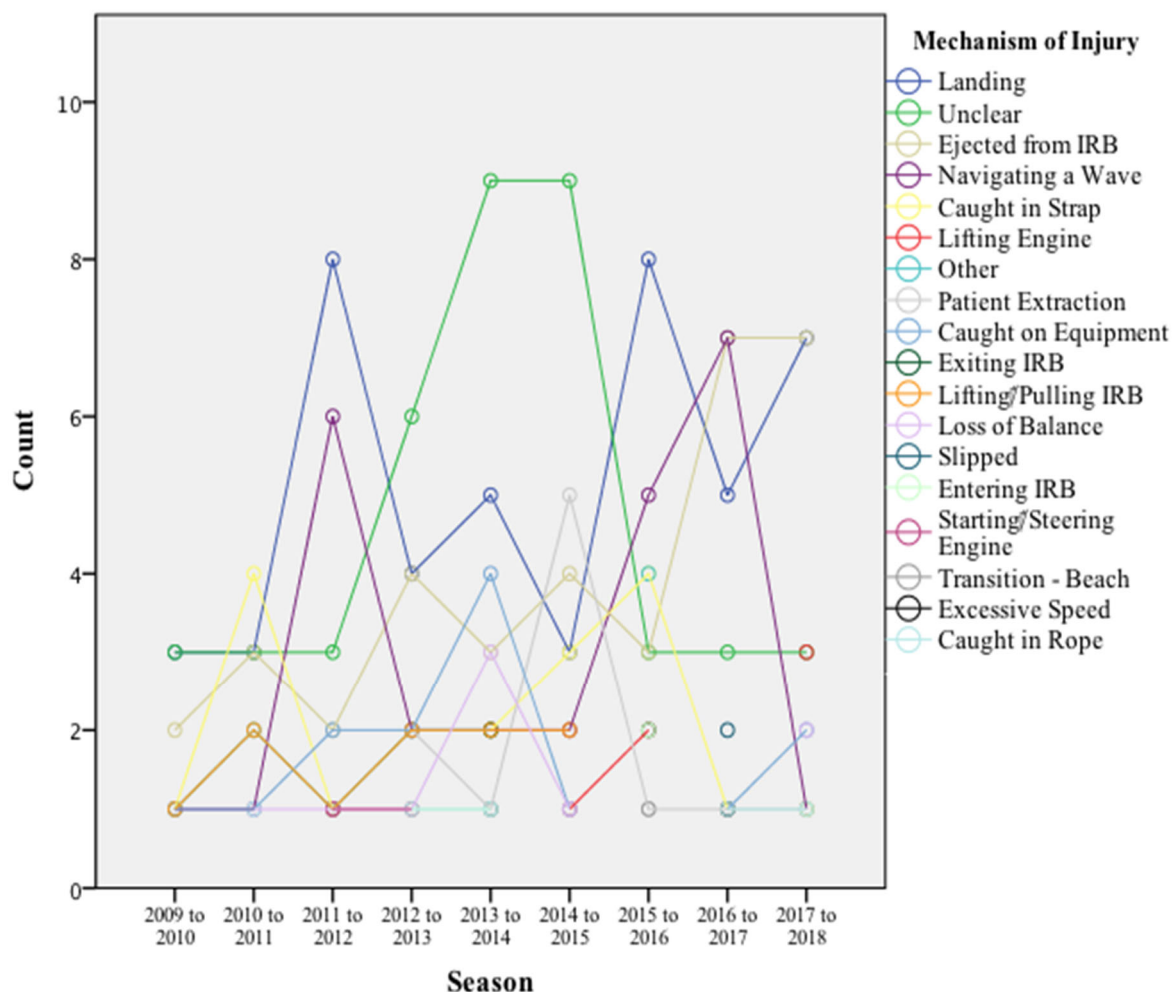


Figure 3: SLSNZ Injury Reporting Database IRB-related incidents occurring to surf life savers from 2009 to 2018 – Injury Mechanism

Table 5: SLSNZ Injury Reporting Database IRB-related incidents occurring to surf life savers from 2009 to 2018 – Injury Mechanism

	Season ^a																			Total	
	2009 to 2010		2010 to 2011		2011 to 2012		2012 to 2013		2013 to 2014		2014 to 2015		2015 to 2016		2016 to 2017		2017 to 2018				
	Cases (n)	Total (%)	Cases (n)	Total (%)	Cases (n)	Total (%)	Cases (n)	Total (%)	Cases (n)	Total (%)	Cases (n)	Total (%)	Cases (n)	Total (%)	Cases (n)	Total (%)	Cases (n)	Total (%)	Cases (n)	Total (%)	Cases (n)
Caught in Rope	0	0.0	1	4.8	0	0.0	1	3.6	1	2.6	0	0.0	0	0.0	1	3.4	1	3.3	5	2.0	
Caught in Strap	1	7.7	4	19.0	1	3.7	0	0.0	2	5.1	3	9.7	4	11.4	1	3.4	0	0.0	16	6.3	
Caught on Equipment ^b	1	7.7	1	4.8	2	7.4	2	7.1	4	10.3	1	3.2	0	0.0	1	3.4	2	6.7	14	5.5	
Total Caught in IRB Equipment	2	15	6	29	3	11	3	11	7	18	4	13	4	11	3	10	3	10	35	13.8	
Transition - Beach ^c	0	0.0	0	0.0	0	0.0	0	0.0	1	2.6	0	0.0	1	2.9	0	0.0	0	0.0	2	0.8	
Exiting IRB	0	0.0	0	0.0	1	3.7	0	0.0	2	5.1	0	0.0	2	5.7	0	0.0	0	0.0	5	2.0	
Entering IRB	0	0.0	0	0.0	0	0.0	1	3.6	1	2.6	0	0.0	2	5.7	0	0.0	1	3.3	5	2.0	
Total Transition Injuries	0	0	0	0	1	4	1	4	4	10	0	0	5	14	0	0	1	3	12	4.7	
Lifting Engine	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	3.2	2	5.7	0	0.0	3	10.0	6	2.4	
Lifting/Pulling IRB	1	7.7	2	9.5	1	3.7	2	7.1	2	5.1	2	6.5	0	0.0	0	0.0	1	3.3	11	4.3	
Starting/Steering Engine	0	0.0	0	0.0	1	3.7	1	3.6	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	2	0.8	
Patient Extraction ^d	0	0.0	0	0.0	0	0.0	2	7.1	1	2.6	5	16.1	1	2.9	1	3.4	1	3.3	11	4.3	
Total Equipment Maneuver Injuries	1	8	2	10	2	7	5	18	3	8	8	26	3	9	1	3	5	17	30	11.9	
Slipped	0	0.0	0	0.0	0	0.0	0	0.0	1	2.6	0	0.0	0	0.0	2	6.9	0	0.0	3	1.2	
Loss of Balance	0	0.0	1	4.8	1	3.7	1	3.6	3	7.7	1	3.2	0	0.0	0	0.0	2	6.7	9	3.6	
Landing ^e	3	23.1	3	14.3	8	29.6	4	14.3	5	12.8	3	9.7	8	22.9	5	17.2	7	23.3	46	18.2	
Total Floorboard Injuries	3	23	4	19	9	33	5	18	9	23	4	13	8	23	7	24	9	30	58	22.9	
Navigating a Wave	1	7.7	1	4.8	6	22.2	2	7.1	2	5.1	2	6.5	5	14.3	7	24.1	1	3.3	27	10.7	
Ejected from IRB	2	15.4	3	14.3	2	7.4	4	14.3	3	7.7	4	12.9	3	8.6	7	24.1	7	23.3	35	13.8	
Repetitive on Waves ^f	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	
Excessive Speed	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	3.4	0	0.0	1	0.4	
Total Open Water Injuries	3	23	4	19	8	30	6	21	5	13	6	19	8	23	15	52	8	27	63	24.9	
Other	1	7.7	2	9.5	1	3.7	2	7.1	2	5.1	0	0.0	4	11.4	0	0.0	1	3.3	13	5.1	
Unclear ^g	3	23.1	3	14.3	3	11.1	6	21.4	9	23.1	9	29.0	3	8.6	3	10.3	3	10.0	42	16.6	

- a. The active surf lifesaving season in New Zealand runs from 1 October - 30 April the following year. For the purposes of this study, the inactive season ran from 1 May to 30 September. Incidence rates and total were calculated based on this season (e.g. 1 October 2013 - 30 September 2014). Population was determined as all active surf life savers in New Zealand that were surf lifeguard certified and active during that season. Population data were obtained from SLSNZ. Incidence rates were calculated and reported per 1000 active surf lifesaving members
- b. Other equipment includes metal, side of the pontoon, etc.
- c. Injuries involving movement on the beach, prior to or following IRB operation
- d. Including injuries to both the IRB crew member and the patient being extracted (if a surf lifesaver)
- e. Injuries occurring upon landing after aerial movement while inside the IRB and on water
- f. Injuries described as occurring due to the repetitive nature of IRB operation
- g. Mechanism of injury was specified, but was unclear

DISCUSSION

The aim of this study was to analyse the SLSNZ incident database for IRB-related injuries occurring to surf life savers from 2009-2010 to 2017-2018 season. Overall, there were 253 IRB-related incidents found, averaging over 28 IRB-related incidents reported per season. There was no significant difference in injury frequency between genders or age groups. Findings were investigated to extent of the IRB-related injuries occurring to surf life savers in New Zealand. Injury sites, types, and mechanisms deduced from findings.

Mitchell, Brighton [10] analysed all surf-sport related injuries in Australia from 2003-2011 and found 283/1148 (19.5%) competition and 358/1197 (29.9%) training IRB-related incidents. Similarly, SLSNZ results showed 43.9% of reported IRB-related incidents occurred during volunteer services. However, over one fifth of IRB-related cases did not report the activity during the incident, and over 11% reported “other”. Furthermore, prior to 2015-2016 season, there were IRB-related cases without an activity defined; from 2015-2016 to 2017-2018 season, the number of cases without an activity defined increased to over 80% of all reported cases. Staff from SLSNZ have reported that many surf lifesavers are not reporting their activity that resulted in injury as they were either doing something they “shouldn’t be”, or were afraid they may be reprimanded, and rules would be put in place due to their incident. The format of the IRFs, and the reporting processes may need to be modified to ensure this information is captured.

Injury site

Surf lifesaving research has previously identified the ankle and foot as the most common injury sites for IRB-related activities, with no difference based on gender [10-12]. Our results concur, identifying the ankle as the most reported injured site for both males and females from 2009-2018. However, there was a gender difference in back injuries reported to SLSNZ, with 90% reported by males. It may be beneficial to investigate mechanisms of back injuries in male surf life savers to identify potentially hazardous activities.

The SLSNZ database focuses on acute injuries, as they are reported at the scene of the incident. Therefore, there were likely many day to day lacerations and foot injuries that would be reported to SLSNZ, but not severe enough to be reported to ACC (or remembered on a questionnaire).

Injury type

In the literature, the most common injury types were sprains (16.0%), strains (15.3%), and bruising (12.4%) [10]. Results from the SLSNZ database showed lacerations were the most common injury type (65/253, 25.7%), with soft tissue injuries (suspected and known) accounting for 15.8% of IRB-related incidents. Mitchell, Brighton [10] did not specify IRB-related injuries specific body sites. SLSNZ results showed a greater occurrence of ankle soft tissue injuries, and lacerations to the hand, wrist, and fingers as the most occurring injuries. This was consistent with Fong, Chan [13] who identified the ankle as the most commonly injured body site in 24/70 sports. Traumatic ligament sprains of the ankle joint are the most common injuries at every level of sports, and comprise about 14% of all sport-related injuries [14].

Injury mechanisms

Mitchell, Brighton [10] identified surf lifesaving injuries occurring mostly when navigating the break and returning to shore. Ashton and Grujic (2001) found the design of the ankle strap was consistent with ankle and foot fractures occurring to surf life savers in Queensland and recommended the right foot strap be removed from the IRB. The SLSNZ database results showed only 6.3% of incidents were due to the foot strap; most incidents were due to landing in the IRB (18.2%). However, there was a decrease in ankle and foot injuries from 2012 to 2015. The removal of the right foot strap was recommended in New Zealand in 2010 [15], and mandated in 2017 and 2018 [16]. This may explain the decrease in lower extremity injuries reported to the SLSNZ database. Coincidentally, there was a 133% increase in injuries due to being ejected from the IRB from 2015 to 2017. The removal of the right foot strap may have hindered the ability of IRB crew members to stay stable inside the boat during operation. This could be potentially hazardous, as results identified all head injuries reported to SLSNZ occurred while being ejected from the IRB. The potential cost of these injuries is high based on data from ACC and therefore SLSNZ may benefit from finding alternative ways to ensure IRB crew members can remain stable, inside the IRB while navigating the waves.

Limitations and future recommendations

The limitations of this study are due to the SLSNZ reporting processes which are dependent upon a variety of factors; including, IRF formats, member training, and supervisory adherence and promotion. Erby, Heard [9] piloted

an injury reporting system for surf life savers in Australia in 1998/1999, and used four strategies to assess if the reporting form provided interpretable data: number of incidents captured; completeness of data recorded; details of difficulties in results analysis; and detailed feedback from personnel surrounding the usability of the form. Limitations in the current SLSNZ reporting processes exist in each one of these four strategies.

It is unknown as to the accuracy of the number of cases reported and previous knowledge suggests an underestimation [9]. SLSNZ would benefit from investigating the reporting rates of surf life savers and member mindset surrounding incident reporting, particularly in cases involved IRBs.

From the findings of the study, there were many fields left blank in many of the cases. These fields varied from case to case and seemed to vary between seasons. There is a potential that the IRFs request too much information under time-constrained situations (minor to severe injuries). Furthermore, there were no specific fields for injury site, injury type, or mechanism of injury. In order to effectively manage and reduce injury in sport, the risk needs to be identified. This includes identifying the sites of injuries, types of injuries, and how these injuries are occurring. SLSNZ should modify the current IRF to include these fields, as well as remove unnecessary fields to ensure all required information is completed when under time constraints.

The medium of the SLSNZ IRFs may be a limitation, increasing to the underestimation. IRFs are currently paper format. Inherently, it is difficult to use paper around water, where most of surf lifesaving incidents occur; therefore, increasing the time between the occurrence and reporting of the incident. SLSNZ could benefit from the implementation of a mobile reporting format (App or the like), to decrease the number of unreported incidents, as well as increase the quality in data collected.

CONCLUSIONS

The SLSNZ injury database likely provides an underestimation of the number of injuries resulting from the use of IRBs during patrol and competition. Lower limb and hand/wrist injuries are frequent. Landing after going airborne while the IRB was in the water was a common cause of injury. Many causes of injury from the SLSNZ Database were unclear.

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CONTRIBUTORS STATEMENT

According to the definition given by the International Committee of Medical Journal Editors (*ICMJE*), the authors listed qualify for authorship on the basis of making one or more of the substantial contributions to the intellectual content of the manuscript. Study conception and design [Diewald, Wilson, Hume, Wooler, Merrett]; Acquisition of data [Diewald, Wooler, Merrett], Extraction of data [Diewald, Hume, Wilson]; Interpretation of data [Diewald, Wilson, Hume, Wooler, Merrett]; Drafting of manuscript [Diewald, Hume, Wilson, Fong, Wooler, Merrett]; Critical revision of manuscript [Wilson, Hume, Fong, Wooler, Merrett, Reay, Smith].