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Australian bushfire fatalities 1900–2008: exploring trends in relation to the ‘Prepare, stay and defend or leave early’ policy

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ABSTRACT

In many jurisdictions, including parts of the US, authorities often dictate mandatory evacuations of communities threatened by bushfire (wildfire). Prior to the 2009 ‘Black Saturday’ fires in Victoria, Australian fire authorities in all States advised residents to decide whether they would prepare to stay and defend homes or leave early. The clear intent of that policy was to avoid late evacuations and the risks to life that this could entail. This study re-examines evidence underpinning this policy using analyses of a database of bushfire fatalities. The database contains information on 552 civilian (non-fire fighter) fatalities obtained from print media archives at Risk Frontiers and forensic, witness and police statements contained within coronial inquest reports for all bushfire fatalities between 1901 and 2008. This data, compiled before the Black Saturday fires, clearly show the dangers of being caught outside during a bushfire and the gendered division of the circumstances of these deaths. While men have been most often killed outside while attempting to protect assets, most female and child fatalities occurred while sheltering in the house or attempting to flee. The database provides a benchmark against which the Black Saturday experience can be examined.

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1. Introduction

Over the past century, bushfires have been the fourth most hazardous Australian natural disaster in terms of fatalities after heatwaves, tropical cyclones and floods (Coates, 1999). This paper examines bushfire (wildfire) fatalities over this period and does so in the context of what was Australian policy on community bushfire safety prior to the February 7, 2009 ‘Black Saturday’ fires. In these fires, widely regarded as “unprecedented”, 173 people lost their lives and some 2039 homes and many other structures were destroyed (Victorian Bushfires Royal Commission, 2009). The Australasian Fire and Emergency Service Authorities Council (AFAC), community safety policy

(henceforth referred to as “the policy” or the “AFAC policy”) put the actions of residents central to the protection of lives and property: rather than attempting to evacuate all those in the likely path of a bushfire, fire authorities in all states advised residents to decide whether they would prepare to stay and defend homes or leave early (AFAC, 2005). This approach is contrary to that which prevails in most other fire-prone jurisdictions, where mandatory evacuation is still seen as the safest option to protect those at risk (Stephen et al., 2009). In the wake of the loss of life and destruction experienced in the ‘Black Saturday’ fires, the Victorian government has charged a Royal Commission to re-examine all aspects of fire management including the AFAC policy.

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The AFAC policy was based on post-fire investigations into some of Australia's worst bushfire tragedies, including the Hobart bushfires in February 1967 in which 64 civilians were killed and the Ash Wednesday fires in 1983 in which 60 civilians were killed across South Eastern Australia (Table 1). Investigations into these fires revealed two salient points: first, that a high proportion of deaths were due to victims either being outside and exposed to radiant heat or occurred in vehicles while evacuating, and secondly, that well-prepared houses can be successfully defended from bushfires and provide safe refuge for people during passage of the fire front (McArthur and Cheney, 1967; Wilson and Ferguson, 1984; Lazarus and Elley, 1984; Leonard and McArthur, 1999; Handmer and Tibbits, 2005; Blanchi and Leonard, 2008). These findings became the basic tenets of the AFAC policy.

Our study, which was completed prior to the Black Saturday fires, explores the circumstances surrounding all civilian bushfire-related deaths in Australia between 1901 and 2008. It does so in the context of the AFAC policy, as outlined above. It analyses a database of Australian bushfire fatalities created in the course of this study from archival searches of print media as well as forensic, witness and police statements given in coronial inquests.

Detailed examinations of the exact circumstances of deaths from natural hazards are rare; more attention has been devoted to flood fatalities, probably because the data are more readily available and the death tolls generally higher. Analyses of flood deaths have demonstrated that, in many cases, individuals became exposed to greater risk by travelling through flood-affected areas, often while attempting to flee the flooding (Coates, 1999; Jonkman and Kelman, 2005; Drobot et al., 2007; Ashley and Ashley, 2008). These deaths were often associated with motor vehicles as drivers attempted to cross flooded roads. A number of these studies have identified a gender and age bias, with males and those aged between 10 and 29 and >60 over-represented in flood death statistics. This study undertakes an analogous investigation of Australian fire fatalities.

While there have been various reports and studies into bushfire deaths in Australia, the only one – apart from our work – to examine coronial records in order to reveal the actions of bushfire victims prior to their death appears to be that of Krusel and Petris (1999). These authors examined the 1983 Ash Wednesday civilian deaths in Victoria, and identified that the majority of victims died during late evacuation as the fire front arrived or because they were incapable of implementing a safe strategy due to inadequate warning, age and infirmity. Our paper concludes with a discussion of policy implications arising from this work in the light of the events of Black Saturday and the interim conclusions of Royal Commission.

2. Methodology

Since 1994, databases on the occurrence and consequences of natural hazards in Australia – tropical cyclones, floods, bushfires, wind gusts, hail storms, earthquakes, tornadoes, landslides and tsunamis – have been compiled by researchers at Risk Frontiers (formerly the Natural Hazards Research Centre), Macquarie University, covering the period from European settlement to the present day. In addition to

containing information on the physical characteristics of the hazard and consequential damage to property and other assets, these databases also contain information on bushfire fatalities. In terms of this study, a critical attribute was the names of the deceased.

Our interest here is to examine civilian (non-fire fighters) bushfire fatalities, a purpose not envisioned when the data was originally collected at Risk Frontiers. For this reason, it was decided, wherever possible, to re-examine each bushfire fatality. This involved searching coroners' reports for each death, using this information to reveal the circumstances of the death, and then developing a database of these findings. The availability of victims' names in the original Risk Frontiers' database allowed a documentary analysis of forensic, witness and police statements contained in coronial inquest reports carried out between 1901 and 2008. The final database includes details of 552 civilian fatalities from all over Australia for the period 1900–2008.

The bushfire fatality database was analysed with a view to understanding, where possible, the circumstances surrounding the deaths and how this information could best inform the AFAC policy position and its effective implementation. The data are classified into four main categories: demographic, medical cause of death, transport and location of the deceased, and activity prior to death. Further sub-categories were used to help ascribe key features pertinent to each death. As always with this kind of effort, there is a conflict between the desire for fine detail (increased numbers of unique categories or sub-categories) and the need to have enough samples per category to deliver plausible statistics. The current four main category schema reflects a suitable compromise given the nature of the data available.

2.1. Demographics

Cataloguing deaths by age and gender.

2.2. Medical cause of death

This covered an assessment of the actual cause of death: that is, was the death caused by flames and heat leading to burns or asphyxiation (immediately, or, in some cases, many weeks after the fire) or from the impact from a falling tree limb, a heart attack from over-exertion or injuries received in a car accident, etc.? While it is now standard medical practice in Australia to document multiple causes of death, for most of the period under study only a single cause was recorded.

2.3. Transport and location of the deceased

This category indicates if the deceased was in a car or another form of closed or open transport and if they remained in or on the vehicle or had tried to evacuate from the vehicle on foot.

2.4. Activity prior to death and awareness/capacity to respond

This category classifies answers to the following questions: what were victims doing at the time of death? where were they

in relation to the property and fire? and if possible, why victims made certain decisions in relation to life safety? This kind of information is critical to helping understand why these deaths occurred.

We also attempt to examine the types of warnings that victims may have received and how they responded to the fire threat. While inferring people's decisions in respect to their survival is of course problematic, we have, nonetheless, tried to categorise people's awareness and capacity to respond using sub-category schema as outlined below. Varying levels of detail available for each fatality sometimes necessitate that assumptions be made, particularly concerning whether or not the property was defensible. Where there was not enough information available to make sensible judgments, these deaths were labelled as unknown in regard to this sub category. Sub-categories are given below:

- *Activity at time of death*

- (1) Late evacuation:
 - (a) from a shelter thought to be defensible.
 - (b) from a place of work outside.
 - (c) destination or origin unknown.
 - (d) from an undefensible shelter.
- (2) Defending property outside:
 - (a) in a suburban location – defending livelihood or wider property, i.e. caught by fire just outside their home, a friend's home, local community or place of work.
 - (b) in a rural location – death occurred while attempting to save livestock, livelihood or defending wider property or place of work, i.e. farm or timber mill.
- (3) Inside a defensible property:
 - (a) actively defending.
 - (b) meagre attempts to defend.
 - (c) passively sheltering.
 - (d) activity unknown.
- (4) Travelling through the area for work unrelated to fire and being unaware of the fire.
- (5) Travelling through the area for pleasure, e.g. for a picnic and being unaware of the fire.
- (6) Victim left a safe area and deliberately entered fire zone in order to defend or rescue property or loved ones, etc.
- (7) Waiting to be rescued or assisted.
- (8) Assisting fire fighting operations in a professional capacity, e.g. forestry workers.
- (9) Returned into a burning building in order to rescue loved ones, pets or possessions.
- (10) Sheltering in an undefensible shelter.
- (11) Activity unknown at time of death.

- *Awareness and capacity to respond*

The key interest here concerns the warnings received, the level of preparedness and the capacity of the deceased to defend their dwelling or refuge. The sub-categories below are loosely adapted from those devised by Krusel and Petris (1999).

- (1) Physically and/or mentally incapable of implementing an effective survival strategy (perhaps because of shock, drugs and/or alcohol).

- (2) Aware of fire in their area and having enough time to save their lives and were proactive, carrying out a premeditated action, which in the end proved ineffective.
- (3) Aware of fire in their area and having enough time to save their lives and either had no plans or did not follow them and/or acted in panic.
- (4) Unaware of fire and only realised when it was too late to implement an effective survival strategy.
- (5) Extenuating circumstances affected victim's plans, e.g. heart attack.
- (6) Unknown.
- (7) All children with their parents/guardians at time of death.

Much of the data is not detailed enough in respect to timing and types of warnings received by victims, their level of preparedness and previous fire experience and/or knowledge. In these cases, other information recorded in the coronial files was used to ascertain why people took certain actions. Where people were actively trying to defend their house or wider property, or had made preparation in order that they could respond to the fire (water sources, correct clothing, etc.), they have been classified under the 'awareness and capacity to respond' sub-category 2. People who were actively defending or making preparations to do so, but then attempted a last minute evacuation or changed their actions were generally placed in sub-category 3. Where there was just a last minute attempt to flee with little defensive action having been taken, sub-category 4 was adopted. All children, who were with their parents or a guardian, were placed into sub-category 7 on the presumption that children are often not in control of what happens to them and were assumed to have been following the instructions of parents or guardians.

Where no information existed to the contrary, it was assumed that those aged 70 or more would not be physically capable of defending their homes. It is acknowledged that this is an oversimplification and there are many older residents capable of defending their properties.

For the purpose of this study, late evacuation has been defined as an evacuation that puts an individual, or group of individuals, at risk of encountering dangers associated with the passage of a bushfire. Such dangers include, but are not limited to, flames, heavy ember attack and flying debris, thick smoke, falling trees and heavy traffic.

3. Results and discussion

The total number of recorded civilian deaths is 552 with an average annual death rate of 5.1. The data is presented both for the entire period (1900–2008) and also in two portions: the most recent 54 years (1955–2008) and the first 55 years of the last century (1900–1954). Statistical tests have been included where appropriate to identify significant changes in patterns of fatalities from the first half century of data to the more recent half. While not sufficient to define trends, this division does allow us some sense of how patterns of fatalities may have changed over time and reflect the many evident and significant social changes that have occurred over the last century.

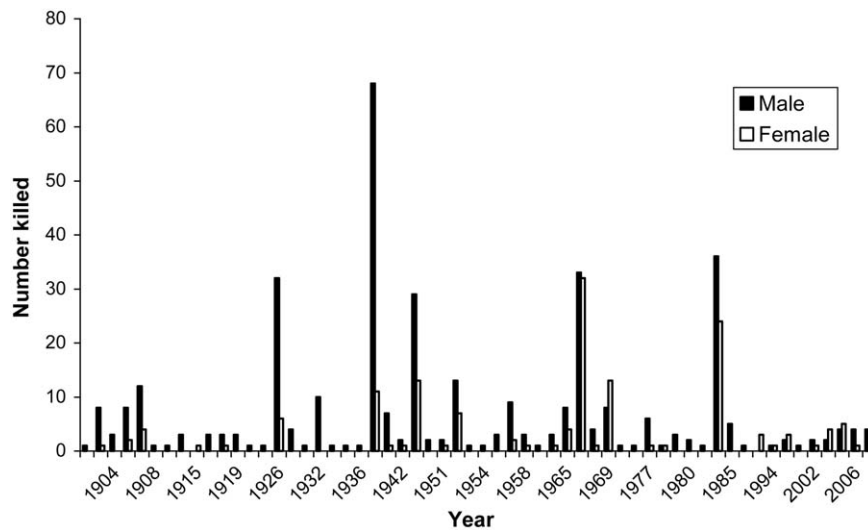


Fig. 1 – Time series showing the distribution of male and female deaths since 1900.

3.1. Demographics

Fig. 1 shows the time series of fatalities: as with the associated pattern of home destruction (McAneney et al., 2009), numbers of deaths are characterised by frequent relatively small numbers of deaths interspersed between episodic events having much greater losses. Table 1 lists major Australian bushfires over the course of our study period. These fires are widely acknowledged as significant because of (a) large number of fatalities, (b) large numbers of homes and property destroyed, and/or (c) the land area burnt. Many of these fires were followed by major inquiries, including a Royal Commission into the causes of the 1939 fires and government inquiries into the 1967, 1983 and 2003 fires.

Fig. 1 exhibits no obvious trend in deaths over the last century despite significant increases in population and the way people live. (Australia's population has increased from around 3.75 to 20 million over the last century, although as pointed out by Chen and McAneney (2005), only a small percentage of the total population is at risk to bushfire;

moreover, 63% of people now live in capital cities rather than just 33% in 1900 (Trewin, 2006).) During the 1939 fires a majority of fatalities were forestry workers, who lived and worked at timber mills in isolated bush settings. Normalising historical losses along the lines of Crompton and McAneney (2008) and Pielke et al. (2003) in order to estimate the likely number of deaths if these events were to recur today will be reported upon separately (Crompton et al., in preparation); suffice to say that an increasing total population and a relatively stable pattern of deaths mean that on average the per capita risk of death by Australian bushfires has decreased.

Both Fig. 1 and Table 2a suggest that on average more than twice as many males have been killed in bushfires as females between 1900 and 2008. This difference in proportion between male and female fatalities is statistically very highly significant ($z = 13.63$, $p < 0.00001$); however the proportion of male deaths has diminished significantly in the last half century compared with the first ($z = 5.01$, $p < 0.00001$) whilst the proportion of female deaths has increased significantly

Table 1 – Significant bushfires or bushfire seasons in Australian history 1900–2008.

Date	States	Homes destroyed	Deaths
February 14, 1926	Victoria	550	39
January 8–13, 1939 “Black Thursday”	Victoria and NSW	650	79
Various fires over the 1943–1944 summer	Victoria	885	46
February 7, 1967	Hobart, Tasmania	1557	64
January 8, 1969 (17 deaths on the Geelong highway in one incident)	Lara, Victoria	230	21
February 16, 1983 “Ash Wednesday”	Victoria and South Australia	2253	60
February 18, 2003	ACT	530	4
January 11, 2005 “Black Tuesday”	Eyre Peninsula, South Australia.	93	9

Table 2a – Gender and age of bushfire fatalities over three different time periods.

	Time period			Comparison of the two periods	
	1900–2008	1900–1954	1955–2008	z-Score	p-Value
Total number killed	552	292	260		
Gender					
Male	373 (67%)	224 (77%)	149 (57%)	5.011	<0.00001
Female	147 (27%)	48 (16%)	99 (38%)	–5.856	<0.00001
Unknown	32 (6%)	20 (7%)	12 (5%)		
Age category					
0–9	48 (9%)	32 (11%)	16 (6%)	See Table 2b	
10–19	42 (8%)	19 (7%)	23 (9%)		
20–29	53 (10%)	29 (10%)	24 (9%)		
30–39	55 (10%)	23 (8%)	32 (12%)		
40–49	45 (8%)	21 (7%)	24 (9%)		
50–59	51 (9%)	16 (5%)	35 (13%)		
60–69	60 (11%)	19 (7%)	41 (16%)		
70 and above	59 (11%)	23 (8%)	36 (14%)		
Unknown	139 (25%)	110 (38%)	29 (11%)		

Table 2b – Significance values for changes in the proportion of fatalities in the various age ranges.

Age category ^a	1900–1954	1955–2008	Comparison of the two periods	
			z-Score	p-Value
0–19	51 (17.5%)	39 (15.0%)	–0.793	>0.4
20–39	52 (17.8%)	56 (21.5%)	–1.094	>0.2
40–59	37 (12.7%)	59 (22.7%)	–3.093	<0.002
60 and above	42 (14.4%)	77 (29.6%)	–4.335	<0.00001
Unknown	110 (37.7%)	29 (11.2%)		

^a In the interest of sample sizes the significances calculated for changes in the proportion of fatalities in the various age ranges are in 20-year groupings.

($z = -5.86$, $p < 0.00001$). In some recent fires more females than males have died, although the absolute numbers are small.

The breakdown by age of victim (Table 2a) shows no preferential at-risk age group when the complete data set is considered. Note that this is contrary to what a number of other studies (e.g. Coates, 1999; Jonkman and Kelman, 2005; Ashley and Ashley, 2008) have found in relation to flood deaths where a definite age bias exists with males and those aged between 10 and 29 and >60 over-represented in the statistics. The grouping of fatalities by 20-year age groups in Table 2b shows that in the 40–59-year age group there is a statistically significant increase in the proportion of fatalities in the more recent period ($z = -3.09$, $p < 0.002$), influenced most by the increase in fatalities in the 50–59-year age group. In the 60 and above age category, there is a very highly significant increase in the proportion of fatalities in the more recent period ($z = -4.34$, $p < 0.00001$).

In terms of the geographic distribution, the majority of fatalities have occurred in Victoria, followed by NSW and Tasmania (Table 3). Victoria has also more frequently experienced extreme fires in terms of property losses (Table 1) and accounts for just over one half of all known bushfire fatalities.

3.2. Medical cause of death

Table 4 shows that the vast majority of victims succumbed to flames and heat. It should be noted that coronial examinations

during the first half of the last century often attributed the cause of death simply to 'burns received during a bushfire'. Thus it is likely that the numbers of those whose death is ascribed to other medical causes, in particular, from smoke inhalation and heart-attacks, may be underrepresented. Also until very recently only one cause of death could be recorded; now multiple factors may be stated and death may, for example, be listed as being due to heart attack and lung damage from heated air in addition to burns.

3.3. Activity at the time of death

Late evacuation is the most common activity at the time of death, accounting for nearly one-third of fatalities in the total

Table 3 – Number of fatalities per state 1900–2008.

State	Number	%
Victoria	296	53.6
New South Wales	105	19.0
Tasmania	67	12.1
South Australia	44	8.0
Queensland	17	3.1
Western Australia	17	3.1
Australian Capital Territory	5	0.9
Northern Territory	1	0.2
Total	552	100

Table 4 – Medical cause of death 1900–2008.

Medical cause	Number	%
Flames, heat	427	77.3
Smoke	29	5.3
Heart attack, over-exertion	27	4.9
Tree/limb fall	10	1.8
Vehicle accident	13	2.4
Drowned or fell	2	0.4
Unknown	44	8.0
Total	552	99.4

sample (Table 5). Although overall numbers of fatalities have decreased in recent times, particularly those who died while evacuating from working outside, the number of those who died while evacuating from shelter has increased. Overall, however, the proportion of fatalities from late evacuation has decreased significantly in the more recent half century ($z = 2.99$, $p < 0.005$).

Defending property outside is the second most common activity at time of death, with the majority of these deaths occurring in rural locations. On an overall level there has been no statistical change in recent times in the proportion of fatalities whilst defending property outside ($z = 0.85$, $p > 0.4$).

While fatalities in rural locations have halved during the most recent half century, those occurring in suburban locations have doubled. Suburban or semi-rural fatalities include those who were killed just outside their own or a neighbour's homes or outside in their local community; "Suburban or semi-rural" refer to locations on the fringe of an urban area or a country town. This is opposed to "rural", which refers to more isolated farms and dwellings.

For the 8.3% of bushfire fatalities that took place inside a defensible property, only one (in the 1967 Hobart fires) occurred while actively defending and this was due to a heart attack. The majority of these deaths took place while the victims were passively sheltering; note that only 35 out of the total of 552 occur in this category. Although the proportions are fairly small, from a statistical perspective there has been a very significant increase in the proportion of fatalities that took place inside a defensible property in recent times ($z = -4.42$, $p < 0.00001$).

Most of those who were killed while travelling through the area and unaware of the fires were engaged in activities other than paid employment. The proportion of these fatalities has increased significantly in recent times ($z = -4.04$, $p < 0.0005$), a result that should be viewed with some caution, since a high proportion of these deaths occurred in a single fire, the 1969

Table 5 – Activity at time of death (Numbers in brackets refer to the percentage of the total given in the bottom row.).

Activity	1900–2008	1900–1954	1955–2008	Comparison of the two periods	
				z-Score	p-Value
Late evacuation	176 (31.9%)	109 (37.3%)	67 (25.8%)	2.894	<0.005
Of these:					
from shelter	100	42	58		
from a place of work outside	53	51	2		
destination or origin unknown	20	15	5		
from an undefendable shelter	3	1	2		
Defending property outside	145 (26.3%)	81 (27.8%)	64 (24.6%)	0.853	>0.4
Of these:					
In a suburban location	42	14	28		
In a rural location	103	67	36		
Inside defensible property	46 (8.3%)	10 (3.4%)	36 (13.8%)	-4.421	<0.00001
Of these:					
Actively defending	1 ^a	0	1 ^a		
Meagre attempts to defend	5	1	4		
Passively sheltering	35	8	27		
Activities unknown	5	1	4		
Travelling through the area unaware	35 (6.3%)	7 (2.4%)	28 (10.8%)	-4.038	<0.0005
Of these:					
Travelling for work	6	2	4		
Travelling for pleasure	29	5	24		
En route to defend or rescue	25 (4.5%)	10 (3.4%)	15 (5.8%)	-1.353	>0.01
Waiting rescue	8 (1.4%)	1 (0.3%)	7 (2.7%)	-2.370	<0.02
Assisting fire fighting operations	12 (2.1%)	2 (0.7%)	10 (3.8%)	-2.501	<0.02
Returned into burning building	8 (1.4%)	2 (0.7%)	6 (2.3%)	-1.568	>0.1
In an undefendable shelter	8 (1.4%)	8 (2.7%)	0 (0.0%)	2.669	<0.01
Activity unknown at time of death	89 (16.1%)	62 (21.2%)	27 (10.4%)	3.445	<0.001
Total	552	292	260		

^a Died from a heart attack while defending home.

Table 6 – Relationship between gender, age and activity at time of death (figures in brackets are percentages of the activity total for each time period).

Activity	1900–2008			1900–1954			1955–2008		
	Male	Female	<18	Male	Female	<18	Male	Female	<18
Late evacuation	81 (17.5)	48 (10.4)	47 (10.2)	59 (25.7)	20 (8.7)	30 (13)	22 (9.5)	28 (12.1)	17 (7.3)
Defending property outside	127 (27.5)	9 (1.9)	9 (1.9)	72 (31.3)	4 (1.7)	5 (2.2)	55 (23.7)	5 (2.2)	4 (1.7)
Inside a defensible property	15 (3.2)	27 (5.8)	4 (0.9)	3 (1.3)	4 (1.7)	3 (1.3)	12 (5.2)	23 (9.9)	1 (0.4)
Travelling through the area unaware	13 (2.8)	8 (1.7)	13 (2.8)	4 (1.7)	1 (0.4)	2 (0.9)	9 (3.9)	7 (3.0)	11 (4.7)
En route to defend or rescue	18 (3.9)	3 (0.6)	4 (0.9)	10 (4.3)	–	–	8 (3.4)	3 (1.3)	4 (1.7)
Awaiting rescue	2 (0.4)	6 (1.3)	–	1 (0.4)	–	–	1 (0.4)	6 (2.6)	–
Assisting fire fighting operations	12 (2.6)	–	–	2 (0.9)	–	–	10 (4.3)	–	–
Returned into burning building	3 (0.6)	5 (1.1)	–	1 (0.4)	1 (0.4)	–	2 (0.9)	4 (1.7)	–
In an undefendable shelter	6 (1.3)	2 (0.4)	–	6 (2.6)	2 (0.9)	–	–	–	–
Total	277	108	77	158	32	40	119	76	37

Lara fires, which trapped and killed 17 motorists on the Geelong to Melbourne highway. In any event, with vehicular transport accessible to everyone nowadays, this result is not surprising.

Table 6 presents the same data in Table 5 but distinguishes between adult male victims, adult females and under-18s. (“Male” and “Female” denote those 18 or over and also any for whom age was unknown but from their description it seems highly probable that they were adults.) Most males have been killed whilst outside defending property (45.8% of all male deaths and 27.5% of all deaths). In the first half of last century, this occurred mainly in rural locations. In the last 54 years deaths in this category were roughly equally divided between suburban and rural locations.

The second most fatalities for males is late evacuation: in the first half of the century, this was mostly from a place of work and outside; in the latter period (1954–2008), however, this changed to evacuation from places of shelter. Overall, however, the proportion of male fatalities from late evacuation has decreased significantly in the more recent half century ($z = 3.42$, $p < 0.001$). Late evacuation accounted for the majority of female and child (<18) deaths, most of whom died whilst evacuating from a place of shelter.

The fourth most fatalities for males and the second for females occurred while staying inside a defensible property, with most of these particular deaths occurring while passively sheltering.

The second most fatalities for the under 18s was: for the first 55-year period, defending property outside and, for the most recent 54-year period, travelling through the fire area but being unaware of the danger. These figures probably reflect the fact that in the earlier part of last century most young people worked, especially in rural areas, and at that time travelling for pleasure, especially in cars, was unusual.

Of those who were killed while travelling, nearly half were on foot (Table 7). In more recent times, however, there has been an increasing trend for people to be killed while inside or exiting a vehicle (in both cases the change in proportion to the most recent half century is very highly significant, with $z < -5$ in both cases, i.e. $p < 0.00001$). This trend is particularly evident for the under-18 group, where fewer fatalities are recorded as occurring on foot and more whilst in or exiting from a vehicle.

3.4. Awareness and capacity to respond

As stated above, much of the data is not detailed enough in respect to timing and types of warnings received by victims, their level of preparedness and previous fire experience and/or knowledge. However, where possible, information from witness statements and the conclusions drawn by the coroner were used to classify decisions made by the deceased (Table 8). For deaths, where such data existed, it is clear that the

Table 7 – Transport at time of death – all age categories.

	1900–2008		1900–1954		1955–2008		Comparison of the two periods	
	Number	%	Number	%	Number	%	z-Score	p-Value
On foot	255	46.2	176	60.3	79	30.4	7.033	<0.00001
Inside a closed vehicle	36	6.5	3	1.0	32	12.3	–5.445	<0.00001
Exited a closed vehicle or found with the door open	70	12.7	15	5.1	54	20.8	–5.568	<0.00001
On open transport or ran from	23	4.2	13	4.5	12	4.6	–0.056	>0.5
Transport not applicable, i.e. found inside their house or died from exhaustion or shock	90	16.3	26	8.9	64	24.6	–4.986	<0.00001
Unknown	78	14.1	59	20.2	19	7.3	4.344	<0.00001
Total	552	100	292	100	260	100		

Table 8 – Awareness/capacity to respond.

	1900–2008		1900–1954		1955–2008		Comparison of the two periods	
	Number	%	Number	%	Number	%	z-Score	p-Value
Physically and/or mentally incapable	24	4.3	8	2.7	16	6.2	–2.013	<0.05
Aware of the fire and carrying out a premeditated action	152	27.5	72	24.7	80	30.8	–1.601	>0.1
Aware of the fire but had no plans or did not follow them	110	19.9	54	18.5	56	21.5	–0.881	>0.2
Unaware of the fire and realised too late	59	10.7	28	9.6	31	11.9	–0.873	>0.2
Extenuating circumstances, e.g. heart attack	25	4.5	10	3.4	15	5.8	–1.353	>0.1
Children who followed adults' decisions	60	10.9	39	13.4	21	8.1	1.994	<0.05
Unknown	122	22.1	81	27.7	41	15.8	3.364	<0.001
Total	552	100	292	100	260	100		

majority were aware of the fire and carrying out a plan (mainly males) for each time period examined. Whilst the proportion has increased slightly in recent times, the change is not statistically significant ($z = -1.60$, $p > 0.1$). For both time periods, to be aware of the fire and either having no plan or not following it was the second highest category. Again the difference in proportion between the two periods is not statistically significant ($z = -0.88$, $p > 0.2$). More males were casualties of this circumstance in the first 55-year period; mainly females in the more recent 54-year period. The third most common category was, for the most recent 54-year period, to be unaware of the fire and, overall and for the first 55-year period, for children who followed adults' decisions.

No relationship was found between age and awareness/capacity to respond.

4. Conclusions

Typically data on cause of death are notoriously unreliable (e.g. Mathers et al., 2005), and are almost always available only in aggregated form: that is, as statistics rather than individual incidents. In comparison, the detail revealed in our search of coronial inquiries not only offers an opportunity to assess the circumstances of each individual fatality but also provides reliable metadata for the majority of the fatalities. In practice, this means that for many of the entries there is a link to a detailed independent report that has legal status and is available for review or verification.

Analysis of coronial reports and witness statements from the standpoint of our pre-Black Saturday perspective of bushfire risk management demonstrates that fatalities relate to the roles that people adopt in fire-prone environments and the resources (including warnings and preparations) at hand. (Preparation would include issues of house defendability and the proximity of fuels, although we do not explicitly examine these factors.) When activities at the time of death are examined, it becomes clear that the numbers of men dying while evacuating from work outdoors or while outside defending property or livelihoods has fallen while numbers of female deaths have increased. This likely reflects social changes with relatively few men now working outside, and with universal car ownership providing the means to drive into (or away from) danger. These livelihood and lifestyle

factors also help explain why the male to female death ratio has approached equality in some more recent fires.

Other research suggests that men often take on defensive activities, while women and children are left to shelter passively in the home or evacuate at the last minute (Goodman and Proudley, 2008). Although the AFAC policy fosters community self-reliance at a household level, gender and youth issues appear to have been neglected.

Our study has focussed on fatalities and so has not been able to include comparative figures of successful defence of a property compared to all those that failed. However, it is clear that prior to the Black Saturday 2009 fires, most bushfire fatalities have resulted from late evacuations or, in the case of males, defending property outside. Only one out of the 46 known fatalities that occurred inside a defendable property (the third most common activity of bushfire victims at the time of death) while actively defending, and this person died of a heart attack. In terms of awareness and capacity to respond, the ranking of numbers of fatalities were as follows: the majority were aware of the fire and carrying out a plan in the open (mostly males); second were those aware of the fires but having either no plan or having a plan that was not followed and that in turn usually resulted in late evacuation (mostly females). Thirdly were those unaware of the fire and children following the decisions of adults (and whose bodies were found in cars or outside with adults).

5. Policy implications

The clear implication for policy based on the evidence available prior to the 2009 Black Saturday fires is that while there is no zero risk option when confronted with a bushfire, staying and actively defending a dwelling appeared to be the safest option, and leaving at the last minute the most dangerous. This statement is set within three important caveats: we have no data for those who left early, but assume that none in that category died, although people evacuating early are subject to normal traffic risks to their lives. Secondly, fatality data is far from perfect as discussed earlier. The third important caveat is that while our analysis includes over a century of Australian bushfire-related fatalities, it stops short of the devastating fires of February 2009. At the time of writing, relevant data from the February 2009 fires is unavailable for

analysis and is being examined by the police. However, analysis of these fatalities and circumstances of these fires will certainly refine and may alter our conclusions.

An intention of the AFAC policy position has been one of community self-reliance, where people were asked to decide what action they would take should a bushfire threaten their property. They were also encouraged to prepare both mentally and physically for a situation in which they may not receive warnings and therefore would have no choice but to stay and defend their homes. The 2005 Eyre Peninsula fires, which broke containment lines and travelled very rapidly across the peninsula, demonstrates how fires remain a dynamic danger sometimes making warnings for early evacuations very difficult if not impossible. This being the case, unless people were expected to self-evacuate every time there was a likelihood of bushfire, actively defending a dwelling while using it for protection from radiant heat, smoke and embers was seen as the most viable option. But as has been pointed out already, it is a strategy that is not without risk and one that would benefit from thorough household and community level preparations to increase the likelihood of building survival.

Translating the ‘stay or go’ message into practice is complex, with both vagueness and ambiguity in the ‘leave early’ advice. The idea of “stay and defend or leave early” suggests to many that they can stay until it seems dangerous. These issues had been identified prior to the ‘Black Saturday’ fires. For example, Tibbits and Whittaker (2007) found that many people considered late evacuation a valid last resort, with children, valuables or pets being loaded into vehicles so that they could be evacuated if the situation were deemed too dangerous to stay. People often expected the emergency services to provide help and warning and many of those who planned to stay were often not well-prepared: they did not expect to lose electricity or water and did not wear adequate protective clothing.

This investigation has focused on the response of victims of bushfires during the period 1900–2008 in terms of how they might have responded on the day and smaller scale preparations or plans they may have made. Comment on the Black Saturday fatalities is premature, however, some of the interim recommendations of the Royal Commission (Victorian Bushfires Royal Commission, 2009) are not inconsistent with our findings based on previous evidence. *Inter alia*, it recommends greater emphasis on early evacuations as the safest response and that the risks of defending properties need to be spelt out more plainly, including the risk of death. We also recognise that adaptations such as risk-informed land use planning and fuel management are also important factors on the public’s ability to survive bushfire threats. All of these issues and others pertaining to the AFAC policy and its implementation are currently under consideration by the Victorian Bushfires Royal Commission (2009). Our current study provides a benchmark and statistical framework against which the Black Saturday data can be examined.

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