Public holiday and long weekend mortality risk in Australia: A behaviour and usage risk analysis for coastal drowning and other fatalities

Luke Strasiotto,[1] Annabel Ellis,[1] Shane Daw,[1] Jasmin C. Lawes[1,2,*]

[1]Surf Life Saving Australia, Bondi Beach, NSW, 2026, Australia
[2]UNSW Beach Safety Research Group, Kensington, NSW, 2052, Australia

Submitted: 22 March 2023; Accepted: 27 March 2023

Abstract

Objective: This article aims to determine the impact of public holidays and long weekends on the risk of drowning and non-drowning deaths on the Australian coast.

Methods: A retrospective case-control study using relative risk ratios and Z-scores to compare all unintentional fatalities on the Australian coast between 2004 and 2021 to a longitudinal representative survey sample of the Australian public and their coastal usage.

Results: Overall, the coastal mortality risk increased by 2.03 times for public holidays (95%CI = 1.77–2.33, $p<0.0001$) and 2.14 times by long weekends (95%CI = 1.85–2.48, $p<0.0001$). Children <16 years had the highest increased risk of death on public holidays (RR = 3.53, 95% CI = 1.98–6.31, $p = 0.0005$) and long weekends (RR = 2.90, 95%CI = 1.43–5.89, $p = 0.011$), while residents who were born overseas had a higher risk of death compared to those born in Australia. For public holidays, the greatest increase in risk was for swimming/wading and bystander rescues, while for long weekends, it was for scuba diving and snorkelling.

Conclusions: Public holidays and long weekends increase the risk of both drowning and non-drowning deaths on the Australian coast, which differed by demographics and activities.

Implications for public health: These results highlight periods of risk when targeted coastal safety messaging to high-risk demographics (particularly children and overseas-born residents), and provision of surf lifesaving resources can be increased.

Keywords: drowning, public holidays, long weekends, mortality, coastal

Introduction

Public holidays in Australia are official days where workers are absent from their place of employment.[1] When they occur directly adjacent to a weekend, they create a three-day break, colloquially termed a "long weekend." These holidays enable Australians to participate in coastal activities, resulting in the well-publicised increased coastal usage and crowded beaches.[2] Increasing visitation raises exposure to coastal risks and hazards, which can result in drowning or injury. Holidays may also encourage dangerous behaviours and risk factors for drowning, such as increased alcohol consumption.[3,4] Understanding how risk differs on public holidays and long weekends is crucial for coastal safety organisations, who provide surf lifesaving services to safeguard the community.

Accidents, deaths and hospital admissions increase during public holidays,[5,6] including drowning.[7] On Australian public holidays, drowning is increased 1.73 times,[3] but this risk varies based on age, sex and activity (e.g., 3,8). Behavioural or cultural differences may influence public holiday drowning, for example, increased risk taking behaviours, including alcohol and drug consumption.[3,9,10] However, there have been less studies undertaken on the impact of long weekends on coastal deaths despite potentially similar influences on coastal usage, behaviour and increasing risk on long weekends. For instance, travel in Canada is thought to be responsible for the changes in accident profiles based on province on long weekends.[5] Similarly in South Africa, the risk of drowning on public holidays or long weekends increases by 1.2 times.[11]

Studies investigating drowning risk on public holidays and long weekends are limited (but see 11), focusing on drowning only and excluding potentially preventable non-drowning deaths. Similarly, these studies compared drowning risk to the population or to other decedent categories. While this approach is common, a more accurate

*Correspondence to: Surf Life Saving Australia, Bondi Beach, Sydney, NSW, 2026, Australia.
e-mail: jaz.lawes@sls.com.au.

Aust NZ J Public Health. 2023; Online; https://doi.org/10.1016/j.anzjph.2023.100054

estimate of mortality risk can be calculated using the number of coastal visitors or activity participants.[12,13]

This retrospective case control study explores coastal mortality risk on public holidays and long weekends. Coastal deaths during these holiday time periods are compared to a longitudinal survey dataset representative of the Australian population. Demographic factors that may influence the risk of coastal fatalities on public holidays or long weekends are investigated such as biological sex, age, cultural background and rurality. Behavioural factors on public holidays or long weekends such as coastal activity participation, alcohol and drug consumption, and social company while participating in activities will also be explored. We hypothesise increased mortality risk for social activities where participation is often with company (e.g., swimming, bystander rescues), and for high risk-taking demographics and behaviours (e.g., males, young adults, alcohol/drug consumption). In investigating these factors, this study will provide information to that can inform coastal safety managers and organisations. This information can subsequently be used to enable tailored service delivery of preventative strategies including public health messaging or allocation of lifeguarding and surf lifesaving services.

Methods

This case-control study identified risk factors for total coastal deaths in Australia (drowning deaths and non-drowning deaths combined) on long weekends and public holidays. This was undertaken by comparing the Australian population's coastal participation (through a representative survey sample) to total deaths on long weekends and public holidays.

Data inclusion

Two databases were used to explore this issue: Surf Life Saving Australia's (SLSA's) Fatality Database and National Coastal Safety Survey (NCSS) data.

Unintentional coastal deaths within the Fatality Database that occurred from July 1, 2004, to June 30, 2021, were included in analysis. These included both drowning and non-drowning fatalities (i.e., marine fauna deaths, medical conditions, injuries) that occurred within 12NM from the coast. Case information were collected from multiple sources and verified with National Coronial Information System (NCIS) as previously described.[4,8,14] The NCIS is an online the database of deaths reported to Australian and New Zealand Coroners and maintained by the Victorian Department of Justice and Community Safety. Since the survey data include responses of Australian residents, only decedents determined to be Australian residents were included in analyses.

The list of public holidays was taken from data supplied by the Australian Government.[15] For years not provided in that dataset (holidays prior to 2014), data were manually input from a third-party website.[16] All national and state holidays were included; a death was only attributable to a state holiday if the decedent resided within the corresponding state. If a decedent had date of death within a three-day range, it was assumed the date of death was the earliest date (often the date of the incident, or date last seen). For decedents with a date of death that ranged greater than three days, classifications of public holiday and long weekends were determined where possible. For incidents that occurred both on a long weekend on the actual public holiday (such as a death on Good Friday) were included in both the public holiday and long weekend analyses. The dataset included all eligible cases was N = 2665. However, date ranges were unable to be classified for some cases, which were excluded from the study. The final fatality dataset for analysis included n = 2645 cases for public holiday and n = 2648 for long weekends (**Figure 1**).

The data from SLSA's Fatality Database were compared to a representative sample of the Australian population forming a control dataset for coastal participation, namely the combined results from annual NCSSs.

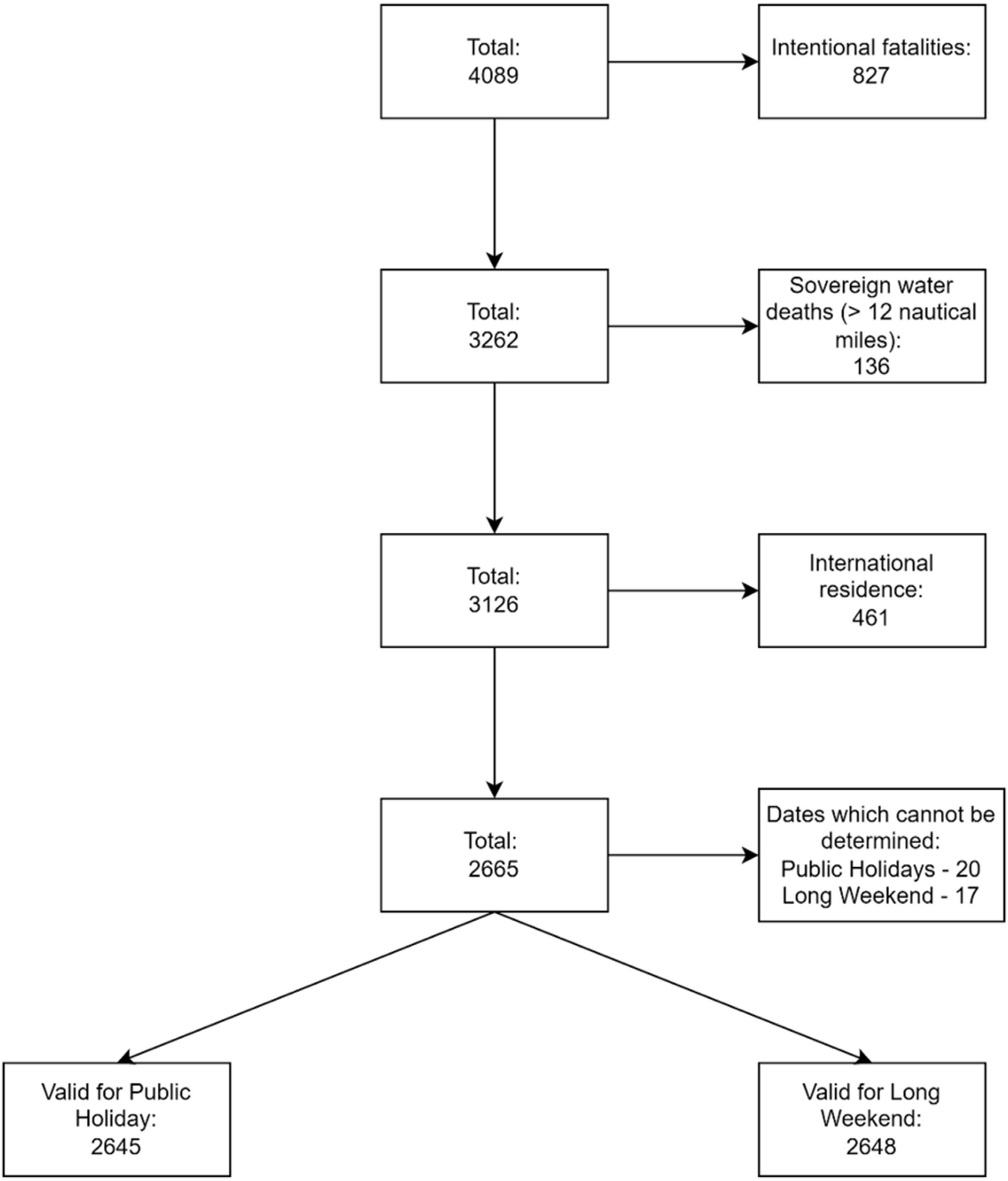
The NCSS dataset included data from 2014 to 2021 (inclusive). The NCSS is a representative online survey of the Australian population (aged 16 years and above), with highly consistent questions across the time period.[13] These representative surveys provide a robust longitudinal control dataset for coastal participation and behaviours regarding the usage of coastal environments. This allows for results to be interpreted as more causative than correlative, as well as providing more accurate coastal participation and behavioural data using exposure time rather than total population. The collection of this data and creation of the longitudinal dataset is discussed in detail in previously published literature.[13] Although the NCSS dataset provides key and otherwise unobtainable data for analyses, limitations still exist. This means that assumptions needed to be made to create a complete dataset comparable to the Fatality Database. Population estimates needed to be made for specific age groups who were unable to be surveyed—specifically, people over the age of 70 for 2014–2017 and for children under the age of 16.

Estimating coastal visitation participation populations

Children under the age of 16 are not surveyed in the NCSS due to ethical and survey delivery requirements. Consequently a "Child" group was created for <16 year olds, by creating a "Parent" category based on the responses of participants who indicated the number of children <16 in the household. This assumed that children aged <16 years recreate on the coast similarly to their parents,[17,18] with the "Child" group retaining the parents activity participation and demographics data (with the exception of scuba diving, where regulations means children aged <10 years cannot participate and children aged 10–15 have significant restrictions[19]). This meant that children under the age of 16 years (the extrapolated Child group) were excluded from scuba diving analyses, with the over 16-year-old children being represented within the survey (although classified as "Young Adults"). Participants were not classified in the "Parent" group (and therefore corresponding children not extrapolated into the "Child" group) if the participants were aged <20 years at the birth of the child or if the participants were >45 years (if female) or >55 years (if male). This was to minimise classifying older siblings and grandparents into the "Parent" group age. These age ranges were based on Australian population data demonstrating <2.5% of children are born to parents of these ages.[20,21] More details on the proxy dataset development are in Supplementary Text A.

Australians aged 70+ years were only included from the NCSS from 2018, being initially excluded (2014–2017) due to concerns regarding internet penetrance for these age demographics. They were therefore underrepresented in the combined database,[13] which was addressed by increasing the weights of the responses from the 2018–2021 data. Further details on how this weight modification was calculated are in Supplementary Text A.

Figure 1: Decision making pathway for case inclusion in the fatality dataset.



After removing survey respondents who did not engage in coastal activities, the original NCSS dataset had a sample size of n = 7572 respondents. After calculation and addition of the proxy "Child" and 70+ groups, the final representative dataset included an effective sample size of n = 10911 respondents representing the control coastal participant population.

NCSS Dataset structuring process

Most variables were analysed by comparing the coastal fatality dataset to the control coastal participant population dataset (Table 1). For time-based exposure analyses, some variables (Table 1) were compared to the number of participant days per year, determined from the control dataset.

Since many holidays are jurisdiction-specific, the sum of the coastal participants for each category was divided by the state of residence, then multiplied by the corresponding number of public holidays and long weekends for each state over the 17-year study period. For instance, if State A had 100 coastal participants and 50 public holiday days in the period, State A would have 100*50 = 5000 expected participant public holiday days, which would then be summed with all other states for a total participant public holiday days.

Some variables were measured in the number of participation days per year (Table 1). There were further questions asked on how often respondents engage in safe practices. From these questions, it could be extrapolated as to what percentage of the time and consequently how many days a year respondents engaged in risk taking behaviour. The number of days participating in an activity/risk taking behaviour was then multiplied by the percentage of public holidays and long weekends for each state to represent the days of holiday participation vs. days of non-holiday participation for each variable. For example, to estimate the number of participant swimming (days) that occurred on public holidays, total swimming participation (days) was multiplied by the proportion of public holidays compared to total days (public and non-public holiday days) over the 17-year period to give a proxy for the average number of participant swimming days (holiday days). So, if there were 80 participant swimming days in State A and 25% of days in State A were public holidays, then there would be 80*0.25 = 20 expected swimming days on public holidays in State A, which would then be summed with all states. Further details on how data were cleaned and extrapolated can be found in Supplementary Text A.

Data Analyses

Statistical analyses were performed on R (V.3.6.1)[22] and RStudio (V.1.2.5019).[23] Data were cleaned using the package tidyverse (v 1.2.1)[24] and relative risk ratios were calculated using the package epitools (V 0.5.10).[25] Relative risk ratios compared the differences in mortality risk using number of coastal deaths (drowning and non-drowning fatalities) that occurred on holiday days and non-holiday days, to the corresponding coastal participant populations or participant days as calculated using the NCSS dataset (see section above). Analysis of toxicological data from the Fatality Database was performed as per previous methods,[4] where a decedent was classified as being affected by intoxicating substances if their blood concentration reached a predetermined threshold set by the literature[4] (e.g., 0.05 blood alcohol concentration for alcohol). However, this previous method was modified[4] to only include alcohol and illicit drugs (as opposed to also including prescription and/or over the counter drugs), to align more accurately with the wording of questions in the NCSS. Indigenous Australian decedents and participants were included both in the Indigenous category and the Australia-born category for the relative risk analyses. However, in order to maintain independent statistical samples, when directly comparing Australian born to Indigenous Australians, Indigenous Australian decedents were not included in both categories. The comparisons for each variable are described in Table 1. Between-group comparisons explored whether relative risk ratios differed and were made using calculated Z scores,[26] with Bonferroni corrections applied. Visual representations were developed using the package ggplot2.[27]

Results

Of the fatality dataset (n = 2665), holiday status was determined for 99% of coastal drowning and non-drowning fatalities (Figure 1), with cases with unknown holiday status excluded from analyses (public holiday: n = 20; long weekend; n = 17). Over the 17-year period, 185 coastal deaths occurred on public holidays (6.99%) and 167 on long weekends (6.31%). In comparison, the control participant populations, based on their state of residency, experienced 3.45% of their days as public holidays and 2.98% as long weekends. See Supplementary Tables 1-2 for group comparison tests and Supplementary Table 3 for breakdown of coastal deaths by drowning and non-drowning deaths.

Public holiday coastal mortality risk

Overall, public holidays increased mortality risk by 2.03 times (95% CI = 1.77–2.33, $p<0.0001$). This risk was increased for both drowning deaths (RR = .18, 95%CI = 1.85–2.56, $p<0.0001$) and non-drowning deaths (RR = 1.67, 95%CI = 1.28–2.17, $p = 0.0004$; **Figure 2**). Public holiday mortality risk did not differ by sex (Z = 0.65, $p = 0.51$), with risk increasing for both sexes. Public holiday risk was 2.05 times greater for males (95%CI = 1.81–2.48, $p<0.0001$) and 1.77 times greater for females (95%CI = 1.17–2.68, $p = 0.011$; Figure 2).

The public holiday mortality risk was 3.53 times higher for children (<16 years) (95%CI = 1.98–6.31, $p = 0.0005$), 2.69 times higher for young adults (16–39 years) (95%CI = 2.19–3.31, $p<0.0001$), and 1.76 times higher for adults (40–64 years) (95%CI = 1.40–2.22, $p<0.0001$; Figure 2). There was no effect of public holidays on older persons (65+ years) mortality risk (RR = 1.24, 95%CI = 0.83–1.86, $p = 0.28$; Figure 2). Public holiday mortality risk for children (Z = 2.9, $p = 0.0018$) and young adults (Z = 3.35, $p = 0.0041$) were higher than older persons, and the risk of death for young adults was higher than the adults (Z = 3.35, $p = 0.0041$).

Public holiday mortality risk increased for Australian-born individuals (RR = 1.80, 95%CI = 1.46–2.22, $p<0.0001$; Figure 2) and for those born overseas (RR = 2.66, 95%CI = 2.1–3.36, $p<0.0001$; Figure 2). No effect of public holidays was observed for Indigenous Australians (RR = 2.19, 95%CI = 0.85–5.62, $p = 0.11$; Figure 2). People born overseas had higher mortality risk than those born in Australia (Z = −2.40, $p = 0.0075$).

Public holiday mortality risk was increased regardless of rurality (Z = −0.29, $p = 0.38$), increasing for both major cities (RR = 2.06, 95% CI = 1.65–2.57, $p<0.0001$) and regional/rural areas (RR = 2.15, 95% CI = 1.8–2.58, $p<0.0001$) (Figure 2).

Public holiday mortality risk was increased for most coastal activities, except scuba diving, boating, fishing and PWC (personal watercraft). The activities with the highest increased risk were swimming/wading

Table 1: Comparison between variables and categories analysed for the Fatality Database and NCSS Dataset.

Variable	Fatality Database		NCSS Dataset	
	Categories	Definition	Categories	Definition
Incident Type	Drowning	If classified as a drowning or immersion death on NCIS	Total coastal participation	Participant days per year across all coastal activities
	Death	Any cause of death that does not fit drowning criteria	Total coastal participation	
Sex		As defined by NCIS		Coastal participants
	Male		Male	
	Female		Female	
Age		As defined by NCIS		Coastal participants
	Child (0–15)		Child (0–15)	Extrapolated from parent responses
	Young adult[16–39]		Young adult[16–39]	
	Adult (40–64)		Adult (40–64)	
	Older persons (65+)		Older persons (65+)	Increased weighting for 70+ age group (2018–21)
Activity		Activity at time of incident		Participant days per year in corresponding coastal activities
	Attempting a rescue		Attempting a rescue	Attempting a rescue—Compared to participant days per year across all coastal activities
	Boating		Boating	
	Fall		Fall	Fall—Compared to participant days per year across all coastal activities
	Fishing		Fishing	
	Jump		Jump*	*no appropriate comparison
	Non-aquatic transport		Non-aquatic transport*	*no appropriate comparison
	PWC (personal watercraft/jet skis)		PWC (personal watercraft/jet skis)	
	Rock fishing		Rock fishing	
	Scuba diving		Scuba diving	
	Snorkelling		Snorkelling	
	Swimming/wading		Swimming/wading	
	Watercraft		Watercraft	
Alone		If the decedent was participating in their activity alone when the incident occurred or with others		Participant days per year in all coastal activities for participating alone or with others
	Alone		Alone	
	With others		With others	
Cultural Background		Continent of decedents birth		Coastal participant indicated ethnicity
	Australia		Australia	
	Overseas		Overseas	
	Indigenous Australian	Whether the patient was Aboriginal and/or Torres Strait Islander as specified by NCIS	Indigenous Australian	
Rurality/Regionality		Remoteness based on location of incident		Coastal participants
	Major city (RA1)		Major city (RA1)	
	Regional/remote (RA2-RA5)		Regional/remote (RA2-RA5)	
Toxicology		Toxicology was positive for alcohol and/or illicit drugs		Participant days per year in all coastal activities for participating under the influence of alcohol and/or drugs
	Positive toxicology		Participating under the influence	
	No Toxicology		Not participating under the influence	

*indicates that there was no appropriate comparison that could be made in the NCSS Dataset.

(RR = 2.94, 95%CI = 2.31–3.76, $p<0.0001$) and attempting a rescue (RR = 3.41, 95%CI = 1.78–6.55, $p = 0.002$; Figure 2). Swimming/wading mortality risk was higher than boating (Z = −3.76, $p = 0.00017$).

Public holiday mortality risk was 2.4 times greater (95%CI = 2.01–2.88, $p<0.0001$) when participating in activities with others and 1.16 times greater when alone (95%CI = 0.81–1.67, $p = 0.41$; Figure 2). This risk was higher when with participating with others than participating alone (Z = –3.53, $p = 0.00021$).

Both positive and negative toxicology revealed increased public holiday mortality risk (positive toxicology: RR = 1.70, 95% CI = 1.16–2.51, $p = 0.014$; negative toxicology: RR = 2.16, 95%

Figure 2: The impact of public holidays on the relative risk of coastal death. A relative risk ratio greater than one indicates increased risk of death.

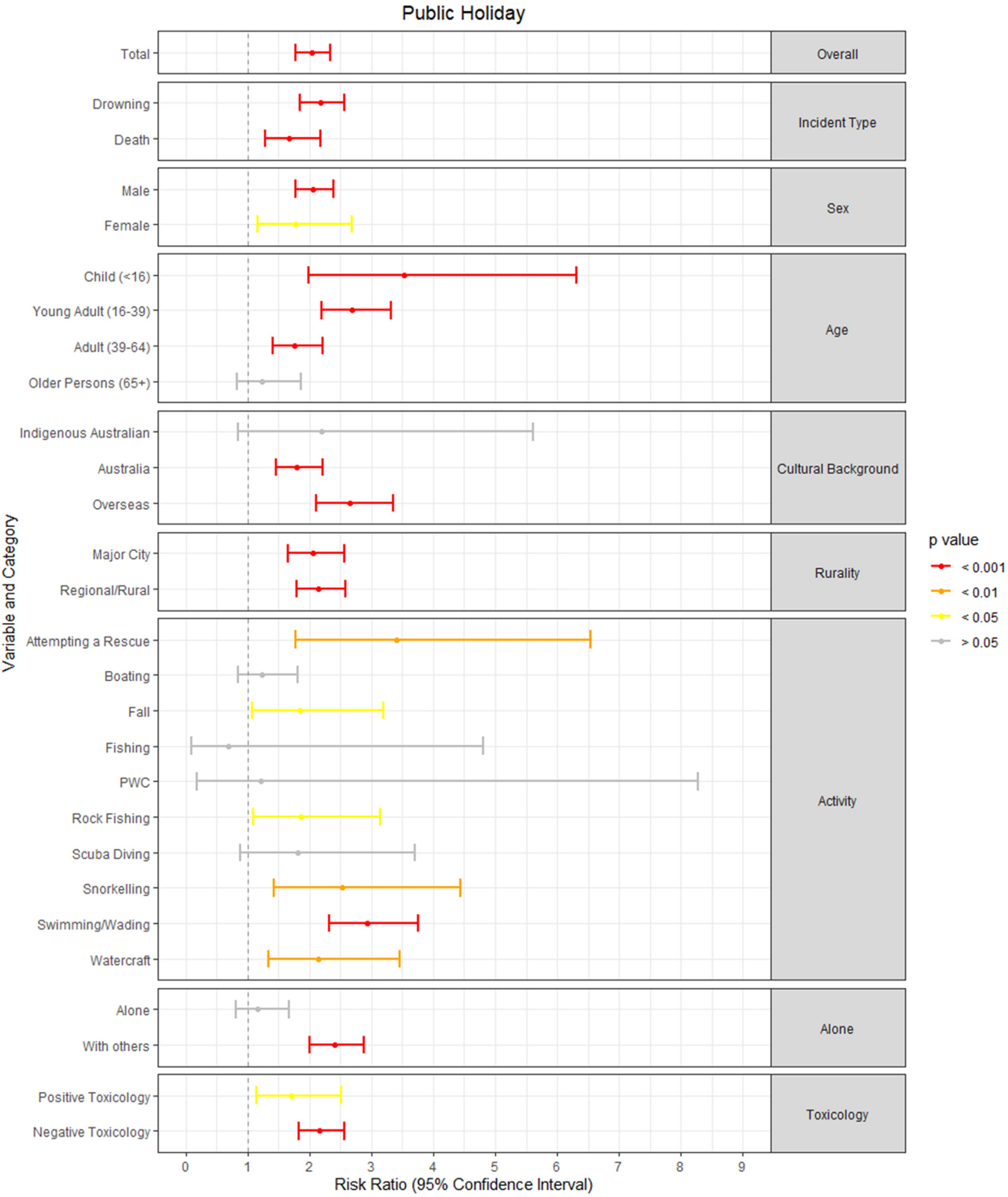
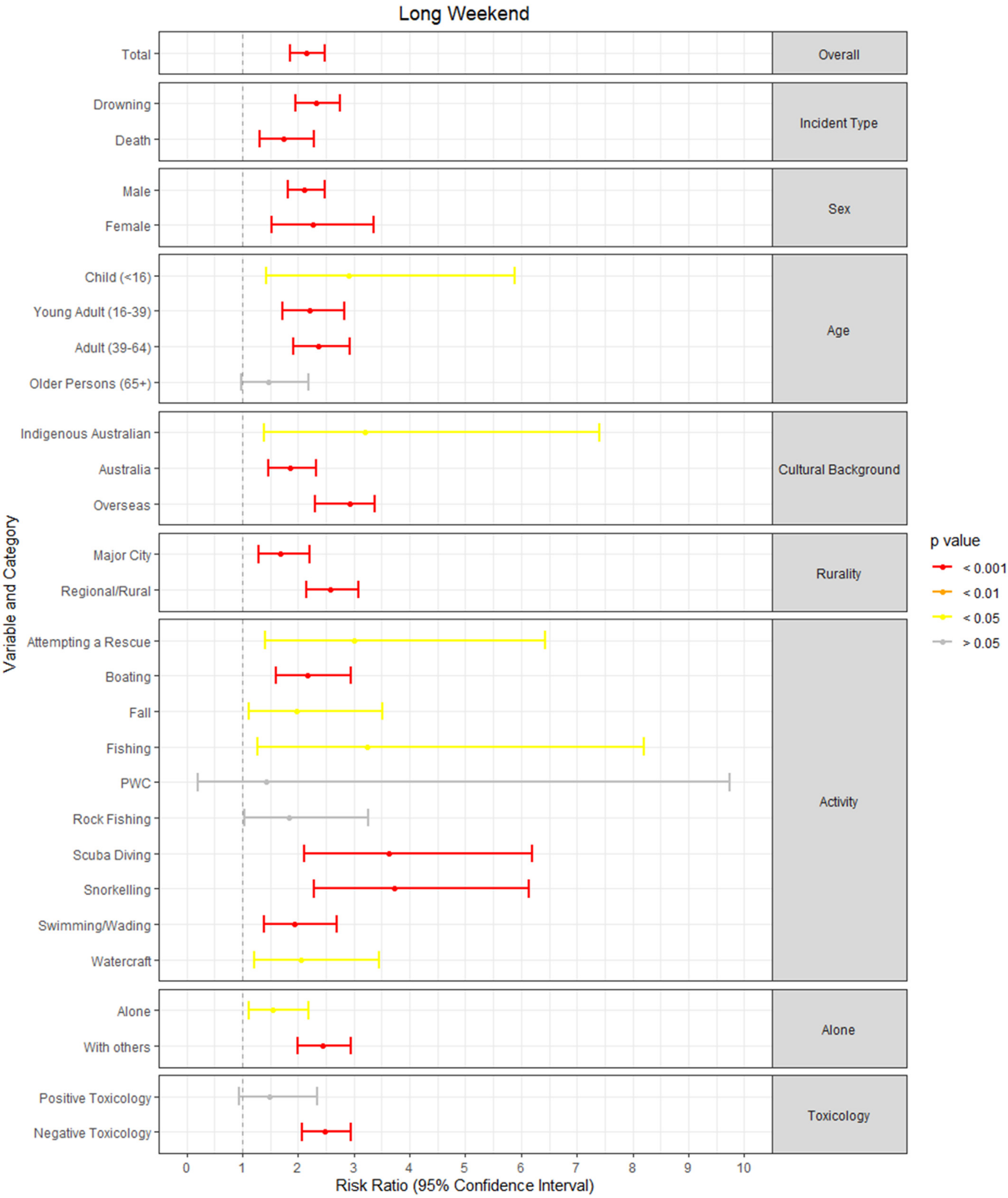


Figure 3: The impact of long weekends on the relative risk of coastal death. A relative risk ratio greater than one indicates increased risk of death.



CI = 1.83–2.57, $p<0.0001$; Figure 2), but this increased risk did not differ significantly between groups (Z = −1.1, p = 0.27).

Long weekend coastal mortality risk

Overall, long weekends increased mortality risk by 2.14 times (95% CI = 1.85–2.48, $p<0.0001$; **Figure 3**). This risk was increased for both drowning (RR = 2.32, 95%CI = 1.95–2.76, $p<0.0001$) and non-drowning deaths (RR = 1.73, 95%CI = 1.31–2.29, p = 0.0004) but did not differ between fatality types (Z = 1.74, p = 0.08).

Long weekend mortality risk increased for males (RR = 2.11, 95% CI = 1.81–2.48, $p<0.0001$), females (RR = 2.26, 95%CI = 1.52–3.36, p = 0.0003), children (RR = 2.90, 95%CI = 1.43–5.89, p = 0.011), young adults (RR = 2.21, 95%CI = 1.72–2.83, $p<0.0001$) and adults (RR = 2.36, 95%CI = 1.91–2.92, $p<0.0001$) but did not differ for older persons (RR = 1.46, 95%CI = 0.98–2.18, p = 0.07; Figure 3). Between-group comparisons found no significant difference in risk for between sexes (Z = 1.74, p = 0.08) or age groups ($p>0.0083$).

Long weekend mortality risk increased for all cultural groups, Australian-born (RR = 1.85, 95%CI = 1.47–2.32, $p<0.0001$), overseas-born (RR = 2.93, 95%CI = 2.3–3.37, $p<0.0001$) and Indigenous Australians (RR = 3.19, 95%CI = 1.38–7.4, p = 0.02; Figure 3). Decedents born overseas were at higher risk compared to Australian-born individuals (Z = −3.03, p = 0.001).

Long weekend mortality risk increased at major cities (RR = 1.68, 95% CI = 1.29–2.20, p = 0.0004) and regional/rural areas (RR = 2.58, 95% CI = 2.15–2.08, $p<0.0001$), with regional/rural areas at greater risk than major cities (Z = −2.26, p = 0.004)

Long weekend mortality risk increased for all activities, except rock fishing and PWC (Figure 3). Risk increased more than threefold for scuba diving (RR = 3.62, 95%CI = 2.11–6.2, p = 0.00013), fishing (RR = 3.23, 95%CI = 1.27–8.21, p = 0.035) and snorkelling (RR = 3.73, 95%CI = 2.28–6.13, $p<0.0001$; Figure 3).

Long weekend mortality risk increased both for solo activity participants (RR = 1.55, 95%CI = 1.11–2.18, p = 0.018) and those with others (RR = 2.43, 95%CI = 2.00–2.95, $p<0.0001$; Figure 3). This risk was higher when with others than alone (Z = −2.26, p = 0.011).

Long weekend mortality risk increased for decedents with negative toxicology (RR = 2.47, 95%CI = 2.07–2.94, $p<0.0001$; Figure 3) but not those with positive toxicology (RR = 1.49, 95%CI = 0.95–2.35, p = 0.10; Figure 3). Mortality risk of death with negative toxicology was significantly higher than positive toxicology (Z = −2.04, p = 0.041).

Discussion

Holidays can be high-risk periods. This study supports and builds on previous research, demonstrating both public holidays and long weekends increase not only the risk of drowning deaths[3,7] but also overall mortality risk of death on the coast. Overall, similar patterns between public holidays and long weekends were observed, revealing increased risk on public holidays or long weekends for most variables. This included an increased risk of both drowning deaths and other non-drowning coastal fatalities. Children (age <16 years) were at the greatest risk, as were those born overseas, swimmers/waders and bystander rescuers. Coastal participants recreating with others and not under the influence of alcohol or drugs were also had a higher mortality risk on public holiday and long weekends.

The increased risk for children and young adults compared to older persons on public holidays was expected as older Australians are closer to retirement and, consequently, public holidays and long weekends may not deviate much from 'normal'. Previous studies report that retirees undergo more leisure activities in general.[28] Similarly, the increased mortality risk of young adults compared to adults may be due to the social nature of public holidays and the increased time young adults spend engaged in leisure activities with others.[28] This highlights that public safety messaging around the risk of these holidays could be most beneficial targeted at younger populations.

Both public holidays and long weekends increased mortality risk for most coastal activities with boating, land-based fishing and scuba diving were more at risk on long weekends, and rock fishing on public holidays. This variation may be explained by long weekends being a three-day holiday as opposed to a single day public holiday. This lengthened holiday time could increase opportunities for extended trips or to participate in organised activities including scuba diving, boating and fishing, which may be less achievable or desirable for a single day. Complex, regulated activities such as scuba diving and boating also offer professionally organised activities conducted by commercial operators that may have modified or reduced operations on public holidays (in some cases legislated such as Good Friday).[29] However, these highly regulated activities may experience greater availability and participation over the extended break period offered by long weekends. Activity risks in this study largely reinforced previous research, except for the increase for rock fishing, which was previously found non-significant.[3] This increased rock fishing mortality likely reflects the popularity of rock fishing and increased sample size available for contemporary analysis. Public holidays may also facilitate flexible opportunities to travel and fish, as most rock fishing decedents live greater than 50km from the incident location.[30] This increased mortality for rock fishers further emphasises the need for more widespread legislative changes enforcing lifejacket use during increased rock fishing periods.[31] The higher swimming risk compared to boating on public holidays may reflect increased beach usage for swimming[32] and demonstrate the ongoing and perhaps expanded need for coastal lifesaving services at these times.

Mortality risk for Indigenous Australian decedents increased only for long weekends. This may reflect cultural determinants such as historically fragmented or isolation populations, combined with contemporary financial challenges and culturally important family structures, meaning time and travel may be needed to visit family and country.[33] Long weekends may better facilitate such trips, and this increased availability of travel on long weekends is further reinforced by increased risk of death in regional/rural Australia compared to major cities on long weekends as opposed to public holidays. Consequently, engagement with Aboriginal and Torres Strait Islander communities and rural/regional communities around long weekends regarding safe water practices could help mitigate this risk.

A higher mortality risk was found for overseas-born compared to Australia-born decedents for both public holidays and long weekends. The risk of migrant demographics drowning is attributed to limited water safety knowledge, swimming skills, and experience in recreational aquatic environments.[34] Consequently, when combined with desires to assimilate into Australian culture,[35] for example, coastal recreation on holidays, these communities can be at a greater risk of death during holiday periods. This highlights the general need for the migrant community to have increased education on the risks of coastal activities and further training regarding water safety and swimming skills.[36]

Mortality risk increased for both long weekends and public holidays when participating in activities with others. This may reflect the social aspect of holidays, where people are more likely to recreate with others, especially friends and family.[32,37] This may also contribute to the increased risk of fatal bystander rescues, as the action of rescuing is largely altruistic and often involve the rescuer going to the aid of a child or other family member.[14] This further highlights the increased coastal usage during these time periods and the need for increased services and public education to mitigate the risk of death.

Toxicology (alcohol and/or drugs) is known to increase drowning and injury events[4,38] and greater consumption of toxicants occur on public holidays and long weekends.[9,39] In this study, increased risk was observed for both positive and negative toxicology groups on public holidays (as per[3]), and the negative toxicology group for long weekends. Public holiday risk did not differ between toxicology groups, while long weekend risk was significantly higher risk for the negative group. This suggest that while, for instance, alcohol consumption increases on holidays,[9,39] it is not a dominant contributory factor on long weekends, and that mortality risk is higher in general on public holidays, regardless of toxicology (e.g., [4]). This general increase in risk independent of toxicology is indicative that the most probable increase in mortality on public holidays and long weekends is increased participation, as opposed to increased risk-taking behaviours.

Strengths and Limitations

This is the first case-control study to demonstrate coastal mortality risk on public holidays and long weekends, with several strengths to highlight. A significant strength is the ability to more accurately determine the risk of death using participation, as the representative coastal participant dataset allowed comparisons between coastal participants and coastal deaths, as opposed to the general population. This further facilitated detailed analyses of high-risk holiday behaviours, that is, participating in activities alone or with others, alcohol and drug consumption, and coastal activity participation. Analyses explored both drowning and other non-drowning deaths, presenting the overall coastal mortality burden to better inform preventative service provision.

Despite these strengths, limitations exist relating to the extrapolated "Child" dataset and weighted 70+ respondents. However, the detailed and systematic approach to these data (see methods and Supplementary Text A) was logical and evidenced.[20,21] The resulting dataset therefore provides a better estimate of children coastal participation than otherwise available. Another limitation is that these data cannot fully delineate whether the increased risk of death is driven by increased coastal participation or risk-taking behaviour. However, risk analyses of high-risk behaviours, for example, alcohol/drug consumption or participating alone in activities, were not significantly increased from their counterpart, indicative that increased coastal participation may be the primary driver of public holidays and long weekend risk. A further limitation of this study is that some variables that have been demonstrated to increase the risk of drowning deaths in holidays, such as decedent's distance from home to location of death,[3] were unable to be analysed as the participation data from the NCSS does not capture detail to the granular level of the number of days spent on the coast at various distances from home.

Finally, public holidays in Australia largely occur within warmer months (from October to April),[3] such that confounding effects of temperature and season with increased drowning risk needs to be acknowledged (e.g.,[40]). Similarly, overlapping public holidays and long weekends could also confound results. However, correction for these factors (such as only analysing summer/autumn data, analysing data within a couple of days of the public holiday/long weekends) would create its own analysis challenge, by reducing sample size and analysis power, limiting practical applications of this research.

Future research should further explore the estimation of coastal usage on public holidays and long weekends to determine whether risks are predominantly behaviour or exposure and usage driven. For coastal safety managers and services, identification of specific public holidays and long weekends that record the highest burden will better inform service delivery and risk mitigation strategies.

Conclusion

This is the first investigation into impacts of public holidays and long weekends on preventable, unintentional coastal deaths in Australia (drowning and non-drowning), and the first large scale study estimating this risk using a representative survey as a control dataset. The results highlight different risk profiles between public holidays and long weekends, particularly by activity and demographic groups. Higher mortality risks on public holidays and long weekends were determined for children, young adults, people born overseas and Indigenous Australians, with behavioural risk factors identified. However, the results are indicative that the increased risk of death on public holidays and long weekends may be primarily driven by increased participation, as opposed to increased risk-taking behaviours. This study extended current knowledge and support the development of targeted, coastal safety, risk-reduction strategies for these high-risk populations that work to minimise exposure to risk and improve safety service provision during these busier holiday periods.

Ethical information

The development of the Drowning Database conformed to ethical guidelines set by NCIS, including restricting data access to the handful of researchers approved to access data, and de-identification of the data for publication, including not displaying any total counts which had less than 5 individuals.

The development of the NCSS involved recruitment of specified target demogrpahics to ensure repsentative sampling via a third party company (Lightspeed), to ensure the survey could not be associated with SLSA. Input on the structure of the survey and collation of the data was through another another third party company, Omnipoll. Both companies adhering to the Privacy Principles contained in the Privacy Act 1988 and Privacy (Market and Social Research) Code 2021. Survey participation was voluntary, no coercion was used, consent was sought, the survey was opt in and participants able to opt out at any time. The final NCSS dataset received by SLSA is completely deidentified. The NCSS datset is still ongoing and until complete the dataset cannot be shared publicly. Case-by-case approval for use of the dataset for research purposes can be requested through SLSA's Coastal Safety department (contact via: info@sls.com.au) or through the UNSW Beach Safety Research Group (https://www.beachsafetyresearch.com/contact-us).

Acknowledgements

The authors would like to acknowledge the Victorian Department of Justice and Community Safety as the source organisation of coronial data, the NCIS as the database source of the data and for their continued assistance with case data quality assurance. The authors would also like to acknowledge the SLSA Coastal Safety team and Frederic Anne from OmniPoll for their ongoing input, editing and support. The authors would also like to thank the anonymous reviewers for their invaluable feedback during the preparation of this manuscript for publication.

Author ORCIDs

Luke Strasiotto https://orcid.org/0000-0002-2777-5178

Conflicts of interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Luke Strasiotto reports a relationship with Surf Life Saving Australia that includes: employment. Shane Daw reports a relationship with Surf Life Saving Australia that includes: employment. Jasmin Lawes reports a relationship with Surf Life Saving Australia that includes: employment. Annabel Ellis reports a relationship with Surf Life Saving Australia that includes: employment. Luke Strasiotto, Dr Jasmin Lawes and Shane Daw are current employees of Surf Life Saving Australia (SLSA) and Annabel Ellis is a previous employee. The outcome of this research will be of use to SLSA in its operational procedures to prevent deaths on the Australian coast. Shane Daw is further a long-time volunteer of various clubs at Surf Life Saving Australia.

References

1. Stevenson R. Your legal workplace: basic entitlements-community service, public holidays and more. *The Proctor* 2019;**39**(11):45.
2. Panagopoulos Joanna. *Christmas day: crowds head to bondi beach on record day of covid cases*. Nationwide News Pty Ltd; 2021. 25/12/2021.
3. Barnsley PD, Peden AE. A retrospective, cross-sectional cohort study examining the risk of unintentional fatal drowning during public holidays in Australia. *Saf Now* 2018;**4**(4):42.
4. Strasiotto L, Ellis A, Daw S, Lawes JC. The role of alcohol and drug intoxication in fatal drowning and other deaths that occur on the Australian coast. *J Saf Res* 2022;**82**:207–20.
5. Anowar S, Yasmin S, Tay R. Comparison of crashes during public holidays and regular weekends. *Accid Anal Prev* 2013;**51**:93–7.
6. Eyerly-Webb S, Solomon R, Young L, Bard K, Laituri C, Rosenthal A, et al. Impact of holidays on pediatric trauma admissions to a community hospital in South Florida. *South Med J* 2019;**112**(3):164–9.
7. Tellier É, Simonnet B, Gil-Jardiné C, Lerouge-Bailhache M, Castelle B, Salmi R. Predicting drowning from sea and weather forecasts: development and validation of a model on surf beaches of southwestern France. *Inj Prev* 2021;**28**(1):16–22.
8. Lawes JC, Ellis A, Daw S, Strasiotto L. Risky business: a 15-year analysis of fatal coastal drowning of young male adults in Australia. *Inj Prev* 2020;**27**(5):442–9.
9. Abercromby M, Leavy JE, Tohotoa J, Della Bona M, Nimmo L, Crawford G. Go hard or go home": exploring young people's knowledge, attitudes and behaviours of alcohol use and water safety in Western Australia using the Health Belief Model. *Int J Health Promot Educ* 2021;**59**(3):174–91.
10. Lai FY, Bruno R, Hall W, Gartner C, Ort C, Kirkbride P, et al. Profiles of illicit drug use during annual key holiday and control periods in Australia: wastewater analysis in an urban, a semi-rural and a vacation area. *Addiction* 2013;**108**(3):556–65.
11. Saunders CJ, Adriaanse R, Simons A, van Niekerk A. Fatal drowning in the Western Cape, South Africa: a 7-year retrospective, epidemiological study. *Inj Prev* 2019;**25**(6):529–34.
12. Mitchell RJ, Williamson AM, Olivier J. Estimates of drowning morbidity and mortality adjusted for exposure to risk. *Inj Prev* 2010;**16**(4):261–6.
13. Lawes JC, Uebelhoer L, Koon W, Strasiotto L, Anne F, Daw S, et al. Understanding a population: a methodology for a population-based coastal safety survey. *PLoS One* 2021;**16**(8):e0256202.
14. Lawes JC, Rijksen EJT, Brander RW, Franklin RC, Daw S. Dying to help: fatal bystander rescues in Australian coastal environments. *PLoS One* 2020;**15**(9): e0238317.
15. Australian Government Digital Transformation Agency. Australian public holidays dates machine readable dataset. *Australian Government* 2022 [Available from: https://data.gov.au/data/dataset/australian-holidays-machine-readable-dataset.
16. Time and date. Holidays and observances in Australia 2022 [Available from: https://www.timeanddate.com/holidays/australia/.
17. Carver A, Timperio A, Crawford D. Playing it safe: the influence of neighbourhood safety on children's physical activity—a review. *Health Place* 2008; **14**(2):217–27.
18. Ashbullby KJ, Pahl S, Webley P, White MP. The beach as a setting for families' health promotion: a qualitative study with parents and children living in coastal regions in Southwest England. *Health Place* 2013;**23**:138–47.
19. Professional Association of Diving Instructors. Become a certified scuba diver FAQs. *PADI* 2022 [Available from: https://www.padi.com/help/scuba-certification-faq.
20. Australian Government. Births, by nuptiality, by age of mother. *Australian Bureau of Statistics* 2022 [Available from: https://explore.data.abs.gov.au/vis?tm=mother%20age&pg=0&hc[dimensions]=Age&df[ds]=PEOPLE_TOPICS&df[id]=BIRTHS_AGE_MOTHER&df[ag]=ABS&df[vs]=1.0.0&pd=2020%2C2020&dq=....A.
21. Australian Government. Paternity, by age, by state. *Australian Bureau of Statistics* 2022 [Available from: https://explore.data.abs.gov.au/vis?tm=paternity&pg=0&df[ds]=PEOPLE_TOPICS&df[id]=PATERNITY_AGE_STATE&df[ag]=ABS&df[vs]=1.0.0&pd=2020%2C2020&dq=...A.
22. R Core Team. R. *A language and environment for statistical computing*. Vienna, Austria: R Foundation for Statistical Computing; 2013.
23. RStudio Team. *RStudio: integrated development environment for R*. Boston, MA: RStudio, Inc.; 2019.
24. Wickham H. *Tidyverse: easily install and load the 'tidyverse'. R package version 1.2.1*. 2017.
25. Aragon TJ. *Epitools: epidemiology tools*. 2017.
26. Altman DG, Bland JM. Interaction revisited: the difference between two estimates. *BMJ* 2003;**326**(7382):219.
27. Wickham H. *ggplot2: elegant graphics for data analysis*. Springer-Verlag New York; 2016. Available from: https://ggplot2.tidyverse.org.
28. Marcum CS. Age differences in daily social activities. *Research on aging* 2013; **35**(5):612–40.
29. Mistry M, Worthington AC, Gerace D, Gulati C. The impact of trading-restricted, business days and trading, non-business days on Australian small-cap, large-cap and market returns. *SSRN Electron J* 2008. https://doi.org/10.2139/ssrn.1290908.
30. Cooney N, Lawes J, Daw S. *Coastal safety brief: rock fishing*. Sydney, Australia: Surf Life Saving Australia; 2020.
31. Peden AE, Daw S, Lawes JC. Preliminary evaluation of the impact of mandatory life jacket laws at declared high-risk rock platforms on unintentional rock fishing drowning deaths. *Inj Prev* 2022;**28**(6):560.
32. Maguire GS, Miller KK, Weston MA, Young K. Being beside the seaside: beach use and preferences among coastal residents of south-eastern Australia. *Ocean Coast Manag* 2011;**54**(10):781–8.
33. Prout Quicke S, Green C. Mobile (nomadic) cultures" and the politics of mobility: insights from Indigenous Australia. *Trans Inst Br Geogr* 2018;**43**(4):646–60.
34. Willcox-Pidgeon SM, Franklin RC, Leggat PA, Devine S. Identifying a gap in drowning prevention: high-risk populations. *Injury prevention* 2020;**26**(3): 279–88.
35. Smith R, Spaaij R, McDonald B. Migrant integration and cultural capital in the context of sport and physical activity: a systematic review. *J Int Migrat Integrat* 2019;**20**(3):851–68.
36. Willcox-Pidgeon SM, Franklin RC, Leggat PA, Devine S. Identifying a gap in drowning prevention: high-risk populations. *Inj Prev* 2020;**26**(3):279–88.
37. Merz J, Osberg L. *Keeping in touch: a benefit of public holidays*. Working Papers: ECINEQ, Society for the Study of Economic Inequality; 2006.
38. Hamilton K, Keech JJ, Peden AE, Hagger MS. Alcohol use, aquatic injury, and unintentional drowning: a systematic literature review. *Drug Alcohol Rev* 2018; **37**(6):752–73.
39. Calverley HL, Petrass LA, JDJHpjoA Blitvich. They don't think it will ever happen to them": exploring factors affecting participation in alcohol-influenced aquatic activity among young Australian adults. *Health promotion journal of Australia* 2021;**32**:229–37.
40. Chauvin M, Kosatsky T, Bilodeau-Bertrand M, Gamache P, Smargiassi A, Auger N. Hot weather and risk of drowning in children: opportunity for prevention. *Preventative Medicine* 2020;**130**:105885.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.anzjph.2023.100054.