Victim behaviours, intentionality, and differential risks in residential fire deaths

I. Miller¹ & P. Beever²
¹Heimdall Consulting, Wellington, New Zealand
²New Zealand Fire Service Commission, Wellington, New Zealand

Abstract

The majority of fire deaths in New Zealand occur in residential structures. These are seen as largely preventable and are a basis for fire safety and prevention strategies. While such strategies have emphasised technological and engineering solutions (i.e. smoke alarms, egress standards, building code reform), there has been a lesser consideration of victim behaviours as a key factor in fire safety and prevention. This paper reports on a study of behavioural factors in all unintentional residential fire deaths from 1997-2003 in which inquest reports were examined to determine a range of demographic, fire dynamic, forensic, and behavioural features in 131 cases. The results support other findings which highlight the potent role of victim behaviours in fire ignition and spread, and in fatal outcomes. Significant factors identified include alcohol consumption, acts of omission, carelessness, dangerous habitual behaviours, and consequences of disabilities. A dichotomy between intentional and unintentional fires was not supported, as several cases fell into a borderline group whose role in fire causation was established (although intent to harm was not). Features of this group included attention seeking, irrational behaviour, and diminished cognitive/intellectual capacities. Those identified as being differentially at most risk of residential fire deaths were the young, the elderly, the disabled, and lower socioeconomic groups. Effective safety and prevention strategies must address specific behavioural characteristics of these disparate groups, especially socio-psychological processes, attitudes, and cognitive patterns that contribute to elevated fire risks. The theoretical and applied implications of these findings are discussed as part of a wider approach to fire safety and prevention strategies.

Keywords: residential fire deaths, behaviour in fire, intentionality, differential fire risks, socio-psychological processes, fire safety and prevention.
1 Introduction

There has been a shift in the past three decades in the focus of fire safety and prevention with a realisation that engineering solutions alone will not achieve enduring outcomes, but that an understanding of human behaviour in fire is a key factor in reducing deaths and injuries. As Shields and Proulx [1] note –

“The development of human behaviour in fire into an area of scholarly study of vital importance has been extremely rapid. ... Hard fire science alone cannot solve the “fire problem”. With increasing international emphasis on community fire safety policy initiatives knowledge of occupant behavioural characteristics associated with fire is essential.”

Initial studies of human behaviour in fires focussed on large group settings, ie., high rise buildings, places of entertainment, transportation systems [2]. This reflected the potential for mass casualties and associated liabilities in places of high population density. Ironically, one consequence has been lesser attention on residential fires, although these events collectively result in greater deaths and injuries, albeit as single or small numbers of casualties.

2 Residential fire death studies

In most developed countries the majority of fire deaths occur in residential settings. However, in contrast with major fires, residential fire deaths tend to be overlooked as Rhodes and Reinholtd [3] note “perhaps because they are a diffuse form of disaster”. The diffuse character of residential fires may account for a delay in focussing on this area of fire risks, although the magnitude of the problem is well recognised. Ward [4] observes almost 5,000 Americans die each year in fires, with 80 percent of those deaths resulting from home fires, and that fire “kills more Americans each year than all natural disasters combined.”

One outcome has been a closer examination of human behaviour in residential fires because of the cumulative magnitude of these deaths and their potential for prevention and reduction strategies. A significant part of this research has been undertaken in Australia and New Zealand eg. [3], [5], [6], [7], [8]. A theoretical advance comes from Brennan and Thomas [9] who advocate a paradigm shift in conceptualising human behaviour in fire. Their new paradigm challenges the traditional assumption that occupants confronted with fire will react to it; rather, they argue occupants interact with fire, ie. a move from a reactive to an interactive model in which the role of occupants in fire ignition and spread is a central behavioural theme. The focus moves from fire being an imposed event to a situation where more subtle roles are recognised in which occupants inadvertently contribute to fire ignition through their actions, or add to the risk of becoming fire casualties from deliberate actions such as attempting to fight the fire or failing to maximise the chances of safe escape from the threat. This model is presented in Figure 1 as follows –
3 New Zealand residential fire deaths 1997-2003

The New Zealand Fire Service is committed to reducing the consequences of fire, especially residential fires which are seen to be largely preventable. Of 234 fire deaths in the 1997-2003 period, 131 (56%) occurred in unintentional residential fires. All New Zealand fire deaths are subject to coronial notification and require Police and Fire Service investigations to determine causation and possible criminal liabilities. Thus, inquest files provide comprehensive information from fire investigation reports, witness accounts, pathological findings, and other evidential material. The senior author [10] applied quantitative and qualitative methods to inquest files on all unintentional residential fire deaths in the period to examine a range of fire dynamic, demographic, forensic, and behavioural features. The full report (This research was supported by the NZ Fire Service Commission Contestable Research Fund) is available from the New Zealand Fire Service website [11]. The study identified significant behavioural issues that have a differential impact of fire safety and prevention initiatives.

3.1 Key victim risk factors

The study confirmed other research [12], [13] highlighting age and ethnicity as particular risk factors. Those at greatest risk of were - males (62.6% of deaths), aged 0 - 15 (32.1% of deaths) or 60 or more (25.9% of deaths). Maori victims were disproportionately represented (39.7% of deaths) which is approximately three times their representation in the general population.
A key demographic feature was the socio-economic decile of properties in which these fire deaths occurred. A Deprivation Index Decile (DID) measure was derived from census records which gives a relative deprivation score based on several material and social dimensions of deprivation (i.e. income, employment, support, qualifications, living space, communication, transport, home ownership). The DID ranges from 1 (least deprived) to 10 (most deprived). It was found a disproportionate number of fire deaths occurred in the decile 7-10 range, accounting for 62.2% of all deaths as shown in Figure 2.

![Figure 2: % of fatalities vs deprivation index decile.](image)

It was also found that 38.8% of victims had pre-existing health conditions that may have impacted on their involvement in fires and consequent fatality, including - physical disabilities, sensory incapacities (eg. vision and hearing losses), cardio-vascular conditions, dementia, consequences of conditions associated with age, affects of mental disorders, and drug and alcohol abuse.

### 3.2 Features of fatal fires

Analysis of causes of fatal fires identified significant behavioural elements in fire ignition and spread. Not surprisingly, the rooms of fire origin were in order of occurrence, bedrooms (33.9%), kitchen areas (29.4%) and lounge areas (19.3%) which illustrates the relationship between habitual domestic activities and the potential for fire ignition. This relationship is further highlighted by the times the fires were reported with a majority reported during night hours, including -

- 45% reported between 11 pm and 3 am,
- 72% reported between 7 pm and 7 am.

Further temporal analysis shows 45% of fatal fires occurred in the weekend period between 6 pm Friday and 6 am Monday. This temporal pattern reflects domestic and recreational activities, effects of fatigue, impairment from alcohol and drug consumption, smoking behaviours, involvement in social and cultural events, and, significantly, dangerous habitual behaviours.
The causes of the fire deaths as established at inquest were as follows –

### Table 1: Causes of fatal fires.

<table>
<thead>
<tr>
<th>Fire Cause</th>
<th>% Deaths</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unattended Cooking</td>
<td>16.9%</td>
<td>Stove top/oven fires from ignition of unattended cooking.</td>
</tr>
<tr>
<td>Careless Smoking</td>
<td>13.1%</td>
<td>Fires from careless disposal or use of smoking materials.</td>
</tr>
<tr>
<td>Unattended Candle</td>
<td>10.0%</td>
<td>Fires from unattended burning candles.</td>
</tr>
<tr>
<td>Children With Fire</td>
<td>9.2%</td>
<td>Children playing with lighters and fire.</td>
</tr>
<tr>
<td>Not Established</td>
<td>7.7%</td>
<td>Cause not established at inquest due to inconclusive evidence.</td>
</tr>
<tr>
<td>Appliance Fault</td>
<td>7.7%</td>
<td>Failure of electrical or mechanical appliances causing fire.</td>
</tr>
<tr>
<td>Electric Blanket</td>
<td>7.7%</td>
<td>Fires caused by malfunction and misuse of electric blankets.</td>
</tr>
<tr>
<td>Electric Heater Fire</td>
<td>6.9%</td>
<td>Fires due to misuse or failure of safety features in electric heaters.</td>
</tr>
<tr>
<td>Naked Flame</td>
<td>6.2%</td>
<td>Fire due to naked flames such as burning coals &amp; embers.</td>
</tr>
<tr>
<td>Electrical Overload</td>
<td>5.4%</td>
<td>Ignition from electrical systems overload, eg. incorrect fuses.</td>
</tr>
<tr>
<td>Gas Fault</td>
<td>4.6%</td>
<td>Fires from gas systems due to poor or inappropriate maintenance.</td>
</tr>
<tr>
<td>Carelessness</td>
<td>4.6%</td>
<td>Fire caused by careless acts &amp; omissions, &amp; irresponsible actions.</td>
</tr>
</tbody>
</table>

This table shows a clear picture of high fire risks associated with unattended cooking, careless smoking, unattended candles, and children playing with fire (which collectively account for nearly 50% of all fatalities).

### 3.3 Causes of death

Cause of death is a primary determination to be established at inquest and which relies on *post mortem* and other forensic findings. Post mortem examinations may indicate the time an individual survived before they succumbed to lethal fire elements. It was found 88.5% of victims died during the fire, often in the early stages once it was established. Only 11.5% initially survived the fire (by their actions or through rescue) to later die of injuries. The longest periods of post-fire survival were 31, 26, and 22 days. In most cases death was immediately proximate to the fire, with victims having insufficient time to make an escape before they succumbed to smoke and fumes. For many the time between fire awareness and fatal incapacity appeared no more than 2-3 minutes.
Pathological determinations of cause of death show the lethality of ingesting smoke and fumes, and of oxygen deprivation, as factors in these fatalities as is presented in Table 2. *Note:* more than one cause may apply to each victim.

### Table 2: Causes of Death

<table>
<thead>
<tr>
<th>Cause of Death</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smoke Inhalation</td>
<td>72</td>
</tr>
<tr>
<td>Carbon Monoxide Poisoning</td>
<td>32</td>
</tr>
<tr>
<td>Hypoxia, Asphyxia</td>
<td>14</td>
</tr>
<tr>
<td>Cardiac Failure</td>
<td>6</td>
</tr>
<tr>
<td>Burns/Thermal Injuries</td>
<td>53</td>
</tr>
<tr>
<td>Incineration</td>
<td>3</td>
</tr>
<tr>
<td>Multi-Organ Failure</td>
<td>3</td>
</tr>
<tr>
<td>Respiratory Disease</td>
<td>2</td>
</tr>
</tbody>
</table>

Although 38% of victims had pre-existing health conditions that may have affected survivability, the remainder were apparently healthy yet were unable to escape the lethal outcome. This raises the role of human agency as a factor in these deaths.

### 4 Role of human agency

An apparent feature of these deaths is the role of human agency in fire ignition and spread. Consumption of alcohol is an evident contributive factor affecting fire ignition, responsiveness to fire cues, and effective escape behaviours. Blood alcohol levels assessed at post mortem examination present a compelling picture when compared with victim age, as is shown in Figure 3 -

![Figure 3: Age vs blood alcohol levels.](image-url)
This graphically shows a number of victims were markedly alcohol impaired, especially when benchmarked against the legal blood alcohol limit for driving of 80mg/100 ml in New Zealand; further, many of these impaired victims were also responsible for the deaths of others in their care (eg. children and relatives).

Individual case analysis identified a grouping of carelessness, acts of omission, and dangerous habitual behaviours that contributed to fire ignition and spread. These were often mediated by alcohol consumption. The habitual nature of such activities was often highlighted by evidence of previous fires, or by other actions that increased the risk of fatal outcomes (eg. disabling smoke detectors to prevent activation). A difficulty with dangerous habitual behaviours in the home is that these are not usually amenable to external scrutiny. The crux of the problem is expressed in the maxim “A person’s home is their castle” which reflects a view that residential areas are a special territory where individual freedom is paramount. In contrast, behaviour in the external environment is governed by accepted rules (eg. responses to fire alarms, obeying fire wardens). In the home environment such constraints may not apply with a consequential increase in risks from dangerous habitual behaviours.

It is concluded that human agency is a significant contributor to fire ignition (largely from inadvertent acts) and fire spread (due of a lack of appreciation of impending risks, or because victims did not have sufficient time to escape). Significantly there was little evidence of panic among the victims; rather their actions indicated an apparent disjunction between the impending risk of the fire and a perceived inertia affecting escape responses. Predominant reactions appear to be more of a lethargic character than of alarm and quick actions.

5 The question of intentionality

The study concentrated on unintentional residential fires as these are seen as being amenable to prevention and safety interventions. Coronial rulings are specific on whether a fire death was intentional or not. However, closer analysis suggests that a distinction between intentional and unintentional fires is not a simple dichotomy. Of 131 deaths studied 15 borderline cases were identified (11.5%) where determination of intent was unclear or ambiguous. These cases reflect a more complex level of intentionality and suggest a need for conceptual review around the notion of intent.

A tentative model is proposed that distinguishes between Intentional and Unintentional fire causation through an overlapping Borderline category. Combined within these three headings are behavioural and environmental factors that contribute to the model’s complexity in which increasing human agency and consideration of intent to harm are driving factors. The Borderline group highlights an amalgam of Attention Seeking, Diminished Capacity Substance Abuse, and Irrational Actions as individual considerations that influence victim behaviour in fires. The model is presented in Figure 4.
The validity of this tentative model requires testing against a wider sample of fire deaths, including analysis of intentional fires, to further identify other potentially significant behavioural variables.

6 Towards an integrated approach

The complexity of behaviours identified in the study highlight differential risks of fire deaths associated with age, health and disabilities, ethnicity, and socio-economic status. Added to these are the consequences of social activities such as smoking and alcohol consumption, illicit drug and substance abuse, cultural practices, and individual patterns expressed as dangerous habitual behaviours. This amalgam of risk factors suggests effective fire safety and prevention strategies must address particular characteristics of these disparate groupings if robust and effective changes are to be effected. An integrated behavioural approach to fire safety and prevention must incorporate an understanding of key socio-psychological, attitudinal and cognitive patterns of behaviour if enduring gains are to be expected. This suggests a “one size fits all” approach is less likely to succeed as some at risk groups may not be amenable to generalised fire safety and prevention initiatives. This is noted by Rhodes and Reinholdt [3] who argue for a holistic approach to fire intervention strategies “which recognises the complexity of the problem and employs a range of integrated measures to address the specific needs of vulnerable groups in the community”.

Figure 4: Intentionality, harm and fire causation.
One means of applying an integrated behavioural approach to fire safety and prevention is to specifically recognise key target areas for targeted interventions, including the following -

1. **The Developmental Continuum:** Differential strategies apply according to where individuals fall on the developmental continuum. These need to take into account different physical, intellectual, and cognitive levels that apply across the life span (i.e. initiatives targeting children markedly differ from those which apply to young adults or the aged).

2. **Cultural Factors:** Recognition of disparate cultural and ethnic practices as specific fire risk factors is necessary in multi-cultural societies. Effective targeted interventions must be developed from within these communities and work within appropriate cultural norms for different groups.

3. **Socio-economic Status:** The relationship between socioeconomic status and differential risk of fire deaths is well established. This co-varies with factors such as smoking, alcohol/drug use, gender, health conditions, disabilities, education level, employment status, residential location, and ethnicity. While socio-economic status in itself is not a causal factor in residential fires, it describes an aggregation of economic, material, and social deprivation factors associated with those over-represented in fire statistics. Henry [14] notes a set of characteristics that systematically differ by social class and influence a range of health outcomes that broadly fall into three domains –

   - **psychological domain** including norms and habits, health knowledge, abstract-level modes of thought, and behavioural intentions.
   - **behavioural constraints** including economic resources and situational effects.
   - **physical influences** including physiological stress, genetic dispositions, and environmental conditions.

It is suggested that an integration of developmental, cultural, and socio-economic factors is central to developing effective fire safety and prevention initiatives. While gains have been achieved from engineering and technological solutions, it is apparent that behavioural processes underlying these solutions require equal consideration if enduring reductions in fire deaths and injuries are to be realised. Given advances in the understanding of human behaviour in fires over the past three decades, it is timely to attempt a wider theoretical integration of this work with equally significant engineering and technological developments, in order to further reduce a greatly preventable social toll from fire deaths and injuries. This objective requires a multi-disciplinary approach, and may take direction from other areas of social risk mitigation. For example, initiatives that have reduced the levels of preventable deaths and injuries from road crashes provide an appropriate multi-disciplinary role model in this context.
References


