Analysis of unintentional fatal drowning in Australia 2002-2022: Progress, challenges and data to inform prevention

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Abstract

Objectives: The purpose of this study was to analyse 20 years of drowning data in Australia, using the Royal Life Saving – Australia National Fatal Drowning Database (NFDD).

Methods: This study is a retrospective, total population epidemiological analysis of unintentional fatal drowning in Australia between 1 July 2002 and 30 June 2022. Data were extracted from the NFDD, which was collected over the years using coroner's findings, toxicology reports, autopsy reports and police reports from the National Coronial Information System (NCIS), in conjunction with media reports.

Results: There were 5,692 unintentional drowning deaths during the study period. Overall, drowning trends were found to decrease at a statistically significant rate of 2.60% annually over the 20-year period. The average annual age-standardised mortality rate was 1.22 per 100,000. Rivers/creeks were the leading location for drowning, accounting for 26.3% of cases. Trend analysis identified a significant decrease in the drowning rate among children aged 0-4-years, with an annual decrease of 5.41%, while there was no statistically significant change in older adults (+65 years), who had an annual decrease of 0.59%.

Conclusion: There was no evidence of statistical change in drowning rates at beaches or among people aged 65 years and over, indicating that this demographic and location remain priorities for drowning prevention campaigns.

Implications for Public Health: There is an opportunity to enhance existing strategies and develop new and innovative strategies focusing on key populations, activities and risk factors. In addition, this study highlights the need to broaden our focus beyond just specific age groups and locations and to improve the availability of exposure data.

Key words: drowning, epidemiology, water safety, risk factors, prevention

Introduction

Australia is renowned for its waterways, with swimming being a popular activity for locals and visitors of all ages. Drowning is defined as the process of experiencing respiratory impairment due to submersion/immersion in liquid, with three possible outcomes: death, morbidity, and no morbidity.[1] Although Australia has a relatively low burden of drowning compared to other countries,[2] drowning prevention remains a major priority for government and civil society.[3–5] Persisting challenges have prompted the development of various drowning prevention initiatives,[6,7] including pool fencing legislation,[6,8] and the formulation of the Australian Water Safety Strategy (AWSS), first released in 1998.[5] The current AWSS aims to reduce drowning by 50% by the year 2030,[5] reaffirming the nation's strong commitment to enhancing water safety and reducing the impact of drowning.

Australia leads the world in drowning research output,[9] partly due to the long-term commitment to the collection and maintenance of a National Fatal Drowning Database (NFDD).[10] These data have provided the foundation for important advances in understanding of specific aspects of the problem and have guided prevention priorities in several AWSS key focus areas including high-risk populations such as children[11] and young males,[12] locations such as inland bodies of water[13,14] and coastal areas,[15] activities such as boating[16] and rock fishing;[17] and risk factors such as alcohol and drugs use.[18] High-risk

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populations including multicultural communities[19] and Aboriginal and Torres Strait Islander (First Nations) peoples.[20] Of note, recent studies have underscored the drowning risk for migrants and international visitors to Australia[21–23]

While the depth and breadth of drowning studies from Australia is unparalleled, few studies have evaluated long-term trends in the drowning burden over time.[15,22] One study focused on coastal drowning deaths and found little to no change over time, but uniquely identified exposure rates, calculating 0.55 costal drowning deaths per 10 million coastal visitor hours.[15] Another study examining drowning temporal trends, found an overall drowning rate to have decreased by 28%, with the highest decrease (-56%) occurring in children ages 0-4 years.[22]

Overall, assessing if and where progress has and has not occurred, especially related to specific national downing prevention priorities, is an essential reflective activity required for any public health issue.

To that end, this study aims to:

1. describe the burden of drowning in Australia over a 20-year period from July 2002 through to June 2022,
2. evaluate temporal trends over the 20-year period,
3. identify and characterise areas of success and areas that require significant attention for future drowning prevention action.

Methods

This study represents a retrospective, total population epidemiological analysis of unintentional fatal drowning in Australia between 1 July 2002 and 30 June 2022.

Data sources

Fatal drowning data were extracted from the Royal Life Saving Australia NFDD. While described in detail elsewhere,[10] briefly, the NFDD records drowning deaths from 1 July 2002 and is based on information from the National Coronial Information System (NCIS), which includes coronial findings, toxicology reports, autopsy reports and police reports. This information is then triangulated with media reports, drowning prevention/lifesaving organisation reports and data from State/Territory Child Death Review teams. Cases are included if they were unintentional in nature and drowning, defined as the "*process of respiratory impairment from submersion or immersion in liquid*",[1] is listed as a primary or contributory cause of death by the coroner. Drownings that are intentional in nature, such as homicide and suicide, and cases involving animal attacks in water (e.g. shark, crocodile, etc.) are excluded. All drowning cases in the NFDD are checked regularly against information in the NCIS. Case information was extracted from the NFDD and is current as of 30 June 2024.

Variables are categorised and coded from case file documentation as per the Royal Life Saving National Fatal Drowning Data Dictionary and Coding Manual.[10] All population data for rates were sourced from the Australian Bureau of Statistics (ABS),[24] including Socio-Economic Indexes for Areas, a measure of socio-economic status and remoteness categories.

Australian financial years were used due to how the data were collected over the study period, to ensure consistent comparison of government public health data and seasonal factors, as the summer season in Australia spans December to February. This allows to accurately look at seasonal trends and potential high-risk periods.

Statistical analysis

We described the cohort with counts, frequencies, and percentages of drowning deaths by person- and incident-specific variables. We calculated age-standardised mortality rates based on the 2001 Australian standard population using the direct standardisation method for all drowning deaths over the time period. Age-specific rates were calculated using age-specific population estimates from the ABS. Supplementary File 1 indicated which analyses were conducted on which variables.

Adult age groups were presented in ten-year increments when analysing age-specific rates; however, older age groups were combined and presented as +65-years when analysing trends for this priority group according to the AWSS.

We evaluated changes in fatal drowning rates over time in two ways. First, for clear communication and advocacy purposes, we calculated five-year cumulative fatal drowning rates for the starting years 2002/03 to 2006/07 and the ending years 2017/18 to 2021/22, and calculated the percentage difference between the two. Second, to describe and evaluate statistically significant trends in drowning rates, we analysed annual fatal drowning rates using the Joinpoint Regression Program version 5.0.2.[25]

To understand the geospatial nature of drowning deaths in Australia, we used the ArcGIS Fishnet tool[26] to visualise point density for all cases. This was done using latitude and longitude coordinates of the incident location, triangulated from available data in the NFDD (e.g. police, coroner reports and media).[10] Incident coordinates were then presented as a density map to not disclose single or identifiable drowning deaths. Density was calculated by spatially joining points within 20 km^2 cells across a fishnet covering the entire Australian continent, including the Torres Strait Islands and Tasmania. A fishnet heatmap is presented, identifying high- versus low-density drowning areas.

Data analysis was conducted using IBM SPSS,[27] with associated graphics produced in ArcGIS pro. Counts less than five are not presented in this study to prevent case identification and to keep to ethical standards.

Results

A total of 5,692 drowning deaths occurred in Australia between July 2002 to June 2022. The average annual age-standardised crude fatal drowning rate over the 20-year period was 1.22 per 100,000 population. The crude drowning rate in males was 3.7 times higher than that of females. Alcohol was present in 23.9% of drowning cases, and pre-existing medical conditions was present in 36.0% of drowning cases.

When comparing the starting years (2002-2007) of the study period with the ending years (2017-2022), the crude fatal drowning rate in Australia decreased by 24.1% (1.45 per 100,00 population *vs.* 1.10 per 100,000, respectively; Table 1). Evaluation of age-standardised crude fatal drowning rates per 100,000 population using Joinpoint analysis also showed a statistically significant decrease over the study period, -2.6% per year (Annual Percent Change [APC] = -2.62; 95%CI=-4.0 - -1.99; $p<0.001$). (Figure 1; Supplementary File 2).

Table 1: Cumulative drowning count, drowning rates and change over time.

Variables	Change in rate over time (per 100,000 population)			20-year cumulative count and rate (per 100,000 population)		
	Starting-year cumulative rate (2002-2007 avg)	Ending-year cumulative rate (2017-2022 avg)	% change	N (%)	Crude rate	CI
Total	1.45	1.10	-24.1%	5692	1.24	1.21 – 1.27
Age-group						
0-4 years	2.87	1.17	-59.2%	549	1.93	1.77 – 2.09
5-9 years	0.68	0.37	-45.6%	151	0.53	0.44 – 0.61
10-14 years	0.43	0.31	-27.9%	100	0.35	0.28 – 0.42
15-17 years	0.60	0.68	13.3%	112	0.65	0.53 – 0.77
18-24 years	1.47	1.22	-17.0%	563	1.29	1.19 – 1.40
25-34 years	1.50	1.09	-27.3%	845	1.29	1.20 – 1.38
35-44 years	1.33	1.07	-19.5%	751	1.17	1.09 – 1.26
45-54 years	1.58	1.05	-33.5%	765	1.27	1.18 – 1.36
55-64 years	1.57	1.14	-27.4%	711	1.40	1.29 – 1.50
65-74 years	1.74	1.62	-6.9%	615	1.68	1.55 – 1.82
75+ years	1.78	1.53	-14.0%	526	1.77	1.62 – 1.92
Sex						
Males	2.21	1.73	-22.0%	4472	1.97	1.91 – 2.02
Females	0.69	0.43	-37.4%	1220	0.53	0.50 – 0.56
Priority groups						
Children (0-4 years)	2.87	1.17	-59.2%	549	1.93	1.77 – 2.09
Young males (15-29 years)	2.11	1.77	-16.1	948	2.01	1.88 – 2.14
Older adults (+65-years)	1.80	1.61	-11.1%	1141	1.76	1.65 – 1.86
State of death						
ACT	0.66	0.49	-25.8%	43	0.54	0.39 – 0.73
NSW	1.59	1.19	-25.2%	1999	1.30	1.29 – 1.41
NT	4.07	2.81	-31.0%	170	3.51	3.11 – 4.21
QLD	1.74	1.27	-27.0%	1385	1.46	1.44 – 1.60
SA	1.15	0.73	-36.5%	304	0.87	0.81 – 1.02
TAS	2.18	1.54	-29.4%	211	1.95	1.76 – 2.31
VIC	0.92	0.74	-19.6%	882	0.73	0.72 – 0.82
WA	1.62	1.26	-22.2%	698	1.40	1.35 – 1.57
Body of water						
Bathtub/spa bath	0.11	0.05	-52.7%	359	0.08	0.067 – 0.083
Beach	0.23	0.23	0%	1019	0.21	0.200 – 0.226
Lake/dam	0.14	0.10	-28.6%	522	0.11	0.100 – 0.119
Ocean/harbour	0.25	0.14	-44.0%	906	0.19	0.177 – 0.202
River/creek	0.37	0.29	-21.6%	1499	0.31	0.298 – 0.330
Rocks	0.06	0.09	42.2%	378	0.08	0.071 – 0.087
Swimming pool	0.22	0.12	-45.5%	783	0.16	0.152 – 0.175
Other	0.06	0.04	-31.6%	217	0.05	0.039 – 0.051

CI = confidence interval; ACT = Australian Capital Territory; NSW = New South Wales; NT = Northern Territory; VIC = Victoria.

Age

Most drowning deaths occurred in the 25–34-year age group (n=845, 14.8%), children aged 0-4 years had the highest drowning rate (1.93 per 100,000 population) and the largest decrease in rates over time (59.2%). All age groups, except 15-17 years, showed a reduction in drowning rates over the study period (Table 1). Additional detail is presented below on key focus areas of the AWSS "People" section (Figure 1).

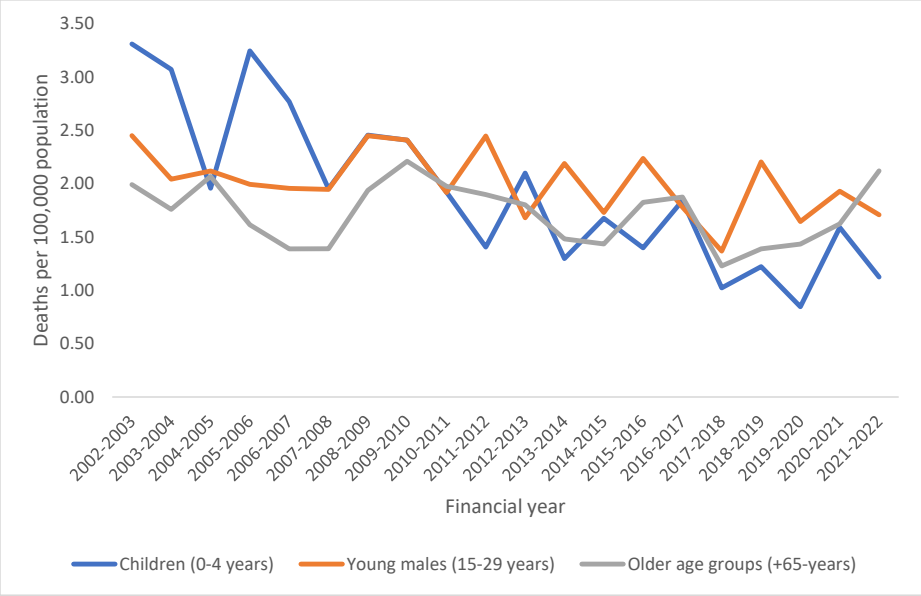
Children

A total of 549 drowning deaths occurred in children aged 0-4 years. This age group recorded the highest number of drowning deaths at swimming pools over the 20-year period, representing 36.0% (n=282). The leading activity prior to drowning was an unintentional fall into water, representing 76.9% (n=422) of all drowning deaths in this age group. Joinpoint analysis indicated a statistically significant decreasing trend of -5.41% per year (APC=-5.41; 95%CI=-7.27 - -3.84; $p<0.001$) for all deaths in this age group (Supplementary file 2, Supplementary file 3). Further, a Joinpoint analysis of trends of swimming pool drowning deaths (excluding cases that occurred in other locations) in children aged 0-4 also showed a statistically significant decreasing trend -5.84% per year (APC=-5.84, 95%CI=-7.69 - -4.32, $p<0.001$; Supplementary file 2, Supplementary file 3).

Young males

Males represented 79.0% (n=4472) of drowning cases over the 20-year period, with young males, aged 15-29 years, representing 21.2%

Figure 1: Crude fatal drowning rate over time by key people priority areas of the Australian Water Safety Strategy 2030: children (0-4 years), young males (15-29 years) and older age groups (+65-years).



(n=948) of male drowning deaths. The cumulative fatal drowning rate was 2.01 per 100,000 population. Trends over time showed a statistically significant decrease by -1.44% per year (APC=-1.44, CI=-0.012 - -2.87, $p<0.05$). A comparison between starting and ending years showed a -16% decrease in drowning rates overall. Young males most commonly drowned at rivers/creeks (32.6%), followed by beaches (21.8%). The majority of drowning deaths occurred while swimming and recreating (37.9%) followed by boating (9.7%). Alcohol was present in 307 (32.4%) of young male drowning deaths, with 55.7% (n=171) having a Blood Alcohol Concentration (BAC) greater than 0.05%. Drugs were present in 252 (26.6%) cases, 32.1% of which involved illicit drugs.

Older age groups

A total of 1,141 drowning deaths occurred among people aged 65 years and older, representing 20.1% of all drowning deaths during the 20-year period and a fatal drowning rate of 1.77 per 100,000 population. Of those 65-years and older, 62.3% had a pre-existing medical condition, the majority of which were cardiovascular issues. Trend analysis showed no statistically significant decrease over time (APC=-0.59, 95%CI=-2.09 – 1.14, $p=0.38$), although comparison between the starting and ending years indicated a -7% decrease in the 65-75-year age group drowning rate, and a -14% decrease in the +75 age group drowning rate. Most drowning deaths occurred at rivers/creeks (n=292, 25.6%), followed by beaches (n=198, 17.4%). The leading activity prior to drowning was an unintentional fall into water (n=231, 20.4%), this being an unexpected trip, slip or fall into water. Three quarters (76.3%) of drowning deaths in this cohort were males. Most deaths occurred during the summer (n=2,102, 36.9%), specifically during the months of January (n=827, 14.5%) and December (n=708, 12.4%). The majority of drowning deaths occurred over the weekend (n= 2,107, 37.0%) and in the afternoon (n=2,245, 39.4%).

Incident location

The majority of drowning deaths occurred in rivers/creeks, representing 26.3% of all drowning cases, with a crude drowning rate of 0.31 drowning death per 100,000 population (Table 1). Trend analysis identified a statistically significant annual decrease of -6.38% in drowning in rivers/creeks between 2010/11 to 2019/20 (APC=-6.38, 95%CI=-18.9 - -4.05, $p<0.001$); however, it spiked between 2019/20 and 2021/22 by 42.5% (APC=42.5, 95%CI=12.5 – 67.95, $p=0.001$). Beaches were the second highest drowning location, representing 17.9% (n=1,019) of drowning deaths, with a drowning rate of 0.21 per 100,000 (Table 1). Fatal beach drowning rate trends over time showed no statistically significant change during the 20-year period (APC=0.77, 95%CI=-1.13 – 2.93, $p=0.33$).

The male fatal drowning rate was 4.20 times that of females at river/creek locations, and 4.72 times that of females at beaches.

New South Wales (NSW) was the state with the highest number of drowning deaths (n=1,999), representing 35.1% of drowning deaths across Australia; 79.4% of NSW drowning deaths were males. Starting and ending-year comparisons showed a 25.2% decrease in drowning for NSW (Table 1).

The Northern Territory had the highest drowning rate (3.51 deaths per 100,000 population), despite having the second lowest number of drowning deaths (n=170, 3.0%), after the Australian Capital Territory (n=43, 0.8%) (Table 1). The NT also had the second highest percent change when comparing starting and ending-year rates–with a 31.0% decrease.

In contrast, Victoria had a low drowning rate (0.73 per 100,000 population) and the lowest percent change when comparing starting and ending-year cumulative rates (19.6% decrease; Table 1).

The majority of drowning incident locations are in major cities (n=2509, 44.1%) followed by inner regional areas (n=1603, 28.2%). High-density drowning locations are seen along coastal communities

and around major cities, where most people live in Australia; however, drowning is also notably spread out in regional locations (Figure 2). Six percent (n=392) of drowning occurred in remote and very remote locations. Trend analysis identified only a decrease in major cities (APC=-2.25, 95%CI=-345 - -1.09, $p<0.001$), whereas other remoteness categories showed no statistically significant change over time.

Place and population-based vulnerabilities

Addressing vulnerabilities to drowning can be complex and layered, and includes the context in which a person lives and the social determinants like socio-economic status, educational attainment and migration status.[3] Over half of those who drowned (n=3,009, 52.9%) during the study period, were major city residents; however, 23.8% of these residents drowned outside of their residential area. The fatal drowning rate for major cities residents was 0.97 per 100,000 population; that of inner regional residents (n=1220, 21.4%) was 54.6% higher at 1.50 per 100,000 population. Furthermore, 16.7% of inner regional residents drowned in areas that were not classified as inner regional. Over three quarters of drowning deaths that occurred in remote and very remote locations were residents to those areas (n=186, 79.5%). The highest drowning rates were recorded among residents of very remote locations; 2.48 drowning deaths per 100,000 population (Table 2).

The residential areas of people who drowned during the study period were evenly distributed across the socio-economic spectrum, 19.2% from the most disadvantaged areas versus 24.9% from the most advantaged areas. However, the drowning rates per 100,000 population show that those in the most disadvantaged areas drown at rates 75% higher than those from the most advantaged areas (1.63 per 100,000 compared to 0.93 per 100,000, respectively (Table 2).

Those born overseas represented 27.0% (n=1539) of drowning cases, with the top countries of birth being China (n=153, 2.7%) and New Zealand (n=102, 1.8%). Of those born overseas, 65.3% (n=1005) of cases were Australian residents, whereas 18.8 % (n=290) were overseas visitors.

Aboriginal and Torres Strait Islander people represented 5.1% (n=292) of drowning cases, with the highest number of deaths occurring in the 35-44-year age group (n=57, 19.5%) and in males (n=218, 74.7%). In this population, the most frequent drowning location occurred at rivers/creeks (n=141, 48.3%) and while swimming (n=77, 26.4%).

Discussion

This epidemiological study of drowning deaths in Australia over a 20-year period identifies areas of success and concern for national drowning prevention organisations and stakeholders. The AWSS has demonstrated its crucial role in national, state and territory and community-based approaches towards drowning prevention, contributing to the decrease in fatal drowning.[28] The AWSS has also highlighted the positive impact that water safety policies, legislation, ongoing education programs and public awareness campaigns have had in improving better water safety knowledge and behaviour. The strategy has also played a key role in advancing drowning prevention policies and research.[22] The AWSS has identified and directed water safety efforts to key areas using a multipronged approach. This type of approach identifies and uses several strategies to tackle the overall goal of improving water safety and to prevent unintentional fatal drowning incidents. Examples include raising awareness about water safety, educating and teaching the community, involving local communities in promoting water safety, implementing policies that support safer water practices and introducing regulations to enforce water safety standards. This approach has supported and informed

Figure 2: Drowning heatmap.

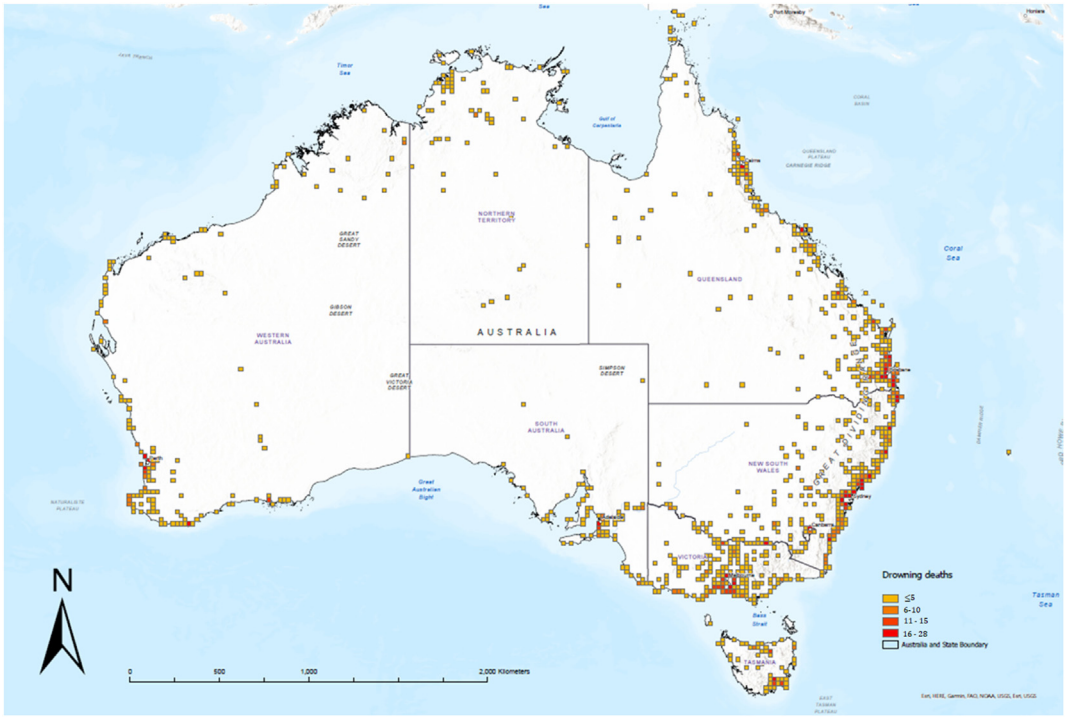


Table 2: Number of drowning deaths and crude rates by activity, Socio-Economic Indexes for Areas and remoteness.

Variables	Drowning deaths (n=5692)		Crude rate	95% Confident intervals
	N	%	Per 100,000 population	[CI]
Activity prior to drowning				
Bathing	358	6.3%	0.07	0.067 – 0.083
Boating	758	13.3%	0.16	0.147 – 0.170
Diving	302	5.3%	0.06	0.056 – 0.070
Fall	1055	18.5%	0.22	0.208 – 0.234
Fishing	85	1.5%	0.02	0.015 – 0.022
Jumped in	111	2.0%	0.02	0.019 – 0.027
Non-aquatic transport	377	6.6%	0.08	0.071 – 0.087
Other	39	0.7%	0.01	0.005 – 0.011
Rescue	119	2.1%	0.02	0.020 – 0.029
Rock fishing	243	4.3%	0.05	0.044 – 0.057
Swept away	42	0.7%	0.01	0.006 – 0.011
Swept in	52	0.9%	0.01	0.008 – 0.014
Swimming and recreating	1307	23.0%	0.27	0.259 – 0.288
Unknown	567	10.0%	0.12	0.109 – 0.128
Watercraft	273	4.8%	0.06	0.050 – 0.063
Season				
Summer	2102	36.9%	0.44	0.42 – 0.46
Autumn	1279	22.4%	0.27	0.25 – 0.28
Winter	986	17.3%	0.21	0.19 – 0.22
Spring	1325	23.2%	0.28	0.26 – 0.29
SEIFA				
Decile 9-10 advantage	1304	22.9%	0.93	0.87 – 0.98
Decile 7-8	1056	18.6%	1.01	0.94 – 1.07
Decile 5-6	929	16.3%	1.05	0.98 – 1.11
Decile 3-4	938	16.5%	1.39	1.30 – 1.48
Decile 1-2 disadvantage	1005	17.7%	1.63	1.52 – 1.73
Unknown	460	8.1%	-	-
Remoteness of incident				
Major cities	2509	44.1%	0.81	0.78 – 0.84
Inner regional	1603	28.2%	1.97	1.87 – 2.07
Outer regional	1045	18.4%	2.86	2.69 – 3.04
Remote	229	4.0%	4.37	3.80 – 4.93
Very remote	163	2.9%	5.56	4.71 – 6.41
Unknown	143	2.5%	-	-
Residential remoteness				
Major cities	3009	52.9%	0.97	0.93 – 1.00
Inner regional	1220	21.4%	1.50	1.42 – 1.58
Outer regional	733	12.9%	2.01	1.86 – 2.15
Remote	132	2.3%	2.51	2.09 – 2.95
Very remote	102	1.8%	2.48	2.80 – 4.15
Unknown	496	8.7%	-	-

CI = confidence interval.

the implementation of legislation such as pool fencing[29,30] and mandatory wearing of lifejackets when boating and fishing.[16,17]

Aside from the overall 24.1% decrease in drowning rates over the study period, the most remarkable finding from this study was the significant decrease in drowning rates, by 59%, that occurred among children aged 0-4. This decrease, while surely supported by a focus on caregiver supervision, access to early water familiarisation lessons, sustained water safety education programs and consistent prioritisation in national strategies, is most likely due to significant advances in pool fencing legislation at the state and local level.[6] A recent review describing interventions to prevent children drowning found that most remain primarily educational, and few recommendations in the published literature relate to policy.[31] Continued success in this age cohort is not guaranteed; rates have mostly stagnated since 2017-2018. Further research that provides robust evidence for why the decrease occurred is essential. Critically evaluating the impact of policy changes (e.g. pool fencing, school-based swimming programs) versus other types of educational efforts would guide success into the next decade and beyond, for this priority focus of children aged 0-4 years and other areas of the AWSS.

To this end, and while not all areas of the AWSS were studied in depth here, this study does identify some priority areas where progress has

been less defined, such as drowning among young males and people aged 65 years and older, nonevident, such as drowning at beach locations, or trending in the wrong direction, such as drowning at rock locations. Continued focus on these priority areas is warranted given their high rates, proportion of the overall drowning burden and slow or lack of improvement. The Australian drowning prevention sector must critically appraise whether the current strategies focused on these AWSS priority areas are working, why they are or are not working and what must happen to catalyse a decrease in the future.

While young males did experience an overall reduction in rates over the 20-year period, males in general still represent the largest proportion of deaths each year of any demographic group. Sex differences have long been a focus in drowning prevention research. While understanding of risk-perception and its influence on risk-taking behaviour is improving,[12,32] the cohort is complex and heterogenous, and evidence showing that interventions prioritising this group are effective is still lacking. A recent thinktank workshop focused on drowning prevention for young males in Australia acknowledged as much, recommending high school-based water safety education as one of the last places for population-level intervention.[33] While most prevention activities that focus on young males has been communication or education focused with questionable effectiveness, several known high-risk activities including swimming after drinking alcohol,[34] jumping from heights, or rapidly evolving social media-driven risky behaviour[35] might be addressed with targeted policy interventions. As behaviour change in this group has proven elusive from existing efforts, future progress may depend on more robust system-level action such as embedded programs in high schools, establishment and enforcement of alcohol bans in public places near waterways, and stricter regulation of alcohol advertising targeting young people while depicting waterways and water recreation.

Older adults (65+ years) are a cohort of growing concern with increasing numbers of cases and no evidence of statistically significant downward trends in drowning rates over the study period, despite some indication of movement when comparing starting and ending-year average rates. This finding is consistent with previous global studies of drowning among older people in high income countries (HICs),[36,37] where risk factors included gender, ethnicity, medical conditions, alcohol, rurality and unintentional falls.[37] As Australia's population ages, the growing proportion of drowning cases this cohort represents is not surprising but presents major challenges, as a drowning prevention sector with historical focus on children must adapt to this emerging issue of a growing older population. One challenge is how best to reach this cohort with water safety promotion and skills, while trying to support an active lifestyle into older adulthood. The role of medical conditions and medical episodes (e.g. cardiac-related incidents) in drowning fatalities among older people can be hard to determine or control for before or after going into the water. Future strategies and drowning prevention efforts for this cohort will need to consider cross-sector collaborations in fields such as falls prevention, occupational therapy, physiotherapy and other allied health settings where water safety messages can be integrated.

One way to prioritise interventions is by focusing on the body of water where someone drowns, in combination with the activities partaken at said locations. This study shows that drowning rates: i) decreased in bathtubs, at swimming pools, at ocean and harbour locations and at lakes/dams (Table 1); ii) had a period of decrease (2010-2019), followed by sharp increase (2019-2021) at rivers/creeks, likely do to major flooding events in 2020 and 2021 (Supplementary File 2); iii) did not change at beaches, which is consistent with other studies[15]; and iv) increased at rocks (Table 1). In Australia, and globally, these mentioned water locations represent places of recreational, economic, cultural, spiritual and societal significance. Improving understanding of people's exposure to, and subsequently ensuring their safety at, these places is a national drowning prevention priority.

In addition, the use of waterways has changed over time; therefore, future drowning prevention strategies should be tailored to address a range of activities and participants undertaking those activities. The successes around mandatory life jacket use for boating, and the advocated use of life jackets while rock fishing across Australian States/Territories,[16,17] provide a leading example and should be considered when identifying water safety strategies.

National safety guidelines and standards have existed for over 30 years for swimming pools[30,38] and were recently developed and released for inland waterways,[39] both with robust multisectoral national committees that ensure they adapt and evolve with needs and emerging issues. Some guidelines also exist for coastal spaces.[40] Over the study period, multiple uses of educational campaigns focused on different bodies of water or activities over the study period, yet evaluation of such campaigns are rare and have showed mixed results.[41] Especially for open bodies of water, rapidly evolving recreational trends driven by a growing and diversifying population, development in regional areas and climate change require Australia's drowning prevention strategies to be agile and adaptable. Recognising and having the courage to evolve parts of the drowning prevention system that are not working will be essential for driving drowning rates down.

Implications for public health

Finally, as the conceptual understanding of drowning prevention evolves to factor in the role of vulnerabilities, exposure and building resilience,[3] so too must our approach. While segmenting drowning into high-risk age groups, such as children or older adults, or places such as rivers or beaches has provided a platform which has led to some success, as shown here, it fails to account for the intersectionality and complexity that makes an individual, community or entire population vulnerable to drowning. This study shows, in line with previous drowning literature,[15,42,43] that populations identified as having increased vulnerabilities to drowning in Australia include those who live in socio-economically disadvantaged areas, those who live in regional and remote areas, people born overseas and those who identify as Aboriginal and Torres Strait Islander persons. Future research is needed to better characterise these vulnerabilities, including the social, political and economic determinants of drowning.[3]

By reflecting over the successes in drowning prevention, a range of interventions, including regulatory (e.g. pool fencing), educational (e.g. swimming lessons) and behavioural (e.g. public awareness water safety campaigns) have shown positive outcomes over the years with informing communities around water safety.[31,44] The AWSS has identified a framework outlining key drowning prevention priority areas of focus, which include people, places, activities, populations and risk factors.

Although drowning has decreased over the past 20 years, the future of drowning prevention needs to expand outside our general focus from specific age groups and locations. This includes addressing the impact of residential socio-economic status on access to water safety resources, overcoming the barriers faced by multicultural communities and improving the accuracy of data on Indigenous status in drowning cases. Additionally, enhancing the availability of exposure data will provide a more complete picture of risk factors.

Strengths and limitations

One of this study's strengths is the ability to track drowning over time, identify drowning trends in Australia and determine where additional prevention measures need to be directed. Broader inclusion definitions beyond just ICD-10 (International Classification of Diseases, Tenth Revision) allows for a more complete understanding of the drowning burden to inform appropriate drowning prevention stratagems.[10] Another strength of this study is its focus on all drowning deaths, including those caused by disasters (e.g. flooding in Australia), which are becoming an emerging challenge due to climate change.[45,46]

Future research will need to heavily focus on drowning events in communities with vulnerabilities to drowning, such as Aboriginal and Torres Strait Islander peoples and culturally diverse populations. Aboriginal and Torres Strait Islander peoples are known to be underreported in the data, as indigeneity status is not always presented or reported in coroner reports. This is also the case for country of birth, where information around country of origin and time in country is not always reported or available for some drowning cases. This limitation in the data collection and reporting identifies the need to prioritise consistent recording of Indigenous status in collaboration with community leaders.

Crude rates for location and activity were presented; however, the true population around those locations and the activities partaken is lacking, as exposure data is not readily available or is non-existent. It is important to note that coroners' reports take time, particularly toxicology reports; therefore, alcohol and drug results will be underreported. Although this study focuses on fatal drowning events, the need for more data sharing on non-fatal drowning will be essential for understanding the true burden of drowning in Australia.

This study has focused on the AWSS priority areas of people, places and location, with an in-depth analysis on tends over time. However, future research will need to consider focusing on temporal drowning trends outside the usual scope of drowning demographics and location, and include activities, socioeconomic status and residential remoteness variables.

Conclusion

Drowning deaths in Australia have reduced significantly over the past 20 years, particularly in the areas of child drowning and swimming pools.

A National Water Safety Strategy informed by epidemiological and contextually relevant data has enabled concerted and targeted efforts over a sustained period. However, there is still a need for improvement to meet the AWSS 2030 goal. This study identified where significant progress had been made in reducing drowning deaths over a twenty-year period, and where continued efforts are required.

Conflicts of interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: This research is supported by Royal Life Saving Society – Australia. Research at Royal Life Saving Society – Australia is supported by the Australian Government. Lauren Miller reports a relationship with Royal Life Saving Society Australia that includes: employment. Stacey Willcox-Pidgeon reports a relationship with Royal Life Saving Society Australia that includes: employment. William Koon reports a relationship with Royal Life Saving Society Australia that includes: employment. Justin-Paul Scarr reports a relationship with Royal Life Saving Society Australia that includes: employment. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Ethics

Ethical approval for this study was granted by the Victorian Department of Justice and Community Safety Human Research Ethics Committee (JHREC) (CR/19/25126).

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Appendix A Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.anzjph.2025.100258.