UNINTENTIONAL DOMESTIC FIRE-RELATED FATAL INJURY IN NEW ZEALAND: 2007-2014

University of Otago November 2018

Fire and Emergency commissioned this research to build upon previous investigations into fire fatalities, to identify the number of fire fatalities between 2007—2014 within Coronial reports.

The research focused on the two key questions:

- Who is at highest risk of fire-related fatal injury?
- What are the common causes and circumstances of fire-related fatal injury?

By answering these questions, the research would inform Fire and Emergency to effectively prioritise and target action to reduce fire-related fatalities in NZ.

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Unintentional domestic fire-related fatal injury in New Zealand: 2007-2014.

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1. Executive Summary

This descriptive study, utilising Coronial case review, approached unintentional injury from fire and flame in New Zealand from a public health and injury prevention perspective. Fire fatality data from the Ministry of Health's Mortality Collection were linked with Coroners' case files to provide a comprehensive account of fire-related deaths in New Zealand for the period 2007-2014.

The Coronial case review process identified 118 deaths which occurred in 107 unintentional domestic fire incidents in New Zealand from 2007 to 2014 inclusive. Most were single fatality events with nine multiple fatalities involving a further 22 deaths. Overall, rates of fire-related fatal injury have declined since the earlier case review of Duncanson et al., (2001) covering the period 1991-1997.

The demographic groups of older adults aged ≥65 years of age, males and Māori were identified as having the highest rates of unintentional residential fire mortality. The greatest burden of fatal injury occurred in the 15-64 year age group with the largest number of fatalities in these working age adults.

The majority of residential fires were due to cigarettes igniting fabric, in the bedroom or living area. Dwellings with increased risk of fatal injury included those located in main urban areas, in areas of high deprivation, and in fires occurring at night (midnight-6am). Smoke alarms were fitted in half of all properties where fatal fires occurred, but one third of these smoke alarms were not operational. Private rental properties were less likely to have a smoke alarm fitted. Fatal fire incidents were over-represented in rental properties, dwellings of wooden construction and single story dwellings.

Individuals at increased risk of unintentional fire-related fatal injury included those with pre-existing disability and/or co-morbidities, those consuming alcohol and/or drugs in the immediate lead up to the fire, and habitual smokers, with these circumstances often contributing to the ignition of the fire and/or impeding the response to the fire cues. Half of the fatalities were involved in the fire ignition in some capacity with many deaths a consequence of habitual behaviours, such as smoking or intoxication.

In depth narratives highlighted that combinations of limited mobility, confusion caused by alcohol or drug use, involvement with the fire ignition and/or fire source, being asleep at the time of ignition and rapid reductions in visibility from smoke drastically reduces the chance of fire fatalities escaping from the fire event.

The main recommendations for fatal fire risk-reduction strategies to address the burden of unintentional fire-related fatal injuries focus on the implementation and promotion of passive interventions, primarily focused on preventing fires in the first instance.

Recommendation 1: Fire and Emergency support and promotion of the comprehensive tobacco control Smoke Free 2025 initiatives, particularly those initiatives that create Smoke Free Homes as the most effective means of reducing cigarette related fire fatalities. Fire and Emergency should promote and support the review of voluntary standards surrounding Reduced Ignition Propensity cigarettes for sale in New Zealand along the lines of established mandatory standards in other countries.

Recommendation 2: Continued advocacy for the development of standard, implementation and enforcement for consumer products involved in the ignitions of domestic fire incidents. This should include fabrics used for upholstered furniture, bedding and adult clothing, as well as cigarettes and heaters.

Recommendation 3: Fire and Emergency to continue participation in and support of intersectoral strategies and partnerships to improve the well-being of New Zealanders, including consideration of the social and economic policy on fire safety particularly among deprived communities and households at greatest risk of fire-related injury. Activities should continue the development of further targeted education initiatives to address these significant contributors to fire fatalities to effect long term behavioural changes in 'at risk' populations, including building broader partnerships for fire prevention with older people personal care and health providers including the possibility of fire prevention training for personal carers.

Recommendation 4: Efforts to reduce underlying disparities should be a focus of fire safety activities. Fire and Emergency should continue supporting and developing: 1) bicultural policy and culturally appropriate services and networks to promote fire safety to Māori; and 2) effective fire safety strategies for Pacific peoples & other ethnic minorities. Establishing active community partnerships to support Fire and Emergency fire safety programmes may produce more effective means of accessing and educating at risk communities. Educational or awareness activities to guide safe fire-fighting should be considered.

Recommendations 5. That Fire and Emergency continue support and advocacy for embedding fire safe design and materials as a means of primary prevention, including the installation of sprinkler systems into new and renovated residential dwellings, in future Building Code legislative and regulatory updates

That Fire and Emergency continue to promote the use of smoke alarms in domestic dwellings through public education and community based fire safety programmes which intentionally include private rental properties. The extension of existing mandatory stipulations to include mandatory installation of smoke alarms in all private dwellings should be supported. Future Fire and Emergency promotion and awareness activities need to focus on supporting tenant maintenance of operational alarms in rental settings.

2. Introduction

This report was commissioned by Fire and Emergency New Zealand (Fire and Emergency) to describe unintentional residential fire-related fatal injury in New Zealand for the period 2007-2014. This research builds upon two previous Coronial case reviews into residential fire-related fatal injury in New Zealand undertaken for the periods 1991-1997 and 1997-2003 inclusive (Duncanson et al.,2001; Millar, 2005).

The aim of this research is to accurately inform Fire and Emergency directions for unintentional fire-related fatal injury prevention efforts in residential premises by using fire-related fatal injury data derived from Coronial case file review to identify the current high-risk groups, causes and circumstances in order to effectively prioritise and target preventive action to reduce fire-related deaths in New Zealand.

Through epidemiological analyses of Coronial case file data with comprehensive capture of fire-related fatalities, this project addresses the following key research questions on fire-related fatal injury in residential fires for the total population:

RQ-1: Who is at highest risk of fire-related fatal injury?

RQ-2: What are the common causes and circumstances of fire-related fatal injury?

3. Acknowledgements

The research was funded by Fire and Emergency New Zealand's contestable research fund.

Dave Barson and Brandon de Graaf in the Injury Prevention Research Unit (IPRU), University of Otago, Dr Amy Harpur of Fire and Emergency New Zealand, and Clifford Slade at the Tribunals Court Unit, Ministry of Justice provided the basic data for this research and were extremely helpful in answering numerous questions. The Dunedin based Fire Investigation team allowed our coding team to observe a house fire first hand in order for us to gain insight into the fire investigation process.

Other staff involved from the Injury Prevention Research Unit included: Rose Moffatt and Sarah Peters who requested and copied coronial records for relevant information; Wendy Aitken who coded all the relevant fire-related Coronial case files; Brandon de Graaf who created and managed the data entry system and geocoded addresses to census meshblock level and Gabrielle Davie who provided denominator data for the calculation of population based rates and calculated age-standardised rates. Glenda Oben, New Zealand Child and Youth Epidemiology Service provided ethnicity denominator data for the calculation of population based rates by prioritised ethnicity.

The study was considered and approved by the University of Otago Human Ethics Committee (17/159).

4. Background

4.1 Introduction

This section will introduce the scientific evidence on at-risk populations and known risk factors for residential fire-related injury fatalities relevant to the New Zealand context. There have been two key comprehensive pieces of work investigating these fatalities in New Zealand over the past 30 years. The first was led by Dr Duncanson (Otago University) and encompassed the period 1991 to 1997 (Duncanson et al., 2001, with more comprehensive analysis available in Duncanson, 2011) and the second is by Dr Miller (Heimdall Consulting Ltd) who updated the findings from 1997 to 2003 and further examined fire-related behaviours (Miller, 2005).

Internationally evidence on the epidemiological risk factors for residential fire fatalities is limited and may not be directly relevant to New Zealand's housing and social context. A recent systematic review, which included both fatal and non-fatal injury, identified 11 relevant studies, all of which were rated as low to medium quality based on the authors' pre-defined criteria (Turner et al., 2017).

4.2 Risk Factors

In this section, an overview of current epidemiological understanding of risk factors associated with fire deaths identified from New Zealand research utilising Coronial case review and from the most recent systematic review of risk factors for fatal residential fire fatalities will be briefly introduced.

4.2.1 At-risk populations

In New Zealand, both Duncanson and Miller identified similar age groups at risk of fire fatalities, namely children aged < 15 years of age, particularly < 5 years (Duncanson et al., 2001; Miller, 2005) and older adults aged ≥ 60 years (Miller, 2005) or aged ≥75 years (Duncanson et al., 2001). Both case reviews identified that males and households in areas with high deprivation scores were over-represented in fire fatalities. Additionally, Duncanson established Māori were at substantially higher risk of fatal fire-related injury than non-Māori (Duncanson et al., 2001).

Individual residence characteristics commonly implicated internationally in fire fatalities in residential house fires included households with male residents, with a high number of residents under the age of 5 years or over 65 years, and those with low income and/or low property values (Turner et al., 2017).

4.2.2 Risk factors

The range of risk factors examined in research studies differs widely and is highly dependent on the data available to researchers.

Residential circumstances were further examined in New Zealand by Duncanson et al (2001) who found that fire fatalities often occurred when individuals returned home after midnight from a social function. International evidence indicates households with a higher number of total residents, with high vulnerability residents (either ≤ 5 years old, ≥65 years old, with residents who have either a cognitive or physical disability, and/or impaired by alcohol and/or drugs), or where there is no potential rescuer when the fire ignited are at increased likelihood of fatal injury during a residential fire (Turner et al., 2017).

The common fire related circumstances identified in New Zealand includes fires starting mainly in bedrooms, kitchen or living areas, due to cigarettes and other smokers' materials, or unattended cooking. Means of heating, temporary means of lighting and children playing with fire were also notable ignition sources observed in both reviews. Weekend and night fires were also risk factors identified in common. International evidence indicates that fires ignited in the living room, bedroom, at night, at the weekend or during winter months increased the risk of fire-related fatality. Ignition sources that included a heating unit, smoking materials, a combustible material too close to heat or a human behaviour where the decedent was involved in ignition also increased the risk of fatal injury (Turner et al., 2017).

Property factors identified in previous New Zealand case reviews indicate temporary residential dwellings pose an increased likelihood of fire fatalities. In previous New Zealand case reviews it was uncommon for Coronial case files to report on the status of smoke alarms, but where it was reported it was most common to find an absence of installed smoke alarm or inoperative alarms. A range of household risk factors for fatal fire-related injury emerge from international literature (Turner et al., 2017). Property characteristics associated with the risk of residential fire deaths include: apartments and mobile home (especially mobile homes with only one exit), homes that are rented, and properties owned by state/municipality/council and social associations. Older property (>19 years old), cluttered buildings and buildings in a poor state of repair also increase the risk of fatal injury during residential fires.

In terms of lifestyle factors alcohol consumption and smoking were commonly associated with fatal residential house fires in New Zealand (Duncanson et al., 2001; Miller, 2005). Disability was further identified a being associated with fatal injury in the period 1997-2003 (Miller, 2005). Synthesised international evidence identified resident behaviours associated with smoking, resident impairment by alcohol and/or drugs and disabled residents put these individuals at increased risk of fatal injury during a residential fire (Turner et al., 2017).

Human behaviours in fire have also been examined as risk factors for fatal residential fires. Individuals interact with fires deliberately or inadvertently by: having role in ignitions (deliberate or inadvertent); facilitating fire growth or spread; and attempting to fight fire (Brennan & Thomas, 2001). Millar examined human behaviours in New Zealand residential fire fatalities for the period 1997-2003 observing the majority of fatalities involved careless acts by the decedent, and the response to the fire was impeded by not having enough time to escape or being unable to escape - typically due to being intimate with the fire itself or impaired by alcohol/drugs or disability. The most recent international review of behaviours associated with increased risk of fatal fire-related injuries identifies fires where at the time of fire ignition the decedent was either alone, asleep or in the room of ignition (Turner et al., 2017).

5. Methodology

5.1 Data sources

5.1.1 Coronial case files

This study utilises Coronial case files to review the circumstances of residential fire fatalities. Coronial case files are copies of the materials used by the Coroner during Coronial investigations into "sudden and unexpected deaths" in New Zealand. Fatalities due to fire are typically referred to the Coroner for investigation due to their traumatic and sudden nature. The purpose of coronial investigation is to learn from the circumstances of individual fire-related fatal injuries. Material included in a Coronial case file includes the Coroners summary and full findings, Police report, post-mortem pathology and toxicology reports, expert reports, including those from Fire and Emergency (and the former New Zealand Fire Service), and witness statements. Physical copies of Coronial case files are stored at Archives NZ (up until 2000), Ministry of Justice (MOJ) (2001 to current) and Ministry of Health (for a small subset of files with a partial inquest).

Coronial files are usually stored in boxes ordered by inquest date. Information about box number and coronial number for inquests prior to 2001 is generally available through the Archives New Zealand online database. The database of coronial numbers/box number post 2000 is held by, and confidential to, MOJ staff. Identification of the coronial file number/box requires that details of the decedent are provided to the MOJ who attempt to match it with the appropriate coronial file details.

In addition to physical files, from 2007 forward, an electronic truncated coronial file (which usually includes coronial finding, toxicology, post-mortem and Police reports) is held by National Coronial Information System housed in Australia. The research team at the Injury Prevention Research Unit (IPRU) have remote access to this database, and although these files may be sufficiently detailed to either include or exclude the case from further review it lacks the richness of detail for in-depth coding required for the current project, and thus the full coronial files were still requested from the MoJ for these fatalities.

5.1.2 Identification of fire fatalities for review

Fatalities that were of unintentional or undetermined intent that occurred as a result of exposure to fire, flames and smoke were identified from the Ministry of Health's Mortality Collection. Cases were identified on the basis of the International Classification of Disease (ICD) classified primary underlying cause of death e-code assigned to each death (Table 1).

Initially a sample from 1998-2014 was selected, however this period was refined down to 2007-2014 to allow for more detailed data collection to occur to increase the utility of these data for Fire and Emergency for the most recent 8 year period available from the Mortality Collection.

Table 1 Identification of cases

Underlying cause of death	ICD10 e-code	Number of cases ('07-'14)
Exposure to smoke, fire and flames - unintentional	X00-X09	148
Exposure to smoke, fire and flames - undetermined	Y26	7

5.2 Ethical considerations

Ethical approval for the review was obtained from the University of Otago Human Ethics Committee (Ref 17/159). This approval includes permission for the provision of de-identified data to Fire and Emergency for restricted staff access for research purposes at the completion of the project. To protect individual privacy, response categories have been combined within the report to ensure that there are at least three individuals, or incidents, in each cell of a table for the most personal socio-demographic characteristics.

5.3 Data collection methodology

5.3.1 Resources – Coding framework

The amount of information available in a coronial file is highly variable. The number of pages in the coronial files reviewed ranged from 7 to 2216 pages (average length 299 pages).

The coding framework was developed using the Haddon Injury Matrix framework with fire and personal characteristics collected across pre-ignition, ignition and post-ignition time periods. Potential characteristics of the dwelling, fire attributes and household social characteristics were collected at the event level. At the individual level sociodemographic, health and lifestyle factors, victims' behaviours contributing the fire, and cause of death were also collected. The choice of variables collected was informed by an a priori relationship between the variable and fatal fire-related injury demonstrated in the most recent systematic review of Turner (Turner et al., 2017) and on previous data collections on residential dwelling fire fatalities using Coronial case file review in NZ and Ireland (Duncanson et al., 2001; Harpur, 2014; Miller, 2005).

Appendix 9.1 provides an overview of the variables collected.

5.3.2 Resources – Data Management

The data coded for all cases have been abstracted into an electronic, purpose built, data collection database developed by IPRU data management staff using REDCap online data collection software. The data from this can be exported to most electronic formats (e.g. Excel, SPSS, Stata etc) for statistical analysis.

5.3.3 Inclusion/exclusion criteria

The inclusion and exclusion criteria were agreed between IPRU and Fire and Emergency, and were applied to the sample as follows.

Inclusion criteria

- Residential house fire which includes: garage, sleep out, caravan, house bus, camper van, shed, bach, caravan, cabin or tent (if permanent residence and or long term rental arrangement in place);
- Cause of death is fire or the effects of fire which includes: clothing that caught fire but did not result in fire (even when fire service not called), decedent falling into fires.

Exclusion criteria

In order of exclusion[1]:

- Fire occurred outside New Zealand;
- Intentional which includes: suicide as classified by coroner, self-inflicted but not classified as suicide, fire deliberately lit without intention of taking own life;
- Homicide by fire;
- Vehicle fires (apart from registered campervans) which includes: decedent asleep or residing in vehicle;
- Non-residential location fires which includes: commercial premises or workplaces even if being used as residence, garden area of residential address;
- Communal residence fires which includes: room in residential facility (such as rest-home), National Park Huts, hostels or hotels (except where long term rental arrangement in place);
- Boat fires.

5.3.4 Coding methodology

To avoid variability between coders, one trained data coder undertook the data abstraction and coding of all the relevant Coronial case files. The files were reviewed in a random order so as to avoid coder bias. Data quality checks were undertaken at regular intervals to ensure reliability in coding. Where data for each variable were missing, or not specifically reported in the Coronial case file, this has been recorded as "no information" and reported for each variable. Each Coronial case file took on average 2.5 hours to fully code.

5.4 Data analysis

To determine groups with high rates of fire-related fatal injury (RQ-1) rates per 100,000 person years were calculated by age groups, gender and ethnicity using New Zealand census population data and inter-censal population estimates available from Statistics New Zealand as the denominator.

The common causes and circumstances of fire-related fatal injury (RQ-2**)**, including the distribution of the personal, lifestyle, health, housing, and behavioural characteristics, were examined using both frequencies and proportions.

A series of residential fire fatality "profiles" were created using a combination of quantitative data (analysis described above) and qualitative analyses using a thematic analytical approach examining what the decedent was doing prior to the fire, what went wrong to cause the fire and the cause of death.

All quantitative analyses were undertaken using STATA, version SE13.1, statistical software.

[1] *For example:* Fire related suicide that occurred outside NZ would be excluded because occurred 'outside NZ' not because it was a suicide

6. Results

6.1 Fatal fire incidents 2007-2014

Using the described process of Coronial case file identification and review for eligibility we identified 118 fire fatalities from 107 fire events in residential dwellings for the period 2007-2014 (Table 2). There were between 10 and 21 deaths per annum (average 13.4); crude annual mortality rates varied from 0.23 to 0.49 deaths per 100,000 person years. Overall the age standardise rate mortality rate was 0.28 (95%CI 0.22,0.34) deaths per 100,000 person years for the period 2007-2014.These deaths occurred in between 10 and 18 incidents per annum with an average of 14.8 incidents per annum over the eight year period of this study.

Table 2 Table of number and rate of fatalities due to the effects of fire, flame and smoke in residential dwellings by year of death registration, New Zealand, 2007-2014

	Year of death registration (2007-2014)								
Unintentional fire deaths	07	08	09	10	11	12	13	14	Total
Number of eligible residential fire deaths with Coronial case files	15	21	19	14	10	11	17	11	118
Number of eligible fire incidents with Coronial case files	15	18	14	14	10	11	17	8	108
Rate per 100,000 person years	0.36	0.49	0.44	0.32	0.23	0.25	0.38	0.24	0.34

When compared with previous reviews conducted in New Zealand the frequency of unintentional residential fire fatalities has declined (Table 3). Since the first examination of fire fatalities for the seven year period of 1991-97 the number of unintentional fire fatalities has reduced from 178 fatalities down to 118 fatalities for the most recently available eight year period 2007-2014. Our age standardised rate of 0.28 fatalities per 100,000 person years is under half that of Duncanson's age standardised rate. It is beyond the scope of this report to examine the reason for the decline in-depth however, crude comparisons indicate there have been substantial reduction in the number of deaths involving children aged <15 years of age, and in the number of multiple fatality incidents and the number of fatalities involved in multiple fatalities.

Table 3 Comparison of cases 2007-2014 with previous Coronial case file reviews in New Zealand

Unintentional fire deaths	Period examined		
	1991-97[1]	1997-2003[2]	2007-2014[3]
Number of eligible residential fire deaths	178	131	118
Number of eligible residential dwelling fire events	154	108	107
Rate per 100,000 (95% Confidence Interval)	0.7 (0.6,0.8)[4]	1.01[5]	0.28 (0.22,0.34)[4]

1 – Duncanson et al., 2001 & Duncanson, 2011; 2 – Millar, 2005; 3 - year of death registration, selected using Mortality Collection; 4 - age-standardised rate; 5 - average rate across period, not age

standardised.

6.2 Residential fatal fire-related injuries 2007-2014

The following sub-sections describe the fire incident and individual fatality characteristics of the fire event and subsequent fatal injuries.

6.2.1 Fire characteristics (incident level)

This section reports the findings concerning the 107 unintentional residential fire incident identified in New Zealand for the period 2007-2014.

6.2.1.1 Fatal incidents

Of the 107 fatal fire incidents, 98 (92%) incidents involved single fatalities, while nine incidents involved multiple fatalities: six incidents involved two fatalities, two incidents involved three fatalities and a single incident involved four fatalities.

Table 4 outlines the number of fatalities per fire event and total fatal and non-fatal injuries sustained in these events. Non-fatal injuries, including those burn injuries requiring simple first aid at the scene, as described in the Coronial record. While single fatality events are the most common resulting in 98 fatal injuries these events have a wider injury burden than just fatal injury with 120 survivors, of which 50 also sustained non-fatal injuries.

Table 4 Casualties sustaining fatal and non-fatal injuries from fire events, by number of fatalities per event, New Zealand, 2007-2014 (n=107 fire incidents)

Number of fatalities per incident	Total fatal injuries	Total injured survivors	Total uninjured survivors
1	98	50	70
2	6	2	5
3	2	No information	No information
4	1	3	1

6.2.1.2 Geographical location of fire incidents

Table 5 presents the geographical locations and features of fire incidents. The NZDep2013 index of deprivation is used as an area level indicator of social and material deprivation. The NZDep2013 index is available from Statistics New Zealand. The index measures the relative socioeconomic deprivation of an area and does not directly relate to individuals. The NZDep 2013 index combined census data on income, home ownership, employment, family structure, housing, access to transport and communications (Aitkinson et al, 2014). A NZDep2013 score is assigned to each census meshblock using the index. An ordinal scale is produced by grouping scores into quintiles. Quintile 1 comprises the 20% of Census meshblocks with the lowest NZDep2013 scores whereas the 20% of Census meshblocks with the highest NZDep2013 scores are in quintile 5.

In this study each fire event was assigned to NZDep2013 quintile according to the meshblock in which the incident occurred. Over a third of fire fatalities occurred in households in areas with the highest deprivation scores; 36% of fatalities occurred in dwellings in areas with the highest 20% of deprivation scores (quintile 5). Households in areas with lower deprivation scores have a lower likelihood of fire fatalities. Few fatalities occurred in rural centres, however 15% of fire fatalities occurred outside of urban or rural centres, in more remote rural areas.

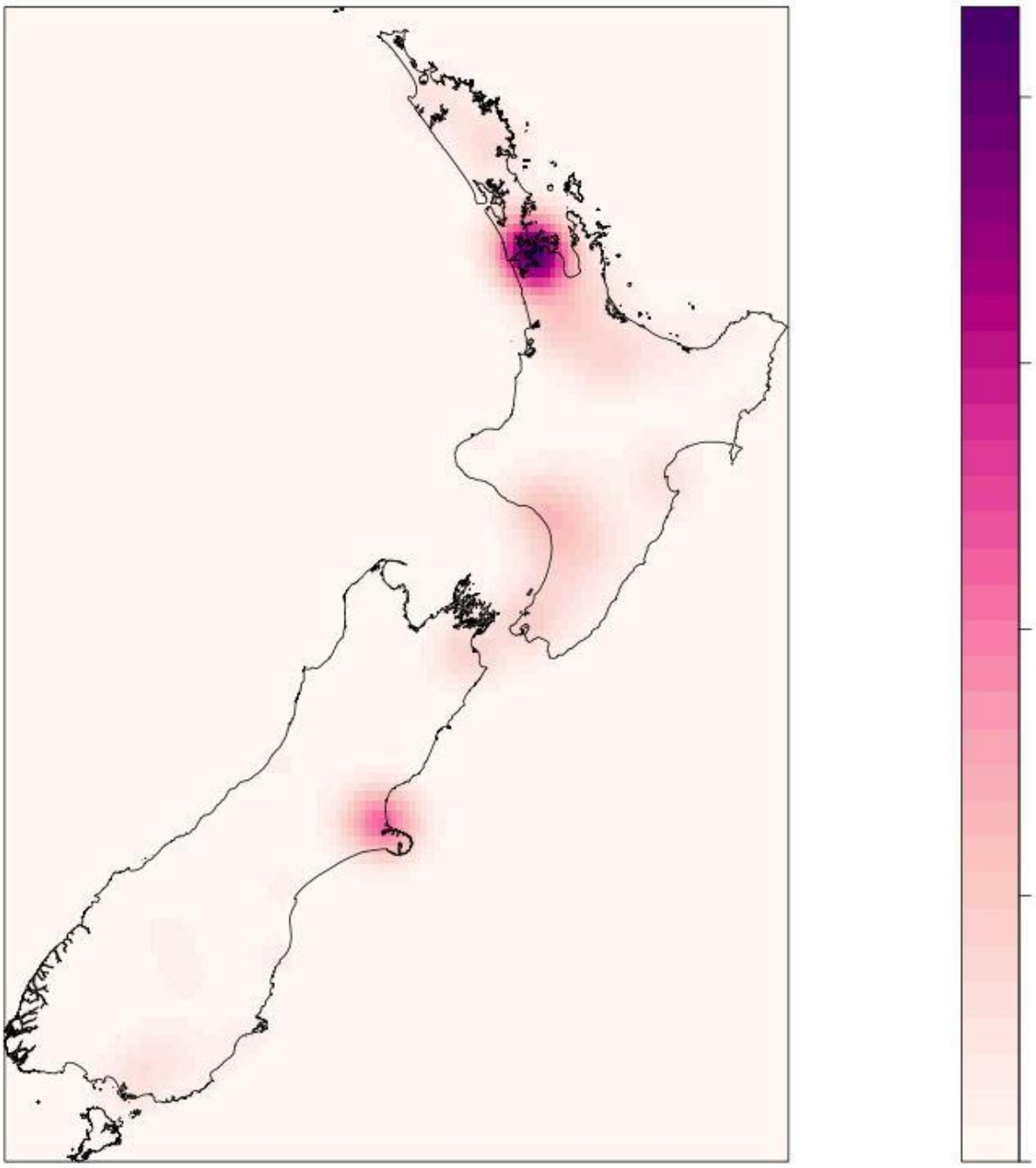
Fatal fire incidents are geographically spread throughout New Zealand (Table 5). The highest number of fatalities was observed in Fire and Emergency fire region 1 (32%) which covers Auckland and areas north of Auckland and Fire and Emergency region 3 (27%) covering Central and Eastern North Island. Regions 3, 4 and 5 have a higher proportion of fire-related fatalities when compared with the proportion of the New Zealand population normally residing in these areas (for example, region 3 has 27% of the fatalities while only 22.5% of the population resides in this region).

Table 5 Geographical location characteristics of fire incidents, New Zealand, 2007-2014 (n=107 fire incidents)

Geographical location characteristics	Frequency	Percent
Deprivation level of dwelling		
NZDep2013 quintile 1 (low deprivation score)	11	10
NZDep2013 quintile 2	11	10
NZDep2013 quintile 3	13	12
NZDep2013 quintile 4	34	32
NZDep2013 quintile 5 (high deprivation score)	38	36
Urban/rural location		
Main urban area	64	60
Secondary urban area	7	7
Minor urban area	16	15
Rural centre area	3	3
Other rural area	17	15
Fire and Emergency region		
Region 1: Northland, Whangarei, Auckland *(37.3% NZ pop)*	34	32
Region 2: Hamilton, Tauranga, Rotorua, Gisborne *(16.5%)*	17	16
Region 3: Napier, New Plymouth, Wellington *(22.5%)*	27	25
Region 4: Nelson, Greymouth, Christchurch, Timaru *(16.7%)*	19	18
Region 5: Queenstown, Dunedin, Invercargill *(7.0%)*	10	9

Figure 1 maps the location of fire deaths in New Zealand to greater geographical detail to those figures presented in Table 5 and assigns a density colour to those areas with the most fire deaths (including multiple fatality fire incidents). Unsurprisingly the areas with the highest density of incidents and corresponding high numbers of deaths are the greater Auckland area, followed by Christchurch.

Figure 1 Kernel density map of unintentional residential fire fatality locations, New Zealand, 2007-2014



6.2.1.3 Fire vector characteristics

Table 6 presents the main fire vector characteristics.

Table 6 Fatal fire vector characteristics, New Zealand, 2007-2014 (n=107 fire incidents)

Fire vector characteristics	Frequency	Percent
Underlying cause of fire		
Cigarettes or other smokers' materials[1]	27	25
Electrical fault	22	21
Combustibles overheated	16	15
Combustibles too close to heat source	10	10
Unattended open fire/candles	4	4
Gas fault	5	5
Children playing with ignition sources	7	6
Other	7	6
Undetermined	9	8
Item ignited		
Fabric	53	50
Cooking oil/food	11	10
Ignitable liquids/gas	5	5
Paper/cardboard	3	3
Plastic	11	10
Wooden items	5	5
Other	8	8
Undetermined	10	9
Heat source		
Cigarette or smoking materials[1]	30	28
Heat from properly functioning electrical equipment	20	19
Heat from malfunctioning electrical equipment	16	15
Deliberately lit match or lighter	8	7
Gas fire	9	8
Candle or flames	3	3
Open fire, coals or ashes	3	3
Other	6	6
Undetermined	11	10
No information	1	1

1 – includes probable cases

The most common underlying cause of fatal fire incidents was cigarettes or other smokers' material (25%) followed by electrical faults (21%), over heated combustibles (15%) and combustibles too close to heat sources (10%). Unsurprisingly, cigarettes or smokers' materials (30%) are the most common sources of heat for ignition. Electrical equipment is also a prominent source of heat for fire ignition with 19% of fires ignited by properly functioning electrical equipment, with a further 15% ignited by malfunctioning electrical equipment. Deliberately lit matches (7%), mainly lit by children, and gas heaters (8%) are also notable sources of heat for ignition.

Stoves were the main type of electrical equipment involved in fires (50%) ignited by electrical equipment, predominantly igniting oil or food. Heaters (10%), electric blankets (10%) & cord, plug or electrical wiring (10%) were also common types of electrical equipment involved in fire ignition. The item ignited in electrical equipment fires was most likely to be fabric (50%), with cooking oil or food (10%) and plastic (10%) also common items ignited (full result listed in Appendix 9.2).

6.2.1.4 Fire location and spread

Table 7 presents the characteristics of the fire location and spread. The majority of fires originated in the bedroom (36%), with fires originating in lounges/sitting (29%) and kitchen areas (16%) also common. Close to half of bedroom fires were caused by cigarettes or other smokers' material (15/31, 48%), while close to a quarter were caused by electrical faults (7/31, 23%). The overwhelming majority of fires originating in the kitchen were due to overheated combustibles (18/19, 95%) while two thirds of all fires initiated in the lounge/living areas were caused by cigarettes (8/34, 24%), combustibles too close to a heat source (9/34, 26%) and electrical faults (6/34, 17%).

A single seat of the fire was the most common, indicating a single location of fire ignition. Incidents with multiple seats of fire involved an explosion, scattering flammable materials throughout the room, or burning materials being distributed around a room by the decedent or as the material disintegrates in the fire.

The majority (85%) of fires started on the ground floor with 81 of the 91 fire originating on the ground floor occurring in single story dwellings. Ten incidents started on the ground floor in multi-story dwellings while a further 11 incidents started on the first floor of a multi-story dwelling.

Extensive fire damage (i.e. to whole dwelling, compartment or entire room of origin with major damage to other rooms) was reported in 60% of incidents. Limited fire damage where only the item ignited, or part of the room of fire origin, was damaged was observed in 13% of incidents. Smoke damage was extensive in most fire events with 72% of incidents resulting in smoke damage through the entire dwelling. Only five incidents were observed where the smoke damage was limited to the item ignited (results reported in Appendix 9.3).

Table 7 Table of characteristics of fire location and spread, New Zealand, 2007-2014 (n=107 fire incidents)

Fire event characteristics	Frequency	Percent
Room of origin		
Bedroom - child	8	7
Bedroom - adult	31	29
Kitchen/dining room	17	16
Lounge/sitting room	31	29
Garage	5	5
Caravans	3	3
One room dwellings	3	3
Other	9	8
Seats of fire		
1	100	94
2 or more	5	5
No information	2	1
Level of fire origin		
Ground floor	91	85
First floor	12	11
Other	2	2
No information	2	2

6.2.1.5 Time of the fire

Table 8 presents the temporal aspects and notification of the fire event. Three in five fatal fire events occurred in the evening or at night (23%, 18:00-23.59; 38%, 00:00-05:59), with most of these fatal fire events occurring between midnight and 6am. When considering the most common hours of sleep of 10pm to 7am over half of all fatalities (63/118, 53%) occurred during this time. Two in five fatal fires occurred during the weekend (Friday-Sunday). Over half of the fatal fires due to overheated combustibles (i.e. cooking fires) and due to children playing with ignition sources occurring during the weekend. The highest number of fire incidents occur in winter and spring with 34 incidents each in these seasonal periods. Fires due to inadequate control of an open fire or candle and combustibles too close to a heat source were more common in colder seasons. Overall November was the month with the highest number of fatal fire incidents with 17 incidents.

The location of first person alerted to the fire (first person to discover fire and be capable of carrying out action to mitigate situation) was most commonly a person inside the building (63%), followed by people external to the building (24%). The most prominent fire cues that alerted the first person to

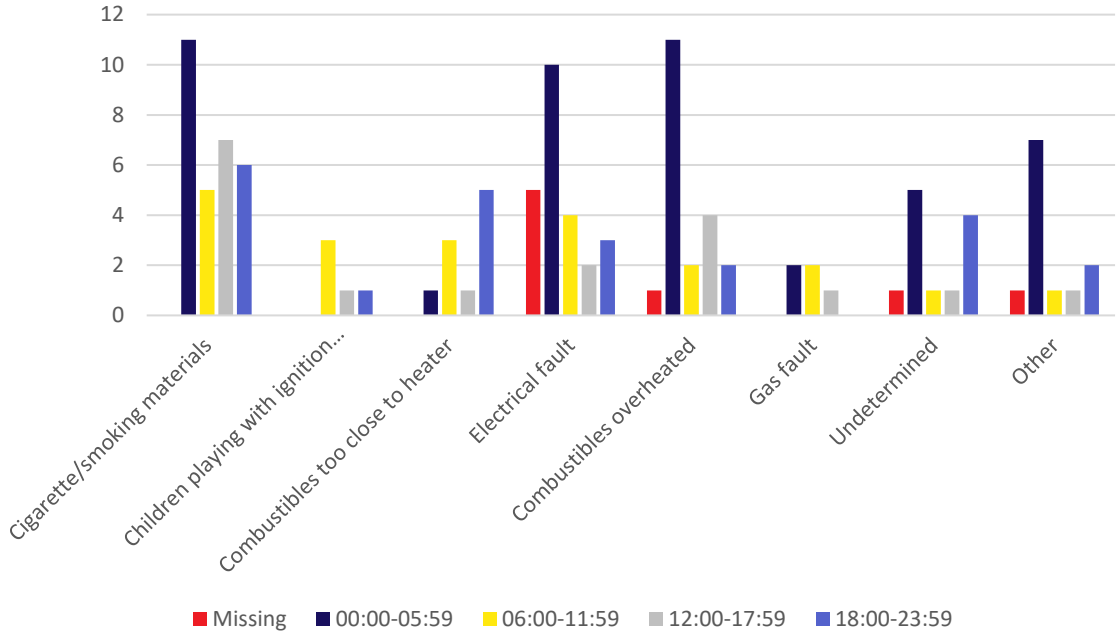
the fire was observing flames (38%), followed by hearing a fire alarm (15%) or sounds associated with the fire, such as fire-related explosions (15%).

Table 8 Table of temporal aspects and notification of fire event, New Zealand, 2007-2014 (n=107 fire incidents)

Time characteristics	Frequency	Percent
Time of fire		
00:00-05:59	40	38
06:00-11:59	20	19
12:00-17:59	16	15
18:00-23:59	25	23
No information	6	5
Fire during weekend (Friday- Sunday)		
Yes	46	43
No	61	57
Month of fire		
Summer (Dec-Feb)	13	12
Autumn (Mar-May)	26	24
Winter (Jun-Aug)	34	32
Spring (Sep-Nov)	34	32
Person first alerted to fire		
Person in building	67	63
Persons outside building	26	24
Persons both inside & outside building	7	7
Other	6	5
No information	1	1
How alerted		
Saw flames	41	38
Heard smoke alarm	16	15
Heard fire/explosions	16	15
Smelt smoke	8	7
Saw smoke	7	6
Fatality was in flames	7	6
Other	9	8
No information	5	5

The most common time for the occurrence of fatal fire incidents differs by the primary cause of the fire (Figure 2). Fires caused by cigarette or other smoking materials predominantly occur during the evening or night, mainly between midnight and 6 am. Fatal fire incidents due to electrical fault and overheated combustibles are also most common between midnight and 6am. Fires caused by children playing with ignition sources occurred most commonly during the day between 6am and noon while fire due to combustibles being too close to a heat source occur mainly in the evening between 6pm and midnight.

Figure 2 Underlying cause of fire by time of day, New Zealand, 2007-2014



6.1.2.6 Physical and ownership properties of dwelling

The dwelling characteristics consider the physical and ownership properties of the dwelling where the fire incident occurred (Table 9). Property ownership was common with 39% of fatalities in privately-owned dwellings occupied by the owner. Rented dwellings were also prominent with 43% of fatal fire incidents collectively in rented dwellings: 31% in privately owned rented situations, while 16% were in State provided dwellings. Just one rented dwelling was council owned and operated. Community care services which operate dwellings to house community based patients with disability and mental health concerns, but where the residence operates like a typical household situation, also appear in residential fire incidents contributing to 4% of these events. In the 2013 Census 64% of New Zealand households lived in an owner-occupied dwelling (Statistics New Zealand, 2014). Our findings suggest that the risk of fire fatalities is lower for owner-occupied dwellings.

Fire fatalities in temporary dwellings are uncommon with 7% in temporary structures such as caravans and other sleep-out arrangements. Temporary structures, however, comprise just 1% of New Zealand's housing stock (Statistics New Zealand, 2014) suggesting temporary structures pose an increased risk of fatal fires. The vast majority of dwellings involved in fatal fire incidents were single story (78%). Single story, separated dwellings are most common in NZ (Statistics New Zealand, 2014) and reflects the major structure type Fire and Emergency attended for this period (81% single

houses, 15% flats/apartments). The dominant construction type in fatal fire incidents are wooden structures (50%). Building age and building condition were collected but are limited by the large proportion of missing data (refer to Appendix 9.4).

Table 9 Table of dwelling characteristics, New Zealand, 2007-2014 (n=107 fire incidents)

Dwelling characteristics		Frequency	Percent
Property ownership			
Private & occupied by owner		41	38
Housing NZ/council owned, rented		17	16
Privately owned, rented		33	31
Community care services		4	4
No information		5	5
Other		7	6
Building permanency			
Temporary dwelling		7	7
Permanent dwelling		99	92
No information		1	1
Building type			
Single detached house		69	64
Flats, apartments	(1-2 units)	11	10
	(Other)	8	8
Caravan, campervan, campsite		4	4
Garage/converted to sleep-out		4	4
Other/No information		10	10
Number of levels			
Single		83	78
Double		19	18
Triple		3	2
No information		2	2
Construction type			
Wood		54	50
Brick/stone/block		21	20
Composite materials		18	17
Iron/Aluminium		5	5
Other		2	2
No information		6	6

5.2.1.7 Fire detection characteristics

Functioning smoke alarms provide an effective early warning system to people within a residential dwelling. Table 10 presents the characteristics of fire detection for fatal fire incidents. Unfortunately, 17% of Coronial files were missing information on whether smoke detectors were present or not. Smoke detectors were present in over half (53%) of all fatal fire incidents. In total 22% of smoke detectors were present in the room of fire origin and 33% elsewhere in the dwelling. Two incidents had mains power operated smoke detectors.

Overall, where a smoke detector was recorded as being present, 63% were operational (charged battery inserted or mains power operated). The smoke detector was reported as being destroyed in 27% of incidents involving a smoke detector, indicating smoke and heat has managed to reach the alarm an operational alarm should have activated. Information on the operational capacity of a smoke alarm was absent from the majority of Coronial reports.

Table 10 Smoke alarm status in dwellings where fatal fire incidents occurred, New Zealand, 2007-2014 (n=107 fire incidents)

Fire detection characteristics	Frequency	Percent
Smoke detector present		
Yes, in room of fire origin	26	24
Yes, elsewhere	34	32
No	31	29
No information	16	15
Where detector present, detector operational (n=60)		
Yes operational (charged battery/mains operated)	38	63
No (no battery or discharged battery)	22	37
Where detector present, detector destroyed (n=60)		
Yes	16	27
No	13	22
No information	31	51

Where an operational alarm was present at the time of the fatal fire incident, there were no distinct patterns of fire cause or personal characteristics associated with these fatalities. The only exception to this was age where 50% of fatal fire incidents involving fatalities aged ≥65 years of age had an operational alarm present in the dwelling, compared with 39% and 11% of fatal incidents involving fatalities aged 15-64 and <15 years respectively.

The absence of smoke alarms were more likely in private rental properties, however when fitted the majority had an operational alarm with charged battery fitted. Three quarters (76%) of Housing New Zealand properties had a fitted smoke alarm. However, even though a fitted smoke alarm was present nearly half (45%) had a missing or discharged battery. Close to two thirds of owner occupied

dwellings had smoke alarms fitted although about one third of these were not operational.

Fitted sprinklers can provide an effective means of extinguishing or containing a fire to part of a dwelling. Around one in five post-fire Coronial investigations did not mention either the presence or absence of sprinklers. Where sprinkler presence was considered during the Coronial investigation (87 incidents) there were no reports of fitted sprinklers in use in any of the incidents reviewed.

6.2.1.8 Social household characteristics

The social household characteristics of the fire incident are presented in Table 11. The most common household situation was a single person living alone (43%), followed by families comprising of two parent (13%), extended (8%) and single parent (7%) families. House share, flatting like situations, were also frequent (16%). At the time of the 2013 Census the most common housing situation in New Zealand was one-family with children (68%) and one-person households (24%) (Statistics New Zealand, 2014 B).

Unsurprisingly, in 41% of dwelling fire there was a single person usually resident, while 47% had 2 or more people usually resident. Eight incidents occurred in a dwelling where no-one normally resided such as sleep outs and converted garages typically used temporarily for sleeping.

Table 11 Table of dwelling's social characteristics, New Zealand, 2007-2014 (n=107 fire incidents)

Dwelling social characteristics	Frequency	Percent
Household situation		
Single person	46	43
House share (i.e. flat)	17	16
Two parent family	13	12
Extended family	9	8
Co-habiting adults	6	6
Single parent family	7	7
Mobile occupancy	4	4
Other	5	4
Crowding ratio		
<1: under utilised	74	69
1-2: equalised	9	8
>2: over crowded	3	3
No information	21	20
Households with adults ≥75 years in dwelling	29	27
Households with children <10 years in dwelling	30	28
Care proximity if children in household aged <10 yrs		
In dwelling	18	90
No information	2	10

A measure of overcrowding was calculated using the number of persons in the dwelling at the time of fire ignition and the number of bedrooms in the dwelling. A ratio above 2 indicates more than 2 persons per bedroom which is considered in this report to be over-crowded. Only three incidents had a ratio above 2 and are therefore considered to be over-crowded at the time of the fire ignition (Table 11).

It was common for vulnerable age-groups to be present in the household prior to fire, namely the young and the elderly. Close to three in ten households had children under 10 years present at the time of the fire event. Children under 5 years were present in the dwelling prior to 15 fire incidents. In all instances of dwelling housing children under 10 years of age, where the information was available, a parent or caregiver was in the dwelling at the time of the fire. More than one in four fatal fire incidents involved dwelling with elderly adults over 75 years.

In the lead up to the fire event alcohol consumption by someone in the dwelling (resident or visitor) was reported in 39% of incidents while household drug consumption (legal or illegal) was likewise reported in the same proportion of incidents (39%).

Household access to a telephone was infrequently reported (59% had no information) in Coronial case files with only 41% of files containing this information. Where it was available just over two in five households had access to a telephone, including a cell phone, giving these households a potential means by which to contact emergency services.

Other information on number of rooms and people within them prior to the fire are available in Appendix 9.5.

6.2.2 Fatality characteristics

The following reports the findings concerning the 118 unintentional residential fire fatalities identified in New Zealand for the period 2007-2014.

6.2.2.1 Socio-demographic characteristics

There are clear differences in rates of fatal injury by age, gender & ethnicity (Table 12). The older adults, aged 65 years or greater have a rate of fire-related fatal injury three times that of working age adults aged 15-64 years, and four times greater than the youngest group of children. Fatalities in the 0-14 year age group are more common in very young children with half (50%) of this group aged less than 6 years of age.

Males have close to twice the rate of fire-related fatal injury, compared with females. Deaths in males were most common in the 15-64 year old age group (73%), while female deaths were more likely to occur in older adults aged 65 years and greater (59%).

Māori have the highest rate of fire-related fatal injury, followed by New Zealand Europeans. Māori make up over a quarter of all fatalities in young children (29%) and adults aged 15-64 years (26%). Rates and number of fatalities for Pacific, Asian, MELAA (Middle Eastern, Latin American or African) and other specified ethnic groups have been aggregated to protect individual identities. Overall there are few fatalities involving Pacific peoples, however, they constitute a third of all deaths (5 out of 14 deaths) in children. There are very few deaths in people with Asian or MELAA ethnic identities.

Details on marital status and occupation are presented in Appendix 9.6

Table 12 Table of number and rates of sociodemographic characteristics of fatalities by age group, New Zealand, 2007-2014

Socio-demographic factors	Age group n (%)			Total	Rate per 100,000 (95% CI)
	0-14 yrs N=14	15-64 yrs N=65	≥65 yrs N=39		
Age					
0-14 years	-	-	-	14 (12)	0.19 (0.11,0.33)
15-64 years	-	-	-	57 (55)	0.28 (0.22,0.36)
65+ years	-	-	-	39 (33)	0.84 (0.60,1.15)
Sex					
Female	6 (43)	18 (27)	23 (59)	47 (40)	0.23 (0.66,0.31)
Male	8 (57)	47 (73)	16 (41)	71 (60)	0.42 (0.33, 0.53)
Ethnicity (prioritised)					
NZ Māori	4 (29)	17 (26)	5 (13)	26 (22)	0.48 (0.32,0.71)
Pacific, Asian, MELAA, other	5 (32)	3 (5)	3 (8)	10 (10)	0.13 (0.06,0.23)
NZ European	5 (32)	40 (62)	31 (79)	76 (68)	0.35 (0.28,0.44)

Figure 3 Fatalities by 10 year age group and gender, New Zealand, 2007-2014

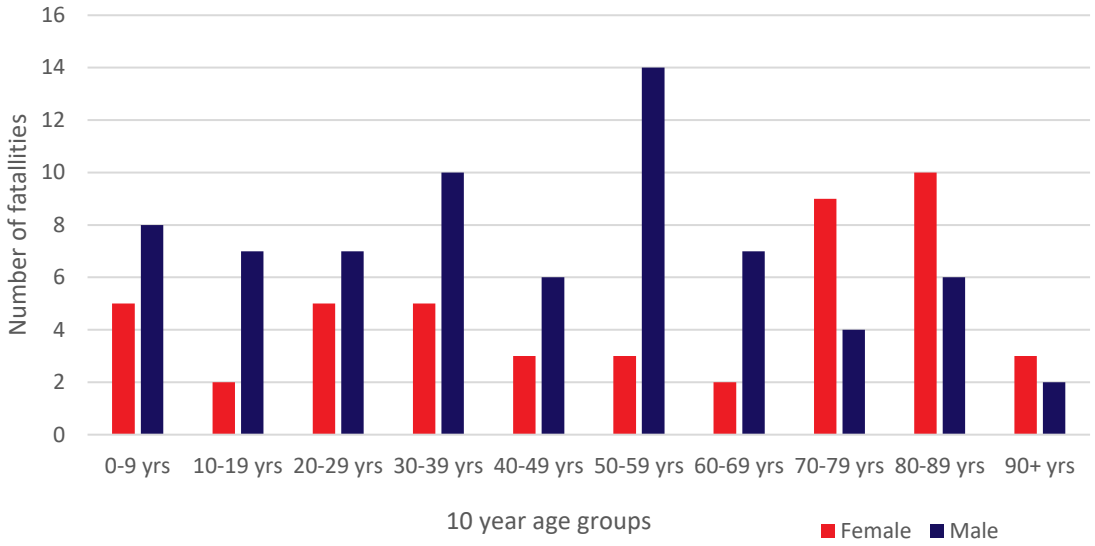


Figure 3 breaks down fire fatalities by 10 year age groups and gender. Male fatalities are more prevalent in young and middle age groups up to 60-69 years of age. The greatest difference is observed for 50-59 year olds where the number of deaths in males is over 4 times greater than the number of deaths in females. After 70 years of age female deaths are more prevalent. At 90 years or older the number of fire fatalities are lower overall and more evenly distributed by gender.

6.2.2.2 Occupancy characteristics

Fatalities in visitors to dwellings were most common in the 0-14 and 15-64 year old age groups (Table 13). Although visitors contribute to a small number of fatalities, it is notable that when it was children visiting, it was in all instances a familiar family members dwelling. Conversely with working age adults, 50% of the fatalities occurred to people unfamiliar with the dwelling.

Table 13 Table of occupancy duration by age group, New Zealand, 2007-2014 (n=118)

Occupancy factors	Age group, n (%)			Total
	0-14 yrs N=65	15-64 yrs N=65	≥65 yrs N=39	
Occupancy duration				
Temporary/visitor	3 (21)	6 (9)	-	9 (8)
Up to 1 month	2 (14)	7 (10)	-	9 (8)
1 to 6 months	3 (21)	7 (10)	1 (3)	11 (10)
6 to 12 months	1 (7)	4 (6)	1 (3)	6 (5)
Over 12 months	5 (36)	37 (54)	35 (92)	75 (63)
No information	-	6 (9)	1 (3)	7 (6)

6.2.2.3 Health and disability factors

Vulnerable groups, including those with pre-existing disabilities and health conditions, are known to be at increased risk for fatal fires. Table 14 examines the presence of disabilities and the decedent's health condition prior to the fire event and their potential impact upon the outcome of the fire.

The presence or absence of disabilities was able to be determined for 104 deaths, where 47 (45%) had one, or more, disabilities recorded. The most common type of disability recorded was impaired mobility, which was most prevalent in fatalities aged 65 years or greater (26 cases, 90%). Other disabilities of note for older adults included sensory visual and hearing impairments. While disabilities were most common in the oldest adults, four children had documented disabilities: mainly learning/cognitive impairments and intellectual disabilities. The disabilities most commonly reported for working age adults were impaired mobility and learning/cognitive impairments.

Pre-existing health conditions were frequently documented in Coronial case files in either Coroners findings, health practitioner reports, toxicology or pathology reports with only 9 cases not documenting the health state of the victim prior to the fire. Pre-existing mental health conditions (including alcohol-related conditions) were documented for 38 fatalities, of which 22 were working age adults. Pre-existing physical health conditions were documented for 56 fatalities of which the vast majority (33 fatalities) were older adults aged 65 years or greater.

Table 14 Table of health characteristics by age group, New Zealand, 2007-2014 (n=118)

Health characteristics	Age group n (%)			Total
	0-14 yrs N=14	15-64 yrs N=65	≥ 65 yrs N=39	
Pre-existing disability status				
No disability	10 (71)	41 (63)	6 (15)	57 (48)
Disability	4 (28)	14 (22)	29 (74)	47 (40)
No information	-	10 (15)	4 (10)	14 (12)
Pre-existing mental health conditions				
Yes	3 (21)	22 (34)	13 (33)	38 (32)
No	10 (71)	36 (55)	22 (56)	68 (58)
No information	1 (7)	7 (11)	4 (10)	12 (10)
Pre-existing physical health conditions				
Yes	1 (7)	22 (34)	33 (84)	56 (47)
No	12 (86)	34 (52)	4 (10)	50 (42)
No information	1 (7)	9 (14)	2 (5)	12 (11)
Co-morbidity contribute to outcome				
Yes	3 (21)	20 (31)	24 (61)	47(40)
No	11 (79)	40 (62)	14 (36)	65 (55)
No information	-	5 (8)	1 (3)	6 (5)

Documented pre-existing co-morbidities were found to contribute to the fire outcome in 47 (39%) of fatalities; in 37 deaths (31%) a Coroner or health practitioner explicitly stated the co-morbidity contributed to outcome and in 10 deaths (8%) the co-morbidity was highly likely to have contributed although this was not explicitly stated by a Coroner or health practitioner (Table 14). Older adults had a disproportionately greater proportion of fatalities where the co-morbidity clearly contributed to the fire outcome: In 24 out of 36 cases with either a diagnosed mental or physical health condition this was confirmed to have contributed to the fire outcome.

6.2.2.4 Lifestyle factors

Alcohol use in the lead up to a fire is a well-documented risk factor for fire fatalities. The number of alcohol-involved fatal incidents and associated fatalities are presented in Table 15. Alcohol was considered to have had a role in fatal fire incidents when a decedent had a blood alcohol level over 50 mL/100mL, or where there is a confirmed history of excessive alcohol consumption, or a confirmed observation by members of the household in the hours immediately preceding the fire fatality.

Overall 49 incidents involved alcohol (42%), which was disproportionally common in the 15-64 year age group and it was mainly the decedent (primary fatality) who consumed the alcohol (93%). The three secondary fatalities, which occurred a result of someone else's alcohol-related consumption and fire behaviour, were primarily children.

Table 15 Number of alcohol-involved residential fire fatalities by age group, New Zealand, 2007-2014 (n=118)

Lifestyle factors	Age group n (%)			Total
	0-14 yrs N=14	15-64 yrs N=65	≥65 yrs N=37	
Number of alcohol-involved fatalities	2 (14)	37 (56)	10 (27)	49 (42)
Number of primary fatalities	0	36	10	46
Number of secondary fatalities	2	1	0	3

The level of intoxication and history of alcohol use of victims of fire related injury are presented in Table 16. Post-mortem blood alcohol levels were documented for 46 cases with almost all reporting alcohol levels above the 2014 legal driving Blood Alcohol Concentration (BAC) of 50 mg per 100mL. The vast majority of blood alcohol levels were over 80mg/mL, especially in working age adults. The levels of alcohol intoxication were highest in working age adults with blood alcohol levels often (25 of 36 fatalities, 69%) over 150 mg per mL. These levels indicate very high levels of alcohol intoxication likely to impair the decease's speech, walking, vision and induce drowsiness (Alcohol.org.nz, 2018). Half of all older adults (5 of 10 fatalities) were also highly intoxicated at the time of the fire.

Excluding children, the decedent's alcohol history was reported in 59 Coronial case files, where a current or previous alcohol dependency or heavy drinking was documented in 24 cases aged 15-64 and 10 cases aged 65 or over.

Table 16 Table of alcohol-related factors by age group, New Zealand, 2007-2014 (n=118)

Lifestyle factors	Age group n (%)			Total
	0-14 yrs N=14	15-64 yrs N=65	≥65 yrs N=39	
Decedent's blood alcohol level (n=46)				
<50 mg/100mL	-	2 (5)	2	4
50-80 mg/100mL	-	2	1	3
80-149 mg/mL	-	67	2	9
≥150 mg/mL	-	25	5	30
Decedent's alcohol history				
Diagnosed current alcohol dependency	-	4 (6)	5 (13)	9 (8)
Prev history alcoholic/heavy drinking	-	5 (8)	0	5 (4)
Heavy drinker	-	15 (23)	5 (13)	20 (17)
Teetotaller	-	1 (2)	1 (3)	2 (2)
Occasional/moderate drinker	-	13 (20)	8 (21)	22 (17)
Child	14	-	-	15 (13)
No information	-	27 (42)	19 (50)	45 (38)

The number of drug-involved fatal incidents and fatalities are presented in Table 17. Drug (illegal or legal prescription drugs) was considered to have had a role in fatal fire incidents where a decedent had a positive toxicology test for an illegal drug, or where there is a confirmed history of regular prescription or illegal drug consumption, or a confirmed observation of drug by members of the household in the hours immediately preceding the fire fatality. Where drug involvement was able to be determined we identified drug involvement in 49 deaths (42%). The largest number of drug related incidents and fatalities is identified for adults aged 15-64 years, followed by older adults. Secondary fatalities, where the fatality was a bystander to someone else's drug-involved fire behaviour, were most prevalent in fatalities involving children (three of four drug involved fatalities as a bystander).

Table 17 Number of drug-involved residential fire fatalities by age group, New Zealand, 2007-2014

Drug-involved incidents	Age group n			Total
	0-14 yrs N=14	15-64 yrs N=65	≥65 yrs N=39	
Number of drug-involved fatalities	4 (29)	31 (48)	14 (36)	49 (42)
Number of primary fatalities	1	29	14	44
Number of secondary fatalities	3	2	0	5

The use of legal or illegal drugs was reported in 44 victims, 29 of which were working age adults while 14 were aged over 65. Positive post-mortem toxicology reports were available for 34 fatalities

(Table 18). The sedentary load of toxicologically quantified drugs was able to be undertaken with 29 of 34 (85%) decedents taking legal or illegal drugs with known sedating effects. Many were on multiple prescription drugs with cumulative sedating effects. Cannabis use was reported in 15 fatalities with this use mainly confined to those adults aged 15-64 years.

Table 18 Table of drug and smoking-related factors by age group, New Zealand, 2007-2014 (n=118)

Lifestyle factors	Age group			Total
	0-14 yrs N=14	15-64 yrs N=65	≥65 yrs N=39	
Toxicology confirmed drug use				
Yes - positive	0	25 (38)	9 (24)	34 (29)
No - negative	1 (7)	4 (62)	5 (13)	10 (9)
No information/no test	13 (93)	36 (55)	23 (62)	73 (62)
Sedating effect known[1]				
Little-mild sedating effect	-	3 (12)	2 (22)	5 (15)
Moderate-high sedating effect	-	22 (88)	7 (78)	29 (85)
Cannabis use reported				
Yes	-	14 (21)	1 (3)	15 (13)
No	14 (100)	51 (79)	38 (97)	103 (87)
Smoking status – decedent				
Yes	-	42 (65)	17 (44)	59 (50)
No	-	13 (20)	7 (18)	20 (17)
Child	14 (100)	-	-	14 (12)
No information	-	10 (15)	16 (38)	25 (21)
Smoking status – household[2] (n=39)				
Yes	7 (50)	7 (35)	1 (16)	15 (38)
No	-	1 (5)	-	1 (3)
No information	7 (50)	12 (60)	5 (83)	23 (59)

Key: 1 - Legal or illegal drugs; 2 - Only examined for decedents: a) not identified as a smoker and b) not living alone.

The smoking status of the decedent was reported for 93 fatalities with 59 fatalities recorded as being smokers. Where the decedent was a documented smoker, 47% of these fire fatalities were due to cigarettes and smoking materials. The highest proportion of smokers were in the working age group with 42 fatalities. If the victim themselves did not smoke the household was examined further for documented evidence of other household smokers. Despite household smoking status being poorly reported in Coronial case files in secondary deaths where it is reported a further 15 fatalities had documented evidence of household smokers: seven fatalities involving children, seven involving working age adults and one involving an older adult.

In the 36 fatalities with an underlying cause of fire involving a cigarette or children playing with

ignition type smoking materials 27 (75%) fatalities were smokers and 7 fatalities were non-smoking children with another adult smoker in the household. Two non-smokers had no information available about household smoking.

6.2.2.5 Human behaviours

Human behaviours before and during the fire can contribute to both the fire ignition and/or outcome of the fire. Table 19 presents specific behaviours of the decedent (deceased person) with regard to the ignition of the fire.

The decedent's action in relation to fire ignition is measured by the location of the decedent in proximity to the fire seat. Before ignition, fatalities were most often located in the room of fire origin. Half of the fatalities were involved in the ignition of the fire: either directly, such as deliberately lighting fabric while playing with a lighter, or indirectly, such as dropping a cigarette while intoxicated, through their own actions. No differences were observed by age.

Prior to ignition, the decedent was most commonly sleeping (44%) or engaged in smoking tobacco/drug (24%) or drinking alcohol (19%). Older adults and children were more likely to be sleeping, while working age adults were more likely to be smoking and/or drinking alcohol prior to fire ignition.

Table 19 Table of decedent's behaviours prior to fire by age group, New Zealand, 2007-2014 (n=118)

Decedent behaviours	Age group n (%)			Total
	0-14 yrs (N=14)	15-64 yrs (N=65)	≥65 yrs (N=39)	
Location in proximity to fire				
In dwelling, same room as fire seat	6 (43)	35 (54)	22 (56)	63 (53)
In dwelling, another room	8 (57)	29 (45)	15 (39)	52 (44)
Not in dwelling prior to fire	0	1 (2)	2 (5)	3 (3)
Involvement in ignition				
Yes, directly involved	5 (36)	12 (18)	8 (21)	25 (21)
Yes, indirectly involved	-	20 (31)	15 (38)	35 (30)
Not involved	8 (57)	24 (37)	12 (31)	44 (37)
Possibly involved	1 (7)	5 (8)	4 (10)	10 (9)
No information	0	4 (6)	0	4 (3)
Action prior to ignition*				
(3 most common observations)				
Sleeping	7 (50)	24 (36)	21 (54)	52 (44)
Drinking alcohol	-	17 (26)	5 (13)	22 (19)
Smoking tobacco/drugs	-	18 (28)	10 (26)	28 (24)

*multiple responses possible, percentages may add up to greater than 100%

The behaviour of the decedent during the fire event is presented in Table 20. Behaviours reported in Coronial cases files taken during the fire were mainly escape actions, followed by sleeping and fire-fighting/ rescue type actions. Older adults were more likely to take fire-fighting actions while young children and working age adults were more likely to sleep.

The common conditions inhibiting escape reported as potentially hindering escape in Coronial case files were smoke and/or visibility problems (67%), disorientation due to intoxication (31%) and the exit being blocked by fire (26%). Interestingly in fatalities involving older adults mobility restrictions, falling or other health issues occurring during the fire were observed in 24 of 39 (62%) fatalities.

Table 20 Table of decedent behaviours during fire by age group, New Zealand, 2007-2014 (n=118)

Decedent behaviours	Age group n (%)			Total
	0-14 yrs (N=14)	15-64 yrs (N=65)	≥65 yrs (N=39)	
Actions taken during fire* (3 most common observations)				
Escape actions	4 (29)	27 (42)	18 (46)	49 (41)
Sleeping	7 (50)	7 (11)	1 (3)	15 (13)
Fire-fighting or rescue actions	-	5 (8)	10 (26)	15 (13)
Conditions inhibiting escape* (5 most common observations)				
Smoke/visibility problems	9 (64)	41 (63)	29 (74)	79 (66)
Exit blocked by fire	3 (21)	20 (31)	8 (21)	31 (26)
Disorientated due to intoxication	-	30 (46)	6 (15)	36 (31)
Clothing on casualty burning	1 (7)	15 (23)	13 (33)	29 (25)
Unable to move due to mobility/health/fall	-	4 (6)	24 (62)	28 (24)

* Multiple response possible, percentages may add to greater than 100%

The behaviour of the decedent following the fire is presented in Table 21. The decedent was located most often in the house, either in the room of fire origin (49%) or in another room (47%). Children were more likely to outside the house (35%) and if in the house, not in the room of fire origin (57%). Three quarters of fatalities died in the fire, with a further one quarter escaping the house and being treated on scene. A total of 15% were transported to hospital and died due to complications from their injuries. In particular, older adults were the most likely to survive the fire but die while receiving treatment in hospital.

Table 21 Table of decedent behaviour after fire by age group, New Zealand, 2007-2014 (n=118)

Decedent behaviours	Age group n (%)			Total
	0-14 yrs (N=14)	15-64 yrs (N=65)	≥65 yrs (N=39)	
Decedent's location				
In house, room of fire origin	6 (43)	32 (50)	19 (49)	57 (49)
In house, not room of fire origin	8 (57)	32 (48)	16 (41)	55 (47)
Other	-	1 (2)	4 (8)	5 (4)
Decedent's action				
Died in fire	9 (64)	57 (88)	24 (61)	90 (76)
Treated at scene, died at scene	2 (14)	4 (6)	4 (10)	10 (9)
Treated, died enroute/at hospital	3 (21)	4 (6)	11 (28)	18 (15)

6.2.2.6 Cause of death

The post-mortem physiological cause of death is presented in Table 22. Injuries caused by smoke inhalation were the most common primary cause of death followed by burns and other thermal injuries. Smoke inhalation and carbon monoxide poisoning were most common in children and working age adults. Complications of fire injuries, including cardiac, respiratory and multi-organ failure were most prevalent in older adults (10 fatalities). Carbon monoxide poisoning as the main cause of death was more commonly assigned to working age adults. Multiple effects of fire were common and burns were the sole cause of death in only 4 fatalities.

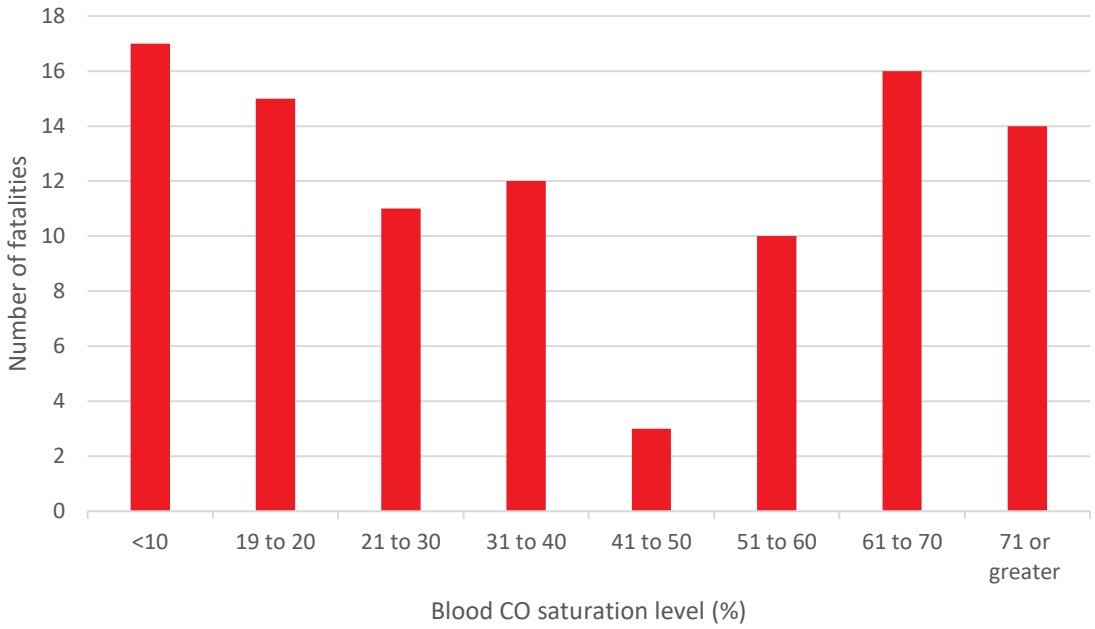
Table 22 Table of post-mortem physiological cause of death by age group, New Zealand, 2007-2014 (n=118)

Physiological cause of death*	Age group n (%)			Total
	0-14 yrs (N=14)	15-64 yrs (N=65)	≥65 yrs (N=39)	
Smoke inhalation	12 (86)	59 (90)	28 (71)	100 (85)
Carbon monoxide poisoning/hypoxia	9 (64)	32 (49)	9 (23)	33 (28)
Burns/thermal injuries	7 (50)	41 (63)	26 (66)	74 (63)
Inhalation burns	*0*	*2*	*3*	*5*
Cardiac/respiratory/multi-organ failure	-	4 (6)	10 (26)	14 (12)
Other causes	3 (21)	14 (22)	9 (23)	26 (22)

*multiple responses possible

Blood carbon monoxide (CO) saturation levels were documented in 103 fatalities (Figure 4). There is no distinct pattern to the post-mortem blood CO saturation levels as they are relatively equally distributed. The median is 40.6% blood CO saturation with a minimum of 5% and a maximum of 85% saturation. Differences in blood CO saturation levels are also presented by proximity to the seat of the fire at the time of ignition and by age group in Appendix 9.12.

Figure 4 Graph of blood carbon monoxide saturation levels in fatalities, New Zealand, 2007-2014 (n=103)



6.3 Narrative examples of typical fire scenarios

This section will give an overview of the five most common fire incident scenarios and fatality characteristics observed in the data.

The following scenarios are not representative of a single fatality rather they are compositions based on the experiences of several common fatalities in order to protect individuals identities. The scenarios are presented in no particular order.

6.3.1 Typical fire scenario 1: Working age adults and careless smoking

Working age adult males are a common group involved in fires due to cigarette and other smokers' materials, such as matches. Typically those who are aged in their 20-30's live in a house sharing arrangement, while those aged in their 40-50's live alone. The decedent is likely to be of Māori or New Zealand European descent, most commonly living in major urban areas of high deprivation. All the decedents are smokers. Half the incidents involve alcohol and a few cannabis.

Fires typically start in the bedroom or lounge with the deceased heavily involved in the ignition of the fire, often falling asleep, letting a lit cigarette fall into soft furnishings or bedding. The decedent awakes to a fire in the bed or couch/seat. Many, but not all, are impaired in the lead up to the fire by heavy alcohol consumption and a few have additionally used Cannabis, which contributes to the ignition of the fire and response to the fire.

Almost all are found in the room of the seat of the fire and very few escape from the dwelling, with most dying in the fire from smoke inhalation and burn injuries. The extent of fire and smoke damage in the dwelling was often extensive, involving the room of fire origin or whole dwelling. Post-mortem carbon monoxide levels are high indicating the decedent was probably asleep during the fire event. Typically a dwelling lacks smoke alarms and if one is fitted it is inoperable due to a lack of battery.

6.3.2 Typical fire scenario 2: Mobility impaired older adults & careless smoking

This group of fatalities is represented by elderly and older adults who frequently smoke in their own dwelling and have mobility impairments due to pre-existing health conditions or disabilities. Typically the decedent lives alone and is a heavy smoker who has a history of careless smoking; some are known to have been involved in previous fire incidents or have dropped cigarettes into soft furnishings. Previous to the fire, the decedent was frequently identified as having some difficulty in getting about on their own sometimes requiring the assistance of a carer to care for themselves and undertake day to day activities. In many of these instances the risk posed to the decedent by their smoking habits had been recognised by carers and associates of the fatality. Often the fatality is scared of being moved into supported living arrangements away from an independent arrangement.

The decedent is heavily involved in the ignition of the fire through the careless disposal of cigarettes and other smoking material into bedding, next to the bed or in lounge seating. It is very common for those with restricted mobility and/or poor health to set bedding alight after falling asleep while smoking in bed, awaking to a fire in the bed. Many are impaired in the lead up to the fire by heavy alcohol consumption and/or sedating prescription medicine use, such as sleeping pills or multiple prescription medications, which contributes to the ignition of the fire.

Alarms have previously been fitted in decedent's dwelling but alarms or batteries are frequently removed due to constant activation from the smoking activity of the victim. Many have operational alarms (previously placed on ceiling) on furniture at table height delaying the activation of the alarm during the fire. Combinations of limited mobility, confusion caused by alcohol or prescription drugs (particularly in the elderly), intimacy with fire source (ie. still in bed as it catches fire), and rapid spread of fire drastically reduces the chance of older adults with health/disability issues from escaping the fire event by impeding response to fire cues & ability to escape. Most are attempting to escape but have insufficient time or lose consciousness while still in the dwelling, failing to vacate the dwelling. When a fire is discovered at the early stages the decedent often attempt to extinguish the fire, even if they have restricted mobility, ignoring the early opportunity to vacate the premises. Victims are often rescued by neighbours or people passing by, but due to the poor pre-existing physical health condition of the decedent, or health events occurring during the fire they are unable to recover from their injuries, often burns and smoke inhalation, sustained in the fire.

6.3.3 Typical fire scenario 3: Child fire play

Children playing with fire or sources of fire ignition were the most common scenario for deaths in those aged 0-14 years. The child (median age 5yrs, range 2-8 yrs of age) lives with family or extended family and is highly likely to be in large, dynamic Pacific or Māori household. The household is in a minor urban area (small urban towns with a population of 1,000 or more) with high levels of deprivation. It is clear that household smoking is common place with a parental smoker or multiple generations of smokers in the household. A previous history of playing with fire using smokers' materials was common across all incidents of child fire play. On the day of the fire the household routine can be disrupted by older children staying home with illness, dividing the attention of the sole supervisory adult when other very young children are present.

During the day the child accesses smoking materials, particularly lighters or matches, obtained from where the household smoker last left them. Despite adult attempts to put smoking materials out of easy access to children, some children have scaled heights to access smoking materials on top of fridges or ovens in the kitchen. Other times little attempt was made to prevent easy access to smoking materials with lighters and matches left in areas of easy access and high visibility to children. The fires typically starts in the child's bedroom in bedding, soft furnishings or toys, fewer incidents originate in the living area.

While an adult was in the dwelling during the time of the fatality (either asleep or doing household activities) the adult was often unaware of the child's fire play activities only becoming aware when another child, bystander, or the parent/caregiver themselves has observed smoke or flames or by hearing a smoke alarm when fitted. The child is likely to have stayed in the bedroom or hidden in another room, probably scared of the consequences of alerting parents/caregivers to the fire. It was often too late to affect a rescue of children as the fire has become fully involved in the room containing the seat of the fire. Other times when a smoke alarm is activated there has been time to effect a rescue but the evacuation of a large particularly young family has been confused by thick smoke and other very young occupant victims have not been rescued. Fatalities are more likely to have severe burn injuries due to fire intimacy when the victim started the fire. Other occupant victims in the household are likely to be overcome by smoke when trying to escape or while asleep.

6.3.4 Typical fire scenario 4: "Older adults and intimacy with heating source"

This small yet important group of older adults typically live alone and are most likely to be NZ European. Although not always from a deprived area these older adults are more likely to reside in major urban areas (centred on a city or main urban centre) of moderate to high social deprivation.

These incidents are commonly associated with keeping warm and being intimate with sources of heating in the morning or during the day. Articles, such as soft furnishings, drying laundry or the decedent's own clothing are placed too close to the heat source by the decedent. The heat source is often a portable LPG gas cabinet and a number of fatalities start during attempts to ignite the gas heater with the decedent's own clothing entering the gas ignition/flame mechanism while the decedent is close by operating the gas heater starter mechanism. Fabrics worn and ignited are often synthetic and highly flammable.

The decedent is normally situated in close proximity to the heater and seat of fire, therefore they became aware of the fire quickly and typically take some action to fire-fighting action to attempt to extinguish the fire. Often this action spreads the fire around the living area of the dwelling, particularly if the decedent's own clothing has ignited, thus accelerating the development of the fire. Many are typically overcome with a combination of burns and inhalation injuries owing to their close proximity to the fire. Most succumb to smoke inhalation and burns due to the intimacy with the fire at the fire scene, while some will survive the fire and be transported to hospital where they succumb to their injuries or other complications.

6.3.5 Typical fire scenario 5: "Adults and cooking while intoxicated"

The majority of cooking fires occur in middle-aged working males (aged 25-45 years) in a mixture of housing situations including sharing with family, with other occupants or living alone. If the house is co-occupied the decedent is typically home alone at the time of the fire event. Although not always from a deprived area these male working-age adults are more likely to reside in major urban areas of moderate to high social deprivation. The decedent is likely to be of Māori or New Zealand European descent. Most commonly these incidents are associated with occasional instances of binge drinking, but some do have histories of heavy drinking or alcohol dependency. Operational alarms are commonly fitted in these households.

After an evening out the male came home late at night or early morning considerably intoxicated and decided to cook something to eat using a pan of oil or fry pan. The decedent is often intoxicated with very high blood alcohol levels and a few are additionally impaired by cannabis at the time of cooking. The decedent starts cooking by putting a pot of oil on the stovetop, turning the element on and leaving the oil unattended by vacating the kitchen to sit in a lounge or lie down in the bedroom where decedent falls asleep. While unattended the oil overheats and ignites, quickly spreading to surrounding kitchen walls and ceilings.

The decedent is often in an impaired, sleeping state and isn't aware of the cooking fire until the fire is well involved and fitted smoke alarms are activated. The response to fire cues and alarms where fitted is often impaired by alcohol/drugs and/or a confused sleepy state. About half of the fatalities in these incidents became aware of the fire and made an attempt to fire fight or to escape. Almost all die at the scene of the fire succumbing to smoke inhalation and, for some, burns. Very high blood CO levels in most cases indicate the decedent was probably asleep during the fire event

6.3.6 "Electrical fires while asleep"

Overall electrical fires are a common source of fire causation, second only to fires caused by cigarettes and smoking materials. Many vulnerable groups, including older adults, those living in high deprivation areas, those living in rural areas, and those living alone are represented in fires started by electrical fires with no one group dominant, however, the main aspect in common in these fatalities is that the decedent is asleep at the time of fire ignition in the bedroom or living area. Common electrical items ignited include overloaded multi-boxes, electric blankets, televisions, dehumidifiers, electric plugs and worn out fixed electrical wiring, again with no one source dominant. Many items are old, in poor condition or misused.

Fires are generally well advanced before the decedent is awoken and aware of the fire. Often the decedent's response to fire cues is impaired by alcohol and/or drugs, sleep or the escape is impeded by smoke, fire blocked exits or the fire progressing rapidly. Many have operational smoke alarms, but equally many have alarms without batteries. Victims of electrical fires are unable to remove themselves from danger when the fire started. Often failed to escape and are frequently found dead at the scene having failed to escape the dwelling.

7. Discussion

7.1 Principal findings

The aim of this study was to gain an in-depth understanding of who was at the highest risk of unintentional residential fire-related fatal injury and what were the common causes and circumstances surrounding these fatalities in New Zealand for the period 2007-2014.

Overall the number of residential fire fatalities and incidents and, subsequently, the rate of fire fatalities in New Zealand has declined since the previous case reviews of residential fire fatalities. When crudely compared with the first case review for the seven year period 1991 to 1997, conducted by Duncanson et al., (2001), substantial declines are observed in fatal fire-related injuries involving children aged <15 years and in the number of multiple fatalities and their relative contribution toward the total burden of fire-related fatal injuries. Identification of the drivers for this decline are beyond the scope to this case review therefore it was not possible to make any comment on the effectiveness of the key fire safety strategy promoted in New Zealand on the reductions observed.

The demographic groups of older adults aged ≥65 years of age, males and Māori, identified as being at increased risk of fire related fatal injury in the period 2007-2014, are broadly similar to "at risk" groups previously described nationally and internationally. The greatest burden of fatal injury occurred in the 15-64 year age group with the largest number of fatalities in these working age adults.

Overall the circumstances and causes of residential fire fatalities was consistent with wider international and national findings. The predominant cause of residential fires was cigarettes igniting fabric, in the bedroom or living area. Fire-related circumstances with increased risk of fatal injury included the dwelling being in a main urban area, in an area of high deprivation, and the fire occurring at night (midnight-6am). Our study found smoke alarms were fitted in half of all properties where fatal fires occurred, but one third of these smoke alarms were not operational due the complete absence of a battery or the presence of a discharged battery. We also noted during the qualitative analysis that many operational smoke alarms are inappropriately placed in a low position on walls or furniture. Private rental properties are less likely to have a smoke alarm fitted. While State housing rental properties had a higher proportion with fitted alarms, many of these were inoperable.

This is the first Coronial case review in New Zealand to examine housing and property characteristics in great depth, therefore, we identified new characteristics not previously examined in relation to unintentional residential fire fatalities. Housing types at increased risk of unintentional residential fatal fires included houses of wooden construction, and single story detached homes, broadly reflecting the general state of New Zealand's single story detached housing stock (Statistics New Zealand, 2014) and the major form of single detached housing Fire and Emergency attend for fire incidents over this period. Fatal fire incidents were found to be over-represented in rental properties, as New Zealand has a comparatively high rate of private household ownership (Statistics New Zealand, 2014).

Consistent with previous national and international research individual resident circumstances with increased risk of unintentional residential fire fatalities that were over-represented in the 2007-2014

data included individuals with pre-existing disability and/or co-morbidities, individuals consuming alcohol and/or drugs in the lead up to the fire, and habitual smokers, with these circumstances often contributing to the ignition of the fire and/or impeding the response to the fire cues.

Examination of human behaviours identified that many of the fatalities were involved in the fire ignition in some capacity and that their deaths were most likely a consequence of habitual behaviours such as smoking. The narratives highlighted that combinations of limited mobility, confusion caused by alcohol or drug use, involvement with the fire ignition/source, being asleep at the time of ignition and rapid reductions in visibility from smoke drastically reduces the chance of fire fatalities escaping from the fire event.

7.1 Strengths and weaknesses of the study

The richness of detail contained within Coronial case files makes this data source ideal for case review. Abstracting and aggregating Coronial case data is a major strength of this study and review of Coronial case files enables independent assessment of the cause of death and the identification cases of fire-related fatal injury occurring in residential dwellings. There have been noticeable improvements in data available since the previous series of case reviews in New Zealand, particularly with regard to smoke alarms. Duncanson et al., 2001 noted for the period 1991-1997 “the almost complete lack of data concerning presence or absence of a smoke alarm in affected dwellings”. Our study found 15% of Coronial case files had missing information on smoke alarms and while this rate need to improve further it does represent an improvement in data availability over time.

The presence of Fire and Emergency fire investigation reports in Coronial case files is common and these data are an incredibly important source of information on the characteristics of the fire and house, and of the causes and circumstances of fire fatalities. When the Fire and Emergency fire investigation reports are missing from Coronial case files Fire and Emergency lacks a central repository of fire investigation reports to be utilised for research purposes. Future Coronial case reviews would be strengthened by a complete indexed and searchable central repository of Fire and Emergency fire investigation reports available to researchers with appropriate ethical approvals and data security.

This Coronial case review is subject to the limitations of document review. The causes and circumstances of fire-related fatal injuries are not systematically considered during a Coronial inquest and only when a risk factor is confirmed, or reported, in a Coronial case files have we been able to capture data on these potential risk factors. When data is not stated, or specifically mentioned, by a Coroner the variable has been recorded as having “no information”. This effectively missing data means that the magnitude of observed frequencies and differences is subject to possible selection and information bias. Some variables have a high proportion of missing data which undermines the ability to comment on effective fire safety strategies in some areas and we have noted where the proportion of data recorded as having “no information” is of concern. The lack of photographic evidence of the fire scene and autopsy means some aspects of the data collection reliant on witness and Coroner descriptions were unable to be verified, such as smoke and visibility problems hindering escape during a fire event.

8. Potential Risk Reduction Strategies

This section outlines recommendations for prevention of deaths in unintentional residential fire incidents in New Zealand as informed by these research findings.

Injury prevention is based on the principle that injuries are predictable and preventable. There are clear commonalities in unintentional residential fire fatalities that are prime for intervention to avoid unnecessary deaths. Opportunities to intervene focus in the main on primary prevention, thus prevention efforts are aimed at preventing the fire from occurring in the first place. The Haddon matrix informs suitable approaches for primary prevention should focus on: preventing the existence of the fire causing agent; preventing the release of the fire causing agent; separating the fire from the host; and providing protection for the host (Haddon, 1980). Where a fire occurs secondary prevention efforts focus on: minimising the amount of the fire causing agent present, control the pattern of release of fire to minimise damage, control the interaction between the fire and host to minimise damage and increase the resilience of the host (Haddon, 1980). Furthermore, passive interventions, that don't require humans to actively engage in a behaviour to afford safety protections, are generally considered the most effective means of reducing injuries (Haddon, 1980).

Fire and Emergency has a stated outcome aim of "reducing the consequences from emergencies" through "reductions in harm from fire". The following outlined strategies, if implemented, will contribute towards reductions in unintentional residential fire fatalities.

Cigarettes accounted for the majority of fatal fire incidents identified with cigarettes commonly being dropped onto bedding, soft upholstered furnishings or the contents of rubbish bins, with fires often slowly smouldering away until ignition. Strategies to reduce fatal fires due to cigarettes should focused on 1) the behaviour of the smoker, 2) on the propensity of cigarettes to remain alight providing heat for ignition and 3) on the flammability of household fabrics.

Reductions in tobacco smoking have been a key strategic focus of the government adopted Smokefree 2025 goal, with population level reductions in smoking prevalence recently observed in the adult population (HPA, 2018). Fire and Emergency should support movements towards a Smokefree 2025 New Zealand as the most effective means to reduce cigarettes related residential fires including supporting and promoting initiatives to 1) reduce the supply and demand for cigarettes and other smokers' materials and 2) increase successful quitting. Adoption of a "Smoke Free Home" approach provides an effective and sustainable means for reducing smoking behaviour in areas of high fire risk in the house and could be targeted at rental properties, and households with working age male smokers for maximum fire safety impact.

Changes to the smoking habits of the high fatal fire risk sub-group of mobility or health impaired/incapacitated individuals is more difficult and requires the involvement of community based social, personal care and health services to identify at risk individuals. Fire and Emergency should provide fire safety training to community based personal care and health services as these individual have the greatest potential to instigate changes to smoking behaviours in this group. Additionally awareness needs to be raised in these personal care and health sectors of the risk of smoking in bed amongst those in the community with mobility restrictions and poor health.

In theory low ignition propensity cigarettes (aka Fire Safe cigarettes) have high potential to reduce the number of fires, including fatal fires, due to cigarettes. A number of countries such as Australia,

Sweden and much of the United States have introduced mandatory legislation to introduce Fire Safe cigarettes as a fire safety initiative. Moves towards similar legislation in New Zealand were diverted towards development of a voluntary consumer standard. Evaluation of the implementation of fire-safe cigarette legislation in the United States and other countries has returned mixed results. Technical testing of ignition propensity in realistic fire settings, such as in soft furnishings and mattresses, indicate that there is little to no difference in the ignition propensity of fire safe cigarettes compared with conventional cigarettes (Bonander et al., 2018). A recent analysis showed weak, statistically insignificant effects on rates of all-cause fire mortality, or mortality due to home fires caused by cigarettes (Bonander et al., 2018), while other earlier analyses have reported large statistically significant reductions in overall residential fire mortality rates and in fatalities where smoking materials are an ignition source (Yau & Marshall 2014; McLoughlin et al. 1985; Butry and Thomas 2017). While the evidence in total suggests Fire Safe cigarettes reduce cigarette-related mortality rates overall more research is needed to confirm the magnitude of the effect and the mechanisms given that it appears that the rate of cigarette-related fires changes little (Bonander et al., 2018).

Cigarette lighters are a common sources of ignition during child fire play and upcoming review of Fire Lighter Standards and regulations and newly proposed regulations for novelty/utility lighters are in progress. Any improvements in reducing the ease of operation and the appeal of lighters to children will be effective at reducing these fatalities in this vulnerable, at risk population.

Recommendation 1: Smoking-related fire deaths are identified as a significant risk in the study and in previous case reviews in New Zealand. Accordingly, there is a strong a case to aim strategies to the period prior to ignition (pre-event) by addressing the habitual smoker (host and the cigarette (vector).

As the most efficient means of preventing cigarette-related fire fatalities Fire and Emergency support and promotion of the comprehensive tobacco control Smoke Free 2025 initiatives, particularly those initiatives that create Smoke Free Homes.

Fire and Emergency should promote and support an update of voluntary standards to require cigarette manufacturers to introduce Reduced Ignition Propensity cigarettes for sale in New Zealand along the lines of established legislation in the United States, Canada & Australia.

Fabrics were identified as the main item ignited in the current, and previous, case reviews. The development and adoption of fire safety standards on a wide range of consumer products, including fabrics, to reduce motility due to fire can result in reductions in fire-related mortality. Changes to cigarette lighter standards in the United States in the 1980s has resulted in a 58% reduction in fires caused by very young children (Smith, Green & Singh, 2002). International differences in mortality rates due to fire have also been attributed, in part, to differences in fire regulations for consumer products like furniture and furnishings (Winberg, 2016). While there are concerns about the potential carcinogenic nature and environmental persistence of halogenated chemical fire retardants added to fabrics and furniture there are other opportunities to promote consumer products with lower fire ignition propensity such as products using less flammable materials, design changes and safer flame retardant chemicals (Shaw et al., 2010).

Recommendation 2: Continued advocacy for the development of standards, implementation and enforcement for consumer products involved in the ignitions of domestic fire incidents. This

should include fabrics used for upholstered furniture, bedding and adult clothing, as well as cigarettes and heaters.

Lifestyle factors including, alcohol and drug use, as well as **health and disability factors**, such as impaired mobility, were found in the current and in previous case reviews to have had a clear influence on fire ignitions and/or responses to fire cues. These lifestyle and health factors fall outside Fire and Emergency's operational brief and will require intersectoral engagement to address the fire risk across different groups of at risk individuals. Intersectoral approaches addressing underlying social environmental factors operating in society more generally, such as addressing the underlying causes of harmful drinking and drug use, as well as the availability of alcohol and drugs, will have significant co-benefits for fire safety and allow delivery of prevention efforts though multiple channels. Particular to health and disability factors Fire and Emergency should build broader partnerships for fire prevention with older people personal care & health providers including the possibility of fire prevention training for personal carers. The fire risk for those on combinations of sedative prescriptions needs further research in order to inform the best strategy and channels to utilise to reduce the risk of fire fatalities for this group.

Recommendation 3: Fire risks associated with alcohol and drug consumption indicate a need for Fire and Emergency to continue participation in and support of intersectoral strategies and partnerships to improve the well-being of New Zealanders, including consideration of the social and economic policy on fire safety particularly among deprived communities and households at greatest risk of fire-related injury. Fire and Emergency should continue the development of further targeted education initiatives to address these significant contributors to fire fatalities to effect long term behavioural changes in 'at risk' populations. Fire and Emergency should build broader partnerships for fire prevention with older people personal care & health providers including the possibility of fire prevention training for personal carers.

The **"at risk" populations** of older adults age 65 years or greater, males, Māori and households in areas of high social deprivation are persistent across the time series of case reviews conducted in New Zealand. It is concerning that the main population groups at risk of fire fatalities have largely remained the same despite observed drops in the overall numbers of fire-related deaths over time. Classic fire safety approaches (i.e. smoke alarms) that may be effective at the level of the general population appear to be less effective at reducing fire fatalities for at risk populations such as older adults with heath or disability related mobility issues who smoke in the home. Little evidence exists on effective means of community fire risk reduction (Gielen et al., 2018), therefore, more evaluation of community based efforts are needed. Establishing active community partnerships to support Fire and Emergency fire safety programmes may produce more effective means of accessing and educating at risk communities (Duncanson, 2000; Gielan, 2018). A community based approach with careful consultation and attention to cultural sensitivity was seen to be crucial to the implementation of the Auahi Whatatūpato fire safety programme in the Eastern Bay of Plenty (Duncanson, 2011). Continuing to develop diversity initiatives within Fire and Emergency will provide leverage opportunities to enhance community engagement (Allen and Clarke 2016). Some educational or awareness activities on safety responses to fires may reduce those fatalities, particularly in elderly, where the decedent has ignored the opportunity to escape and attempted to fight a fire.

Recommendation 4: Efforts to reduce disparities should be a focus of fire safety activities. Fire and Emergency should continue supporting and developing of 1) bicultural policy and culturally appropriate services and networks to promote fire safety to Māori; and 2) effective fire safety strategies for Pacific peoples & other ethnic minorities. Establishing active community partnerships to support Fire and Emergency fire safety programmes may produce more effective means of accessing and educating at risk communities. Fire and Emergency should consider developing educational or awareness activities to guide safe fire fighting.

Housing characteristics such as building materials used and type of residence construction was found in this study to influence the likelihood of fire fatality. Future residential construction of dwellings is influenced by Building Code legislation and continued Fire and Emergency support and influence for embedding fire safe design and materials as a means of primary prevention in future legislative and regulatory updates is important. The risk posed by building constructed of highly flammable materials or poorly maintained buildings is increased by the absent or non-operational early warning alarm or fire retarding sprinkler systems.

As a secondary prevention measure the presence of a smoke alarm in a private dwelling influences the outcome during a fire event by providing an early warning of a fire and has been shown to be associated with a lower likelihood of death, potentially halving the risk of fatal injury, when a fire does occur (Runyan, Bangdiwala et al. 1992; Dowswell, Towner et al. 1996; CDC 1998; Marshall, Runyan et al. 1998; Karter, 2006; Istre & Mallonee. 2000). Smoke alarms can be particularly effective in situations where the fire starts in a location remote from the resident, allowing time for the occupant(s) to leave the dwelling. Injury prevention counselling, particularly in the context of well child community care and community based home health or personal care visits to the household, may increase smoke alarm ownership (DiGuiseppi and Higgins 2000), and could be considered for children and older people in particular. Smoke detector legislation has been enacted in New Zealand with the Building Code Act 2004 requiring all new and all existing houses undergoing alterations to have smoke alarms installed (Department of Building and Housing, 2011). A law passed in May 2016 requiring fitted smoke alarms in all rental properties with alarms requiring a battery life of 8 years or be hard-wired (New Zealand Government, 2016). The responsibility of fitting the alarm sits with the landlord but tenants are required to ensure alarms are kept operational. The introduction of this legislation post-dates the period of fatalities examined in this case review so the effectiveness of this fire safety strategy in New Zealand is unable to be examined at this time, however, international findings clearly indicate benefits to mandatory installation of smoke alarms (McLoughlin et al., 1985; Harvey et al., 2013). A future concern raised by our study is the ability of the residents of rental properties to maintain the operability of fitted smoke alarms and future Fire and Emergency fire safety efforts should focus on maintenance of operational smoke alarms, particularly in rental properties. To enhance the impact of smoke alarm installation programmes international evidence indicates community health service worker advanced notice and accompanied visits expands programme reach, while the satisfaction of Fire Service interactions with residents is important for long-term maintenance of alarms (Gielen, et al., 2018).

Sprinkler systems installation is uncommon in New Zealand housing stock, as there is no requirement for the installation or retrofitting of domestic sprinkler systems in the Building code. The benefits of sprinkler systems for reducing fire-related mortality is clearly established with

residential sprinklers estimated to reduce fire fatalities by 69% alone and 82% in combination with smoke alarms (Hall, 2013; Garis & Clare, 2013).

Recommendations 5. That Fire and Emergency continue support and advocacy for embedding fire safe design and materials as a means of primary prevention, including the installation of sprinkler systems into new and renovated residential dwellings, in future Building Code legislative and regulatory updates.

That Fire and Emergency continue to promote the use of smoke alarms in domestic dwellings through public education and community based fire safety programmes which intentionally include private rental properties. That Fire and Emergency support the extension of existing mandatory stipulations to include mandatory installation of smoke alarms in all private dwellings. Future Fire and Emergency promotion and awareness activities need to focus on supporting tenant maintenance of operational alarms in rental settings.

9. Future risks

Future risks and potentially vulnerable groups not represented in current data:

- Increased risk to residential dwelling in fire-prone environments with climate change and more high impact weather and climatic events.
- Potentially increased numbers of older adults succumbing to fatal fires due to New Zealand's rapidly aging population, an increased proportion of the population living with chronic health conditions and disabilities, and aging in place policies driving the movement of personal care and health provisions into the home setting.
- The growth of the use of high fire risk temporary housing structures due to rapid declines in the availability of affordable housing in New Zealand's main urban areas. Temporary structure often fall outside of existing building consent systems, therefore the opportunities to upgrade the fire safety aspects of the building are limited.
- Electronic Nicotine Delivery Systems, e-cigarettes, vape-pens and personal vapourisers, collectively known as vaping devices pose a potential threat to fire safety with the threat of explosion of vaping devices and overheating during charging. While strategies that support smoking cessation will be the most effective means of reducing fires for reducing cigarette-related fire fatalities there is an argument that for those people who are unable to stop smoking, especially those with health or disability-related mobility restrictions, who smoke in bed, who are at greatest risk from fire fatalities vaping may be a safer alternative than using cigarettes and may reduce the potential for fire-related harm. At present there is insufficient evidence either way to support an evidence based strategy on vaping devices.

10. References

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11. Appendices

Appendix 11.1: Table of overview of variables collected in data abstraction

Potential characteristics & risk factors related to the ….	**Pre-fire (pre & during ignition)**	**During fire**	**Post-fire (rescue, treatment, outcome)**
Fire event		Number of seats of fire[4] Who extinguished fire[4] Fire extinguishing method[4]	Extent of fire damage[4] Extent of smoke damage[4]
Person	Age[1, 2, 3] Sex[1, 2, 3] Ethnicity[1, 2] Pre-existing disability[1, 2, 4] Pre-existing health[1, 4] Socioeconomic status (NZ Dep)[1] Employment status[1] + Occupation [3,4] Marital status[1, 4] Previous fire[1] Location of fire incident[4] Region of NZ [3]		Pre-existing conditions contribute to outcome[4] Mental health contributed to outcome[4] Physical health contributed to outcome[4]
Vector	Cause of fire [4] Certainty of cause of fire[4] Item ignited[1,2,4] Heat source[1,2,4] Equipment involved in ignition[4]		
Physical Environment	Duration of occupancy[1] Property ownership[1,4] Building condition[1] Building/property type[1, 3,4] Number of storys[1, 4] Story of fire origin[4] Number of rooms & bedrooms[1]	Telephone [1,2] Smoke alarm – present, active [1,2, 3, 4] Smoke alarm – closest destroyed in fire[4] Smoke alarm – closest activated[4] Sprinklers present[4] Household composition at ignition[1, 2] Number people in room of origin[4]	

	Climate – month of fire[1, 2, 3] Timing of incident[2, 3] Room of origin[2, 3] Dwelling permancy[2] Construction type[4] Year of construction[4]		
Social Environment	Alcohol misuse[2,4] Tobacco use[1,2,4] Alcohol use by deceased[1, 2,4] Drug use by deceased[2,4] Usually resident at residence[4] Familiarity of residents to residence[4]		
Additional behaviours	Victim behaviour in ignition[3, 4] Victim proximity seat of fire[3, 4] Victim involved in starting fire[4] Victim's behaviour prior to fire[4] Location of victim before fire[4] Action of victim before ignition[4] Condition of victim before ignition[4] Location of victim during ignition[4] Condition of victim during ignition[4]	Victim action in relation to fatal consequence[3] Alarm raising – time alerted[4] Alarm raising - who[4] Alarm raising – how alerted[4] Method notifying fire services[4] Time fire service alarm[4] Location of victim during fire[4] Action of victim during fire[4] Condition of fatality that inhibited escape[4]	Location of victim after fire[4] Deceased's activity after fire[4]
Outcome			Proximity of death to fire incident[3] Number of non-fatal injuries[4] Number of fatalities[2, 4] Percent burn[4] Blood CO levels[4]

Source key: 1 – Turner et al., 2017: literature review of risk factors for fire fatalities examined internationally; 2 – Duncanson, 2011: NZ risk factors examined (1991-1997); 3 – Millar, 2005: NZ risk factors examined in NZ (1997-2003); 4 – Harpur, 2014: Northern Ireland risk factors examined (1999-2009)

Appendix 11.2: Table of additional fire vector characteristics, 2007-2014 (n=107 fire incidents)

Fire vector characteristics	Frequency	Percent
Type of equipment as heat source (n=40)		
Stove	18	45
Heater	4	10
Chord/plug/wiring	4	10
TV set	2	5
Electric blanket	4	10
Other electrical item	7	20

Appendix 11.3: Table of additional fire spread characteristics, 2007-2014 (n=107 fire incidents)

Fire spread characteristics	Frequency	Percent
Extent of fire damage		
Object	9	8
Part of room of origin	5	5
Entire room of origin	8	7
+ minor damage to others	18	17
+ major damage to other	27	25
Entire dwelling	30	28
Entire compartment	5	5
Other	3	3
No information	2	2
Extent of smoke damage		
Object	5	5
Entire room of origin	3	3
+ minor damage to others	9	8
Entire dwelling	76	71
Entire compartment	7	7
Other	5	5
No information	2	1

Table 11.4: Table of additional dwelling characteristics, 2007-2014 (n=107 fire incidents)

Dwelling characteristics	Frequency	Percent
Building condition		
Well maintained	32	29
Cluttered, hording	29	27
Poorly maintained/state of disrepair	6	5
No information	42	39
Building age		
2014-1990	7	7
1989-1970	14	13
1969-1950	12	11
1949-1930	5	5
Pre 1930's	9	9
No information	60	55

Appendix 11.5: Table of additional dwelling characteristics, 2007-2014 (n=107 fire incidents)

Dwelling characteristics	Frequency	Percent
Number of levels		
Single	83	78
Double	19	18
Triple	3	3
No information	2	1
Level of fire origin		
Ground floor	91	85
First floor	12	11
Other	2	2
No information	2	2
Number of rooms		
1	10	9
2-6	28	26
7-9	41	38
10 or more	10	10
No information	18	17
Number of bedrooms		
0	3	3
1	26	24
2	13	12
3-4	48	45
5+	7	7
No information	10	9
Numbers usually resident		
0	8	7
1	44	41
2	17	16
3-4	16	15
5 or more	18	17
No information	4	4

In dwelling during fire event		
0	2	2
1	60	56
2	18	17
3-4	12	11
5 or more	13	12
No information	2	2
Number of people in room of fire origin		
0	29	27
1	69	64
2 or more	8	8
No information	1	1
Household composition*		
Children 0-4	16	15
Children 5-9	14	13
Children 10-19	19	18
Adults 20-59	66	62
Adults 60-74	18	17
Adults 75+	29	27

*Multiple options available may add up to greater than 100%

Appendix 11.6: Table of additional socio-demographic factors, 2007-2014 (N=118 fatalities)

Total	Age group, n (%)			Total
	0-14 yrs N=14	15-64 yrs N=65	≥65 yrs N=39	
Employment status				
Unemployed	-	19 (29)	1 (3)	20 (17)
Retired	-	-	38 (98)	38 (32)
Parent/homemaker	-	3 (5)	-	3 (4)
Student	-	4 (6)	-	8 (7)
Child	14 (100)	-	-	10 (8)
Disabled	-	10 (15)	-	10 (8)
Worker	-	24 (36)	-	24 (20)
No information	-	5 (8)	-	5 (4)
Marital status				
Married	-	9 (14)	8 (21)	17 (14)
Single	-	21 (33)	6 (15)	31 (26)
Single, divorced/separated	-	15 (23)	4 (10)	19 (16)
Widowed	-	2 (3)	18 (46)	20 (17)
Living with partner	-	8 (12)	0	8 (7)
Other	-	2 (3)	1 (3)	3 (4)
No information	-	8 (12)	2 (5)	10 (8)
Child	14	-	-	10 (8)

Appendix 11.10 Analysis by sex

Table 9.10.1 Table of socio-demographic and occupancy characteristics, by sex, New Zealand, 2007-2014 (n=118)

Sociodemographic & occupancy factors	Sex, n (%)		Total N=118
	Female N=47	Male N=71	
Age			
0-14 yrs	6 (13)	8 (11)	14 (12)
15-64 yrs	18 (38)	47 (66)	65 (55)
≥65 yrs	23 (49)	16 (23)	39 (33)
Prioritised ethnicity			
NZ European	28 (60)	48 (68)	76 (64)
NZ Māori	9 (19)	17 (24)	26 (22)
Pacific & other specified	8 (17)	3 (4)	11 (9)
Missing	2 (4)	3 (4)	5 (4)
Living alone			
Yes	18 (38)	42 (59)	70 (59)
No	28 (59)	24 (34)	42 (36)
Missing	1 (2)	5 (7)	6 (5)
Occupancy duration			
Temporary/visitor	3 (6)	6 (9)	9 (7)
Up to 1 month	1 (2)	8 (11)	9 (7)
1 to 6 months	5 (11)	2 (3)	2 (2)
6 to 12 months	4 (9)	6 (9)	15 (13)
Over 12 months	32 (68)	43 (61)	75 (64)
No information	2 (4)	5 (7)	7 (7)

Table 11.10.2 Table of health characteristics, by sex, New Zealand, 2007-2014 (n=118)

Health characteristics	Sex, n (%)		
	Female N=47	Male N=71	Total N=118
Pre-existing disability status			
No disability	19 (40)	38 (54)	57 (49)
Disability	22 (47)	25 (35)	47 (39)
No information	6 (13)	8 (11)	14 (12)
Pre-existing mental health conditions			
Yes	18 (38)	19 (27)	37 (31)
No	28 (59)	43 (61)	71 (61)
No information	1 (2)	9 (13)	10 (8)
Pre-existing physical health conditions			
Yes	23 (49)	29 (41)	52 (44)
No	21 (45)	36 (51)	57 (48)
No information	3 (6)	6 (8)	9 (8)
Co-morbidity contribute to outcome			
Yes	15 (32)	23 (32)	38 (32)
No	28 (60)	37 (52)	65 (55)
No information	4 (8)	11 (15)	15 (13)

Table 11.10.3 Number of alcohol-involved fatal residential fire fatalities by sex, New Zealand, 2007-2014 (n=118)

Lifestyle factors	Sex, n (%)		
	Female N=47	Male N=71	Total N=118
Number of alcohol-involved fatalities	18 (38)	31 (44)	49 (42)
Number of drug-involved fatalities	16 (34)	25 (35)	41 (35)

Table 11.10.4 Table of alcohol-related factors by sex, New Zealand, 2007-2014 (n=118)

Lifestyle factors	Sex, n (%)		
	Female N=47	Male N=71	Total N=118
Decedent's blood alcohol level (n=46)	n=16	n=30	n=46
<50 mg/100mL	1 (6)	3 (10)	4 (9)
50-80 mg/100mL	2 (12)	1 (3)	3 (6)
80-149 mg/mL	2 (12)	7 (23)	9 (20)
≥150 mg/mL	11 (69)	19 (63)	30 (65)
Decedent's alcohol history			
Diagnosed current alcohol dependency	4 (9)	5 (7)	9 (8)
Prev history alcoholic/heavy drinking	1 (2)	4 (6)	5 (4)
Heavy drinker	7 (15)	13 (19)	20 (17)
Teetotaller	1 (2)	1 (1)	2 (2)
Occasional/moderate drinker	6 (13)	15 (21)	21 (18)
Child	6 (13)	8 (11)	14 (12)
No information	22 (47)	25 (34)	47 (39)

Table 11.10.5 Table of drug and smoking-related factors by sex, New Zealand, 2007-2014 (n=118)

Lifestyle factors	Sex, N (%)		
	Female N=47	Male N=71	Total N=118
Toxicology confirmed drug use			
Yes - positive	14 (78)	22 (81)	36 (80)
No - negative	3 (17)	5 (19)	8 (18)
No information/no test	1 (6)	0	1 (2)
Sedating effect known[1] (n=34)	n=14	n=20	n=34
Little-mild sedating effect	1 (7)	4 (20)	5 (15)
Moderate-high sedating effect	13 (93)	16 (80)	29 (85)
Smoking status – decedent			
Yes	20 (43)	39 (55)	59 (50)
No	8 (17)	12 (17)	20 (17)
Child	6 (13)	8 (11)	14 (12)
No information	13 (28)	12 (17)	25 (21)
Smoking status – household[2] (n=40)	n=18	n=22	n=40
Yes	6 (33)	9 (41)	15 (38)
No	1 (6)	0	1 (3)
No information	11 (61)	13 (59)	24 (59)

Key: 1 - Legal or illegal drugs; 2 - Only examined for decedent a) not identified as a smoker and b) not living alone.

Table 11.10.6 Table of decedent's behaviours prior to fire by sex, New Zealand, 2007-2014 (n=118)

Decedent behaviours	Sex, n (%)		
	Female N=47	Male N=71	Total N=118
Location in proximity to fire			
In dwelling, same room as fire seat	26 (55)	47 (66)	73 (62)
In dwelling, another room	21 (45)	20 (28)	41 (35)
Not in dwelling prior to fire	0	4 (6)	4 (3)
Involvement in ignition			
Yes, directly involved	8 (17)	17 (24)	25 (21)
Yes, indirectly involved	13 (28)	22 (31)	35 (30)
Not involved	20 (43)	24 (34)	44 (37)
Possibly involved	5 (11)	5 (7)	10 (8)
No information	1 (2)	3 (4)	4 (4)
Action prior to ignition*			
(3 most common observations)			
Sleeping	29 (62)	37 (52)	66 (56)
Drinking alcohol	8 (17)	14 (20)	22 (19)
Smoking tobacco/drugs	14 (30)	71 (20)	28 (24)

*multiple responses possible, percentages may add up to greater than 100%

Table 11.10.7 Table of decedent behaviours during fire by sex, New Zealand, 2007-2014 (n=118)

Decedent behaviours	Sex, n (%)		
	Female N=47	Male N=71	Total N=118
Actions taken during fire*			
(3 most common observations)			
Escape actions	19 (40)	30 (42)	49 (42)
Sleeping	7 (15)	6 (8)	13 (11)
Fire-fighting or rescue actions	5 (11)	5 (7)	10 (8)
Conditions inhibiting escape*			
(5 most common observations)			
Smoke/visibility problems	33 (70)	46 (65)	79 (67)
Exit blocked by fire	13 (28)	18 (25)	31 (26)
Disorientated due to intoxication	13 (27)	23 (32)	36 (31)
Clothing on casualty burning	12 (26)	17 (24)	29 (25)
Unable to move due to mobility/health/fall	19 (40)	11 (15)	30 (25)

* Multiple response possible, percentages may add to greater than 100%

Table 11.10.8 Table of decedent behaviour after fire by sex, New Zealand, 2007-2014 (n=118)

Decedent behaviours	Sex, n (%)		
	Female N=47	Male N=71	Total N=118
Decedent's location			
In house, room of fire origin	21 (46)	36 (51)	57 (49)
In house, not room of fire origin	23 (50)	32 (45)	55 (47)
Other	1 (4)	3 (4)	5 (4)
Decedent's action			
Died in fire	34 (72)	56 (79)	90 (76)
Treated at scene, died at scene	6 (13)	4 (6)	10 (9)
Treated, died enroute/at hospital	7 (15)	11 (15)	18 (15)

Table 11.10.9 Table of post-mortem physiological cause of death due to fire, flames and smoke by sex, New Zealand, 2007-2014 (n=118)

Physiological cause of death*	Sex, n (%)		
	Female N=47	Male N=71	Total N=118

Smoke inhalation	39 (83)	60(85)	50 (42)
Carbon monoxide poisoning/hypoxia	21 (45)	36 (51)	57 (48)
Burns/thermal injuries	27 (57)	50 (70)	77 (65)
Cardiac/respiratory/multi-organ failure	6 (13)	7 (10)	13 (11)
Other causes	12 (26)	14 (20)	26 (22)

*multiple responses possible

Appendix 11.11 Analysis by prioritised ethnicity

Table 11.11.1 Table of socio-demographic & occupancy duration, by prioritised ethnicity, New Zealand, 2007-2014 (n=118)

Occupancy factors	Prioritised ethnicity, n (%)				Total N=118
	NZ European N=76	NZ Māori N=26	Pacific & other specified N=11	Missing N=5	
Age					
0-14 yrs	5 (7)	4 (15)	5 (45)	0	14 (12)
15-64 yrs	40 (53)	17 (66)	3 (27)	5 (100)	65 (55)
≥65 yrs	31 (41)	5 (19)	3 (27)	0	39 (33)
Gender					
Female	28 (37)	9 (35)	8 (73)	2 (40)	47 (40)
Male	48 (63)	17 (65)	3 (27)	3 (60)	71 (60)
Living alone					
Yes	43 (57)	15 (58)	11 (100)	1 (20)	70 (59)
No	32 (42)	9 (35)	0	1 (20)	42 (36)
Missing	1 (1)	2 (8)	0	3 (60)	6 (5)
Occupancy duration					
Temporary/visitor	4 (5)	2 (8)	2 (18)	1 (20)	9 (8)
Up to 1 month	7 (9)	2 (8)	0	0	9 (8)
1 to 6 months	7 (9)	2 (8)	2 (18)	0	11 (9)
6 to 12 months	5 (7)	0	1 (20)	0	6 (5)
Over 12 months	48 (64)	19 (73)	6 (55)	2 (40)	75 (64)
No information	4 (5)	1 (4)	0	2 (40)	7 (6)

Table 11.11.2 Table of health characteristics, by prioritised ethnicity, New Zealand, 2007-2014 (n=118)

Health characteristics	Prioritised ethnicity, n (%)				Total N=118
	NZ European N=76	NZ Māori N=26	Pacific & other specified N=11	Missing N=5	
Pre-existing disability status					
No disability	33 (43)	20 (77)	8 (73)	2 (40)	63 (53)
Disability	38 (50)	0	3 (27)	0	41 (35)
No information	5 (7)	6 (23)	0	3 (60)	14 (13)
Pre mental health condition					
Yes	25 (33)	10 (38)	2 (18)	0	37 (31)
No	48 (63)	12 (46)	9 (82)	2 (40)	71 (60)
No information	3 (4)	4 (15)	0	3 (60)	10 (9)
Pre physical health condition					
Yes	39 (51)	8 (31)	4 (36)	1 (20)	52 (44)
No	35 (46)	14 (54)	7 (64)	1 (20)	57 (48)
No information	2 (3)	4 (15)	0	3 (60)	9 (8)
Co-morbidity contr outcome					
Yes	31 (41)	3 (12)	3 (27)	1 (20)	38 (32)
No	38 (50)	18 (69)	8 (73)	1 (20)	65 (55)
No information	7 (9)	5 (19)	0	3 (60)	15 (13)

Table 11.11.3 Number of alcohol and drug-involved fatal residential fire fatalities by prioritised ethnicity, New Zealand, 2007-2014 (n=118)

Lifestyle factors	Prioritised ethnicity, n (%)				Total N=118
	NZ European N=76	NZ Māori N=26	Pacific & other specified N=11	Missing N=5	
Number of alcohol-involved fatalities	35 (46)	10 (38)	0	4 (80)	49 (42)
Number of drug-involved fatalities	27 (36)	9 (35)	2 (18)	3 (60)	41 (35)

Table 11.11.4 Table of alcohol-related factors by prioritised ethnicity, New Zealand, 2007-2014 (n=118)

Lifestyle factors	Prioritised ethnicity, n (%)				Total N=118
	NZ European N=76	NZ Māori N=26	Pacific & other specified N=11	Missing N=5	
Decedent's blood alcohol level (n=46)	n=33	n=9	n=0	n=4	n=46
<50 mg/100mL	1 (3)	2 (22)	0	1 (25)	4 (9)
50-80 mg/100mL	2 (6)	1 (11)	0	0	3 (7)
80-149 mg/mL	7 (21)	2 (22)	0	0	9 (20)
≥150 mg/mL	23 (70)	4 (44)	0	3 (75)	30 (64)
Decedent's alcohol history					
Current alcohol dependency	9 (12)	0	0	0	9 (8)
History of alcoholic dependency	3 (4)	2 (8)	0	1 (20)	5 (4)
Heavy drinker	14 (19)	5 (19)	0	0	20 (17)
Teetotaller	2 (3)	0	0	0	2 (2)
Occasional/moderate drinker	17 (23)	2 (8)	2 (18)	0	21 (18)
Child	5 (7)	4 (15)	5 (45)	0	14 (12)
No information	25 (33)	13 (50)	4 (36)	4 (80)	46 (39)

Table 11.11.5 Table of drug and smoking-related factors by prioritised ethnicity, New Zealand, 2007-2014 (n=118)

Lifestyle factors	Prioritised ethnicity, n (%)				Total N=118
	NZ European N=76	NZ Māori N=26	Pacific & other specified N=11	Missing N=5	
Toxicology confirmed drugs (n=45)	n=30	n=10	n=0	n=0	n=45
Yes - positive	24 (80)	9 (90)	1 (100)	2 (100)	36 (80)
No - negative	5 (17)	1 (10)	2 (67)	0	8 (18)
No information/no test	1 (3)	0	0	0	1 (2)
Sedating effect known[1] (n=15)	n=13	n=2	n=0	n=0	n=15
Little-mild sedating effect	4 (31)	0	0	0	4 (27)
Moderate-high sedating effect	9 (69)	2 (100)	0	0	11 (73)
Smoking status – decedent					
Yes	42 (55)	14 (54)	2 (18)	1 (20)	59 (50)
No	13 (17)	4 (15)	2 (18)	1 (20)	20 (17)
Child	5 (7)	4 (15)	5 (45)	0	14 (12)
No information	16 (21)	4 (15)	2 (18)	3 (60)	25 (21)
Smoking status – house[2] (n=40)	n=19	n=8	n=9	n=4	n=40
Yes	6 (32)	3 (38)	3 (33)	3 (75)	15 (38)
No	0	0	1 (11)	0	1 (3)
No information	13 (68)	5 (63)	5 (56)	1 (25)	24 (59)

Key: 1 - Legal or illegal drugs; 2 - Only examined for decedent a) not identified as a smoker and b) not living alone.

Table 11.11.6 Table of decedent's behaviours prior to fire by prioritised ethnicity, New Zealand, 2007-2014 (n=118)

Decedent behaviours	Prioritised ethnicity, n (%)				Total N=118
	NZ European N=76	NZ Māori N=26	Pacific & other specified N=11	Missing N=5	
Location in proximity to fire					
In dwelling, room of fire seat	50 (66)	17 (65)	4 (36)	2 (40)	73 (62)
In dwelling, another room	22 (29)	9 (35)	7 (63)	3 (60)	41 (35)
Not in dwelling prior to fire	4 (5)	0	0	0	4 (3)
Involvement in ignition					
Yes, directly involved	17 (22)	5 (19)	1 (9)	2 (40)	25 (21)
Yes, indirectly involved	25 (33)	9 (35)	1 (9)	0	35 (30)
Not involved	27 (36)	8 (31)	8 (73)	1 (20)	44 (37)
Possibly involved	5 (7)	4 (15)	1 (9)	0	10 (8)
No information	2 (3)	0	0	2(40)	4 (4)
Action prior to ignition*					
(3 most common observations)					
Sleeping	38 (50)	17 (65)	7 (64)	4 (80)	66 (56)
Drinking alcohol	17 (22)	4 (15)	4 (15)	0	22 (19)
Smoking tobacco/drugs	21 (28)	6 (23)	1 (9)	0	28 (24)

*multiple responses possible, percentages may add up to greater than 100%

Table 11.11.8 Table of decedent behaviours during fire by prioritised ethnicity, New Zealand, 2007-2014 (n=118)

Decedent behaviours	Prioritised ethnicity, n (%)				Total N=118
	NZ European N=76	NZ Māori N=26	Pacific & other specified N=11	Missing N=5	
Actions taken during fire*					
(3 most common observations)					
Escape actions	34 (45)	9 (35)	2 (18)	4 (80)	49 (42)
Sleeping	4 (5)	4 (15)	5 (45)	0	13 (11)
Fire-fighting or rescue	7 (9)	2 (8)	2 (8)	1 (9)	10 (8)
Conditions inhibiting escape*					
(5 most common observations)					
Smoke/visibility problems	55 (73)	18 (69)	5 (45)	1 (20)	79 (67)
Exit blocked by fire	17 (22)	10 (38)	2 (18)	2 (40)	31 (26)
Disorientated due to intoxication	28 (37)	7 (27)	0	1 (20)	36 (31)
Clothing on casualty burning	21 (38)	3 (12)	3 (12)	1 (20)	29 (25)
Unable to move due to mobility/health/fall	24 (32)	1 (4)	4 (36)	1 (20)	30 (25)

* Multiple response possible, percentages may add to greater than 100%

Table 11.11.9 Table of decedent behaviour after fire by prioritised ethnicity, New Zealand, 2007-2014 (n=118)

Decedent behaviours	Prioritised ethnicity, n (%)				Total N=118
	NZ European N=76	NZ Māori N=26	Pacific & other specified N=11	Missing N=5	
Decedent's location					
In house, rm of fire origin	38 (50)	12 (48)	5 (45)	2 (40)	57 (49)
In house, not rm of fire origin	33 (43)	13 (52)	6 (55)	3 (60)	55 (47)
Other	5 (7)	0	0	0	5 (4)
Decedent's action					
Died in fire	57 (75)	20 (80)	8 (73)	5 (100)	90 (76)
Treated at scene, died at scene	7 (9)	2 (8)	1 (9)	0	10 (9)
Treated, died enroute/at hosp	12 (16)	4 (16)	2 (18)	0	18 (15)

Table 11.11.10 Table of post-mortem physiological cause of death due to fire, flames and smoke by prioritised ethnicity, New Zealand, 2007-2014 (n=118)

Physiological cause of death*	Prioritised ethnicity, n (%)				Total N=118
	NZ European N=76	NZ Māori N=26	Pacific & other specified N=11	Missing N=5	
Smoke inhalation	62 (82)	21 (81)	11 (100)	5 (100)	99 (84)
Carbon monoxide poisoning/hypoxia	38 (50)	13 (50)	6 (55)	0	57 (48)
Burns/thermal injuries	57 (75)	14 (54)	6 (55)	0	77 (65)
Cardiac/respiratory/multiorgan failure	30 (39)	4 (15)	3 (27)	0	37 (31)
Other causes	22 (29)	9 (82)	1 (9)	1 (20)	33(28)

*multiple responses possible

Appendix 11.12 Post-mortem blood carbon monoxide saturation levels in fatalities

Figure 11.12.1 Post-mortem blood carbon monoxide saturation levels in fatalities in the same room as the seat of the fire during fire ignition, 2007-2014

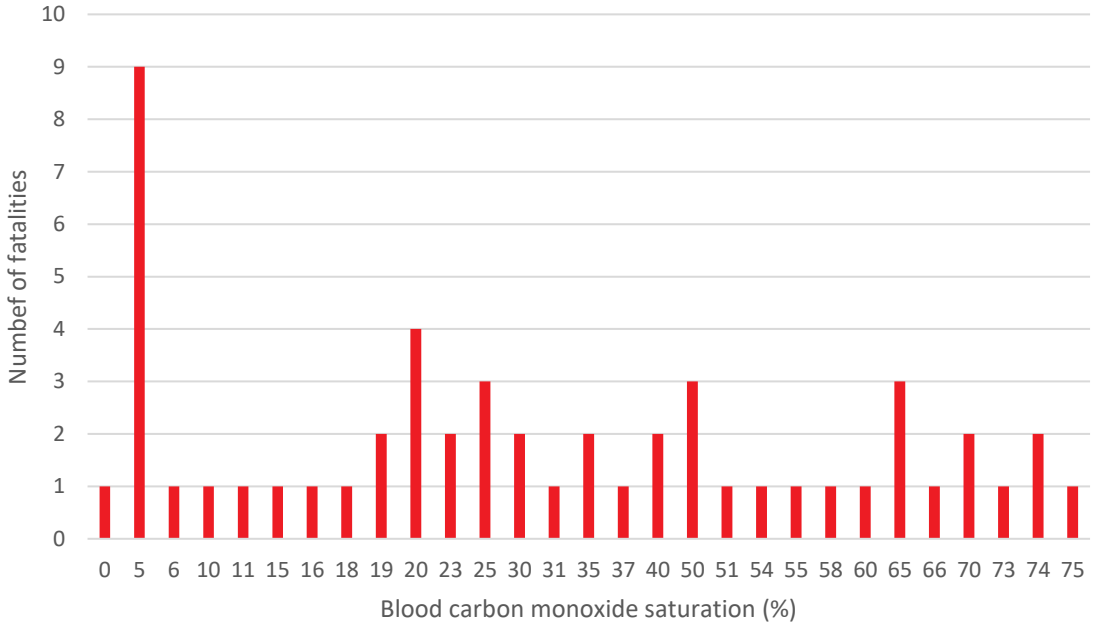

Figure 11.12.2 Post-mortem blood carbon monoxide saturation levels in fatalities by age group, 2007-2014