Quantifying fatal and non-fatal drowning in children under five in Aotearoa, New Zealand

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Abstract

Objective: To quantify unintentional drowning trends and risk factors for children under five years of age in Aotearoa, New Zealand.

Methods: A population-based analyses of fatal and non-fatal (hospitalisations and Accident Compensation Corporation [ACC] claims) unintentional drowning of children 0-4 years of age between 2005 and 2019 was conducted using DrownBase™ data. Analyses comprises calculation of linear temporal trends, crude drowning rates per 100,000 and relative risk (95% confidence interval) and ratios of fatal to non-fatal drowning.

Results: 557 incidents (16.0% fatal) were recorded. Fatalities declined (y=-0.0769x+2.5678;R2=0.01509), while hospitalisations increased (y=0.1418x+9.1093;R2=0.0979). Males were overrepresented. One year-olds recorded the highest rates (fatal=4.39/100,000) and (non-fatal=2.14/100,000). 'Other' ethnicity (8.77/100,000) and Māori (2.49/100,000) children recorded the highest fatal drowning rates. Home pools were the leading fatal location, while domestic environments attracted the highest hospitalisation rate. For every one fatal drowning there were 6.9 hospitalisations and 74.7 ACC claims.

Conclusions: Drowning among young children represents a preventable cause of injury-related harm. While fatalities are declining, non-fatal drowning is increasing.

Implications for public health: Strategies to prevent drowning among young children are well understood, particularly restricting water access and active adult supervision. Further investment in effective prevention strategies for young children will deliver significant social, economic and health system savings.

Key words: drowning, paediatric, economic burden, prevention, policy

Drowning disproportionately impacts children and young people, with half the global burden of fatal drowning occurring among people under 25 years of age.[1] However, drowning may also be non-fatal, with outcomes classified as morbidity or no morbidity.[2] Available data indicates significantly more people are impacted by non-fatal drowning.[3-7]

Global drowning statistics highlight the greatest fatal drowning burden among children aged 0-4 years.[8] Similarly, children under five years of age are overrepresented in cases of hospitalisation due to non-fatal drowning.[6] Young children are at increased risk of drowning due to developmental factors. Although risk appraisal capacities are not well developed, their mobility and curiosity about their environment increases,[9] highlighting the need for parental or caregiver supervision and restricted access to water.[10] Domestic water hazards such as bathtubs for children under one[11-13] and home swimming pools and dams for children between the ages of one and four years pose the greatest risk.[14-16]

Aotearoa, New Zealand (NZ) records an annual average of 79 unintentional drowning fatalities and a further 135 hospitalisations.[17] Studies point to historically high rates of drowning,[18,19] and a recent comparison study identified higher fatal drowning rates in NZ than in Australia or Canada.[20] High drowning rates result in significant social and economic costs. The NZ Ministry of Transport has developed an estimate using the willingness to pay and statistical value of a life approach, which is generally considered to be the benchmark for the cost to society of a death in NZ.[21] The latest estimate of the cost of a fatality (including drowning), using the value of a statistical life approach, is $4.7 million NZ dollars (NZD) per fatality.[22]

Such impacts are not restricted to fatal drowning alone. Non-fatal drowning can result in detrimental health and personal outcomes. Additionally, individuals, families, the community and the health sector experience considerable financial and social costs. Long-term conditions which result from water-related injuries consume a vast number of resources in NZ including direct healthcare costs. In addition, individuals incur direct costs (i.e. healthcare, medication and income support), indirect costs (i.e. lost productivity) and intangible costs (i.e. the physical and emotional effects on the individual and their family) from conditions resulting from long-term water-related injury or disability.[23] The NZ Accident Compensation Corporation (ACC) estimates the cost of non-fatal drowning-related injuries to be $16,208 NZD for a minor injury and $405,202 NZD for serious injuries.[24]

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Child drowning is a significant issue in NZ,[25] with drowning the leading cause of injury-related death among children under five years of age.[26] Drowning fatalities and hospitalisations are highest among the 0-4 years age group, representing significant social and economic impact, as well as health system burden.[26]

Given the disproportionate impact of drowning on young children under five years of age and the importance of exploring the full burden of drowning (i.e. both fatal and non-fatal), this study aims to explore causal factors and temporal trends in drowning among children aged 0-4 years in NZ between 2005 and 2019 to inform drowning prevention efforts.

Methods

This study reports a population-based analysis of all fatal unintentional drowning and drowning-related hospitalisations in NZ among children under five between 2005 and 2019.

Fatal drowning data acquisition

Fatal drowning data acquisition in NZ has been reported in depth previously.[20,27] However, in brief, data on all drowning deaths (unintentional and intentional) which have occurred in NZ are included in DrownBase™, the database of Water Safety NZ (WSNZ).[28] Drowning fatalities due to road or air vehicle incidents, homicide, suicide, or of unknown origin (i.e. where it is unknown how the person came to be in the water) were excluded from this study.

Data used to populate DrownBase™ comprises of data initially collected from the NZ Police via *Drown reports and media reports. This is supplemented by data from Coroners reports and Ministry of Health information. Data included in this study were correct as at 12 February 2021.

Non-fatal drowning-related hospitalisation data acquisition

Data on unintentional non-fatal drowning requiring hospitalisation were also sourced from DrownBase™. A case of non-fatal drowning was defined as admission to hospital resulting in a hospital stay of any duration. Data on hospitalisations were provided by the Ministry of Health NZ Health Information System and include all hospitals in NZ. Only those incidents that have been identified to be a drowning-related event were sent to WSNZ and subsequently recorded in DrownBase™. All drowning fatalities which occur in hospital are removed before data is provided for inclusion in DrownBase™. Data was correct as at 12 February 2021.

Accident Compensation Corporation (ACC) data acquisition

Data on drowning-related claims for medical care were sourced from ACC. ACC is the NZ crown entity responsible for administering the country's no-fault accident injury compensation scheme. The information WSNZ receives is largely reliant on the information claimants provide when the ACC45 (ACC claim form) is completed. This research includes all claims defined as drowning based on free text where the word DROWN appeared or claims coded with contact=drowning or where the claim's readcode was 'Drown' or 'Submersion'. Data from ACC is available for 2012-2017. ACC data included in this study was correct as at 15 February 2021.

Data coding and statistical analysis

Individual case-level data for both fatal drowning and drowning-related hospitalisations were received in Microsoft Excel format and transferred into SPSS V25[29] for analyses. Ethnicity was coded to one of the four largest ethnicities in NZ being NZ European, Māori (NZ's indigenous population), Pasifika and Asian. A fifth category 'other' comprised all other ethnicities in NZ. Drowning location was coded to beaches, domestic, home pools, inland still waters, public pools, rivers and tidal waters. Domestic locations included large containers used for immersing the body (i.e. bathtub), containers with handles for carrying liquids, other environments in the home or garden area surrounding the home (i.e. toilets, troughs, dog bowls, personal thermal pools).[30] Inland still waters, natural or artificial bodies of water surrounded by land which may be small (i.e. fishponds, duckponds) or large (i.e. lakes, quarries). Inland still waters also comprised drains, channels and pipes, and rural drainage systems such as water races and effluent pits.[30]

Due to limitations regarding reporting activity coding associated with drowning fatalities, activity coding for non-fatal drowning-related hospitalisations and ACC drowning-related claims, were recoded to match the fatality codes of immersion incident and water sports/recreation (Supplementary Table 1). An immersion incident occurs where the person who drowned had no intention of participating in recreational activity in or on the water such as a fall and water sport/recreation incidents are those which require intentional exposure to water such as swimming. Hospitalisation cases coded as 'not classified' (n=15) and ACC cases coded as 'other' (n=47) were excluded from the ratio calculations.

Temporal trends in fatal and non-fatal drowning related hospitalisations for 2005-2019 were calculating using the linear trend function in Microsoft Excel. Crude drowning rates per 100,000 resident population were calculated by sex, single year of age and ethnicity using population data from Stats NZ.[31] Resident population data by ethnicity and age group was only available in NZ Census years (2006, 2013 and 2018).[32] To calculate drowning rates by ethnicity, a 15-year average of drowning deaths and non-fatal drowning related hospitalisations were used as the numerator, with a three-year average of the resident population used as the denominator. Rates were used to calculate relative risk with a 95% confidence interval using females, 0-11 month-olds, Asian ethnicity, beaches and water sport/recreation as the reference groups. As ACC data was only available for the 2012-2017 period only, ratios of non-fatal drowning-related hospitalisations and ACC drowning-related claims to fatal drownings were calculated for the 2012-2017 period only. As ACC drowning-related claims data are not available by location of drowning incident, ratios of fatal to non-fatal drowning related hospitalisations by location were calculated separately for the entire study period (2005-2019).

Ethics and consent to participate

WSNZ has agreements with Coronial Services NZ, the National Coronial Information System (Australia) (NZ008) and the NZ Ministry of Health (2007–0825) to access data in order to maintain DrownBase. The protocols of DrownBase access adhere to the principles of the NZ Privacy Act 2020. A data access agreement is in place between WSNZ and the ACC to access anonymised ACC data as requested for research. Consent to participate was not gained as data is de-identified, reflects people who are deceased (in the case of the coronial data) and reported in an aggregated manner. As such, consent

to participate was not required by ethics committees who provided approval for this research.

Results

Across the full study period (2005-2019) there were 557 drowning incidents, of which 16.0% fatal drownings (n=89) and 84.0% (n=468) non-fatal drownings requiring hospitalisation (Table 1). Across the study period, the average fatal drowning rate was 1.95 per 100,000 children while the non-fatal drowning hospitalisation rate was 10.25 per 100,000 children. When exploring temporal trends, the rate of fatal child drowning decreased across the study period (y=-0.0769x + 2.5678; R^2=0.01509), while the rate of drowning-related hospitalisations increased (y=0.1418x+9.1093; R^2=0.0979). (Figure 1)

Males accounted for 62.9% of drowning deaths and 61.8% of non-fatal drowning-related hospitalisations respectively. Compared to females, males were 1.6 times more likely (RR=1.61; CI:1.05-2.48) to fatally drown than females, and 1.5 times (RR=1.54; CI: 1.27-1.85) more likely than females to be admitted to hospital due to a non-fatal drowning. (Table 1)

The highest drowning rates were seen among one-year-olds (4.39/100,000 children) with children of this age 4.5 times more likely to drown than four-year-olds (RR=4.46; CI: 2.16-9.19). One-year-olds also recorded the highest rate of non-fatal drowning-related hospitalisation (15.90 per 100,000 children), a rate that was 2.14 times higher (RR=2.14; CI: 1.60-2.85) than the hospitalisation rate among four year-olds (Table 1). When exploring linear trends in fatal and non-fatal drowning by single year of age, all ages recorded reductions in fatal drowning, aside from four-year-olds (y=0.0346x + 0.7005; R^2=0.0133). For non-fatal drowning-related hospitalisations all ages recorded increases aside from three-year-olds (y=-0.01429x + 10.407; R^2=0.0234) and four-year-olds (y=-0.4071x + 10.806; R^2=0.0133) (Table S2).

Children of 'other' ethnicity recorded the highest fatal drowning rate (8.77 per 100,000 children) followed by Māori children (2.49 per 100,000 population). Conversely, the highest non-fatal drowning-related hospitalisation rates were seen among Māori children (14.68 per 100,000 children), with children of 'other' ethnicity recording the second lowest non-fatal drowning rate (6.27 per 100,000 children). Children of Asian ethnicity

Figure 1: Rate and linear trends of fatal unintentional drowning and non-fatal drowning-related hospitalisations in children aged 0-4 years, New Zealand, 2005-2019.

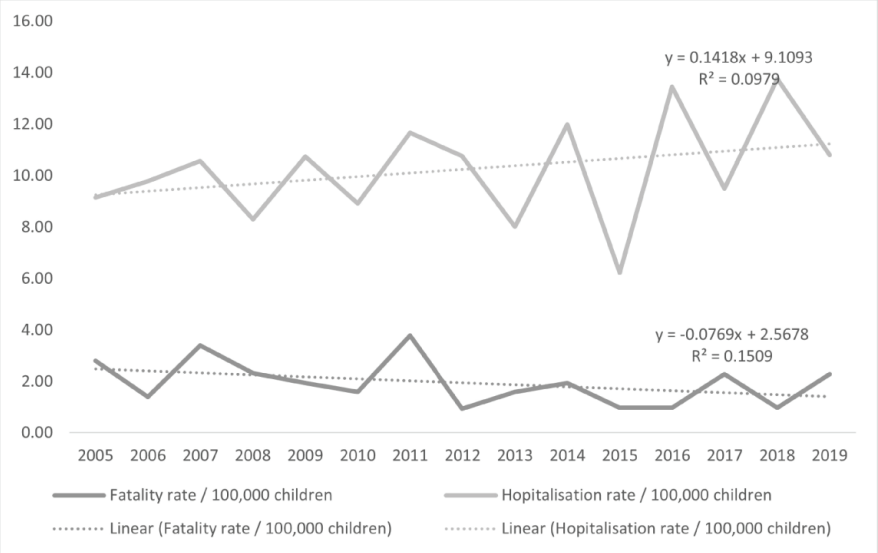

Table 1: Crude drowning rates for fatal and non-fatal drowning-related hospitalisation by sex, age in years and ethnicity, 0-4 year-olds, New Zealand 2005-2019.

	Fatal drowning			Non-fatal drowning		
	Fatal drowning number	Fatal drowning rate/100,000	Relative Risk (95% Confidence Interval)	Non-fatal drowning number	Hospitalisation drowning rate/100,000 pop	Relative Risk (95% Confidence Interval)
Total	89	1.95	-	468	10.25	-
Sex						
Male	56	12.34	1.61 (1.05-2.48)	289	2.39	1.53 (1.27-1.85)
Female	33	8.05	1	179	1.48	1
Age in years						
0-11 months	11	1.21	1.23 (0.51-2.96)	75	8.22	1.11 (0.80-1.54)
1 year	40	4.39	4.46 (2.16-9.19)	145	15.90	2.14 (1.60-2.85)
2 years	15	1.64	1.67 (0.73-3.81)	95	10.40	1.40 (1.02-1.91)
3 years	14	1.53	1.56 (0.67-3.60)	85	9.30	1.25 (0.91-1.72)
4 years	9	0.98	1	68	7.43	1
Ethnicity						
NZ European	41	1.30	4.14 (0.02-1,015.88)	218	6.91	1.83 (0.36-9.36)
Māori	30	2.49	7.92 (0.03-2,037.78)	177	14.68	3.88 (0.75-20.25)
Pasifika	7	1.09	3.47 (0.01-1,537.51)	44	6.86	1.81 (0.26-12.46)
Other	9	8.77	27.89 (0.06-12,348.59)	5	6.27	1.64 (0.04-69.90)
Asian	NP	0.31	1	24	3.78	1
Location of drowning incident						
Domestic	18	0.39	9.00 (2.09-38.79)	148	3.24	4.35 (3.00-6.32)
Home Pools	31	0.68	15.50 (3.71-64.77)	109	2.39	3.21 (2.18-4.71)
Inland Still Waters	22	0.48	11.00 (2.59-46.78)	28	0.61	0.82 (0.50-1.36)
Public Pools	NP	0.09	2.00 (0.37-10.92)	123	2.69	3.62 (2.47-5.29)
Rivers	10	0.22	5.00 (1.10-22.82)	25	0.55	0.74 (0.44-1.23)
Tidal waters	NP	0.04	1.00 (0.14-7.10)	-	-	-
Beaches	NP	0.04	1	34	0.74	1
Activity prior to drowning						
Immersion incident	85	1.86	21.25 (7.80-57.93)	174	3.81	0.59 (0.49-0.71)
Water sports/recreation	NP	0.09	1	294	6.44	1

Note:

There were two cases of unknown ethnicity which are excluded from the fatal drowning rate calculations. There was one non-fatal drowning-related hospitalisation with an unknown location, which has been excluded from the rate calculations. NP=Not Presented for cases <5

recorded the lowest fatal drowning rate (0.31 per 100,000 children) and the lowest non-fatal drowning rate (3.78 per 100,000 children). (Table 1)

The highest fatal drowning rate was recorded for home pools (0.68 per 100,000 children), followed by inland still waters (0.48) and domestic locations (0.39). Compared to beaches, children 0-4 years of age in NZ were 15 times (RR=15.5; CI: 3.71-64.77) times more likely to drown in a home pool, 11 times (RR=11.00; CI: 2.59-46.78) more likely to drown in inland still waters and nine times (RR=9.00; CI: 2.09-38.79) more likely to drown in domestic environments. (Table 1)

For non-fatal drowning-related hospitalisations, the highest rates were seen for domestic locations (3.24 per 100,000 children), followed by public pools (2.69) and home pools (2.39). When compared to beaches, drowning-related hospitalisations were four times as likely (RR=4.35; CI: 3.00-6.32) for domestic locations and four times (RR=3.62; CI: 2.47-5.29) more likely for public pools. Fatalities were 21 times (RR=21.25; CI: 7.80-57.93) more likely as a result of an immersion incident when compared to a water sports/recreation incident. However, this trend was reversed for non-fatal drowning with a hospitalisation rate of 6.44 for water sports/recreation, compared to a rate of 3.81 for immersion incidents.

Between 2012 and 2017, for every fatal drowning in NZ of a child 0-4 years of age, there were 6.9 non-fatal drowning-related hospitalisations and 74.7 ACC drowning-related claims. The fatal to non-fatal drowning-related hospitalisation ratio is higher among males (1:7.3) than females (1:6.3), however there were more ACC claims for each fatal drowning among females (1:78.6) when compared to males (1:71.9). (Table 2)

The highest non-fatal drowning-related hospitalisation to fatal drowning ratio was seen among the 0-11 months age group (a ratio of 1:15.0), whereas for ACC drowning-related claims, the highest ratio was seen among the four-year-old age group (1:326.5). For every one fatal drowning of Māori children there were 13 non-fatal drowning-related hospitalisations (1:13.3), the highest of all ethnicities explored in this study. This was followed by eight non-fatal drowning-related hospitalisations for every one drowning fatality among Pasifika children (1:8.0). For ACC drowning-related claims, the highest number were seen among Asian children, with 112.0 claims for each drowning fatality, followed by NZ European children with 91.5 ACC claims for every one fatal drowning. (Table 2)

The highest ratio of non-fatal drowning-related hospitalisations to fatal drowning incidents among children under five years of age occurred at public pools, with 30.8 hospitalisations for every one fatal drowning. The lowest ratio occurred at inland still waters, with 1.3 hospitalisations for every fatal drowning. (Table S3)

Table 2: Ratios of fatal drowning to non-fatal drowning related-hospitalisations and ACC drowning-related claims overall and by sex, single year of age, ethnicity and drowning location, Aotearoa, New Zealand, 2012-2017.

	Fatal drowning (N=27)	Non-fatal drowning	
		Drowning-related hospitalisation (N=185)	Accident Compensation Corporation (ACC) drowning-related claims (N=2,016)
Total	1	6.9	74.7
Sex			
Male	1	7.3	71.9
Female	1	6.3	78.6
Single year of age			
0-11 months	1	15.0	63.0
1 year	1	3.4	18.0
2 years	1	13.7	148.3
3 years	1	12.3	162.0
4 years	1	9.5	326.5
Ethnicity			
Asian	1	10.0	112.0
NZ European	1	6.0	91.5
Māori	1	13.3	78.7
Pasifika	1	8.0	70.5
Other/Unknown	1	0.2	20.2
Activity prior to drowning			
Immersion incident	1	2.4	8.3
Water sports/recreation	1	117.0	1,753.0

Note:
There were 3 cases of drowning-related hospitalisation with unknown activity; these have been excluded from the calculation of ratios.

Discussion

Drowning is a significant yet preventable threat to public health. Children under five years of age are particularly susceptible to drowning due to many age- and developmental-related factors.[9] To inform drowning prevention efforts, this study aimed to explore fatal and non-fatal drowning among children aged 0-4 years in NZ between 2005 and 2019. This study identified drowning accounts for a significant personal, social and economic impact, with every fatal drowning resulting in seven non-fatal drowning hospitalisations and 75 ACC claims. Males were overrepresented in both fatal and non-fatal drowning incidents, with one-year-olds at highest risk.

As with older age groups, Māori children were overrepresented in both fatal and non-fatal drowning statistics.[17,28] This is congruent with higher drowning rates identified among Aboriginal and Torres Strait Islander children in Australia[33] and among Indigenous children in Canada[34,35] when compared to non-Indigenous children. In the current study, Māori children experienced high rates of fatal drowning (2.49/100,000 children) and non-fatal drowning-related hospitalisations (14.68/100,000 children). As part of WSNZ's strategic focus on Māori, WSNZ has a funding arrangement with ACC for the delivery of drowning prevention initiatives using a kaupapa Māori approach and the Wai Puna approach.[36] Developed by Dr Chanel Phillips these approaches underpin Wai ora Aotearoa, the water safety sector strategy's 2025 outlook.[37] Work is currently underway on a Māori strategy and specific outcomes for Māori, which will include strategies specific to reducing drowning risk in children under five years of age.

Home pools were the leading location for both fatal drowning (a rate of 0.68 per 100,000 children) and the third leading location for non-fatal drowning-related hospitalisations (2.39 per 100,000 children).

This was in alignment with findings from Australia[38] and the United States[39] that identify swimming pools as the leading drowning location for children under five years of age.

In NZ, the Building (Pools) Amendment Act 2016 states that all residential pools (including portable pools) that are filled or partly filled with water must have physical barriers that restrict access by unsupervised children.[40] This requirement applies to pools that can be filled with water to a depth of 400 millimetres (mm) or more. The act also provides for the mandatory inspections of swimming pools every three years by territorial authorities, and gives territorial authorities additional enforcement tools, including notices to fix.[40]

Despite legislation in place, there is push-back by select groups of residential pool owners.[41] Some councils issued waivers to pool owners if they had a pool cover, however, the Ministry of Business Innovation and Employment has clarified that this is not an acceptable barrier and as such many pool owners need to bring their pools up to safety fencing standards. This is a particular issue in the Marlborough region of NZ with locals setting up a group to push back against the Ministry's determination.[41] This is despite that fact that pool covers have been shown not to be an effective barrier with at least five drowning deaths among children under five years of age in pools and spas that were meant to have safety covers fitted (in the last 20 years) and several hospitalisations stemming from incidents in pools with removed covers.[28] Consumer awareness campaigns are clearly required, though ensuring coverage among all pool owners will be challenging with the current number of residential pools unknown, but thought to be well in excess of the current official estimate of 40,000.[42] Using a health belief model to inform such strategies to create behaviour change are likely to be a valuable approach, including an understanding of the perceived barriers to action.[43]

Supervision lapses are commonly implicated in cases of child drowning[44] and current initiatives such as Recreation Aotearoa's Poolsafe campaign aim to remind parents and caregivers of the importance of constant supervision at pools and that drownings can happen in seconds.[45] This is important, as although public pools have a low fatality rate (0.09 per 100,000 children) due in part to lifeguard supervision, they have the second highest non-fatal drowning-related hospitalisation rate (2.69 per 100,000 children). While this likely represents the 'near-misses' being caught by pool lifeguards it does represent a significant health system burden.

Several other interventions aimed at reducing drowning risk among young children are currently in place in NZ. These include a bathmat campaign to reduce bathtub drowning deaths,[46] social marketing campaign 'Eight ways to keep babies and toddlers safe'[47] and swimming pool legislation.[40] Such interventions have impacted on the reduction in fatal drowning seen across the study period. However, as this study has identified, non-fatal drowning-related hospitalisations are increasing, indicating the need for a broader range of interventions or expansion of existing interventions.[10]

There are several findings in the current study worthy of future investigation and explanation. The increase in fatal drowning among four-year-olds requires further investigation. This may be linked to the decreasing number of non-fatal drowning incidents among children of the same age, however, the reasons behind the decrease in non-fatal drowning incidents among three-year-olds is also not currently fully understood. Changes in supervision patterns and child behaviour as children develop may also play a role. Similarly, factors influencing the significantly higher number of ACC claims related to water recreation incidents when compared to immersion incidents in this age group require further investigation. This may be due to the presence of adults and thus rescue and resuscitation being more likely in recreational incidents as opposed to immersion incidents which are more likely to occur due to a lapse in adult supervision.[44] Thus, presence of adult supervision and enactment of CPR are areas worthy of further examination to explain this finding. The high drowning rates (in particular fatal drowning) among children classified as 'other' ethnicity is also an area worthy of further exploration. So too, are the differences in drowning-related hospitalisations and ACC claims by ethnicity, with high non-fatal drowning hospitalisations and ACC claims compared to deaths in children of Asian ethnicity and high drowning-related ACC claims compared to lower drowning-related hospitalisations among children of NZ European ethnicity.

Implications for public health

Drowning is preventable, yet all-age drowning fatalities and non-fatal drowning-related hospitalisations have resulted in an economic burden totalling $4.79 billion NZD in the 10 years to 2017.[48] This economic burden disproportionately impacts young children, where the greatest health losses are attributed.[8] However, financial figures alone do not illustrate the real cost in pain and suffering, and disruption to families and work. The lifetime economic and social consequences of non-fatal drowning are also significant.[49] Drowning-related injuries are estimated to have the highest average lifetime cost of any injury type[23] and have a significant impact on families including psychosocial consequences for victims, parents, siblings and caregivers. As such, significant and ongoing investment in expansion of prevention interventions is warranted, including culturally appropriate strategies for Māori and other culturally diverse populations, as well as innovative approaches to promoting appropriate parental supervision. The sector is well-placed for such approaches, given the newly released Wai ora Aotearoa, the NZ Water Safety Sector Strategy 2025,[37] includes a strategic focus on preventing drowning among children under five years of age.

Strengths and limitations

This is a population-based analyses which explored both fatal and non-fatal drowning, including the lesser known area of drowning-related compensation claims, thus addressing a research gap in published knowledge on the full burden of drowning.[6] The collation of data from three official sources (coronial, hospitalisation and ACC) strengthens data validity, however, does present some limitations. ACC data may include some cases of drowning represented in hospitalisation data, if these children were treated and released with ongoing medical costs. ACC data does not include location information thereby limiting the ability to calculate ratios of fatal to hospital to ACC claims by location of drowning incident. The congruence between datasets has not been assessed and is worthy of further examination. Crude drowning rates do not take into account exposure to aquatic location. Gathering exposure data is recommended as an area of future research to more accurately identify those at highest risk. Data on socioeconomic status of those who drown is not currently available in

New Zealand. It is suggested that such data be collated and included in future studies, for both fatal and non-fatal drowning. The provision of hospitalisation data to WSNZ does not currently include information on severity (i.e. length of stay or condition upon release). This is valuable information to enhance understanding of non-fatal drowning and options to collect and explore data of this type should be explored for future studies.

Conclusion

Drowning is a preventable cause of fatal and non-fatal injury and health system burden. While investment in prevention efforts is contributing to a reduction in fatal drowning in children under five years of age, non-fatal drowning is increasing, representing a significant personal, social and health system burden. Investment in prevention efforts must be focused on culturally and linguistically diverse groups (children and parents/caregivers) and identify strategies to achieve reductions in non-fatal drowning, as have been seen in fatal incidents. Investment in effective prevention for this age group will deliver significant social, economic and health system savings and WSNZ is well-placed to monitor impacts across the full burden of drowning.

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Supporting Information

Additional supporting information may be found in the online version of this article:

Supplementary Table 1: Coding of activity prior to drowning across the three drowning data sets.

Supplementary Table 2: Annual rates by single year of age for fatal drowning and non-fatal drowning-related hospitalisations, Aotearoa, New Zealand, 2005-2019.

Supplementary Table 3: Ratios of fatal to non-fatal drowning-related hospitalisations by location of drowning incident, Aotearoa, New Zealand, 2005-2019.