

DISASTER MEDICINE



Flood fatalities in contemporary Australia (1997–2008)

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Abstract

Objective: Flood is the most common natural disaster in Australia and causes more loss of life than any other disaster. This article describes the incidence and causes of deaths directly associated with floods in contemporary Australia.

Methods: The present study compiled a database of flood fatalities in Australia in the period of 1997–2008 inclusive. The data were derived from newspapers and historic accounts, as well as government and scientific reports. Assembled data include the date and location of fatalities, age and gender of victims and the circumstances of the death.

Results: At least 73 persons died as a direct result of floods in Australia in the period of 1997–2008. The largest number of fatalities occurred in New South Wales and Queensland. Most fatalities occurred during February, and among men (71.2%). People between the ages of 10 and 29 and those over 70 years are overrepresented among those drowned. There is no evident decline in the number of deaths over time. 48.5% fatalities related to motor vehicle use. 26.5% fatalities occurred as a result of inappropriate or high-risk behaviour during floods.

Conclusion: In modern developed countries with adequate emergency response systems and extensive resources, deaths that occur in floods are almost all eminently preventable. Over 90% of the deaths are caused by attempts to ford flooded waterways or inappropriate situational conduct. Knowledge of the leading causes of flood fatalities should inform public awareness programmes and public safety police enforcement activities.

Key words: *Australia, disaster, flood fatalities, flooding.*

Introduction

Floods have always represented an obstacle for settlers in Australia,¹ are the most common natural disaster and cause greater mortality than any other natural disaster.²

Floods account for approximately 40–50% of all disasters and disaster-related deaths worldwide.^{3,4} Although improvements in mitigation and preparedness have reduced flood-related mortality, in the last decade of the 20th century, floods still caused an estimated 100 000

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deaths and affected almost 1.4 billion people worldwide.⁵ Oceania has the lowest flood fatality rate of any region in the world.⁵

Flood is Australia's most costly form of natural disaster, with losses estimated at over \$400 million a year.⁶ Australia's aged geology means that it does not generally experience the rapid onset, debris laden flash floods that occur in geologically younger continents. Australian climate intersperses mostly dry and often drought conditions with widely dispersed floods. The annual monsoonal trough and tropical storms and cyclones, might suddenly inundate large tracks of arid land.

Patterns of flood-related deaths vary significantly around the world,⁷ reflecting the fundamental differences in demography and socioeconomic environments. Coates examined flood fatalities in Australia from 1788 to 1996 and demonstrated that the principal causes of death included waiting for rescue in a house or camp (31.5%) and attempting to cross a watercourse (28.3%).¹ However, Coates's study pooled data from the time of European arrival in Australia to the end of the 20th century, and therefore is not necessarily informative of modern challenges or of the preventive and mitigation strategies required to further reduce flood-related deaths.

This article is a brief descriptive report that describes the incidence and causes of flood-related deaths in contemporary Australia (1997–2008) in order to remind health planners of the contemporary risk profile and to further inform prevention and response management strategies.

Methods

The Disaster Database⁸ maintained by Emergency Management Australia was examined to identify floods associated with death. For each of these incidents electronic data sources were searched in order to retrieve descriptions of the circumstances and contributing factors to the deaths. Sources of information included relevant newspapers, historic accounts, and government and scientific reports. For each incident and each death associated with each incident, a record was constructed, which included the number and location of fatalities, age and gender of the victims, circumstances of fatalities and date of incident. Verification of sources was achieved through cross referencing of different media sources; the number of sources used was recorded in the database.

The flood fatality database constructed for the present study includes all deaths that are immediately and directly attributable to the flood event (e.g. death due to drowning or death due to physical trauma within water). Mid- and long-term flood fatalities are excluded from the present study as they were unable to be identified from the publicly available sources. Indirect or secondary flood fatalities (e.g. death due to electrocution or death due to motor vehicle accidents on rain-soaked roads) were not included in the present study because the association with the flood was unclear in the sources examined. For example, several people were killed from falling trees weakened by the flood waters. These were not included in this analysis because the association between the flood and the death was not direct. Such events may result from heavy rain without flooding.

Findings

During the 12 years of 1997–2008, a total of 73 fatalities directly related to floods occurred in Australia; an average of approximately six cases per year (Fig. 1). There is no evidence of decline in the number of deaths and no significant reduction in the number of deaths per million people per annum.

Most flood-related deaths occur in the Australian summer. February is the peak month for deaths from floods in Australia (Fig. 2). This is reflective of floods associated with summer storms in north-eastern Australia. Southern States of Australia tend to experience winter rains, which are less likely to be associated with flash flooding and thus less likely associated with fatalities. Although June is another high fatality month, this may be impacted by a single high fatality event. Eight people died in New South Wales related to a flood caused by storms in June 2007, including five members of one family swept into a swollen creek when a submerged road collapsed and the vehicle fell into waterway.

The majority of flood fatalities occurred in the eastern States; New South Wales and Queensland and along the coast. This region is the most hazardous zone in regard to flood fatalities (Fig. 3).

Most fatalities have occurred among men (71.2%). This is most notable in younger age groups and reflects the risk-taking behaviour evident among younger men in particular (Fig. 4). Figure 5 demonstrates the fatalities where the age of the victim was reported. Young adults between the ages of 10 and 29 and those over

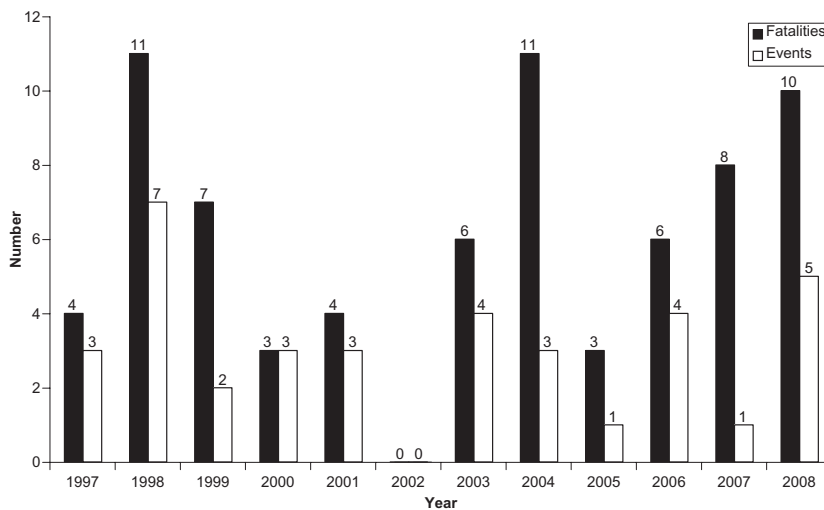


Figure 1. The frequency of all flood deaths and fatalities events (exclude indirect) by year in Australia (1997–2008).

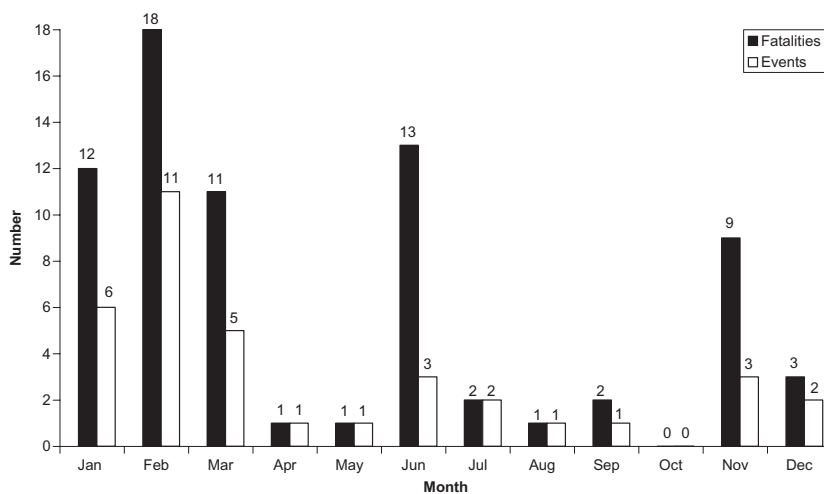


Figure 2. The frequency of all flood deaths and fatalities events (exclude indirect) by month in Australia (1997–2008).

70 years are overrepresented among those drowned (Fig. 5).⁹

Details of circumstances at or just before the time of death were available for 68 of the 73 total fatalities. Most of the victims were not trapped by the floods (98.5%). Use of a motor vehicle was involved in 48.5% of deaths. 39.7% were using vehicles to cross waterway whereas the other 8.8% involved the collapse of a flooded roadway. This cause of death might be relatively overrepresented as a result of a single event involving five fatalities. 26.5% of the victims were engaged in behaviour such as swimming or surfing in

flooded waterways. A further 16% were associated with attempts to swim or wade across flooded water ways.

Discussion

In Australia, floods are viewed relatively benignly as they bring an end to drought and a promise of more fertile times in rural areas. This perspective of floods is in contrast to less developed countries where floods pose not only an immediate risk to life but also a

significant medium to long-term risk from crop destruction and disease outbreak.

However, floods remain a real risk to health in Australia. The current study examines flood-related mortality for the period of 1997–2008. This period is the most recent for which information is available in a readily accessible format and which most aligns with the challenges of contemporary Australia. The trends evident from the data can inform public health policy



Figure 3. The frequency of all flood deaths and fatalities events (exclude indirect) by State in Australia (1997–2008).

interventions that may be directed towards further reducing the impact of flood-related mortality. These results confirm the accepted impression of flood-related deaths and helps inform public policy, health promotion and response management strategies that aim at fostering community awareness of the risks associated with floods and protecting the individual from risk-taking behaviour.

The circumstances of death are most relevant to public policy and health promotion strategies. The risks identified in the present study will help inform public policy initiatives. The taxonomy identified in Figure 6, which is derived from observations of the data and from previous taxonomies identified in the literature, aligns with possible policy responses and may prove a useful categorization of flood-related deaths.

Flood-related mortality varies considerably between communities on the basis of underlying demographic and socioeconomic characteristics. International experience demonstrates contrasting patterns of mortality between highly developed and developing countries,⁷ whereby less developed countries are more susceptible to other consequences such as crop destruction and infrastructure collapse. The present study suggests that the vast majority of deaths in Australia (>90%) that occur as a result of floods occur because of the choices made by the individual; choices to engage in inappropriate risk-taking behaviour or to enter flooded waterways either by foot or in a vehicle. Despite public warnings to avoid the fording of flooded streams and

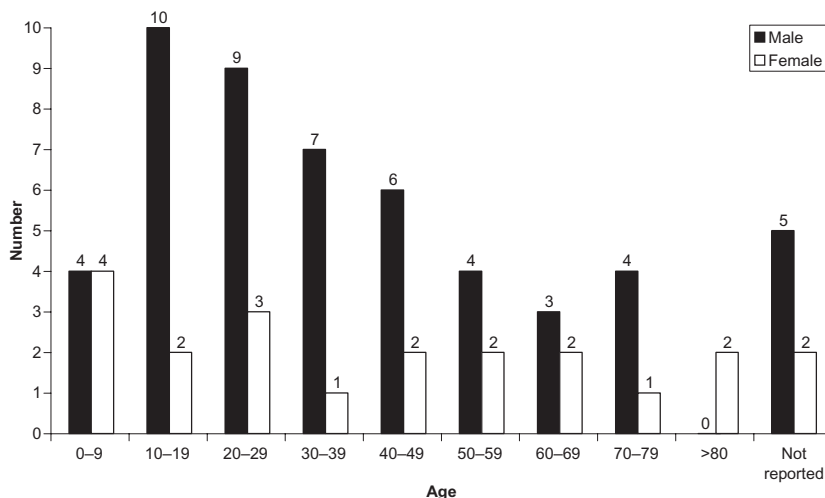


Figure 4. The frequency of all flood deaths and fatalities events (exclude indirect) by gender and age in Australia (1997–2008).

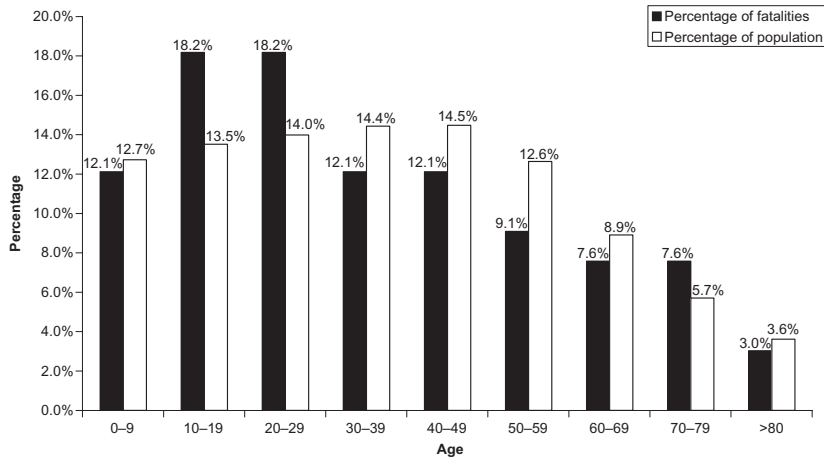


Figure 5. The percentage of flood fatalities and population by age classification.

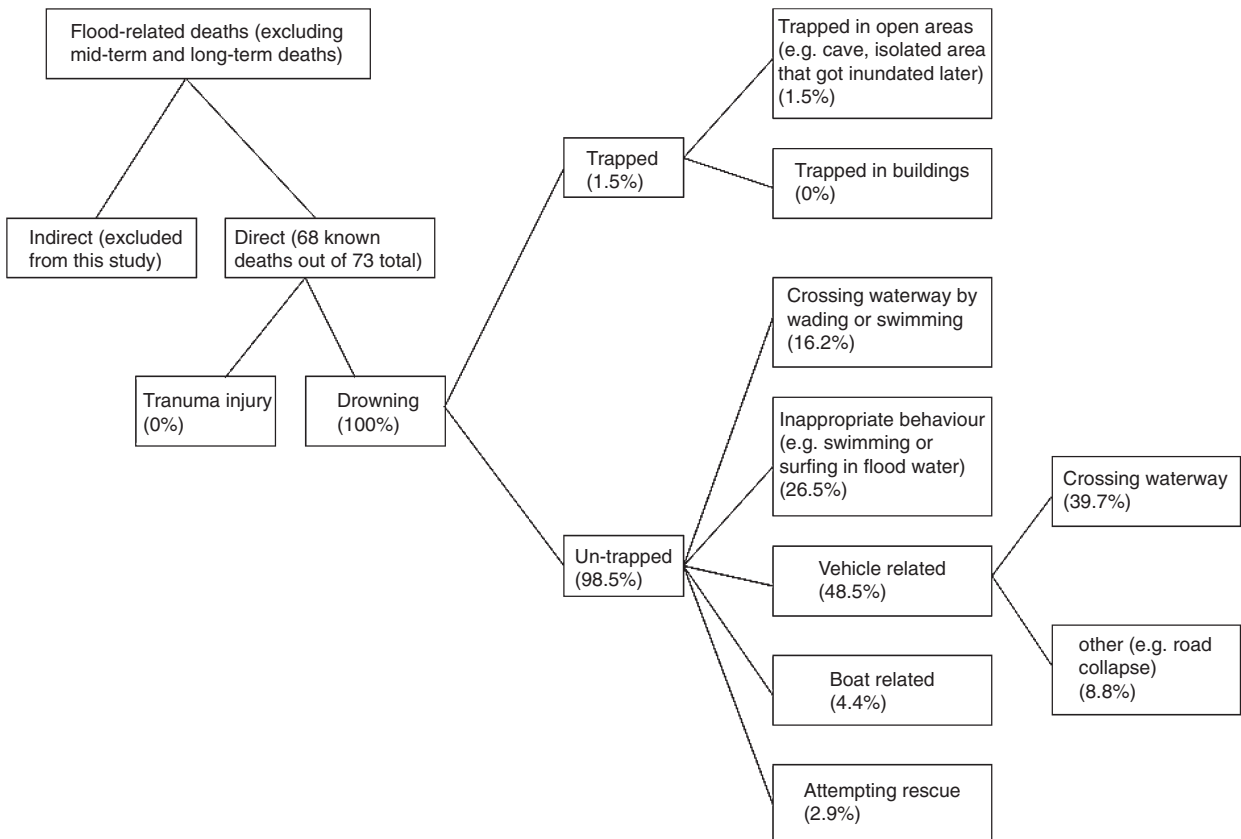


Figure 6. Circumstances of flood victims in Australia before death, 1997-2008.

waterways, almost half of the deaths were associated with driving motor vehicles across flooded waterway—driving on flooded roadways. Drivers often underestimate the force of flowing water and its capacity to dislodge relatively large motor vehicles. An average car is 6–8 m² in surface area and a displacement of 10–20 cm of water above the bottom of the chassis will cause the car to float and therefore be washed away. In addition, it is not possible for the driver to know the status of the roadway under the flood water or often the depth of the water.

Despite the best efforts of emergency management agencies, the Australian public's knowledge and awareness of flood threats is inadequate and there is a need for flood safety awareness education programmes targeting the general population and specific high-risk groups such as young men, parents of teenagers and older people. The provision of information about the facts in both written (facts sheets) and broadcast format would be helpful. Additional research is required to identify the most effective evidence based policy approaches to addressing this community risk.

Australia has highly developed community infrastructure, which is largely built to standards that withstand most imposts. Thus the failure of the built environment such as bridges, buildings or dams is less likely than in developing countries.^{5,10} Further changes to community infrastructure may reduce the opportunities for risk-taking behaviour. Construction of higher level bridges or causeways, which are above flood height, may avoid the inappropriate decision to attempt to cross a flooded water way. However, the cost of doing so at every possible floodable location throughout Australia would be prohibitive. In the long term, strategies should aim at structural solutions that protect the individual from inappropriate decisions. These may include construction of flood proof roadways and bridges and protective fencing of flood prone areas. They may also include automated warning devices that warn motorists of the depth of water. In the interim, response management should focus on the rapid isolation and protection of flood prone waterways during times of flood and public awareness-raising through educational strategies and public warnings during times of floods. However, it is not possible to eliminate all such risks, and it remains up to the individual to be aware of the risks and act responsibly in avoiding such risks.

There are limitations to the present study. Public reports are often incomplete and potentially inaccurate.

The quality of information derived from public sources is potentially inconsistent. Public reports may be biased towards areas that have significant access to media and less so in sparsely populated rural and remote areas. Newspaper articles may be biased towards significant and newsworthy events rather than small local issues. It is likely that some flood-related deaths by drowning were not identified in news reports or public reports. Exhaustive cross checking of sources attempted to minimize these influences along with the use of the EM-DAT as the primary identifier of incidents. However, the number of unreported deaths is not likely to impact on the relative frequency of deaths or on the relative causes of flood-related deaths. The small number of deaths involved presents difficulties with data analysis and significance. A single event in New South Wales in June, 2007 caused eight flood fatalities, which represents all the flood deaths and fatal flood events in Australia in 2007.

Further research to understand the decision-making processes that underlie the behaviours would be beneficial, especially the behaviours leading to individual choices, including the impact of alcohol consumption on risk-taking behaviour. A detailed case study dealing either with incidents resulting in deaths or 'near misses' would be helpful. The individual may be able to contribute to an understanding of the rationale behind the behaviours observed. Finally further research should identify the evidence behind intervention programmes so as to inform cost-benefit analysis of intervention strategies.

Conclusion

Despite the best efforts of public safety agencies, there is no evidence of a decline in flood fatalities in Australia in the period of 1997–2008 and the vast majority of these flood-related deaths are eminently preventable. The present study identifies the causes of flood-related deaths in contemporary Australia. These causes are consistent with those observed in other developed countries but fundamentally different to those identified previously for Australia and to those in less developed countries.

The present paper calls for enhanced public protection, awareness and public information programmes in the short- and longer-term investments in infrastructure, which may further protect the community from personal decisions placing themselves at risk.

Competing interests

Gerry FitzGerald is a member of the editorial board for *Emergency Medicine Australasia*.

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