Fire-related Injuries and Deaths

Evidence Brief #207 - 2022

Fire and Emergency commissions research to support its main functions:

- Reducing the likelihood of unwanted fires.

- Reducing consequences from emergencies.

- Helping build resilient communities.

Evidence Briefs summarise this research, on specific topics. They are the initial port of call for decision makers, policy makers and operational staff looking to influence fire-related outcomes.

Summary

This Evidence Brief relates to 14 quantitative and qualitative studies commissioned by Fire and Emergency over the last 20 years on fire-related injuries and death. The studies include:

- Analysis of data at the population and workplace level, to identify trends in who, where and why fires, injuries and deaths occur. The data used relates to periods ranging from 1985-1999 to 2013-2017.
- Smaller, qualitative studies with a behavioural focus, which were delivered in 2021 and 2022.

Who was involved in fire-related injuries and deaths?

- Males
- Children under 5 years old
- Younger people (between 15 and 34 years old)
- Older people, aged over 74 years
- People in lower socio-economic settings
- Māori
- Disabled people

Themes in fire-related injuries and deaths were:

- Mostly occur at home and in the kitchen.
- Alcohol is a contributing factor.
- For older adults, fire-related deaths were related to living alone, fire starts in the bedroom, and heating appliances were the source.
- For children, lighters and matches were the most common heat sources.
- Disruption to usual routines was a significant factor of fire mortality.
- In the workplace, industrial facilities were the most risky location – particularly in the agricultural sector.

How do people experience fire, and what leads to getting injured or dying?

- Being forgetful (leaving fire sources on), and carelessness
- Attempting to fight the blaze
- Entering or re-entering burning properties
- Smoke alarms help, but they should be used in tandem with an escape plan

Further policy development, and careful tailoring of campaigns and interventions with vulnerable communities, are suggested as next steps.

Recommendations from the research

Policy recommendations

1. Continue to support other agencies and departments as they address the social and economic determinants of deprivation

Recommendations for who interventions could be aimed at

1. At-risk communities:
   • Māori, Pacific and ethnic minorities
   • Low socio-economic communities
   • Workplaces
2. Community partners, to co-design and co-deliver strategies and support
3. Partnerships with other government agencies and stakeholders

Recommendations for campaign and intervention content

1. Review scale and scope of existing prevention campaigns for fires in residential dwellings
2. Review and redevelop campaigns in line with experiences of survivors
3. Continue providing fire safety training and knowledge
4. Continue to promote smoke alarms, with emphasis on the importance of also having a detailed escape plan

Recommendations for future research

1. Improve data collection and analysis, to enable a more comprehensive knowledge base of the precursors and antecedents of fire-related injury and death
2. More qualitative and quantitative data and research on survivor experiences, motivations, and actions
3. Update and extend existing research using existing national, longitudinal, and linked datasets

Contents

Who was involved in fire-related injuries and deaths?

Fire was the leading cause of unintentional death from injury in domestic environments, for the working age population.[2] It is one of the top three causes of unintentional death from injury in domestic settings for children and seniors.

Males, individuals aged between 20-29 years of age, and Māori, have a higher rate of intentional and unintentional non-fatal fire-related injuries

Analysis of three national datasets* over the period 2013-2017 covering intentional and unintentional incidents, and residential and non-residential fires found that the following demographic characteristics had higher rates of injury (Figure 1):[13]

- Males

- People aged between 20-29 years

- Māori.

This supports an earlier study over the 1991-1997 period where the risk was highest for males, and for Māori.[4, 5]

Males, children under five years, seniors over 74 years, and Māori, are most at risk of fire-related deaths

Between 1991-1997, mortality rates were highest for children under five years, and older adults aged over 74 years.[*,5] Again, a study of unintentional residential fire deaths between 1997-2003 found that the very young and the elderly were identified as most at risk of residential fire deaths.[14] Mortality rates for people between the age of 65 and 74 years were consistent with that for younger adult age groups, but rates triple for each decade over the age of 75.[3]

Fire fatality rates were higher for male children and male adults aged under 55 years. Males were 2.5 times more likely to die.[1]

There were marked disparities in fire mortality rates between Māori and non-Māori, and Māori were more likely to be involved in a multiple fatality incident.[5]

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* Ministry of Health, National Minimum Dataset (NMDS) of hospital discharges; Accident Compensation Corporation's (ACC), Claims Management database; and Fire and Emergency Fire Incident Recording System (FIRS).
* Although the rates for seniors declined over the study period.

Who was involved in fire-related injuries and deaths?

People with disabilities were more at risk

The studies show that people with disabilities were at increased risk of injury and death from fire.[12, 14] The extent of disabilities was a factor in almost 40% of residential fire deaths between 1997 and 2003.

Pre-existing health conditions included:

- Mobility difficulties.
- Alzheimer's disease.
- Dementia.
- Cardiovascular conditions.
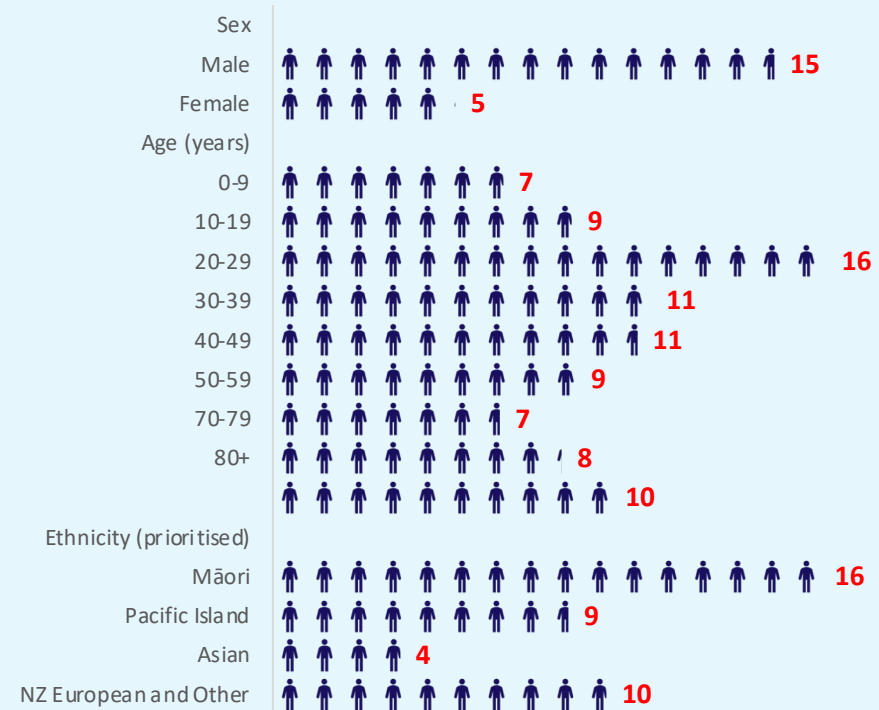- Respiratory diseases.
- Sensory losses.

In workplace fires, younger males were at the highest risk

A quantitative study from 1985-1999 found that there were, on average:[9]

- 1.6 deaths to workers per year.
- 1.7 deaths to bystanders per year.
- 30.8 work-related fire injury hospitalisations per year.

Younger males were at the highest risk.

Figure 1.
Sex, age, and ethnicity of individuals with non-fatal fire-related injuries, 2013-2017, per 100,000 people

Sex	
Male	15
Female	5
Age (years)	
0-9	7
10-19	9
20-29	16
30-39	11
40-49	11
50-59	9
70-79	7
80+	8
	10
Ethnicity (prioritised)	
Māori	16
Pacific Island	9
Asian	4
NZ European and Other	10

Source: *Understanding non-fatal fire related injuries in New Zealand: 2013-2017*[13]

* Ministry of Health, National Minimum Dataset (NMDS) of hospital discharges; Accident Compensation Corporation's (ACC), Claims Management database; and Fire and Emergency Fire Incident Recording System (FIRS).
* Although the rates for seniors declined over the study period.

Where were fire-related injuries and deaths occurring?

Fires causing injury or death mostly occurred in the home and in the kitchen

Collectively, the studies find that the most common scenarios leading to hospitalisation or death were:

- In single houses.[12]
- In the kitchen and in cooking-related fires.[1, 2,3, 13]
- Where the heat source was a stove top or oven, deaths were related to the following factors[1]: abandoned cooking that involved cooking with oil or fat; aluminium pot; and/or excess blood alcohol levels.

Alcohol was a contributing factor

Analysis of data between 1991-1997 find that of stove top or oven fire fatalities: [1, 2]

- Alcohol was a known factor in over half of the incidents.
- Almost half of deceased adults had post-mortem blood alcohol levels in excess of 100 mg per 100 ml, and the remainder had confirmed alcohol consumption prior to the incident.

Alcohol consumption was also identified as a risk factor in unintentional residential fire deaths between 1997 and 2003.[14]

Deaths in the 65+ cohort tended to live alone, and the fire starts in the bedroom from a heating appliance

Between 1991-1997, mortality in the 65 years and older cohort was related to living alone.[3] The most common location of origin for fatal fires was the bedrooms, followed by lounge, and kitchen. Heating appliances were the main heat source with bedding the most common item ignited.

For child fatalities, lighters & matches were the most common heat sources

Between 1991-1997, in child fatalities, the most common heat sources were lighters and matches.[5] While most fatalities occurred in permanent private dwellings, a significant number were found to have occurred in temporary accommodation. Operating smoke alarms were not present in nearly every incident involving fatalities among children.

For child fatalities,
lighters & matches
were the **most common** heat sources

Where were fire-related injuries and deaths occurring?

Disruption to usual routines appears to be a significant factor for fire mortality

Analysis of national datasets for incidents between 1991-1997 and for ages 15 – 64 years old, disruption to usual routine for the deceased was a significant factor in mortality.[2]

Disruptions from routine include:

- Attendance at a social function.
- Returning home after midnight.
- Being away from home or having overnight guests.

For children, "doing something different" also appears to be a significant contributing factor.[4] Examples include:

- children were visiting an unfamiliar house, or
- there were visitors to the family home.

The most socially and materially deprived households experience higher rates of fatal fires

International literature, and the Fire and Emergency studies, indicate that that the most socially and materially deprived households experience higher rates of fatal fire incidents.[7, 8] The University of Otago study using 1988-1998 data found that the most deprived decile areas had 4.5 times the rates of fatal fires than the least deprived decile. [8]

The council areas with the highest fatality rates per 100,000 houses were (in order of highest rate to lowest rate) Kawerau District, Grey District, Taupo District, Ruapehu District and Waimate District.

Temporary accommodation was also a risk factor.[2, 4]

In workplace fires, industrial facilities were the riskiest location

Data from 1985-1999 found that the agricultural, fishing and manufacturing industries were at the highest risk.[9] The agricultural and fishing industry had the highest mortality rate.

Welding torches were the primary source of ignition in fatal work-related fires, and the risk of fatal workplace fire was highest in the afternoon.

The **most deprived** decile areas had

4.5 times

the rates of fatal fires than the **least deprived** decile

A note on the data

The studies rely on data from the Ministry of Health, Stats NZ, Accident Compensation Corporation (ACC), coronial records, and Fire and Emergency. There were data concordance challenges which make it difficult to link and analyse data across agencies.[5, 13] Additionally, consistent and comprehensive data was not always collected by Fire and Emergency staff when attending incidents.[13]

How do people experience fire, and what leads to them getting injured or dying?

The victim often plays a significant role in fire ignition, spread, and fatality

In 1997-2003, the following victim behaviours contributed to fire ignition, spread, and in fatal outcomes:[14]

- acts of omission (leaving heaters on, leaving things cooking)
- carelessness (smoking near flammables, burning cigarettes fall on items, placing smouldering electric blanket under a bed)
- attempting to fight the blaze, and
- entering/re-entering burning properties.

In 2021, semi-structured interviews with 31 individuals* who had experienced an unintentional residential dwelling fire (UDF), support the earlier quantitative findings. While there were a diverse range of experiences, a phased behaviour process was observed (Figure 2).[11] In this phased behaviour process, injury tended to occur through:

- Direct interaction with fire, as part of their reaction
- Re-entry into the fire, despite strong fire or smoke cues.

This suggests that survivors are not following the advice provided by Fire and Emergency, including: "Get out, Stay out" and are under-estimating the risks of injury.

The researchers also suggested that Fire and Emergency consider undertaking formal fire investigations where fire injuries occur* (as with fatal fires) so that more information and data is collected on the circumstances associated with such injuries, to build up a more comprehensive knowledge base.

Smoke alarms are useful but the relationship between smoke alarms and physical injury and/or property damage is unclear

In the majority of cases in the period 1991-1997 where the heat source was a stove top or oven, there was no functioning smoke alarm.[2]

A more recent interview-based study found that smoke alarms were:[10]

- Useful for alerting occupants to investigate (particularly if sleeping)
- Not always functional or in the right position to alert in time (need to be placed in cavities as well as kitchen etc)
- Not as useful for hearing impaired who need additional technology
- Most effective when used in conjunction with an escape plan (not just alone).
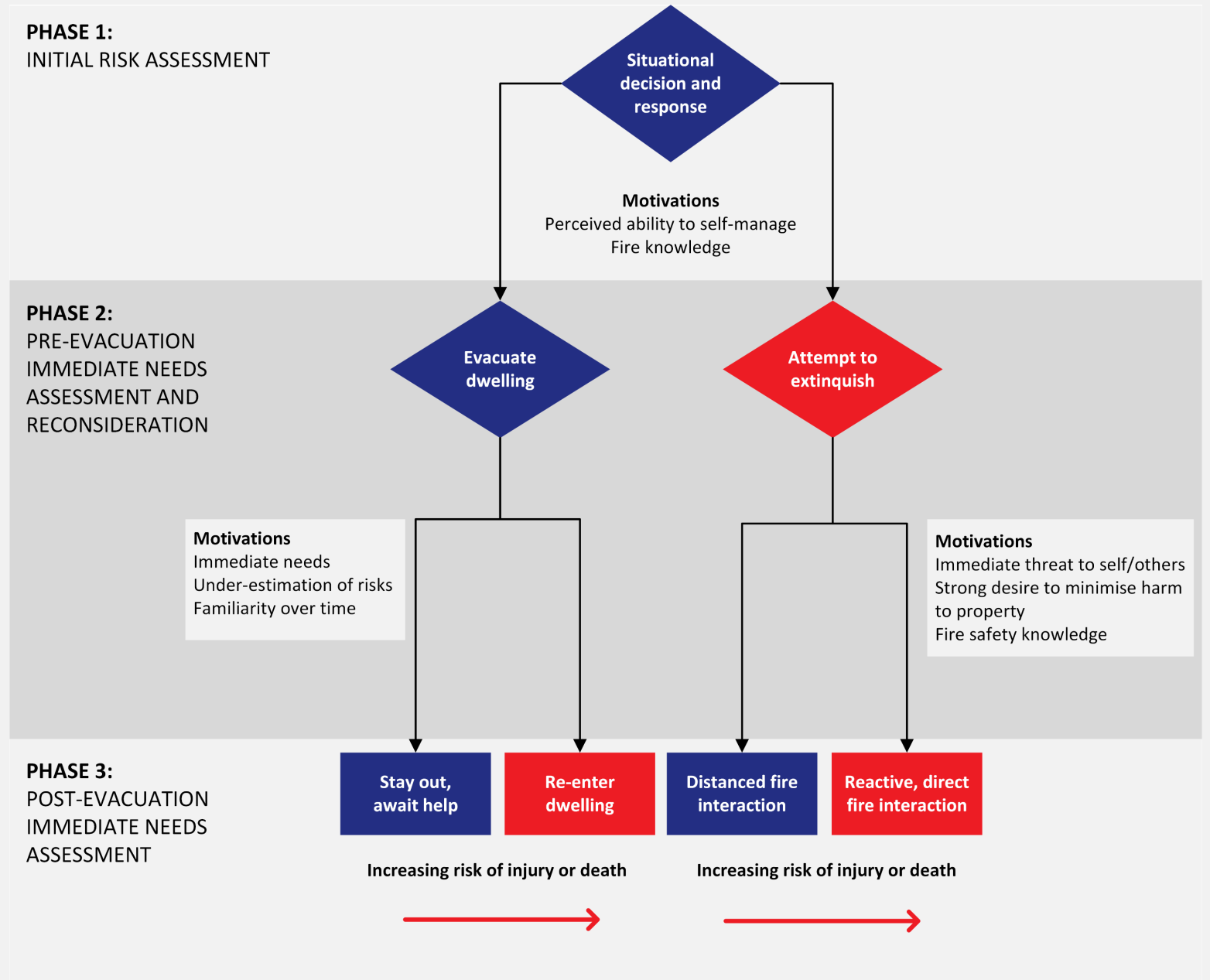
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* The sample characteristics, while not intended as representative, were broad: the majority of participants were female, of working age, identified as European, had adequate financial security and came from the Auckland and Northland regions.
* At a minimum, those with serious or critical injuries requiring hospitalisation.

How do people experience fire, and what leads to them getting injured or dying?

Figure 2.
Phased behaviour process of injured and uninjured survivors of unintentional residential dwelling fires

Source: Adapted from *Non-fatal fire related injuries: The lived experiences of those who have been involved in a house fire event* [11]

PHASE 1:
INITIAL RISK ASSESSMENT

Situational decision and response

Motivations
Perceived ability to self-manage
Fire knowledge

PHASE 2:
PRE-EVACUATION IMMEDIATE NEEDS ASSESSMENT AND RECONSIDERATION

Evacuate dwelling

Attempt to extinquish

Motivations
Immediate needs
Under-estimation of risks
Familiarity over time

Motivations
Immediate threat to self/others
Strong desire to minimise harm to property
Fire safety knowledge

PHASE 3:
POST-EVACUATION IMMEDIATE NEEDS ASSESSMENT

Stay out, await help

Re-enter dwelling

Distanced fire interaction

Reactive, direct fire interaction

Increasing risk of injury or death

Increasing risk of injury or death

What does this mean for hapori Māori?

The research consistently finds that Māori were at more risk of fire-related injury and death

- Māori had the highest rates of fire-related fatality.[12] Māori were four times more likely to die than non-Māori.[1, 5]
- For older people (aged over 65 years), mortality rates were higher for Māori than for other New Zealanders.[3]
- For children (aged 15 years and younger), mortality rates were higher for Māori than for other New Zealanders.[4]
- Hospitalisation for injury from fire and flame of Māori were 2.5 times the rates of non-Māori.[6]
- Māori disproportionately died at younger ages – 7 out of 11 deaths were Māori under 25 years.[1, 5]
- Māori were more likely to be involved in a multiple fatality incident.[5]

" … It is clear that patterns of risk … are persistent over time and require improved inter-sectoral and cross-cultural collaboration and partnership … "

Dr Rebbecca Lilley, Dr Amy Richardson and Ms Gabrielle Davie, Injury Prevention Unit, Dunedin School of Medicine, University of Otago

Recommendations from the research

1 Bicultural policy and culturally appropriate services and networks to promote fire safety to Māori

2 Māori liaison staff in each fire region and ongoing training in cultural awareness should be provided to all fire-fighters

3 Fire safety strategies as part of health promotion for Māori aged 65 years and older. Work with Te Puni Kōkiri, Age Concern, Greypower, and Māori social and health service providers.

4 Develop and implement appropriate fire safety programmes for Māori with particular focus on families with children aged under 15 years.

Synthesis of recommendations

Policy development

The social and economic determinants of deprivation were highly related to fire injury and death

Given the relationship between social and economic deprivation and fatal fire incidents, longer term policy should address socio-economic determinants of deprivation.[7] Specific areas for policy development include:

- Increase the prevalence of installed and functioning smoke detectors.
- Support and advocate for the provision of interconnected smoke alarms as a minimum requirement in future Building Code legislative and regulatory updates.[10]
- Improve quality and affordability of housing.
- Regulation of cigarettes to reduce risk of ignition from abandoned heat sources.
- Adequate support for families affected by fatal or non-fatal fire incidents.
- Increase community awareness of appropriate action.

The following policy initiatives already in place were described as appropriate risk reduction strategies:

- legislation to ensure that lighters are child safe.
- smokefree legislation.
- provision of programmes to help smokers become smokefree.

Policy recommendations

1 Continue to support other agencies and departments as they address the social and economic determinants of deprivation

Synthesis of recommendations

Who do interventions need to be aimed at?

Communities at particular risk of fatal and non-fatal fire events:

- Reduce ethnic disparities, particularly Māori, Pacific and ethnic minorities.[13]
- **Low socio-economic communities:** The barriers to household fire safety in social and economically deprived population groups.[7] Ensuring smoke alarms are installed at higher levels in socially and economically deprived areas. Mandatory installation in all rental accommodation has mitigated some of the risk.
- To improve fire safety training and knowledge, and with **workplaces**.[11]

Active community partnerships[13]

- To co-design injury prevention strategies, and provide advocacy support.[7]

Partnerships with other agencies and stakeholders:

- **Social agencies:** Training social workers to assess fire safety of dwellings as part of a routine risk assessment.[7]
- **Health and emergency service agencies and services:** Importance of timely and appropriate treatment of fire-related burns.[11]

- **Emergency agencies and services**: Mitigate the disruptive aftermath of injuries and event on survivors' lives.[11]
- **Health, disability and aged care stakeholders:** Promote systematic installation of specialised smoke alarm systems for occupants that may have trouble hearing or comprehending smoke alarm signals.[10] It is recommended to collaborate with health, disability and aged care stakeholders to make appropriate equipment available and accessible to those that need it. Engagement with rest homes was highlighted given the high risk of mortality of older people, those that live alone, and fires starting in the bedroom.[3]
- **Agricultural and manufacturing industries.** Given the high risk of mortality for those in the agricultural sector (including fishing), and welding-related injuries and death.[9]

Recommendations for who interventions could be aimed at

1 Communities at particular risk of fatal and non-fatal fire events:
- Māori, Pacific and ethnic minorities
- Low socio-economic communities
- Workplaces

2 Community partners, to co-design and co-deliver strategies and support

3 Partnerships with other government agencies and stakeholders:
- Social agencies
- Health agencies
- Emergency agencies and services
- Disability and aged care
- Agricultural and manufacturing industries

Synthesis of recommendations

Public campaign and intervention content

Review scale and scope of existing prevention campaigns for fires in residential dwellings

Semi-structured interviews suggest that the messages to "get out, stay out" are still not getting through.[11] Alternative messages, tailoring to specific audiences, and/or increasing the audience of the messages may need to be considered.

Review and redevelop campaigns in line with the lived experiences of survivors

As mentioned above, the research finds that survivors are not adhering to the "get out and stay out" messaging, and often under-estimate the risks of fire, re-enter a burning dwelling, and/or attempt to fight the fire.[10, 11] It is recommended that fire safety campaigns be reviewed and developed in line with how people are likely to assess and respond, that is, influence:

- How people assess the risks of fire
- Methods and techniques for safely extinguishing dwelling fires, especially cooking fires
- Appropriate use of fire extinguishers in the home
- What services are provided by Fire and Emergency, and when Fire and Emergency should be called.

Continue providing fire safety training and knowledge

The research confirms the importance of fire safety training and knowledge. This knowledge can be gained from many different sources – Fire and Emergency advertisements, workplace training, school fire education programmes, and community groups. Fire safety training and knowledge tended to result in faster decisions to evacuate a fire, taking steps to minimise property damage, and stopped people from re-entering.[10, 11]

As part of this fire safety training and knowledge, the risks of non-fatal fire-related injuries from cooking/kitchen fires should be reinforced.[13]

Continue to promote smoke alarms, with emphasis on the importance of also having a detailed escape plan

Continue to promote the installation, maintenance and testing of smoke alarms in residential settings – in as many places as possible. Including reminding people to be familiar with the sound of their smoke alarm.[10] The research also highlighted that to be the most effective, every household should have smoke alarms as part of a detailed escape plan.

Recommendations for campaign and intervention content

1   Review scale and scope of existing prevention campaigns for fires in residential dwellings

2   Review and redevelop campaigns in line with experiences of survivors

3   Continue providing fire safety training and knowledge

4   Continue to promote smoke alarms, with emphasis on the importance of also having a detailed escape plan

Synthesis of recommendations

Recommendations for future research

Improve data collection and analysis, to enable a more comprehensive knowledge base of the precursors and antecedents of fire-related injury and death

- Improve collection of data from residential fire incidents, particularly person-level details (name, actual age, date of birth, residential address) to understand risk profile and outcomes.[13]
- Ensure injury severity field is completed by attending Fire and Emergency staff.[13]
- Ensure that there is data concordance, linkage and interoperability between Fire and Emergency, Statistics NZ and Ministry of Health to link casualty and hospital inpatient data.[6]
- Formal fire investigations (as conducted for fatal fire incidents) for, at a minimum, Fire and Emergency attended cases with serious and critical injuries requiring hospitalisation to improve the knowledge base for how and why fire-related injuries occur.[13]

More qualitative and quantitative data and research on survivor experiences, motivations, and actions

A model of human fire behaviour could be developed and tested, to inform public behaviour change programmes, and support firefighter interactions during and after fires.

The model would extend the phased model developed through the semi-structured interviews of survivors.[11] It could also consider lessons learned from other research in disaster management, and psychology.

Update and extend existing research using existing national, longitudinal, and linked datasets

Research to date has relied on a limited number of datasets – usually Census, FIRS – Fire and Emergency's Fire Incident Recording System, ACC claims management, and Ministry of Health's National Minimum Dataset (NMD). Some research suggests alternative, or more refined indicators, such as using the Ministry of Health NMD with the addition of ICISS (International Classification of Diseases-based injury severity score).[11]

New Zealand is unique in that there is an Integrated Data Infrastructure (IDI) which is a large research database held by Stats NZ. It holds data from government agencies, Stats NZ surveys, and non-government organisations. The data is linked together so that it holds de-identified microdata about people and households.

There is also the Longitudinal Database (LBD) which holds linked data about businesses. It is linked to the IDI through tax data.

Future research should update and extend the research conducted to date using the IDI and LBD.

Recommendations for future research

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