Report

FRNSW Adverse Structure Fire Outcomes 2016 - 2021

Identifying risk factors of structure fire fatality, injury, evacuation, and fire extension to inform an evidence-based approach to Prevention + Education

Document ID: Final Report
Issued: 20 April 2023

Fire Investigation and Research Unit
Community Safety and Research

FRNSW Adverse Structure Fire Outcomes 2016-2021

Identifying risk factors of structure fire fatality, injury, evacuation, and fire extension to inform an evidence-based approach to Prevention + Education

Final Report
April 2023

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Foreword

The *FRNSW Adverse Structure Fire Outcomes Report 2016-2021* is an important contribution to FRNSW's approach to community risk reduction. It applies a rigorous and forward-looking approach to the identification and measurement of risk in a way that is significant and context specific to FRNSW and the communities we serve. The Report shows that risk is complex and multifaceted, and that we need a deep and comprehensive understanding to inform meaningful, evidence-based decision-making.

The Report, like all research, should be read in totality and understood within the context of its methodology. It analyses eAIRS data to identify risk factors of adverse outcomes resulting from structure fires that occurred in our jurisdiction between 2016 and 2021. While it is robust and forward-looking in its use of predictive analysis to measure risk, it is limited by the scope and validity of eAIRS data.

When considered amongst other empirical research, the Report provides additional insight into community risk reduction. Alongside other organisational frameworks, the Report will be used by FRNSW to inform an evidence-based approach to research and resource prioritisation and to the development, implementation, and evaluation of Prevention + Education.

I commend the Report authors and wish to thank Monash University for their generous assistance and expertise in peer reviewing the Report. I look forward to seeing the Report's recommendations implemented across FRNSW in support of our efforts to improve the safety and resilience of the NSW community.

Jeremy Fewtrell AFSM
Deputy Commissioner
Field Operations

Executive Summary

All structure fires that occurred within Fire and Rescue NSW's (FRNSW) jurisdiction between 1 January 2016 and 31 December 2021 as recorded by the electronic Australasian Incident Reporting System (eAIRS) were analysed to identify risk factors of structure fire fatality, preventable fatality, injury, evacuation, and fire extension.

Fire-related fatalities, injuries, evacuations, and fire extension are adverse outcomes of structure fires. These consequences serve as incident level indicators of the effectiveness of FRNSW's approach to Prevention + Education. Fire fatality is the most severe adverse personal structure fire outcome, followed by injuries that do not cause fatality, and firefighter-assisted evacuations. Fire extension beyond the room of origin is the most common property damage measure.

Although analysis of these outcomes does not constitute a direct measure of effectiveness of FRNSW's Prevention + Education approaches, it does provide insight into the risk factors of adverse outcomes to inform a targeted approach. Further, because this analysis uses population-level data (all incidents that occurred within FRNSW's jurisdiction), the results of repeated analyses can be compared to identify whether the implementation of Prevention + Education approaches are associated with changes in risk.

Between 1 January 2016 and 31 December 2021, there were 30,891 structure fires in FRNSW's jurisdiction recorded in eAIRS. These fires led to a total of 109,592 persons evacuated, 2,346 injuries, and 88 fatalities. Preventable fatality information was available for 84 fire fatalities, of which 52 were deemed preventable. The fire extended beyond the room of origin in 5,417 cases.

Risk factors of fatality, preventable fatality, injury, evacuation, and fire extension were identified by conducting predictive analysis. Predictive analysis is methodologically rigorous. Albeit constrained by the limitations inherent in eAIRS, the results herein should be considered significant and context specific to FRNSW and the communities it serves.

The findings reveal that structure fire fatality, preventable fatality, injury, evacuation, and fire extension have shared risk factors, but distinct risk profiles. To mitigate the consequences of structure fires, Prevention + Education should target shared risk factors to prevent and intervene in adverse personal outcomes that exist along a continuum from evacuation to injury and fatality; and distinct risk profiles that are unique to fatality, preventable fatality, injury, evacuation, and fire extension.

Recommendations

The following recommendations have been made to mitigate the consequences of structure fires. They should be used to inform an evidence-based approach to research and resource prioritisation and to the development, implementation, and evaluation of Prevention + Education advocacy, programs, resources, and messaging.

Contribution to knowledge

To contribute to gaps in existing literature, it is recommended that FRNSW:

- Conduct regular analyses of structure fire adverse outcomes and publish the results of these analyses to contribute to the broader knowledge base, nationally and internationally.
- Ensure all future analyses of risk factors of adverse structure fire (and other emergency) outcomes employs multivariate analyses to identify predictors.
- Explore regression models and entry methods to identify models of best fit.

Data linkages
To overcome some of the limitations of eAIRS, it is recommended that FRNSW link eAIRS data with:

- The Burns Registry of Australia and New Zealand (BRANZ) and NSW Ambulance datasets to measure the incidence, severity, mechanisms, and outcomes of structure fire injuries.
- NSW Coronial dataset to measure the incidence, severity, and mechanisms of structure fire fatalities, and to identify opportunities to intervene when there is a continuum from evacuation to injury and fatality.
- NSW Rural Fire Service data to analyse adverse structure fire outcomes across NSW.
- Social housing and support service data to reconcile the discrepancies within eAIRS and to examine other factors that may increase risk of adverse outcomes in social housing occupants.
- Social and support services data to conduct deeper analysis of the risk factors that compound or contribute to the relationships between hoarding, neurodiversity, physical diversity, cultural diversity, Indigeneity, and adverse structure fire outcomes.

eAIRS enhancements
To enhance data collection and analysis, changes to eAIRS are recommended. These include the need to create distinct data objects in eAIRS that:

- Identify whether an injured person is treated on scene or transported to hospital, and the mechanism of fatality and injury by burns, smoke inhalation, or other.
- Distinguish type of hoarders and severity of hoarding using the Clutter Image Rating Scale.
- Distinguish between mental impairment caused by neurodiversity (mental illness and intellectual disability), intoxication (alcohol), and the effects of drugs (illicit and prescribed).
- Identify whether there is evidence of physical disability, aids and equipment, and the provision of support services/in-home care.
- Identify type of cultural practice and/or culture/ethnicity involved.
- Identify Indigeneity and cultural-specific practices.
- Identify whether a property functions as a social housing property regardless of which entity owns the property.

Reporting Officer training
To enhance the validity and reliability of data collected by eAIRS, Reporting Officers should be provided with comprehensive and regular training that:

- Enhances their capacity to make accurate determinations of fire incidents, particularly regarding the determination of undetermined and deliberate fires.
- Increases the likelihood that incidents will be recorded accurately in eAIRS, particularly where discrepancies were identified in Department of Housing, type of owner, and Mosaic Type variables.

Further research
To deepen understanding of the incidence, characteristics, and risk factors of structure fire adverse outcomes, and to develop evidence-based Prevention + Education programs and resources, further research should be conducted to:

Risk profiles and factors

- Identify self-reported structure fire adverse outcomes to measure the incidence, characteristics, and risk factors, including human behaviour, of structure fire adverse outcomes that are reported and unreported.

- Understand the differences between fatalities, injuries, and evacuations that occur along a continuum and those that have distinct risk profiles.
- Explore fatalities, injuries, and evacuations as a continuum of adverse outcomes to identify opportunities to intervene from a systems-based perspective.

Response time

- Code response time using the most valid measure which includes alarm time as the closest recorded time to the event, call-taking time, notification and activation of firefighters, and travel time (Call time to Code 3).
- Investigate the causes of the risk rate plateaus observed in evacuation and fire extension survival rates.
- Identify the factors that influence response times to ensure that they are as short as possible.
- Identify opportunities to prevent fatalities and injuries in the first 22 minutes of an alarm.

Temporal risk factors

- Understand the intersection of human behaviour, time, and risk to identify risk factors of adverse outcomes related to night-time and Winter and protective factors of adverse outcomes related to daytime, Summer, and Autumn.
- Review response protocols for structure fires that occur at night and in Winter to ensure that resource allocation is proportionate to risk.

Location risk factors

- Understand the relationship between remoteness and adverse structure fire outcomes to better understand the place-based factors influencing risk (contingent on self-report studies and/or data linkages with the NSW Rural Fire Service).

Individual risk factors

- Where SEIFA characteristics are based on population-level data, further research is needed to understand the relationship between relative disadvantage and adverse outcomes to identify the socioeconomic factors influencing risk at the individual level.

Behavioural risk factors

- Inform best practice fire service involvement in reducing the consequences of hoarding and develop evidence-based multi-disciplinary/multi-agency models of hoarding prevention, intervention, and response.
- Understand how each type of mental impairment interacts with other variables to increase risk of adverse structure fire outcomes and develop evidence-based multi-disciplinary/multi-agency models of neurodiversity (mental illness and intellectual disability), intoxication (alcohol), and drug (illicit and prescribed) related fire prevention, intervention, and response.
- Identify at-risk components of physical diversity and how these interact with other risk factors and develop evidence-based multi-disciplinary/multi-agency prevention, intervention, and response.
- Identify at-risk components of cultural diversity and how these interact with other risk factors and develop evidence-based multi-disciplinary/multi-agency prevention, intervention, and response.
- Identify the incidence, characteristics, and risk factors associated with adverse structure fire outcomes in Aboriginal and Torres Strait Islander peoples to develop evidence-based culturally sensitive multi-disciplinary/multi-agency prevention, intervention, and response.
- Identify self-reported misuse of fire by young people in the NSW community to determine the incidence, characteristics, and risk factors of youth misuse of fire for reported and unreported fires.

Building risk factors

- Explore the effect of building age, maintenance, and standard of construction materials, and their interaction with human behaviour, to better understand risk of adverse structure fire outcomes.
- Discern between government bodies who potentially own social housing and other non-housing entities who own and occupy other government buildings.
- Understand the intersectional risk profile of aged care buildings and their relationship to fire and other emergencies, and develop evidence-based approaches to fire prevention, intervention, and response.
- Understand the use and users of non-habitable buildings and how this influences risk.
- Review response protocols for structure fires that occur within high-risk properties such as residential attached, residential detached, aged care, carpark, and storage buildings, particularly those owned by Commonwealth and State Government, to ensure that resource allocation is proportionate to risk.

Smoke alarm/detector risk factors

- Understand self-reported factors affecting the presence and functionality of smoke alarms/detectors and the types selected, and human behaviour in response to smoke alarm/detector activation in the event of a fire.
- Determine the most effective activation and/or suppression systems and number of alarms for different individual, situational, and environmental circumstances.
- Understand why structures fires that result in fatality and injury are being reported by other emergency services agencies via the inter-agency CAD electronic messaging system (ICEMS).

Fire risk factors

- Identify and explore the factors that influence a cause determination of undetermined. A deeper analysis of structure fires with undetermined cause may aid identification of opportunities for Reporting Officer training and/or risk factors that provide opportunities for fire prevention, intervention, and response.
- Identify how the storage, use, and maintenance of cutting, welding, and heating torches can be improved.
- Understand how human behaviour interacts with ignition sources, materials ignited first, and areas of origin to inform Prevention + Education efforts to prevent and intervene in at-risk behaviour.

Prevention + Education

To mitigate the consequences of structure fires, evidence-based Prevention + Education advocacy, programs, resources, and messaging should:

Risk factors and profiles

- Target the distinct risk profiles of each adverse outcome.
- Target shared risk factors to reduce the risk of multiple adverse outcomes.
- Target fatality and injury to have the greatest impact on other adverse outcomes that share the same risk factors.
- Target the risk factors shared by accidental and deliberate fires, and determined and undetermined fires, to mitigate the consequences associated with ‘non-preventable’ and undetermined fires.

Response time

- Prioritise the reduction of response time by improving the efficiency of every variable factor known to influence response time.
- Educate the community about what to do in the first 4-5 minutes of a fire. Where fatalities and injuries increased significantly after 4 minutes and 22 seconds, onus should be placed on enhancing accurate perception of risk and taking appropriate actions, such as self-evacuation.
- Provide Communications Operators with the necessary support to provide callers with safety messaging based on the conditions reported to them. Where fatalities, injuries, firefighter-assisted evacuations, and fire extension all increased significantly between alarm time and the median response time, evidence-based and responsive messaging about safe self-evacuation, remaining in a safe place, and the provision of first aid during the time between alarm and firefighter arrival is critical.
- Enhance accurate perception of risk and appropriate actions, including self-evacuation where possible and how to stay safe if trapped in a fire.
- Prioritise advocacy for the installation of fire suppression systems, such as sprinklers, in structures located outside of a 10–11-minute response time.

Temporal risk factors

- Target human behaviour that increases the risk of adverse outcomes at night and during Winter.
- Enhance natural surveillance. For example, Safety Visit messaging about trimming vegetation and clearing clutter from around a structure will enhance the likelihood that passers-by will observe signs of fire, while also reducing fuel loads. Programs and resources should also enhance people's capacity to identify signs of fire, such as the smell and sight of smoke and the sound of a smoke alarm, and what to do when these signs are observed.
- Target risk at night to mitigate the consequences of preventable and 'non-preventable' fires.

Location risk factors

- Implement injury prevention and self-evacuation programs and resources in inner regional areas and major cities, and targeted programs and resources that reduce the risk of fire extension in outer regional, remote, and very remote areas.
- Target communities in Metropolitan West with education about what to do in the event of a fire to safely evacuate and mitigate fire spread.
- Prioritise education about what to do in the event of a fire to safely evacuate and mitigate fire spread to reduce the consequences associated with preventable and 'non-preventable' fires in Metropolitan West.
- Prioritise the reduction of response time to mitigate the consequences of preventable and 'non-preventable' fires in outer regional, remote, and very remote areas.

Individual risk factors

- Target the most socioeconomically disadvantaged areas with programs and resources that enhance understanding of exponential fire growth, support accurate perceptions of risk and estimations of available time to escape, and reinforce behaviours that mitigate injury and fire spread, such as smoke alarm installation, closing doors, and safe self-evacuation.
- Target each Mosaic Type based on their risk of each adverse outcome, rather than their risk of structure fires alone.
- Prioritise Mosaic Types that are at higher risk of multiple adverse outcomes and target each Mosaic Type with programs and resources that are specific to the risk of each adverse outcome.

- Use odds ratios to list Mosaic Types in order of risk of each adverse outcome where predictive analysis (and thus odds ratios) is a more valid measure of risk than incidence or population-controlled rates.
- Clarify the purpose of existing Prevention + Education approaches that use the Mosaic Types risk hierarchy to target efforts. For example, provide clarity on the purpose of Safety Visits (to reduce structure fires or to reduce structure fire fatalities) to ensure that the appropriate risk hierarchy is applied.
- Target Mosaic Types with tailored approaches to mitigate the consequences of preventable and ‘non-preventable’ fires.

Behavioural risk factors

- Target hoarding, neurodiversity, physical diversity, cultural diversity, and their intersectionality using a multi-disciplinary/multi-agency approach.
- Be culturally sensitive, targeted, and multifaceted for Aboriginal and Torres Strait Islander peoples.
- Target the risk factors of cooking fires that are specific to each adverse outcome, such as programs and resources tailored towards outdoor cooking equipment and kitchen or cooking area fires to reduce the risk of fatality and portable gas cookers and deep fat fryers to reduce the risk of injury.
- Implement evidence-based multi-disciplinary/multi-agency models of fire prevention, intervention to mitigate the consequences of preventable and ‘non-preventable’ fires involving mental impairment.
- Target the risk factors of cooking fires to mitigate the consequences of preventable and ‘non-preventable’ fires.

Building risk factors

- Prioritise fatality and injury prevention in residential attached buildings and injury and fire extension prevention in residential detached buildings.
- Enhance accurate perception of risk and self-evacuation in buildings designed for people on mass, such as assembly, office, shop, and laboratory buildings, where the actions of others may influence perception of risk and appropriate response and/or buildings take longer to be safely evacuated.
- Enhance accurate perception of risk and self-evacuation in occupiers of other residential properties, such as boarding houses, hotel/motels, residential care, and detention centres.
- Focus on what to do in the event of a fire to mitigate fire spread, such as closing doors during safe self-evacuation in residential detached, carpark, and storage buildings which were at higher risk of fire extension.
- Advocate for built environment fire safety mechanisms, such as sprinkler installation, in high-risk buildings such as residential attached, residential detached, aged care, carpark, and storage buildings, particularly those owned by Commonwealth and State Government.
- Enhance accurate perception of risk and self-evacuation in occupiers of privately owned and State Government owned properties to mitigate the consequences of preventable and ‘non-preventable’ fires.
- Enhance safe self-evacuation and mitigate fire spread, and advocate for the installation of fire suppression systems in Class 1a (detached), Class 3 (other residential), Class 7b (storage), and Class 10a (non-habitable) buildings to mitigate the consequences of preventable and ‘non-preventable’ fires.

Smoke alarm/detector risk factors

- Enhance understanding of exponential fire growth and support more accurate perceptions of risk and estimations of available time to escape, particularly for occupants of buildings that take longer to be safely evacuated.

- Prioritise programs and resources that support proper smoke alarm/detector installation, maintenance, testing, and replacing of batteries for battery-operated and hard-wired alarms.
- Provide education about what to do in the event of a fire. Messages such as when and how to safely use a fire blanket and fire extinguisher, when and how to safely evacuate, the need to remain in a safe location until firefighters arrive, and how to provide burns first aid are critical to preventing and mitigating fire injuries and firefighter-assisted evacuations.
- Support proper installation, maintenance, testing, and replacing batteries for hard-wired alarms to mitigate the consequences of preventable and 'non-preventable' fires.

Fire risk factors

- Target the safe use, maintenance, and storage of cutting, welding, or heating torches where this ignition source increased the risk of multiple adverse outcomes.
- Target the safe use, maintenance, and storage of petrol, other flammable liquid, LPG, other (furniture), fixed fans (cooling and exhaust), and other (structural components, finish) where these materials increased the risk of multiple adverse outcomes.
- Target at-risk areas with tailored messaging towards smoke alarm/detector installation, self-evacuation, and early identification and reporting of structure fires. Areas at risk of multiple adverse outcomes include bedrooms for less than five persons, lounge rooms, ceiling cavities, and cells or secure confinement areas.
- Prioritise safe self-evacuation messaging to mitigate the consequences associated with fires that originate in certain residential areas, structural areas, carpark areas, and storage areas.
- Target the safe use, maintenance, and storage of cutting, welding, and heating torches and electrical equipment to mitigate the consequences of preventable and 'non-preventable' fires.
- Target the safe use, maintenance, and storage of atomised, vapourised liquids, alcohol, LPG, other (furniture), clothing on a person, other (structural component, finish), and bush, grass, and forests to mitigate the consequences of preventable and 'non-preventable' fires.
- Target at-risk areas with tailored messaging towards smoke alarm/detector installation, self-evacuation, and early identification and reporting of structure fires to reduce risk in lounge rooms, kitchens, bedrooms for less than five persons, garages or workshops, lifts, exterior wall surfaces, cavity and roof spaces, and process or manufacturing areas to mitigate the consequences of preventable and 'non-preventable' fires.

Contents

1 Introduction

Fire and Rescue New South Wales (FRNSW) is a state government agency in New South Wales responsible for the provision of fire, rescue, and hazmat services. The agency also provides environmental protection, counter terrorism, natural disaster, humanitarian relief, and medical response services. FRNSW is one of the world's largest urban fire and rescue services, covering most of the NSW population of over 8 million people (Australian Bureau of Statistics, 2021a) across the state's metropolitan and regional areas. FRNSW is also the busiest fire service in Australia. Between 2020 to 2021, FRNSW responded to 123,639 emergency incidents, 14% of which were fire-related (Fire and Rescue NSW, 2021), accounting for $172 million dollars in asset loss insurance claims (Australian Government Productivity Commission, 2022).

FRNSW continually strives to reduce the impact of fire and other emergencies. FRNSW's strategic intent aims to establish FRNSW as an organisation 'Prepared for Anything' to 'Protect the Irreplaceable'. The first core capability of FRNSW's Plus Plan is Prevention + Education. Prevention + Education is the first line of defence against the risks and consequences of emergencies. It involves engaging closely with communities and stakeholders to reduce their risk and increase their resilience to fire and other emergencies. It also requires FRNSW to undertake research and benchmark performance against national and international standards in injury and property loss prevention. Prevention + Education includes, but is not limited to, broad-based media campaigns, targeted programs and resources for at-risk communities, built environment fire safety mechanisms, and firefighter education and training.

The consequences of structure fires serve as incident level indicators of the effectiveness of FRNSW's approach to Prevention + Education. These include fatalities, injuries, evacuations, and fire extension. Fire fatality is the most severe adverse personal structure fire outcome, followed by injuries that do not cause fatality, and firefighter-assisted evacuations. Fire extension beyond the room of origin is a common property damage measure.

Although analysis of these outcomes does not constitute a direct measure of effectiveness of FRNSW's Prevention + Education approaches, it does provide insight into the risk factors of adverse outcomes to inform a targeted approach. Further, because this analysis uses population-level data (all incidents that occurred within FRNSW's jurisdiction), the results of repeated analyses can be compared to identify whether the implementation of Prevention + Education approaches are associated with changes in risk.

This report identifies the risk factors of adverse structure fire outcomes that occurred within FRNSW's jurisdiction between 1 January 2016 and the 31 December 2021 as recorded by eAIRS. The findings suggest that structure fire fatality, preventable fatality, injury, evacuation, and fire extension have shared risk factors, but distinct risk profiles. Prevention + Education should target shared risk factors to prevent and intervene in adverse personal outcomes that exist along a continuum from evacuation to injury and fatality; and distinct risk profiles that are unique to fatality, preventable fatality, injury, evacuation, and fire extension.

The recommendations that have emerged from this analysis can be used to mitigate the consequences of structure fires by informing an evidence-based approach to research and resource prioritisation and to the development, implementation, and evaluation of Prevention + Education advocacy, programs, resources, and messaging.

1.1 Towards Zero

There has been a recent push within the emergency services sector to reduce the number of preventable residential fire fatalities towards zero. This priority was driven by a study into preventable residential fire fatalities in Australia (Coates et al., 2019). In response to this study, the Australasian Fire and Emergency Services Authorities Council (AFAC) published a strategic framework to support fire agencies in achieving zero preventable residential fire fatalities (Australasian Fire and Emergency Service Authorities Council, 2021). The AFAC Strategic Framework draws on findings and recommendations made by Coates et al. (2019) to formalise and provide strategic direction for Australian emergency services to develop and implement their own organisational strategies in reducing preventable residential fire fatalities.

In February 2021, Deputy Commissioner Field Operations Jeremy Fewtrell released a Commanders Intent to detail FRNSW's commitments and expectations in relation to the Plus Plan. The Intent prioritised a reduction in the number of fire fatalities; towards zero. To achieve this, the Intent highlighted the importance of community risk reduction activities targeted at the station and Zone level through the use of the Community Engagement Planning System and activities such as Safety Visits and Fire Eds.

Implementation of the findings and recommendations of the Report supports this Intent. The Report identifies significant risk factors of fatality and highlights that fatality may exist along a continuum of other adverse outcomes or as a distinct outcome. When fatality exists along a continuum of adverse personal outcomes, identification of shared risk factors provides an opportunity for prevention and intervention at the beginning of the continuum. When fatality is a distinct outcome, the risk profile of fatality must be identified to inform a targeted approach. The Report contributes to the knowledge base by identifying opportunities for prevention and intervention along the continuum of personal adverse outcomes where risk factors are shared, and by identifying the distinct risk profiles of each adverse outcome, informing targeted Prevention + Education.

While this study contributes to this work by analysing the risk factors of fatality, it is also necessary to avoid conflating risks associated with fatality with other adverse outcomes that may exist along a continuum with fatality. As a result, a broader analysis was conducted.

1.2 Broader Contribution

By analysing all fatalities, injuries, evacuations, and fire extension, regardless of preventability, cause determination, and property location use, specific risk factors and distinct risk profiles can be identified.

Where fatality, injury, and evacuation share similar risk factors, they may exist along a continuum of personal adverse outcomes. An understanding of the risk factors that predict evacuation, injury, and fatality identifies opportunities for prevention and intervention at the beginning of the continuum. As evidence suggests, people who die in fires are almost exclusively those who are unable to evacuate (Gilbert & Butry, 2017), suggesting a continuum of personal adverse outcomes exists. Further, given eAIRS data does not always capture belated fatalities that occur due to injuries, or injuries that are not identified by the Reporting Officer, it is important to analyse evacuations, injuries, and fatalities where they occur along a continuum and provide opportunities for early intervention.

Conversely, where fatality, injury, evacuation, and fire extension have unique combinations of risk factors, these outcomes must also be considered distinct. Evidence shows that fire injuries are not just 'near miss fatalities' but may present as a separate and distinct group that requires a targeted approach (Gilbert & Butry, 2017; Thompson, Galea & Hulse, 2018).

A common mistake within studies that measure adverse fire outcomes is to conflate fire risk as a single type of risk, usually based on factors related to fatalities, mainly those arising from accidental residential fires (Thompson, Galea & Hulse, 2018). However, evidence suggests there are different risk profiles for different adverse outcomes, meaning the translation of risk factors associated with accidental residential fire fatalities to all fatalities, or other adverse outcomes is flawed. Where the risk profiles of structure fires that cause fatality, injury, evacuation, and fire extension differ, they should inform specific, targeted Prevention + Education advocacy, programs, resources, and messaging.

This report contributes to the knowledge base by identifying opportunities for prevention and intervention along the continuum of personal adverse outcomes where risk factors are shared, and by identifying the distinct risk profiles of each adverse outcome, informing targeted Prevention + Education.

1.3 Governance

The analysis of adverse structure fire outcomes as incident level indicators of the effectiveness of Prevention + Education aligns with the FRNSW Outcomes and KPI Framework. The Framework requires FRNSW to statistically analyse outcomes resulting from its services and activities to evaluate and enhance agency performance. By delivering valid, relevant, and reliable outcomes analysis, this report contributes to FRNSW's evaluation of the Plus Plan. Implementation of the recommendations within this report will ensure that Prevention + Education delivers meaningful, beneficial results to the people of NSW. However, it is important to note that this analysis does not constitute a direct measure of effectiveness of FRNSW's Prevention + Education advocacy, programs, resources, and messaging. Monitoring and evaluation mechanisms must be embedded within each approach to directly measure effectiveness. Despite this, this report does provide insight into the risk factors of adverse outcomes at the incident level to inform a targeted approach.

This report also aligns with FRNSW's Prevention + Education Capability Statement. The Statement highlights that an understanding of the factors that affect risk is vital to informing effective Prevention + Education. Research and evidence-based decision-making are key elements underpinning a rigorous and effective approach. By analysing the risk factors of adverse structure fire outcomes, this report makes evidence-based recommendations to address gaps in knowledge to improve the safety of communities.

This report falls under the mandate of the Fire Fatality Analysis Committee (FFAC). The FFAC is responsible for the analysis and reporting of fire fatalities for the purpose of improving Prevention + Education strategies. FFAC analysis compliments the operational debriefing process. Committee findings and recommendations are reported with the aim of reducing the number of fire fatalities in NSW.

2 Scope and Definitions

2.1 Scope

The *FRNSW Adverse Structure Fire Outcomes Report 2016 - 2021* references fire fatalities, injuries, evacuations, and fire extension occurring within FRNSW's jurisdiction, as recorded by eAIRS.

Structure fires were included if they were coded 110 – 139 in eAIRS.

Adverse outcomes included:

- Any fatality, including preventable, non-preventable, and those not containing preventability data, attributed primarily to the effects of fire, as known at the time the eAIRS report was completed or later updated by FRNSW's Fire Investigation and Research Unit.
- Any injury, attributed primarily to the effects of fire, not resulting in the death of the patient, as known at the time the eAIRS report was completed.
- Evacuation, being the action of evacuating a person or persons from a hazardous or potentially hazardous area by FRNSW firefighters.
- Fire extension beyond the room of origin.

2.2 Definitions

The following definitions were drawn from the AFAC Strategic Framework (Australasian Fire and Emergency Service Authorities Council, 2021), were defined by eAIRS or the National Fire Protection Agency (NFPA, 2021), or were defined for the purposes of this report.

Adverse structure fire outcome: An adverse structure fire outcome refers to any fatality, injury, evacuation, or fire extension caused by a structure fire (code 110 – 139)**.**

Preventable fire: Preventable fires are fires where individuals, fire services, or other stakeholders may have been able to identify the risks (related to a person and/ or a physical environment) and take actions or develop intervention strategies which, if applied, may have reduced the risk of a fire taking place. Preventable fires are usually classified as accidental.

Accidental fire: A fire for which the cause does not involve a human act with the intent to ignite or spread a fire (NFPA, 2021).

Deliberate fire: A fire that has been deliberately or intentionally ignited when the person knows the fire should not be ignited (NFPA, 2021).

Undetermined fire: A fire that cannot be determined as accidental, deliberate, or natural; where no hypothesis can withstand an examination by deductive reasoning (NFPA, 2021).

Fire fatality: A fatality is defined as a death where causation, as determined by the Reporting Officer, is related primarily to the effects of fire, including causations such as smoke inhalation or burns, as known at the time the eAIRS report was completed.

Preventable fatality: Preventable fatalities are fatalities where individuals, fire services, or other stakeholders may have been able to identify the risks and take actions or develop intervention strategies which, if applied, may have reduced the risk of a fatality occurring.

Preventable fatalities are classified by FRNSW's Fatality Analysis Committee. While the committee employs some discretion, generally preventable fatalities are defined as fatalities that occur due to accidental fires, fires caused by children (14 years and under), fires caused by young people (15 years and over) where there was no intent to cause the fire or cause harm, and fires caused by someone with impaired cognitive ability. Preventable fatalities are also defined as fatalities caused by undetermined fires where there is evidence of accidental circumstances. Non-preventable fatalities are defined as fatalities that occur due to fires caused by natural or incendiary (criminal behaviour or self-harm) causes, and fatalities caused by undetermined fires where there is evidence of suspicious circumstances.

Preventable fatalities include only those fatalities that are deemed preventable by FRNSW in partnership with its key stakeholders. While FRNSW acknowledges that it operates within a systems-based approach to preventing fatalities, FRNSW is bound by its jurisdiction to prevent fatalities from a fire perspective. This report therefore defines preventable fatalities as those fatalities that can be prevented by FRNSW in partnership with its key stakeholders as governed by its jurisdiction.

Fire injury: An injury is defined as a wound or illness, attributed primarily to the effects of fire, not resulting in the death of the patient, as known at the time the eAIRS report was completed.

Evacuation: An evacuation refers to the action of evacuating a person or persons from a hazardous or potentially hazardous area by FRNSW firefighters.

Fire extension: Fire extension refers to the extension of a fire beyond the room of origin.

Prevention + Education: Prevention + Education is the first line of defence against the risks and consequences of emergencies. It involves engaging closely with communities and stakeholders to reduce their risk and increase their resilience to fire and other emergencies. It also requires FRNSW to undertake research and benchmark performance against national and international standards in injury and property loss prevention. Prevention + Education includes, but is not limited to, broad-based media campaigns, targeted programs and resources for at-risk communities, built environment fire safety mechanisms, and firefighter education and training.

3 Background

3.1 Adverse Structure Fire Outcomes

Structure fires have the potential to cause adverse personal and property outcomes. Structure fire fatalities, injuries, firefighter-assisted evacuations, and property damage by fire extension have a significant impact on the NSW community.

In line with Australasian Fire and Emergency Services Authorities Council's (AFAC, 2020) strategic objectives and FRNSW's strategic, outcomes, and capability frameworks, FRNSW developed an *Adverse Structure Fire Outcomes Report* to inform evidence-based policy and practice supporting a reduction in the consequences of structure fires: fatalities, injuries, firefighter-assisted evacuations, and property damage by fire extension.

To apply an evidence-based approach, it is necessary to identify risk factors that predict fire fatalities, injuries, evacuation, and fire extension. Where risk factors predict adverse outcomes, they can be used to inform an evidence-based approach to research and resource prioritisation and to the development, implementation, and evaluation of Prevention + Education advocacy, programs, resources, and messaging.

Previous Fire Fatality Reports were published by FRNSW (formerly NSW Fire Brigades) in 2006 (2000-2005), 2009 (2004-2008), and 2010 (2005-2009). Although providing detailed insight into the characteristics of fatal fires in NSW for a decade, these studies were descriptive and focused on preventable residential fire fatalities only.

3.2 Research Gaps

3.2.1 Knowledge gaps

Most studies of adverse structure fire outcomes have focused on fire fatalities (Bruck, Ball & Thomas, 2011; Bryant & Preston, 2017; Coates et al., 2019; Duncanson, 2001; Duncanson, Woodward & Reid, 2001; Jonsson & Jaldell, 2019; Miller, 2005, Runefors, Jonsson & Bonander, 2021; Xiong, Bruck & Ball, 2015), or fire injuries (DiGuiseppi et al., 2000;

Duncanson et al., 2002; Lilley, McNoe & Duncanson, 2018; Purcell et al., 2021; Runefors, Jonsson & Bonander, 2021; Shokouhi et al., 2019), with fewer studies on fire extension (Jonsson et al., 2017; Lilley, McNoe & Duncanson, 2018). Further, studies that measure the risk factors of evacuation mainly focus on self-evacuation (Kinateder et al., 2015; Kuligowski, 2009; Lee et al., 2018; Runefors, Johansson & van Hees, 2016), as opposed to firefighter-assisted evacuation (Runefors, Jonsson & Bonander, 2021). Where self-evacuation is a known preventative measure against structure fire fatalities and injuries (Runefors, Johansson & van Hees 2016; Shokouhi et al., 2019), a reliance on firefighter-assisted evacuation increases risk. Further, where fire extension is a known risk factor of fire fatality (Lilley, McNoe & Duncanson, 2018), further research is needed.

Existing literature has predominantly explored adverse outcomes of residential fires (Bruck, Ball & Thomas, 2011; DiGuiseppi et al., 2000; Jonsson & Jaldell, 2019; Jonsson et al., 2017; KC & Corcoran, 2017; Purcell et al., 2021; Runefors, Jonsson & Bonander, 2021; Shokouhi et al., 2019; Warda, Tenenbein & Moffatt, 1999; Wuschke, Clare & Garis, 2013), the most common being preventable (Coates et al., 2019) or accidental (Duncanson, 2001; Duncanson, Woodward & Reid, 2001; Duncanson et al., 2002; Iyer & Ball, 2010; Lilley, McNoe & Duncanson, 2018; Miller, 2005; Xiong, Bruck & Ball, 2015; Xiong, Bruck & Ball, 2016). No known studies have analysed all structure fires to explore cause determination and property location use (among others) as risk factors for fatality, injury, evacuation, and fire extension.

To contribute to this knowledge gap, this study analysed all structure fires regardless of preventability, cause determination, or property location use. It also analysed all adverse outcomes including fatality, preventable fatality, injury, evacuation, and fire extension.

Recommendation: Conduct regular analyses of all structure fires and all adverse outcomes.

Recommendation: Publish the results from this and all future analyses to contribute to the broader knowledge base, nationally and internationally.

3.2.2 Data gaps

Existing literature predominantly analyses secondary data to identify and explore adverse structure fire outcomes. Studies collect and analyse coronial records (Bruck, Ball & Thomas, 2011; Coates et al., 2019; Duncanson, 2001; Iyer & Ball, 2010; Lilley, McNoe & Duncanson, 2018; National Coronial Information System, 2022; Xiong, Bruck & Ball, 2015), national fire fatality databases (Jonsson & Jaldell, 2019; Mulvaney et al., 2008), fire investigation reports (Duncanson, 2001; Runefors, Johansson & van Hees, 2016), fire service incident reporting data (Duncanson, Woodward & Reid, 2001; Wuschke, Clare & Garis, 2013), and police data (Wuschke, Clare & Garis, 2013). Other studies have systematically reviewed the above (Kinateder et al., 2015; Shokouhi et al., 2019; Warda, Tenenbein & Moffatt, 1999). Although these studies provide some insight into the characteristics and risk factors of structure fires, coronial records are restricted to those that cause fatality; fire investigation and police data to those that undergo investigation; and fire service data to those that are reported to fire services. As research has revealed, many fires are unreported (Barnett, 2008; Ghassempour et al., 2021; Jonsson, Bergqvist & Andersson, 2015), reducing the capacity of official statistics to provide a valid and reliable measure of structure fires within the community.

The above limitation has been overcome by studies that have linked multiple databases (DiGuiseppi et al., 2000; Duncanson et al., 2002; Jonsson, Bergqvist & Andersson, 2015; Miller, 2005; Runefors, Jonsson & Bonander, 2021). Where studies link multiple databases, they have the capacity to identify adverse outcomes from unreported fires and longer-term outcomes, such as fatal injury, that are not recorded in incident reports.

Few studies have collected self-reported data on residential fires and their outcomes (Barnett, 2008; Tannous & Agho, 2017; Xiong, Bruck & Ball, 2016). These studies overcome some of the limitations of official statistics by providing a more accurate representation of the incidence and characteristics of reported and unreported structure fires in the community, albeit still limited to residential fires. To enhance community risk reduction and resilience, Prevention + Education approaches should target all factors that increase the consequences of fire in the community, rather than only those associated with fires reported to FRNSW. It is therefore necessary to identify the risk factors of both reported and unreported fires.

This study is limited by the use of eAIRS data and thus to an analysis of the consequences of structure fire. Linkages were made with FRNSW fire fatality and mosaic data, and with Australian Bureau of Statistics data. Despite this, the findings only relate to structure fires that were identified, reported, and responded to within FRNSW's jurisdiction. The findings herein may therefore not represent a complete overview of adverse structure fire outcomes experienced in NSW. Further, eAIRS does not collect the mechanism of fatality and injury, merely the presence or absence of these outcomes. Additional information is needed to understand the mechanism of fatality and injury to better inform Prevention + Education. The use of eAIRS also limits this study to situational and environmental risk factors. Further research is needed to understand how human behaviour interacts with the risk factors identified herein.

Recommendation: To enhance community risk reduction and resilience, Prevention + Education approaches should target all factors that increase the consequences of fire in the community. A self-reported study of structure fire adverse outcomes should be conducted to measure the incidence, characteristics, and risk factors, including human behaviour, of structure fires and adverse outcomes that are reported and unreported.

Recommendation: Link eAIRS data with the Burns Registry of Australia and New Zealand (BRANZ), NSW Ambulance, and NSW Coronial datasets to measure the incidence, severity, mechanisms, and outcomes of structure fire fatalities and injuries.

Recommendation: Link eAIRS data with NSW Rural Fire Service data to analyse adverse structure fire outcomes across NSW.

Recommendation: Create data objects in eAIRS that identify whether an injured person is treated on scene or transported to hospital, and the mechanism of fatality and injury by burns, smoke inhalation, or other.

3.2.3 Methodological gaps

Most studies of adverse structure fire outcomes are descriptive; they describe the characteristics of fires and the frequencies or proportions of those characteristics (Duncanson, Woodward & Reid, 2000; Lilley, McNoe & Duncanson, 2018; Miller, 2005; National Coronial Information System, 2022). They may also account for population, calculating rates per 100,000 persons (DiGuiseppi et al., 2000; Mulvaney et al., 2009) or use theoretical or qualitative analysis to describe themes or concepts (Kuligowski, 2009; Lilley, McNoe & Duncanson, 2018). Although descriptive studies are useful in describing a sample, they provide a general summary of the sample being studied without making inferences based on probability theory. Probability theory measures the likelihood of the occurrence of an event, facilitating the application of findings to the broader population. When descriptive studies are used to identify risk factors, they do so based on perceived differences between categories. Without further analysis, it is not possible to determine whether these perceived differences are caused simply by chance.

Other studies have used bivariate measures to identify relationships (associations or differences) between two variables (Bruck, Ball & Thomas, 2011; Bryant & Preston, 2017; Duncanson, 2001). They identify whether two variables (i.e., fatality and smoking, or fatality and time) are significantly related. Bivariate measures are more rigorous than descriptive statistics because they identify whether a relationship occurred by chance. However, bivariate studies can only identify whether a relationship between two variables exists. They cannot predict outcomes resulting from the interactions of multiple variables.

Other studies use multivariate analysis to identify risk factors of adverse outcomes (Coates et al., 2019; Jonsson & Jaldell, 2019; Mulvaney et al., 2008; Purcell et al., 2021; Runefors, Jonsson & Bonander, 2021; Wuschke, Clare & Garis, 2013; Xiong, Bruck & Ball, 2015). There are different types of multivariate analyses. While studies that employed one sample modelling to identify branching or clustering of variables (Coates et al., 2019; Jonsson et al., 2017; Wuschke, Clare & Garis, 2013) are rigorous, they cannot identify whether variables predict an outcome compared to the absence of that outcome. In contrast, two sample predictive modelling that uses the presence and absence of a variable (fatality, no fatality) or two mutually exclusive variables (fatal injury, non-fatal injury) can identify factors that predict a particular outcome (Jonsson & Jaldell, 2019; Mulvaney et al., 2008; Runefors, Jonsson & Bonander, 2021; Warda, Tenenbein & Moffatt, 1999; Xiong, Bruck & Ball, 2015).

For the above reasons, this study used multivariate analysis to identify predictors, or relative risk factors, of adverse outcomes using modelling that accounted for the presence and absence of an outcome (e.g., fatality vs. no fatality). In this instance, a multiple logistic regression was used with a forward likelihood ratio stepwise entry method. While this model was good fit and had excellent to outstanding discrimination for most adverse outcomes and adverse outcomes split by cause determination, it only had acceptable discrimination for injury and evacuation outcomes, and injury and evacuation outcomes in accidental and undetermined fires. Future analyses should explore other regression models and entry methods for best fit.

Recommendation: Ensure all future analyses of risk factors of adverse structure fire (and other emergency) outcomes employs multivariate analysis to identify predictors.

Recommendation: Future analyses should explore regression models and entry methods to identify models of best fit.

4 Methodology

4.1 Purpose

The aim of this study was to explore eAIRS data to identify the risk factors of adverse structure fire outcomes to inform an evidence-based approach to Prevention + Education.

Structure fire outcomes were defined as:

- Fatality vs no fatality
- Preventable fatality vs non-preventable fatality within the fatality sub-dataset
- Injury vs no injury
- Evacuation vs no evacuation
- Fire extension vs no fire extension

The objectives of this study were to:

- Determine the incidence, population-controlled rates, and trends of structure fire fatalities, preventable fatalities, injuries, evacuations, and fire extension that occurred as a result of structure fires in FRNSW's jurisdiction
- Identify the risk factors of structure fire fatalities, preventable fatalities, injuries, evacuations, and fire extension compared to an absence of these outcomes; and
- Identify the risk factors of each adverse outcome compared to an absence of these outcomes when that outcome arose from an accidental, deliberate, and undetermined structure fire.

The purpose of the study was to:

- Inform an evidence-based approach to resource and research prioritisation; and
- Inform an evidence-based approach to the development, implementation, and evaluation of Prevention + Education advocacy, programs, resources, and messaging.

4.2 Data Collection

Data was exported from eAIRS for all structure fires (codes 110 – 139) that occurred within FRNSW's jurisdiction between 1 January 2016 and the 31 December 2021, inclusive.

4.2.1 eAIRS Base Dataset 1

The following variables were directly extracted from eAIRS in wide format.
Incident data:

- Report ID
- Incident number
- Call source
- Alarm date
- Alarm time
- Address
- Local Government Area
- Latitude and longitude
- FRNSW jurisdiction

Response data:

- Station name
- Station number
- Region
- Zone
- Platoon
- Additional response activities
- Competed time
- Control time
- Response time

Owner/occupant data:

- Property location use

Fire characteristics:

- Fire type levels 1 and 2
- Cause determination levels 1, 2, and 3
- Ignition source
- Material ignited first
- Point of origin
- Area of fire origin

Damage data:

- Confinement of fire
- Percent of collapse damage
- Percent of fire damage
- Percent of smoke damage
- Percent of water damage

Behavioural data:

- Youth misuse of fire
- Cultural factors
- Hoarding
- Mental impairment
- Due to alcohol
- Due to mental illness

Smoke alarm/detector data:

- Alarms present
- Alarms operating
- Type of alarm
- Sprinkler performance

Mosaic data:

- Mosaic group
- Mosaic type

4.2.2 eAIRS Outcomes Dataset 2

The following variables were extracted from eAIRS separately.
Incident data:

- Report ID
- Incident number
- Alarm date
- Alarm time

Outcomes data:

- Fatality
- Injury
- Evacuation

4.2.3 eAIRS Additional Dataset 3

The following variables were directly extracted from eAIRS in cube form, by calendar year.
Incident data:

- Report ID
- Incident number
- Alarm date
- Alarm time
- Type of incident
- Revised incident type

Response data:

- Staffing type
- Recovery kit given
- Primary response activity

Owner/occupant data:

- Type of owner
- Type of occupant
- Department of Housing

- Property descriptor
- Remote index category

Behavioural data:

- Cultural factors/practices level 2

Smoke alarm/detector data:

- Reason alarm not operating

4.2.4 eAIRS Time Dataset 4

The following variables were directly extracted from eAIRS in cube form, by calendar year.
Incident data:

- Report ID
- Incident number
- Alarm date
- Alarm time
- Dispatch time
- Arrival time
- Control stop time
- Duties completed time

4.2.5 Fire Fatality Dataset

The following variables were directly extracted from the fire fatality dataset, by calendar year.
Incident data:

- Report ID
- Incident number

Outcomes data:

- Preventable fatality

4.2.6 Mosaic Dataset

The following variables were directly extracted from the mosaic dataset collected and collated by Experian (2018) based on the 2016 Australian Bureau of Statistics Census data.

- Mosaic group and type descriptions
- Mosaic group and type population

4.2.7 Australian Bureau of Statistics Dataset 1

The following variables were extracted from the 2016 Australian Bureau of Statistics Census of Population and Housing: Socioeconomic Indexes for Areas (SEIFA).

- Usual resident population of postcode
- SEIFA decile of postcode

4.2.8 Australian Bureau of Statistics Dataset 2

The following variables were extracted from the Australian Bureau of Statistics website (valid September 2021).

- Population of NSW
- Cultural and linguistic diversity in population of NSW

4.2.9 Australian Bureau of Statistics Dataset 3

The following variables were extracted from the Australian Bureau of Statistics Census Table Builder, extracted from the 2016 Australian Bureau of Statistics Census data.

- Dwelling type

- Type of non-private dwelling
- Dwelling structure
- Tenure and landlord type
- Household composition

4.2.10 Australian Government Productivity Commission Dataset

The following variables were extracted from the Australian Government Productivity Commission dataset.

- Fire injuries by admission to a health service per 100,000 persons
- Fire deaths in NSW per 100,000 persons

4.3 Data Cleaning

eAIRS Datasets 3, 4, and 5 were collated by appending the data cubes for each calendar year. Report ID was used to merge all five eAIRS datasets. Incident numbers and alarm years were checked to ensure data appended and merged correctly. Once merged, the dataset was split by jurisdiction. Only those cases that occurred inside FRNSW's jurisdiction were included in the analysis.

There were 8 cases in the Fire Fatality Dataset that did not match with the eAIRS structure fire dataset using Report ID and incident number variables. Upon further analysis, 4 of these fatalities occurred in a vehicle which was not being used as a residence. The remaining 4 fatalities occurred outside of FRNSW's jurisdiction. These cases were not included in the analysis as they did not meet the inclusion criteria of the study.

There were 16 cases in the eAIRS time dataset that did not match with the eAIRS structure fire dataset using Report ID and incident number variables. Further, there were 5,435 missing arrival times and 21 arrival times that occurred before alarm date and time. In total, 5,472 cases had missing alarm to arrival time data. By removing the cases that had missing time data from the survival analysis (alarm time to arrival time), the survival curves may not accurately reflect survival rates. While the remaining sample size was large (n = 25,419) and there were no discernible patterns in the missing data, suggesting the data was missing at random, the survival analysis results may be limited by, and must be considered in the context of, this missing data. Time data was not included in the multivariate model as the variable did not meet the assumptions of the test. As a result, this missing data did not impact the multivariate analysis.

Australian Bureau of Statistics dataset 1 was merged with the collated eAIRS database (above) using postcode. Suburb names were used to ensure the data merged correctly. Missing and incorrect eAIRS postcodes were corrected by manually searching for suburb name postcodes to match with Australian Bureau of Statistics data.

Australian Bureau of Statistics datasets 2 and 3, Productivity Commission, and Mosaic datasets were saved separately to compare overall findings with population and household characteristics.

4.4 Data Coding

Variables were coded categorically and numerically. Categorical variables are descriptive words that group together cases that share similar characteristics. Categorical variables were dichotomous (yes/no), ordinal (categories that have a particular order, such as proportion of fire damage), and nominal (categories that have no particular order, such as area of origin). Numerical or continuous variables are numbers. Some numerical variables were ratio as they had a true zero (time between events), while others were interval as they did not have a true zero (SEIFA).

Once cleaned, there were 30,891 cases by 119 variables, totalling 3,676,029 data points.

4.4.1 Outcome data

- Structure fire: Any structure fires (codes 110 – 139) that occurred in FRNSW's jurisdiction, as recorded in eAIRS between 1 January 2016 and the 31 December 2021, inclusive
- Fatality: Death of a person caused by the structure fire
- Preventable fatality: Death of a person caused by the structure fire where the fatality was determined preventable by the Fire Investigation and Research Unit
- Injury: Injury to a person caused by the structure fire
- Evacuation: The evacuation of persons from the structure because of the fire
- Fire extension: Fire extension beyond the room of origin

4.4.2 Incident data

- Report ID: A unique number assigned to each eAIRS report

4.4.3 Response data

- Call source: The source of the notification of the incident
- Alarm to arrival: Response time between the notification of the incident to the call centre and arrival at the scene by the first arriving appliance (Code 3)
- Alarm to extinguished: Response time between the notification of the incident to the call centre and the extinguishment of the fire (controlled)
- Alarm to completed: Response time between the notification of the incident to the call centre and completion of the incident (Code 4)
- Arrival to extinguished: Response time between arrival at the scene by the first arriving appliance (Code 3) and the extinguishment of the fire (controlled)
- Arrival to completed: Response time between arrival at the scene by the first arriving appliance (Code 3) and completion of the incident (Code 4)
- Extinguished to completed: Response time between extinguishment of the fire (controlled) and completion of the incident (Code 4)

4.4.4 Temporal data

- Date: The date of the notification of the incident
- Month: The month of the notification of the incident
- Year: The year of the notification of the incident
- Season: The season of the notification of the incident
- Time: The time (in 24 hours) of the notification of the incident
- Day of the week: The day of the week of the notification of the incident
- Time of day: Whether the incident occurred during the day (0800 - 1959 hrs) or at night (2000 – 0759 hrs)
- Time of week: Whether the notification of the incident occurred on a weekday or weekend

4.4.5 Location data

- Postcode: The postcode pertaining to the address where the incident occurred
- Remoteness: The remoteness index, as classified by the Australian Bureau of Statistics, of the address where the incident occurred

- FRNSW jurisdiction: Whether the incident occurred within FRNSW's jurisdiction (urban fire district) or outside of FRNSW's jurisdiction (rural fire district)
- SEIFA decile: Australian Bureau of Statistics 2016 census data was used to classify each incident postcode with the socioeconomic index for areas (SEIFA) decile. The decile divides a distribution into 10 equal groups, with the lowest scoring 10% of areas given a decile number of 1, the second-lowest 10% of areas a decile number of 2, and so on, until the highest 10% of areas is given a decile number of 10. The lower the number, the greater the degree of relative socioeconomic disadvantage (ABS, 2016).
- Usual resident population: Australian Bureau of Statistics 2016 census data was used to classify each incident postcode by the usual resident population of that postcode.

4.4.6 Property data

- Building code: The building code that classifies the structure in accordance with the Building Code of Australia
- Property location use: The main use of the property in which the incident occurred
- Type of owner: The type of owner of the property in which the incident occurred
- Type of occupant: The type of occupant of the property in which the incident occurred

4.4.7 Mosaic data

- Mosaic group: Community segmentation data that classifies households into broad groups based on multiple risk factors
- Mosaic type: Community segmentation data that classifies households into specific types based on multiple risk factors

4.4.8 Fire data

- Cause determination: The determination of the cause of the fire
- Ignition source: The source of heat that caused the ignition of the fire
- Material ignited first: The material that first came into contact with the heat source to cause the fire
- Area of origin: The area where the fire originated

4.4.9 Damage data

- Confinement: Whether the fire spread was confined to the object, room, floor/level, or structure of origin, or extended beyond the structure of origin
- Collapse damage: The degree of collapse damage of the structure because of the fire
- Fire damage: The degree of fire damage of the structure because of the fire
- Smoke damage: The degree of smoke damage of the structure because of the fire
- Water damage: The degree of water damage of the structure due to firefighting operations

4.4.10 Human behaviour data

- Hoarding: Whether there was any evidence of hoarding behaviour; the accumulation of items beyond that reasonably expected for the function and use of the property
- Mental impairment: Whether there was any evidence of mental impairment due to mental illness, intellectual disability, intoxication, or medication
- Youth misuse of fire: Whether the fire was caused by a young person under the age of 17 years

- Cultural practices: Whether there was any evidence of non-Caucasian-Australian cultural practices or factors that contributed to the cause or intensity of the fire

4.4.11 Smoke alarm data

- Alarms present: Whether smoke alarms or detectors were present in the structure
- Alarms operating: Whether present alarms or detectors were operating at the time of the fire
- Type of alarm: The type of alarm or detector that was present in the structure
- Reason alarm not operating: The reason an alarm or detector failed to operate at the time of the fire

4.4.12 Post-incident data

- Recovery Kit: Whether a Recovery Kit was provided to the owner/occupier after the structure fire to assist them in the recovery phase

4.5 Data Analysis

Data analysis was conducted using Microsoft Excel and IBM SPSS.

4.5.1 Univariate Analysis

Descriptive statistics were calculated to measure presence, frequencies, and proportions of the data. It was also used to measure incidence and population-controlled rates, and to draw population comparison. Descriptive data provides a summary of structure fires, their characteristics, and outcomes.

4.5.2 Bivariate Analysis

Measures of association and variance were calculated to identify relationships between two variables. These measures indicate whether two variables are associated with each other or differ from each other. Often, variables will be related to each other for a variety of reasons, many of which may not be controlled for or identified within the analysis. This means that causality cannot be inferred from association; it cannot be assumed that because two variables have a relationship, that one causes the other to occur. Instead, associations are used to explore the relationships between variables.

4.5.2.1 Survival Analysis

Survival analysis was used to measure the rates of survivability for fatality, injury, evacuation, and fire extension over response time (alarm to arrival). Survival analysis measures the time to each adverse outcome where arrival time is deemed the event time. Although arrival time is not a true measure of event time, it assists in measuring different outcomes based on points in time. Survival analysis is useful when the outcome of interest being studied is censored. Censored data occurs when the time to an outcome cannot be fully observed. For example, when it is known that the time to attend a fire was three minutes but that this may not have been the time of the event (fatality). In this instance, we know that the response time was at least three minutes but not the exact time of the fatality (which may have occurred well before the alarm was raised or at the exact time the appliance arrived). Survival analysis allows the information contained in the censored data to be considered fully in the analysis.

Data was prepared by coding the absence of an adverse outcome as 0 and the presence of an adverse outcome as 1. The survival function was used, where 1 represents 100% probability of survival.

The areas of interest included the survivability of:
- Fatality
- Injury
- Evacuation; and
- Fire Extension

over response time measured as time between alarm and arrival.

4.5.2.2 Trend Analysis

Spearman's *rho* was also used to measure if there were any statistically significant correlations between year and the number of occurrences of each categorical variable. Spearman's *rho* was used where the data was not normally distributed and there were small numbers of classes (six years). The underlying assumptions of continuous data and monotonicity (where the ranked sets either increase together or one increases as the other decreases; Dancey & Reidy, 2011) were met. This test was used to identify whether the number of occurrences in any categorical variable changed linearly (increased or decreased) over time (2016 to 2021).

The areas of interest included correlations between:
- Year (2016 to 2021)

and all categorical variables:
- Outcomes
- Response characteristics
- Temporal characteristics
- Location characteristics
- Property characteristics
- Fire characteristics
- Damage characteristics
- Mosaic group and type
- Human behaviour
- Alarms presence and functionality
- Post-incident characteristics

Outcomes analysis was repeated with the dataset split by cause determination.

4.5.3 Multivariate Analysis

4.5.3.1 Predictive Analysis

Multivariate analysis was used to identify whether the presence of one or multiple variables predicted an outcome variable. Multiple logistic regression was conducted to predict the outcome (dependent) variables using all other (independent) variables. Multiple logistic regression is used when a binary (yes, no) outcome is predicted by multiple factors. To conduct multiple logistic regression with categorical data, dummy variables (yes = 1, no = 0) were created for each level of each categorical variable.

Multiple logistic regression assumes linearity, an absence of outliers, independence, and no multicollinearity. The Box Tidwell Test for linearity was used to test whether there was a linear relationship between the continuous independent variables and the logit transformation of each dependent variable. The results revealed that the continuous variable (usual resident population) did not have a linear relationship with the logit transformation of each dependent variable. This variable was removed from the analysis to meet the linearity assumption. Outliers were identified by analysing the univariate results. These results indicate that the frequency in each categorical variable level varies widely but tends to remain consistent across adverse outcomes. Given smaller frequency category levels were important inclusions in the analysis, they were retained. The test of independence was upheld where each case was independent and included in the dataset once. This means that each of the observations is mutually exclusive. Further, each dependent variable has mutually exclusive and exhaustive categories (yes, no). Chi-square tests of independence were conducted on variables that measure the same underlying construct. These results revealed significant associations between multiple variables that measured similar constructs. Only one variable that measured each construct was included in the analysis to meet the assumptions of no multicollinearity.

A forward likelihood ratio (LR) stepwise entry method was used to construct the regression model. The method added independent variables to the basic model based on the significance of the score statistic, and removed variables based on the probability of a likelihood-ratio statistic. The forward stepwise method was deemed the most suitable to meet the needs of this study. This analysis aimed to identify significant predictors of adverse outcomes to inform Prevention + Education efforts. Where resources are finite, the priority was to identify rigorous predictors rather than those that made very small contributions to the model. The forward stepwise method facilitated this. The LR entry method was chosen as this is considered the least prone to error (ESRC National Centre for Research Methods, 2011).

Multiple logistic regression was used to determine whether any of the variables were predictors of:

- Fatality (vs no fatality)
- Preventable fatality (vs non-preventable fatality) within the fatality sub-dataset
- Injury (vs no injury)
- Evacuation (vs no evacuation); and
- Fire extension (vs confinement)

This analysis was repeated with the dataset split by cause determination.

While multiple logistic regression was good fit and had excellent to outstanding discrimination for most adverse outcomes and adverse outcomes split by cause determination, it only had acceptable discrimination for injury and evacuation outcomes, and injury and evacuation outcomes in accidental and undetermined fires. Future analyses should explore other regression models and entry methods for best fit.

4.6 Data Limitations

This report analysed incident data to identify risk factors of adverse outcomes resulting from structure fires. The report does not analyse the risk of a structure fire occurring in the first place. Consequently, the findings and recommendations pertain to adverse outcomes of structure fires as opposed to structures fires themselves. It is likely that the risk factors of adverse outcomes differ from the risk factors of structure fires occurring in the first place. The results herein are limited to preventing and reducing the consequences of structure fires rather than their occurrence.

The electronic Australasian Incident Reporting System (eAIRS) is an online program designed to capture incident related information for the creation of incident reports. The database contains information automatically captured by emergency Triple Zero calls and that which is submitted by the Reporting Officer (RO) at the completion of the incident. The RO for eAIRS can be any firefighter or Officer who first arrived at the incident scene; however, is usually the Station Officer of the first arriving crew (NSWFB, 2007, p.2). Although the RO is obligated to make a reasonable, educated judgement to complete a report as accurately as possible, they do not require irrefutable evidence before making a determination (NSWFB, 1998, sec. 9, p.9). As a result, fire incident records are reliant upon the discretion of the RO, their experience, expertise, and perceptions at the time of the incident. Consequently, fire incident reports may differ by RO, meaning data input may not be consistent. This may hamper the consistency and internal validity of the study.

eAIRS captures the consequences of structure fires as reported by RO's at the completion of the incident. Firefighter-assisted evacuations and fire extension occur at the time of the incident and, as a result, are generally recorded accurately in eAIRS. However, ROs cannot capture fatalities that occur after an incident report has been completed. Although eAIRS is often manually updated after the incident report has been completed if a fatality is identified during the fire investigation process, or is reported by NSW Police, NSW Health, or the media, eAIRS data may not include fatalities that occur after long periods of time. Further, injury data is captured when an injury is apparent at the time of the incident. Injury data is therefore more likely to include severe injuries and/or those requiring ambulance attendance and/or transportation. Minor injuries and injuries which are not immediately apparent, or which manifest later, may not be included in the data. This analysis is limited to adverse outcomes reported in eAIRS only.

Further, eAIRS only records data of interest to FRNSW. As a result, this study was limited by the information collected therein, and could not examine empirical evidence relevant to all variables associated with adverse structure fire outcomes identified in existing literature. Consequently, only those variables identified within existing literature that could be measured by available indicators within the datasets were included in this study, with notable exceptions (physical diversity, Indigeneity). Future research which analyses comprehensive, linked data or primary data collected for the purposes of the study will be better positioned to identify adverse structure fire outcomes.

Due to a reliance on eAIRS data, this report is largely focused on situational and environmental risk factors of adverse outcomes. Although some behavioural factors are included in the analysis (hoarding, mental impairment, cultural practices, youth misuse of fire), there are significant gaps in knowledge concerning how human action or inaction interacts with risk factors. Although existing literature was used to fill some gaps in knowledge, further research is needed to understand how human behaviour interacts with the risk factors identified herein.

Another limitation of relying on fire incident data is that many structure fires remain unreported. It is likely that eAIRS data captures only some of the adverse structure fire outcomes that occur in the population, reducing the capacity of this report to provide a valid and reliable measure of structure fires within the community. Where reported and unreported structure fires may share risk factors, or may represent distinct groups with unique risk factors, self-reported studies of structure fires and associated adverse outcomes are needed.

Finally, FRNSW transitioned to eAIRS in March 2015. Prior to this date, the original windows-based AIRS application was used. eAIRS collects more variables and levels than the original AIRS, meaning the merging of AIRS with eAIRS would generate a dataset with missing variables and the need to aggregate variable levels, reducing statistical power. For these reasons, this study focused on adverse structure fire outcomes from 2016 to 2021. This data collection period enabled the collection of eAIRS data for full calendar years, from the time of eAIRS' inception to the start of the data collection period (January 2022). Although this ensured a more valid and reliable approach, it also means that there remains a gap in reporting adverse structure fire outcomes from 2010 when the last report was published, to 2015 when FRNSW transitioned to eAIRS. A separate study of AIRS data from 2010 to 2015 is recommended if information from this period is sought.

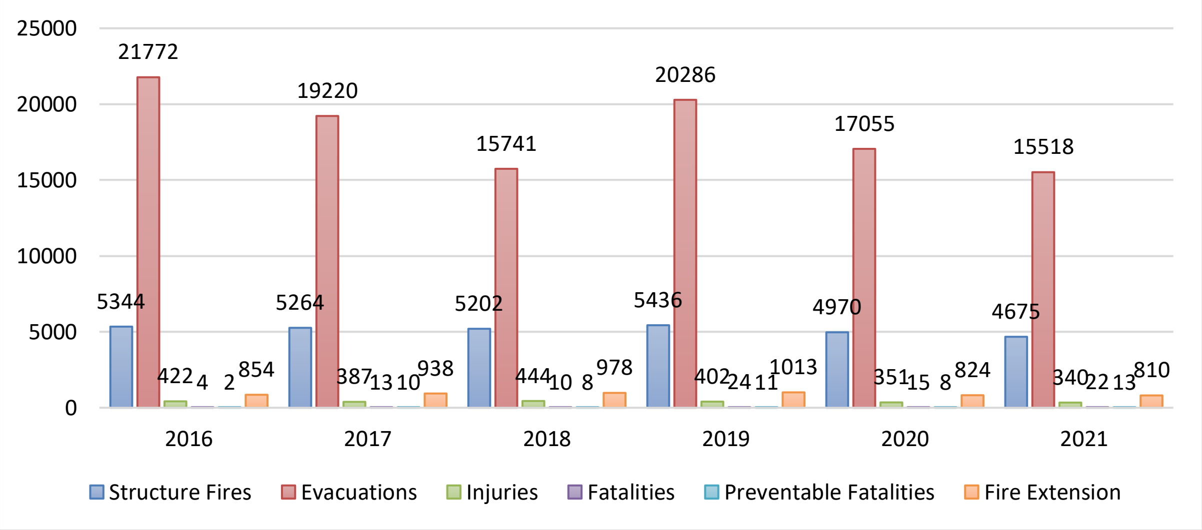
The limitations identified above may be overcome by implementing the recommendations made in this report, namely by conducting data linkage studies, undertaking further research, and providing additional eAIRS and fire investigation training to RO's.

5 Description of Adverse Outcomes

5.1 Incidence

Between 1 January 2016 and 31 December 2021, there were 30,891 structure fires in FRNSW's jurisdiction recorded in eAIRS. These fires led to a total of 109,592 persons evacuated, 2,346 injuries, and 88 fatalities. Preventable fatality information was available for 84 fire fatalities, of which 52 were deemed preventable. The fire extended beyond the room of origin in 5,417 cases.

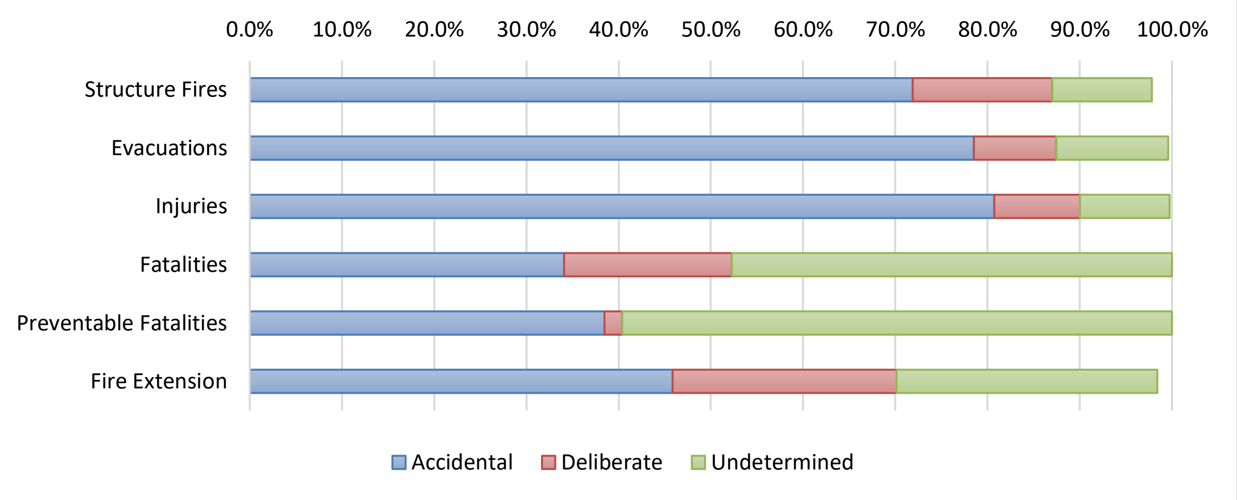
Figure 1. Structure fires by incidence of adverse outcomes



5.1.1.1 Incidence by cause determination

Of the 30,891 structure fires that were recorded in eAIRS, 22,208 (71.9%) were deemed accidental, 4.675 (15.1%) were deliberate, and 3,335 (10.8%) were of undetermined cause. The remainder were deemed natural (2.1%) or not assigned (0.1%). Fatalities (47.7%) and preventable fatalities (59.6%) were usually attributed to an undetermined cause, while injuries (80.7%) and evacuations (78.5%) were attributed to an accidental cause. While fire extension occurred more often when the cause was accidental (45.9%), deliberate fires accounted for one quarter of fires that caused fire extension beyond the room of origin (24.3%).

Figure 2. Adverse structure fire outcomes by cause determination



5.1.1.2 Incidence trends

There were four statistically significant trends over time. Accidental and deliberate structure fires decreased significantly over time, while accidental structure fire fatalities and preventable fatalities increased significantly over time. Existing literature has identified a decrease in deliberate structure fires over time (Bryant & Preston, 2017).

Figure 3. Accidental structure fires

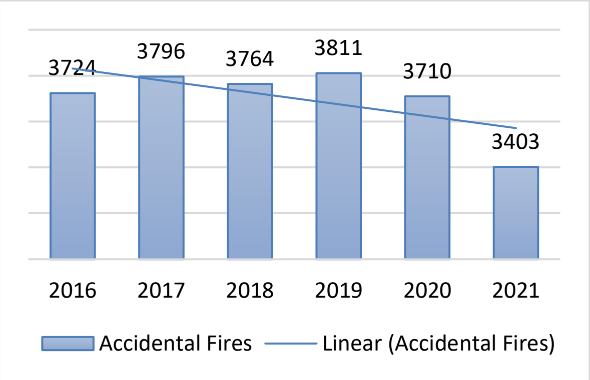


Figure 4. Deliberate structure fires

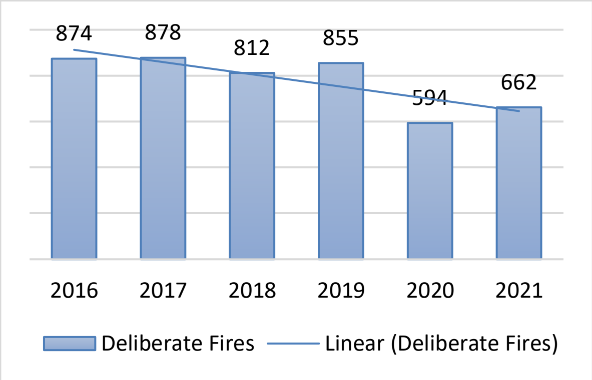


Figure 5. Accidental structure fire fatalities

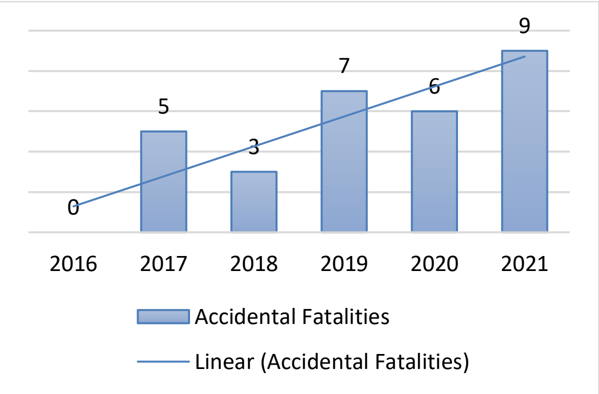
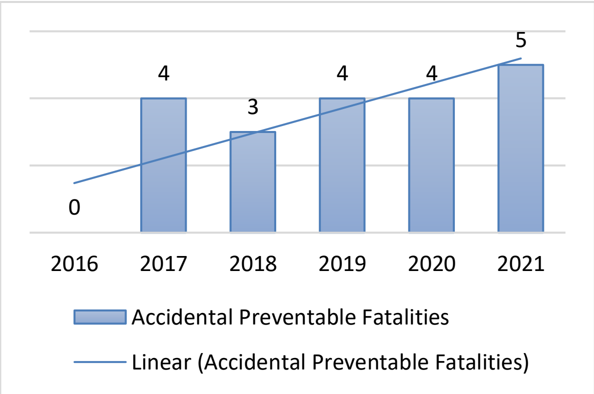


Figure 6. Accidental structure fire preventable fatalities



5.2 Population Controlled

Australian Bureau of Statistics Dataset 2 was used to identify the population of NSW for each calendar year to calculate population-controlled rates per 100,000 persons.

Table 1. Structure fires by population and adverse outcomes

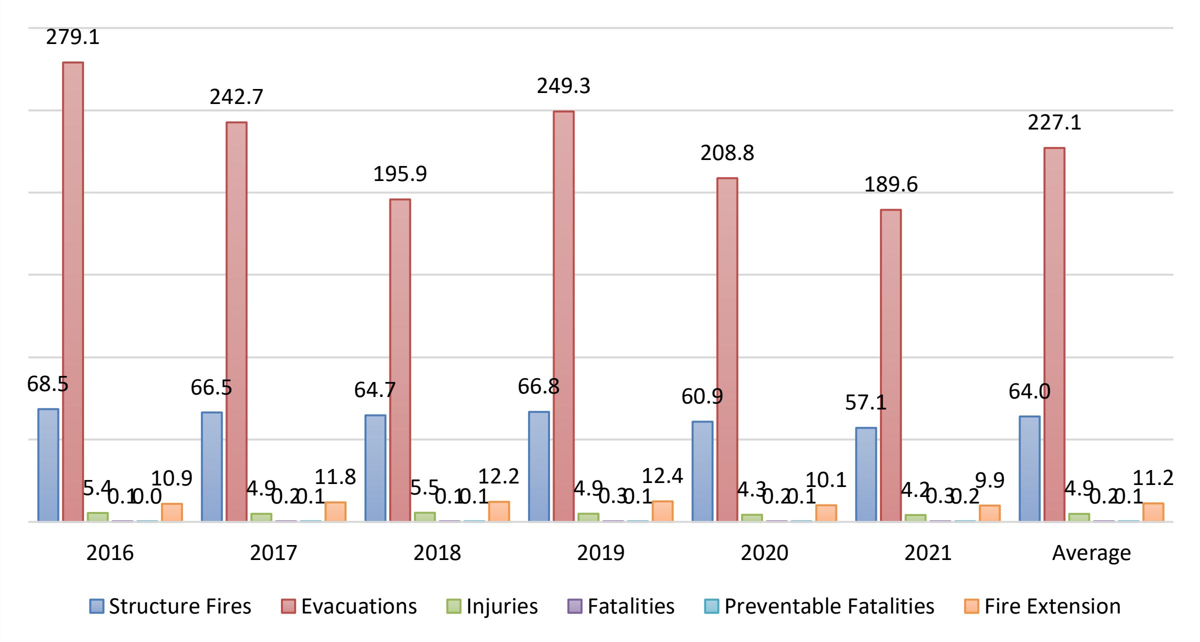
Year	Population of NSW	Structure Fires	Evacuations	Injuries	Fatalities	Preventable Fatalities	Fire Extension
2016	7,801,785	5344	21772	422	4	2	854
2017	7,919,815	5264	19220	387	13	10	938
2018	8,036,665	5202	15741	444	10	8	978
2019	8,137,322	5436	20286	402	24	11	1013
2020	8,168,067	4970	17055	351	15	8	824
2021	8,186,800	4675	15518	340	22	13	810
Average	8,041,742	5148.50	18265.33	391.00	14.67	8.67	902.83

Table 2. Adverse structure fire outcomes per 100,000 persons

Year	Structure Fires	Evacuations	Injuries	Fatalities	Preventable Fatalities	Fire Extension
2016	68.50	279.06	5.41	0.05	0.03	10.95
2017	66.47	242.68	4.89	0.16	0.13	11.84
2018	64.73	195.86	5.52	0.12	0.10	12.17
2019	66.80	249.30	4.94	0.29	0.14	12.45
2020	60.85	208.80	4.30	0.18	0.10	10.09
2021	57.10	189.55	4.15	0.27	0.16	9.89
Average	64.02	227.13	4.86	0.18	0.11	11.23

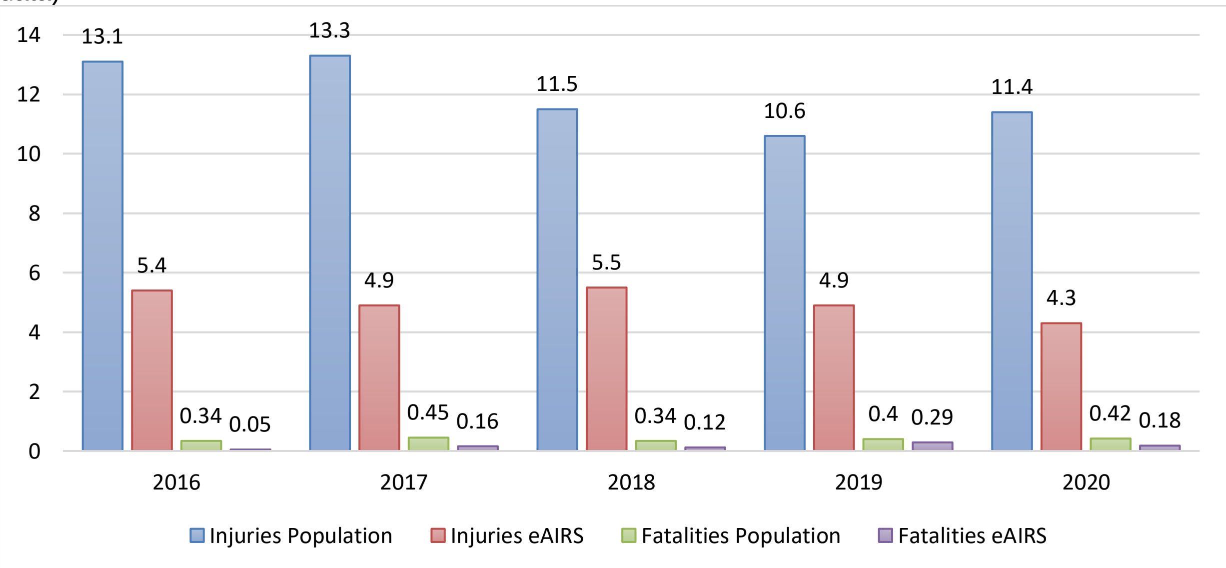
From 2016 to 2021, the average rate of preventable structure fire fatalities was 0.11 per 100,000 persons. This is lower than Coates et al. (2019), who found that the preventable residential fire fatality rate was 0.28 per 100,000 persons in NSW. However, it is important to note that Coates et al. (2019) conducted an analysis preventable residential fire fatalities as recorded in the National Coronial Information System database, while this study conducted an analysis of structure fire fatalities that occurred within FRNSW's jurisdiction, as recorded by eAIRS. FRNSW's records do not capture all fatalities that occur in NSW and may not capture all fatalities that occur after an incident report has been completed. Although eAIRS data is manually updated after the incident report has been completed if a fatality is identified during the fire investigation process, or is reported by NSW Police, NSW Health, or the media, eAIRS data is not updated to reflect coronial findings. The differences between Coates et al. (2019) and this study's findings are therefore likely the product of methodological differences.

Figure 7. Adverse outcomes per 100,000 persons



Australian Government Productivity Commission (2022) data was used to compare eAIRS outcomes by population outcomes. The results revealed higher rates per 100,000 persons for fire injuries and fatalities in the population compared to eAIRS data. However, eAIRS data relates to structure fire injuries and fatalities in FRNSW's jurisdiction only, while Productivity Commission data relates to all fire-related injuries and fatalities in NSW. Further, evidence suggests that many fires remain unreported (Barnett, 2008; Ghassempour et al., 2021; Jonsson, Bergqvist & Andersson, 2015), reducing the capacity of eAIRS to provide a valid and reliable measure of structure fires within the community. This is a limitation of this study.

Figure 8. Comparison of adverse outcomes per 100,00 persons (Productivity Commission vs. eAIRS data)



5.2.1.1 Population controlled rates by cause determination

Australian Bureau of Statistics Dataset 2 was also used to identify the population of NSW for each calendar year to calculate rates per 100,000 persons for accidental, deliberate, and undetermined fires.

Table 3. Adverse structure fire outcomes for accidental fires per 100,000 persons

Year	Structure Fires	Evacuations	Injuries	Fatalities	Preventable Fatalities	Fire Extension
2016	47.73	202.94	4.28	0.00	0.00	5.06
2017	47.93	209.41	3.86	0.06	0.05	5.14
2018	46.84	148.57	4.33	0.04	0.04	5.92
2019	46.83	195.46	3.94	0.09	0.05	5.14
2020	45.42	169.48	3.59	0.07	0.05	5.01
2021	41.57	145.94	3.57	0.11	0.06	4.63
Average	46.03	178.35	3.93	0.06	0.04	5.15

Table 4. Adverse structure fire outcomes for deliberate fires per 100,000 persons

Year	Structure Fires	Evacuations	Injuries	Fatalities	Preventable Fatalities	Fire Extension
2016	11.20	18.68	0.53	0.04	0.01	2.67
2017	11.09	16.39	0.54	0.03	0.00	3.55
2018	10.10	22.21	0.62	0.02	0.00	2.75
2019	10.51	30.71	0.41	0.05	0.00	3.21
2020	7.27	16.99	0.31	0.02	0.00	1.98
2021	8.09	16.71	0.32	0.04	0.00	2.22
Average	9.69	20.30	0.45	0.03	0.00	2.73

Table 5. Adverse structure fire outcomes for undetermined fires per 100,000 persons

Year	Structure Fires	Evacuations	Injuries	Fatalities	Preventable Fatalities	Fire Extension
2016	7.58	57.19	0.58	0.01	0.01	3.01
2017	6.30	15.87	0.44	0.08	0.08	3.02
2018	6.43	23.54	0.56	0.06	0.06	3.36
2019	8.09	22.51	0.59	0.16	0.09	3.83
2020	6.50	20.48	0.40	0.09	0.05	2.85
2021	6.58	26.66	0.27	0.12	0.10	2.97
Average	6.91	27.56	0.47	0.09	0.06	3.18

These results indicate that, while accidental fires caused the highest population-controlled rates of structure fires, evacuations, injuries, and fire extension, undetermined fires caused the highest population-controlled rates of fatalities and preventable fatalities. This provides further evidence that a focus on accidental fires alone reduces capacity to understand the factors that increase risk of fatality.

5.2.1.2 Population-controlled trends

Correlational analysis revealed five statistically significant trends in population-controlled rates over time. The rates of structure fires, accidental structure fires, and deliberate structure fires decreased significantly over time. Conversely, accidental structure fire fatalities and preventable fatalities increased significantly over time. These findings align with existing literature that shows that while the risk of a structure fire has reduced over time, the risk of dying in one has not (Thompson, Galea & Hulse, 2018). These results suggest that, after controlling for population growth, structure fires are becoming less frequent overall, but more fatal when they are accidental.

Figures 9-10. Structure fire and accidental structure fire per 100,000 persons over time

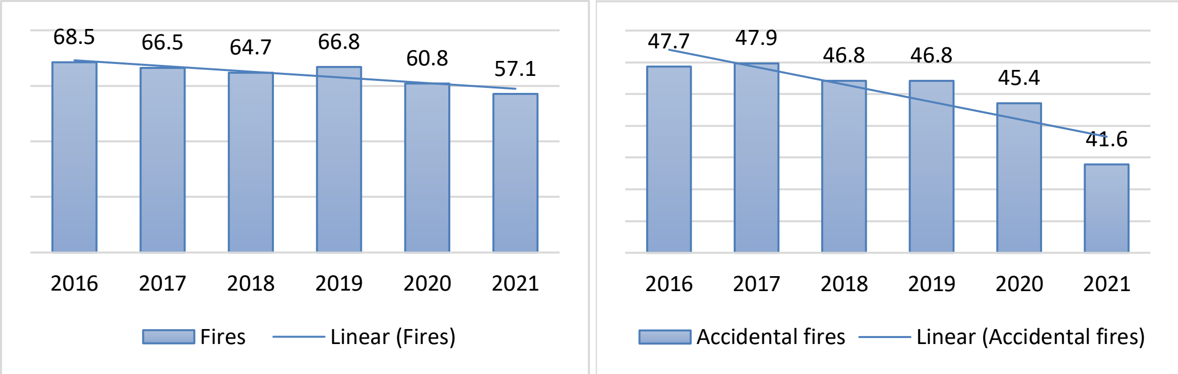
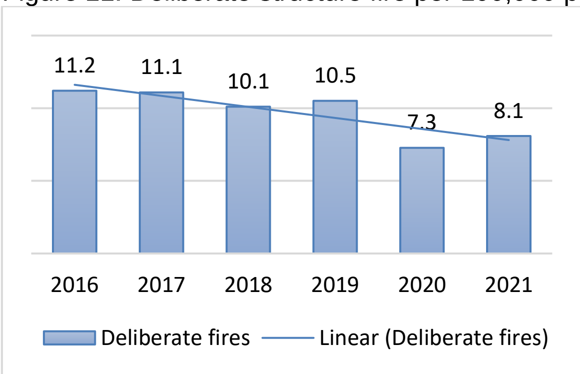
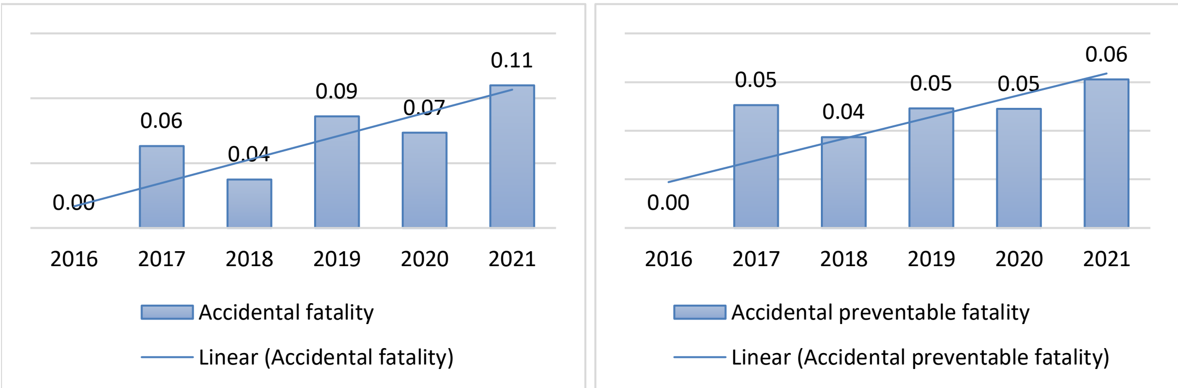


Figure 11. Deliberate structure fire per 100,000 persons over time



Figures 12-13. Accidental structure fire fatality and preventable fatality per 100,000 persons over time



5.3 Description Summary

Between 1 January 2016 and 31 December 2021, there were 30,891 structure fires in FRNSW's jurisdiction recorded in eAIRS. These fires led to a total of 109,592 persons evacuated, 2,346 injuries, 88 fatalities, and 52 preventable fatalities. Accidental fires caused the largest proportion of structure fires, evacuations, injuries, and fire extension, while undetermined fires caused the largest proportion of fatalities and preventable fatalities.

Over this period, the average population-controlled rates were 64.02 per 100,000 for structure fires, 227.13 per 100,000 for evacuation, 4.86 per 100,000 for injuries, 0.18 per 100,000 for fatalities, 0.11 per 100,000 for preventable fatalities, and 11.2 per 100,000 for fire extension. While accidental fires caused the highest rates of structure fires, evacuations, and injuries, undetermined fires caused the highest rates of fatalities and preventable fatalities.

Trend analysis found that population-controlled rates of structure fires, accidental structure fires, and deliberate structure fires decreased significantly over time. Conversely, accidental structure fire fatalities and preventable fatalities increased significantly over time. These results suggest that, after controlling for population growth, structure fires are becoming less frequent overall, but more fatal when they are accidental.

6 Risk Factors of Adverse Outcomes

6.1 Response Time

Where response time data was not normally distributed, it is not accurate to report on average (mean) response times. Instead, median (middle value) response times should be used. The median response time refers to the 50th percentile, where 50% occurred before this time.

Table 6. Structure fire response time percentiles (h:mm:ss)

Percentile	Alarm to Arrival	Alarm to Extinguished	Alarm to Completed	Arrival to Extinguished	Arrival to Completed	Extinguished to Completed
10th	0:04:22	0:15:00	0:18:29	0:07:28	0:10:57	0:03:01
20th	0:05:13	0:19:37	0:23:14	0:11:48	0:15:29	0:03:03
30th	0:05:54	0:24:17	0:28:11	0:16:34	0:20:27	0:03:05
40th	0:06:33	0:29:40	0:33:38	0:21:57	0:25:57	0:03:06
50th (median)	0:07:13	0:36:20	0:40:50	0:28:33	0:33:03	0:03:08
60th	0:07:56	0:45:26	0:50:33	0:37:34	0:42:45	0:03:09
70th	0:08:49	0:58:52	1:05:16	0:51:12	0:57:37	0:03:14
80th	0:09:57	1:18:43	1:28:22	1:11:11	1:20:45	0:03:36
90th	0:11:49	1:54:50	2:12:38	1:46:56	2:04:42	0:11:19

6.1.1 Alarm to arrival time

The median time between notification of the alarm and the arrival of firefighters on scene was 7 minutes and 13 seconds.

Time between alarm and arrival is the most valid measure of response time. Alarm, or notification of the incident, is the closest recorded time to the event. Response time therefore includes the closest recorded time of the event, call-taking time, notification and activation of firefighters, and travel time. Upon arrival, firefighters conduct evacuations and take actions to mitigate risk of fatality, injury, and fire extension. While alarm time is not a perfect measure of event time, it is the closest known event time. By analysing rates of survival between alarm and arrival, this analysis can provide insight into the risk rates of fatality, preventable fatality, injury, evacuation, and fire extension from the time the fire was identified and reported to the time of firefighter arrival.

6.1.1.1 Survival

Survival analysis was conducted to identify the rates of survival, or the absence of an adverse outcome, over time. As stated in section 4.5.2.1, survival analysis is useful when the outcome of interest being studied is censored. Censored data occurs when the time to an outcome cannot be fully observed. For example, when it is known that the time to attend a fire was three minutes but that this may not have been the time of the event (fatality). In this instance, we know that the response time was at least three minutes but not the exact time of the fatality (which may have occurred before the alarm was raised or at the exact time the appliance arrived). Survival analysis allows the information contained in the censored data to be considered fully in the analysis.

Survival analysis revealed that rates of survivability for fatality, injury, evacuation, and fire extension differed by response time.

Table 7. Alarm to arrival survivability rates by percentile

Percentile	Alarm to Arrival	No fatality	No injury	No evacuation	No fire extension
10th	0:04:22	99.92%	97.46%	99.07%	94.99%
20th	0:05:13	99.53%	96.85%	99.07%	94.91%
30th	0:05:54	99.30%	96.62%	99.07%	94.91%
40th	0:06:33	98.99%	96.62%	99.07%	94.91%
50th (median)	0:07:13	98.53%	96.48%	99.07%	94.91%
60th	0:07:56	97.84%	96.32%	99.07%	94.91%
70th	0:08:49	97.61%	95.95%	99.07%	94.91%
80th	0:09:57	96.77%	94.90%	99.07%	94.91%
90th	0:11:49	96.47%	92.27%	98.91%	94.76%

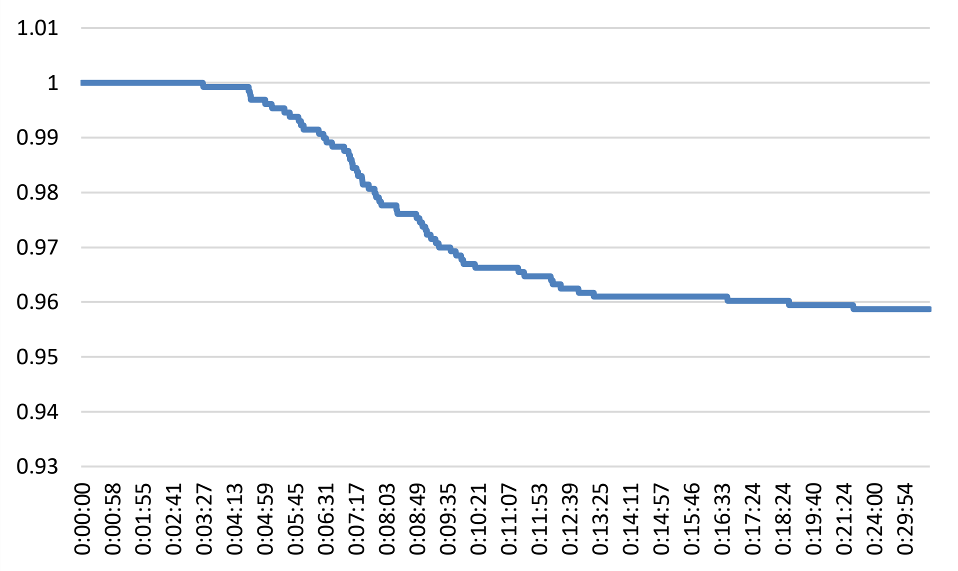
Fatality survival

Until 3 minutes and 26 seconds, the fatality survivability rate was 100.00%. Between 3 minutes and 27 seconds and 13 minutes and 21 seconds, the survivability rate decreased sharply from 100.00% to 96.10%. Thereafter, survivability decreased slowly from 96.10% to 95.87%. The fatality rate plateaued at 95.87% at 22 minutes and 15 seconds.

A significant decrease in fatality survivability after 3 minutes and 26 seconds aligns with evidence that atmospheric tenability (toxicity limit) is reached at around 3 minutes and 50 seconds, while temperature tenability (heat limit) is reached at approximately 3 minutes and 42 seconds when a fire occurs in a closed (non-ventilated) room (NSW Government (FRNSW), 2017). Survivability rates reflect tenability and may indicate that those fatalities that occur soon after 3 minutes and 27 seconds result when the fatality occurs in the room of origin of the fire. Fatalities that occur after 4-5 minutes may result from fires that occur in ventilated rooms or in a different room to the origin of the fire. Fatalities may also occur during attempts to suppress the fire or evacuate the structure (Coates et al. 2019; Lilley, McNoe & Duncanson, 2018; Runefors, Johansson & van Hees, 2016; Shokouhi et al., 2019).

These findings indicate that while the first 13 minutes are critical in preventing fatalities, intervention may still make a significant difference in fatality rates thereafter. These findings align with the literature that response time is most important for shorter response times and becomes less important as response times protract (Jaldell, 2015). Where there is a slight, albeit minor, decrease in survivability after 13 minutes, fatality rates did not plateau until 22 minutes and 15 seconds, suggesting that there remains opportunity to prevent fatalities until this time.

Figure 14. Fatality survival rate



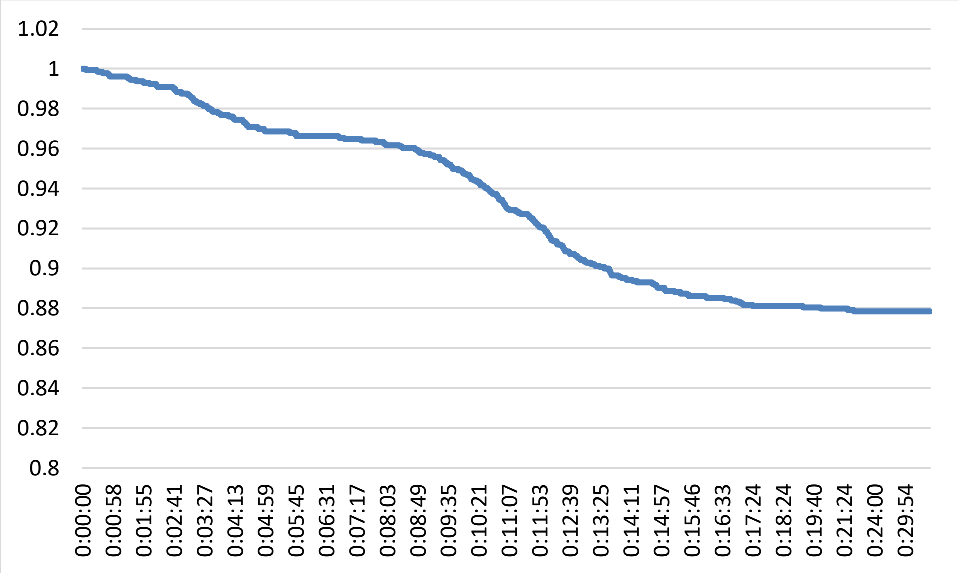
Injury survival

A 100.00% injury survival rate was only evident in the first 8 seconds. Thereafter, survival rates decreased significantly from 99.92% at 9 seconds to 96.62% at 5 minutes and 46 seconds. While survivability slowed, reaching 95.72% at 9 minutes and 7 seconds, the survival rate decreased sharply thereafter, reaching 88.19% at 17 minutes and 7 seconds. Survivability slowly declined to 87.84% by 22 minutes and 13 seconds, after which rates plateaued.

Non-fatal injuries may occur when occupants attempt to extinguish the fire or evacuate the structure. Existing literature suggests that people take information-seeking actions after being alerted to a fire but before evacuating (Kinateder et al., 2015), and that attempts to suppress a fire or escape from it are associated with fire injury (Shokouhi et al., 2019). Injury may also occur when occupants are trapped in a different room to the origin of the fire and are affected by heat and/or smoke.

These findings indicate that while the first 17 minutes are critical in preventing injuries, intervention may still make a significant difference in injury rates thereafter. Like fatalities, while there was a slow decline after 17 minutes, rates did not plateau until 22 minutes and 13 seconds, suggests that there remains opportunity to prevent injuries until this time.

Figure 15. Injury survival rate



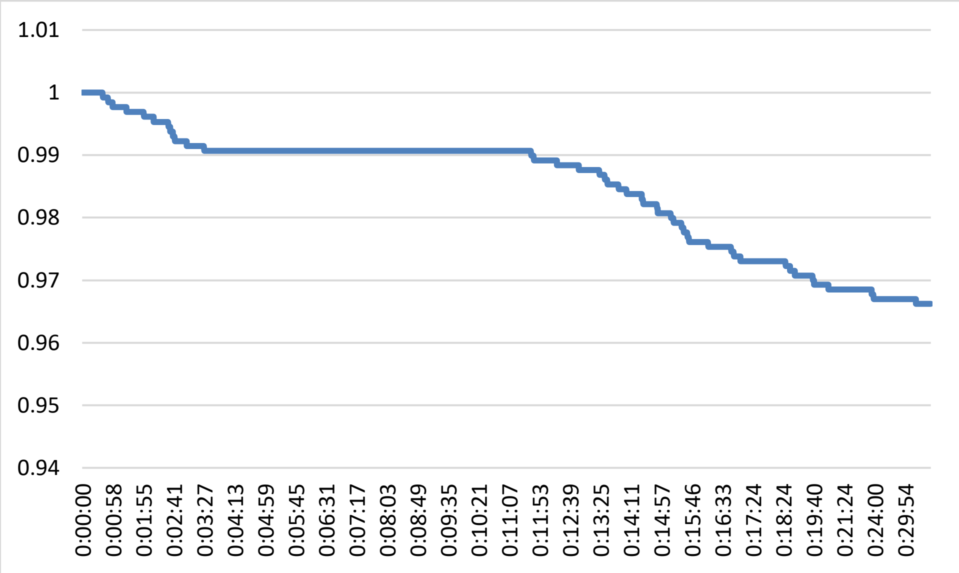
Evacuation survival

Evacuation survival refers to no firefighter-assisted evacuations (which may indicate self-evacuation or no evacuation). There were no firefighter-assisted evacuations until 38 seconds, after which the evacuation survivability rate decreased from 99.92% to 99.07%. After this time, the evacuation rate plateaued at 99.07% until 11 minutes and 41 seconds. Thereafter, the evacuation survivability rate decreased to 96.62% at 37 minutes and 37 seconds, after which it remained stable.

Firefighter-assisted evacuation occurs when firefighters arrive on scene, occupant/s remain inside the structure, and fire conditions allow for evacuation. Firefighter-assisted evacuation represents the last opportunity for evacuation and is critical to preventing fatalities where occupants remain inside a structure but are still alive upon firefighter arrival (Runefors, Jonsson & Bonander, 2021). When occupants take protective actions, such as moving away from the fire and closing doors to mitigate fire spread, the timeframe for evacuation is extended (Runefors, Jonsson & Bonander, 2021).

These results indicate that the first 3 minutes and 27 seconds are critical to firefighter-assisted evacuations. After this time, evacuations plateaued until 11 minutes and 41 seconds, after which the evacuation rate increased until 37 minutes and 37 seconds, after which it plateaued again.

Figure 16. Evacuation survival rate



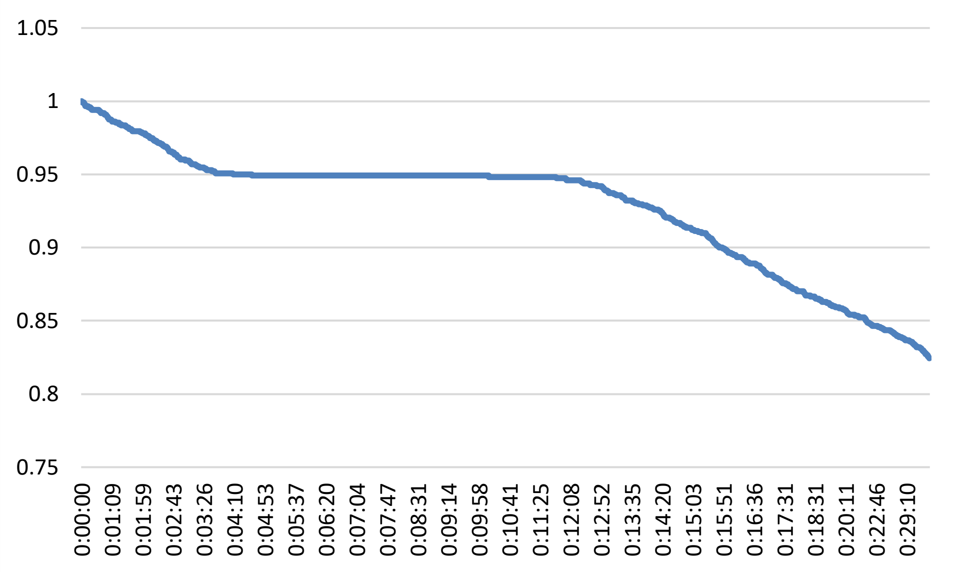
Fire Extension Survival

Fire extension survival refers to no fire extension beyond the room of origin (confinement). Fire extension was evident from 2 seconds. Fire extension survivability decreased sharply, from 99.01% at 53 seconds, to 98.03% at 1 minute and 45 seconds, 97.01% at 2 minutes and 28 seconds, 96.02% at 3 minutes, 95.08% at 4 minutes and 8 seconds, to 94.91% at 4 minutes and 35 seconds. Survivability remained stable from 4 minutes and 35 seconds until 10 minutes and 12 seconds, after which it declined sharply again to 90.00% by 15 minutes and 49 seconds, and 82.44% by the final response time.

Fire extension beyond the room of origin is facilitated by several factors. It may occur when the fire originates in a ventilated room, where there are high fuel loads, when accelerant is used, when the structure is vulnerable to fire (poorly constructed and/or maintained), and/or when the fire remained undetected or unreported, leading to fire development prior to firefighter arrival.

These findings indicate that the first 4 minutes and 35 seconds are critical to reducing fire extension. After this time, fire extension plateaus, but only until 10 minutes and 12 seconds, after which the rate of survivability decreases again. Despite a plateau in fire extension between 4 and 10 minutes, survivability decreases thereafter, suggesting there remains opportunity to prevent fire extension before 4 minutes and any time after 10 minutes.

Figure 17. Fire extension survival rate



Survivability Summary
In the first 3-5 minutes of response time, the fatality rate was low, while evacuation rates slowly increased, and injury and fire extension rates rapidly increased. This may indicate that fire extension caused people to become injured as they self-evacuated or injured while trapped, requiring some firefighter-assisted evacuation, which prevented some fatality.

Between 3-5 and 10-11 minutes, fatality rates increased while injury rates slowed, and evacuation and fire extension rates plateaued. When fire extension did not occur, self-evacuation may have been more likely, reducing risk of injury and firefighter-assisted evacuation. However, where fatality and injury rates continued to increase, some evacuations may have transitioned to injuries and/or fatalities in situ, and/or higher rates of self-evacuation may have increased associated injuries and fatal consequences during this time.

After 10-11 minutes, evacuation and fire extension rates increased. After 13 minutes, fatality rates slowed. After 17 minutes, injury rates slowed. Fatality and injury rates continued to slowly increase until 22 minutes, after which they plateaued. Evacuation rates increased until 37 minutes, after which they plateaued. Fire extension rates never plateaued. These findings indicate that there remains opportunity to prevent fatalities and injuries until 22 minutes, to conduct firefighter-assisted evacuations until 37 minutes, and to prevent fire extension along the continuum of response time.

Where fatality and injury rates plateaued at 22 minutes, but the evacuation rate rose until 37 minutes, it appears that people remaining in a structure after 22 minutes were not at risk of fatality or injury, but still required firefighter-assisted evacuation. These findings suggest that those who remain in a structure after 22 minutes but still require firefighter-assisted evacuation have distinct risk profiles, differentiating them from those at risk of fatality and injury within the first 22 minutes.

After 37 minutes, fire extension rates increased without increasing risk of fatality, injury, or evacuation. This suggests that, after 37 minutes, firefighter-assisted evacuation is not required because fatalities in situ or fatalities or injuries sustained during self-evacuation have already occurred.

Where transitioning from evacuation to injury and fatality occurred, it is likely that these groups existed along a continuum with shared risk factors. When transitioning did not occur, the groups may be distinct with unique risk profiles. Further research must be conducted to understand the differences between fatalities, injuries, and evacuations that occur along a continuum and those that have distinct risk profiles.

6.1.1.1 Percentiles

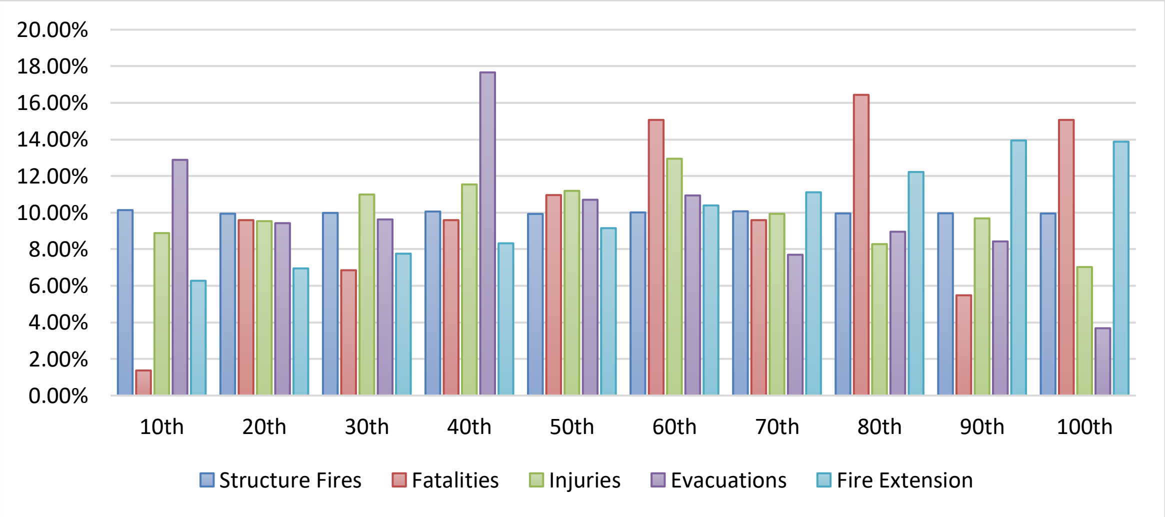
Percentile analysis was conducted to identify the proportion of adverse outcomes by response time percentile.

Table 8. Alarm to arrival adverse outcomes change from previous percentile

Percentile	Alarm to Arrival	Fatalities	Injuries	Evacuations	Fire Extension
10th	0:04:22	1.37%	8.88%	12.88%	6.27%
20th	0:05:13	700.00%	107.34%	-73.14%	110.76%
30th	0:05:54	-71.43%	115.26%	102.16%	111.60%
40th	0:06:33	140.00%	105.02%	183.51%	107.30%
50th (median)	0:07:13	114.29%	-96.96%	-60.59%	109.95%
60th	0:07:56	137.50%	115.70%	102.20%	113.57%
70th	0:08:49	-63.64%	-76.74%	-70.36%	106.92%
80th	0:09:57	171.43%	-83.33%	116.35%	110.00%
90th	0:11:49	-33.33%	116.97%	-94.07%	114.08%

Percentile analysis revealed that when alarm to arrival times were less than 4 minutes and 22 seconds (10th percentile), there were few fatalities (1.4%), injuries (8.9%), evacuations (12.9%), and fire extension (6.3%). When response time increased by just 50 seconds, to 5 minutes and 13 seconds (20th percentile), there was a 700.0% increase in fatalities, 107.3% increase in injuries, 110.8% increase in fire extension, yet an 73.1% decrease in evacuations. These findings indicate that Prevention + Education approaches that enhance safety in the first 4-5 minutes of response time are critical to preventing a substantial increased risk of fatality. The difference between a response time of 4 minutes and 22 seconds (10th percentile) and the median response time of 7 minutes and 13 seconds (50th percentile) was an accumulated 2700.00% increase in fatalities, 487.01% increase in injuries, 512.85% increase in fire extension, and 368.05% increase in evacuations.

Figure 18. Alarm to arrival percentiles by adverse outcome



6.1.1.1 Alarm to arrival time summary

The median time between notification of the alarm and the arrival of firefighters on scene was 7 minutes and 13 seconds.

Survivability rates suggest that, in the first 3-5 minutes of response time, the fatality rate was low, while evacuation rates slowly increased, and injury and fire extension rates rapidly increased. Between 3-5 and 10-11 minutes, fatality rates increased while injury rates slowed, and evacuation and fire extension rates plateaued. After 10-11 minutes, evacuation and fire extension rates increased. After 13 minutes, fatality rates slowed. After 17 minutes, injury rates slowed. Fatality and injury rates continued to slowly increase until 22 minutes, after which they both plateaued. Evacuation rates increased until 37 minutes, after which they plateaued. Fire extension rates increased for the remainder of response time.

Percentile analysis identified significant increases in risk between each percentile. The difference between a response time of 4 minutes and 22 seconds and the median response time of 7 minutes and 13 seconds was an accumulated 2700.0% increase in fatalities, 487.01% increase in injuries, 512.85% increase in fire extension, and 368.05% increase in evacuations. These findings highlight the importance of reducing response time to mitigate risk. Reducing response time from 7 minutes and 13 seconds to 4 minutes and 22 seconds, would lead to a 2700.00% decrease in fatalities, 487.01% decrease in injuries, 512.85% decrease in fire extension, and 368.05% decrease in evacuations.

Where transitioning from evacuation to injury and fatality occurred, it is likely that these groups existed along a continuum with shared risk factors. When risk factors are shared, there may be opportunity to intervene at the beginning of the continuum. When transitioning did not occur, the groups may be distinct with unique risk profiles. Further research must be conducted to understand the differences between fatalities, injuries, and evacuations that occur along a continuum and those that have distinct risk profiles. As mandated by the Fire Fatality Analysis Committee, analysis of coronial data may identify opportunities to intervene when there is a continuum from evacuation to injury and fatality.

Further research is also necessary to identify the factors that influence response time. For example, KC and Corcoran (2017) found that season, time of week, and commute time influenced response time. Response times may also increase where it takes longer to geolocate incidents when calls are made from cellular phones rather than standard landlines (Challands, 2020). The availability of resources and the relative location of those resources also impacts response time (Claridge & Spearpoint, 2013; KC & Corcoran, 2017; Shokouhi et al., 2019). Claridge and Spearpoint (2013) highlighted that response time can be delayed by firefighter activities at the time of the alarm, such as community safety work, drills, fitness training, or having to travel to the station to respond, as occurs at volunteer and on-call stations. Further, KC and Corcoran (2017) found that fire station location results in longer response times when the first arriving fire appliance is not from the geographical most proximate fire station.

Where factors such as weather, traffic, and commute time impact upon response time and cannot be mitigated, Prevention + Education must empower communities to take protective action. Where fatalities and injuries increased significantly after 4 minutes and 22 seconds, programs and resources must educate the community about what to do in the first 4-5 minutes of a fire. Onus should be placed on enhancing accurate perception of risk and taking appropriate actions, such as self-evacuation.

Where factors such as the speed of geolocating and accurately prioritising incidents may be improved through technological advancements and systematic information gathering and classification, further research is needed to identify opportunities for reducing call-taking time, firefighter notification and activation, and travel time.

6.1.2 Response time summary

Response time risk may be best understood from two perspectives: where evacuations, injuries, and fatalities exist along a continuum with shared risk factors and where adverse outcomes have distinct risk profiles that require a targeted approach.

Where the first 13 minutes were critical in preventing fatalities and the first 17 minutes in preventing injuries, intervention may make a significant difference during this time. Thereafter, rates slowed but did not plateau until 22 minutes, suggesting there remains opportunity to prevent fatalities and injuries until this time.

Where the rates of fire extension and injury, and to a lesser extent evacuation, increased before 3-5 minutes, but no fatalities occurred during this time, fire extension may have caused people to become injured as they self-evacuated or injured while trapped, requiring some firefighter-assisted evacuation, which prevented fatality.

A plateau in fire extension and firefighter-assisted evacuations between 3-5 and 10-11 minutes coincided with an increased risk of fatality and a lower, yet still increasing, risk of injury, suggesting that while the fire did not extend beyond the room of origin, evacuations transitioned to injuries and/or fatalities in situ, and/or there were higher rates of self-evacuation and associated injuries and fatal consequences during this time.

Where fatality and injury rates plateaued at 22 minutes, but the evacuation rate rose until 37 minutes, it appears that people remaining in a structure after 22 minutes were not at immediate risk of fatality or injury, but still required firefighter-assisted evacuation to ensure they were safely removed from the structure. This may have occurred where people were trapped in a structure by fire, but not in the fire-affected area. After 37 minutes, fire extension rates increased without increasing risk of fatality, injury, or evacuation. This suggests that, after 37 minutes, firefighter-assisted evacuation is not required because fatalities in situ or fatalities or injuries sustained during self-evacuation have already occurred.

Recommendation: Further research must be conducted to understand the differences between fatalities, injuries, and evacuations that occur along a continuum and those that have distinct risk profiles.

Recommendation: As mandated by the Fire Fatality Analysis Committee, research should involve an analysis of coronial data to identify opportunities to intervene when there is a continuum from evacuation to injury and fatality.

Recommendation: Further research should be conducted to investigate the causes of the risk rate plateaus observed in evacuation and fire extension survival.

Recommendation: Future research should code response time using the most valid measure which includes alarm time as the closest recorded time to the event, call-taking time, notification and activation of firefighters, and travel time (Call time to Code 3).

Recommendation: Where there are critical windows of opportunity to reduce adverse outcomes, further research is needed to identify the factors that influence response times to ensure that they are as short as possible.

Recommendation: Prevention + Education efforts should prioritise the reduction of response time by improving the efficiency of every factor known to influence response time.

Recommendation: Where fatalities and injuries increased significantly after 4 minutes and 22 seconds, programs and resources must educate the community about what to do in the first 4-5 minutes of a fire. Onus should be placed on enhancing accurate perception of risk and taking appropriate actions, such as self-evacuation.

Recommendation: Where fatalities, injuries, firefighter-assisted evacuations, and fire extension all increased significantly between alarm time and the median response time, Communications Operators should provide callers with safety messaging based on the conditions reported to them. Evidence-based and responsive messaging about safe self-evacuation, remaining in a safe place, and the provision of first aid are critical during the time between alarm and firefighter arrival.

Recommendation: Where fatality and injury rates slowed after 13 and 17 minutes respectively, they did not plateau until 22 minutes. It is therefore necessary to identify opportunities to prevent fatalities and injuries until 22 minutes.

Recommendation: Where fire extension rates were higher, yet self-evacuation rates were lower, in the first 3-5 minutes, and after 10-11 minutes, Prevention + Education programs, resources, and messaging should focus on enhancing accurate perception of risk and taking appropriate actions. While this may involve self-evacuation where possible, messaging should also inform people what to do if they are trapped in a structure that is on fire.

Recommendation: Where fire extension rates rapidly increased after 10-11 minutes, advocacy for the installation of fire suppression systems, such as sprinklers, should be prioritised in structures located outside of a 10–11-minute response time.

6.2 Outcome Characteristics

The presence of some adverse outcomes predicted others.

When structure fires caused:

- Fatality, the odds of injury increased 2.8 times and the odds of fire extension increased 3.3 times
- Injury, the odds of fatality increased 2.9 times and the odds of evacuation increased 1.7 times
- Evacuation, the odds of injury increased 1.7 times
- Fire extension beyond the room of origin, the odds of fatality increased 4.3 times and the odds of evacuation increased 1.7 times

When accidental fires caused:

- Fatality, the odds of fire extension increased 8.6 times
- Injury, the odds of evacuation increased 1.4 times and the odds of fire extension increased 1.6 times
- Evacuation, the odds of injury increased 1.4 times and the odds of fire extension increased 1.9 times
- Fire extension, the odds of fatality increased 17.3 times, the odds of injury increased 1.5 times, and the odds of evacuation increased 1.9 times

When deliberate fires caused:

- Injury, the odds of evacuation increased 3.6 times
- Evacuation, the odds of injury increased 4.0 times and the odds of fire extension increased 1.7 times
- Fire extension, the odds of evacuation increased 1.6 times

When undetermined fires caused:

- Fatality, the odds of injury increased 6.1 times
- Injury, the odds of fatality increased 4.9 times and the odds of evacuation increased 2.5 times
- Evacuation, the odds of injury increased were 2.4 times and the odds of fire extension increased 2.2 times
- Fire extension, the odds of fatality increased were 3.4 times, the odds of preventable fatality increased 17.3 times, the odds of injury increased 15.2 times, and the odds of evacuation increased 2.1 times

6.2.1 Outcome summary

These findings indicate that adverse structure fire outcomes are risk factors for other outcomes. The relationships between fatality, injury, evacuation, and fire extension suggest that targeted Prevention + Education efforts to reduce one adverse outcome may have a continuing or multiplying effect on other outcomes that share the same risk factors. Findings suggest that Prevention + Education approaches that target fatality and injury may have the greatest impact on other adverse outcomes that share the same risk factors.

Recommendation: Where adverse outcomes increase the risk of other adverse outcomes, they may be interrelated and shared risk factors. As a result, Prevention + Education programs and resources should be directed towards those factors that increase the risk of multiple adverse outcomes.

Recommendation: Prevention + Education approaches that target fatality and injury may have the greatest impact on other adverse outcomes where risk factors are shared.

6.3 Temporal Characteristics

6.3.1 Time of day

Time of day predicted fatality, evacuation, and fire extension. It also predicted evacuation in accidental fires and fire extension in accidental, deliberate, and undetermined fires.

When structure fires occurred at night (2000 - 0759 hrs), the odds of fatality increased 1.8 times compared to fires that occurred during the day.

When fires occurred during the day (0800 – 1959 hrs), the odds of firefighter-assisted evacuation decreased 0.89 times compared to fires that occurred at night. This was also reflected in accidental fires (0.87).

When fires occurred during the day, the odds of fire extension decreased 0.65 times compared to fires that occurred during the night. In contrast, when structure fires occurred at night, the odds of fire extension increased 1.4 times when the fire was accidental, 2.0 times when the fire was deliberate, and 1.6 times when the fire was undetermined compared to fires that occurred during the day.

These findings indicate that fires that occur at night may take longer to be identified and reported than fires that occur during the day, increasing the relative risk of fatality. Fires that occur during the day may be identified and reported sooner, reducing the risk of fire extension and the need for firefighter-assisted evacuation. Existing literature confirms an increased risk of fatality in structure fires that occur at night (Barnett, 2008; Coates et al., 2019; Jonsson et al., 2017; Lilley, McNoe & Duncanson, 2018; Shokouhi et al., 2019; Warda, Tenenbein & Moffatt, 1999), but few comment on evacuation or fire extension (Barnett, 2008). Barnett (2008) found that fires that occur during the day are generally confined to the object or room of origin because people are awake and active, and more likely to deal with the fire sooner. Where fires are smaller during the day due to timely identification, suppression, and/or reporting, the risk of fire extension and firefighter-assisted evacuation is lower.

6.3.2 Time of week

Time of week predicted evacuation. It also predicted evacuation and fire extension in accidental fires.

When structure fires occurred on a weekday, the odds of firefighter-assisted evacuation increased 1.1 times compared to fires that occurred on a weekend. When accidental fires occurred on a weekend, the odds of firefighter-assisted evacuation decreased 0.92 times compared to a weekday.

When accidental fires occurred on a weekday, the odds of fire extension decreased 0.89 times compared to a weekend.

These findings suggest that structure fires that occur on a weekday are at higher risk of firefighter-assisted evacuation but lower risk of fire extension when the fire was accidental. There were no differences in type of structure by time of week. This indicates that accidental fires that occur on a weekday may be identified, suppressed, and/or reported sooner, leading to a lower risk of fire extension. Where fires are identified sooner and may be smaller when reported, occupants may be more likely to attempt to extinguish the fire and/or remain in the structure until firefighter arrival, requiring firefighter-assisted evacuation. Existing literature suggests that people may remain in a structure after reporting a fire to extinguish the fire, save other occupants or pets, or due to a lack of comprehension of the exponential growth of fire and available time to escape (Runefors, Johansson & van Hees, 2016). While existing literature explores time of week and fire fatality (Lilley, McNoe & Duncanson, 2018; Jonsson et al., 2017), there is a paucity of research on time of week and evacuation and fire extension. Further investigation is necessary.

6.3.3 Season

Season predicted fatality and evacuation. It also predicted fatality in accidental fires and fire extension in deliberate fires.

When structure fires occurred in Winter, the odds of fatality increased 1.8 times compared to all other seasons. When the fire was accidental and occurred in Winter, the odds of fatality increased 3.8 times compared to all other seasons.

When structure fires occurred in Summer, the odds of evacuation decreased 0.93 times compared to all other seasons.

When deliberate fires occurred in Autumn, the odds of fire extension decreased 0.82 times compared to all other seasons.

These findings suggest that the odds of fatality are higher when a structure fire occurs in Winter, particularly when the fire is accidental, while the odds of firefighter-assisted evacuation are lower in Summer, and the odds of fire extension are lower in Autumn. There were no differences in materials ignited first and ignition source by season. This suggests that there are circumstances unique to Winter that increased the odds of fatality, to Summer that decreased the odds of firefighter-assisted evacuation, and to Autumn that decreased the odds of fire extension. Existing literature has identified an increased risk of fatality in structure fires in Winter (Barnett, 2008; Coates et al., 2019; Lilley, McNoe & Duncanson, 2018; Shokouhi et al., 2019), although few studies have reported on seasonal predictors of evacuation and fire extension. Runefors, Jonsson, and Bonander (2021) found that the odds of self-evacuation were higher in Winter, but that season did not predict firefighter-assisted evacuation. Further research is necessary.

6.3.4 Temporal characteristics summary

The above indicates that structure fires that occurred at night increased the odds of fatality, while fires that occurred during the day reduced the risk of fire extension and the need for firefighter-assisted evacuation. Fires that occurred at night may have taken longer to be identified and reported, increasing risk of fatality, while fires that occurred during the day may have been identified, extinguished, and/or reported sooner, reducing risk of fire extension and the need for firefighter-assisted evacuation. Fires that occurred on a weekday increased the odds of firefighter-assisted evacuation but decreased the odds of fire extension in accidental fires. This indicates that fires that occur on a weekday may be identified, extinguished, and/or reported sooner, leading to decreased odds of fire extension. Where fires are identified sooner and may be smaller when reported, occupants may be more likely to attempt to extinguish the fire and/or remain in the structure until firefighter arrival, requiring firefighter-assisted evacuation. Finally, structure fires that occurred in Winter increased the odds of fatality, while fires that occurred in Summer decreased the odds of evacuation, and fires that occurred in Autumn decreased the odds of fire extension. This suggests that there are seasonal factors that influence relative risk of adverse outcomes.

Recommendation: Prevention + Education programs and resources should target human behaviour that increases the risk of adverse outcomes at night and during Winter.

Recommendation: Conduct further research into the intersection of human behaviour, time, and risk to identify risk factors of adverse outcomes related to night-time and Winter and protective factors of adverse outcomes related to daytime and Summer and Autumn.

Recommendation: Review response protocols for structure fires that occur at night and in Winter to ensure that resource allocation is proportionate to risk.

6.4 Location Characteristics

6.4.1 FRNSW Region

FRNSW Region was a predictor of evacuation and fire extension. It also predicted preventable fatality in undetermined fires, evacuation in accidental and deliberate fires, and fire extension in accidental, deliberate, and undetermined fires.

The odds of preventable fatality (compared to non-preventable fatality) in an undetermined fire decreased 0.12 times when the fire occurred in Metropolitan North compared to all other regions.

The odds of evacuation increased 1.2 times when the fire occurred in Metropolitan East, 1.1 times in Metropolitan West, and 1.4 times in Regional West. These findings are reflected in accidental fires. In addition, the odds of evacuation in accidental fires increased 1.2 times in Regional North, and in deliberate fires increased 1.5 times in Metropolitan East.

The odds of fire extension increased 1.2 times in Metropolitan West yet decreased 0.79 times in Regional North. When the fire was accidental, odds increased 1.2 times in Metropolitan West and Regional South respectively. When the fire was deliberate, odds of fire extension decreased 0.59 times in Metropolitan East and 0.70 times in Metropolitan South. When the fire was undetermined, odds increased 1.7 times in Metropolitan West, 1.8 times in Regional South, and 1.9 times in Regional West.

These results suggest that odds of evacuation and fire extension increased in some Metropolitan and Regional regions, particularly Metropolitan West. Preventable fatalities in undetermined fires decreased in Metropolitan North. These findings indicate that there may be factors unique to certain Metropolitan and Regional regions that influence odds of evacuation, and fire extension, and preventable fatality in undetermined fires.

6.4.2 Remoteness

Remoteness was a predictor of injury, evacuation, and fire extension. It also predicted injury, evacuation, and fire extension in accidental and undetermined fires.

When structure fires occurred in an outer regional (0.53) or remote area (0.30), the odds of injury decreased. When the fire was accidental, the odds of injury decreased in outer regional areas (0.58). Conversely, when the cause of the fire was undetermined, the odds of injury increased in inner regional (3.0) and major city (6.1) areas.

When structure fires occurred in an outer regional (0.53), remote (0.33), or very remote (0.89) area, the odds of evacuation decreased. When the fire was accidental, the odds of evacuation decreased in outer regional (0.49) and remote (0.28) areas. When the fire was undetermined, the odds of evacuation increased in inner regional (2.1) and major city (3.8) areas.

When structure fires occurred in an outer regional (1.4) or very remote area (3.5), the odds of fire extension increased. When a structure fire occurred in a major city, the odds of fire extension decreased (0.80). When the fire was accidental, odds of fire extension increased in outer regional (1.4) and very remote (4.2) areas. When the fire was deliberate, odds increased in outer regional (1.5), remote (2.7), and very remote (3.6) areas. When the fire was undetermined, odds decreased in remote areas (0.43) yet increased in very remote areas (6.4).

These findings suggest that there were lower odds of injury and evacuation, but higher odds of fire extension in outer regional and remote and/or very remote areas compared to inner regional areas and major cities. The results suggest that people in outer regional and remote and/or very remote areas may self-evacuate structure fires early, avoiding injury and the need for firefighter-assisted evacuation. However, longer response times in these areas may mean that the relative risk of fire extension is greater in outer regional and very remote areas.

It is important to note that this analysis only included fires that occurred within FRNSW's jurisdiction. As an urban fire service, most fires within this jurisdiction occurred in major cities, and inner and outer regional areas. As a result, these findings likely underrepresent the risk to remote and very remote areas.

Nevertheless, these results indicate that there are factors unique to remoteness that influence odds of injury, evacuation, and fire extension. Where other studies have found higher rates of fatalities in remote areas (Coates et al., 2019; Jonsson et al., 2017), this study did not identify remoteness as a predictor of fatality. Studies that link NSW Rural Fire Service data with FRNSW eAIRS data will be better placed to explore the relative risk of remoteness on structure fire outcomes in NSW.

6.4.3 Location characteristics summary

Collectively, these findings indicate that the odds of preventable fatality in undetermined fires decreased in Metropolitan North, while the odds of evacuation and fire extension increased in some Metropolitan and Regional regions, particularly Metropolitan West. By remoteness, the odds of injury and evacuation decreased in outer regional, remote and/or very remote areas compared to inner regional areas and major cities. In contrast, the odds of fire extension increased in outer regional and very remote areas. These results suggest that people in outer regional, remote, and/or very remote areas may self-evacuate structure fires early, avoiding injury and the need for firefighter-assisted evacuation. Longer response times in these areas may mean that the relative risk of fire extension is greater in outer regional and very remote areas.

Recommendation: Prevention + Education should implement injury prevention and self-evacuation programs and resources in inner regional areas and major cities, and targeted programs and resources that reduce the risk of fire extension in outer regional, remote, and very remote areas.

Recommendation: Prevention + Education should target communities in Metropolitan West with education about what to do in the event of a fire to safely evacuate and mitigate fire spread.

Recommendation: Conduct further research into the relationship between remoteness and adverse structure fire outcomes to better understand the place-based factors influencing risk.

Recommendation: Link FRNSW eAIRS data with the NSW Rural Fire Service incident data to explore the relative risk of remoteness on structure fires in NSW.

6.5 Individual Characteristics

6.5.1 SEIFA Decile

SEIFA decile was a significant predictor of injury, evacuation, and fire extension. It also predicted injury in accidental and undetermined fires; evacuation in accidental, deliberate, and undetermined fires; and fire extension in accidental and undetermined fires.

SEIFA decile was not a predictor of fatality. This contrasts with existing literature that identifies relative disadvantage as a risk factor of fire fatality (Coates et al., 2019; Duncanson, Woodward & Reid, 2000; Jonsson & Jaldell, 2019; Jonsson et al., 2017; Lilley, McNoe & Duncanson, 2018; Mulvaney et al., 2008; Warda, Tenenbein & Moffatt, 1999; Xiong, Bruck & Ball, 2015).

The odds of injury increased 1.3 times in SEIFA Decile 1. This is reflected in accidental fires. In undetermined fires, odds increased 1.9 times in SEIFA Decile 3. This means that the odds of injury were higher in the most socioeconomically disadvantaged areas. This is reflected in accidental and undetermined fires. Existing literature supports the finding that socioeconomically disadvantaged people are at a higher risk of fire injury (Mulvaney et al., 2008; Purcell et al., 2021; Shokouhi et al., 2019). Further, evidence suggests that as disadvantage increases, severity of burns increase (Purcell et al., 2021), meaning further analysis is needed.

The odds of evacuation decreased 0.88 times in SEIFA Decile 3. In accidental fires, odds of evacuation decreased 0.90 times in SEIFA Decile 6, in deliberate fires, odds decreased 0.53 times in SEIFA Decile 3, and in undetermined fires, odds decreased 0.55 times in SEIFA Decile 4. These findings indicate that the relative risk of firefighter-assisted evacuation decreased in moderately disadvantaged areas.

The odds of fire extension increased 1.1 times in SEIFA Decile 1 yet decreased 0.83 times in SEIFA Decile 8. When the fire was accidental, odds of fire extension increased 1.2 times in SEIFA Decile 7 yet decreased 0.75 times in SEIFA Decile 8. When the fire was undetermined, odds increased 1.6 times in SEIFA Decile 1. These findings indicate that the relative risk of fire extension increased in socioeconomically disadvantaged areas yet decreased in the second most advantaged area.

An increased relative risk of injury and fire extension, yet a decreased relative risk of firefighter-assisted evacuation in socioeconomically disadvantaged areas suggests that disadvantaged people may be more likely to self-evacuate a structure that is on fire, reducing the risk of firefighter-assisted evacuation. Where the fires may be more advanced prior to identification and reporting, and/or where occupants do not perform safe self-evacuation actions, such as remaining low under smoke and closing doors behind them, the risk of injury and fire extension may be higher. These findings contrast with studies that found self-evacuation is less likely in lower income households and more likely in higher income households (Lee et al., 2018). Where evacuation is a protective factor against fatality and injury, and drills are an effective means through which to increase likelihood of self-evacuation (Kuligowski, 2009; Lee et al., 2018), Prevention + Education programs and resources should focus on safe self-evacuation planning and practice in all communities.

6.5.2 Mosaic Type

Mosaic Type was a significant predictor of fatality, preventable fatality, injury, evacuation, and fire extension. It also predicted fatality, evacuation, and fire extension in accidental, deliberate, and undetermined fires, and injury in deliberate and undetermined fires.

6.5.2.1 Fatality

The odds of a structure fire resulting in a fatality were higher in a diverse array of Mosaic Types characterised by young, middle-aged, and older people, with or without children, retired or on average incomes, living in metro, inner-urban, or outer-suburban areas. Relative risk of fatality in an accidental fire was higher for singles or single parents on average or low incomes, sometimes living in social housing, in outer-suburban or regional areas. When the fire was deliberate, relative risk was higher in young, middle-aged, and older people, with or without children, some with multicultural backgrounds or living in social housing, with high to low incomes, living in metro, inner-urban, outer-suburban, regional, or rural areas. In undetermined fires, relative risk was higher in young, middle-aged, and older people, with or without children, some with multicultural backgrounds, with high to below average incomes, living in metro, inner-urban, outer-suburban, or coastal areas.

Figure 9. Mosaic types at highest risk of fatality (odds)

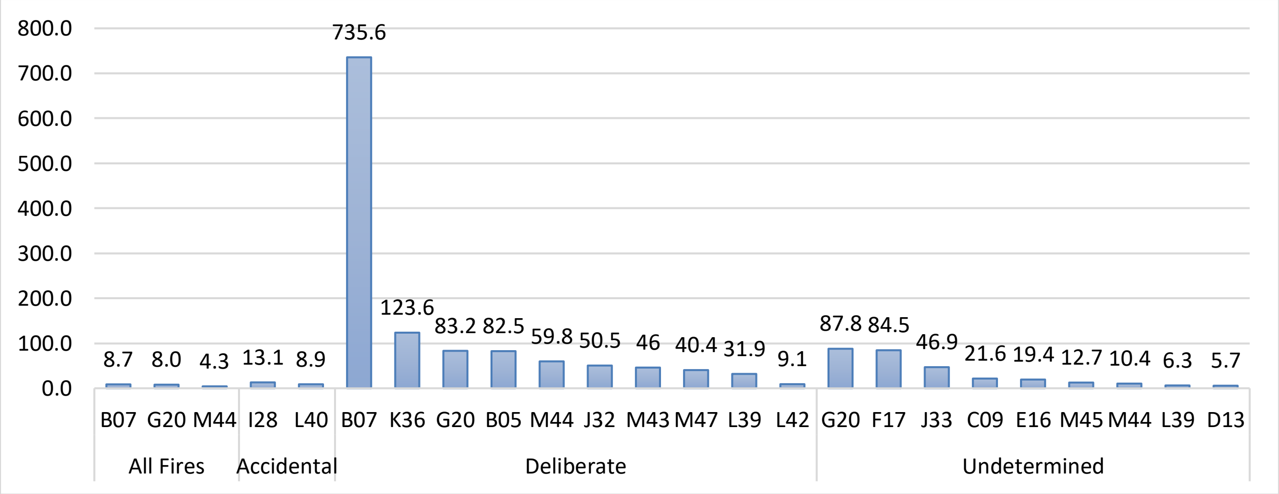


Table 9. Fatality in all fires

Odds	Mosaic Type	Mosaic Description
8.7	B07	Gen X families with many children, living in metro-fringe areas, with high income
8.0	G20	Young singles and couples, some students, with no children, renting flats in inner-urban areas, with average income
4.3	M44	Older, retired couples, sometimes with adult children or carers, who are long term resident in outer-suburban areas

Table 10. Fatality in accidental fires

Odds	Mosaic Type	Mosaic Description
13.1	I28	Millennial families with young children, sometimes single parents, commuting from outer-suburban areas with average incomes
8.9	L40	Low-income singles in regional towns, sometimes living in social housing

Table 11. Fatality in deliberate fires

Odds	Mosaic Type	Mosaic Description
735.6	B07	Gen X families with many children, living in metro-fringe areas, with high income
123.6	K36	Middle-aged, empty nester couples living in outer-suburban/metro-fringe areas, with above average income
83.2	G20	Young singles and couples, some students, with no children, renting flats in inner-urban areas, with average income
82.5	B05	Young, married couples with children and high income, living in outer-suburban/metro-fringe areas
59.8	M44	Older, retired couples, sometimes with adult children or carers, who are long term resident in outer-suburban areas
50.5	J32	Blue-collar families from multicultural backgrounds, living in outer-suburban areas, with average to high income
46.0	M43	Multicultural older couples living in outer-suburban areas for a long time, with low income but high property value
40.4	M47	Elderly couples, sometimes with adult children or carers, who are long term residents in rural towns, with low pension income
31.9	L39	Multicultural families, sometimes single parents, living in outer-suburban areas with low income
9.1	L42	Younger families, often single parents, with low incomes in regional towns, often living in social housing

Table 12. Fatality in undetermined fires

Odds	Mosaic Type	Mosaic Description
87.8	G20	Young singles and couples, some students, with no children, renting flats in inner-urban areas, with average income
84.5	F17	Professional couples and singles with high income, owning their first home in high growth inner suburbs
46.9	J33	Middle-aged, blue-collar couples living in outer-suburban/metro-fringe areas, with average income
21.6	C09	Well-educated professionals, living in trendy inner-urban areas, with high income
19.4	E16	Working in trades, middle-aged families owning acreages of land with large properties just outside the metro fringe
12.7	M45	Older singles, living in outer-suburban areas and satellite towns, with below average income

10.4	M44	Older, retired couples, sometimes with adult children or carers, who are long term resident in outer-suburban areas
6.3	L39	Multicultural families, sometimes single parents, living in outer-suburban areas with low income
5.7	D13	Retired, traditional couples living in coastal and scenic areas, with average pensionable income levels

6.5.2.2 Preventable fatality

The odds of a structure fire resulting in a preventable fatality (compared to non-preventable fatality) were lower in elderly couples, sometimes with adult children or carers, who are long term residents in rural towns, with low pension income.

Table 13. Preventable fatality

Odds	**Mosaic Type**	**Mosaic Description**
0.02	M47	Elderly couples, sometimes with adult children or carers, who are long term residents in rural towns, with low pension income

6.5.2.3 Injury

The odds of a structure fire resulting in an injury were lower in well-educated, high-powered businesspeople with very high income and no children, living in expensive properties in central Sydney. Relative risk of injury in a deliberate fire was higher for young, middle-aged, or older couples or families from multicultural backgrounds on low-average incomes, living in outer or inner suburban areas. In undetermined fires, relative risk of injury was higher for elderly couples from multicultural backgrounds living in expensive properties in suburban areas of Sydney and Melbourne.

Figure 20. Mosaic types at highest risk of injury (odds)

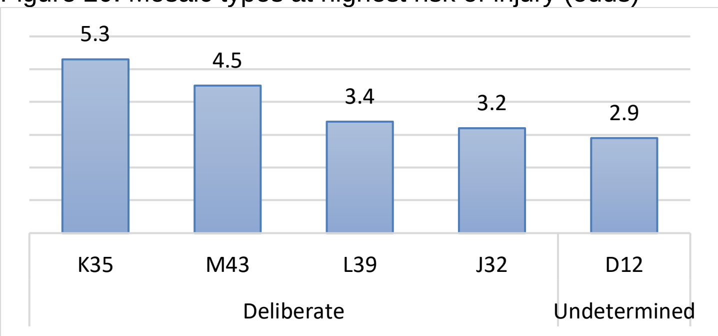


Table 14. Injury

Odds	**Mosaic Type**	**Mosaic Description**
0.61	C08	Well-educated, high-powered businesspeople with very high income and no children, living in expensive properties in central Sydney

Table 15. Injury in deliberate fires

Odds	**Mosaic Type**	**Mosaic Description**
3.2	J32	Blue-collar families from multicultural backgrounds, living in outer-suburban areas, with average to high income
5.3	K35	Middle-aged couples without children, renting in inner suburban apartments and terraces
3.4	L39	Multicultural families, sometimes single parents, living in outer-suburban areas with low income

4.5	M43	Multicultural older couples living in outer-suburban areas for a long time, with low income but high property value

Table 16. Injury in undetermined fires

Odds	**Mosaic Type**	**Mosaic Description**
2.9	D12	Elderly couples from multicultural backgrounds living in expensive properties in suburban areas of Sydney & Melbourne

6.5.2.4 Evacuation

The odds of a structure fire resulting in firefighter-assisted evacuation were higher for young or middle-aged couples or singles, with or without children, with high to average income, renting or owning in metro, inner-urban, outer, or inner suburban areas. Odds of a structure fire resulting in firefighter-assisted evacuation were lower for young, middle-aged, or older singles, couples, or families, working in professional or labour occupations, sometimes in retirement or social housing, on high to low incomes, in metro, inner-urban, suburban, regional, or rural areas. In accidental fires, the odds of evacuation were higher for young to middle-aged singles or couples, sometimes culturally diverse, on low to high income, living in inner our outer suburban areas. Odds of evacuation in accidental fires were lower for professionals, farm workers, and semi-retired couples with high to low income, living in inner-urban, suburban, or rural towns. In deliberate fires, odds of evacuation were higher for young or middle-aged singles and couples, with or without children, on high to low incomes, sometimes in social housing, living in inner-urban, suburban, or regional areas. In undetermined fires, odds of evacuation were higher in middle-aged and elderly couples, on average to low incomes, living in suburban or rural areas.

Figure 21. Mosaic types at highest risk of evacuation (odds)

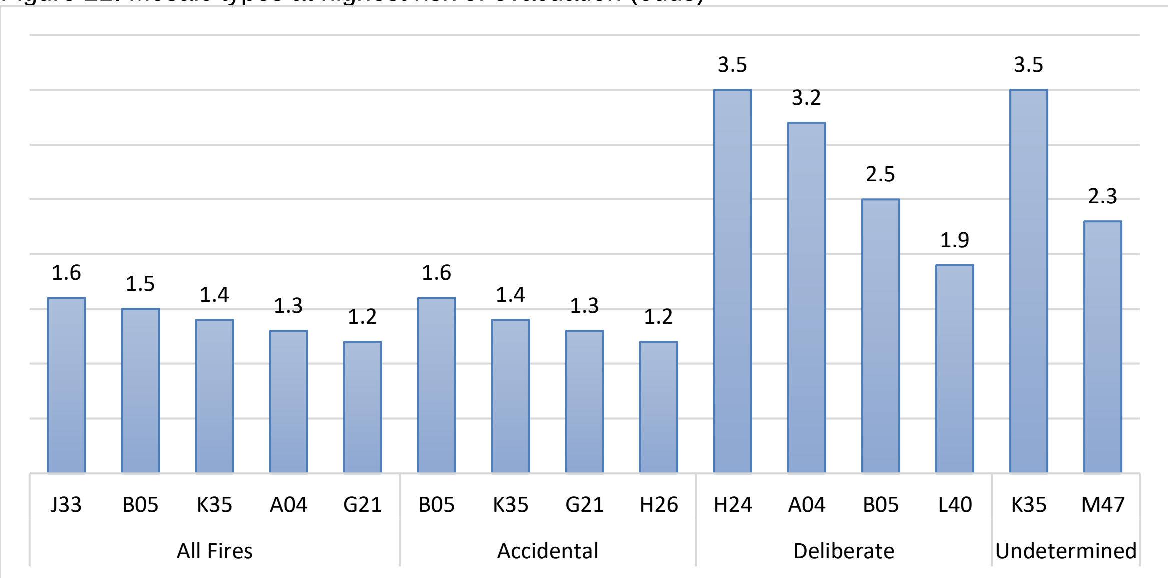


Table 17. Evacuation

Odds	**Mosaic Type**	**Mosaic Description**
1.3	A04	Traditional baby boomer couples with adult children, owning expensive properties in inner-urban & suburban areas of Sydney & Melbourne
1.5	B05	Young, married couples with children and high income, living in outer-suburban/metro-fringe areas
1.2	G21	Young, well-educated, and culturally diverse, renting flats in suburban areas of Sydney, with above average income and no children

1.6	J33	Middle-aged, blue-collar couples living in outer-suburban/metro-fringe areas, with average income
1.4	K35	Middle-aged couples without children, renting in inner suburban apartments and terraces
0.82	C08	Well-educated, high-powered businesspeople with very high income and no children, living in expensive properties in central Sydney
0.67	C09	Well-educated professionals, living in trendy inner-urban areas, with high income
0.63	D11	Older couples in semi-retirement, living in suburban areas and nearby towns for many years, with high income
0.78	L41	Older single and diverse, city centre renters with very low income, often living in social housing
0.81	L42	Younger families, often single parents, with low incomes in regional towns, often living in social housing
0.36	N50	Single farm workers in very small rural towns. with low income and low value properties

Table 18. Evacuation in accidental fires

Odds	**Mosaic Type**	**Mosaic Description**
1.6	B05	Young, married couples with children and high income, living in outer-suburban/metro-fringe areas
1.3	G21	Young, well-educated, and culturally diverse, renting flats in suburban areas of Sydney, with above average income and no children
1.2	H26	Younger, diverse blue-collar commuters renting apartments in Sydney outer-suburban areas, with low income
1.4	K35	Middle-aged couples without children, renting in inner suburban apartments and terraces
0.65	C09	Well-educated professionals, living in trendy inner-urban areas, with high income
0.58	D11	Older couples in semi-retirement, living in suburban areas and nearby towns for many years, with high income
0.24	N50	Single farm workers in very small rural towns. with low income and low value properties

Table 19. Evacuation in deliberate fires

Odds	**Mosaic Type**	**Mosaic Description**
3.2	A04	Traditional baby boomer couples with adult children, owning expensive properties in inner-urban & suburban areas of Sydney & Melbourne
2.5	B05	Young, married couples with children and high income, living in outer-suburban/metro-fringe areas
3.5	H24	Millennial blue-collar couples and singles, living in outer-suburban areas and surrounding towns with average income
1.9	L40	Low-income singles in regional towns, sometimes living in social housing

Table 20. Evacuation in undetermined fires

Odds	**Mosaic Type**	**Mosaic Description**
3.5	K35	Middle-aged couples without children, renting in inner suburban apartments and terraces
2.3	M47	Elderly couples, sometimes with adult children or carers, who are long term residents in rural towns, with low pension income

6.5.2.5 Fire extension

The odds of a structure fire resulting in fire extension were higher for young to middle aged blue collar or rural workers, sometimes single parents or from multicultural backgrounds, with high to low incomes, living in outer-suburban, regional, and rural areas. The odds of a structure fire resulting in fire extension were lower for young, middle-aged, or older people, usually culturally diverse and with no children, living alone or in couples, on high to low incomes, in metro and suburban areas. In accidental fires, odds of fire extension were higher for younger or older singles or couples, sometimes multicultural, living in outer suburban or regional areas, with financial stability. In accidental fires, odds were lower in young, middle aged, or older singles or couples, sometimes culturally diverse, working high-powered or blue-collar occupations, on very low to high incomes, living in metro and suburban areas. In deliberate fires, odds of fire extension were higher in professional couples and singles with high income, owning their first home in high growth inner suburbs. In deliberate fires, odds of fire extension were lower in couples and single parents with children living in regional areas with low to average incomes. In undetermined fires, odds of fire extension were higher for young, middle-aged, or older families or couples, sometimes multicultural, on high to low incomes, living in suburban, regional, or rural areas. In undetermined fires, odds were lower for younger, diverse blue-collar commuters renting apartments in Sydney outer-suburban areas, with low income.

Figure 22. Mosaic types at highest risk of fire extension (odds)

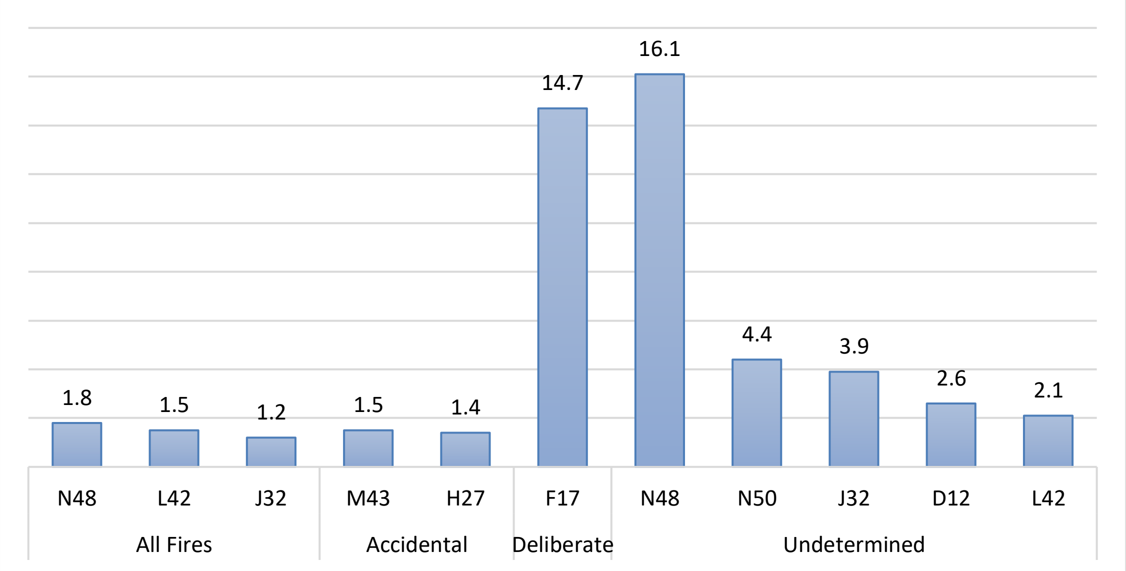


Table 21. Fire extension

Risk Change	Mosaic Type	Mosaic Description
1.2	J32	Blue-collar families from multicultural backgrounds, living in outer-suburban areas, with average to high income
1.5	L42	Younger families, often single parents, with low incomes in regional towns, often living in social housing
1.8	N48	Rural farmers and farm owners with below average income, living 10-40km away from the nearest town
0.58	C08	Well-educated, high-powered businesspeople with very high income and no children, living in expensive properties in central Sydney
0.32	C10	Young diverse couples, well-educated, transient, city centre renters with high income and no children
0.39	G21	Young, well-educated, and culturally diverse, renting flats in suburban areas of Sydney, with above average income and no children
0.56	H26	Younger, diverse blue-collar commuters renting apartments in Sydney outer-suburban areas, with low income
0.59	L41	Older single and diverse, city centre renters with very low income, often living in social housing

0.51	M45	Older singles, living in outer-suburban areas and satellite towns, with below average income

Table 22. Fire extension in accidental fires

Odds	Mosaic Type	Mosaic Description
1.4	H27	Younger blue-collar singles in regional towns, with low income but have financial stability
1.5	M43	Multicultural older couples living in outer-suburban areas for a long time, with low income but high property value
0.55	A03	Middle-older aged empty nester couples renting very expensive properties in inner-urban areas, with high income
0.58	C08	Well-educated, high-powered businesspeople with very high income and no children, living in expensive properties in central Sydney
0.34	C10	Young diverse couples, well-educated, transient, city centre renters with high income and no children
0.66	D12	Elderly couples from multicultural backgrounds living in expensive properties in suburban areas of Sydney & Melbourne
0.38	G21	Young, well-educated, and culturally diverse, renting flats in suburban areas of Sydney, with above average income and no children
0.69	H26	Younger, diverse blue-collar commuters renting apartments in Sydney outer-suburban areas, with low income
0.42	L41	Older single and diverse, city centre renters with very low income, often living in social housing
0.46	M45	Older singles, living in outer-suburban areas and satellite towns, with below average income

Table 23. Fire extension in deliberate fires

Odds	Mosaic Type	Mosaic Description
14.7	F17	Professional couples and singles with high income, owning their first home in high growth inner suburbs
0.27	I30	Couples and single parents with children living in regional areas with low to average incomes

Table 24. Fire extension in undetermined fires

Odds	Mosaic Type	Mosaic Description
2.6	D12	Elderly couples from multicultural backgrounds living in expensive properties in suburban areas of Sydney & Melbourne
3.9	J32	Blue-collar families from multicultural backgrounds, living in outer-suburban areas, with average to high income
2.1	L42	Younger families, often single parents, with low incomes in regional towns, often living in social housing
16.1	N48	Rural farmers and farm owners with below average income, living 10-40km away from the nearest town
4.4	N50	Single farm workers in very small rural towns. with low income and low value properties
0.39	H26	Younger, diverse blue-collar commuters renting apartments in Sydney outer-suburban areas, with low income

6.5.3 Individual characteristics summary

These findings indicate that odds of fatality in a diverse array of Mosaic Types. This finding aligns with other results which found that socioeconomic status and remoteness were not predictors of fatality, meaning fatalities were present across different socioeconomic statuses and remoteness areas.

The odds of a structure fire resulting in a preventable fatality (compared to non-preventable fatality) were lower in elderly couples, sometimes with adult children or carers, who are long term residents in rural towns, with low pension income. This finding indicates that this group is at a lower risk of a preventable fatality compared to non-preventable fatality.

While there were higher odds of injury in the lowest socioeconomic areas by SEIFA Decile, none of the Mosaic Types increased relative risk of injury. Instead, but similarly, odds of injury were lower in the most advantaged Mosaic Type.

Odds of firefighter-assisted evacuation were lower in socioeconomically disadvantaged areas. This is supported by Mosaic data which shows that the odds of evacuation were lower for people who were retired or lived in social housing.

While the odds of fire extension were higher in the lowest socioeconomic areas by SEIFA Decile, odds of fire extension by Mosaic Type suggests a diverse array of people were most at risk.

Risk hierarchy comparisons revealed that at-risk Mosaic Types differed by adverse outcomes. Consequently, risk hierarchies should list Mosaic Types according to each adverse outcome, with Prevention + Education approaches targeting each type based on the risk of each adverse outcome.

Finally, risk hierarchies differed when odds ratios were used to measure risk, compared to incidence or population-controlled rates (see section 10.2.1.2 for comparison). Where predictive analysis is a more valid measure of risk than descriptive analysis (incidence and population-controlled rates), future risk hierarchies should be based on odds ratios, as used in this study.

Recommendation: Prevention + Education programs and resources should target the most socioeconomically disadvantaged areas with programs and resources that enhance understanding of exponential fire growth, support accurate perceptions of risk and estimations of available time to escape, and reinforce behaviours that mitigate injury and fire spread, such as smoke alarm installation, closing doors, and safe self-evacuation.

Recommendation: Where at-risk Mosaic Types differed by adverse outcome, Mosaic Types should be listed according to each specific adverse outcome, with Prevention + Education approaches targeting each type based on the risk of each adverse outcome.

Recommendation: Use odds ratios to list Mosaic Types in order of risk of each adverse outcome where predictive analysis (and thus odds ratios) is a more valid measure of risk than incidence or population-controlled rates.

Recommendation: Clarify the purpose of existing Prevention + Education approaches that use the Mosaic Types risk hierarchy to target efforts. For example, provide clarity on the purpose of Safety Visits (to reduce structure fires or to reduce structure fire fatalities) to ensure that the appropriate risk hierarchy is applied.

Recommendation: Where SEIFA characteristics are based on population-level data, further research is needed to understand the relationship between relative disadvantage and adverse outcomes to identify the socioeconomic factors influencing risk at the individual level.

6.6 Behavioural Characteristics

6.6.1 Hoarding

When there was evidence of hoarding, the odds of fatality (4.2), injury (1.7), and evacuation (1.7) were higher compared to structure fires with no evidence of hoarding. In accidental fires, the odds of fatality (14.8), evacuation (1.9), and fire extension (1.6) were higher compared to no evidence of hoarding.

Research suggests that 2.5% of the Australian population have hoarding disorder (Catholic Healthcare, 2022). Compared to the population, hoarding was under-represented in structure fires (0.6%) and evacuations (0.5%), equally represented in injuries (2.3%), but over-represented in fatalities (5.7%) and preventable fatalities (7.7%). These findings are similar to Coates et al. (2019) who found that hoarding accounted for 8.2% of preventable residential fire fatalities in Australia.

Hoarding, or clutter, has been identified as a risk factor of structure fire, fire fatality, and fire injury (Coates et al., 2019; Shokouhi et al., 2019). Studies have identified distinct populations of hoarders: those who have a discrete condition, and those whose hoarding co-occurs with a psychopathological condition (Iyer & Ball, 2010). Where these populations differ on degree of hoarding, type of items hoarded, degree of social isolation, and cause of fatality, they require different interventions. Further, hoarding has been associated with other risk factors, such as the absence of functional smoke alarms, smoking, and the misuse of electrical appliances (Iyer & Ball, 2010), suggesting further research is needed. Where hoarders are socially isolated, risk identification and mitigation through information sharing and the delivery of education and resources may be facilitated through fire service collaboration with social workers, community outreach workers, occupational therapists, and neuropsychologists (Iyer & Ball, 2010; Steen-Hansen, Storesund & Sesseng, 2021).

6.6.2 Mental impairment

When there was evidence of any mental impairment (mental illness, alcohol, or drug use), the odds of injury (2.1) and evacuation (1.6) were higher compared to structure fires involving no evidence of mental impairment. In accidental fires, the odds of injury (2.0) and evacuation (1.4) were higher when there was evidence of mental impairment. In deliberate fires, the odds of fatality (6.9), injury (1.8), and evacuation (1.6) were higher when there was evidence of mental impairment, yet the odds of fire extension (0.67) were lower. In undetermined fires, the odds of injury (5.8) were higher when there was evidence of mental impairment.

Recent studies indicate that around 22% of the Australian population have a mental or behavioural disorder (Australian Institute of Health and Welfare, 2019), 33.0% of the NSW population use alcohol weekly (Australian Institute of Health and Welfare, 2021a), and 16.4% of the NSW population have used any illicit drug at least once in the past 12 months (Australian Institute of Health and Welfare, 2022). Despite this, mental impairment by means of mental illness, alcohol or drug use was only evident in 3.5% of structure fires, 2.5% of persons evacuated, 8.1% of injuries, 8.0% of fatalities, 1.9% of preventable fatalities, and 3.2% of fire extension. Mental impairment due to mental illness caused the highest proportion of structure fires (1.6%), persons evacuated (1.2%), injuries (3.8%), fatalities (6.8%), and fire extension (1.4%) compared to other forms. Mental impairment due to alcohol was the most common form associated with preventable fatalities (1.9%).

While these findings align with existing literature that suggests mental impairment impacts upon one’s ability to accurately perceive and respond appropriately to risk (Kuligowski, 2009), they indicate lower proportions of mental impairment in fire fatalities compared to other studies (Coates et al., 2019; Duncanson, 2001; Lilley, McNoe & Duncanson, 2018; National Coronial Information System, 2022). While these studies were descriptive, Xiong, Bruck, and Ball (2015) conducted predictive analysis and found that diagnosed mental illness increased risk of fatality in accidental residential structure fires.

Where this study found that any mental impairment (mental illness, alcohol, or drug use) was a risk factor of injury, firefighter-assisted evacuation, and fire extension, but not fatality, further investigation is needed to better understand how mental impairment interacts with other variables to increase risk in some domains but not others. For example, Bruck, Ball, and Thomas (2011) found that risk of fatality was higher when males consumed alcohol compared to females, and when males were under the age of 60 years, while the use of smoker's materials was significantly higher when alcohol was a factor. It is necessary to explore these interacting risk factors further.

6.6.3 Physical diversity

Physical diversity refers to any differences in vision, hearing, or mobility. eAIRS does not systematically collect data on the presence or influence of physical diversity and the associated risk of fire and other emergencies. This is problematic where existing literature suggests that disability is associated with fire fatality and injury (Coates et al., 2019; Lilley, McNoe & Duncanson, 2018; Miller, 2005; Shokouhi et al., 2019; Thompson, Galea & Hulse, 2018; Warda, Tenenbein & Moffatt, 1999; Xiong, Bruck & Ball 2015). Studies have identified an association between fire fatality and the use of equipment and aids, and the receipt of service, support, or intervention from government or other funded services (Coates et al., 2019). Research also suggests that people with perceptual (intellectual) disabilities have a decreased capacity to perceive risk and take appropriate actions, such as self-evacuate (Choi et al., 2019; Kuligowski, 2009; Runefors, Johansson & van Hees, 2016; Thompson, Galea & Hulse, 2018). Where people with a vulnerability are disproportionately more likely to be adversely affected by structure fires (Gilbert & Butry, 2017), and where traditional prevention and intervention mechanisms, such as smoke alarms, and traditional messaging, such as get down low under smoke, may not be effective for this group (Choi et al., 2019; Runefors, Johansson & van Hees, 2016; Steen-Hansen, Storesund & Sesseng, 2021), further research is necessary.

6.6.4 Cultural practices

When there was evidence of cultural practices, the odds of evacuation were 1.4 times higher compared to structure fires involving no evidence of cultural practices. When cultural practices were evident in an accidental fire, the odds of evacuation were 1.5 times higher.

Almost one-third (29.1%) of the Australian population were born overseas (Australian Bureau of Statistics, 2022a). Assuming this proportion of the population engage in practices unique to their cultures, cultural practices were under-represented in structure fires (0.7%), evacuations (1.3%), injuries (1.2%), and 0.6% of fire extension. Cultural practices were not evident in fatalities or preventable fatalities. These findings support research which suggests that people who are culturally diverse (speak another language in addition to English at home) are less likely to experience a house fire than those who are not (speak only English at home; Tannous & Agho, 2017). However, there is evidence to indicate the contrary (Thompson, Galea & Hulse, 2018). Where culturally diverse populations may be over-represented in other at-risk populations, such as socioeconomically disadvantaged groups (Thompson, Galea & Hulse, 2018), further investigation is needed.

In addition, eAIRS does not collect data on the type of cultural practice involved. Where different cultural practices may represent different levels of risk, eAIRS should collect information on the type of cultural practice or culture/ethnicity involved. This information can also facilitate the inclusion of culture/ethnicity in adverse structure fire outcomes analysis.

6.6.5 Aboriginal and Torres Strait Islander peoples

eAIRS does not collect data on the presence or influence of Indigeneity on the risk of fire and other emergencies. This is problematic where Indigenous peoples are more likely to experience socioeconomic disadvantage, overcrowded living conditions, substandard housing, underuse of working smoke alarms, limited access to healthcare services, and longer time for fire service response in rural areas, placing them at a higher risk of fire-related injury and fatality (Al-Hajj et al., 2022; Banerji, 2012; Coates et al., 2019). Research also suggests that Aboriginal and Torres Strait Islander young people are over-represented in misuse of fire statistics (Muller, 2008; Pooley, 2021), indicating that fire presents a significant risk to young Indigenous Australians. Where evidence suggests that fire prevention programs should be culturally sensitive, targeted, and multifaceted, further research is needed to identify the incidence, characteristics, and risk factors associated with adverse structure fire outcomes in Aboriginal and Torres Strait Islander peoples to inform Prevention + Education.

6.6.6 Youth misuse of fire

Youth misuse of fire was not a significant predictor of fatality, injury, evacuation, or fire extension. However, when structure fires were split by cause determination, youth misuse of fire in accidental fires increased the odds of fire extension by 1.6 times. Despite this, evidence of youth misuse of fire in structure fires decreased significantly over time.

This study found that youth misuse of fire accounted for 2.6% of structure fires, 1.6% of persons evacuated, 3.1% of injuries, 4.2% of fire extension, yet no fatalities or preventable fatalities. While injuries and fire extension were over-represented in fires caused by young people, these findings indicate lower rates of youth misuse of fire compared to other studies. Coates et al. (2019) identified ‘fire play’ in 7.2% of preventable residential fire fatalities, while Lilley, McNoe, and Duncanson (2018) found that 6.0% of their sample of fatal fires involved children playing with ignition sources. However, due to sampling differences, these studies are not directly comparable. Further, evidence suggests that youth misuse of fire is a covert behaviour that is difficult to detect and measure. This means that a large proportion of fires caused by young people go unreported and thus, that eAIRS data is not the most accurate measure of youth misuse of fire or associated adverse outcomes. Further research is needed to identify the true incidence of youth misuse of fire within the NSW community.

6.6.7 Cooking

Area of origin and material ignited first were predictors of fatality, injury, evacuation, and fire extension. Within these, cooking related fires can be identified.

The odds of fatality were higher when the material ignited first was outdoor cooking equipment (24.0). Odds of fatality increased 5.1 times when a fire originated in a kitchen or cooking area. When the fire was accidental, odds of fatality increased 75.1 times when the material ignited first was outdoor cooking equipment, while kitchen fires increased odds of fatality 5.2 times. When the fire was undetermined, kitchen fires increased odds of fatality 12.9 times.

Odds of preventable fatality (compared to non-preventable fatality) in an accidental fire were lower when the fire originated in the kitchen or cooking area (0.03).

Odds of injury were higher when the material ignited first was a portable gas cooker (3.1) or fixed deep fat fryer (2.6); however, fires originating in the kitchen or cooking area did not increase odds of injury. These findings are reflected in accidental fires. When the fire was undetermined, odds of injury increased 31.9 times when the material ignited first was a small cooking appliance.

Odds of evacuation were lower when the material ignited first was cooking materials or foodstuffs (0.66) or outdoor cooking equipment (0.58). These findings were reflected in accidental fires. Odds of evacuation also decreased when the fire originated in a kitchen or cooking area (0.85).

Odds of fire extension were lower when the material ignited first was cooking materials or foodstuffs (0.50) or a fixed stationary oven (0.45), or when the fire originated in the kitchen or cooking area (0.37). In accidental fires, odds of fire extension decreased when the material ignited was cooking materials or foodstuffs (0.56) and when the fire originated in a kitchen or cooking area (0.34). In deliberate fires, odds were lower when the material was cooking materials or foodstuffs (0.10). In undetermined fires, odds decreased when the fire originated in a kitchen or cooking area (0.67).

While other studies have found cooking fires increased risk of fatality and injury (DiGuiseppi et al., 2000; Duncanson et al., 2002; Lilley, McNoe & Duncanson, 2018; Miller, 2005; Mulvaney et al., 2008; Xiong, Bruck & Ball, 2015), this study found that different cooking related materials ignited first and fires originating in a kitchen or cooking area resulted in different levels of risk. These findings suggest that aggregating cooking fires into one category reduces capacity to identify at-risk materials. Further investigation is needed to determine why certain materials present different levels of risk. For example, Xiong, Bruck and Ball (2016) conducted interviews with non-injury victims of residential fires and found that unsafe human behaviour (e.g., unattended cooking), long-term inaction (e.g., a lack of maintenance and cleaning), and no human action (e.g., electrical failure) caused fires.

6.6.8 Smoking

Smokers' materials predicted fire extension in accidental fires. When accidental structure fires were ignited by smokers' materials, odds of fire extension were 0.76 times lower compared to fires ignited by other ignition sources.

Data suggests that 9.5% of the NSW population engage in tobacco smoking daily (Australian Institute of Health and Welfare, 2021b). Compared to the population of people who smoke, evidence of smoking was under-represented in structure fires (4.2%), evacuations (4.2%), injuries (5.8%), fatalities (4.5%), preventable fatalities (7.7%), and fire extension (3.4%). However, compared to the proportion of structure fires caused by smokers' materials, injuries and preventable fatalities were over-represented.

While DiGuiseppi et al. (2000), Duncanson et al. (2002), and Shokouhi et al. (2019) found smokers' materials to be a leading cause of fire injury, these studies are limited by descriptive statistics to explore smokers' materials and risk of injury. In contrast, multiple studies have linked fire fatalities with smokers' materials, but most are constrained by methodological limitations. Two predictive studies found smoking to be the leading cause of fire fatalities (Runefors, Jonsson & Bonander, 2021; Xiong, Bruck & Ball 2015). Despite high methodological rigour, neither study is directly comparable to this study where Runefors, Jonsson and Bonander (2021) analysed residential fire outcomes for people aged 65 years and over, and Xiong, Bruck, and Ball (2015) compared fatal fires with accidental residential fires. Other studies have also identified smoking as a risk factor for fire fatality, but these used descriptive or cluster analysis (Coates et al., 2019; Jonsson et al., 2017; Lilley, McNoe & Duncanson, 2018; Miller, 2005; Mulvaney et al., 2009). After conducting predictive analysis for all structure fires, this study found that smokers' materials did not increase risk of any adverse outcomes and instead, reduced odds of fire extension in accidental fires.

6.6.9 Behavioural characteristics summary

This study found that hoarding was a significant risk factor of fatality, injury, and evacuation, and fire extension. Hoarding was also over-represented in fatalities compared to that which exists in the population, suggesting hoarding represents a significant concern. Where studies have identified the need to develop multi-disciplinary, multi-agency models of fire prevention for people who hoard, further research is necessary.

This study found that any mental impairment (mental illness, alcohol, or drug use) was a risk factor of fatality, injury, and evacuation, but not fire extension. Further investigation is needed to better understand how mental impairment interacts with other variables to increase risk. To inform Prevention + Education, it is also necessary to distinguish between mental impairment caused by mental illness and that caused by intoxication and/or the effects of illicit and prescribed drugs. Further, there is a paucity of literature on the effect of intellectual disability on adverse structure fire outcomes and eAIRS does not yet capture this data.

eAIRS does not systematically collect and analyse data on the presence or influence of physical diversity and the associated risk of fire and other emergencies. This is problematic where existing literature suggests that disability is associated with fire fatality and injury. Where people with a vulnerability are disproportionately more likely to be adversely affected by structure fires and are less likely to self-evacuate, further research is necessary.

Cultural practices increased risk of evacuation. Evidence suggests that, although cultural practices increase risk, it may be the interaction of cultural practices with other factors, rather than just cultural diversity alone, that influences risk. Where different cultural practices represent different levels of risk, eAIRS should collect information on the type of cultural practice or culture/ethnicity involved.

Despite collecting data on cultural practices broadly, eAIRS does not collect data on the presence or influence of Indigeneity on risk of fire and other emergencies. This is problematic where Indigenous peoples are more likely to experience risk factors associated with fire fatality and injury. Evidence suggests that fire prevention programs should be culturally sensitive, targeted, and multifaceted, meaning further research is needed to identify the incidence, characteristics, and risk factors associated with adverse structure fire outcomes in Aboriginal and Torres Strait Islander peoples to inform Prevention + Education.

Youth misuse of fire was a significant predictor of fire extension in accidental fires. Although structure fires caused by young people have decreased over time, evidence suggests that young people misuse fire most often against bush, grass, and forests, and that youth misuse of fire is a covert behaviour that is difficult to detect and measure. This means that a large proportion of fires caused by young people go unreported. This analysis is therefore not the most accurate measure of youth misuse of fire or associated adverse outcomes. Further research is necessary.

Cooking fires present different levels of risk, depending on the materials and room involved. These findings suggest that aggregating cooking fires into one category reduces capacity to identify and target risk. Where injuries and evacuations have unique cooking risk profiles as well as shared cooking risk factors, Prevention + Education programs and resources should target these specific risk profiles and factors.

After conducting predictive analysis for all structure fires, this study found that smokers' materials did not increase risk of any adverse outcomes and instead, reduced odds of fire extension in accidental fires.

Existing literature suggests that the key to effective Prevention + Education for vulnerable groups is multi-disciplinary, multi-agency collaboration (Steen-Hansen, Storesund & Sesseng, 2021). This is thus recommended for all the above.

Recommendation: Create a data object in eAIRS that measures hoarding type and severity using the Clutter Image Rating Scale to better inform targeted Prevention + Education.

Recommendation: Conduct research to inform best practice fire service involvement in reducing the consequences of hoarding, and to develop evidence-based multi-disciplinary/multi-agency models of hoarding prevention, intervention, and response.

Recommendation: Create distinct data objects in eAIRS that distinguish between mental impairment caused by neurodiversity (mental illness and intellectual disability), intoxication (alcohol), and the effects of drugs (illicit and prescribed).

Recommendation: Conduct further research to understand how each type of mental impairment interacts with other variables to increase risk of adverse structure fire outcomes, and to develop evidence-based multi-disciplinary/multi-agency models of neurodiversity (mental illness and intellectual disability), intoxication (alcohol), and drug (illicit and prescribed) related fire prevention, intervention, and response.

Recommendation: Create distinct data objects in eAIRS that captures physical disability, aids and equipment, and the provision of support services/in-home care.

Recommendation: Conduct research to identify at-risk components of physical diversity and how these interact with other risk factors, and to develop evidence-based multi-disciplinary/multi-agency prevention, intervention, and response approaches for physically diverse communities.

Recommendation: Create distinct data objects in eAIRS that captures type of cultural practice and/or culture/ethnicity involved.

Recommendation: Conduct research to identify at-risk components of cultural diversity and how these interact with other risk factors, and to develop evidence-based multi-disciplinary/multi-agency prevention, intervention, and response approaches for culturally diverse communities.

Recommendation: Create distinct data objects in eAIRS that captures Indigeneity and associated cultural practices.

Recommendation: Conduct research to identify at-risk components of Indigeneity and how these interact with other risk factors, and to develop evidence-based culturally sensitive multi-disciplinary/multi-agency prevention, intervention, and response approaches for Indigenous peoples.

Recommendation: Link eAIRS data with social and support services data to conduct deeper analysis of the risk factors that compound or contribute to the relationships between hoarding, neurodiversity, physical diversity, cultural diversity, Indigeneity, and adverse structure fire outcomes.

Recommendation: Conduct a self-reported study of misuse of fire by young people in the NSW community to identify the incidence, characteristics, and risk factors of youth misuse of fire for reported and unreported fires.

Recommendation: To reduce cooking-related adverse outcomes, Prevention + Education efforts should target the risk factors of cooking fires that are specific to each adverse outcome, such as programs and resources targeted towards outdoor cooking equipment and kitchen or cooking area fires to reduce the risk of fatality and portable gas cooker and deep fat fryers to reduce the risk of injury.

6.7 Building Characteristics

6.7.1 Type of owner

Type of owner predicted injury, evacuation, and fire extension. It also predicted fatality and injury in accidental fires; evacuation in accidental, deliberate, and undetermined fires; and fire extension in accidental and deliberate fires.

6.7.1.1 Department of Housing

Department of Housing was not a predictor of any adverse structure fire outcomes. This finding supports research which has found no significant differences between fatalities and injuries in social housing and other properties using fire service data (Ghassempour, 2021). However, other studies have found social housing to be a risk factor for fire fatality (Lilley, McNoe & Duncanson, 2018).

These conflicting results may exist because eAIRS data is not the most valid measure of social housing. While there is a Department of Housing variable within eAIRS, discrepancies exist between Department of Housing and government owned properties. There is a chance that Reporting Officers select Department of Housing as the occupier, but local, state, or commonwealth government as the owner of a property. Further research is needed to access valid and reliable social housing data to reconcile these discrepancies. Further research is also needed to understand the intersectional risk profile of social housing occupants and their relationship to fire and other emergencies, and to develop evidence-based approaches to fire prevention, intervention, and response in social housing.

6.7.1.2 Private

When a fire occurred in a privately owned property, the odds of evacuation were 1.1 times higher than fires that occurred in properties owned by other entities. Higher odds of evacuation are reflected in accidental (1.1), deliberate (1.4), and undetermined (1.4) fires.

6.7.1.3 Government

When an accidental fire occurred in a Commonwealth Government owned property, the odds of fatality were 17.2 times higher than fires that occurred in properties owned by other entities.

When a fire occurred in a State Government owned property, the odds of injury were 1.2 times higher than fires that occurred in properties owned by other entities. When the fire was accidental, the odds of injury were 1.3 times higher in State Government owned properties. When the fire was deliberate, odds of fire extension were 1.3 times higher in State Government owned properties.

When a fire occurred in a Local Government owned property, the odds of injury were 0.43 times lower, the odds of evacuation were 0.57 times lower, and the odds of fire extension were 0.58 times lower than fires that occurred in properties owned by other entities. When the fire was accidental, odds of fire extension decreased 0.42 times in properties owned by Local Government.

Structure fires in Commonwealth and State Government owned properties decreased significantly over time. Despite this, Commonwealth Government properties present an increased risk of fatality in accidental fires, and State Government properties present an increased risk of injury. Structure fires in Local Government properties had lower odds of causing injury, evacuation, and fire extension compared to fires that occurred in properties owned by other entities.

6.7.1.4 Unoccupied

When a fire occurred in an unoccupied property, the risk of evacuation was 0.21 times lower than in occupied properties.

Where structures are genuinely unoccupied at the time of the fire, there is no need for firefighter-assisted evacuation. Where structure fires in unoccupied properties are caused by human behaviour, self-evacuation may have occurred before the arrival of emergency services. Further research is needed to understand the use and users of unoccupied structures and how this influences risk.

6.7.2 Building class

Building class was a predictor of fatality, injury, evacuation, and fire extension. It also predicted fatality and injury in accidental fires, and evacuation and fire extension in accidental, deliberate, and undetermined fires.

The odds of a structure fire resulting in fatality were 2.2 times higher when the fire occurred in a Class 1a (residential attached) building compared to all other building classes. When the fire was accidental, odds of fatality were 23.8 times higher when the fire occurred in a Class 9c (aged care) building.

The odds of a structure fire resulting in injury were higher in Class 1a (residential attached; 1.3) and Class 1a (residential detached; 1.4) buildings. Odds of injury in accidental fires reflect these findings, with the addition of Class 7a (carpark) buildings; however, structure fires in Class 7a buildings decreased significantly over time.

The odds of a structure fire resulting in evacuation were higher in Class 3 (other residential; 1.4) and Class 9b (assembly; 1.3) buildings. Odds of evacuation were lower in Class 1a (detached; 0.81), Class 4 (dwelling in another class; 0.53), Class 7a (carpark; 0.44), Class 7b (storage; 0.55), and Class 10a (non-habitable; 0.51) buildings. When the fire was accidental, odds of evacuation were higher in Class 3 (other residential; 1.4), Class 5 (office; 1.5), Class 6 (shop; 1.3), Class 8 (laboratory; 1.5), and Class 9b (assembly; 1.9) buildings, but lower in Class 10a (non-habitable; 0.54) buildings. When the fire was deliberate, odds of evacuation were higher in Class 1a (attached; 2.1), Class 1b (boarding house; 2.5), Class 2 (unit; 3.7), Class 3 (other residential; 6.2), and Class 9a (health care; 3.2) buildings. When the fire was undetermined, odds were higher in Class 1a (attached; 2.0) and Class 2 (unit; 2.7) buildings.

The odds of a structure fire resulting in fire extension were higher when the fire occurred in a Class 1a (detached; 1.5), Class 7a (carpark; 1.7), Class 7b (storage; 1.7), and Class 10a (non-habitable; 3.2) building, but lower in Class 3 (other residential; 0.51) and Class 9a (health care; 0.17) buildings. When the fire was accidental, odds of fire extension were higher when the fire occurred in a Class 1a (detached; 1.4), Class 7b (storage; 2.0), or Class 10a (non-habitable; 3.9) building and lower when the fire occurred in a Class 3 (other residential; 0.55), Class 5 (office; 0.61), or Class 9c (aged care; 0.57) building. When the fire was deliberate, odds were higher in Class 1a (detached; 1.7), Class 5 (office; 1.8), and Class 10a (non-habitable; 2.0) buildings and lower in Class 3 (other residential; 0.24) buildings. When the fire was undetermined, odds were higher in Class 1a (detached; 1.8), Class 7b (storage; 2.1), Class 8 (laboratory; 2.3), and Class 10a (non-habitable; 2.0) buildings and lower in Class 2 (unit; 0.50), Class 9a (healthcare; 0.07), and Class 9b (assembly; 0.55) buildings.

These findings indicate that the relative risk of a structure fire resulting in fatality were higher in residential attached buildings, unless the fire was accidental, in which case the odds of fatality were higher in aged care buildings. The relative risk of injury was higher in residential attached and detached and carpark buildings. The relative risk of a structure fire resulting in evacuation was higher in a variety of buildings designed for people on mass and other residential dwellings, but lower in residential detached, storage, carpark, and non-habitable buildings. In contrast, the odds of fire extension were higher when fires occurred in residential detached, carpark, storage, and non-habitable buildings, but lower in other residential and health care buildings.

6.7.3 Building characteristics summary

The odds of a structure fire resulting in fatality were higher in residential attached buildings, unless the fire was accidental, in which case the odds of fatality were higher in aged care and Commonwealth Government owned properties. Residential structures and aged care or nursing home properties have been identified as risk factors for fire fatality (Coates et al., 2019; Jonsson et al., 2017). Existing literature has discerned privately and publicly owned rentals in terms of risk of fire fatality, with privately and publicly owned rentals over-represented in fire fatality statistics (Coates et al., 2019). While this study also conducted population-controlled analysis (see section 10.2.1.3), this is a less rigorous approach than predictive analysis.

The odds of a structure fire resulting in injury were higher in residential attached and detached and carpark buildings, and State Government owned properties, but lower in Local Government owned properties. While there is a paucity of existing literature on fire injury risk and building class and owner, evidence does suggest that it may not be the type of building that increases risk of injury, but the age, maintenance, standard of construction materials, and their interaction with human behaviour within these buildings (Shokouhi et al., 2019).

The odds of a structure fire resulting in evacuation increased when a structure fire occurred in a variety of buildings designed for people on mass. Evidence suggests that the actions of others in response to fire cues influences one's interpretation of the situation as a fire and understanding of risk to oneself and others (Kuligowski, 2009). Where the relative risk of firefighter-assisted evacuation is higher in buildings designed for people on mass, this may indicate that people are not responding appropriately to fire cues, such as alarm activation, reducing the likelihood of accurate perception of risk and self-evacuation. Alternatively, where buildings designed for people on mass take longer to be evacuated, self-evacuation may have commenced before firefighter arrival, with firefighters assisting these efforts. Risk was also higher in other residential dwellings and privately owned properties, but lower in Local Government owned and unoccupied properties. Where structures are genuinely unoccupied at the time of the fire, there is no need for firefighter-assisted evacuation. Where structure fires in unoccupied properties are caused by human behaviour, self-evacuation may have occurred before the arrival of emergency services. Further research is needed to understand the use and users of unoccupied structures and how this influences risk.

The odds of a structure fire resulting in fire extension were higher when a structure fire occurred in residential detached, carpark, storage, and non-habitable buildings, but lower in other residential and health care buildings, and properties owned by Local Government. Storage, carpark, and non-habitable buildings may not be occupied, meaning the fire takes longer to be identified and reported, increasing relative risk of fire extension. Storage and carpark facilities may also be outdoors, meaning fires may be fuel controlled rather than ventilation controlled, increasing risk of fire extension.

Recommendation: Given the discrepancies between Department of Housing and government owned properties, further research is needed to discern between government bodies who potentially own social housing and other non-housing entities who own and occupy other government buildings.

Recommendation: Create a distinct data object in eAIRS that identifies whether a property functions as a social housing property regardless of which entity owns the property.

Recommendation: Link eAIRS data with valid and reliable social housing data to reconcile the discrepancies within eAIRS and to examine other factors that may increase risk of adverse outcomes.

Recommendation: Conduct further research to understand the intersectional risk profile of aged care buildings and their relationship to fire and other emergencies, and to develop evidence-based approaches to fire prevention, intervention, and response.

Recommendation: Prevention + Education efforts should prioritise fatality and injury prevention in residential attached buildings and injury and fire extension prevention in residential detached buildings.

Recommendation: Conduct further research to explore the effect of building age, maintenance, and standard of construction materials, and their interaction with human behaviour, to better understand risk of adverse structure fire outcomes.

Recommendation: Where the actions of others may influence perception of risk and appropriate response and/or buildings take longer to be safely evacuated, Prevention + Education programs and resources should enhance accurate perception of risk and self-evacuation in buildings designed for people on mass, such as assembly, office, shop, and laboratory buildings.

Recommendation: Where other residential properties (such as boarding houses, hotel/motels, residential care, and detention centres) were at a higher risk of firefighter-assisted evacuation, Prevention + Education programs and resources should enhance accurate perception of risk and self-evacuation.

Recommendation: Where residential detached, carpark, and storage buildings were at higher risk of fire extension, Prevention + Education should focus on what to do in the event of a fire to mitigate fire spread, such as closing doors during safe self-evacuation, and advocate for the installation of fire suppression, such as sprinkler systems.

Recommendation: Where non-habitable buildings were at a higher risk of fire extension, further research is needed to understand the use and users of non-habitable structures and how this influences risk.

Recommendation: Advocate for built environment fire safety mechanisms, such as sprinkler installation, in high-risk buildings such as residential attached, residential detached, aged care, carpark, and storage buildings, particularly those owned by Commonwealth and State Government.

Recommendation: Review response protocols for structure fires that occur within high-risk properties such as residential attached, residential detached, aged care, carpark, and storage buildings, particularly those owned by Commonwealth and State Government, to ensure that resource allocation is proportionate to risk.

6.8 Alarm/Detector Characteristics

6.8.1 Functionality

Smoke alarms/detectors were found to be present in 57.5% of structure fires. Of these, 71.1% were functioning at the time of the fire. These proportions align with existing literature (Coates et al. 2019; Lilley, McNoe & Duncanson, 2018). While other studies have found that the absence of a functioning smoke alarm increases risk of fatality (Duncanson, Woodward & Reid, 2000; Runefors, Johansson & van Hees, 2016), this study found that smoke alarm functionality was not a predictor of fatality. Instead, smoke alarm operation predicted injury and fire extension. It also predicted injury in undetermined fires, and evacuation and fire extension in deliberate and undetermined fires.

The odds of a structure fire resulting in injury were 0.84 times lower when smoke alarms were operating compared to not operating at the time of the fire. However, when the fire was of undetermined cause, the odds of injury were 1.8 times higher when alarms were operating.

The odds of evacuation in a deliberate fire were 0.65 times lower when alarms were not operating at the time of the fire. When the fire was of undetermined cause, odds of evacuation were 2.0 times higher when alarms were operating.

The odds of fire extension were 0.65 times lower when smoke alarms were operating. This was reflected in deliberate (0.54) and undetermined (0.33) fires.

6.8.2 Type of alarm

Type of alarm predicted fatality, injury, evacuation, and fire extension. It also predicted fatality and evacuation in accidental and undetermined fires, and fire extension in accidental fires.

The odds of a structure fire resulting in fatality were 51.3 times higher when the alarm type was aspirating smoke detection compared to other alarm types. This relationship was reflected in accidental fires (90.7). Odds of fatality in an undetermined fire were 4.2 times higher when the alarm type was a hard-wired smoke alarm.

The odds of injury were 6.9 times higher when an infrared detector was present, compared to other alarm types.

The odds of evacuation were 0.86 times lower when the type of alarm was a smoke detector, but 1.5 times higher when a sprinkler system was present. When the fire was accidental, the relative risk of evacuation was 0.85 times lower when the type of alarm was smoke detection. When the fire was undetermined, relative risk increased 5.2 times when the alarm was a multicriteria detector.

The odds of fire extension were higher when the alarm type was a Manual Call Point (4.3) or a battery-operated smoke alarm (1.1) compared to other alarm types. This held true for accidental fires (4.8 and 1.2, respectively).

The presence of aspirating smoke detection (n = 1 to 16), battery-powered smoke alarms (n = 231 to 830), and hard-wired smoke alarms (n = 259 to 1097) increased significantly over time. The presence of thermal detectors (n = 47 to 20) decreased significantly over time.

6.8.3 Reason for alarm failure

Reason for alarm failure predicted fatality, injury, evacuation, and fire extension. It also predicted fatality and evacuation in accidental fires; injury in accidental and undetermined fires; and fire extension in accidental, deliberate, and undetermined fires.

The odds of fatality were 4.5 times higher when alarms were present but did not operate because they were defective, compared to all other reasons for failure. This was reflected, yet higher, in accidental fires (11.9).

The odds of injury were 1.7 times higher when the alarm was present but did not operate because the battery was missing or disconnected, compared to all other reasons for failure. However, when the alarm did not operate because the fire was not within range (0.72) or because the fire was too small (0.66), the odds of injury were lower. These findings are reflected in accidental fires, where risk was higher for failure caused by missing or disconnected batteries (1.6), but lower when the fire was not within range (0.64) or was too small (0.56). When the fire was undetermined, odds of injury were 7.6 times higher when alarms failed to operate because the battery was discharged or dead.

The odds of evacuation were 1.6 times higher when the alarm was present but did not operate because the battery was missing or disconnected and 1.4 times higher when the alarm was defective. Odds of evacuation were lower when the alarm failed because the fire was not within range of the detector (0.88) or the fire was too small (0.61). When the fire was accidental, odds of evacuation were higher when alarms failed to operate because the battery was discharged or dead (1.7), the battery was missing or disconnected (1.8), the alarm was defective (1.7), there was a hard-wire power failure and dead or discharged back-up batteries (1.8), or when there was a hard-wire power failure and missing back-up batteries (1.8). The odds of evacuation in accidental fires were lower when the fire was too small to activate the alarm (0.63).

Odds of fire extension were 2.5 times higher when alarms failed to operate due to a hard-wire power failure and a discharged or dead back-up battery. Odds of fire extension were lower when alarms did not operate because the fire was not within range of the detector (0.41), and the fire was too small (0.14). When structure fires were accidental or deliberate, odds of fire extension increased when alarms failed to operate due to a hard-wire power failure and a discharged or dead back-up battery (2.3 & 4.8 respectively) and decreased when alarms did not operate because the fire was not within range of the detector (0.61 & 0.24 respectively), and the fire was too small (0.20 & 0.11 respectively). When the fire was undetermined, odds of fire extension decreased when alarms failed to operate because they were defective (0.19), because the fire was not within range of the detector (0.17), and the fire was too small (0.06).

Missing or disconnected batteries (n = 51 to 39) and hard-wire failure and missing back up batteries (n = 20 to 8) decreased over time, while alarm failure due to the fire not being within range of the detector (n = 254 to 410) increased over time.

6.8.4 Call source

Call source predicted fatality, preventable fatality, injury, evacuation, and fire extension. It also predicted fatality and injury in accidental and deliberate fires and evacuation and fire extension in an accidental, deliberate, and undetermined fires.

The odds of a structure fire resulting in fatality were 2.6 times higher when the call source was an ICEMS (inter-agency CAD electronic messaging system), compared to any other call source. This was reflected in accidental (5.1) and deliberate (4.6) fires.

The odds of preventable fatality (compared to non-preventable fatality) were 24.5 times higher when the call source was a Triple Zero call, compared to any other call source.

The odds of injury were 2.0 times higher when the call source was an ICEMS (inter-agency CAD electronic messaging system), but 0.58 times lower when the call source was a call to station. These findings are reflected in accidental fires (2.3 and 0.49, respectively). In deliberate fires, odds of injury were 2.0 times higher when the call source was an ICEMS.

The odds of evacuation were higher when the call source was a Triple Zero call (1.5) or an AFA (1.7), compared to any other call source. When the call source was a call to station, odds of evacuation were lower (0.65). When the fire was accidental, odds of evacuation were higher when the call source was an AFA (1.2) yet lower when the source was a call to station (0.45) or an ICEMS (0.73). When the fire was deliberate or undetermined, odds of evacuation were higher when the source was a Triple Zero call (1.6, respectively) or AFA (4.1, respectively).

The odds of fire extension were higher when the call source was a Triple Zero call (2.2) but lower when the call source was an ICEMS (0.64), compared to other call sources. When the fire was accidental (1.7), deliberate (1.9), or undetermined (1.6), odds of fire extension were higher when the call source was a Triple Zero call.

These findings suggest that Triple Zero calls are used when risk of preventable fatality, evacuation, and fire extension are higher, while calls to station are used when risk of injury and evacuation are lower. Inter-agency CAD electronic messaging systems are used when risk of fatality and injury are higher, but risk of evacuation and fire extension are lower.

6.8.5 Alarm/detector summary

These findings suggest that operating smoke alarms decreased risk of injury, unless the fire was undetermined, in which case risk of injury increased. The purpose of smoke alarms/detectors is to provide early notification of a fire to facilitate safe suppression or self-evacuation to reduce the risk of personal harm (Kinateder et al., 2015; Runefors, Johansson & van Hees, 2016). Where smoke alarm operation decreased the risk of injury, alarms functioned as intended. However, an increased risk of injury in undetermined fires may have occurred where a functioning smoke alarm alerted occupants to the fire, who then, in an attempt to seek further information about the fire, extinguish the fire, or in the process of evacuating the building, became injured. This is a valid hypothesis where existing literature suggests that people take information-seeking actions after being alerted to a fire but before evacuating (Kinateder et al., 2015), and that attempts to suppress a fire or escape from it are associated with fire injury (Shokouhi et al., 2019) and fatality (Coates et al. 2019; Lilley, McNoe & Duncanson, 2018; Runefors, Johansson & van Hees, 2016; Shokouhi et al., 2019). Further, people may overestimate the available time to escape because they are unable to comprehend the exponential growth of fire (Runefors, Johansson & van Hees, 2016) and do not accurately perceive risk in time to evacuate (Kinateder et al., 2015). There is also evidence to suggest that people sleeping in a room of fire origin may not be woken by an activating smoke alarm/detector. Instead, the alarm may be raised by passers-by. In these situations, the sleeping occupiers may not be alerted to the fire until woken by another occupier, a passer-by, or firefighters and may be injured due to a delayed response (Sekizawa & Mizuno, 2017).

Risk of firefighter-assisted evacuation was higher when the call source was an AFA and when smoke alarms were operating during a fire of undetermined cause. Although literature suggests that smoke alarms/detectors alert occupants and initiate evacuation (Kinateder et al., 2015; Runefors, Johansson & van Hees, 2016), this is not reflected here. When the smoke alarm/detector operated in an undetermined fire or an AFA operated, it was not sufficient in initiating self-evacuation before firefighter arrival. Instead, some occupants may have remained in the structure until firefighters arrived to initiate evacuation. This may reflect the findings above where people do not accurately perceive risk, do not initiate self-evacuation, or are not woken by an activating alarm. Alternatively, or in addition, AFAs may have occurred more often in structures designed for people on mass. Where these structures take longer to self-evacuate, some firefighter-assistance may have been necessary to complete evacuation.

Conversely, risk of fire extension was lower when smoke alarms were operating. This may have occurred where smoke alarms/detector activation shortened the time taken to identify and report, and thus to respond to and extinguish, the fire. Again, this finding provides evidence that smoke alarms/detectors are working as intended.

The presence of different alarm types increased risk of different adverse outcomes. This may have occurred where the effectiveness of smoke alarm/detectors differed by individual, situational, and environmental factors. Runefors, Johansson, and van Hees (2016) found that even though thermally activated suppression systems, such as sprinklers, had the highest potential effectiveness for the prevention of fire fatalities, effectiveness was significantly lower for smokers who received home care, particularly when the fatality occurred in the object of first ignition, such as a bed. Instead, detector activated suppression systems may be more suitable for high-risk groups. Although usually more prone to false activation than thermally activated systems, these systems could be used in high-risk structures (Runefors, Johansson & van Hees, 2016). Further research is necessary to ascertain the most effective alarm/detector for individual, situational, and environmental circumstances.

A variety of reasons impacted alarm functionality, and these had differing effects on risk of adverse outcomes. When alarms were present but did not operate because the fire was not within the designed range of the detector or was too small to be detected, risk of injury, evacuation, and fire extension were lower compared to other reasons for failure. Conversely, when alarms failed because they were defective, had missing or disconnected batteries, or failed to operate due to a hard-wire power failure and a discharged or dead back-up battery, relative risk was higher. These findings highlight the importance of smoke alarm/detector installation, maintenance, testing, and replacing of batteries.

Finally, these findings suggest that Triple Zero calls were used when risk of preventable fatality, evacuation, and fire extension were higher, while calls to station were used when risk of injury and evacuation were lower. This reflects the intended purpose of Triple Zero, which is for use during time critical, life-threatening emergencies, and direct lines to stations, which are intended for non-emergency incidents. Inter-agency CAD electronic messaging systems were used when risk of fatality and injury were higher, but risk of evacuation and fire extension were lower. This indicates that structure fires causing fatality and injury are coming to the attention of other emergency services agencies, who are then relaying the message to FRNSW.

Recommendation: Prevention + Education programs and resources should enhance understanding of exponential fire growth and support more accurate perceptions of risk and estimations of available time to escape, particularly for occupants of buildings that take longer to be safely evacuated.

Recommendation: Prevention + Education efforts should prioritise programs and resources that support proper installation, maintenance, testing, and replacing batteries for battery-operated and hard-wired alarms.

Recommendation: Prevention + Education messaging, resources, and programs should provide education about what to do in the event of a fire. Messages such as when and how to safely use a fire blanket and fire extinguisher, when and how to safely evacuate, the need to remain in a safe location until firefighters arrive, and how to provide burns first aid are critical to preventing and mitigating fire injuries and firefighter-assisted evacuations.

Recommendation: Collect self-report data to understand the factors affecting the presence and functionality of smoke alarms/detectors and the types selected, and human behaviour in response to smoke alarm/detector activation in the event of a fire.

Recommendation: Where the presence of different alarm types increased risk of different adverse outcomes, there is a need to conduct further research to determine the most effective activation and/or suppression systems and the number of alarms for different individual, situational, and environmental circumstances.

Recommendation: Investigate why there is a higher risk that structures fires that result in fatality and injury are reported by other emergency services agencies via the inter-agency CAD electronic messaging system (ICEMS).

6.9 Fire Characteristics

6.9.1 Cause determination

Cause determination was a risk factor for fatality, injury, evacuation, and fire extension.

6.9.1.1 Undetermined

When the cause of the fire remained undetermined, the odds of fatality (2.6), injury (1.8), evacuation (1.4), and fire extension (1.4) were higher compared to other cause determinations.

6.9.1.2 Accidental

When the cause of the fire was accidental, the odds of injury (2.6) and evacuation (1.6) were higher, while the odds of fire extension (0.79) were lower, compared to other cause determinations.

6.9.1.3 Deliberate

When the cause of the fire was deliberate, the odds of evacuation were 0.68 times lower compared to other cause determinations.

6.9.1.4 Natural

When the cause of the fire was natural, the odds of fire extension were 12.0 times higher compared to other cause determinations.

6.9.2 Ignition source

Ignition source predicted preventable fatality, injury, evacuation, and fire extension. It also predicted fatality in accidental fires and injury, evacuation, and fire extension in accidental, deliberate, and undetermined fires. These findings align with existing evidence that ignition sources such as candles, heating, and electrical appliances are risk factors of adverse outcomes (Coates et al., 2019; Jonsson et al., 2017; Lilley, McNoe & Duncanson, 2018; Miller, 2005; Runefors, Jonsson & Bonander, 2021; Shokouhi et al., 2019). However, there is a paucity of research on specific at-risk ignition sources, such as electric lamps or light bulbs, or cutting, welding, or heating torches. Deeper analysis is necessary.

In accidental structure fires, the odds of fatality were 10.0 times higher when the ignition source was an electric lamp or light bulb compared to other ignition sources.

The odds of preventable fatality (compared to non-preventable fatality) were 0.02 times lower when the fire was ignited by radiated heat compared to other ignition sources.

The odds of a structure fire resulting in injury were higher when the fire was ignited by a candle or taper (1.5), a cutting, welding, or heating torch (3.1), or static discharge (6.4) compared to other ignition sources. Odds of injury were lower when the ignition source was hot ember or ash (0.59) or a re-kindle or re-ignition (0.16). These findings are reflected in accidental fires. When the fire was deliberate, odds of injury were 79.6 times higher when the ignition source was a cutting, welding, or heating torch, while odds of injury in undetermined fires were 2.6 times higher when the form of heat ignition was undetermined.

The odds of evacuation were higher when the fire was ignited by heat from overloaded electrical equipment (1.2) or molten, hot material (1.5), but lower when the ignition source was properly operating electrical equipment (0.88), hot ember or ash (0.74), an open fire (0.34), a re-kindle (0.14), or the sun’s heat (0.32). This was very closely reflected in accidental fires, except where improperly operating electrical equipment increased odds of evacuation (1.2). In deliberate fires, odds were 11.8 times higher when the ignition source was overloaded electrical equipment. In undetermined fires, risk was lower when the ignition source was hot ember or ash (0.32), a match or lighter (0.55), or a re-kindle (0.19).

The odds of fire extension were higher when the fire was ignited by a cutting, welding, or heating torch (1.6), heat from a flying brand or ember (2.5), hot ember or ash (1.4), an incendiary device (1.7), a match or lighter (1.4), or an undetermined source (1.7), but lower when the fire was ignited by properly operating electrical equipment (0.78). In accidental fires, odds were higher when the ignition source was an open fire (2.2), heat from a flying brand (2.0), undetermined (1.8), or hot ember (1.3) and lower when the ignition source was conducted heat (0.66), properly operating electrical equipment (0.77), or smokers’ materials (0.76). In deliberate fires, odds were lower when the fire was ignited by properly operating electrical equipment (0.19) or an open fire (0.24). When the fire was undetermined, odds were higher when the ignition source was conducted heat (4.8), an incendiary device (3.9), direct flame (3.0), overloaded electrical equipment (2.5), undetermined (2.2), or a match or lighter (1.8).

6.9.3 Material ignited first

Material ignited first predicted fatality, injury, evacuation, and fire extension. It also predicted fatality, injury, evacuation, and fire extension in accidental, deliberate, and undetermined fires. While existing literature has identified a link between bedding, furniture, domestic appliances, heating appliances, and adverse outcomes, particularly fatality and injury (Duncanson et al., 2002; Jonsson et al., 2017; Miller, 2005; Runefors, Jonsson & Bonander, 2021; Shokouhi et al., 2019; Steen-Hansen, Storesund & Sesseng, 2021; Xiong, Bruck & Ball 2015), this study has identified at-risk materials that require further investigation.

6.9.3.1 Flammable gases and liquids

The odds of a structure fire leading to fatality were higher when the material ignited first was petrol (9.2) or another flammable liquid (8.7). In a deliberate fire, odds were higher when the material ignited first was petrol (27.9).

Odds of injury were higher when the material ignited first was an atomised, vapourised liquid (8.2), LPG (4.2), natural gas (3.2), a petroleum fuelled engine (4.7), other flammable liquid (3.1), petrol (3.3), a fuel or gas system component (2.1), a gas outlet (3.1), or gas lines (2.4). In accidental fires, odds of injury were higher when the material ignited first was alcohol (7.2), an atomised vapourised liquid (6.0), gas lines (2.4), a gas outlet (3.6), LPG (4.1), natural gas (3.2), other flammable liquid (3.4), petrol (5.5), or a petroleum fuelled engine (7.0). In deliberate fires, odds were higher when the material was an atomised vapourised liquid (32.6), while when the fire was undetermined, risk increased when the material was alcohol (61.7).

Odds of evacuation were higher when the material ignited first was LPG (1.5), but lower when it was petrol (0.60). When the fire was accidental or undetermined, odds were higher when the material was LPG (1.7 and 21.5 times respectively). When the fire was deliberate, odds were higher when the material was alcohol (9.8).

Odds of fire extension were higher when the material ignited first was petrol (1.8). When the fire was deliberate, odds of fire extension were higher when the material was LPG (25.7), petrol (1.9), or a petroleum fuelled engine (8.7). When the fire was undetermined, odds were higher when the material was other flammable liquid (68.8).

6.9.3.2 Bedding

When the material ignited first was bedding, there were higher odds of adverse outcomes.

In accidental structure fires, the odds of fatality were higher when the material ignited first was bedding (23.7) or a mattress or pillow (50.1).

The odds of injury were higher when the material ignited first was bedding (2.0). This reflects risk in accidental (2.1) and deliberate (2.7) fires.

When the fire was undetermined, the odds of fire extension were higher when the material ignited first was a mattress or pillow (7.0).

6.9.3.3 Furniture and soft goods

Structure fires involving furniture, curtains, linen, and clothing increased odds of adverse outcomes.

The odds of fatality were higher when the material ignited first was other (furniture; 6.2). When the fire was undetermined, odds of fatality were higher when the material ignited first was other (furniture; 29.8).

The odds of injury were higher when the material ignited first was clothing not on a person (1.6) or a sofa, chair, or seating (1.5). When the fire was accidental, odds of injuries were higher when the material was a fixed stationary surface unit (2.7). When the fire was deliberate, odds were higher when the material was clothing not on a person (2.7) or other (soft goods, wearing apparel; 12.0).

In accidental fires, the odds of evacuation were higher when the material ignited first was a sofa, chair, or seating (1.9). In deliberate fires, odds were higher when the material was curtains, blinds, drapery (2.5) or other (furniture; 1.8). When the fire was undetermined, odds were higher when the material was other (furniture; 2.1).

Odds of fire extension were higher when the material ignited first was cabinetry (1.8) or other (furniture; 1.5), but lower when the material was clothing not on a person (0.60). When the fire was accidental, odds were higher when the material was cabinetry (2.1) or other (furniture; 1.7). When the fire was deliberate, odds were higher when the material was other (furniture; 1.7) but lower when the material was clothing not on a person (0.46) or curtains, blinds, or drapery (0.23).

6.9.3.4 Clothing on a person

Structure fires resulting from fires ignited against clothing on a person predicted injury. When the material ignited first was clothing on a person at the time of the fire, odds of injury were 26.3 times higher. When the fire was accidental, odds of injury were 13.1 times higher; when it was deliberate, odds of injury were 40.0 times higher.

6.9.3.5 Domestic appliances

Structure fires involving domestic appliances increased risk of injury, evacuation, and fire extension.

Odds of injury were higher when the material ignited first was a washing machine (2.7). This is reflected in accidental fires (2.5). When the fire was deliberate, odds of injury were higher when the material was electrical equipment domestic appliance (15.4) or a fixed stationary oven (14.1). When the fire was undetermined, odds were higher when the material was an iron (20.6).

Odds of evacuation were higher when the material ignited first was a dryer (1.6), but lower when the material was other (appliances, home equipment; 0.60). This was reflected in accidental fires.

Odds of fire extension were higher when the material was a television, monitor, of visual display (2.8). This was reflected in accidental fires (2.8).

6.9.3.6 Air-conditioning, refrigeration, heating

Structure fires involving air-conditioning, refrigeration, and heating items also presented a significant risk. The odds of fatality were higher when the material ignited first was a fixed fan (cooling or exhaust; 42.1x) or an air conditioning unit, portable (37.3x). This was true for accidental structure fires, where odds of fatality were 256.3 times higher when the material was a portable air conditioning units and 70.1 times higher for fixed fans.

The odds of evacuation were higher when the material was a local refrigeration unit, fixed stationary (2.1) and a fixed fan (cooling and exhaust; 1.7), yet lower when the material was a local heating unit, fixed, stationary (0.42). When the fire was accidental, odds of evacuation were higher when the material was a fixed stationary air conditioning unit (1.4), a fixed fan (cooling and exhaust; 1.6), or a local refrigeration unit, fixed, stationary (2.1). When the fire was deliberate, odds were higher when the material was an indoor open fireplace (5.1).

When the fire was undetermined, the odds of fire extension were higher when the material was other (heating systems; 10.0).

6.9.3.7 Tools and equipment

Structure fires involving tools and equipment presented some risk of adverse outcomes.

Odds of injury were higher when the material ignited first was an electric bike, mobility scooter, or ride on toy (13.0). When the fire was accidental, odds were higher when the material was heat treating equipment (4.7). When the fire was undetermined, odds were higher when the material was an electronic device, battery powered (15.4), electric motor driven equipment (16.4), or chemical process equipment (21.1).

Odds of fire extension were higher when the material ignited first was a charger (device) or battery charger (1.9), chemical process equipment (9.5), or torches, welding, and cutting equipment (5.9). When the fire was accidental, odds were higher when the material was a charger (device) or battery charger (1.9) or torches, welding, and cutting equipment (5.9).

6.9.3.8 Structural components

Structure fires involving structural components increased odds of adverse outcomes.

Odds of fatality were higher when the material ignited first was other (structural component, finish; 7.8x). When the fire was deliberate, odds of fatality were higher when the material ignited first was other (structural component, finish; 81.1x) or floor covering, surface (11.8x).

In deliberate fires, odds of injury were higher when the material ignited first was insulation within a wall or space (13.9). When the fire was undetermined, odds were higher when the material was electrical system, component, wiring, or outlet (2.8).

Odds of evacuation were lower when the material ignited first was inverters, converters, rectifiers, and capacitors (0.28), electrical wiring, fixed (0.52), floor covering or surface (0.47), interior covering or permanently affixed surface item (0.42), fixed lighting (0.59), other (structural component, finish; 0.47), power switch gear, over-current protection devices (0.48), or structural member, framing (0.61). Odds of evacuation in accidental fires were lower when the material was electrical wiring fixed (0.56), floor covering or surface (0.38), inverters etc. (0.16), and other (structural component, finish; 0.36). When the fire was undetermined, odds were higher when the material was mains supply, transformer (24.1).

Odds of fire extension were higher when the material ignited first was an electrical system component, wiring, or outlet (1.3), exterior covering or permanently affixed surface item (2.0), exterior roof overing, surface, finish (2.4), exterior side wall covering, cladding, surface, finish (2.1), flooring, trim or upholstery material (1.9), interior wall covering, surface, items permanently affixed to wall or door surface (2.6), other (structural component, finish; 2.7), other (mobile property component; 2.2), or structural member, framing (1.9). Odds were lower when the material was fixed lighting (0.29). When the fire was accidental, odds were higher when the material was exterior trim (3.4), floor covering (2.0), flooring trim (3.3), other (structural component, finish; 2.3), or structural member, framing (2.2) and lower when the material was fixed lighting (0.21). When the fire was deliberate, odds were higher when the material was ceiling covering (7.9), an electrical system, component, wiring (6.3), or other (mobile property component; 3.0), and lower when the material was exterior trim (0.24). When the fire was undetermined, odds were higher when the material was fixed electrical wiring (4.1), exterior covering (16.6), interior wall covering (15.9), or other (structural component, finish; 7.1).

6.9.3.9 Goods, stock, and supplies

Structure fires involving goods, stock, and supplies also increased risk.

Odds of injury were higher when the material ignited first was cleaning supplies and products (2.7) or supplies or stock in a basket or barrel (11.1). These were reflected in accidental fires. When the fire was deliberate, odds were higher when the material was supplies or stock in a box, carton, or bag (11.5), or a toy or game (18.3).

Odds of evacuation were higher when the material ignited first was supplies or stock in a box, carton, or bag (1.7). This was reflected in accidental fires (1.9). Accidental fires also increased odds of evacuation when the material was other (books, papers, recreational materials, decorations; 1.7).

Odds of fire extension were higher when the material ignited first was other (supplies, stock; 2.4) and lower when the material was packing, wrapping material (0.50) or other (books, papers, recreational material, decorations; 0.51). When the fire was accidental, odds were lower when the material was other (books, papers, recreational materials, decorations; 0.38). When the fire was deliberate, odds were lower when the material was packing, wrapping material (0.18). When the fire was undetermined, odds were higher when the material was other (supplies or stock; 5.7).

6.9.3.10 Other materials

Other materials also increased risk.

Odds of injury were higher when the material ignited first was other (other fuel; 4.5), other (special form; 14.4), or an agricultural product (12.2). When the fire was undetermined, odds were higher when the material was other (general form; 4.9).

Odds of evacuation were lower when the material ignited first was a fence, pole, or sign (0.43), grass, bush, or forests (0.53), rubbish, trash, or waste (0.73), solid fuel (0.55), or other object (0.59). This was reflected in accidental fires. When the fire was undetermined, odds were higher when the material was other (power transfer equipment; 12.3).

Odds of fire extension were higher when the material ignited first was bush, grass, forests (1.9). When the fire was accidental, odds were higher when the material was fertiliser (8.7) or bush, grass, forests (2.2). When the fire was undetermined, odds where higher when the material was bush, grass, forests (9.6).

6.9.3.11 Undetermined or unassigned

Odds of fatality were higher when the material ignited first was not assigned (17.7) or was undetermined (4.8). The odds of fatality were higher when the material ignited first was undetermined in an accidental fire (6.3), undetermined fire (11.1) and deliberate fire (24.4). Odds of fatality in an accidental fire were higher when the material ignited first was not assigned (33.2).

Odds of evacuation were higher when the materials ignited first was undetermined (0.71) or not assigned (0.51). This was reflected in accidental fires (0.48 and 0.71, respectively).

Odds of fire extension were higher when the material ignited first was undetermined (2.9), yet lower when it was unassigned (0.31). This was reflected in accidental fires (2.4 and 0.30, respectively), deliberate fires (3.4 and 0.23, respectively), and undetermined fires (undetermined 3.9).

6.9.4 Area of origin

Area of origin predicted fatality, preventable fatality, injury, evacuation, and fire extension. It also predicted fatality in accidental and undetermined fires and injury, evacuation, and fire extension in accidental, deliberate, and undetermined fires. This aligns with studies that have identified a relationship between area of origin, particularly bedrooms, lounge rooms, and kitchens with fatality and injury (Coates et al., 2019; Jonsson et al., 2017; Lilley, McNoe & Duncanson, 2018; Runefors, Jonsson & Bonander, 2021; Shokouhi et al., 2019; Steen-Hansen et al., 2021).

6.9.4.1 Residential areas

Odds of fatality were higher when the fire originated in a bedroom for less than five people (16.9), a lounge room (14.1), a hallway or corridor (12.2), an exterior balcony, open porch, or veranda (5.2), or a kitchen or cooking area (5.1). When the fire was accidental, odds of fatality were higher when the fire originated in a lounge room (9.3) or kitchen (5.2). When the fire was undetermined, odds of fatality were higher when the fire originated in a bedroom for less than five people (62.4), a lounge room (41.3), an exterior balcony, open porch, or veranda (31.7), a hallway or corridor (30.4), or a kitchen or cooking area (12.9).

Odds of preventable fatality (compared to non-preventable fatality) in an accidental fire were lower when the fire originated in the kitchen or cooking area (0.03).

Odds of injury were higher when the fire originated in a bedroom for five or more persons (2.0), a bedroom for less than five persons (2.1), a lounge room (1.5), an office (2.0), or a garage (1.4). In accidental fires, odds were higher in a bedroom for less than five persons (2.1), lounge room (1.7), and office (2.0). When the fire was deliberate, odds were higher when the fire originated in a bedroom for less than five persons (1.7).

Odds of evacuation were higher when the fire originated in a bedroom for less than five persons (1.5) or a garage or workshop (1.3) and lower when the fire originated in a kitchen or cooking area (0.85). When the fire was accidental, odds of evacuation were higher in a bathroom (1.5), bedroom for less than five persons (1.9), or a garage or workshop (1.4). When the fire was deliberate, odds were higher when the fire originated in a bedroom for less than five persons (1.4) and a garage or workshop (2.3). When the fire was undetermined, odds were higher in a bedroom for less than five persons (1.5), a bedroom for five or more persons (3.1), or an exterior balcony, open porch, or veranda (1.8).

Odds of fire extension were lower when the fire originated in a bathroom, lavatory, or locker room (0.22), kitchen or cooking area (0.37), lobby or entrance way (0.38), or laundry room (0.49). When the fire was accidental, odds were higher in a garage or workshop (1.4) but lower when the fire originated in a bathroom, lavatory, or locker room (0.27), laundry (0.49), or kitchen or cooking area (0.34). When the fire was deliberate, odds were lower in a bathroom, lavatory, or locker room (0.25) and lobby (0.37). When the fire was undetermined, odds were higher in a lounge room (1.8), but lower in a bathroom, lavatory, or locker room (0.07), kitchen or cooking area (0.67), or laundry room (0.40).

6.9.4.2 Structural areas

Odds of injury were lower when a fire originated in a ceiling cavity (0.34) or chimney/flue (0.28). These findings are reflected in accidental fires (0.34 and 0.29, respectively).

Odds of evacuation were higher when the fire originated in a ceiling cavity (1.3), chute or conveyor (2.9), interior stairway (2.2), fire stairway (5.8), lift (2.9), or duct (2.1), but lower when the fire originated in a vacant structural area (0.44). When the fire was accidental, odds of evacuation were higher in a ceiling cavity (1.4), chimney or flue (1.2), chute or conveyor (2.7), or duct (2.0). When the fire was deliberate, odds were higher when the fire originated in a fire stairway (4.8) and lift (45.5). When the fire was undetermined, were higher in a lift (30.9) or duct (9.1).

Odds of fire extension were higher when the fire originated in a ceiling cavity (1.3), but lower when the fire originated in a chimney or flue (0.28), or exterior roof surface (0.51). When the fire was accidental, odds were higher in an area under construction or renovation (2.0), ceiling cavity or roof space (1.5), exterior wall surface (1.7), and sub-floor space (2.7), while lower in a chimney or flue (0.35) and exterior roof surface (0.41). When the fire was deliberate, odds were higher in an exterior wall surface (1.9) but lower in a chimney or flue (0.14). When the fire was undetermined, odds were higher in a ceiling cavity or roof space (1.8) but lower in a chimney or flue (0.07).

6.9.4.3 Carpark areas

Odds of evacuation were higher when the fire originated in a closed carpark for more than 40 cars (2.4) or a closed carpark for up to 40 cars (2.6). When the fire was undetermined, odds were higher when the fire originated in a close carpark for up to 40 cars (5.7).

6.9.4.4 Storage areas

Odds of evacuation were higher when the fire originated in a storage area for greater than 2000 sqm (2.5). This held true for accidental fires (2.3). Odds of fire extension were higher in accidental fires when the fire originated in a storage area less than 10 sqm (1.6).

6.9.4.5 Assembly/Recreation areas

Odds of evacuation were lower when the fire originated in a dining room, lunchroom, or cafeteria (0.71) or a recreational area (0.37). When the fire was deliberate, odds of evacuation were higher when the fire originated in a or a retail or sales area (3.6).

Odds of fire extension were lower when the fire originated in a dining area, lunchroom, or cafeteria (0.56), medium sized assembly area (0.36), a recreational area (0.51), or retail or sales area (0.33). When the fire was accidental, odds were lower when the fire originated in a dining area, lunchroom, or cafeteria (0.37) or retail or sales area (0.28). When the fire was undetermined, odds were lower in a retail or sale area (0.09).

6.9.4.6 Outdoor areas

Odds of injury were lower in outdoor areas including a lawn, field, or open area (0.51) and highway or roadway (0.08). These findings are reflected in accidental fires (0.43 and 0.08, respectively).

Odds of evacuation were lower when the fire originated in court, patio, or terrace (0.66), a lawn, field, or open area (0.39), or on a highway, roadway, public way (0.43). These findings reflect risk in accidental fires (0.64, 0.46, and 0.30, respectively). When the fire was deliberate, odds were lower when the fire originated in a lawn, field, or open area (0.15).

Odds of fire extension were lower when the fire originated in a lawn, field, or open area (0.56), highway, roadway, or public way (0.18), or court, terrace, or patio (0.71). When the fire was accidental, odds were lower when the fire originated on the highway, roadway, or public way (0.25). When the fire was deliberate, odds were lower in a lawn, field, open area (0.32) and highway, roadway, or public way (0.14). When the fire was undetermined, odds were lower in a highway, roadway, or public way (0.26).

6.9.4.7 Other areas

Odds of injury were higher when the fire originated in a cell or secure confinement area (3.6). However, odds were lower in electricity, gas, or water areas (0.32). This finding is reflected in accidental fires (0.29). When the fire was deliberate, odds were higher when the fire originated in a rubbish tip (12.4).

Odds of evacuation were higher when the fire originated in a cell or secure confinement area (3.2), process, manufacturing area (1.5), and a laboratory (2.6). When the fire was accidental, odds of evacuation were higher in a laboratory (3.7) and a process, manufacturing area (1.5). When the fire was deliberate, odds were higher when the fire originated in a passenger compartment (7.3) or process manufacturing area (13.5).

Odds of fire extension were lower when the fire originated in a cell or secure confinement area (0.16), electricity, gas, or water area (0.32) or waste recycling/disposal area (0.65). When the fire was accidental, odds were lower when the fire originated in an electricity, gas, or water area (0.37). When the fire was deliberate, odds were lower in a medium sized assembly area (0.26) or a recreational area (0.12). When the fire was undetermined, odds were lower in an equipment room area (0.25).

6.9.4.8 Undetermined or multiple areas

Odds of fatality were higher when the fire originated in multiple areas (12.7). When the fire was undetermined, odds of fatality were higher when the fire originated in an undetermined area (187.8) or multiple areas (61.9).

Odds of preventable fatality (compared to non-preventable fatality) were lower when the fire originated in multiple areas (0.02).

Odds of fire extension were higher when the fire originated in an undetermined area (14.2) or multiple areas of origin (2.5). This held true for deliberate fires (34.1 and 3.0, respectively), undetermined fires (8.1 and 6.5, respectively), and accidental fires (undetermined 9.6).

6.9.5 Fire characteristics summary

Cause determination was a risk factor of fatality, injury, evacuation, and fire extension. Structure fires increased odds of fatality when they were undetermined, injury when they were undetermined or accidental, evacuation when they were undetermined or accidental, and fire extension when they were undetermined or natural.

Ignition source predicted preventable fatality, injury, evacuation, and fire extension. It also predicted fatality in accidental fires and injury, evacuation, and fire extension in accidental, deliberate, and undetermined fires. While electric lamps or light bulbs increased risk of fatality, non-preventable fatality was predicted by radiated heat. Fires ignited by a cutting, welding, or heating torch increased relative risk of injury and fire extension, while the odds of evacuation were higher when the fire was ignited by molten hot material or overloaded electrical equipment. These findings indicate that different ignition sources present different levels of risk depending on the adverse outcome under investigation.

Materials ignited first predicted fatality, injury, evacuation, and fire extension. It also predicted fatality, injury, evacuation, and fire extension in accidental, deliberate, and undetermined fires. Materials such as bedding, flammable gases and liquids, and air conditioning, heating, and refrigeration units predicted multiple adverse outcomes. For example, while petrol increased relative risk of fatality and injury, it decreased risk of evacuation and held no relationship with fire extension. Adverse outcomes also had distinct risk profiles. For example, odds of fatality were higher when the material ignited first was a fixed fan, portable air conditioning unit, outdoor cooking equipment, other (furniture), other (structural component), other flammable liquid, or petrol. Certain materials ignited first were also distinct to adverse outcomes when they had a particular cause determination. For example, odds of evacuation were higher when the material ignited first was alcohol, but only in deliberately lit fires. These findings suggest that different materials ignited first present different levels of risk depending on adverse outcome and cause determination.

Area of origin predicted fatality, preventable fatality, injury, evacuation, and fire extension. It also predicted fatality in accidental and undetermined fires and injury, evacuation, and fire extension in accidental, deliberate, and undetermined fires. Fires originating in residential areas presented higher relative risk of fatality, injury, and evacuation, while structural areas presented a higher risk of fire extension. Fires originating in carparks, storage, and other areas increased relative risk of evacuation, while undetermined areas of origin or multiple areas of origin increased risk of fatality, preventable fatality, and fire extension. Again, these findings reiterate the findings that different areas of origin present different levels of risk depending on the adverse outcome.

Recommendation: Conduct further research to identify and explore the factors that influence a cause determination of undetermined. A deeper analysis of structure fires with undetermined cause may aid identification of opportunities for Reporting Officer training and/or risk factors that provide opportunities for fire prevention, intervention, and response.

Recommendation: Conduct further research to understand how human behaviour interacts with ignition sources, materials ignited first, and areas of origin to inform Prevention + Education efforts to prevent and intervene in this behaviour.

Recommendation: Prevention + Education programs and resources should target the safe use, maintenance, and storage of shared risk factors such as cutting, welding, and heating torches; bedding; flammable gases and liquids; air conditioning, heating, and refrigeration units; furniture and soft goods; domestic appliances; structural components; tools and equipment; and goods, stock, and supplies.

Recommendation: Where there was an increased risk of firefighter-assisted evacuation when a fire originated in certain residential, structural, carpark, and storage areas, Prevention + Education should prioritise safe self-evacuation messaging to mitigate the consequences associated with fires that originate in these areas.

7 Discussion

7.1 Distinct Risk Profiles

The risk profiles of fatality, preventable fatality, injury, evacuation, and fire extension are summarised below. Unique risk profiles are also provided for each outcome by accidental, deliberate, and undetermined fires. While there are some shared risk factors within and between adverse outcomes, each risk profile (combination of risk factors) is distinct.

7.1.1 Fatality

The odds of a structure fire resulting in a fatality were higher when structure fires occurred at night, in Winter, in residential attached buildings, and when the call source was an ICEMS. Odds of a fatal fire were higher when there was evidence of hoarding and the cause of the fire remained undetermined. Relative risk of fatality was higher when the fire involved a fixed fan, portable air conditioning unit, or outdoor cooking equipment or originated in a bedroom for less than five persons, lounge room, hallway, or corridor, or had multiple areas of origin. There were higher odds of fatality in residents from a diverse array of Mosaic types characterised as young, middle-aged, and older people, with or without children, retired or high to average incomes, living in metro, inner-urban, or outer-suburban areas. The odds of fatality increased when injury and fire extension also occurred.

There were no predictors of decreased odds of fatality.

7.1.1.1 Accidental

In an accidental fire, the odds of a structure fire resulting in a fatality were higher when the fire occurred in Winter, in an aged care building and/or a property owned by the Commonwealth Government. Odds of fatality increased when the call source was an ICEMS, when the alarm type was aspirating smoke detection, or when the alarm failed to operate because it was defective. Odds of fatality increased when there was evidence of hoarding, and when the fire occurred in Mosaic types characterised as singles or single parents on average or low incomes, sometimes living in social housing, in outer-suburban or regional areas. The odds of fatality in an accidental fire increased when the fire was ignited by an electric lamp or light bulb and involved a portable air conditioning unit, outdoor cooking equipment, fixed fan, mattress or pillow, or bedding, or when the fire originated in a kitchen or lounge room. Relative risk also increased when the fire extended beyond the room of origin.

7.1.1.2 Deliberate

In a deliberate fire, the odds of a structure fire resulting in a fatality were higher when the call source was an ICEMS, there was evidence of mental impairment, and when the fire involved a structural component or finish, petrol, or an undetermined material. Risk increased when the fire occurred in Mosaic types characterised by young, middle-aged, and older people, with or without children, some with multicultural backgrounds or living in social housing, with high to low incomes, living in metro, inner-urban, outer-suburban, regional, or rural areas.

7.1.1.3 Undetermined

In an undetermined fire, the odds of a structure fire resulting in a fatality were higher when smoke alarms were hard-wired, the material ignited first was other furniture or undetermined, and when the fire originated in an undetermined area, multiple areas, a bedroom for less than five persons, lounge room, hallway or corridor, exterior balcony, or kitchen. Odds of fatality increased in Mosaic types characterised by young, middle-aged, and older people, with or without children, some with multicultural backgrounds, with high to below average incomes, living in metro, inner-urban, outer-suburban, or coastal areas. Risk increased when fire extension beyond the room of origin and injury also occurred.

7.1.2 Preventable fatality

The odds of a structure fire resulting in a preventable fatality compared to a non-preventable fatality were higher when the call source was a Triple Zero call compared to other call sources.

The odds of a structure fire resulting in a preventable fatality compared to a non-preventable fatality were lower when the fire occurred in a Mosaic Type characterised by elderly couples, sometimes with adult children or carers, who are long term residents in rural towns, with low pension income. The odds of preventable fatality also decreased when the fire was ignited by radiated heat, originated in multiple areas, and was confined to the room of origin.

7.1.2.1 Accidental

In an accidental fire, the odds of a structure fire resulting in a preventable fatality compared to a non-preventable fatality were lower when the fire originated in a kitchen or cooking area compared to other areas of origin.

7.1.2.2 Deliberate

There were no risk factors of preventable fatality in deliberate fires.

7.1.2.3 Undetermined

In an undetermined fire, the odds of a structure fire resulting in a preventable fatality compared to a non-preventable fatality were higher when the fire extended beyond the room of origin, but lower when the fire occurred in Metropolitan North.

7.1.3 Injury

The odds of a structure fire resulting in an injury were higher when the call source was an ICEMS, and the fire occurred in the lowest socioeconomic areas, in residential attached and detached properties, or properties owned by the State Government. Relative risk increased when the fire was of accidental or undetermined cause, and when there was evidence of mental impairment. Odds of injury were higher when the fire was ignited by static discharge, a cutting, welding, or heating torch, or a candle against clothing worn on a person, an electric bike or scooter, or supplies or stock in a basket or barrel. Odds of injury increased when the fire originated in a cell, bedroom, office, lounge room, or garage, and when alarms did not operate because the battery was missing or disconnected. Odds of injury also increased when evacuations and fatality also occurred.

The odds of a structure fire resulting in an injury were lower when the call source was a direct call to station, and when the fire occurred in an outer regional or remote area, or in Mosaic Type characterised by well-educated, high-powered businesspeople with very high income and no children, living in expensive properties in central Sydney. Odds of injury decreased in properties owned by Local Government, when the ignition source was a hot ember or a re-kindle, and when the fire originated in a ceiling cavity, chimney, lawn or field, or highway or roadway. Relative risk of injury decreased when the fire was confined to the room of origin.

7.1.3.1 Accidental

In an accidental fire, the odds of a structure fire resulting in an injury were higher when the call source was an ICEMS, and the fire occurred in the lowest socioeconomic areas, in residential attached and detached properties, in carparks, and properties owned by the State Government. Risk increased when there was evidence of mental impairment. Odds of injury increased when the fire was ignited by static discharge, a cutting, welding, or heating torch, or a candle against supplies or stock in a basket or barrel, clothing worn on a person, or alcohol. Risk also increased when the fire originated in a bedroom, office, or lounge room, and when alarms did not operate because the battery was missing or disconnected. Odds of injury also increased when evacuations and fire extension beyond the room of origin also occurred.

In an accidental fire, the odds of a structure fire resulting in an injury were lower when the call source was a direct call to station, and when the fire occurred in an outer regional area. Odds of injury decreased when the ignition source was a hot ember or a re-kindle, and when the fire originated in a ceiling cavity, chimney, lawn or field, or highway or roadway. Odds of injury decreased when smoke alarms were operating and when they failed to operate because the fire was not within range or was too small.

7.1.3.2 Deliberate

In a deliberate fire, the odds of a structure fire resulting in an injury were higher when the call source was an ICEMS, when there was evidence of mental impairment, and when the fire occurred in Mosaic Types characterised as young, middle-aged, or older couples or families from multicultural backgrounds on low-average incomes, living in outer or inner suburban areas. Odds of injury increased when the fire was ignited by a cutting, welding, or heating torch against clothing on a person, an atomised vapourised liquid, or a toy or game. Risk increased in bedrooms for less than five persons and rubbish tips, and where evacuations also occurred.

There were no predictors of a decreased odds of injury in deliberate fires.

7.1.3.3 Undetermined

In an undetermined fire, the odds of a structure fire resulting in an injury were higher when the fire occurred in an inner regional or major city area, in a low-mid socioeconomic area, or in a Mosaic Type characterised as elderly coupes from multicultural backgrounds living in expensive suburbs in major cities. Odds of injury increased when there was evidence of mental impairment, when alarms were operating, or when they failed to operate because the battery was discharged or dead. Risk increased when the fire was ignited by an undetermined heat source against alcohol, a small cooking appliance, chemical process equipment, or irons. Odds of injury increased when the fire extended beyond the room of origin and evacuations and fatality also occurred.

There were no predictors of a decreased odds of injury in undetermined fires.

7.1.4 Evacuation

The odds of a structure fire resulting in evacuation were higher when the call source was a Triple Zero call or an AFA, and when the fire occurred on a weekday, in Metropolitan East, Metropolitan West, and Regional West. Relative risk increased when the fire was accidental or of undetermined cause, and when there was evidence of hoarding, mental impairment, and cultural practices. Odds of evacuation increased in other residential and assembly buildings, and in properties owned by private or other owners. Relative risk was higher in Mosaic Types characterised as young or middle-aged couples or singles, with or without children, with high to average income, renting or owning in metro, inner-urban, outer, or inner suburban areas. Odds of evacuation increased when the fire was ignited by overloaded electrical equipment against a dryer, refrigeration unit, or supplies or stock in a box, carton, or bag. Odds of evacuation increased when the fire originated in a fire stairway, lift, storage area, laboratory, cell, or carpark, when sprinkler systems were present, and alarms did not operate because they were defective or had missing or disconnected batteries. Odds of evacuation increased when the fire extended beyond the room of origin and when injury also occurred.

The odds of a structure fire resulting in evacuation were lower when the call source was a call to station, and when the fire occurred in Summer, during the day, in outer regional, remote, or very remote areas, or in low-mid socioeconomic areas. Odds of evacuation decreased when the fire was deliberate, and when it occurred in a non-habitable, storage, or carpark building, an unoccupied property, or a property owned by Local Government. Odds of evacuation decreased in Mosaic Types characterised as young, middle-aged, or older singles, couples, or families, working in professional or labour occupations, sometimes in retirement or social housing, on high to low incomes, in metro, inner-urban, suburban, regional, or rural areas. Relative risk decreased when the fire was ignited by heat from properly operating electrical equipment or hot embers against rubbish, and when the fire originated in a kitchen, or outdoor area such as a lawn, highway, recreational area, or vacant structural area. Odds of evacuation were lower when the alarm type was smoke detection, and when the alarm did not operate because the fire was not within range of the detector or was too small.

7.1.4.1 Accidental

In an accidental fire, the odds of a structure fire resulting in evacuation were higher when the call source was an AFA and the fire occurred in Metropolitan East, Metropolitan West, Regional North, or Regional West. Relative risk increased when there was evidence of hoarding, mental impairment, and cultural practices, and when the fire occurred in Mosaic Types characterised as young to middle-aged singles or couples, sometimes culturally diverse, on low to high income, living in inner our outer suburban areas. Odds of evacuation increased when the fire occurred in another residential, office, retail, laboratory, or assembly building, particularly when privately owned. Relative risk increased when the fire was ignited by overloaded or improperly operating electrical equipment against an air conditioning unit, dryer, or refrigeration unit. Risk increased when the fire originated in a laboratory, chute, storage area, or duct and when alarms did not operate because the battery was dead or missing, the alarm was defective, or due to a hard-wire power failure and dead or missing back-up batteries. Odds increased when the fire extended beyond the room of origin and when injuries also occurred.

In an accidental fire, the odds of a structure fire resulting in evacuation were lower when the call source was an ICEMS or call to station, and the fire occurred on a weekend or during the day. Risk decreased in outer regional and remote areas, particularly in average socioeconomic areas, and Mosaic Types characterised as professionals, farm workers, and semi-retired couples with high to low income, living in inner-urban, suburban, or rural towns. Odds of evacuation decreased in non-habitable buildings and when the type of alarm was smoke detection, and the alarm did not operate because the fire was too small. Relative risk decreased when the fire was ignited by hot ember, an open fire, a re-kindle, or the sun's heat, against cooking materials, rubbish, or grass. Odds were lower when the fire originated in an outdoor area such as a court, patio, lawn, highway, or recreational area.

7.1.4.2 Deliberate

In a deliberate fire, the odds of a structure fire resulting in evacuation were higher when the call source was a Triple Zero call or AFA, and when the fire occurred in Metropolitan East and Mosaic Types characterised as young or middle-aged singles and couples, with or without children, on high to low incomes, sometimes in social housing, living in inner-urban, suburban, or regional areas. Relative risk increased when there was evidence of mental impairment and the fire occurred in a residential attached, boarding house, unit, other residential, or aged care building. Odds increased when the fire was ignited by overloaded electrical equipment against alcohol, curtains, an indoor open fireplace, and other furniture. Relative risk increased when the fire originated in a lift, process manufacturing area, or fire stairway, and when the fire extended beyond the room of origin and injuries also occurred.

In a deliberate fire, the odds of a structure fire resulting in evacuation were lower when the fire occurred in a low-mid socioeconomic area and when the fire originated on a lawn, field, or open area.

7.1.4.3 Undetermined

In an undetermined fire, the odds of a structure fire resulting in evacuation were higher when the call source was a Triple Zero call or AFA, and when the fire occurred in an inner regional or major city area, and Mosaic Types characterised as middle-aged and elderly couples, on average to low incomes, living in suburban or rural areas. Relative risk increased in residential attached or unit buildings, particularly when privately owned, and when alarms were operating at the time of the fire, and when the type of alarm was a multicriteria detectors. Odds increased when the material ignited first was mains supply, LPG, power transfer equipment, or other furniture and when the fire originated in a lift, duct, or closed carpark. Risk increased when the fire extended beyond the room of origin and when injury also occurred.

In an undetermined fire, the odds of a structure fire resulting in evacuation were lower when the fire occurred in an average socioeconomic area, when the fire was ignited by hot ember or a lighter.

7.1.5 Fire extension

The odds of a structure fire resulting in fire extension were higher when fires of undetermined cause occurred in the lowest socioeconomic areas and in outer regional and very remote areas. Risk increased in residential detached, carpark, storage, and non-habitable buildings, and when fires occurred in Mosaic Types characterised as young to middle aged blue collar or rural workers, sometimes single parents or from multicultural backgrounds, with high to low incomes, living in outer-suburban, regional, and rural areas. Odds of fire extension increased when Manual Call Points or battery-operated smoke alarms were present and when alarms failed to operate due to a hard-wire power failure and a discharged or dead back-up battery. Odds increased when the fire was ignited by a cutting, welding, or heating torch; flying brand or ember; incendiary device; or an undetermined form against chemic process equipment, structural components, or other supplies or stock. Odds of fire extension were higher when the fire originated in an undetermined area or where there were multiple areas of origin. Fire extension increased when fatality also occurred.

The odds of a structure fire resulting in fire extension were lower when the call source was an ICEMS, when the fire occurred during the day, and when the fire occurred in a major city and an advantaged socioeconomic area. Relative risk decreased in Mosaic Types characterised as young, middle-aged, or older people, usually culturally diverse and with no children, living alone or in couples, on high to low incomes, in metro and suburban areas. Odds of fire extension decreased when the fire was accidental, and occurred in another residential or healthcare building, and when the property was owned by Local Government. Relative risk decreased when the fire was ignited by properly operating electrical equipment against clothing and cooking materials in an array of residential, structural, and open areas. Odds were lower when smoke alarms were operating or when they failed to operate because the fire was not within range of the detector, or the fire was too small.

7.1.5.1 Accidental

In accidental fires, the odds of a structure fire resulting in fire extension were higher when the call source was a Triple Zero call, and the fire occurred in an outer regional or very remote area at night. Risk increased when the fire occurred in a relatively advantaged socioeconomic area, and when there was evidence of youth misuse of fire and hoarding. Odds of fire extension increased in Mosaic Types characterised as younger or older singles or couples, sometimes multicultural, living in outer suburban or regional areas, with financial stability. Relative risk increased when the fire occurred in a non-habitable, storage, or residential detached building with Manual Call Points or battery-operated smoke alarms, or when alarms failed to operate due to a hard-wire power failure and discharged or dead back-up batteries. Odds increased when the fire was ignited by a flying brand, open fire, hot ember, or undetermined form against fertiliser or torches, welding, and cutting equipment in an undetermined area. Relative risk increased when fatality, injury, and evacuation also occurred.

In accidental fires, the odds of a structure fire resulting in fire extension were lower when the fire occurred during a weekday, in a relatively advantaged socioeconomic area, particularly in Mosaic Types characterised as young, middle aged, or older singles or couples, sometimes culturally diverse, working high-powered or blue-collar occupations, on very low to high incomes, living in metro and suburban areas. Relative risk decreased when the fire occurred in another residential, office, or aged care building, in a property owned by Local Government, and when smoke alarms failed to operate because the fire was not within the designed range of the detector or was too small. Odds of fire extension decreased when the fire was ignited by conducted heat, smokers’ materials, or heat from properly operating electrical equipment against cooking materials or other (books, papers) in an array of areas including the kitchen, bathroom, dining area, or laundry.

7.1.5.2 Deliberate

In deliberate fires, the odds of a structure fire resulting in fire extension were higher when the call source was a Triple Zero call and the fire occurred in an outer regional, remote, or very remote area, at night. Relative risk increased in non-habitable, office, and detached residential buildings, properties owned by State Government, and when smoke alarms failed to operate due to hard-wire power failure and discharged or dead back-up batteries. Odds increased in Mosaic Types characterised as professional couples and singles with high income, owning their first home in high growth inner suburbs. Odds of fire extension increased when the material ignited first was LPG or a petroleum fuelled engine and when the fire originated in multiple areas or an undetermined area. Relative risk increased when evacuations also occurred.

In deliberate fires, the odds of a structure fire resulting in fire extension were lower when the fire occurred in Metropolitan East and Metropolitan South, and in Autumn. Relative risk decreased when there was evidence of mental impairment and when the fire occurred in a Mosaic Type characterised as couples and single parents with children living in regional areas with low to average incomes. Odds of fire extension decreased when the fire occurred in another residential building, and when smoke alarms were operating or did not operate because the fire was not within the designed range of the detector, or the fire was too small. Odds decreased when the fire was ignited by properly operating electrical equipment or an open fire against soft goods and cooking materials, and when the fire originated in a bathroom, lobby, lawn, or assembly area.

7.1.5.3 Undetermined

In undetermined fires, the odds of a structure fire resulting in fire extension were higher when the call source was a Triple Zero call, and when the fire occurred in a very remote area, the lowest socioeconomically disadvantaged area, and at night. Relative risk increased in Mosaic Types characterised as young, middle-aged, or older families or couples, sometimes multicultural, on high to low incomes, living in suburban, regional, or rural areas. Odds of fire extension increased when the fire occurred in a non-habitable, storage, laboratory, or residential detached building. Risk increased when the fire was ignited by an incendiary device or direct flame against another flammable liquid, exterior covering, or interior wall covering, and when the fire originated in multiple areas or an undetermined area. Odds increased when evacuations also occurred.

In undetermined fires, the odds of a structure fire resulting in fire extension were lower when the fire occurred in a very remote area, in a unit, healthcare, or assembly building, and when the property was owned by Local Government. Relative risk decreased when smoke alarms were operating or when they failed to operate because the alarm was defective, the fire was not within the designed range of the detector, or the fire was too small. Odds decreased in a Mosaic Type characterised as younger, diverse blue-collar commuters renting apartments in Sydney outer-suburban areas, with low income. Odds of fire extension decreased when the fire originated in a bathroom, kitchen, laundry, or outdoor area.

7.1.6 Summary of distinct risk profiles

Fatality, preventable fatality, injury, evacuation, and fire extension have district risk profiles. Evidence-based Prevention + Education advocacy, programs, resources, and messaging that target the risk profiles of each adverse outcome are likely to be most effective.

These risk profiles highlight some findings that contradict the definitions and intentions of cause determinations and suggest discrepancies in data collection. The odds of fatality, injury, and evacuation all increased in deliberate fires when there was evidence of mental impairment. However, the nature of mental impairment reduces capacity to make an informed or rational decision or take an intentional or purposeful action. As evidence indicates, mental impairment can impact capacity to make decisions based on the nature and extent of the impairment at the time a decision is made, and the type and complexity of the decision that needs to be made (Office of the Public Advocate, 2022). When a person is mentally impaired, they may not possess the capacity to deliberately cause a fire. The co-occurrence of deliberate ignition and mental impairment requires further investigation and clarification. Similarly, when a fire was ignited by an incendiary device, it increased risk of fire extension in an undetermined fire. Yet, the presence of an incendiary device as the identified ignition source is evidence of a deliberately lit fire. Further, as identified previously, discrepancies were identified in Department of Housing and type of owner variables. For example, in accidental fires that caused fatality, the risk profile included property owned by Commonwealth Government and Mosaic Types characterised by people living in social housing. In structure fires that caused evacuation, the risk profile included property owned by Local Government and Mosaic Types characterised by people living in social housing. However, the eAIRS variable 'Department of Housing' was not a risk factor in either profile. Although these indicators may not measure the same properties within each profile, there is a risk that Reporting Officers may have attributed a social housing property to Commonwealth or Local Government rather than Department of Housing. These findings indicate that Reporting Officers may make inaccurate determinations of fire incidents and/or report certain variables inaccurately in eAIRS. It may also indicate that eAIRS does not always provide the necessary options to capture data concerning unique or contradictory circumstances.

Recommendation: Implement evidence-based Prevention + Education advocacy, programs, resources, and messaging that target the risk profiles of each adverse outcome.

Recommendation: Provide Reporting Officers with comprehensive Fire Investigation training to enhance their capacity to make accurate determinations of fire incidents, particularly regarding the determination of undetermined and deliberate fires.

Recommendation: Provide Reporting Officers with comprehensive eAIRS training to ensure that incidents are recorded as accurately as possible, particularly where discrepancies were identified in Department of Housing, type of owner, and Mosaic Type variables.

7.1 Shared Risk Factors

Fatality, injury, evacuation, and/or fire extension share the following risk factors.

7.1.1 Adverse outcomes

The presence of some adverse outcomes predicted others. Fatality predicted injury and fire extension; injury predicted fatality and evacuation; evacuation predicted injury; and fire extension predicted fatality and evacuation. Adverse outcomes also predicted other outcomes when the fire was accidental, deliberate, and undetermined. In undetermined fires, fire extension predicted fatality, preventable fatality, injury, and evacuation. The relationships between fatality, injury, evacuation, and fire extension suggest that targeted Prevention + Education efforts to reduce one adverse outcome may have a continuing or multiplying effect on other outcomes that share the same risk factors.

Recommendation: Where adverse outcomes increase the odds of other adverse outcomes, they may be interrelated and share risk factors. As a result, Prevention + Education programs and resources should be directed towards those factors that increase the risk of multiple adverse outcomes.

Recommendation: Prevention + Education approaches that target fatality and injury may have the greatest impact on other adverse outcomes where risk factors are shared.

7.1.2 Response time

In the first 3-5 minutes of response time, the fatality rate was low, while evacuation rates slowly increased, and injury and fire extension rates rapidly increased. This may indicate that fire extension caused people to become injured as they self-evacuated or injured while trapped, requiring some firefighter-assisted evacuation, which prevented fatality.

Between 3-5 and 10-11 minutes, fatality rates increased while injury rates slowed, and evacuation and fire extension rates plateaued. When fire extension did not occur, self-evacuation may have been more likely, reducing risk of injury and firefighter-assisted evacuation. However, where fatality and injury rates continued to increase, some evacuations may have transitioned to injuries and/or fatalities in situ, and/or higher rates of self-evacuation may have increased associated injuries and fatal consequences during this time.

After 10-11 minutes, evacuation and fire extension rates increased. After 13 minutes, fatality rates slowed. After 17 minutes, injury rates slowed. Fatality and injury rates continued to slowly increase until 22 minutes, after which they plateaued. Evacuation rates increased until 37 minutes, after which they plateaued. Fire extension rates never plateaued. These findings indicate that there remains opportunity to prevent fatalities and injuries until 22 minutes, to conduct firefighter-assisted evacuations until 37 minutes, and to prevent fire extension for the remainder of response time.

Where fatality and injury rates plateaued at 22 minutes, but the evacuation rate rose until 37 minutes, it appears that people remaining in a structure after 22 minutes were not at risk of fatality or injury, but still required firefighter-assisted evacuation. These findings suggest that those who remain in a structure after 22 minutes but still require firefighter-assisted evacuation have distinct risk profiles, differentiating them from those at risk of fatality and injury within the first 22 minutes.

After 37 minutes, fire extension rates increased without increasing risk of fatality, injury, or evacuation. This suggests that, after 37 minutes, firefighter-assisted evacuation is not required because fatalities in situ or fatalities or injuries sustained during self-evacuation have already occurred.

Where transitioning from evacuation to injury and fatality occurred, it is likely that these groups existed along a continuum with shared risk factors.

Recommendation: Implement evidence-based Prevention + Education advocacy, programs, resources, and messaging that target shared risk factors to reduce risk of multiple adverse outcomes.

Recommendation: Conduct further research to explore fatalities, injuries, and evacuations as a continuum of adverse outcomes to identify opportunities to intervene from a systems-based perspective.

7.1.3 Temporal and location characteristics

7.1.3.1 Natural surveillance

Natural surveillance, or the everyday presence and movement of people, is a shared risk factor. Structure fires that occurred at night increased the risk of fatality, while fires that occurred during the day reduced the risk of fire extension and the need for firefighter-assisted evacuation. When fires occur at night, there may have been lower levels of natural surveillance, meaning fires take longer to be identified, extinguished, and/or reported, increasing risk of fatality. When fires occur during the day, natural surveillance is likely to be higher, meaning fires may have been identified, extinguished, and/or reported sooner, reducing risk of fire extension and the need for firefighter-assisted evacuation.

Recommendation: Where natural surveillance is a shared protective factor for evacuation and fire extension, Prevention + Education programs and resources should aim to enhance natural surveillance. For example, Safety Visit messaging about trimming vegetation and clearing clutter from around a structure will enhance the likelihood that passers-by will observe signs of fire, while also reducing fuel loads. Programs and resources should also enhance people's capacity to identify signs of fire, such as the smell and sight of smoke and the sound of a smoke alarm, and what to do when these signs are observed.

7.1.3.2 FRNSW Region

The odds of evacuation and fire extension were both higher when a structure fire occurred in Metropolitan West. This finding indicates that the need for firefighter-assisted evacuation and fire extension beyond the room of origin are higher in Metropolitan West, and thus that Prevention + Education efforts in this region should prioritise education about what to do in the event of a fire to safely evacuate and mitigate fire spread.

Recommendation: Prevention + Education efforts in Metropolitan West should prioritise education about what to do in the event of a fire to safely evacuate and mitigate fire spread.

7.1.4 Individual characteristics

7.1.4.1 SEIFA Decile 1

The odds of injury and fire extension were higher in SEIFA Decile 1 compared to all other SEIFA Deciles. This finding indicates that the most socioeconomically disadvantaged areas are most at risk of injury and fire extension, and thus that Prevention + Education efforts should prioritise these areas.

Recommendation: Prevention + Education efforts should target the most socioeconomically disadvantaged areas with programs and resources that enhance understanding of exponential fire growth, support accurate perceptions of risk and estimations of available time to escape, and reinforce behaviours that mitigate injury and fire spread, such as smoke alarm installation, closing doors, and safe self-evacuation.

7.1.4.2 Mosaic Types

Some Mosaic Types had higher odds of multiple adverse outcomes. While most Mosaic Types that were at risk of multiple adverse outcomes had higher odds of two outcomes, Mosaic Type M43 had higher odds of fatality and injury in deliberate fires and fire extension in accidental fires. Prevention + Education efforts should target each Mosaic Type with programs and resources specific to the adverse outcomes they experience.

Table 25. Mosaic Types at risk of multiple adverse outcomes

Mosaic Type	Description	Fatality	Injury	Evacuation	Fire Extension
L40	Low-income singles in regional towns, sometimes living in social housing	Accidental		Deliberate	

B05	Young, married couples with children and high income, living in outer-suburban/metro-fringe areas	Deliberate		All	
J32	Blue-collar families from multicultural backgrounds, living in outer-suburban areas, with average to high income	Deliberate	Deliberate		All
M43	Multicultural older couples living in outer-suburban areas for a long time, with low income but high property value	Deliberate	Deliberate		Accidental
M47	Elderly couples, sometimes with adult children or carers, who are long term residents in rural towns, with low pension income	Deliberate		Undetermined	
L39	Multicultural families, sometimes single parents, living in outer-suburban areas with low income	Deliberate and undetermined	Deliberate		
L42	Younger families, often single parents, with low incomes in regional towns, often living in social housing	Deliberate			All
F17	Professional couples and singles with high income, owning their first home in high growth inner suburbs	Undetermined			Deliberate
J33	Middle-aged, blue-collar couples living in outer-suburban/metro-fringe areas, with average income	Undetermined		All	
K35	Middle-aged couples without children, renting in inner suburban apartments and terraces		Deliberate	All	
D12	Elderly couples from multicultural backgrounds living in expensive properties in suburban areas of Sydney & Melbourne		Undetermined		Undetermined

Recommendation: Prevention + Education efforts should prioritise Mosaic Types at risk of multiple adverse outcomes and should target each Mosaic Type with programs and resources that are specific to their risk of each adverse outcome.

7.1.1 Behavioural characteristics

7.1.1.1 Hoarding

Hoarding was a shared risk factor, increasing risk of fatality, injury, and evacuation. When hoarding was evident in an accidental fire, it also increased risk of fatality, evacuation, and fire extension. Where studies have identified the need to develop multi-disciplinary, multi-agency models of fire prevention for people who hoard, further research is necessary.

Recommendation: Conduct research to inform best practice fire service involvement in reducing the consequences of hoarding, and to develop evidence-based multi-disciplinary/multi-agency models of hoarding prevention, intervention, and response.

7.1.1.2 Mental impairment

Mental impairment was a shared risk factor, increasing risk of injury and evacuation. It also increased risk of injury and evacuation in accident fires; fatality, injury, and evacuation in deliberate fires; and injury in undetermined fires. Further investigation is needed to better understand how mental impairment interacts with other variables to increase risk. To inform Prevention + Education, it is necessary to distinguish between mental impairment caused by neurodiversity (mental illness and intellectual disability), intoxication and/or the effects of illicit and prescribed drugs.

Recommendation: Conduct further research to understand how each type of mental impairment interacts with other variables to increase risk of adverse structure fire outcomes, and to develop evidence-based multi-disciplinary/multi-agency models of neurodiversity (mental illness and intellectual disability), intoxication (alcohol), and drug (illicit and prescribed) related fire prevention, intervention, and response.

7.1.1.3 Cooking

While cooking-related fires increased risk of fatality and injury, each adverse outcome had a distinct risk profile when type of cooking fire was considered. Relative risk of fatality was higher when the material ignited first was outdoor cooking equipment or the fire originated in a kitchen or cooking area, while risk of injury was higher when the material ignited first was a portable gas cooker or deep fat fryer, but not when a fire originated in a kitchen or cooking area. This finding highlights the importance of differentiating cooking fires by the materials ignited first and area of origin when tailoring Prevention + Education efforts.

Recommendation: Differentiate cooking fires by the materials ignited first and area of origin to understanding the risk of each adverse outcome and to tailor Prevention + Education efforts.

7.1.2 Building characteristics

7.1.2.1 Building class

Two building classes experienced higher odds of multiple adverse outcomes. Class 1a (residential attached) buildings were at higher risk of fatality and injury while Class 1a (residential detached) were at higher risk of injury and fire extension. These findings indicate that while residential attached and detached buildings share risk of injury, there are factors unique to attached buildings that increase risk of fatality and factors unique to detached buildings that increase risk of fire extension. As a result, Prevention + Education efforts should target these buildings according to the adverse outcomes they experience.

Recommendation: Prevention + Education efforts should prioritise fatality and injury prevention in residential attached buildings and injury and fire extension prevention in residential detached buildings.

7.1.3 Alarm/detector characteristics

7.1.3.1 Reason for alarm failure

When smoke alarms/detectors were present but failed to operate, defective alarms/detectors predicted fatality and evacuation and missing or disconnected batteries predicted injury and evacuation. To target these shared risk factors, Prevention + Education efforts should prioritise programs and resources that support proper installation, maintenance, testing, and replacing batteries for battery-operated and hard-wired powered alarms.

Recommendation: Prevention + Education efforts should prioritise programs and resources that support proper installation, maintenance, testing, and replacing batteries for battery-operated and hard-wired powered alarms.

7.1.3.2 Call source

Various call sources also predicted multiple adverse outcomes. When the call source was a Triple Zero call, the odds of preventable fatality, evacuation, and fire extension were higher. This reflects the intended purpose of Triple Zero, which is designed to allocate resources to time critical, life-threatening incidents. When the call source was an inter-agency CAD electronic messaging system (ICEMS), the odds of fatality and injury were higher. This indicates that structure fires causing fatality and injury are coming to the attention of other emergency services agencies, who are then relaying the message to FRNSW. Further research is needed to understand how and why other agencies are identifying and reporting structures fires that result in fatality and injury.

Recommendation: Investigate why structures fires that result in fatality and injury are being reported by other emergency services agencies via the inter-agency CAD electronic messaging system (ICEMS).

7.1.1 Fire characteristics

7.1.1.1 Cause determination

Fires of undetermined cause increased risk of all adverse outcomes, while accidental fires increased risk of injury and evacuation. While existing literature focuses predominantly on accidental fires, undetermined fires present an unknown risk. However, as identified below, undetermined fires share risk factors with determined fires, suggesting that shared risk factors can be targeted to reduce risk. Further research is needed to identify and explore the factors that influence a cause determination of undetermined. A deeper analysis of structure fires with undetermined cause will aid in identification of other risk factors that may highlight opportunities for fire prevention, intervention, and response.

Recommendation: Further research is needed to identify and explore the factors that influence a cause determination of undetermined. A deeper analysis of structure fires with undetermined cause will aid in identification of other risk factors that may highlight opportunities for fire prevention, intervention, and response.

7.1.1.2 Ignition sources

Structure fires had a higher risk of causing injury and fire extension when the ignition source was a cutting, welding, or heating torch. While evidence suggests that candles and tapers are a risk factor of injury, there is a paucity of research on other at-risk ignition sources, such as cutting, welding, or heating torches. Targeted Prevention + Education should focus on the safe use, maintenance, and storage of cutting, welding, or heating torches.

Recommendation: Conduct further research to identify how the storage, use, and maintenance of cutting, welding, and heating torches can be improved.

Recommendation: Targeted Prevention + Education should focus on the safe use, maintenance, and storage of cutting, welding, or heating torches.

7.1.1.3 Materials ignited first

Material ignited first predicted fatality, injury, evacuation, and fire extension. It also predicted fatality, injury, evacuation, and fire extension in accidental, deliberate, and undetermined fires. When the material ignited first was petrol, odds of fatality, injury, and fire extension were higher. When it was another flammable liquid, odds of fatality and injury were higher. When it was LPG, odds of injury and evacuation were higher. Other (furniture) increased the odds of fatality and evacuation; fixed fans (cooling and exhaust) increased the odds of fatality and evacuation; and other (structural components, finish) increased the odds of fatality and fire extension. When the material ignited first was undetermined, relative risk of fatality, evacuation, and fire extension were higher. Prevention + Education programs and resources should target the safe use, maintenance, and storage of these shared risk factors.

Recommendation: Prevention + Education programs and resources should target the safe use, maintenance, and storage of these shared risk factors.

7.1.1.4 Area of origin

Area of origin predicted fatality, preventable fatality, injury, evacuation, and fire extension. It also predicted fatality in accidental and undetermined fires and injury, evacuation, and fire extension in accidental, deliberate, and undetermined fires. Fires originating in a bedroom for less than five persons increased risk of fatality, injury, and evacuation and lounge rooms increased risk of fatality and injury. Fires originating in a ceiling cavity increased risk of evacuation and fire extension while cells or secure confinement areas increased risk of injury and evacuation. When a fire originated in multiple areas, risk of fatality, preventable fatality, and fire extension were higher. Prevention + Education programs and resources should target these areas with tailored messaging towards smoke alarm/detector installation, self-evacuation, and early identification and reporting of structure fires.

Recommendation: Prevention + Education programs and resources should target at-risk areas with tailored messaging towards smoke alarm/detector installation, self-evacuation, and early identification and reporting of structure fires.

7.1.2 Summary of shared risk factors

Despite having distinct risk profiles, adverse outcomes also share risk factors. Where fatality, injury, evacuation, and/or fire extension share risk factors, Prevention + Education efforts should target these factors to reduce risk of multiple adverse outcomes. Shared risk factors also suggest that evacuations, injuries, and fatalities may exist along a continuum of personal adverse outcomes. An understanding of these risk factors facilitates that identification opportunities for prevention and intervention at the beginning of the continuum.

Prevention + Education efforts may be most effective when they target the intersectionality of shared risk factors. For example, Prevention + Education could target sprinkler installation advocacy and fire safety education towards residents in residential attached dwellings in the most socioeconomically disadvantaged areas. Such programs should focus on the safe use, maintenance, and storage of cutting, welding, and heating torches, and safe behaviour around flammable gasses and liquids. Information about the proper installation, maintenance, testing, and battery replacement of smoke alarms should be coupled with education about what to do in the event of a fire, such as when and how to safely use a fire blanket and fire extinguisher, and when and how to safely self-evacuate.

Recommendation: Implement evidence-based Prevention + Education advocacy, programs, resources, and messaging that target shared risk factors to reduce risk of multiple adverse outcomes.

Recommendation: Conduct further research to explore fatalities, injuries, and evacuations as a continuum of adverse outcomes to identify opportunities to intervene from a systems-based perspective.

7.2 Shared Risk Factors by Cause Determination

Although outcomes resulting from accidental, deliberate, and undetermined fires have distinct risk profiles, they also share risk factors

7.2.1 Temporal and location characteristics

7.2.1.1 Time of day

When structure fires occurred at night, the odds of fire extension increased when the fire was accidental, deliberate, and undetermined compared to fires that occurred during the day. These findings indicate that fires that occur at night may take longer to be identified, extinguished, and reported than fires that occur during the day, increasing risk of fire extension in accidental, deliberate, and undetermined fires.

Recommendation: Implement Prevention + Education programs and resources that target risk at night and review response protocols for structure fires that occur at night to mitigate the consequences of preventable and ‘non-preventable’ fires.

7.2.1.2 FRNSW Region

When structure fires occurred in Metropolitan West, the odds of fire extension were higher when the fire was accidental and undetermined. Where Prevention + Education efforts in this region prioritise education about what to do in the event of a fire to safely evacuate and mitigate fire spread, the consequences of fire may be mitigated in accidental, deliberate, and undetermined fires.

Recommendation: Implement Prevention + Education programs and resources that target prioritise education about what to do in the event of a fire to safely evacuate and mitigate fire spread to reduce the consequences of preventable and ‘non-preventable’ fires.

7.2.1.3 Remoteness

When structure fires occurred in outer regional and very remote areas, the risk of fire extension was higher in accidental and deliberate fires. The risk in very remote areas also increased in undetermined fires. Longer response times in outer regional, remote, and very remote areas may mean that the relative risk of fire extension is greater in these areas regardless of cause determination. Prevention + Education efforts that prioritise the reduction of response time will mitigate the consequences of accidental, deliberate, and undetermined fires.

Recommendation: Prioritise the reduction of response time to mitigate the consequences of preventable and ‘non-preventable’ fires.

7.2.2 Individual characteristics

7.2.2.1 Mosaic Types

When structure fires occurred in Mosaic Types G20, L39, and M44 there was a higher risk of fatality in deliberate and undetermined fires. When structure fires occurred in Mosaic Type B05 there was a higher risk of evacuation in accidental and deliberate fires. When structure fires occurred in Mosaic Type K35 there was a higher risk of evacuation in accidental and undetermined fires. Prevention + Education approaches targeted towards these types will be best placed to mitigate the consequences of accidental, deliberate, and/or undetermined fires.

Recommendation: Prevention + Education approaches tailored to Mosaic Types will be best placed to mitigate the consequences of preventable and 'non-preventable' fires.

7.2.3 Behavioural characteristics

7.2.3.1 Mental impairment

When there was evidence of mental impairment, the risk of injury was higher in accidental, deliberate, and undetermined fires and the risk of evacuation was higher in accidental and deliberate fires. Evidence-based multi-disciplinary/multi-agency models of neurodiversity (mental illness and intellectual disability), intoxication (alcohol), and drug (illicit and prescribed) related fire prevention, intervention, and response can be used to mitigate the consequences of accidental, deliberate, and undetermined fires.

Recommendation: Implement evidence-based multi-disciplinary/multi-agency models of fire prevention, intervention to mitigate the consequences of preventable and 'non-preventable' fires involving mental impairment.

7.2.3.2 Cooking

When a structure fire originated in a kitchen or cooking area, there was a higher risk of fatality in accidental and undetermined fires. Prevention + Education efforts that target the risk factors of cooking fires can be used to mitigate the consequences of accidental and undetermined fires.

Recommendation: Implement Prevention + Education efforts that target the risk factors of cooking fires to mitigate the consequences of preventable and 'non-preventable' fires.

7.2.4 Building characteristics

7.2.4.1 Type of owner

When a fire occurred in a privately owned property, the odds of evacuation were higher in accidental, deliberate, and undetermined fires. When a fire occurred in a State Government owned property, the odds of injury were higher in accidental and deliberate fires. Prevention + Education programs and resources that enhance accurate perception of risk and safe self-evacuation can be used to mitigate the consequences of accidental, deliberate, and undetermined fires.

Recommendation: Implement Prevention + Education programs and resources that enhance accurate perception of risk and self-evacuation to mitigate the consequences of preventable and 'non-preventable' fires.

7.2.4.2 Building class

When a fire occurred in a Class 3 (other residential) building, the odds of evacuation were higher in accidental and deliberate fires. When a fire occurred in a Class 1a (residential detached) or 10a (non-habitable) building, the odds of fire extension were higher in accidental, deliberate, and undetermined fires. When a fire occurred in a Class 7b (storage) building, the odds of fire extension were higher in accidental and undetermined fires. Prevention + Education that focuses on what to do in the event of a fire to enhance safe self-evacuation and mitigate fire spread, and advocacy for the installation of fire suppression systems, can be used to mitigate the consequences of accidental, deliberate, and undetermined fires.

Recommendation: Implement Prevention + Education programs and resources that enhance safe self-evacuation and mitigate fire spread, and advocate for the installation of fire suppression systems to mitigate the consequences of preventable and ‘non-preventable’ fires.

7.2.5 Alarm/detector characteristics

7.2.5.1 Reason for alarm failure

When alarms failed to operate due to a hard-wire power failure and a discharged or dead back-up battery, structure fires were at a higher risk of fire extension in accidental and deliberate fires. Prevention + Education efforts that prioritise programs and resources to support proper installation, maintenance, testing, and replacing batteries for hard-wired alarms can be used to mitigate the consequences of accidental and deliberate fires.

Recommendation: Implement Prevention + Education programs and resources that support proper installation, maintenance, testing, and replacing batteries for hard-wired alarms to mitigate the consequences of preventable and ‘non-preventable’ fires.

7.2.6 Fire characteristics

7.2.6.1 Ignition source

When a structure fire was ignited by a cutting, welding, or heating torch, the odds of injury were higher in accidental and deliberate fires. When the ignition source was overloaded electrical equipment, the odds of evacuation were higher in accidental and deliberate fires. Prevention + Education programs and resources that target the safe use, maintenance, and storage of cutting, welding, and heating torches and electrical equipment can be used to mitigate the consequences of accidental and deliberate fires.

Recommendation: Implement Prevention + Education programs and resources that target the safe use, maintenance, and storage of cutting, welding, and heating torches and electrical equipment to mitigate the consequences of preventable and ‘non-preventable’ fires.

7.2.6.2 Material ignited first

When a structure fire was caused by an atomised, vapourised liquid, odds of injury were higher in accidental and deliberate fires. For alcohol, odds of injury were higher in accidental and undetermined fires. For LPG, the odds of evacuation were higher in accidental and undetermined fires. For other (furniture), odds of evacuation were higher in deliberate and undetermined fires and odds of fire extension were higher in accidental and deliberate fires. When the material ignited first was clothing on a person, risk of injury was higher in accidental and deliberate fires. For other (structural component, finish), the odds of fire extension were higher in accidental and undetermined fires. For bush, grass, and forests, the odds of fire extension were higher for accidental and undetermined fires. Prevention + Education programs and resources that target the safe use, maintenance, and storage of atomised, vapourised liquids, alcohol, LPG, other (furniture), clothing on a person, other (structural component, finish), and bush, grass, and forests can be used to mitigate the consequences of accidental, deliberate, and undetermined fires.

Recommendation: Implement Prevention + Education programs and resources that target the safe use, maintenance, and storage of atomised, vapourised liquids, alcohol, LPG, other (furniture), clothing on a person, other (structural component, finish), and bush, grass, and forests to mitigate the consequences of preventable and 'non-preventable' fires.

7.2.6.3 Area of origin

When a structure fire originated in a lounge room or kitchen, the risk of fatality was higher in accidental and undetermined fires. For fires originating in bedrooms for less than five persons, the odds of injury were higher in accidental and deliberate fires and the odds of evacuation were higher for accidental, deliberate, and undetermined fires. For fires originating in garages or workshops, the odds of evacuation were higher in accidental and deliberate fires. For fires originating in lifts, the risk of evacuation was higher in deliberate and undetermined fires. For fires in exterior wall surfaces, the risk of fire extension was higher in accidental and deliberate fires, while for cavity and roof space fires, the odds of fire extension were higher in accidental and undetermined fires. For fires in a process or manufacturing area, the odds of evacuation were higher in accidental and deliberate fires. Prevention + Education efforts that target at-risk areas can be used to mitigate the consequences of preventable and 'non-preventable' fires.

Recommendation: Target at-risk areas with tailored messaging towards smoke alarm/detector installation, self-evacuation, and early identification and reporting of structure fires to reduce risk in lounge rooms, kitchens, bedrooms for less than five persons, garages or workshops, lifts, exterior wall surfaces, cavity and roof spaces, and process or manufacturing areas.

7.2.7 Summary of shared risk factors by cause determination

Shared risk factors between adverse outcomes arising from structure fires with different cause determinations is an important finding for two reasons. First, it suggests that fires that are deemed 'non-preventable', such as deliberate fires, share risk factors with fires that are deemed 'preventable', such as accidental fires. By targeting these risk factors, the consequences of some 'non-preventable' fires may be mitigated. Second, the findings indicate that undetermined fires share risk factors with determined (accidental or deliberate) fires. Again, by targeting these risk factors, the consequences of some undetermined fires may be mitigated.

Recommendation: Implement evidence-based Prevention + Education advocacy, programs, resources, and messaging that target the risk factors shared by accidental and deliberate fires, and determined and undetermined fires, to mitigate the consequences associated with preventable and 'non-preventable' fires.

8 Conclusion

All structure fires that occurred within FRNSW's jurisdiction between 1 January 2016 and 31 December 2021 as recorded by Fire and Rescue NSW's eAIRS were analysed to identify risk factors of fire fatality, preventable fatality, injury, evacuation, and fire extension.

Despite contributing significantly to FRNSW's understanding of adverse structure fire outcomes and the literature more broadly, there are limitations associated with a reliance on eAIRS data to identify risk factors. Although existing literature was used to fill some gaps in knowledge, further research is needed to better understand the complexities of risk, particularly how human behaviour intersects with and influences risk.

Results revealed that there are specific factors that increase risk of fire fatality, preventable fatality, injury, evacuation, and fire extension. While most of these findings align with existing literature, some do not. Where this study was methodologically rigorous, albeit constrained to the data collected by eAIRS, the results herein should be considered significant and context specific to FRNSW and the communities it serves.

It is important to note that this analysis does not constitute a direct measure of effectiveness of FRNSW's Prevention + Education programs. Monitoring and evaluation mechanisms must be embedded within each approach to directly measure effectiveness. Despite this, the report provides insight into the risk factors of adverse outcomes at the incident level to inform a targeted approach. Further, because this analysis uses population-level data, the results of repeated analyses can be compared to identify whether the implementation of Prevention + Education approaches are associated with changes in risk.

The recommendations that have emerged from this analysis can be used to mitigate the consequences of structure fires by informing an evidence-based approach to research and resource prioritisation and to the development, implementation, and evaluation of Prevention + Education advocacy, programs, resources, and messaging.

Regular analyses and reporting on all adverse structure fire outcomes will facilitate a current and comprehensive understanding of the risk factors of structure fire fatality, injury, evacuation, and fire extension, ensuring Prevention + Education remains evidence-based, and thus relevant, effective, and sustainable. Regular analysis will also identify whether changes in risk are associated with Prevention + Education implementation.

9 References

Al-Hajj, S., Despriya, E., Pawliuk, C., Garis, L. &Pike, I. (2022). Interventions for preventing residential fires in vulnerable neighbourhoods and Indigenous communities: A systematic review of the literature. *International Journal of Environmental Research and Public Health, 19:* 5434. https://doi.org/10.3390/ijerph19095434

Australasian Fire and Emergency Service Authorities Council. (2021). *Residential Fire Fatality and Injury Prevention Strategy : towards zero fatalities*.

Australian Bureau of Statstics. (2022a). *Australia's population by country of birth.* https://www.abs.gov.au/statistics/people/population/australias-population-country-birth/2021

Australian Bureau of Statistics. (2022b). Regional population. https://www.abs.gov.au/statistics/people/population/regional-population/latest-release#data-download

Australian Bureau of Statistics. (2021a). *National, and territory population*. Australian Bureau of Statistics. https://www.abs.gov.au/statistics/people/population/national--and-territory-population/latest-release

Australian Bureau of Statistics. (2021b). *TableBuilder for Dwelling and Population data.* https://www.abs.gov.au/statistics/microdata-tablebuilder/tablebuilder

Australian Bureau of Statistics. (2021c). *Regional population.* https://www.abs.gov.au/statistics/people/population/regional-population/latest-release#data-download

Australian Bureau of Statistics.(2016). *Census of population and housing: Socioeconomic index for areas (SEIFA), Australia, 2016.* https://www.abs.gov.au/ausstats/abs@.nsf/mf/2033.0.55.001

Australian Government Productivity Commission. (2022). *Report on Government Services 2022*. https://www.pc.gov.au/research/ongoing/report-on-government-services/2022/emergency-management/emergency-services

Australian Institute of Health and Welfare. (2022). *Illicit drug use.* https://www.aihw.gov.au/reports/australias-health/illicit-drug-use

Australian Institute of Health and Welfare. (2021a). *Alcohol risk and harm.* https://www.aihw.gov.au/reports/australias-health/alcohol-risk-and-harm

Australian Institute of Health and Welfare. (2021b). *Tobacco smoking.* https://www.aihw.gov.au/reports/australias-health/tobacco-smoking

Australian Institute of Health and Welfare. (2019). *Mental health.* https://www.aihw.gov.au/reports/australias-health/mental-health

Banerji, A. (2012). Preventing unintentional injuries in Indigenous children and youth in Canada. *Paediatrics & Child Health, 17*(7): 393.

Barnett, M. (2008). *Risk factors and incidence of residential fire experiences reporrted retrospectively.* Victoria University Doctoral Thesis.

Bruck, D., Ball, M. & Thomas, I. R. (2011). Fire fatality and alcohol intake: Analysis of key risk factors. *Journal of Studies on Alcohol and Drugs*, *72*(5), 731–736. https://doi.org/10.15288/jsad.2011.72.731

Bryant, S. & Preston, I. (2017). *Focus on trends in fires and fire-related fatalities.* Home Office Report.

Catholic Healthcare. (2022). *Hoarding and squalor.* https://www.catholichealthcare.com.au/hoarding-and-squalor-overview/

Challands, N. (2010). The relationship between fire service response time and fire outcomes. *Fire Technology, 46*: 665-676.

Choi, et al. (2019). Comparison of emergency response abilities and evacuation performance involving vulnerable occupants in building fire situations. *Sustainability, 12*, 87-106.

Coates, L., Kaandorp, G., Harris, J., Van Leeuwen, J., Avci, A., Evans, J., George, S., Gissing, A., Van Den Honert, R. & Haynes, K. (2019). *Preventable Residential Fire*

Fatalities in Australia July 2003 To June 2017 (Issue June).
Dancey, C.P. & Reidy, J. (2011). *Statistics without Maths for Psychology* (5th ed.). South Melbourne, Victoria: Oxford University Press.
DiGuiseppi, C., Edwards, P., Godward, C., Roberts, I & Wade, A. (2000). Urban residential fire and flame injuries: a population based study. *Injury Prevention,* (6), 250-254.
Dorseif et al. (2016). Call prioritisation times for structure fires in a fire priority dispatch system. *Annuals of Emergency Dispatch and Response, 4*(2):25-30.
Duncanson, M., Reid, P, Langley, J & Woodward, A. (2002). *Hospitalisation for non-fatal injury as a result of unintentional domestic fire incidents: Aotearoa New Zealand 1996-2000.* New Zealand Fire Service Commission Research Report Number 53. New Zealand Fire Service Commission.
Duncanson, M. (2001). *Report Cooking, alcohold and unintentional fatal fires in New Zealand homes 1991019987* (Issue 16).
Duncanson, M., Woodword, A. & Reid, P. (2000). *Report Where in New Zealand have fatal domestic fires occurred* (Issue 6).
ESRC National Centre for Research Methods. (2011). Using statistical regression methods in educational research. https://www.restore.ac.uk/srme/www/fac/soc/wie/research-new/srme/modules/mod4/8/index.html
Fire and Rescue NSW. (2021). *Annual report 2020-21*.
Ghassempour, N. (2021). *Sprinkler systems - a profile of residential fire incidents in social housing dwellings in New South Wales, Australia.* Western Sydney University.
Ghassempour, N., Tannous, W. K., Avsar, G., Agho, K. E. & Harvey, L. A. (2021). Estimating the total number of residential fire-related incidents and underreported residential fire incidents in New South Wales, Australia by using linked administrative data. *International Journal of Environmental Research and Public Health*, *18*(13). https://doi.org/10.3390/ijerph18136921
Gilbert, S & Butry, D. (2017). Identifying vulnerable populations to death and injuries from residential fires. *Injury Prevention, 24*: 358-364.
Iyer, R. & Ball, M. (2010). *The vulnerability of compulsive hoarders to residential fire fatality: A qualitative enquiry.* https://www.researchgate.net/publication/342093247_The_Vulnerability_of_Compulsive_Hoarders_to_Residential_Fire_Fatality_A_Qualitative_Enquiry
Jaldell, H. (2017). How important is the time factor? Saving lives using fire and rescue services. *Fire Technology, 53*: 695-708.
Jonsson, A. & Jaldell, H. (2019). Identifying sociodemographic risk factors associated with residential fire fatalities: a matched case control study. *Injury Prevention*, *26*(2), 147–152. https://doi.org/10.1136/injuryprev-2018-043062
Jonsson, A., Bonander, C., Nilson, F. & Huss, F. (2017). The of the residential fire fatality problem in Sweden: Epidemiology, risk factors, and event typologies. *Journal of Safety Research*, *62*, 89–100. https://doi.org/10.1016/j.jsr.2017.06.008
Jonsson, A., Bergqvist, A. & Andersson, R. (2015). Assessing the number of fire fatalities in a defined population. *Journal of Safety Research, 55:* 99-103.
KC, K. & Corcoran, J. (2017). Modelling residential fire incident response times: A spatial analytic approach. *Applied Geography*, *84*, 64–74. https://doi.org/10.1016/j.apgeog.2017.03.004
Kinateder, M., Kuligowski, E., Reneke, P. & Peacock, R. (2015). Risk perception in fire evacuation behaviour revisited: definitions, related concepts, and empirical evidence. *Fire Science Reviews, 4*(1). doi:10.1186/s40038-014-0005-z
Kuligowski, E. (2009). *The process of human behaviour in fire.* National Institute of Standards and Technology, Technical Note 1632.
Lee et al. (2018). Factors contributing to disaster evacuation: The case of South Korea. *Sustainability, 10*(3818). https://doi.org/10.3390/su10103818
Lilley, D. R., McNoe, M. B. & Duncanson, D. M. (2018). *Unitentional domestic fire- related fatal injury in New Zealand: 2007-2014 University of Otago November 2018* (Issue November).

Miller, I. (2005). *Human behaviour contributing to unintentional residential fire deaths 1997-2003.* New Zealand Fire Service Commission Report Number 47.
Mulvaney, C., Kendrick, D., Towner, E., Brussoni, M., Hayes, M., Powell, J., Robertson, S. & Ward, H. (2009). Fatal and non-fatal fire injuries in England 1995-2004: Time trends and inequalities by age, sex and area deprivation. *Journal of Public Health*, *31*(1), 154–161. https://doi.org/10.1093/pubmed/fdn103
National Fire Protection Agency. (2021). Glossary of terms. https://www.nfpa.org/~/media/Files/Codes%20and%20standards/Glossary%20of%20terms/glossary_of_terms_2021.ashx
National Coronial Information System. (2022). Residential fire related deaths in Australia. https://www.ncis.org.au/wp-content/uploads/2022/09/FS22-08-Residential-fire-related-deaths-in-Australia.pdf
New South Wales Fire Brigade. (NSWFB; 1998). *AIRS Reference Manual*. https://remote.fire.nsw.gov.au.
New South Wales Fire Brigade. (NSWFB; 2007). *AIRS Step by Step Manual*, version 3. https://remote.fire.nsw.gov.au.
Office of the Public Advocate. (2022). About mental capacity. http://www.opa.sa.gov.au/page/view_by_id/21
Pooley, K. (2021). What are the characteristics of effective youth offender programs? *Trends & Issues in crime and criminal justice, 604.* https://www.aic.gov.au/publications/tandi/tandi604
Pooley, K. (2015). *An analysis of youth misuse of fire in New South Wales*. University of New England Honours thesis.
Purcell et al., (2021). The effect of neughbourhood area deprivation index on residential burn injury severity. *Burns, 47*: 447-454.
Runefors, M., Jonsson, A. & Bonander, C. (2021). Factors contributing to survival and evacuation in residential fires involving older adults in Sweden. *Fire Safety Journal, 122*: 103-354.
Runefors, M., Johansson, N. & van Hees, P. (2016). How could the fire fatalities have been prevented? An analysis of 144 cases during 2011-2014 in Sweden. *Journal of Fire Sciences, 34*(6): 515-527.
Sekizawa, A. & Mizuno, M. (2017). Analysis of response behaviour of people in fire incidents where residnetial fire alarms successfully worked. *Fire and Materials.* doi:10.1002/fam.2434
Shokouhi et al. (2019). Preventive measures for fire-related injuried and their risk factors in residential buildings: a systematic review. *Injury & Violence, 11*(1):1-14.
Steen-Hansen, A., Storesund, K. & Sesseng, C. (2021). Learning from fire investigations and research – A Norwegian perspective on moving from a reactive to a proactive fire safety management. *Fire Safety Journal*, *120*(February 2020), 103047. https://doi.org/10.1016/j.firesaf.2020.103047
Tannous, W. K. & Agho, K. (2017). Socio-demographic predictors of residential fire and unwillingness to call the fire service in New South Wales. *Preventive Medicine Reports*, *7*, 50–57. https://doi.org/10.1016/j.pmedr.2017.05.004
Thompson, O., Galea, E. & Hulse, L. (2018). A review of the literature on human behaviour in dwelling fires. *Safety Science, 109*: 303-312.
Warda, L., Tenenbein, M. & Moffatt, M. (1999). House fire injury prevention update. Part 1. A review of risk factors for fatal and non-fatal house fire injury. I*njury Prevention, 5*: 145-150.
Wuschke, K., Clare, J. & Garis, L. (2013). Temporal and geographical clustering of residential structure fires: A theoretical platform for targeted fire prevention. *Fire Safety Journal, 62*: 3-12.
Xiong, L., Bruck, D. & Ball, M. (2015). Comparative investigation of “survival” and fatality factors in accidental residential fires. *Fire Safety Journal*, *73*, 37–47. https://doi.org/10.1016/j.firesaf.2015.02.003
Xiong, L., Bruck, D. & Ball, M. (2016). Preventing accidental residential fires: the role of

human involvement in non-injury house fires. *Fire and Materials*, *41*(1), 3–16. https://doi.org/10.1002/fam.2356

10 Appendix A

10.1 Univariate Results

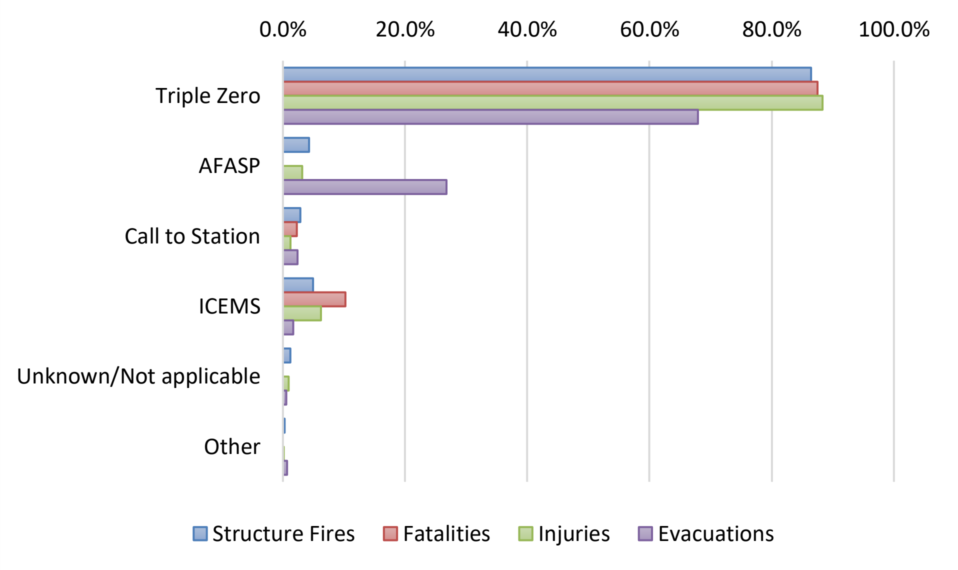
The following statistics are descriptive only. Unless identified as statistically significant in the bivariate and multivariate analyses below, any differences or similarities observed are not statistically significant, meaning it is likely they occurred by chance. As a result, descriptive statistics carry the least weight and should not be used to inform decision-making.

10.1.1 Response Characteristics

10.1.1.1 Call source

Most structure fires, regardless of outcome, were identified from a Triple Zero (000) call.

Figure 23. Structure fire outcomes by call source



10.1.1.2 Response time

Given right skewed time data, average times are not an accurate indicator of response times. Instead, the median has been used. The median is the middle value in the data, separating the lower half from the higher half.

Table 26. Structure fire response times

Time Period	Minimum	Maximum	Mean	Median	Mode	Skewness
Alarm to Arrived	0:00:02	18:47:38	0:07:58	0:07:13	0:06:09	71.1
Alarm to Extinguished	0:00:52	23:58:08	0:56:25	0:36:20	0:14:53	7.6
Alarm to Completed	0:00:25	23:48:11	1:11:19	0:40:50	0:22:49	6.1
Arrive to Extinguished	0:00:00	23:52:23	0:48:34	0:28:33	0:12:45	7.6
Arrive to Completed	0:00:47	23:43:21	1:03:28	0:33:03	0:11:43	6.1
Extinguished to Completed	0:00:00	23:56:35	0:15:53	0:03:08	0:03:09	10.2

Figure 24. Alarm notification to arrival at incident times

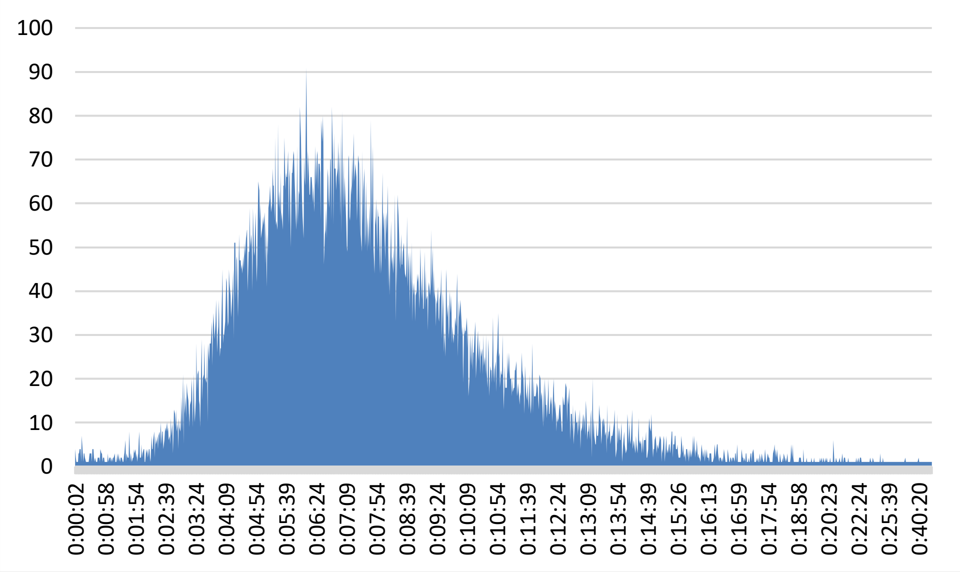


Figure 25. Alarm notification to extinguished times

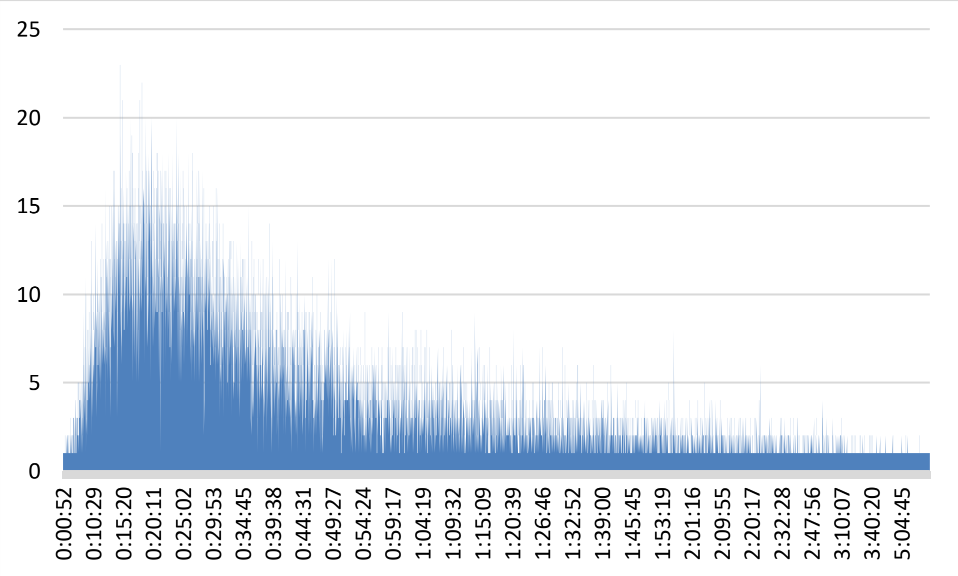


Figure 26. Alarm notification to completed times

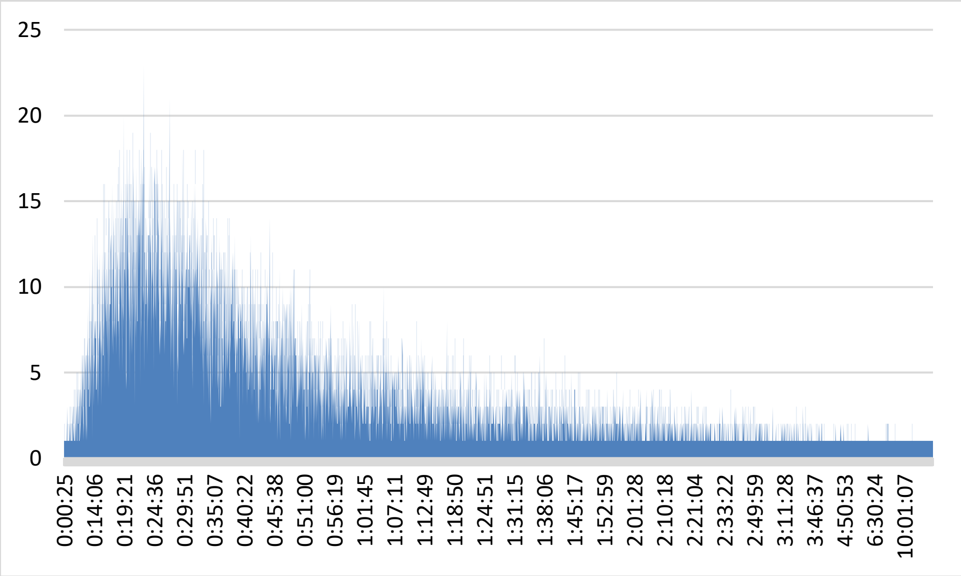


Figure 27. Arrived at incident to extinguished times

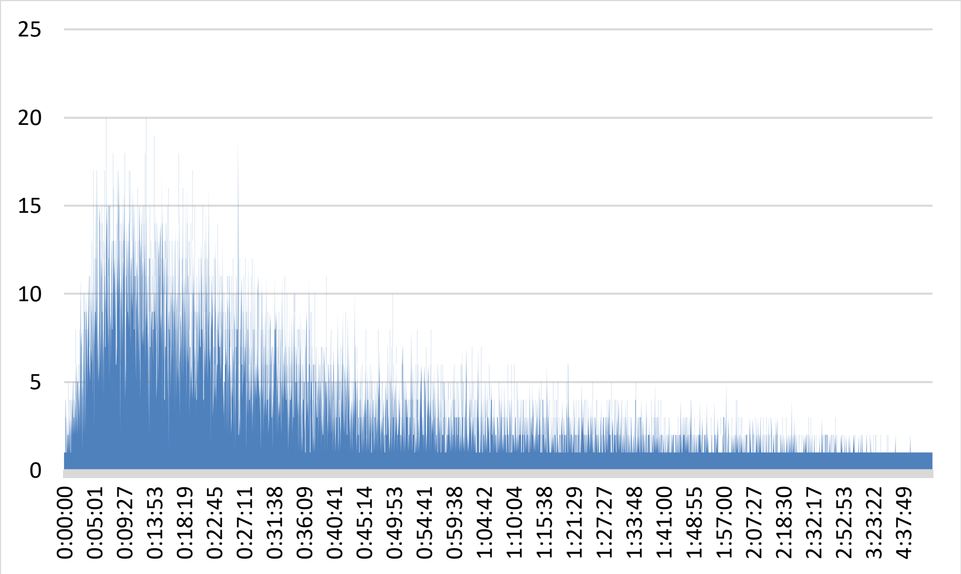


Figure 28. Arrived at incident to completed time

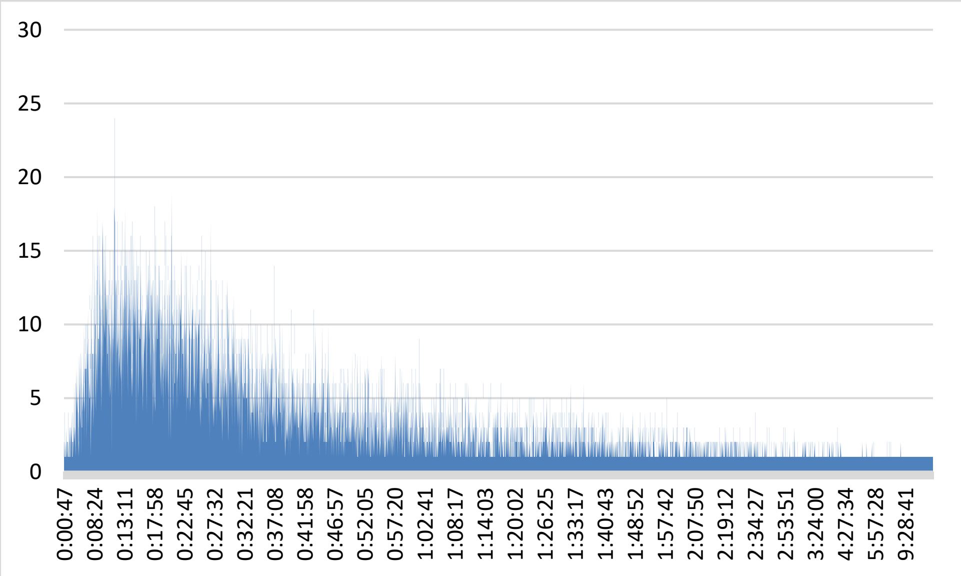
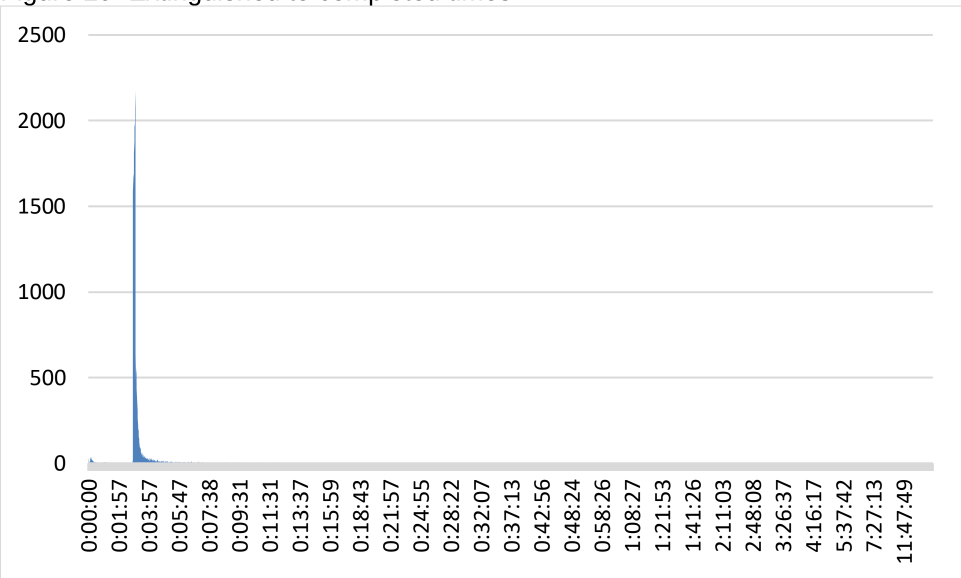


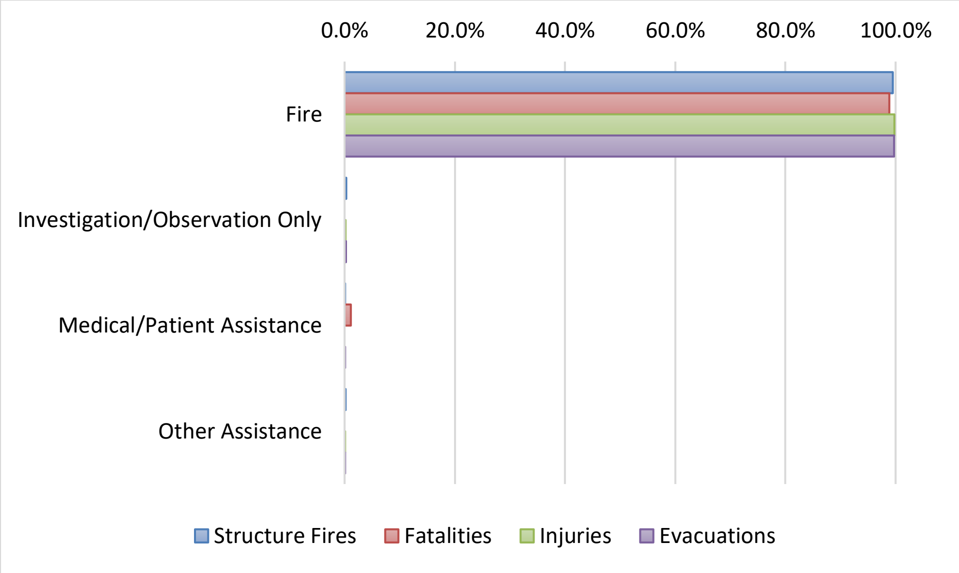
Figure 29. Extinguished to completed times



10.1.1.3 Primary activity

The primary activity for most structure fires (99.5%), evacuations (99.7%), injuries (99.8%), and fatalities (98.9%) was fire response.

Figure 30. Structure fire outcomes by primary response activity

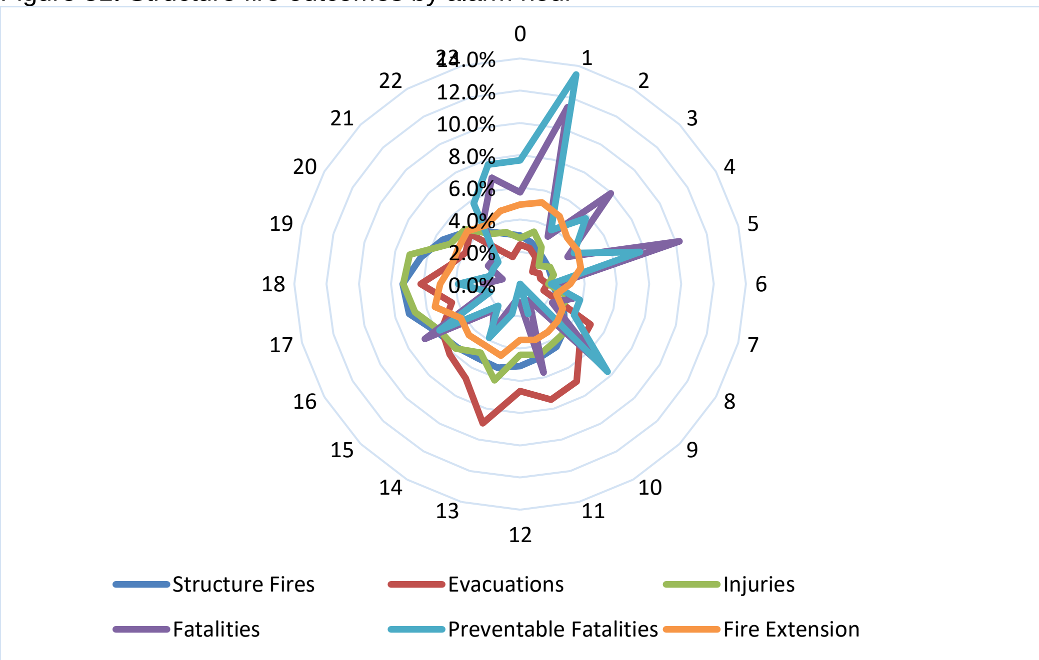


10.1.2 Temporal Characteristics

10.1.2.1 Hour

Structure fires occurred more often at 1800 (9.8%) hours. Evacuations peaked at 1300 hours (8.9%), injuries peaked at 1800 hours (7.2%), fatalities ad preventable fatalities peaked at 0100 hours (11.4% and 13.5% respectively), while fire extension peaked at 1800 hours (5.5%).

Figure 31. Structure fire outcomes by alarm hour

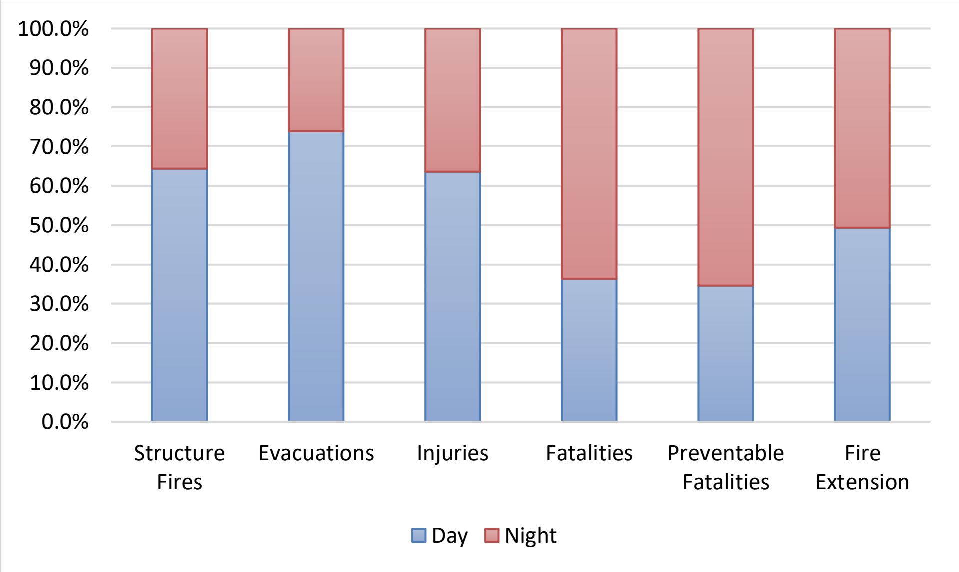


10.1.2.2 Time of day

While most structure fires (64.4%), persons evacuated (73.9%), and injuries (63.6%) occurred during the day (0800-1959 hours), fatalities (63.6%) and preventable fatalities

(65.4%) occurred more often at night (2000-0759 hours). Fire extension beyond the room of origin was equally proportioned over day and night (49.3% vs 50.7%).

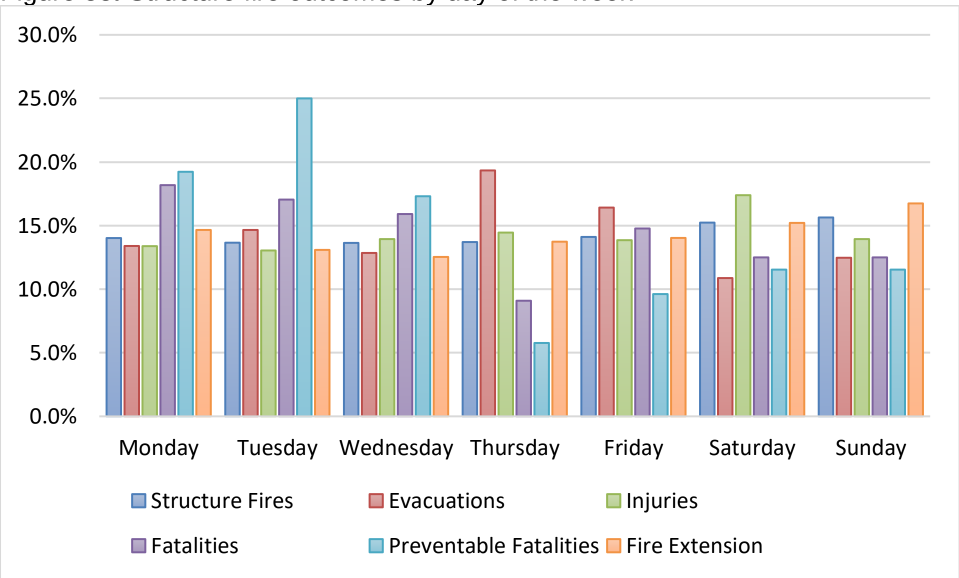
Figure 32. Structure fire outcomes by time of day



10.1.2.3 Day of week

Structure fires peaked on a Sunday (15.6%), while evacuations peaked on a Thursday (19.3%), injuries peaked on a Saturday (17.4%), fatalities on a Monday (18.2%), preventable fatalities on a Tuesday (25.0%), and fire extension on a Sunday (16.7%).

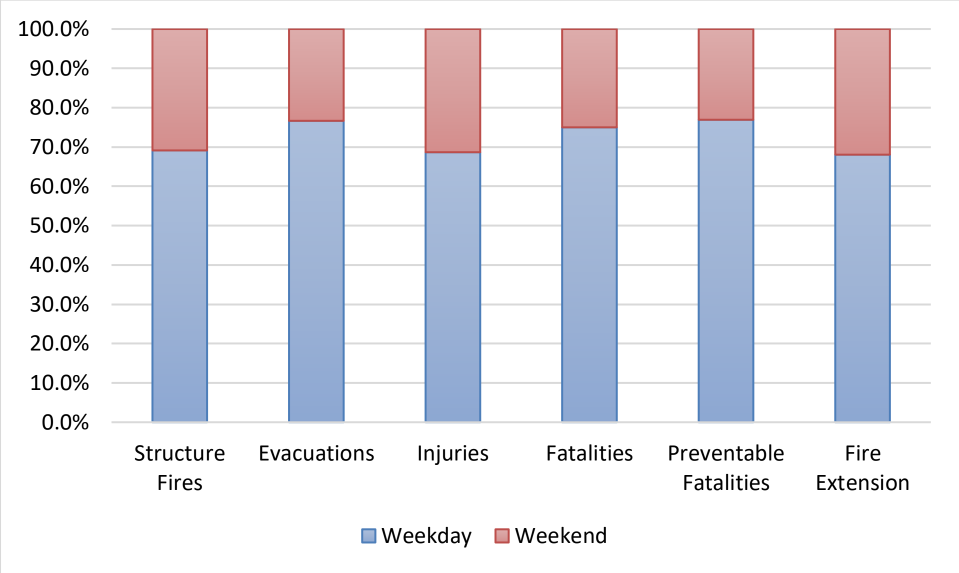
Figure 33. Structure fire outcomes by day of the week



10.1.2.4 Time of week

All structure fires, despite their outcome, were more likely to occur during a weekday than a weekend.

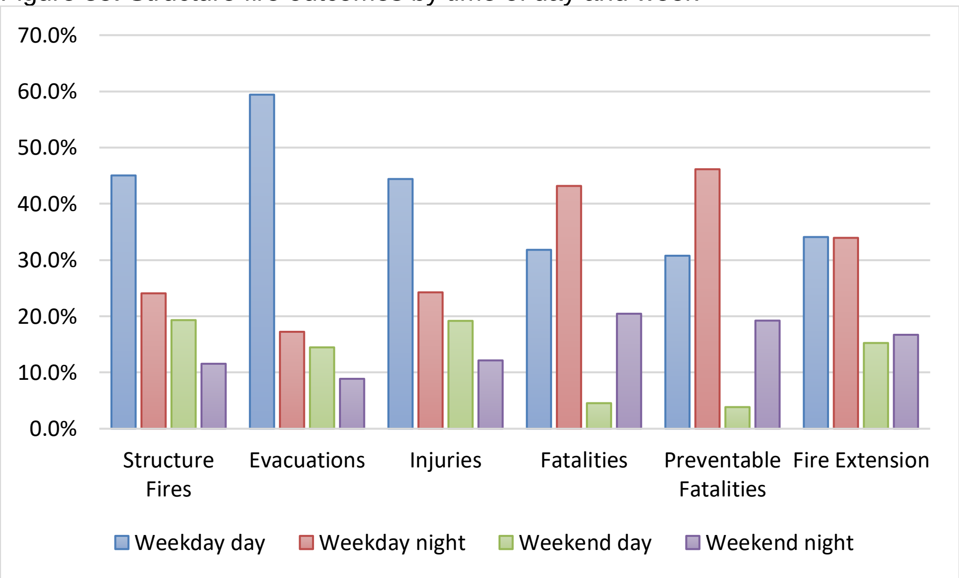
Figure 34. Structure fire outcomes by time of the week



10.1.2.5 Day and time of week

When time of day and day of week were collated, structure fires (45.0%), persons evacuated (59.4%), injuries (44.4%), and fire extension (34.1%) occurred more often on weekday days. Fatalities (43.2%) and preventable fatalities (46.2%) occurred more often on weekday nights.

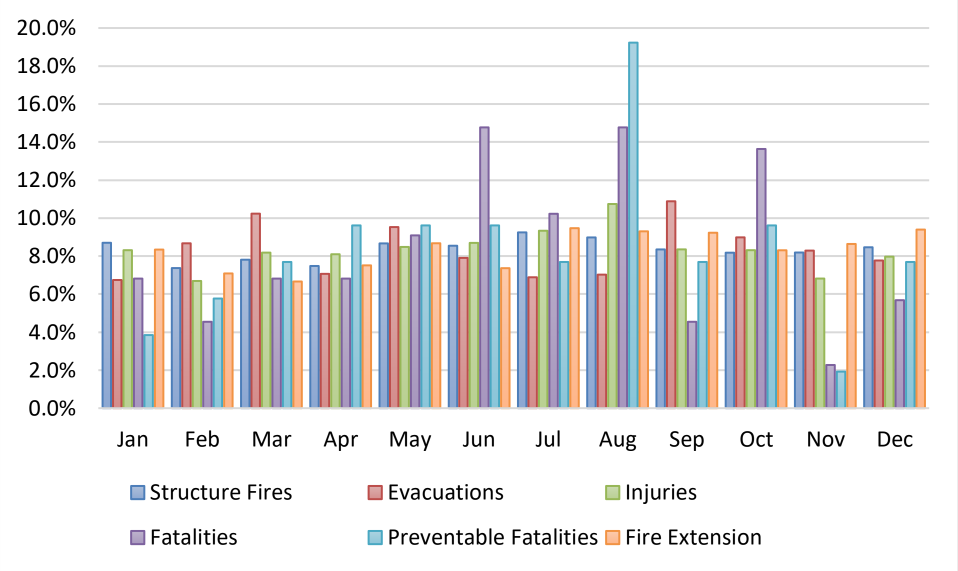
Figure 35. Structure fire outcomes by time of day and week



10.1.2.6 Month

Structure fires peaked in July (9.2%). Injuries (10.7%), fatalities (14.8%), and preventable fatalities (19.2%) peaked in August, while fatalities also peaked in June (14.8%). Evacuations peaked in September (10.9%), while fire extension peaked in July (9.5%).

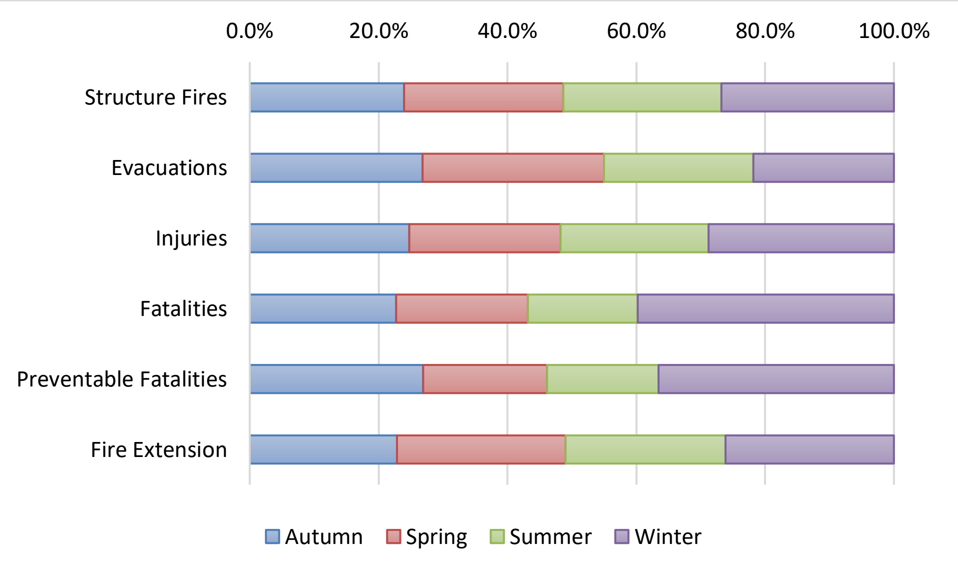
Figure 36. Structure fire outcomes by Month



10.1.2.7 Season

While there were slightly more structure fires (26.8%) and injuries (28.8%) in Winter, fatalities (39.8%) and preventable fatalities (36.5%) peaked noticeably in Winter. Persons evacuated (28.2%) and fire extension (26.2%) peaked in Spring.

Figure 37. Structure fire outcomes by alarm season



10.1.3 Location Characteristics

10.1.3.1 Postcode

Structure fires, evacuations, injuries, and fatalities appeared to occur across New South Wales. There appears to be some clustering of:

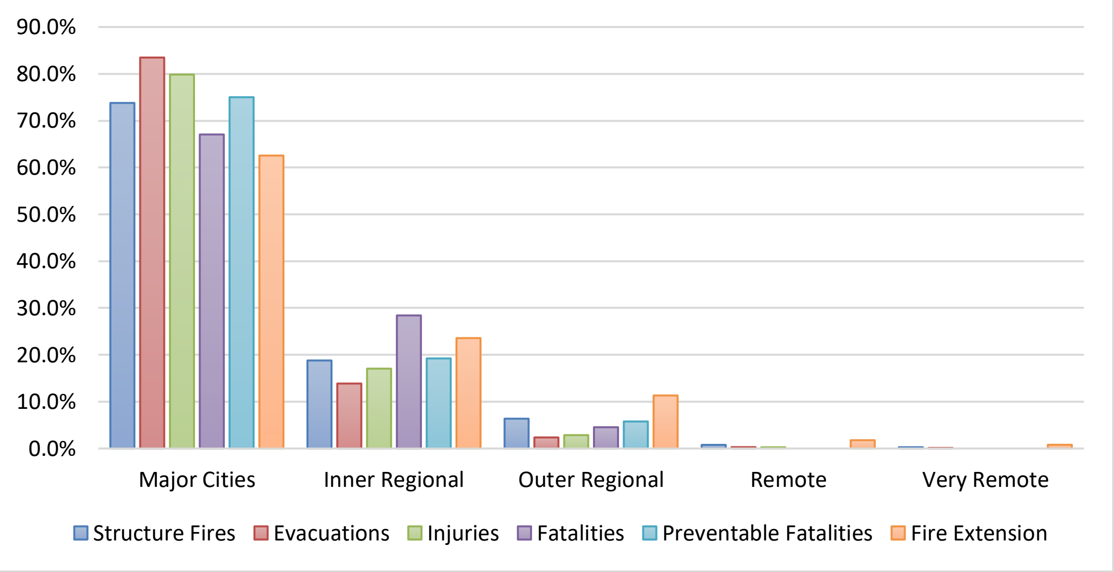
- Structure fires in postcodes 2170 (Moorebank; 1.76%), 2770 (Mount Druitt; 1.52%), and 2560 (Campbelltown; 1.40%).
- Persons evacuated in postcodes 2000 (Sydney; 5.38%), 2150 (Parramatta; 4.36%), 2204 (Marrickville; 3.41%), and 2160 (Merrylands; 2.67%).

- Persons injured in postcodes 2770 (Mount Druitt; 2.56%), 2170 (Moorebank; 1.96%), 2560 (Campbelltown; 1.71%), and 2145 (Greystanes; 1.49%).
- Fatalities in postcodes 2640 (Albury; 4.55%), 2330 (Hunter; 3.41%), and 2770 (Mount Druitt; 2.27%).
- Preventable fatalities in
- Fire extension beyond the room of origin in 2400 (Moree; 2.61%), 2770 (Mount Druitt; 2.03%), and 2650 (Wagga Wagga; 2.01%).

10.1.3.2 Remoteness

Most structure fires and adverse outcomes occurred in major cities of Australia. Compared to structure fires, there appears to be a disproportionate number of evacuations in major cities, fatalities in inner regional areas, and fire extension in inner regional and outer regional areas.

Figure 38. Structure fire outcomes by remoteness

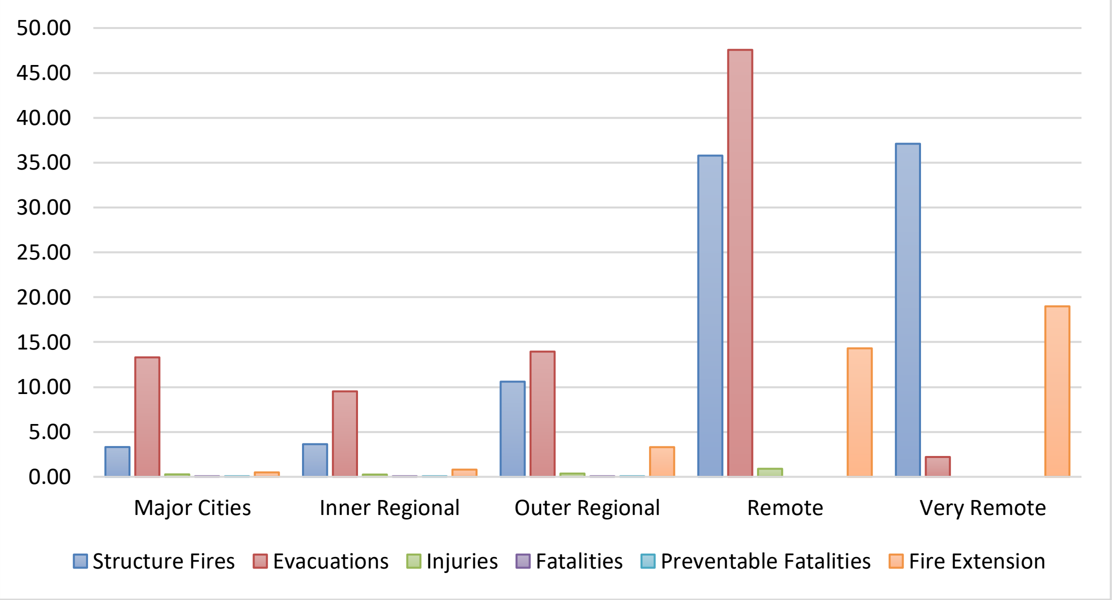


10.1.3.3 Remoteness (population controlled)

Australian Bureau of Statistics Dataset 2 was used to calculate the usual resident population of each postcode. Postcode populations were collated to measure the usual resident population of each remoteness area. This data was used to calculate population-controlled rates.

Very remote areas had higher rates of structure fires (37.11 per 100,000) and fire extension (18.99 per 100,000). Remote areas had higher rates of evacuations (47.57 per 100,000) and injuries (0.89 per 100,000). Fatalities and preventable fatalities occurred more often in outer regional areas (0.02 per 100,000 respectively), while fatalities also occurred more often in inner regional areas (0.02 per 100,000).

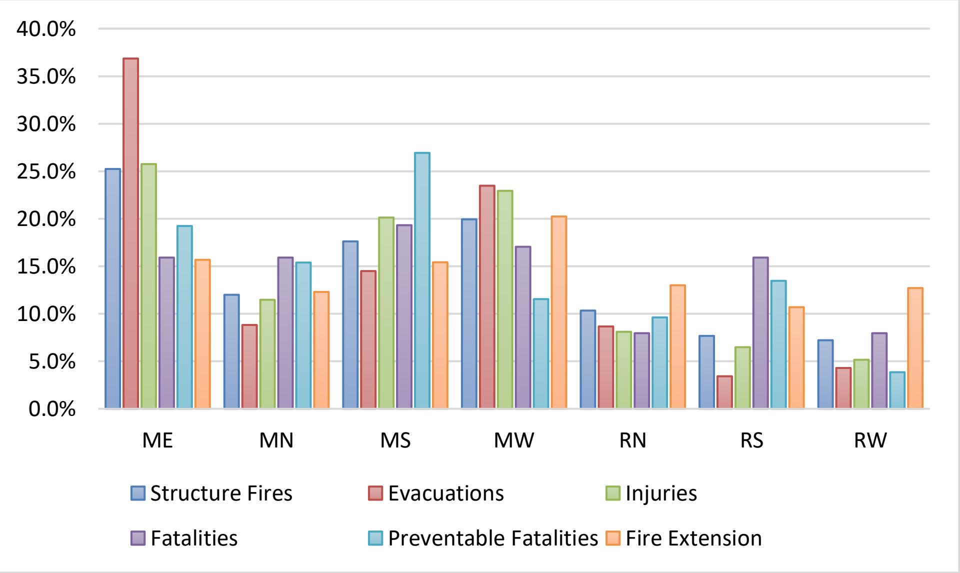
Figure 39. Structure fire outcome rates by 100,000 persons by remoteness



10.1.3.4 FRNSW Region

By FRNSW Region, Metropolitan East attended the largest proportion of structure fires (25.2%), facilitated the largest proportion of persons evacuated (36.9%), and attended the largest proportion of injuries (25.7%). Metro South attended the largest proportion of fatalities (19.3%) and preventable fatalities (26.9%). The highest proportion of fire extension occurred in Metro West (20.2%).

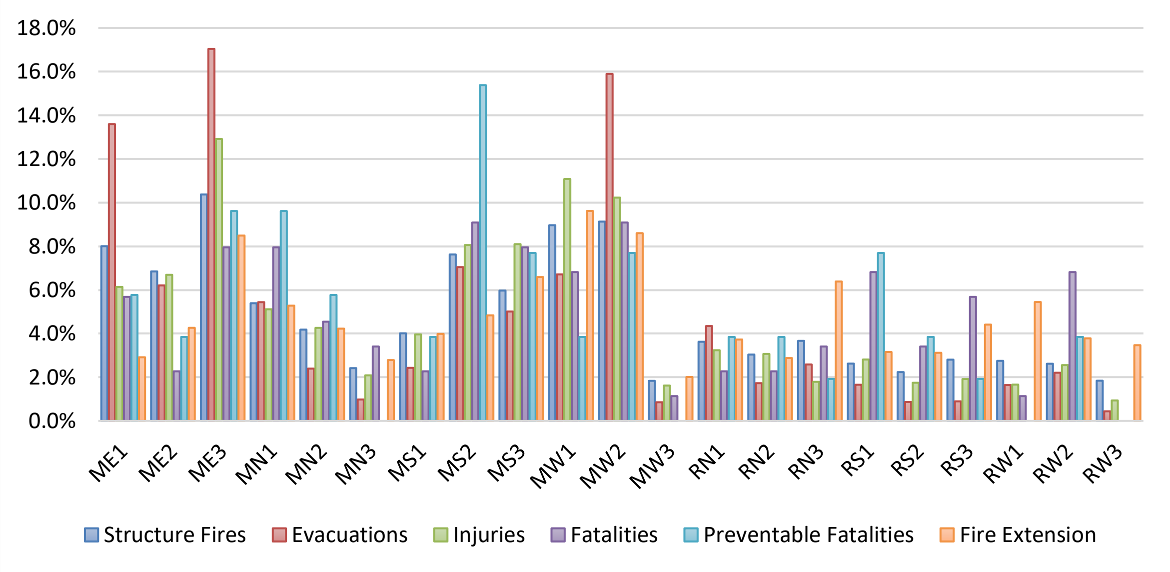
Figure 40. Structure fire outcomes by FRNSW Region



10.1.3.5 FRNSW Zone

By FRNSW Zone, Metropolitan East 3 attended the largest proportion of structure fires (10.4%), facilitated the largest proportion of persons evacuated (17.0%), and attended the largest proportion of injuries (12.9%). Metropolitan South 2 attended the largest proportion of fatalities (9.1%) and preventable fatalities (15.4%). Metropolitan West 1 had the highest proportion of fire extension (9.6%).

Figure 41. Structure fire outcomes by FRNSW Zone

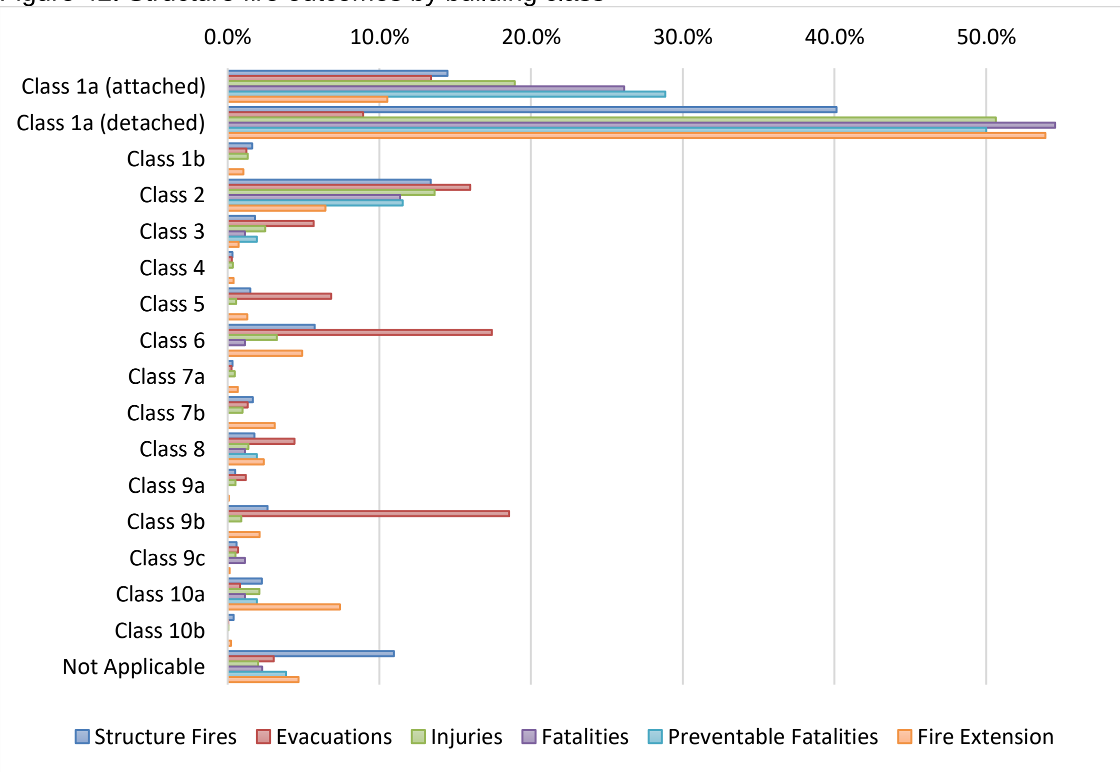


10.1.4 Property Characteristics

10.1.4.1 Building code

The largest proportion of structure fires (40.1%), injuries (50.6%), fatalities (54.5%), preventable fatalities (53.9%), and fire extension (53.9%) occurred in Class 1a (residential detached) buildings. The largest proportion of evacuation (18.5%) occurred in Class 9b (healthcare) buildings.

Figure 42. Structure fire outcomes by building class



10.1.4.2 Property location use

The largest proportion of structure fires (40.2%), injuries (50.6%), fatalities (54.5%), preventable fatalities (50.0%), and fire extension (54.1%) occurred in residential detached properties. The largest proportion of persons evacuated (15.5%) occurred in buildings containing two or more sole occupancy units each being a separate dwelling.

Figure 43. Structure fire outcomes by property location use (top 5)

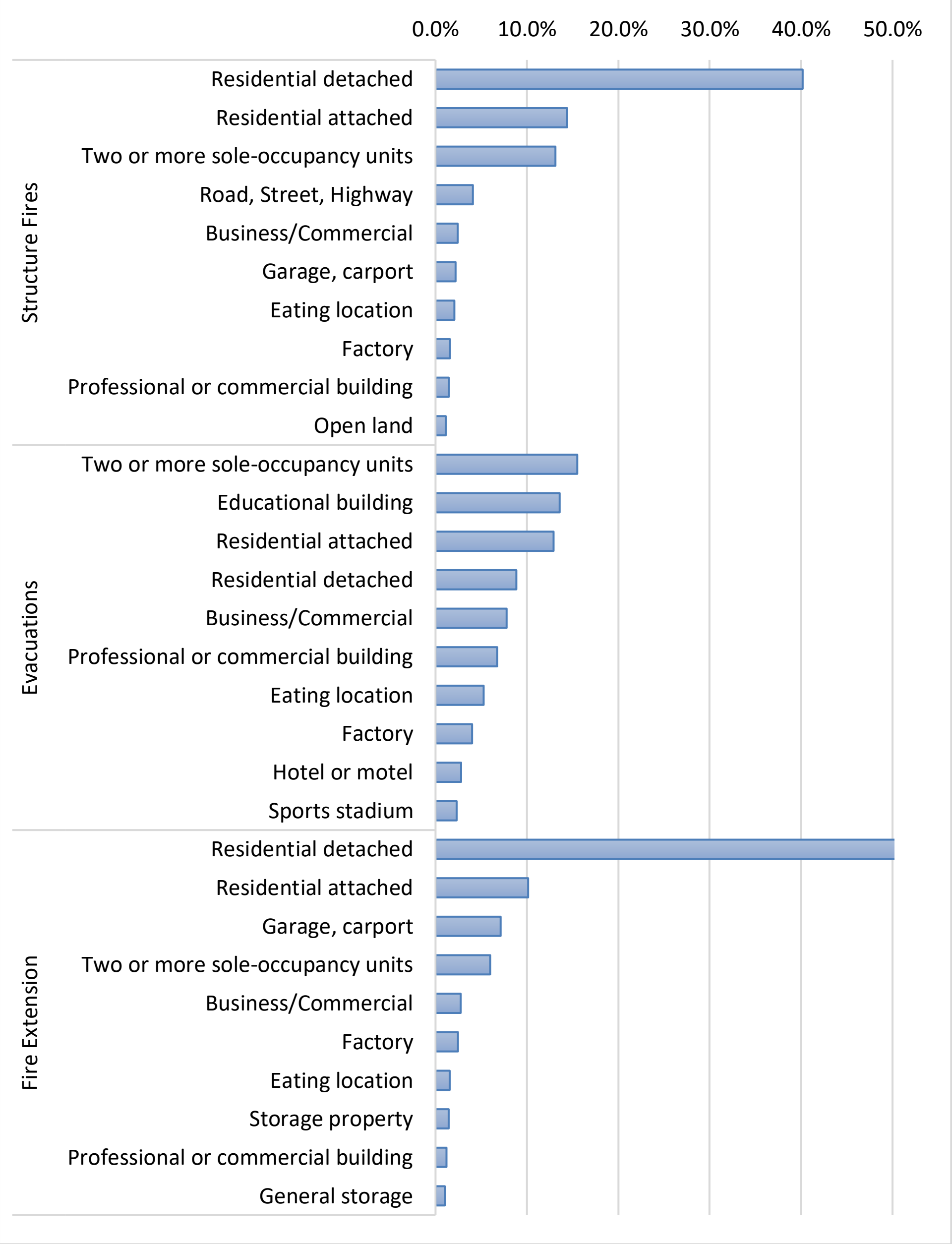
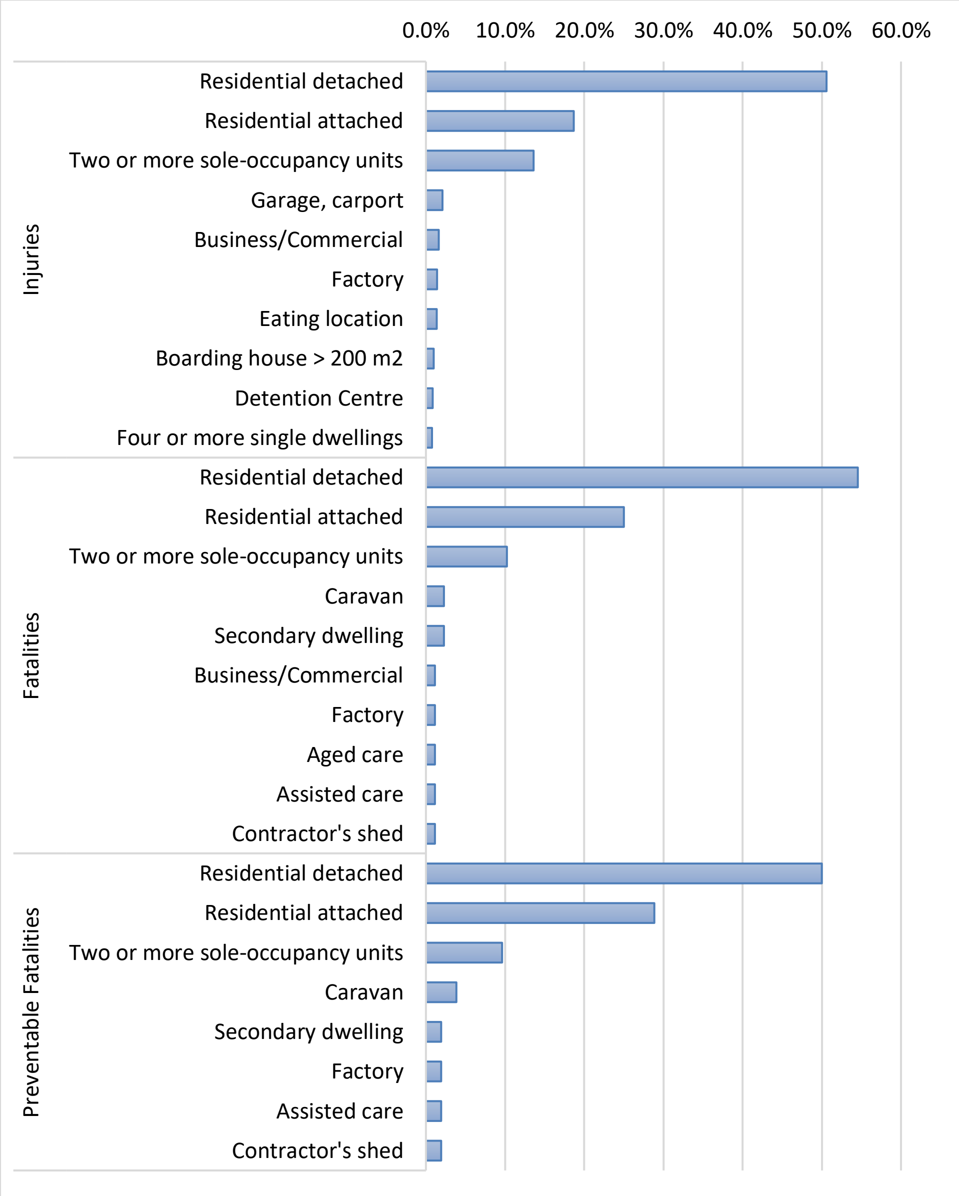


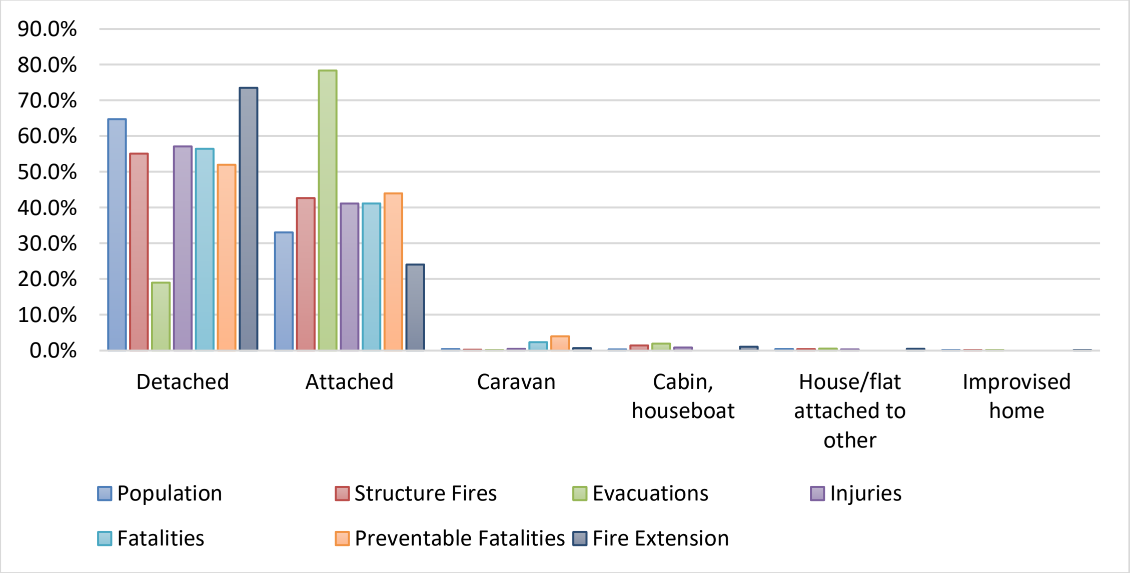
Figure 44. Structure fire outcomes by property location use (top 5) continued



10.1.4.3 Property location use (population controlled)

Australian Bureau of Statistics Dataset 3 was used to identify property location use (structure type) of all dwellings in NSW. This data was compared to all fires that occurred in dwellings in eAIRS data between 2016 and 2021. While detached residences accounted for 64.8% of all dwellings in NSW, structure fires (55.1%), evacuations (19.0%), injuries (57.1%), fatalities (56.5%), and preventable fatalities (52.0%) were under-represented. In contrast, fire extension was over-represented (73.5%). While attached dwellings accounted for 33.1% of all dwellings in NSW, structure fires (42.7%), evacuations (78.4%), injuries (41.2%), fatalities (41.2%), and preventable fatalities (44.0%) were over-represented. In contract, fire extension was under-represented (24.1%). While caravans accounted for 0.4% of all dwellings, they only accounted for 0.2% of structure fires and 0.1% of evacuations. In contrast, caravans accounted for 0.5% of injuries, 0.7% of fire extension, 2.4% of fatalities, and 4.0% of preventable fatalities.

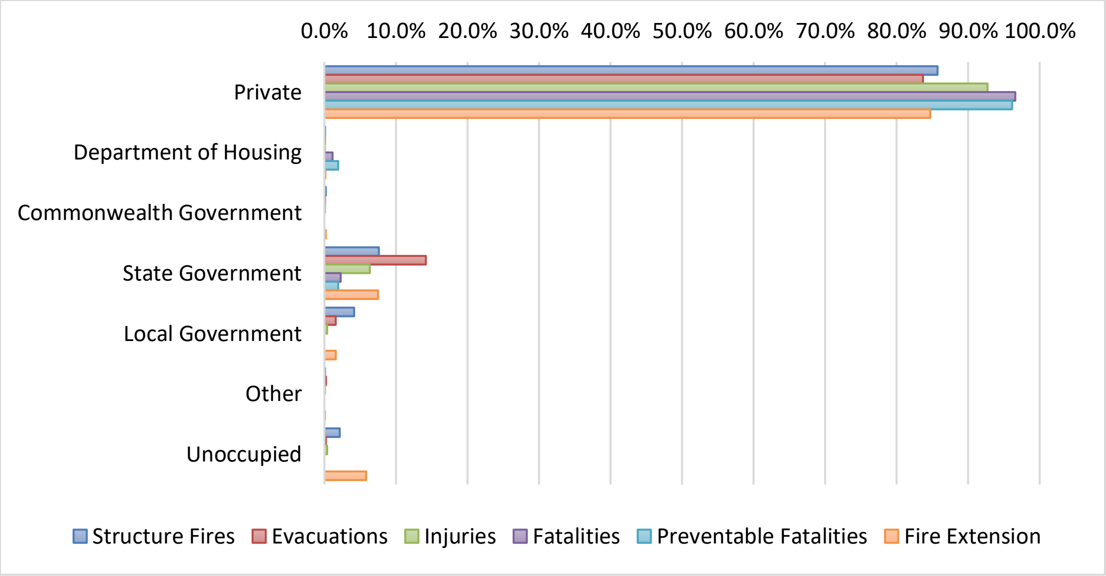
Figure 45. Structure fire outcomes by type of dwelling



10.1.4.4 Type of occupier

Structure fires (85.7%), evacuations (83.7%), injuries (92.7%), fatalities (96.6%), preventable fatalities (96.2%), and fire extension (84.7%) occurred more often in properties of private occupiers. Injuries, fatalities, and preventable fatalities are slightly over-represented in privately occupied properties.

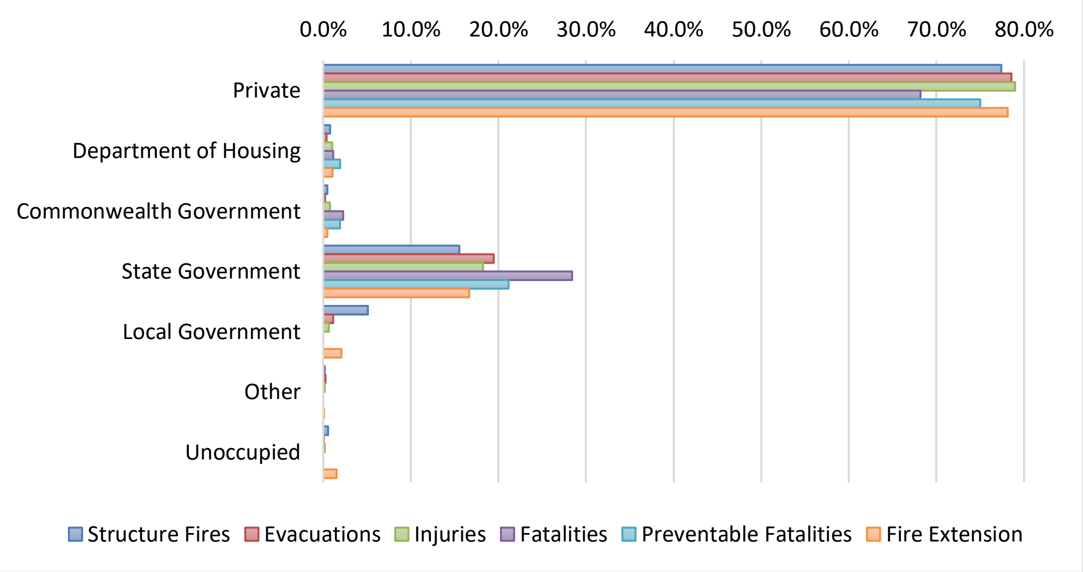
Figure 46. Structure fire outcomes by type of occupant



10.1.4.5 Type of owner

Structure fires (77.4%), evacuations (78.6%), injuries (79.0%), fatalities (68.2%), preventable fatalities (75.0%), and fire extension (78.1%) occurred more often in properties of private owners. However, fatalities and preventable fatalities were under-represented in privately owned properties, and over-represented in state and commonwealth government properties, and Department of Housing properties.

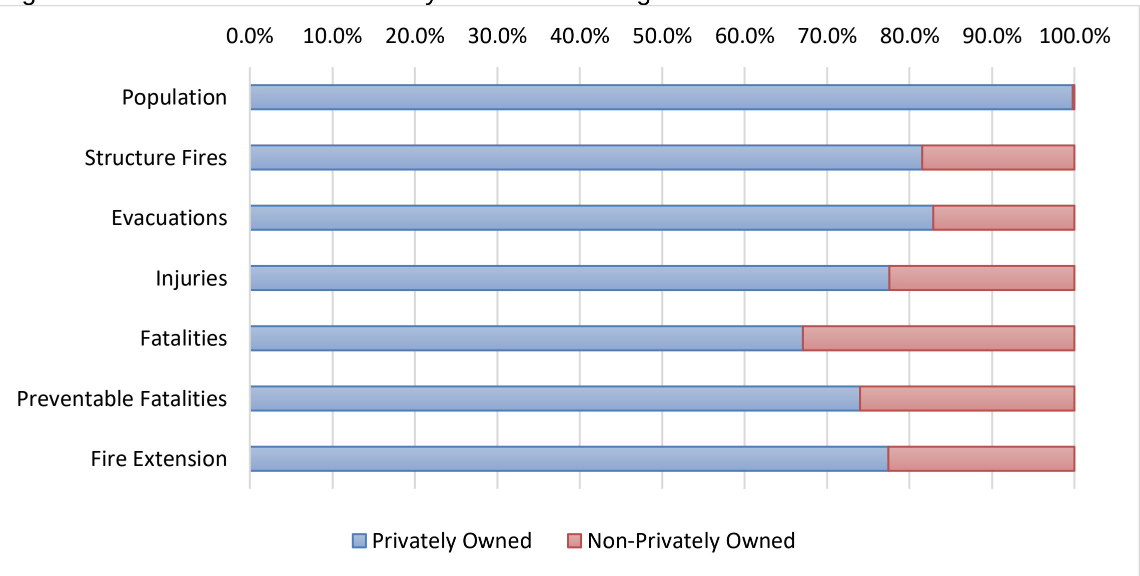
Figure 47. Structure fire outcomes by type of owner



10.1.4.6 Type of owner (population controlled)

Australian Bureau of Statistics Dataset 3 was used to identify ownership type of all dwellings in NSW. This data was compared to eAIRS data. The results show that structure fires (18.5%), evacuations (17.1%), injuries (22.4%), fatalities (32.9%), preventable fatalities (26.0%), and fire extension (22.6%) were over-represented in non-privately owned dwellings compared to the proportion of non-privately owned dwellings in the population (0.2%). Conversely, structure fires (81.5%), evacuations (82.9%), injuries (77.6%), fatalities (67.1%), preventable fatalities (74.0%), and fire extension (77.4%) were under-represented in privately owned dwellings compared to the population of privately owned dwellings (99.8%). These findings suggest that non-privately owned dwellings are disproportionately at risk.

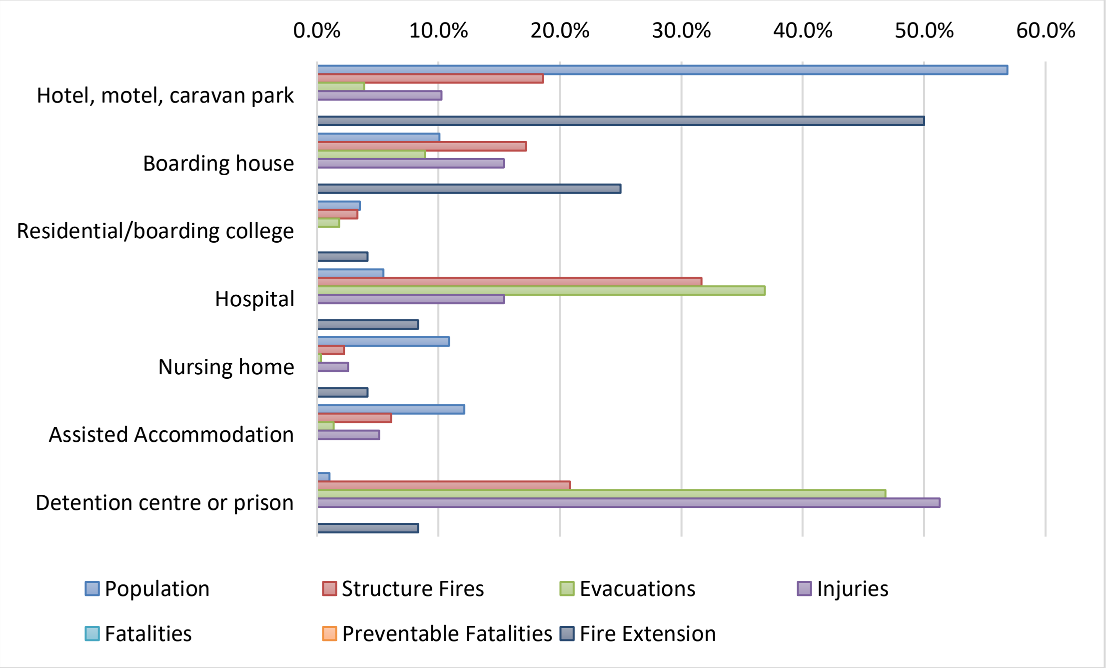
Figure 48. Structure fire outcomes by owner of dwelling



Australian Bureau of Statistics Dataset 3 was used to identify the owners of non-privately owned dwellings in NSW. This data was compared to fires that occurred in dwellings in eAIRS data. The results show that hotels, motels, and caravan parks; residential/boarding colleges, nursing homes, and assisted accommodation had disproportionately fewer structure fires and adverse outcomes than that present in the population.

Conversely, boarding houses accounted for 10.1% of non-privately owned dwellings, yet 17.2% of structure fires, 15.4% of injuries, and 25.0% of fire extension in non-privately owned dwellings. Hospitals accounted for 5.5% of non-privately owned dwellings, yet 31.7% of structure fires, 36.9% of evacuations, 15.4% of injuries, and 8.3% of fire extension in non-privately owned dwellings. Detection centres accounted for 1.0% of non-privately owned dwellings, yet accounted for 20.8% of structure fires, 46.8% of evacuations, 51.3% of injuries, and 8.3% of fire extension.

Figure 49. Structure fire outcomes by owner of non-privately owned dwelling

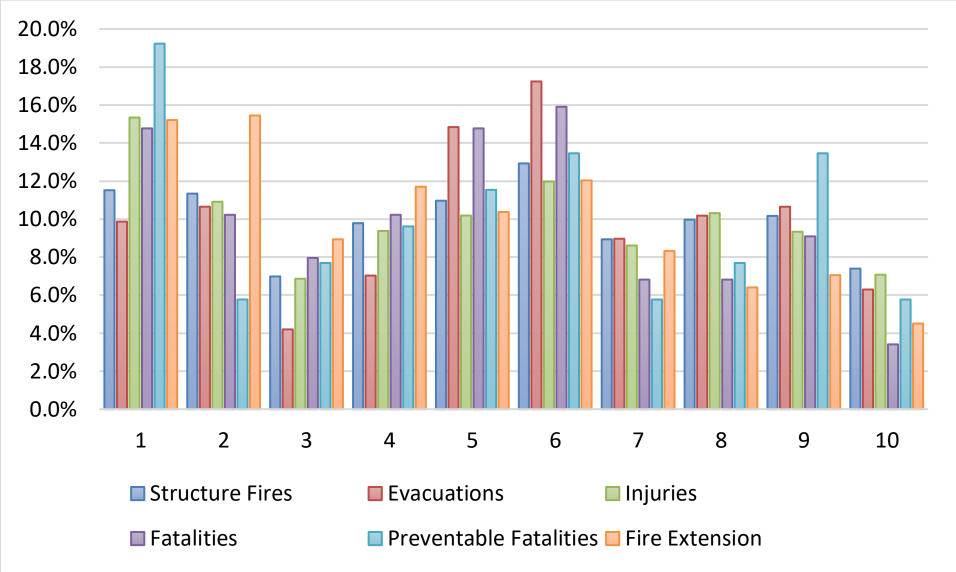


10.1.5 Individual Characteristics

10.1.5.1 SEIFA

While SEIFA decile 6 experienced the highest proportion of structure fires (12.9%), evacuations (17.2%), and fatalities (15.9%), decile 1 experienced the highest proportion of injuries (15.3%) and preventable fatalities (19.2%). Deciles 1 and 2 experienced the highest proportion of fire extension (15.2% and 15.5% respectively).

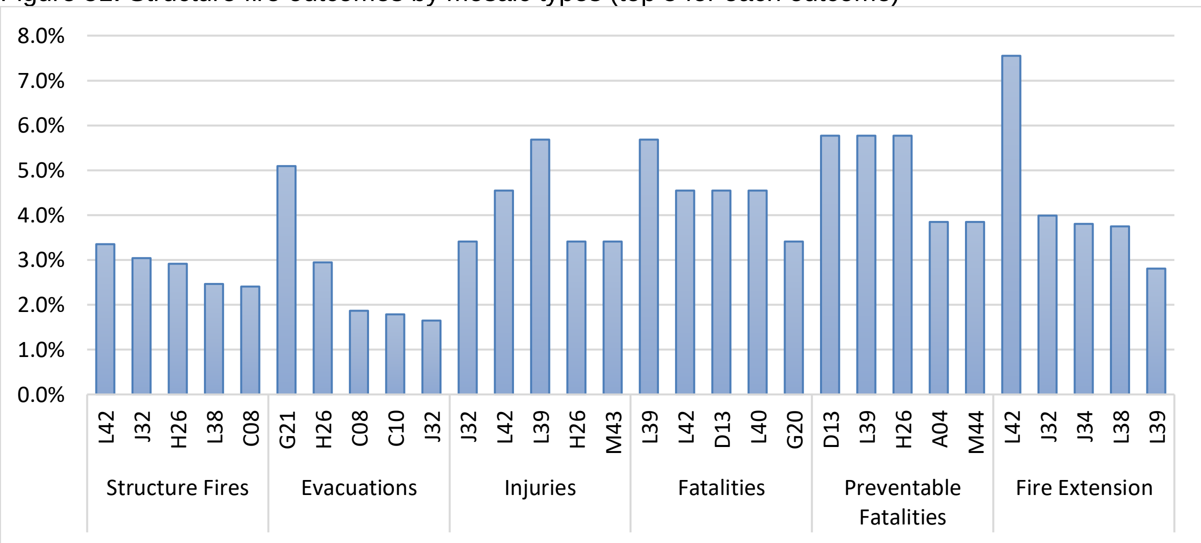
Figure 50. Structure fire outcomes by SEIFA decile



10.1.5.2 Mosaic Type

The highest proportion of structure fires (3.4%) and fire extension (7.6%) occurred in Mosaic Type L42, evacuations in Mosaic Type G21 (5.1%), injuries in J32 (3.4%), fatalities in L39 (5.7%), and preventable fatalities in D13 (5.8%).

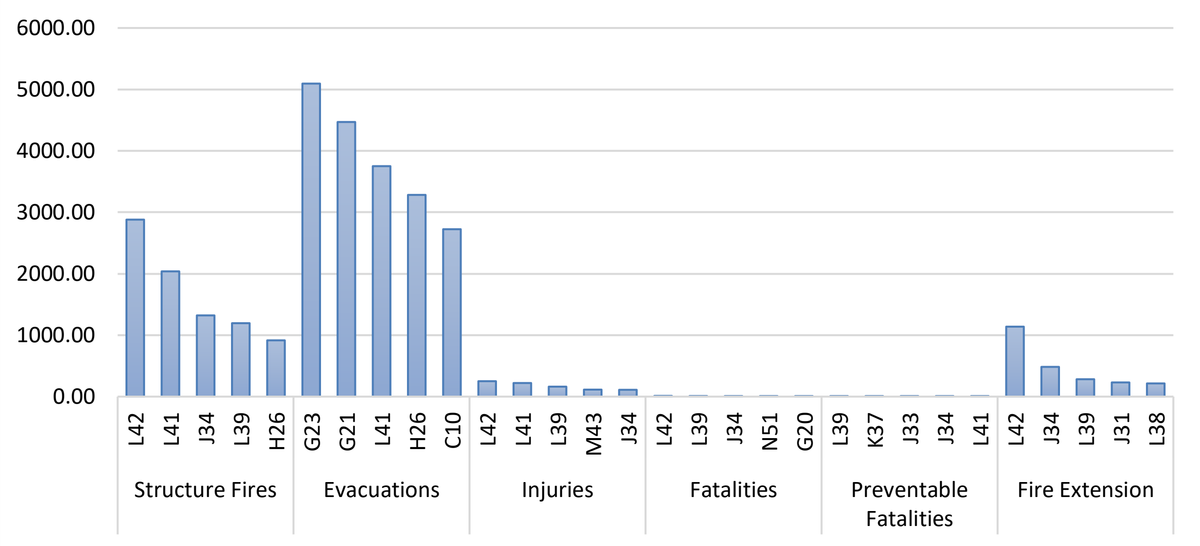
Figure 51. Structure fire outcomes by mosaic types (top 5 for each outcome)



10.1.5.3 Mosaic type (population controlled)

The Mosaic Dataset was used to identify the population within each Mosaic Type. Population data was used to calculate rates per 100,000 persons. Structure fires (2880.8 per 100,000), injuries (250.5 per 100,000), fatalities (11.1 per 100,000), and fire extension (1138.4 per 100,000) occurred more often in Mosaic Type L42. Evacuations occurred more often in Mosaic Type G23 (5095.0 per 100,000), and preventable fatalities in Mosaic Type L39 (5.6 per 100,000). Mosaic Type L42 is the highest risk type.

Figure 52. Structure fire outcomes by mosaic types – population controlled (per 100,000)

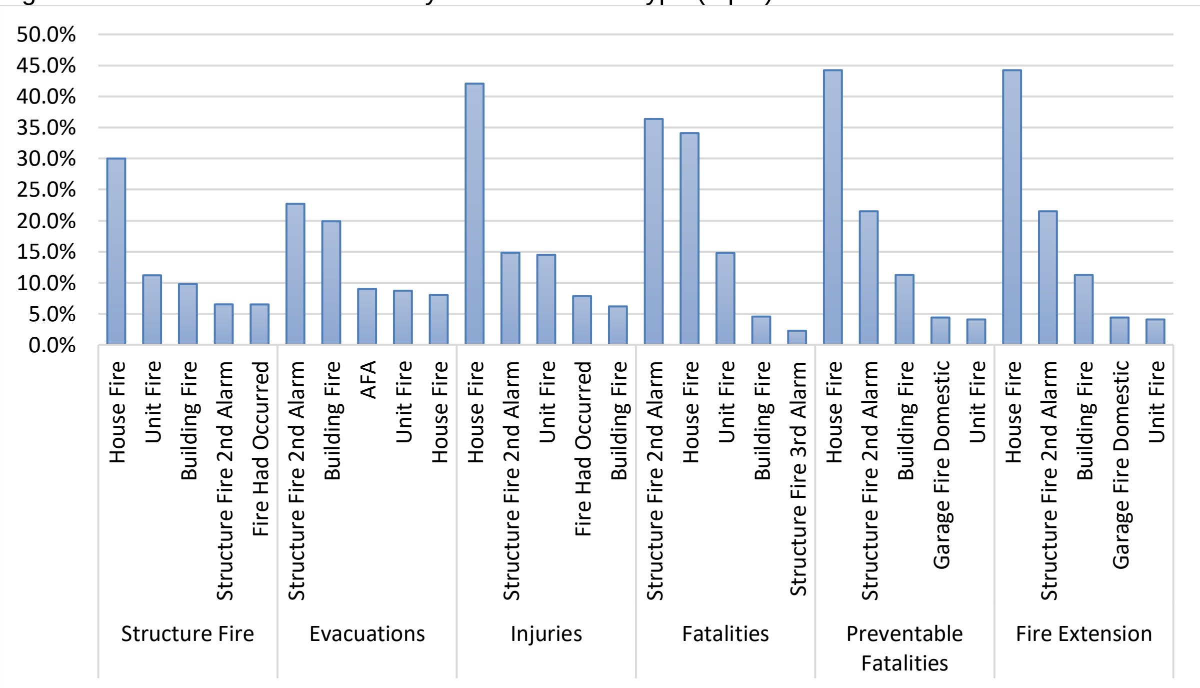


10.1.6 Fire Characteristics

10.1.6.1 Revised incident type

Structure fires (30.0%), fires causing injury (42.1%), preventable fatal fires (44.2%), and fires causing extension beyond the room of origin (44.2%) were usually classified as house fires. Fires that caused persons evacuated (22.7%) and fatalities (36.4%) were most often classified as a structure fire second alarm.

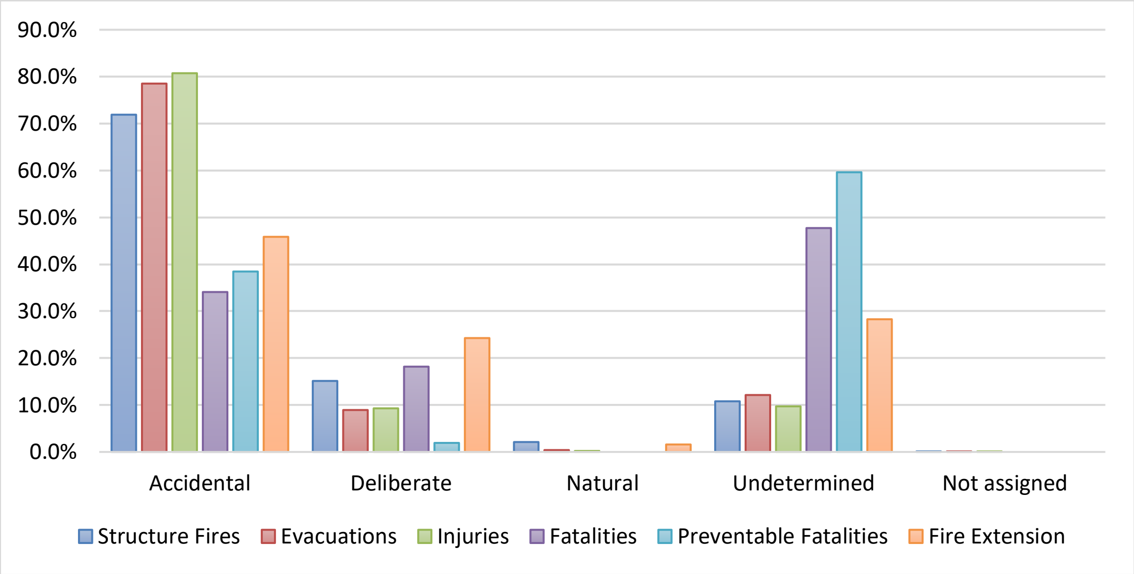
Figure 53. Structure fire outcomes by revised incident type (top 5)



10.1.6.2 Cause determination

Structure fires (71.9%), fires that caused evacuations (78.5%), fires that caused injury (80.7%), and fires that extended beyond the room of origin (45.9%) were more likely to be determined as accidental. Fires that caused fatality (47.7%) and preventable fatality (59.6%) were more likely to be of undetermined cause.

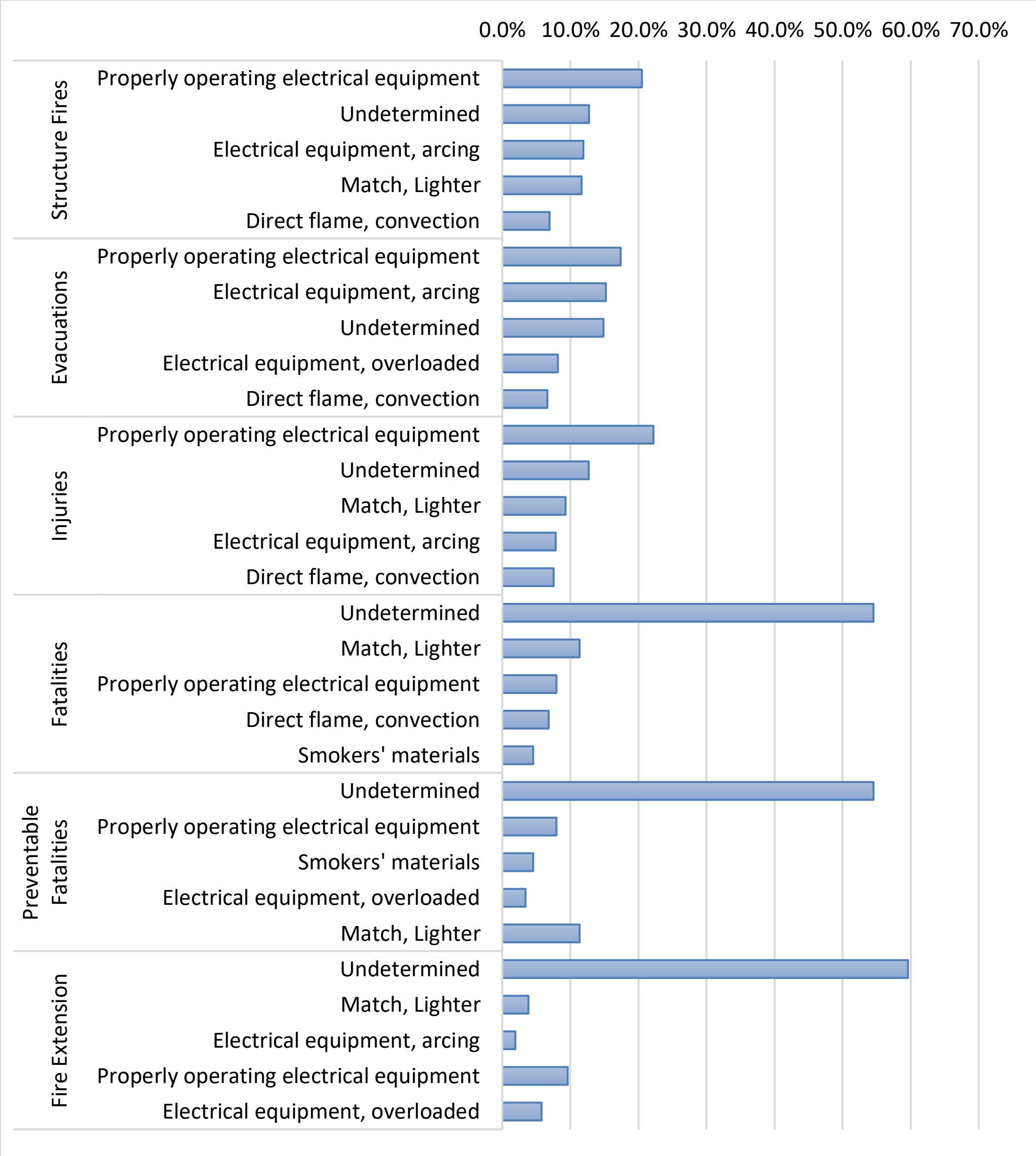
Figure 54. Structure fire outcomes by cause determination



10.1.6.3 Ignition source

The largest proportion of structure fires (20.5%), persons evacuated (15.2%), and injuries (22.2%) were caused by properly operating electrical equipment. The largest proportion of fatalities (54.5%), preventable fatalities (54.5%), and fire extension (59.6%) were caused by an undetermined source.

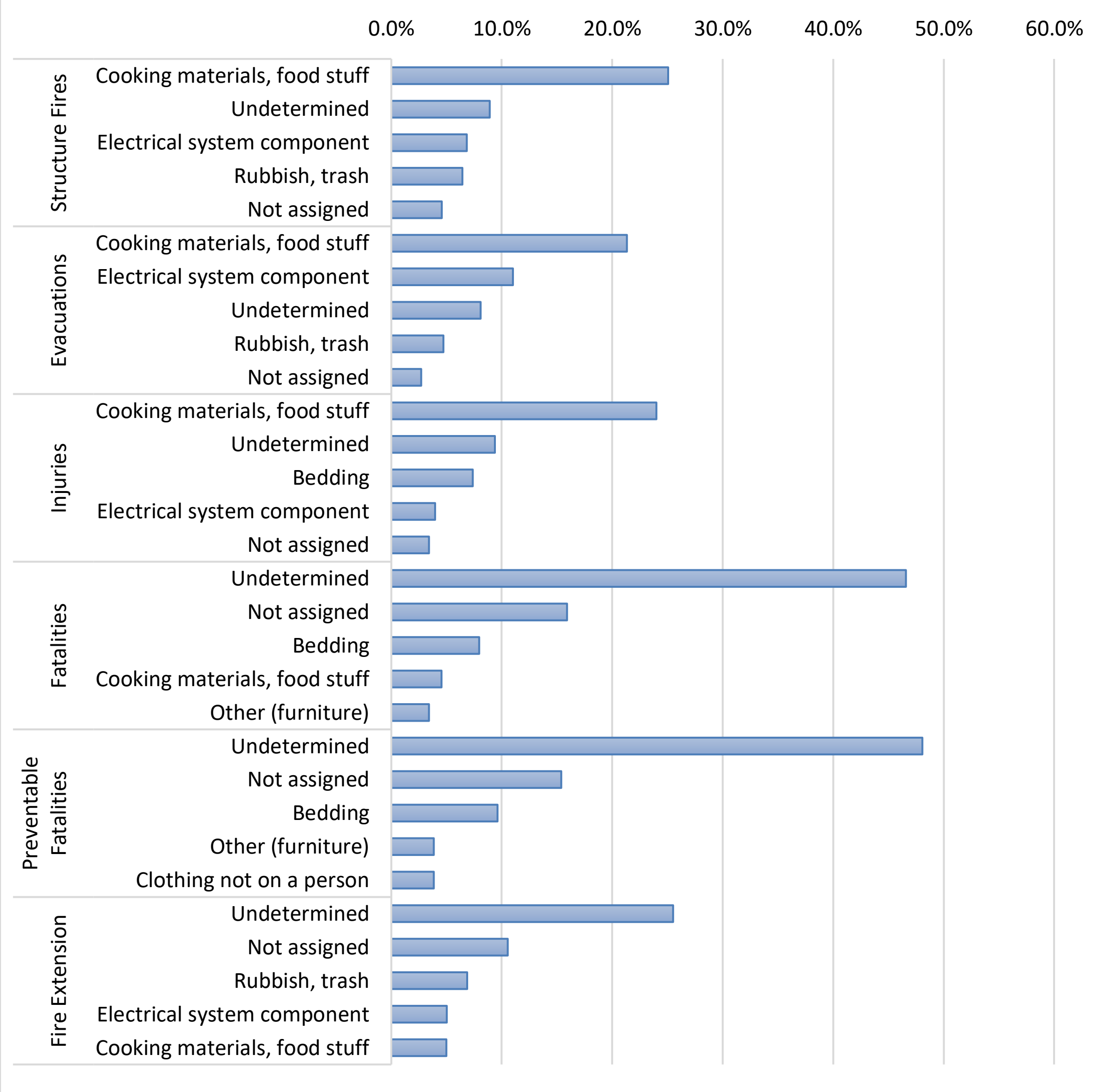
Figure 55. Structure fire outcomes by ignition source and adverse outcome (top 5)



10.1.6.4 Material ignited first

The largest proportion of structure fires (25.1%), persons evacuated (21.3%), and injuries (24.0%) involved cooking materials/food stuffs ignited first. The largest proportion of fatalities (46.6%), preventable fatalities (48.1%), and fire extension (25.5%) were caused by an undetermined material ignited first.

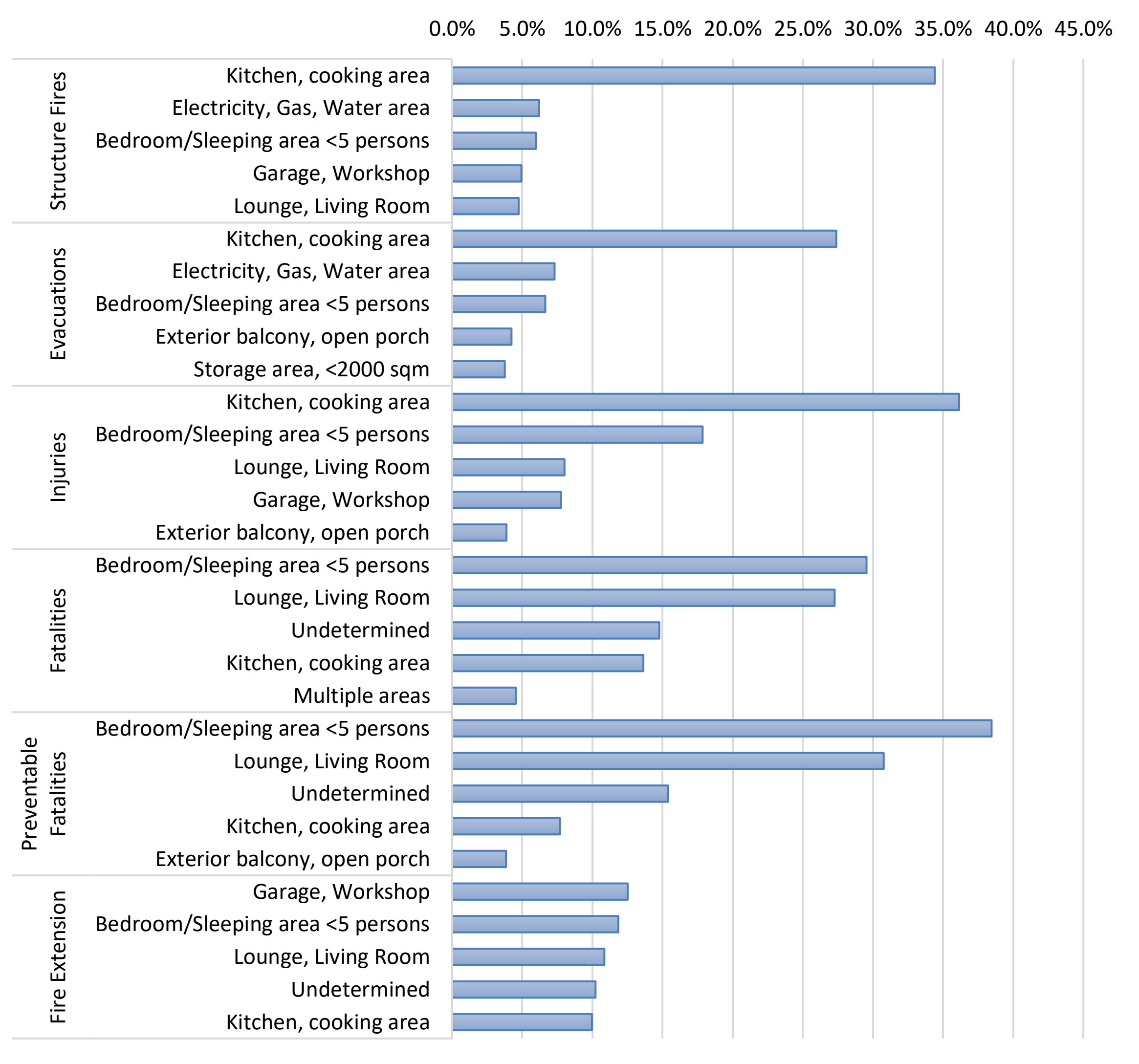
Figure 56. Structure fire outcomes by material ignited first by adverse outcome (top 5)



10.1.6.5 Area of origin

The largest proportion of structure fires (34.4%), persons evacuated (27.4%), and injuries (36.1%) occurred when fires originated in the kitchen or a cooking area. The largest proportion of fatalities (29.5%) and preventable fatalities (38.5%) occurred when the fire originated in a bedroom/sleeping area for under five persons. The largest proportion of fires that led to extension beyond the room of origin originated in a garage or workshop (12.5%).

Figure 57. Structure fire outcomes by area of origin by adverse outcome (top 5)

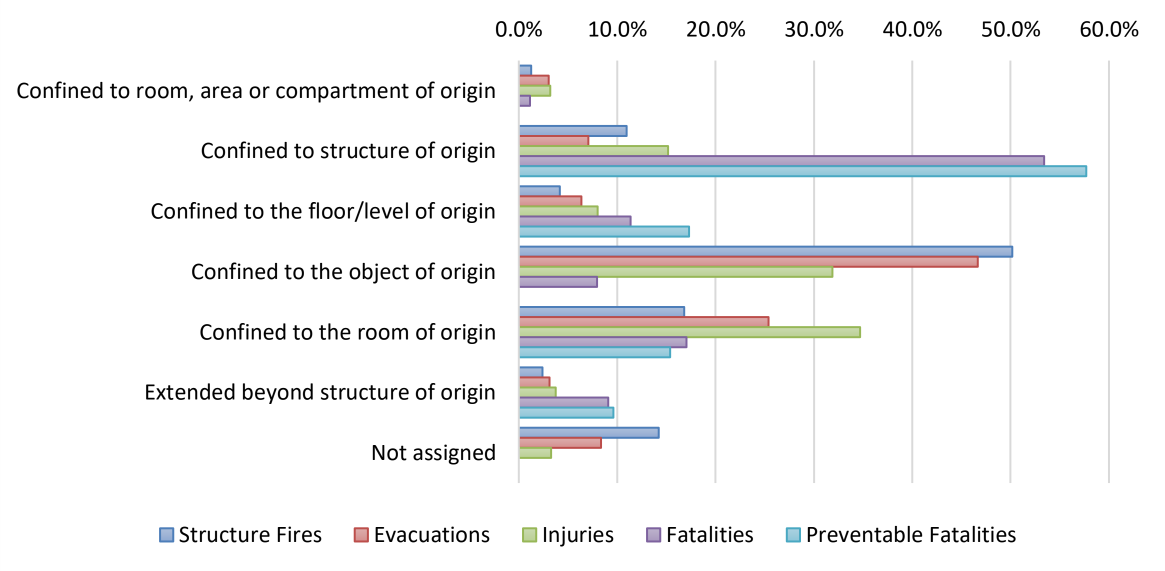


10.1.7 Damage Characteristics

10.1.7.1 Confinement

Structure fires (50.2%) and fires causing evacuations (46.7%) were most often confined to the object of origin. Fires causing injury (34.7%) were most often confined to the room of origin, while fires causing fatality (53.4%) and preventable fatality (57.7%) were usually confined to the structure of origin.

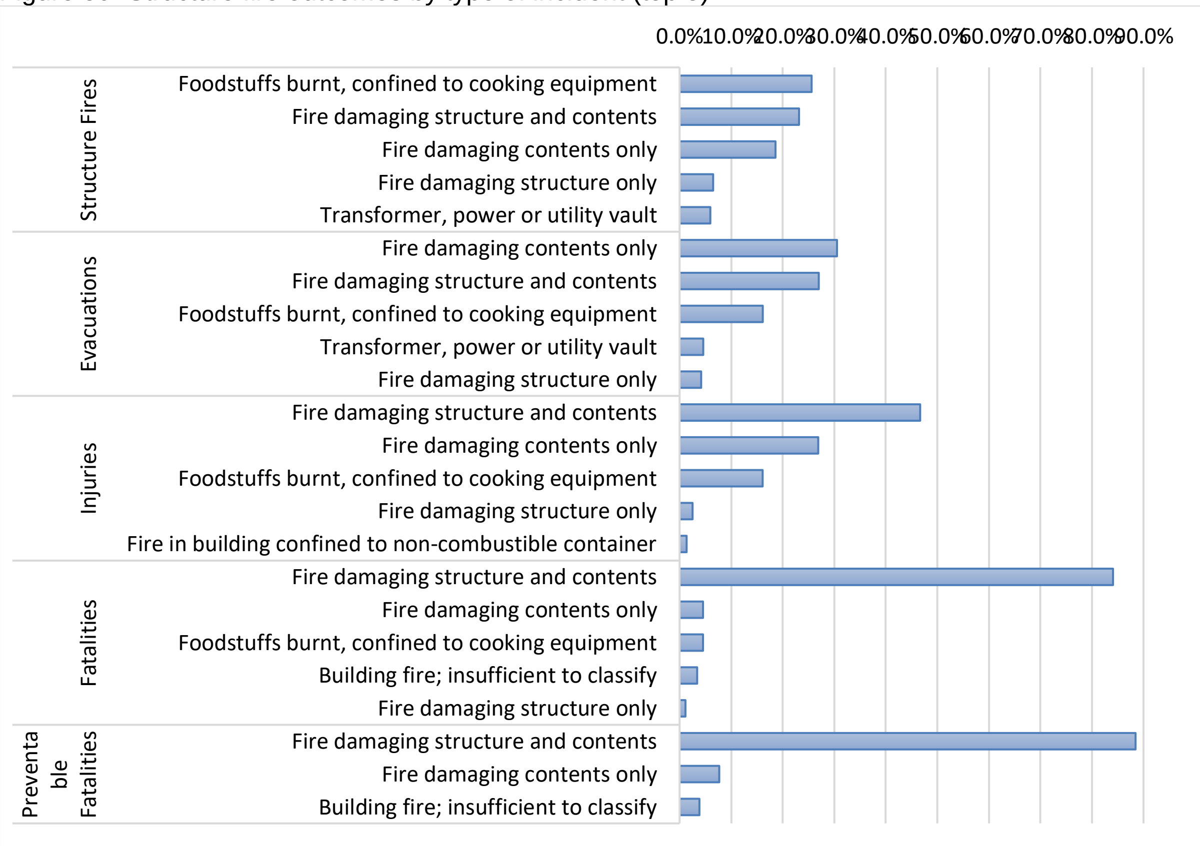
Figure 58. Structure fire outcomes by confinement



10.1.7.2 Type of incident

Structure fires (25.6%) were most often confined to foodstuffs or cooking equipment. Evacuations occurred most often when fire damaged contents only (30.5%). Injuries (46.7%), fatalities (84.1%), and preventable fatalities (88.5%) occurred most often when the fire damaged structure and contents.

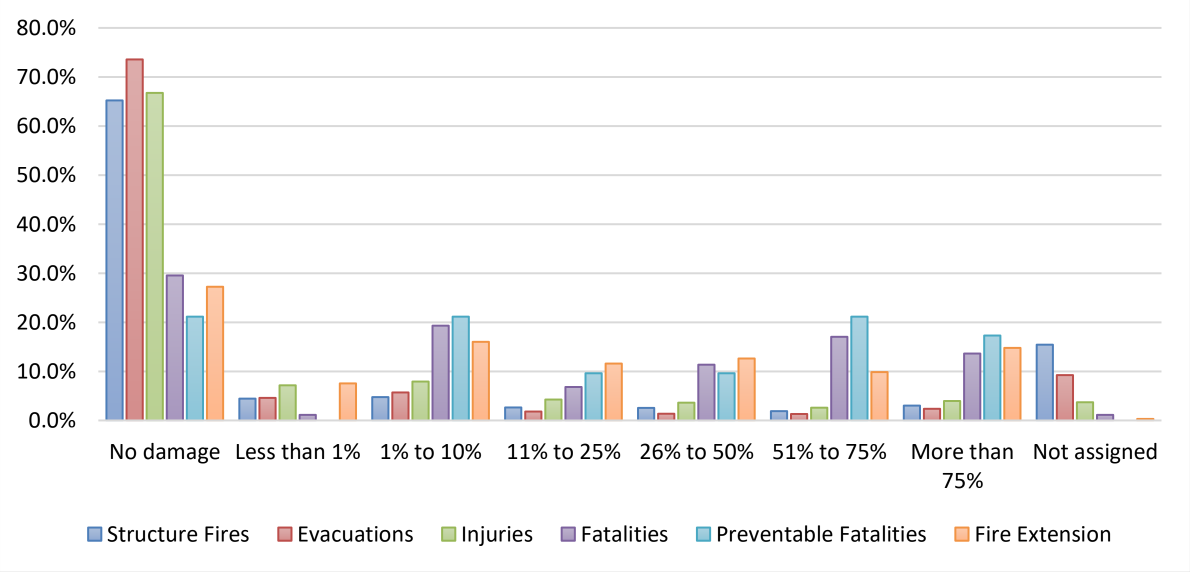
Figure 59. Structure fire outcomes by type of incident (top 5)



10.1.7.3 Collapse damage

Structure fires (65.2%), fires causing evacuation (73.6%), injury (66.8%), fatality (27.2%), preventable fatality (21.2%), and fire extension (27.2%) usually involved no collapse damage. However, preventable fatalities also involved 1% to 10% and 51% to 75% collapse damage (21.2% respectively).

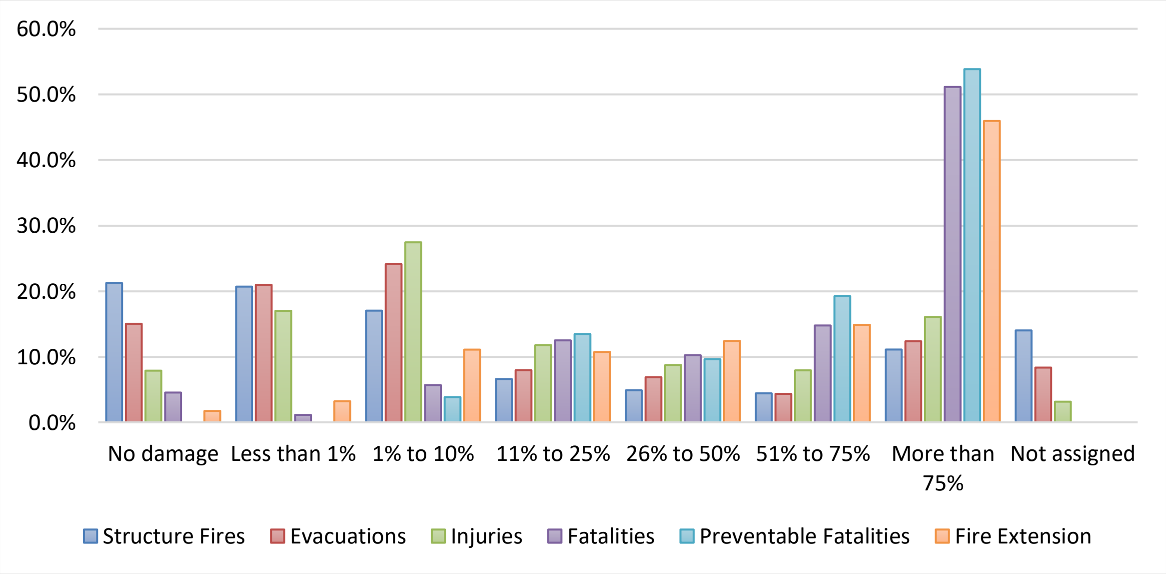
Figure 60. Structure fire outcomes by collapse damage



10.1.7.4 Fire damage

While structure fires most often had no fire damage (21.2%), evacuations (24.1%) and injuries (27.5%) most often occurred when there was 1% to 10% fire damage. Fatalities (51.1%), preventable fatalities (53.8%), and fire extension (45.9%) occurred most often when there was more than 75% fire damage.

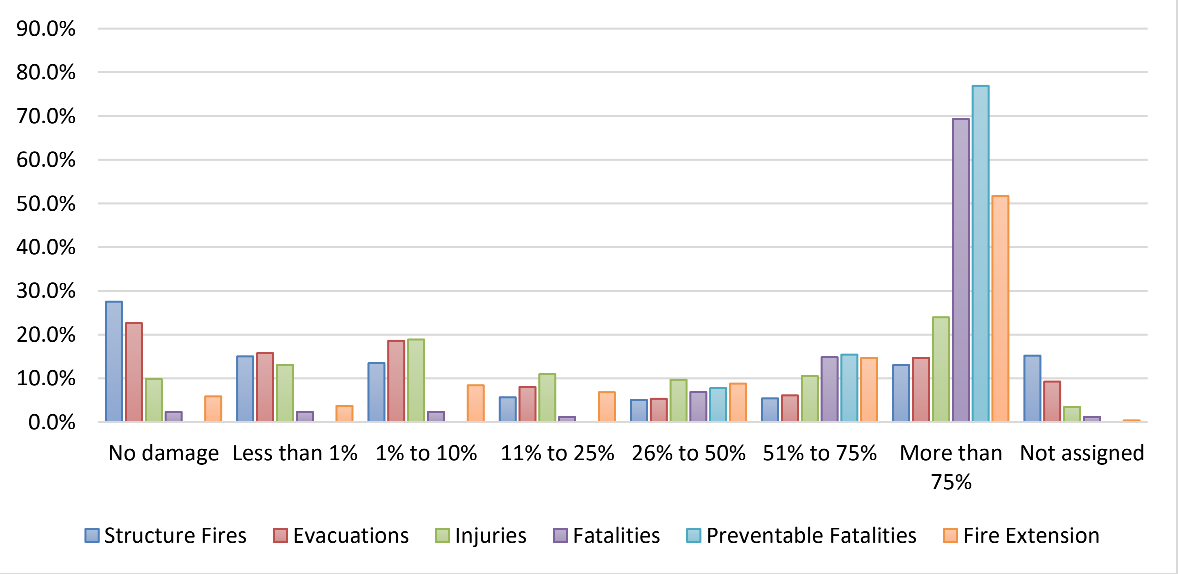
Figure 61. Structure fire outcomes by fire damage



10.1.7.5 Smoke damage

Over one-quarter of structure fires had no smoke damage (27.5%). Fires causing persons evacuated more often involved no smoke damage (22.6%). Fires causing injury (23.9%), fatality (69.3%), preventable fatality (76.9%), and fire extension (51.7%) occurred more often when smoke damage was greater than 75%.

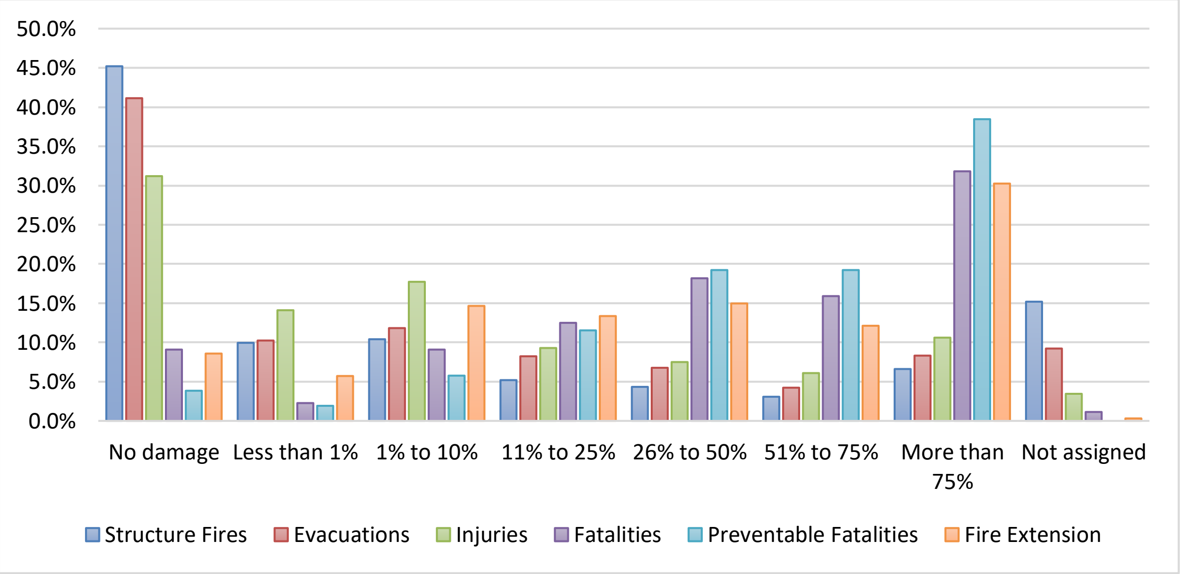
Figure 62. Structure fire outcomes by smoke damage



10.1.7.6 Water damage

Almost half of all structure fires involved no water damage (45.2%). Fires causing persons evacuated (41.1%) and injuries (31.2%) more often involved no water damage. Fires causing fatality (31.8%), preventable fatality (38.5%), and fire extension (30.3%) occurred more often when water damage was greater than 75%.

Figure 63. Structure fire outcomes by water damage

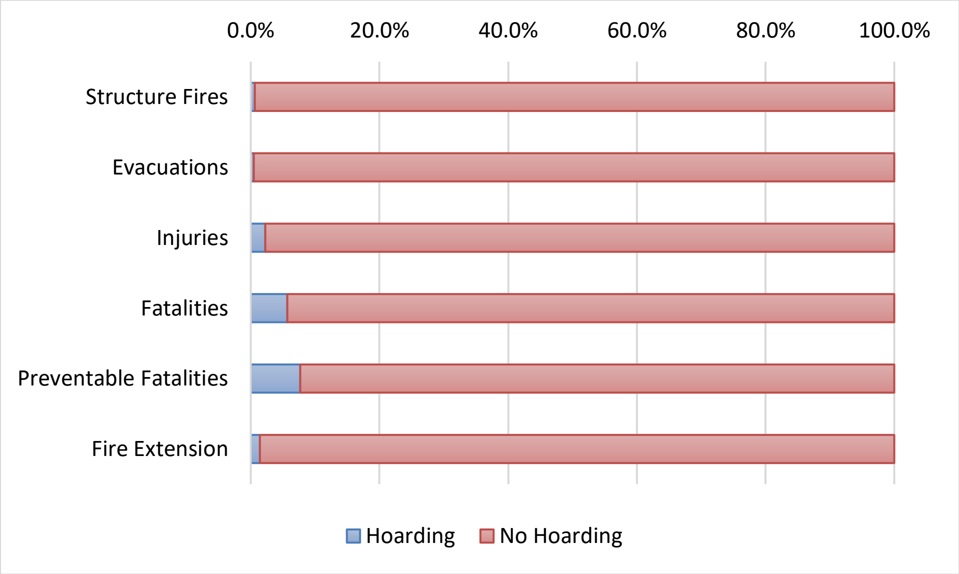


10.1.8 Human Behaviour Characteristics

10.1.8.1 Hoarding

Hoarding was evident in 0.6% of structure fires, 0.5% of evacuations, 2.3% of injuries, 5.7% of fatalities, 7.7% of preventable fatalities, and 1.4% of fire extension. Injuries, fatalities, preventable fatalities, and fire extension were all over-represented when hoarding was present.

Figure 64. Hoarding by adverse outcome



10.1.8.2 Mental impairment

Mental impairment was evident in 3.5% of structure fires, 2.5% of evacuations, 8.1% of injuries, 8.0% of fatalities, 1.9% of preventable fatalities, and 3.2% of fire extension. Compared to the proportion of structure fires where mental impairment was evident, injuries and fatalities were over-represented.

Where identified, mental impairment due to mental illness was most common form associated with structure fires (1.6%), evacuations (1.2%), injuries (3.8%), fatalities (6.8%), and fire extension (1.4%). Mental impairment due to alcohol was the most common form associated with preventable fatalities (1.9%).

Figure 65. Mental impairment by adverse outcome

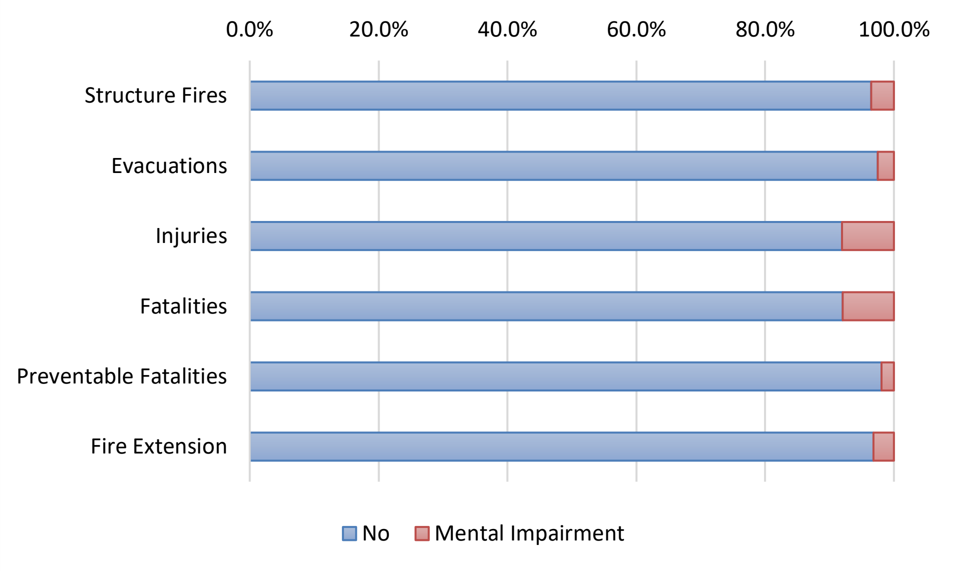
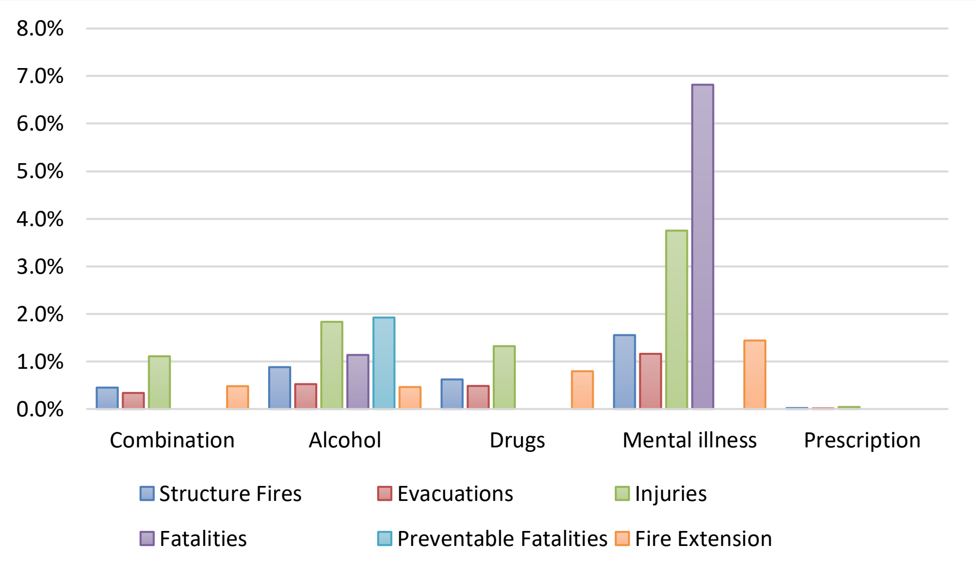


Figure 66. Mental impairment by type



10.1.8.3 Youth misuse of fire

Youth misuse of fire accounted for 2.6% of structure fires, 1.6% of persons evacuated, 3.1% of injuries, 4.2% of fire extension, yet and no fatalities or preventable fatalities. Injuries and fire extension were over-represented in fires caused by young people.

While young people in secondary school accounted for the highest proportion of structure fires (1.1%), young people in primary and infant school accounted for the most evacuations (0.7% respectively), young people in infant school accounted for the most injuries (1.5%), and young people in secondary school accounted for the most fires that extended beyond the room of origin (1.9%).

Figure 67. Youth misuse of fire by adverse outcome

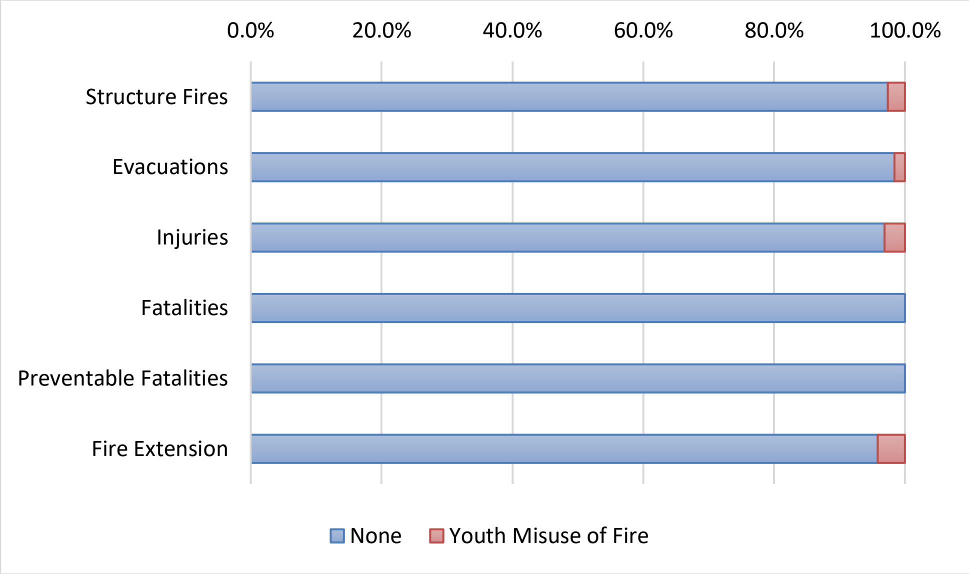
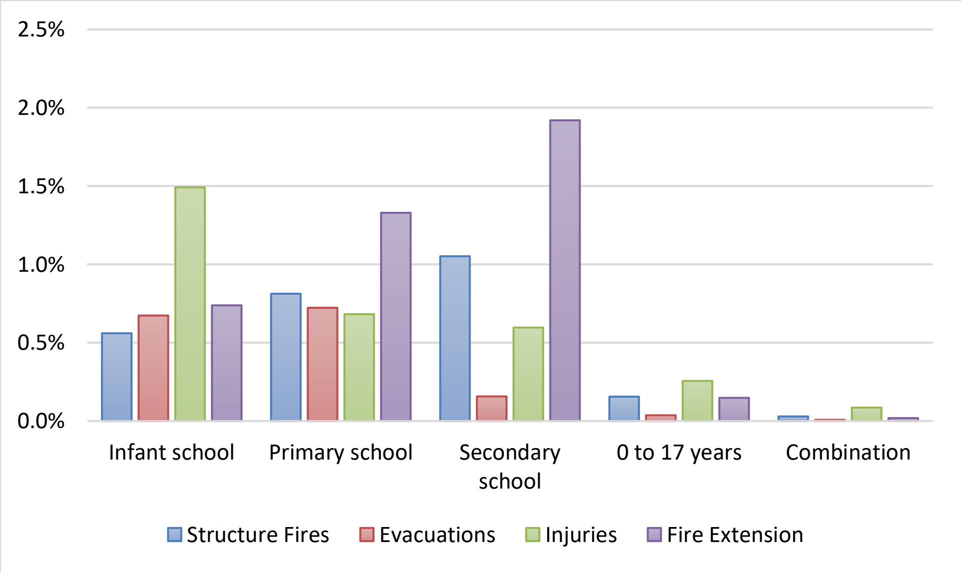


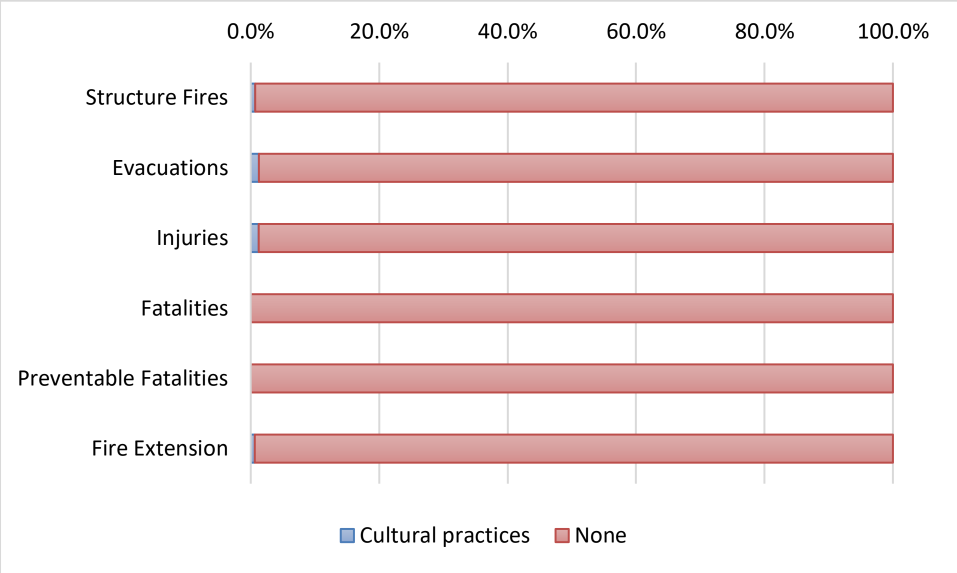
Figure 68. Youth misuse of fire by age



10.1.8.4 Cultural practices

Cultural practices were evident in 0.7% of structure fires, 1.3% of evacuations, 1.2% of injuries, and 0.6% of fire extension. Cultural practices were not evident in fatalities or preventable fatalities. Compared to the proportion of cultural practices in structure fires, evacuations and injuries were over-represented.

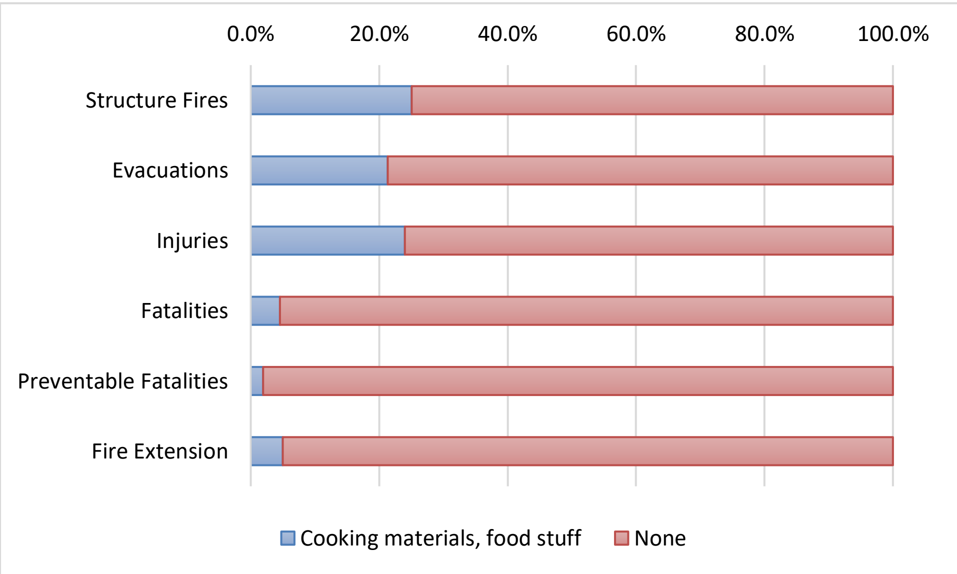
Figure 69. Cultural practices by adverse outcome



10.1.8.5 Cooking

Cooking materials and foodstuffs were the material ignited first in 25.1% of structure fires, 21.3 of evacuations, 24.0% of injuries, 4.5% of fatalities, 1.9% of preventable fatalities, and 5.0% of fire extension. Compared to the proportion of structure fires ignited with cooking materials and foodstuffs, all adverse outcomes were under-represented.

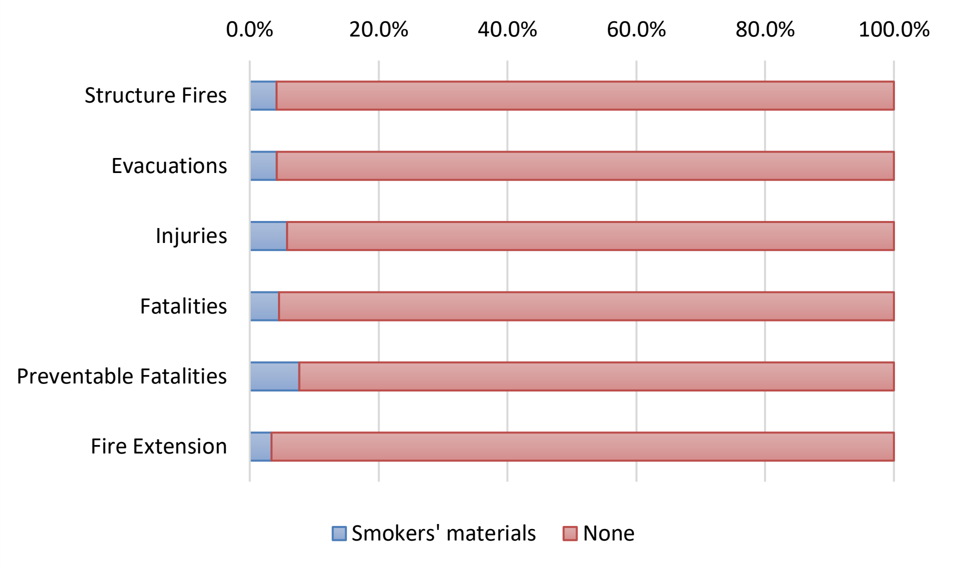
Figure 70. Cooking by adverse outcome



10.1.8.6 Smoking

Smokers' materials ignited 4.2% of structure fires and caused 4.2% of evacuations, 5.8% of injuries, 4.5% of fatalities, 7.7% of preventable fatalities, and 3.4% of fire extension. Compared to the proportion of structure fires caused by smokers' materials, injuries and preventable fatalities were over-represented.

Figure 71. Smoking by adverse outcome



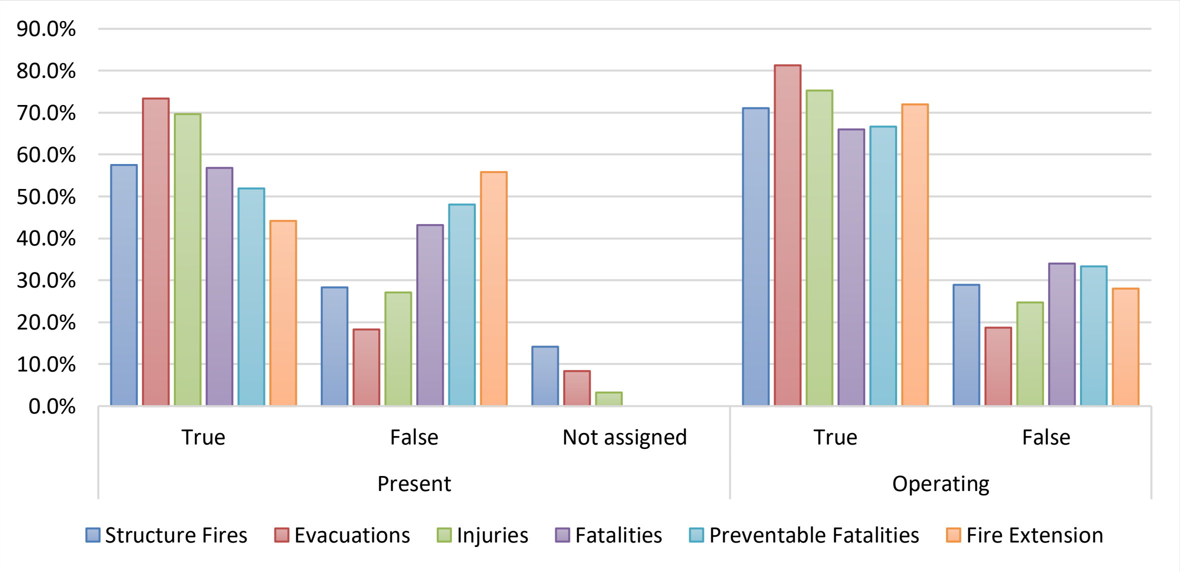
10.1.9 Smoke Alarm Characteristics

10.1.9.1 Alarm presence and functionality

Smoke alarms/detectors were present in structures fires (57.5%), evacuations (73.4%), injuries (69.7%), fatalities (56.8%), and preventable fatalities (51.9%). Smoke alarms/detectors were absent most of the time when the fire extended beyond the room of origin (55.8%).

When alarms/detectors were present, they operated most of the time in structure fires (71.1%), evacuations (81.3%), injuries (75.3%), fatalities (66.0%), preventable fatalities (66.7%), and fire extension (72.0%).

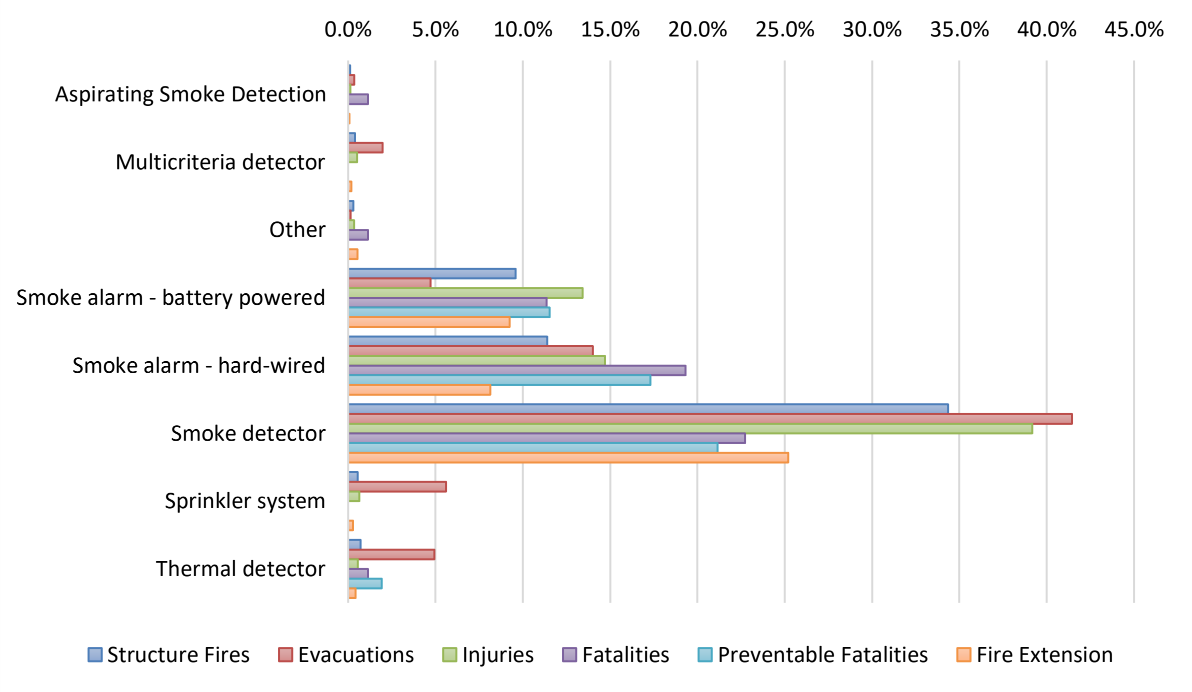
Figure 72. Structure fire outcomes by alarm presence and functionality



10.1.9.2 Alarm type

Most alarms were smoke detectors, despite the outcome.

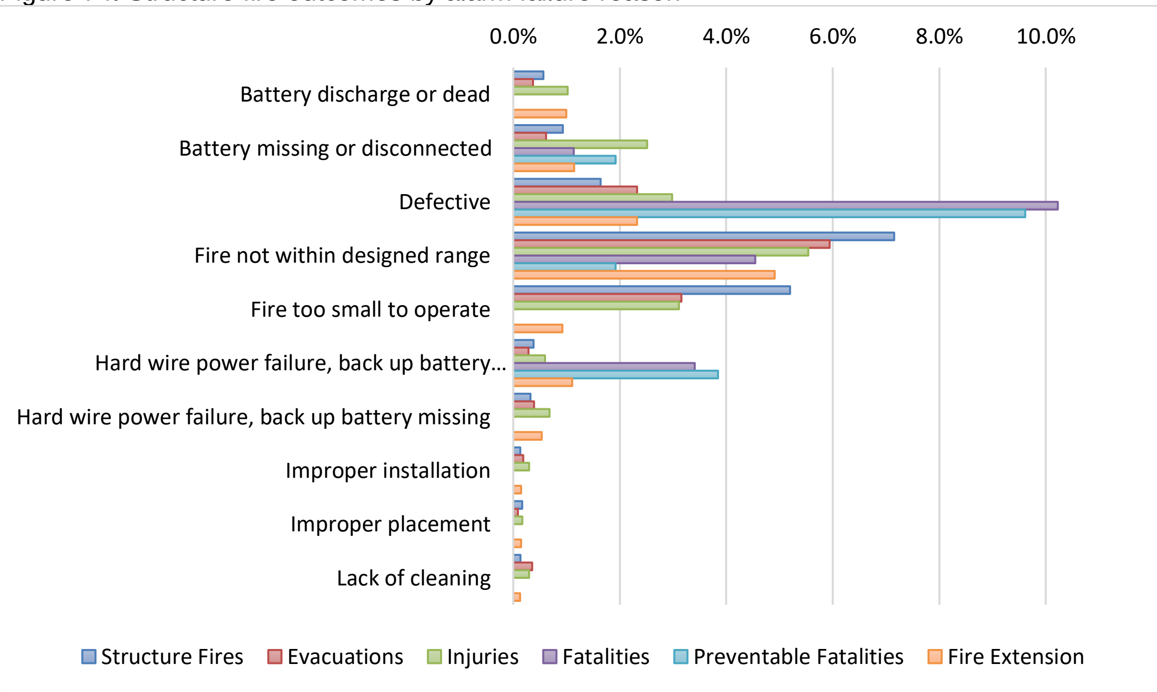
Figure 73. Structure fire outcomes by alarm type



10.1.9.3 Alarm failure

When alarms failed during a structure fire, it was usually because the fire did not occur within the designed range of the detector/alarm (7.2%). This failure was most evident when evacuations (5.9%), injuries (5.5%), and fire extension (4.9%) occurred. When alarms failed because they were defective, this failure was most common in fatalities (10.2%) and preventable fatalities (9.6%).

Figure 74. Structure fire outcomes by alarm failure reason

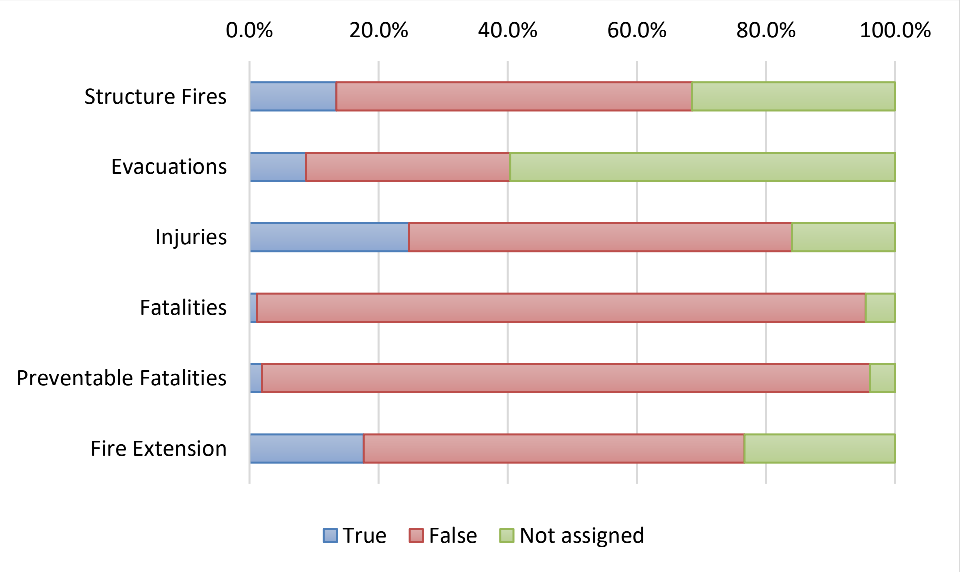


10.1.10 Post-Incident Characteristics

10.1.10.1 Recovery kits

Recovery Kits were not provided at most structure fires (55.1%), fires causing injury (59.3%), fatality (94.3%), preventable fatality (94.2%), and fire extension (59.0%). Recovery Kits were not recorded for most fires causing persons evacuated (59.6%).

Figure 75. Structure fire outcomes by recovery kit given



10.2 Bivariate Results

10.2.1 Population Controlled Analysis

10.2.1.1 Remoteness by Population

Australian Bureau of Statistics (2022b) remoteness population data was used to calculate rates of adverse outcomes by remoteness.

Table 27. Rates of adverse outcomes by remoteness population (per 100,000 persons)

	Structure Fires	**Evacuations**	**Injuries**	**Fatalities**	**Preventable Fatalities**	**Fire Extension**
Major Cities	375.22	1506.07	30.84	0.97	0.64	55.78
Inner Regional	376.66	986.39	25.95	1.62	0.65	82.86
Outer Regional	441.50	580.95	15.05	0.90	0.67	137.66
Remote	860.06	1143.16	21.50	0.00	0.00	344.02
Very Remote	1554.69	92.54	0.00	0.00	0.00	795.85

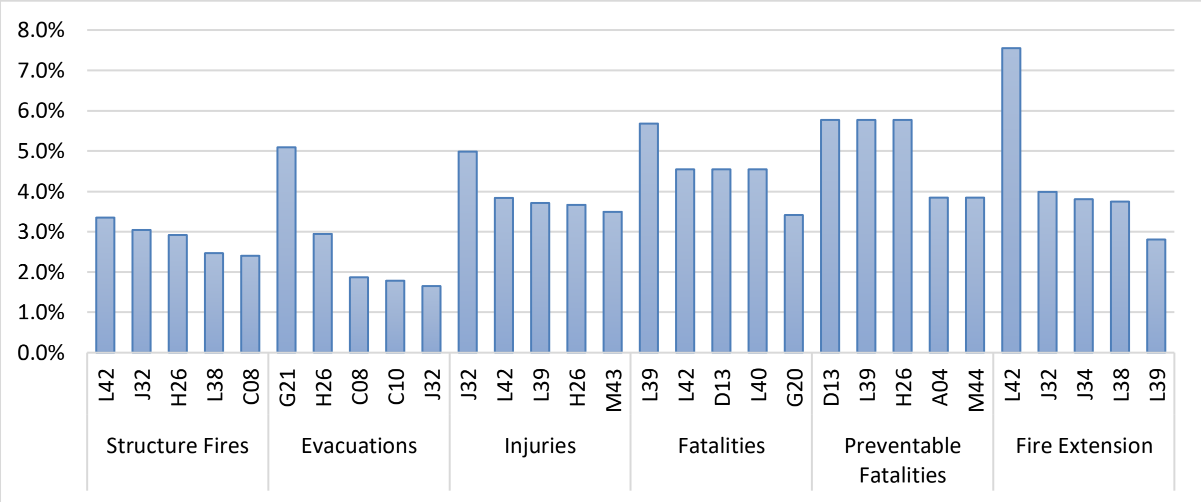
Population-controlled rates reveal that structure fires and rates of fire extension per 100,000 persons were higher as remoteness increased. Injury rates were higher in major cities. While fatality rates were higher in inner regional areas, followed by major cities and outer regional areas, preventable fatality rates increased as remoteness increased. Evacuations occurred most often in major cities followed by remote areas.

10.2.1.2 Mosaic Types by Population

The Mosaic Dataset was used to identify the population within each Mosaic Type. Structure fires (2880.8 per 100,000), injuries (250.5 per 100,000), fatalities (11.1 per 100,000), and fire extension (1138.4 per 100,000) occurred more often in Mosaic Type L42 (Younger families, often single parents, with low incomes in regional towns, often living in social housing). Evacuations occurred more often in Mosaic Type G23 (Young student renters near university campuses, culturally diverse with very low or no income but high spend; 5095.0 per 100,000), and preventable fatalities in Mosaic Type L39 (Multicultural families, sometimes single parents, living in outer-suburban areas with low income; 5.6 per 100,000).

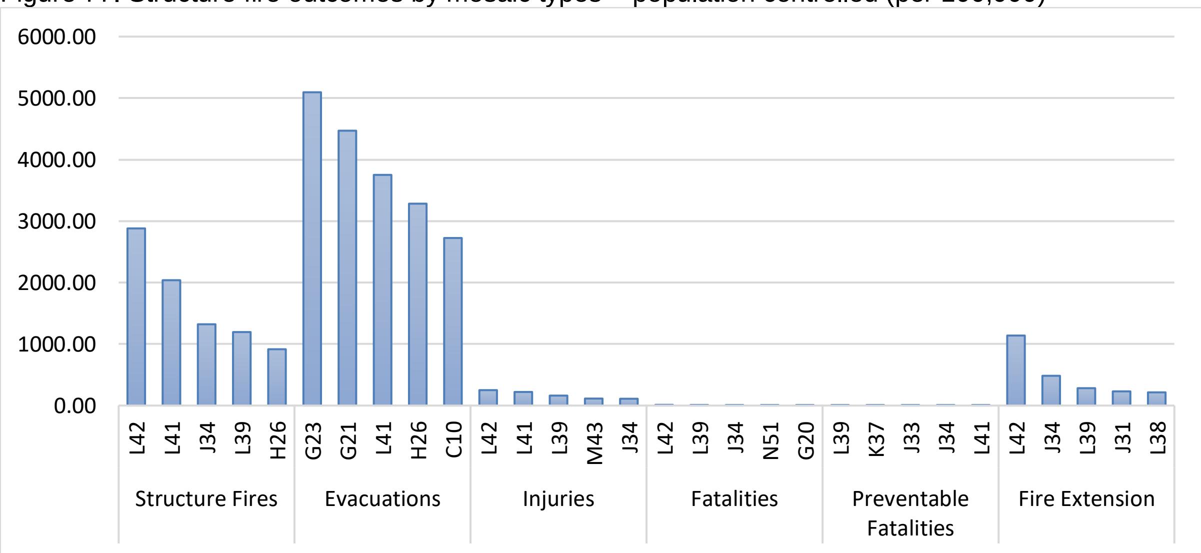
The Mosaic Dataset was used to compare the top five Mosaic Types according to the risk hierarchy with the top five Mosaic Types by adverse outcomes. The Mosaic Dataset lists the top five Mosaic Types as L42, J32, H26, L38, and C08. As identified below, this reflects the top five Mosaic Types by structure fires. However, these types are not reflected in all adverse outcomes. Fire fatalities occurred more often in L39, L42, D13, L40, and G20; preventable fatalities in D13, L39, H26, A04, and M44; injuries in J32, L42, L39, H26, and M43; evacuations G21, H26, C08, C10, and J32; and fire extension in L42, J32, J34, L38, and L39.

Figure 76. Structure fire outcomes by mosaic types (top 5 for each outcome)



Results were population controlled using the number of households in each Mosaic Type, as recorded in the Mosaic Dataset. When the results were population controlled, the top five Mosaic Types for each adverse outcome differed. Structure fires occurred more often in L42, L41, J34, L39, and H26; fire fatalities in L42, L39, J34, N51, and G20; preventable fatalities in L39, K37, J33, J34, and L41; injuries in L42, L41, L39, M43, and J34; evacuations G23, G21, L41, H26, and C10; and fire extension in L42, J34, L39, J31, and L38.

Figure 77. Structure fire outcomes by mosaic types – population controlled (per 100,000)



10.2.1.3 Dwelling Type by Population

Australian Bureau of Statistics Dataset 3 was used to identify property location use (structure type) of all dwellings in NSW. This data was compared to all fires that occurred in dwellings in eAIRS data. While detached residences accounted for 64.8% of all dwellings in NSW, structure fires (55.1%), evacuations (19.0%), injuries (57.1%), fatalities (56.5%), and preventable fatalities (52.0%) were under-represented. In contrast, fire extension was over-represented (73.5%). While attached dwellings accounted for 33.1% of all dwellings in NSW, structure fires (42.7%), evacuations (78.4%), injuries (41.2%), fatalities (41.2%), and preventable fatalities (44.0%) were all over-represented. In contrast, fire extension was under-represented (24.1%). While caravans accounted for 0.4% of all dwellings, they only accounted for 0.2% of structure fires and 0.1% of evacuations. In contrast, caravans accounted for 0.5% of injuries, 0.7% of fire extension, 2.4% of fatalities, and 4.0% of preventable fatalities.

This aligns with Coates et al.'s (2019) findings that while free-standing residences accounted for the largest proportion of fatal fires (61.7%), this housing type accounted for 78.4% of the housing stock in Australia, suggesting free-standing residences are under-represented in fatal fires. It also aligns with Lilley, McNoe and Duncanson's (2018) findings that temporary structures like caravans are over-represented in fire fatalities.

Australian Bureau of Statistics Dataset 3 was used to identify ownership type of all dwellings in NSW. This data was compared to all fires that occurred in dwellings in eAIRS data. The results show that structure fires (18.5%), evacuations (17.1%), injuries (22.4%), fatalities (32.9%), preventable fatalities (26.0%), and fire extension (22.6%) were over-represented in non-privately owned dwellings compared to the proportion of non-privately owned dwellings in the population (0.2%). Conversely, structure fires (81.5%), evacuations (82.9%), injuries (77.6%), fatalities (67.1%), preventable fatalities (74.0%), and fire extension (77.4%) were under-represented in privately owned dwellings compared to the population of privately owned dwellings (99.8%). These findings suggest that non-privately owned dwellings are disproportionately at risk. These findings align with literature that suggests non-privately owned properties increased risk of fatality (Xiong, Bruck & Ball 2015).

Australian Bureau of Statistics Dataset 3 was then used to identify the owners of non-privately owned dwellings in NSW. This data was compared to all fires that occurred in dwellings in eAIRS data. The results show that boarding houses, hospitals, and detention centres are over-represented in adverse structure fire outcomes. Boarding houses accounted for 10.1% of non-privately owned dwellings, yet 17.2% of structure fires, 15.4% of injuries, and 25.0% of fire extension in non-privately owned dwellings. Hospitals accounted for 5.5% of non-privately owned dwellings, yet 31.7% of structure fires, 36.9% of evacuations, 15.4% of injuries, and 8.3% of fire extension. Detection centres accounted for 1.0% of non-privately owned dwellings, yet accounted for 20.8% of structure fires, 46.8% of evacuations, 51.3% of injuries, and 8.3% of fire extension.

10.2.2 Trend Analysis

10.2.2.1 Outcome Frequency

Table 28. Outcome frequency

	Structure Fires	Evacuations	Injuries	Fatalities	Preventable	Fire Extension
Correlation Coefficient	-.657	.771	-.714	-.714	.667	-.429
Sig. (2-tailed)	.156	.072	.111	.111	.148	.397
N	6	6	6	6	6	6

Statistical significance: ***$p < .000$, ** $p < .01$, * $p < .05$

There were no statistically significant correlations.

10.2.2.2 Outcome Population-Controlled Rate

Table 29. Outcome population-controlled rate

	Structure Fires	Evacuations	Injuries	Fatalities	Preventable	Fire Extension

Correlation Coefficient	-.829	-.714	-.714	.771	.667	-.429
Sig. (2-tailed)	.042*	.111	.111	.072	.148	.397
N	6	6	6	6	6	6

Statistical significance: ****p* < .000, ** *p* < .01, * *p* < .05

There was one statistically significant correlation between population-controlled rates and time.

- There was a strong, negative correlation between year and structure fire rate, suggesting that the structure fire rate has decreased over time.

10.2.2.3 Outcome by Cause Determination

Table 30. Outcome by cause determination

	Accidental fires	Accidental fatalities	Accidental injuries	Accidental evacuations	Accidental fire extension	Accidental preventable fatalities
Correlation Coefficient	-.486	.820	-.714	.429	-.086	.820
Sig. (2-tailed)	.329	.046*	.111	.397	.872	.046*
N	6	6	6	6	6	6
	Deliberate fires	Deliberate fatalities	Deliberate injuries	Deliberate evacuations	Deliberate fire extension	Deliberate preventable fatalities
Correlation Coefficient	-.829	.123	-.771	-.029	-.543	-.655
Sig. (2-tailed)	.042*	.816	.072	.957	.266	.158
N	6	6	6	6	6	6
	Undetermined fires	Undetermined fatalities	Undetermined injuries	Undetermined evacuations	Undetermined fire extension	Undetermined preventable fatalities
Correlation Coefficient	.143	.771	-.486	.714	.143	.600
Sig. (2-tailed)	.787	.072	.329	.111	.787	.208
N	6	6	6	6	6	6

There were three statistically significant correlations between outcome by cause determination and time.

- There was a strong, positive correlation between year and accidental fatalities, suggesting that accidental fatalities have increased over time.
- There was a strong, positive correlation between year and accidental preventable fatalities, suggesting that accidental preventable fatalities have increased over time.
- There was a strong, negative correlation between year and deliberate structure fires, suggesting that deliberate structure fires have decreased over time.

10.2.2.4 Outcome Rates per 100,000 persons by Cause Determination

Table 31. Outcome rates per 100,000 persons by cause determination

	Accidental fires	Accidental evacuations	Accidental injuries	Accidental fatality	Accidental preventable fatality	Accidental fire extension
Correlation Coefficient	-.943	-.771	-.714	.886	.820	-.551

Sig. (2-tailed)	.005**	.072	.111	.019*	.046*	.257
N	6	6	6	6	6	6
	Deliberate fires	Deliberate evacuations	Deliberate injuries	Deliberate fatalities	Deliberate preventable fatalities	Deliberate fire extension
Correlation Coefficient	-.886	-.086	-.714	.000	-.655	-.543
Sig. (2-tailed)	.019*	.872	.111	1.000	.158	.266
N	6	6	6	6	6	6
	Undetermined fires	Undetermined evacuations	Undetermined injuries	Undetermined fatalities	Undetermined preventable fatalities	Undetermined fire extension
Correlation Coefficient	.143	-.086	-.600	.771	.600	-.371
Sig. (2-tailed)	.787	.872	.208	.072	.208	.468
N	6	6	6	6	6	6

There were four statistically significant correlations between outcome rates by cause determination and time.

- There was a strong, negative correlation between year and accidental fire rates, suggesting that accidental fire rates have decreased over time.
- There was a strong, positive correlation between year and accidental fatality rates, suggesting that accidental injury rates have increased over time.
- There was a strong, positive correlation between year and accidental preventable fatality rates, suggesting that accidental preventable fatality rates have increased over time.
- There was a strong, negative correlation between year and deliberate structure fire rates, suggesting that deliberate structure fire rates have decreased over time.

10.2.2.5 Response Characteristics

Table 32. Call source

	000	AFASP	Call to Station	D/L Ambulance	D/L Police	ICEMS
Correlation Coefficient	-.710	-.839	-.788	-.786	-.763	.381
Sig. (2-tailed)	.114	.037*	.063	.064	.078	.456
N	6	6	6	6	6	6
	L/E	Other Agency	RCO	RFS	Unknown/Not applicable	White Message
Correlation Coefficient	-.393	-.598	-.393	-.641	-.681	-.228
Sig. (2-tailed)	.441	.210	.441	.170	.137	.664
N	6	6	6	6	6	6

Statistical significance: ***$p < .000$, ** $p < .01$, * $p < .05$

Table 33. Region

	ME	MN	MS	MW	RN	RS	RW
Correlation Coefficient	-.772	-.255	-.727	-.627	.354	-.816	-.683

Sig. (2-tailed)	.072	.626	.102	.183	.491	.048*	.135
N	6	6	6	6	6	6	6

Statistical significance: ****p* < .000, ** *p* < .01, * *p* < .05

10.2.2.6 Temporal Characteristics

Table 34. Month

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Correlation Coefficient	-.224	-.081	.397	-.076	-.631	-.597	-.899	-.777	-.440	-.435	-.550	-.923
Sig. (2-tailed)	.670	.879	.436	.886	.179	.211	.015*	.069	.383	.389	.258	.009**
N	6	6	6	6	6	6	6	6	6	6	6	6

Statistical significance: ****p* < .000, ** *p* < .01, * *p* < .05

Table 35. Season

	Autumn	Spring	Summer	Winter
Correlation Coefficient	.038	-.596	-.557	-.879
Sig. (2-tailed)	.944	.211	.250	.021*
N	6	6	6	6

Statistical significance: ****p* < .000, ** *p* < .01, * *p* < .05

There was one statistically significant correlation between year and season.

- There was a strong negative correlation between year and Winter, indicating that structure fires in Winter have decreased over time.

Table 36. Day of the week

	Friday	Monday	Sat.	Sunday	Thursday	Tuesday	Wed.
Correlation Coefficient	-.852	-.646	-.651	-.543	-.573	-.187	-.816
Sig. (2-tailed)	.031*	.166	.162	.266	.235	.723	.048*
N	6	6	6	6	6	6	6

Statistical significance: ****p* < .000, ** *p* < .01, * *p* < .05

Table 37. Time of day

	Day	Night
Correlation Coefficient	-.723	-.734
Sig. (2-tailed)	.105	.097
N	6	6

Statistical significance: ****p* < .000, ** *p* < .01, * *p* < .05

10.2.2.7 Location Characteristics

Table 38. Remote index

	Inner Regional Australia	Major Cities of Australia	Outer Regional Australia	Remote Australia	Very Remote Australia
Correlation Coefficient	-.060	-.799	-.738	-.629	-.244
Sig. (2-tailed)	.910	.056	.094	.181	.641

N	6	6	6	6	6

Statistical significance: ***p < .000, ** p < .01, * p < .05

Table 39. SEIFA Decile

	1	2	3	4	5	6	7	8	9	10
Correlation Coefficient	-.726	-.475	-.945	-.140	-.684	-.488	.000	-.702	-.659	-.469
Sig. (2-tailed)	.102	.341	.004**	.792	.134	.326	1.000	.120	.154	.349
N	6	6	6	6	6	6	6	6	6	6

Statistical significance: ***p < .000, ** p < .01, * p < .05

There was one statistically significant correlation between year and location characteristics.

- There was a strong negative correlation between year and SEIFA decile 3, indicating that structure fires in SEIFA decile 3 have decreased over time.

10.2.2.8 Property Characteristics

Table 40. Building Class

	Class 10a	Class 10b	Class 1a (attached)	Class 1a (detached)	Class 1b	Class 2	Class 3	Class 4
Correlation Coefficient	.372	-.759	.721	-.534	-.967	-.520	.190	-.982
Sig. (2-tailed)	.468	.080	.106	.275	.002**	.291	.718	<.001***
N	6	6	6	6	6	6	6	6
	Class 5	Class 6	Class 7a	Class 7b	Class 8	Class 9a	Class 9b	Class 9c
Correlation Coefficient	-.799	-.617	-.982	-.938	-.597	-.375	-.464	.832
Sig. (2-tailed)	.057	.192	<.001***	.006**	.211	.464	.354	.040*
N	6	6	6	6	6	6	6	6

Statistical significance: ***p < .000, ** p < .01, * p < .05

Table 41. Type of owner

	Commonwealth Government	Department of housing	Local Government	Other	Private	State Government	Unoccupied
Correlation Coefficient	-.865	-.104	-.861	-.108	-.588	-.985	-.428
Sig. (2-tailed)	.026*	.844	.028*	.839	.219	<.001***	.397
N	6	6	6	6	6	6	6

Statistical significance: ***p < .000, ** p < .01, * p < .05

10.2.2.9 Fire Characteristics

Table 42. Cause determination

	Accidental	Deliberate	Natural	Undetermined
Correlation Coefficient	-.641	-.823	-.428	-.021
Sig. (2-tailed)	.170	.044*	.398	.969
N	6	6	6	6

Statistical significance: ***$p < .000$, ** $p < .01$, * $p < .05$

Table 43. Ignition source

	Candle, taper	Conducted heat	Cutting or Welding or Heating torch	Electric lamp, light bulbs	Explosives	Fireworks, sparklers, munitions	Undetermined	Direct flame, convection currents	
Correlation Coefficient	-.357	.768	-.270	-.299	-.478	.013	-.607	.189	
Sig. (2-tailed)	.488	.074	.605	.565	.338	.981	.201	.721	
N	6	6	6	6	6	6	6	6	
	Electrical equipment, arcing	Electrical equipment, overloaded	Flying brand, ember, spark	Fuel-fired, fuel-powered object	Improperly operating electrical equipment	Properly operating electrical equipment	Smokers' materials (e.g., Cigarettes)	Thermal runaway / self-combustion	Heat, spark from friction
Correlation Coefficient	.233	-.428	-.735	-.458	.753	-.870	-.346	.655	-.406
Sig. (2-tailed)	.657	.397	.096	.362	.084	.024*	.501	.158	.424
N	6	6	6	6	6	6	6	6	6
	Hot ember, ash	Incendiary device	Integrated rechargeable battery	Lightning discharge	Match, Lighter (flame type)	Molten, hot material	Not assigned	Open fire, Camp fire and bonfire	Other (thermal runaway source)
Correlation Coefficient	-.209	-.398	.655	-.412	-.731	-.339	-.781	-.383	.655
Sig. (2-tailed)	.691	.435	.158	.417	.099	.511	.067	.453	.158
N	6	6	6	6	6	6	6	6	6
	Radiated heat	Re-kindle, re-ignition	Removeable rechargeable battery or battery pack	Spontaneous ignition, chemical reaction	Spontaneous ignition, chemical reaction	Static discharge	Sun's heat, unusually concentrated		
Correlation Coefficient	-.694	-.086	.655	-.162	.655	-.083	-.453		
Sig. (2-tailed)	.126	.872	.158	.759	.158	.876	.367		
N	6	6	6	6	6	6	6		

Statistical significance: ****p* < .000, ** *p* < .01, * *p* < .05

Table 44. Material ignited first

	Acetylene	Agricultural product	Air conditioning unit - fixed, stationary	Air conditioning, refrigeration unit portable	Alcohol	Arc, oil lamp	Atomised, vaporised liquid	Audio/visual and entertainment	Battery (starter lights ignition, lead-acid)
Correlation Coefficient	.306	.532	-.547	-.423	.578	-.255	-.257	.655	.655
Sig. (2-tailed)	.556	.277	.261	.404	.229	.626	.624	.158	.158
N	6	6	6	6	6	6	6	6	6
	Battery pack, battery system	Battery powered equipment, portable	Bearing, brake	Bedding, blanket, sheet, comforter	Biogas	Biomedical equipment, device	Book, magazine, newspaper, writing paper	Cabinetry	Camera, camcorder, photographic battery powered
Correlation Coefficient	.655	.655	.917	-.056	.655	-.293	-.842	-.130	.655
Sig. (2-tailed)	.158	.158	.010*	.916	.158	.573	.035*	.806	.158
N	6	6	6	6	6	6	6	6	6
	Casting, moulding, forging equipment	Ceiling covering, surface.	Central air conditioning, refrigeration equipment	Central heating unit or heat transfer	Charger (device), battery charger	Chemical process equipment	artificial Christmas tree/plants	Natural Christmas tree/plants	Cleaning supplies and products
Correlation Coefficient	.698	.057	-.022	.834	-.230	-.116	.807	.683	.549
Sig. (2-tailed)	.123	.915	.968	.039*	.661	.826	.052	.135	.259
N	6	6	6	6	6	6	6	6	6
	Clothing not on a person	Clothing on a person worn at the time	Computer / office equipment	Computer equipment, mains	Conveyer belt, drive belt, V-belt	Cooking materials, food stuff	Curtain, blind, drapery	DC isolation switch (near inverter)	Decoration for special event
Correlation Coefficient	.736	-.229	.655	-.193	-.956	-.466	-.117	.655	.796
Sig. (2-tailed)	.095	.663	.158	.714	.003**	.352	.826	.158	.058
N	6	6	6	6	6	6	6	6	6
	Diesel	Dishwashers	Dryer	Dust, fibre, lint	E-cigarettes, vape pens	Electric bike, mobility scooter	Electric blankets	Electric chain saws, electric hand tools	Electric fencing
Correlation Coefficient	.213	-.564	-.751	.263	.655	.655	-.180	.497	.120

Sig. (2-tailed)	.685	.243	.085	.614	.158	.158	.733	.316	.822
N	6	6	6	6	6	6	6	6	6
	Electrical cord, extension lead	Electrical equipment, domestic appliance	Electrical Outlets	Electrical system component	Electrical wire, cable insulation	Electrical Wiring - fixed	Electronic devices, battery powered	Engine, driveline, or hydraulic system component	Exercise equipment, powered
Correlation Coefficient	.655	.791	.852	.474	-.773	-.791	.821	.717	.655
Sig. (2-tailed)	.158	.061	.031*	.342	.072	.061	.045*	.109	.158
N	6	6	6	6	6	6	6	6	6
	Exterior covering or permanently affixed surface item	Exterior roof covering, surface, finish	Exterior side wall covering, cladding, surface, finish	Exterior trim	Fence, pole, sign	Fertiliser	Fixed deep fat fryer	Fixed fans (cooling fans, exhaust fans)	Fixed stationary surface unit
Correlation Coefficient	.799	.439	-.148	-.756	-.242	.414	-.423	-.541	-.714
Sig. (2-tailed)	.057	.384	.779	.082	.644	.414	.403	.267	.111
N	6	6	6	6	6	6	6	6	6
	Fixed, stationary food warming appliance	Fixed, stationary oven	Flammable liquid transfer equipment.	Floor care equipment, vacuum cleaners	Floor covering, surface.	Flooring, trim, or upholstery material	Fuel or gas system component	Furnace, oven, kiln	Gas lines
Correlation Coefficient	-.393	-.515	.013	.393	.055	-.313	-.197	.031	.804
Sig. (2-tailed)	.441	.295	.980	.441	.918	.545	.709	.953	.054
N	6	6	6	6	6	6	6	6	6
	Gas outlet	Goods, stock, luggage or other stowable	Grass, bush, and forests	Grease hood, duct, range hood	Hair dryer, hair straightener, curling iron	Hand tool battery powered	Heat-treating equipment	Home entertainment equipment	
Correlation Coefficient	.934	.314	-.284	.026	-.353	.655	-.393	-.507	
Sig. (2-tailed)	.006**	.544	.586	.960	.492	.158	.441	.305	
N	6	6	6	6	6	6	6	6	
	Indoor open fireplace	Insulation within wall,	Interior covering or	Interior wall covering,	Inverters, converters,	Irons	Kerosene	Lamps, lights, torches	Lighter Fluid

		partition, or floor/ceiling space	permanently affixed surface item	surface items permanently affixed	rectifiers, capacitors			(battery powered)	
Correlation Coefficient	-.213	-.222	-.310	-.180	-.233	-.814	-.183	.655	.639
Sig. (2-tailed)	.685	.672	.549	.733	.657	.049*	.728	.158	.172
N	6	6	6	6	6	6	6	6	6
	Lighting - fixed	Linen, other than bedding	Local heating unit - Fixed, stationary	Local heating unit - Portable	Local refrigerator unit - Fixed	LPG	Luggage, bags	Mains/Supply Transformer	Mattress, pillow
Correlation Coefficient	.462	-.344	-.736	-.476	-.425	-.756	-.338	.815	.133
Sig. (2-tailed)	.357	.504	.095	.340	.401	.082	.512	.048*	.802
N	6	6	6	6	6	6	6	6	6
	Mechanical Power transfer equipment	Meter, meter box	Microwave	Music, audio, and theatre equipment	Natural gas	Not assigned	Office machines	Open fired grill	Other (air conditioning, refrigeration equipment)
Correlation Coefficient	-.085	-.492	.128	-.325	.353	-.247	.000	-.262	-.014
Sig. (2-tailed)	.874	.321	.809	.529	.492	.638	1.000	.616	.979
N	6	6	6	6	6	6	6	6	6
	Other (appliances, home equipment)	Other (battery powered equipment)	Other (books, papers, recreational material)	Other (cooking equipment)	Other (electrical distribution equipment)	Other (furniture)	Other (general form)	Other (heating systems)	Other (mobile property component)
Correlation Coefficient	-.848	.655	.169	.344	-.269	.977	-.234	.478	-.509
Sig. (2-tailed)	.033*	.158	.748	.504	.606	<.001***	.656	.337	.302
N	6	6	6	6	6	6	6	6	6
	Other (other fuel)	Other (other object)	Other (power transfer equipment)	Other (processing equipment)	Other (service, maintenance)	Other (soft goods, wearing)	Other (solar system component)	Other (special equipment)	Other (special form)
Correlation Coefficient	.163	.026	.361	.418	.000	-.128	.655	-.696	.816
Sig. (2-tailed)	.758	.961	.483	.409	1.000	.809	.158	.124	.048*
N	6	6	6	6	6	6	6	6	6

	Other (structural component, finish)	Other (supplies, stock)	Other electric motor driven equipment	Other electronic equipment	Other Flammable Liquid	Other Gas	Other portable cooking appliances	Outdoor cooking equipment	Packing, wrapping material
Correlation Coefficient	-.784	.064	-.338	.453	.298	-.746	-.474	-.548	.844
Sig. (2-tailed)	.065	.904	.512	.367	.567	.089	.343	.260	.035*
N	6	6	6	6	6	6	6	6	6
	Painting equipment	Petrol	Petroleum fuelled engine	Phone handset, two-way radio (battery powered)	Portable cooling fan	Portable gas cooker	Portable lamp, light, lighting fixture, sign	Power board	Power switch gear, over-current protection
Correlation Coefficient	-.293	-.157	-.355	.655	-.832	-.774	-.767	-.562	-.155
Sig. (2-tailed)	.573	.766	.490	.158	.040*	.071	.075	.246	.769
N	6	6	6	6	6	6	6	6	6
	Powerpack / portable charging device	Pyrotechnics, explosives	Raw materials (fabric)	Rectifier, charger	Rope, cord, twine, yarn	Rubbish, trash, waste, chimney waste	Separate motor, generator	Small cooking appliance - toasters, pie makers	Sofa, chair, seating
Correlation Coefficient	.655	-.503	.487	-.626	.000	-.587	-.498	-.175	-.886
Sig. (2-tailed)	.158	.309	.327	.184	1.000	.221	.315	.741	.019*
N	6	6	6	6	6	6	6	6	6
	Solar inverter	Solar isolation switch (roof mounted)	Solar Panel, PV array, Solar System	Solid Fuel	Structural member, framing	Supplies or stock in or from pipe or container	Supplies or stock in bales	Supplies or stock in basket, barrel	Supplies or stock in box, carton, bag
Correlation Coefficient	.655	.655	.860	.275	-.759	.917	.054	.262	-.262
Sig. (2-tailed)	.158	.158	.028*	.597	.080	.010*	.919	.616	.615
N	6	6	6	6	6	6	6	6	6
	Supplies or stock in bulk	Supplies or stock in pallet	Tables, shelving	Tarpaulin, tent	Television, monitor and visual displays	Torches, welding and cutting equipment	Toy, game	Transformer, over-current or disconnect equipment	Tyre

Correlation Coefficient	-.458	-.194	.655	.503	-.761	.213	-.293	-.236	-.201
Sig. (2-tailed)	.361	.713	.158	.309	.079	.685	.573	.653	.702
N	6	6	6	6	6	6	6	6	6
	Undetermined	Vending machine, water cooler	Washing machine	Waste recovery equipment	Water cooling device, tower	Water heater (hot water service)	Wheat bag, heat pack	Working, shaping machine	
Correlation Coefficient	-.257	-.655	-.341	-.683	.131	-.578	.029	-.618	
Sig. (2-tailed)	.622	.158	.508	.135	.805	.229	.956	.191	
N	6	6	6	6	6	6	6	6	

Statistical significance: ***$p < .000$, ** $p < .01$, * $p < .05$

Table 45. Area of origin

	Area under construction	Bathroom, Lavatory	Bedroom/Sleeping area >5 persons	Bedroom/Sleeping area <5 persons	Ceiling cavity	Cell/Secure confinement area	Chimney/flue	Chute and conveyors	Closed carpark, > 40 cars
Correlation Coefficient	-.332	-.266	.332	-.713	-.087	-.342	.397	.444	-.734
Sig. (2-tailed)	.521	.611	.521	.111	.870	.507	.436	.378	.097
N	6	6	6	6	6	6	6	6	6
	Closed carpark, <40 cars	Court, terrace, patio	Dining area, lunchroom	Duct.	Electricity, Gas, Water areas	Engine compartment	Equipment room/area.	Escalator	Exterior balcony
Correlation Coefficient	-.404	.256	-.475	.008	.775	.696	-.861	.355	-.055
Sig. (2-tailed)	.428	.624	.341	.989	.070	.125	.028*	.490	.918
N	6	6	6	6	6	6	6	6	6
	Exterior exposed surface of transportation	Exterior roof surface	Exterior stairway	Exterior wall surface	Fire stairway	First aid and medical	Fuel tank, fuel line area of transportation	Garage, Workshop	Hallway, corridor
Correlation Coefficient	.570	.871	-.643	.773	-.598	.000	-.057	-.135	-.019
Sig. (2-tailed)	.238	.024*	.168	.072	.210	1.000	.914	.798	.971
N	6	6	6	6	6	6	6	6	6
	Interior stairway.	Kitchen, cooking area	Laboratory	Large assembly areas	Laundry room, area	Lawn, field, open area.	Lifts	Lobby, entrance way	Lounge Living Room
Correlation Coefficient	.552	-.776	-.728	-.020	-.792	-.465	.051	-.662	-.797
Sig. (2-tailed)	.256	.070	.101	.970	.060	.353	.924	.152	.057
N	6	6	6	6	6	6	6	6	6
	Medium-sized assembly area	Multiple areas of origin	Not assigned	Office, Study	On or near highway, roadway	Open air carpark, > 40 cars	Open air carpark, <40 cars	Open deck carpark, > 40 cars	Open deck carpark, < 40 cars
Correlation Coefficient	-.466	-.493	-.765	-.777	-.802	.466	-.098	-.121	-.349
Sig. (2-tailed)	.352	.321	.076	.069	.055	.352	.854	.820	.498
N	6	6	6	6	6	6	6	6	6

	Operating control area of transportation	Passenger compartment	Performance, stage area, projection room	Process, manufacturing area	Railway line	Recreational Area	Retail or Sales Area	Rubbish tip	Scrub or bush
Correlation Coefficient	-.131	-.710	-.357	-.495	-.883	-.783	-.511	.544	-.065
Sig. (2-tailed)	.805	.114	.488	.318	.020*	.065	.301	.264	.902
N	6	6	6	6	6	6	6	6	6
	Shaft	Small assembly area	Storage area, 10 to 2000 sqm	Storage area, Greater than 2000 sqm	Storage area, less than 10 sqm	Storage compartment, area of transportation	Sub-floor space, concealed floor space	Undetermined	Vacant structural area
Correlation Coefficient	.087	-.256	-.276	-.690	-.559	-.509	-.732	-.004	-.608
Sig. (2-tailed)	.869	.624	.597	.129	.249	.303	.098	.994	.200
N	6	6	6	6	6	6	6	6	6
	Wall cavity	Waste Recycling							
Correlation Coefficient	-.012	.189							
Sig. (2-tailed)	.982	.719							
N	6	6							

Statistical significance: ***$p < .000$, ** $p < .01$, * $p < .05$

There were statistically significant correlations between year and fire characteristics.

- There was a strong negative correlation between year and deliberately lit fires, indicating that deliberately lit structure fires have decreased over time.
- There was a strong negative correlation between year and fires ignited by properly operating electrical equipment, indicating that these ignition sources in structure fires have decreased over time.
- There were strong negative correlations between year and materials ignited first including books, magazines, newspapers; conveyor belt; irons; other appliances (home equipment); portable cooling fan; and sofa, chair, or seating; indicating that these materials ignited first have decreased over time.
- There were strong positive correlations between year and materials ignited first including bearing and brakes, central heating unit, electrical outlets, electronic battery-powered devices, gas outlets, mains supply/transformer, other (furniture), other (special form), packing/wrapping material, solar panels or PV arrays, and supplies or stock in pipe or container; indicating that these materials ignited first have increased over time.
- There was a strong negative correlation between year and structure fires originating in an equipment room and railway line, indicating that fires originating here have decreased over time.
- There was a strong positive correlation between year and structure fires originating in an exterior roof surface, indicating that fires originating here have increased over time.

10.2.2.10 Mosaic

Table 46. Mosaic Types

	A01	A02	A03	A04	B05	B06	B07	B08	B09
Correlation Coefficient	-.254	.021	-.280	-.280	.744	.238	.130	-.655	-.131
Sig. (2-tailed)	.628	.969	.591	.590	.090	.650	.806	.158	.805
N	6	6	6	6	6	6	6	6	6
	C08	C09	C10	C12	C13	D11	D12	D13	D16
Correlation Coefficient	-.222	-.326	-.400	-.703	-.621	.183	-.465	-.348	-.655
Sig. (2-tailed)	.673	.528	.432	.119	.188	.728	.353	.499	.158
N	6	6	6	6	6	6	6	6	6
	E14	E15	E16	F17	F18	F19	F21	G20	G21
Correlation Coefficient	.234	-.272	.102	-.712	.336	-.344	-.131	-.114	-.680
Sig. (2-tailed)	.656	.602	.848	.112	.515	.504	.805	.830	.137
N	6	6	6	6	6	6	6	6	6
	G22	G23	G25	G28	H24	H25	H26	H27	H30
Correlation Coefficient	.486	-.754	-.393	-.655	-.259	-.339	-.557	-.166	-.655
Sig. (2-tailed)	.328	.083	.441	.158	.620	.511	.251	.754	.158
N	6	6	6	6	6	6	6	6	6
	H31	H32	I28	I29	I30	I33	I34	I35	J31
Correlation Coefficient	.000	-.621	-.112	.275	-.159	-.393	-.441	-.183	-.236
Sig. (2-tailed)	1.000	.188	.832	.598	.763	.441	.381	.728	.652
N	6	6	6	6	6	6	6	6	6
	J32	J33	J34	J37	K35	K36	K37	K39	K41

Correlation Coefficient	-.727	.312	-.917	-.131	-.022	-.431	-.263	-.655	-.131
Sig. (2-tailed)	.102	.547	.010*	.805	.968	.393	.615	.158	.805
N	6	6	6	6	6	6	6	6	6
	K42	L38	L39	L40	L41	L42	L43	L45	M43
Correlation Coefficient	-.703	-.860	-.226	-.158	-.097	-.552	-.655	-.621	-.180
Sig. (2-tailed)	.119	.028*	.666	.765	.854	.256	.158	.188	.734
N	6	6	6	6	6	6	6	6	6
	M44	M45	M46	M47	M49	N48	N49	N50	N51
Correlation Coefficient	-.240	.136	-.417	.239	-.828	.046	.393	-.254	-.210
Sig. (2-tailed)	.648	.797	.411	.649	.042*	.931	.441	.627	.689
N	6	6	6	6	6	6	6	6	6
	U99								
Correlation Coefficient	.499								
Sig. (2-tailed)	.314								
N	6								

There were statistically significant correlations between year and mosaic characteristics.

- There were strong negative correlations between year and Mosaic Type, where the presence of Mosaic Type J34, L38, and M49 have decreased over time.

10.2.2.11 Human Behaviour

Table 47. Human behaviour

	Youth Misuse of Fire	No Youth Misuse of Fire	Cultural practices	No cultural practices	Hoarding	No hoarding
Correlation Coefficient	-.968	-.719	-.764	-.760	.747	-.772
Sig. (2-tailed)	.002**	.107	.077	.079	.088	.072
N	6	6	6	6	6	6

Statistical significance: ****p* < .000, ** *p* < .01, * *p* < .05

Table 48. Types of mental impairment

	Combination	Due to alcohol	Due to drugs	Due to mental illness	Due to prescription	No mental impairment	Mental Impairment
Correlation Coefficient	.285	-.288	-.451	-.426	.703	-.733	-.338
Sig. (2-tailed)	.584	.580	.369	.399	.119	.098	.512
N	6	6	6	6	6	6	6

Statistical significance: ****p* < .000, ** *p* < .01, * *p* < .05

There was one statistically significant correlation between year and human behaviour.

- There was a strong negative correlation between year and youth misuse of fire, indicating that youth misuse of fire in structure fires have decreased over time.

10.2.2.12 Alarm presence and functionality

Table 49. Alarm presence and operation

	Alarms Present	Alarms Operating
Correlation Coefficient	.470	.288
Sig. (2-tailed)	.347	.580
N	6	6

Statistical significance: ***p < .000, ** p < .01, * p < .05

Table 50. Type of alarm

	Aspirating Smoke Detection	Beam Detector	Flame Detector	Gas detector	Infrared Detector	Manual Call Point	Multicriteria detector
Correlation Coefficient	.929	.707	-.393	.655	.137	.486	-.163
Sig. (2-tailed)	.007**	.116	.441	.158	.796	.329	.758
N	6	6	6	6	6	6	6
	Not assigned	Other type of detector	Smoke alarm - battery powered	Smoke alarm - hard-wired	Smoke detector	Sprinkler system	Thermal detector
Correlation Coefficient	-.867	-.050	.888	.882	-.728	-.405	-.884
Sig. (2-tailed)	.025*	.925	.018*	.020*	.101	.426	.020*
N	6	6	6	6	6	6	6

Statistical significance: ***p < .000, ** p < .01, * p < .05

Table 51. Reason alarm not operating

	Battery discharge or dead	Battery missing or disconnected	Defective	Fire not within range	Fire too small to operate
Correlation Coefficient	.150	-.814	-.389	.867	.393
Sig. (2-tailed)	.777	.049*	.446	.025*	.440
N	6	6	6	6	6
	Hard wire power failure, - back up battery dead	Hard wire power failure, back up battery missing	Improper installation	Improper placement	Lack of cleaning
Correlation Coefficient	.428	-.821	-.298	-.482	-.074
Sig. (2-tailed)	.398	.045*	.567	.333	.890
N	6	6	6	6	6

Statistical significance: ***p < .000, ** p < .01, * p < .05

There were statistically significant correlations between year and alarm characteristics.

- There were strong negative correlations between year and type of alarm, where the presence of thermal detectors decreased over time.
- There were strong positive correlations between year and type of alarm, where the presence of aspirating smoke detection, battery-powered smoke alarms, and hard-wired smoke alarms increased over time.

- There were strong negative correlations between year and reason for alarm failure where missing or disconnected batteries and hard-wire failures and missing back-up batteries decreased over time.
- There was a strong positive correlation between year and reason for alarm failure where the fire not being within the range of the detector increased over time.

10.2.3 Survival Analysis

Survival analysis was conducted to identify the rates of survival, or the absence of an adverse outcome, over time. Analysis revealed that rates of survivability for fatality, injury, and evacuation differed by response time.

Table 52. Alarm to arrival survivability rates by percentile

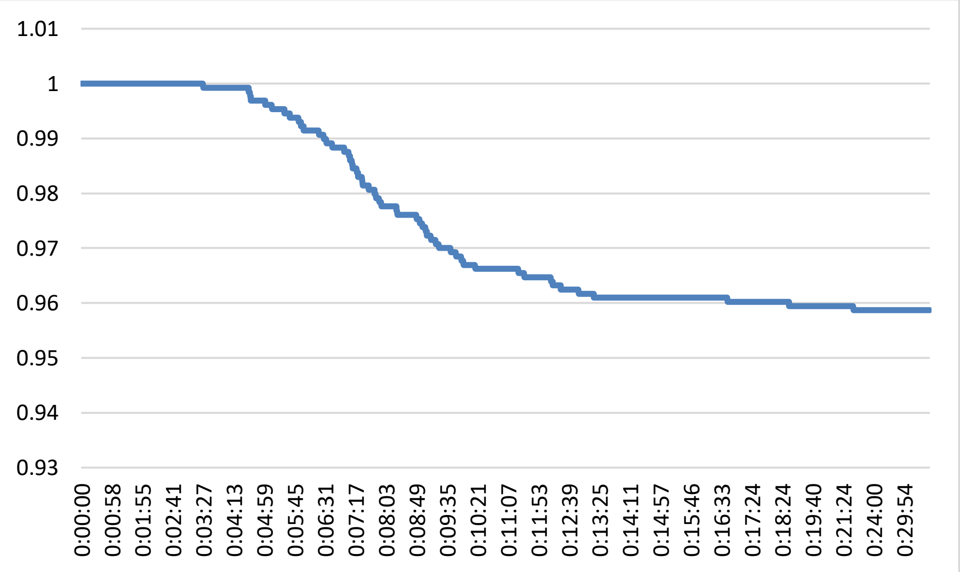
Percentile	Alarm to Arrival	No fatality	No injury	No evacuation[a]	No fire extension
10th	0:04:22	99.92%	97.46%	99.07%	94.99%
20th	0:05:13	99.53%	96.85%	99.07%	94.91%
30th	0:05:54	99.30%	96.62%	99.07%	94.91%
40th	0:06:33	98.99%	96.62%	99.07%	94.91%
50th (median)	0:07:13	98.53%	96.48%	99.07%	94.91%
60th	0:07:56	97.84%	96.32%	99.07%	94.91%
70th	0:08:49	97.61%	95.95%	99.07%	94.91%
80th	0:09:57	96.77%	94.90%	99.07%	94.91%
90th	0:11:49	96.47%	92.27%	98.91%	94.76%

[a] Surviving an evacuation means not being evacuated by firefighters.

Fatality survival

Until 3 minutes and 26 seconds, the fatality survivability rate was 100.00%. Between 3 minutes and 27 seconds and 13 minutes and 21 seconds, the survivability rate decreased sharply from 100.00% to 96.10%. Thereafter, survivability decreased slowly from 96.10% to 95.87%. The fatality rate plateaued at 95.87% at 22 minutes and 15 seconds.

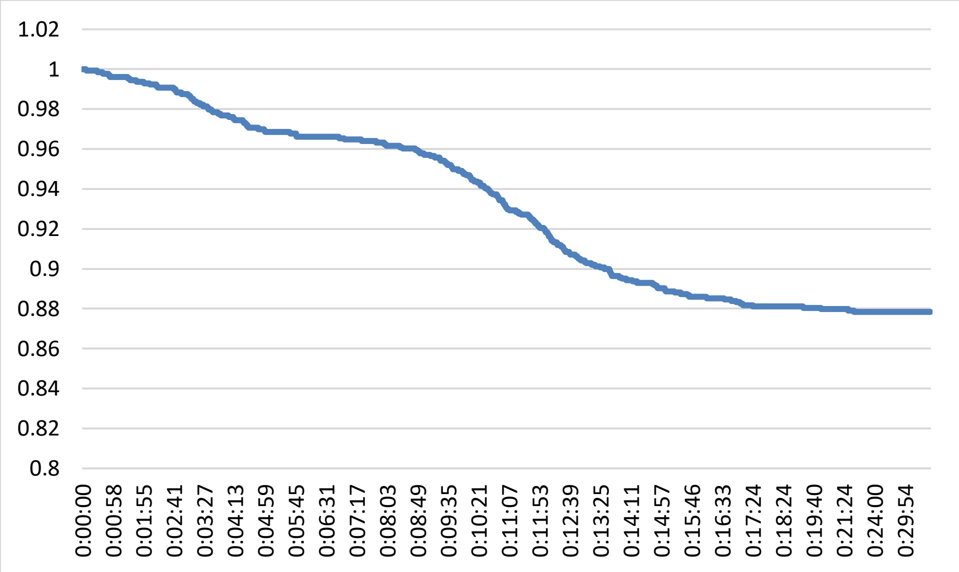
Figure 78. Fatality survival rate



Injury survival

A 100.00% injury survival rate was only evident in the first 8 seconds. Thereafter, survival rates decreased significantly from 99.92% at 9 seconds to 96.62% at 5 minutes and 46 seconds. While survivability slowed, reaching 95.72% at 9 minutes and 7 seconds, injury survival rate decreased sharply thereafter, reaching 88.19% at 17 minutes and 7 seconds. Survivability slowly declined to 87.84% by 22 minutes and 13 seconds, after which rates plateaued.

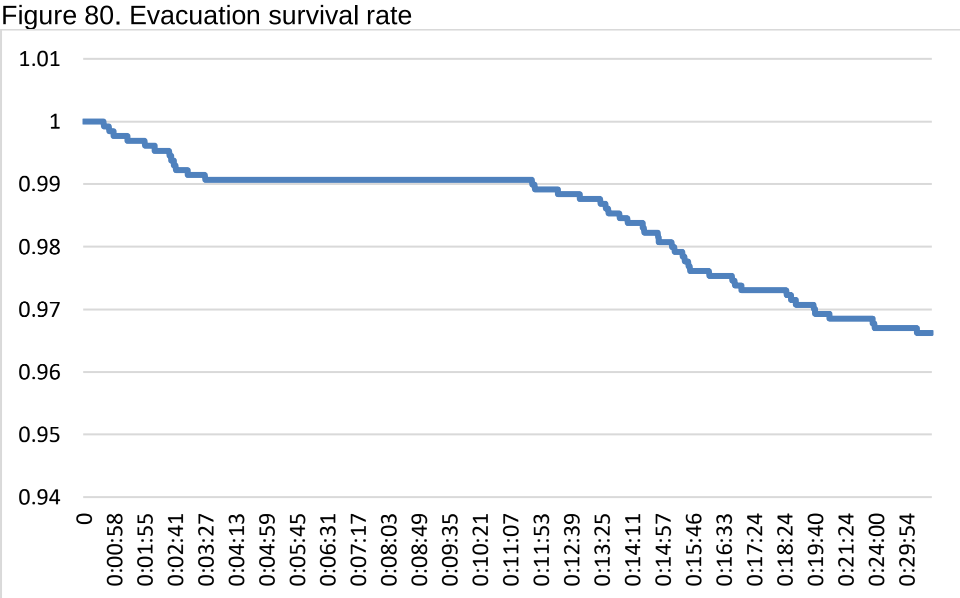
Figure 79. Injury survival rate



Evacuation survival

Evacuation survival refers to no firefighter-assisted evacuations. There were no firefighter-assisted evacuations until 38 seconds, after which the evacuation rate increased from 0.08% to 0.93% by 3 minutes and 27 seconds (survivability decreased from 99.92% to 99.07%). After this time, the evacuation rate plateaued at 0.93% (no evacuations plateaued at 99.07%) until 11 minutes and 41 seconds. Thereafter, the evacuation rate increased to 3.38% (survivability decreased to 96.62%) at 37 minutes and 37 seconds, after which it remained stable until 18 hours, 47 minutes, and 38 seconds.

Figure 80. Evacuation survival rate

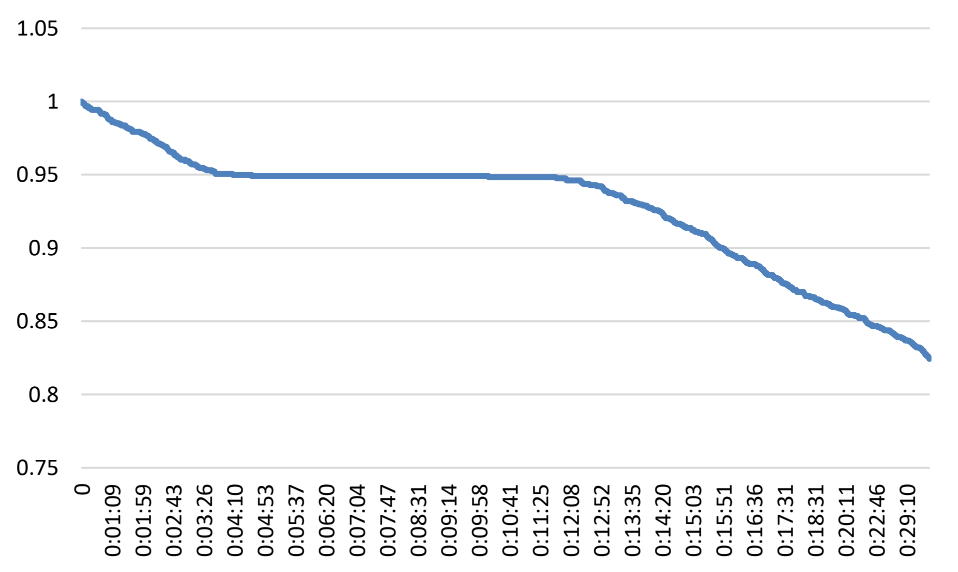


Fire Extension Survival

Fire extension survival refers to no fire extension beyond the room of origin. Fire extension was evident from 2 seconds. Fire extension survivability decreases sharply, from 99.01% at

53 seconds, to 98.03% at 1 minute and 45 seconds, 97.01% at 2 minutes and 28 seconds, 96.02% at 3 minutes, 95.08% at 4 minutes and 8 seconds, to 94.91% at 4 minutes and 35 seconds. Survivability remained stable from 4 minutes and 35 seconds until 10 minutes and 12 seconds, after which it declined sharply again to 90.00% by 15 minutes and 49 seconds, and 82.44% by the 100th percentile.

Figure 81. Fire extension survival rate



10.3 Multivariate Results

10.3.1 Multiple Logistic Regression

Multiple Logistic Regression was used to conduct predictive analysis. A forward likelihood ratio (LR) stepwise entry method was used to construct the regression model. The method added independent variables to the basic model based on the significance of the score statistic, and removed variables based on the probability of a likelihood-ratio statistic. The forward stepwise method was deemed the most suitable to meet the needs of this study. This analysis aimed to identify significant predictors of adverse outcomes to inform Prevention + Education efforts. Where resources are finite, the priority was to identify rigorous predictors rather than those that made very small contributions to the model. The forward stepwise method facilitated this. The LR entry method was chosen as this is considered the least prone to error (ESRC National Centre for Research Methods, 2011).

Linearity test
The Box Tidwell Test for linearity was used to test whether there was a linear relationship between the continuous independent variables and the logit transformation of each dependent variable. The results revealed that usual resident population did not have a linear relationship with the logit transformation of each dependent variable. To meet the assumption of linearity, this variable was removed from the analysis.

Outliers Test
Outliers were identified by analysing the univariate results. These results indicated that the frequency in each categorical variable level varies widely but tends to remain consistent across adverse outcomes. Given smaller frequency category levels were deemed important to include in the analysis, they were retained.

Independence Test

Each case was independent and included in the dataset once. This means that each of the observations was mutually exclusive. Further, each dependent variable has mutually exclusive and exhaustive categories (yes, no). The test of independence is upheld.

Multicollinearity Test

Chi-square tests of independence were conducted on variables that measured the same underlying constructs.

Table 53. Multicollinearity Test of Like Variables

Cross tabulation variables		**X^2**	**Significance**
Region	Zone	114385.908	.000***
Alarm Hour	Time of Day	30891.000	.000***
Day of Week	Time of Week	30891.000	.000***
Alarm Month	Season	92673.000	.000***
Alarms Present	Alarms Operating	30882.817	.000***
Property Location Use	Building Class	119530.304	.000***
Type of Occupant	Type of Owner	19925.530	.000***
Mosaic Group	Mosaic Type	125591.718	.000***
Collapse Damage	Fire Damage	49261.487	.000***
Collapse Damage	Smoke Damage	37790.646	.000***
Collapse Damage	Water Damage	41207.327	.000***
Collapse Damage	Confinement Collated	41485.978	.000***
Fire Damage	Smoke Damage	63359.875	.000***
Fire Damage	Water Damage	62923.819	.000***
Fire Damage	Confinement Collated	42691.086	.000***
Smoke Damage	Water Damage	63577.116	.000***
Smoke Damage	Confinement Collated	38556.936	.000***
Water Damage	Confinement Collated	39920.866	.000***

To avoid multicollinearity, the following variables were used to measure each construct:
- Region
- Time of day
- Time of week
- Season
- Alarms operating
- Building class
- Type of owner
- Mosaic type
- Confinement collated

Given each level of each variable measured a different construct, variable levels were not collapsed or replaced.

10.3.1.1 Fatality

Table 54. Fatality Omnibus Tests of Model Coefficients

		Chi-square	**df**	**Sig.**
Step 28	Step	2.474	1	.116
	Block	370.905	28	<.001***
	Model	370.905	28	<.001***

Statistical significance: ****p* <.001, ** *p* < .01, * *p* < .05

Table 55. Fatality Model Summary

Step	**-2 Log likelihood**	**Cox & Snell R Square**	**Nagelkerke R Square**
28	789.250	.012	.324

Table 56. Fatality Classification Table

Observed			Predicted		
			Fatality		Percentage Correct
			No	Yes	
Step 28	Fatality	No	30795	1	100.0
		Yes	84	0	.0
	Overall Percentage				99.7

*The cut value is .500

Table 57. Fatality ROC Curve

Test Result Variable(s)				
Area	**Std. Error**	**Asymptotic Sig.**	**Asymptotic 95% Confidence Interval**	
			Lower Bound	**Upper Bound**
.947	.010	.000	.928	.966

*A large area value indicates that the model has outstanding discrimination

Figure 82. Fatality ROC Curve

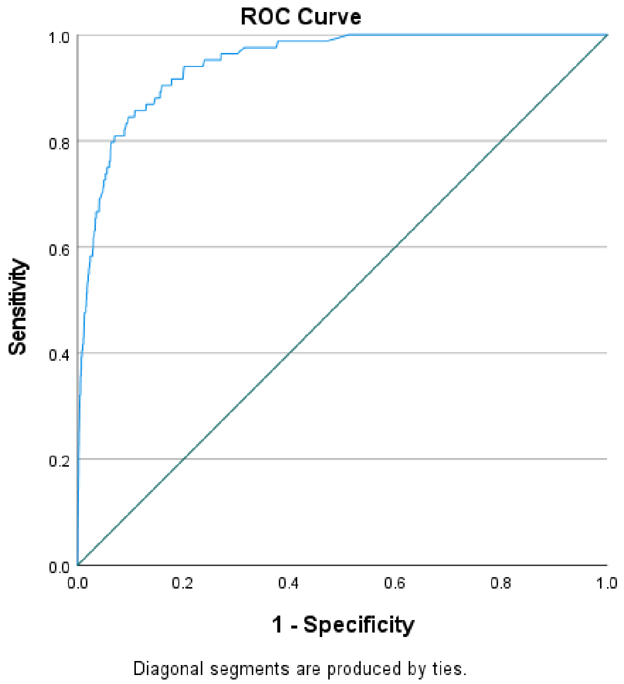


Table 58. Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
28	1.626	8	.990

*A large *p* value indicates that the model is not a poor fit.

Table 59. Fatality Variables in the Equation

Variable	B	S.E.	Wald	df	Sig.	Exp(B)	95% CI Exp(B) Lower	Upper
Call Source=ICEMS	.956	.378	6.416	1	.011*	2.602	1.242	5.454
Season=Winter	.584	.236	6.124	1	.013*	1.794	1.129	2.849
Type of Alarm=Aspirating Smoke Detection (eg. Vesda)	3.938	1.086	13.142	1	<.001***	51.318	6.104	431.440

Reason Alarm not Operating=Defective	1.496	.391	14.637	1	<.001***	4.464	2.074	9.608
CauseDeterminationFirelevel1=Undetermined	.958	.281	11.598	1	<.001***	2.606	1.502	4.522
Material Ignited First=Air conditioning, refrigeration unit - portable	3.619	1.095	10.918	1	<.001***	37.311	4.360	319.304
Material Ignited First=Fixed fans (cooling fans, exhaust fans)	3.740	1.064	12.364	1	<.001***	42.081	5.234	338.337
Material Ignited First=Not assigned	2.874	.463	38.495	1	<.001***	17.709	7.143	43.902
Material Ignited First=Other (furniture)	1.821	.646	7.948	1	.005**	6.178	1.742	21.912
Material Ignited First=Other (structural component, finish)	2.054	.797	6.648	1	.010*	7.801	1.637	37.184
Material Ignited First=Other Flammable Liquid	2.161	1.050	4.236	1	.040*	8.684	1.109	68.014
Material Ignited First=Outdoor cooking equipment	3.179	1.103	8.311	1	.004**	24.033	2.767	208.718
Material Ignited First=Petrol	2.215	.819	7.321	1	.007**	9.162	1.841	45.583
Material Ignited First=Undetermined	1.569	.338	21.511	1	<.001***	4.799	2.474	9.312
Area of Fire Origin=Bedroom/Sleeping area for under five persons	2.826	.429	43.454	1	<.001***	16.882	7.286	39.116
Area of Fire Origin=Exterior balcony, open porch, or veranda	1.642	.704	5.436	1	.020*	5.164	1.299	20.524
Area of Fire Origin=Hallway, corridor	2.502	.813	9.480	1	.002**	12.212	2.483	60.062
Area of Fire Origin=Kitchen, cooking area	1.633	.466	12.310	1	<.001***	5.121	2.056	12.754
Area of Fire Origin=Lounge Room, Family Room, Living Area	2.647	.436	36.930	1	<.001***	14.113	6.010	33.144
Area of Fire Origin=Multiple Areas of Origin	2.540	.729	12.128	1	<.001***	12.683	3.036	52.984
Building code =Class 1a (attached)	.799	.266	9.013	1	.003**	2.224	1.320	3.747
Mosaic Type=B07	2.168	.772	7.878	1	.005**	8.741	1.923	39.725
Mosaic Type=G20	2.082	.667	9.754	1	.002**	8.022	2.172	29.632
Mosaic Type=M44	1.447	.636	5.184	1	.023*	4.252	1.223	14.784
Time of Day=Night	.606	.242	6.271	1	.012*	1.833	1.141	2.946
Hoarding	1.438	.520	7.640	1	.006**	4.211	1.519	11.672

Confinement Collated=Beyond room	1.456	.300	23.610	1	<.001***	4.288	2.384	7.715
Injuries	1.050	.277	14.375	1	<.001***	2.857	1.660	4.915
Constant	-10.372	.513	409.255	1	<.001***	.000		

Statistical significance: ****p* <.001, ** *p* < .01, * *p* < .05

The logistic regression model was statistically significant ($X^2(28) = 370.905$, p<.001). The model was not a poor fit (*p* = .990) and had outstanding discrimination (ROC AUC = .947). The odds of fatality increased:

Response
- 2.6 times when the call source was an ICEMS (inter-agency CAD electronic messaging system) compared to all other call sources

Temporal
- 1.8 times in Winter compared to all other seasons
- 1.8 times when the fire occurred at night compared to day

Human Behaviour
- 4.2 times when there was evidence of hoarding compared to no hoarding

Mosaic Type
- 8.7 times when the Mosaic Type was B07 compared to other Mosaic Types.
- 8.0 times when the Mosaic Type was G20 compared to other Mosaic Types.
- 4.3 times when the Mosaic Type was M44 compared to other Mosaic Types.

Smoke Alarms
- 51.3 times when the alarm type was aspirating smoke detection compared to other smoke detector types
- 4.5 times when the alarm did not operate because it was defective compared to other reasons for failure

Cause Determination
- 2.6 times when the fire was of undetermined cause compared to other cause determinations

Building Class
- 2.2 times when the building class was Class 1a (attached) compared to other building classes

Material ignited First
- 37.3 times when the material ignited first was a portable air conditioning unit
- 42.1 times when the material ignited first was a fixed fan (cooling or exhaust)
- 17.7 times when the material ignited first was not assigned
- 6.2 times when the material ignited first was other (furniture)
- 7.8 times when the material ignited first was other (structural component, finish)
- 8.7 times when the material ignited first was other flammable liquid
- 24.0 times when the material ignited first was outdoor cooking equipment
- 9.2 times when the material ignited first was petrol
- 4.8 times when the material ignited first was undetermined

Each compared to other materials ignited first.

Area of Origin
- 16.9 times when the area of origin was a bedroom for less than 5 persons

- 5.2 times when the area of origin was an exterior balcony, open porch, or veranda
- 12.2 times when the area of origin was a hallway or corridor
- 5.1 times when the area of origin was a kitchen or cooking area
- 14.1 times when the area of origin was a lounge room or living room
- 12.7 times when the area of origin was multiple areas of origin

Each compared to other areas of origin.

Other Outcomes
- 4.3 times when the fire extended beyond the room of origin compared to no extension
- 2.9 times when injury occurred compared to no injury

10.3.1.2 Preventable Fatality

Table 60. Preventable Fatality Omnibus Tests of Model Coefficients				
Step 11	Step	4.540	1	.033
	Block	78.024	11	<.001***
	Model	78.024	11	<.001***

Statistical significance: ****p* <.001, ** *p* < .01, * *p* < .05

Table 61. Preventable Fatality Model Summary			
Step	**-2 Log likelihood**	**Cox & Snell R Square**	**Nagelkerke R Square**
11	33.617	.605	.823

Table 62. Preventable Fatality Classification Table					
			Predicted		
			Preventable Fatality		Percentage Correct
Observed			No	Yes	
Step 11	Preventable Fatality	No	24	8	75.0
		Yes	0	52	100.0
	Overall Percentage				90.5

*The cut value is .500

Table 63. Preventable Fatality ROC Curve				
Test Result Variable(s)				
Area	**Std. Error**	**Asymptotic Sig.**	**Asymptotic 95% Confidence Interval**	
			Lower Bound	**Upper Bound**
.999	.002	.000	.996	1.000

*A large area value indicates that the model has outstanding discrimination

Figure 83. Preventable Fatality ROC Curve

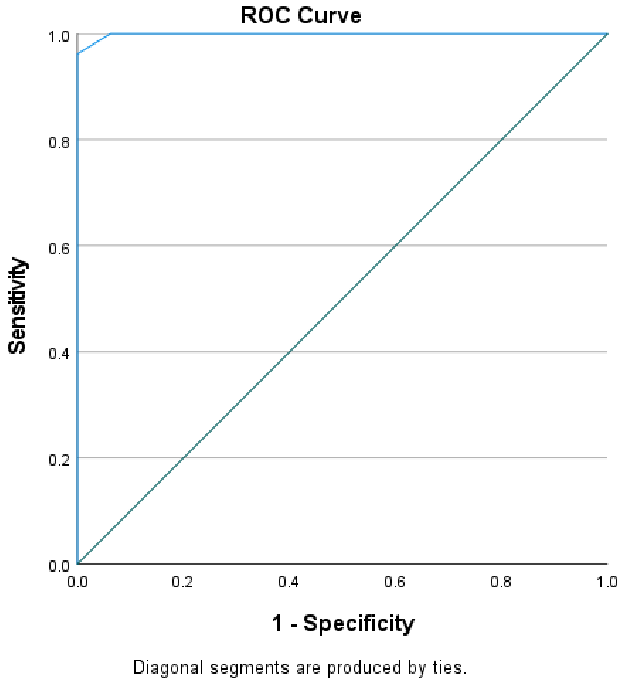


Table 64. Hosmer and Lemeshow Test			
Step	**Chi-square**	**df**	**Sig.**
11	.898	5	.970

*A large *p* value indicates that the model is not a poor fit.

Table 65. Preventable Fatality Variables in the Equation								
Variable	**B**	**S.E.**	**Wald**	**df**	**Sig.**	**Exp(B)**	**95% CI Exp(B) Lower**	**Upper**
Call Source=000	3.199	1.553	4.243	1	.039*	24.512	1.168	514.580
Cause Determination=Deliberate	-23.891	8872.248	.000	1	.998	.000	.000	.
Ignition Source=Radiated heat	-4.051	1.801	5.060	1	.024*	.017	.001	.594
Material Ignited First=Floor covering, surface.	48.702	41160.559	.000	1	.999	1415365342265203500000.000	.000	.
Material Ignited First=Outdoor cooking equipment	-25.254	40192.970	.000	1	.999	.000	.000	.
Material Ignited First=Sofa, chair, seating	-25.254	40192.970	.000	1	.999	.000	.000	.
Area of Origin=Multiple Areas of Origin	-4.051	1.801	5.060	1	.024*	.017	.001	.594
Building code=Class 6	-25.254	40192.970	.000	1	.999	.000	.000	.
Mosaic Type=M45	-25.254	40192.970	.000	1	.999	.000	.000	.
Mosaic Type=M47	-4.051	1.801	5.060	1	.024*	.017	.001	.594

Confinement Collated=To room	-3.608	1.226	8.662	1	.003**	.027	.002	.300
Constant	.852	1.591	.287	1	.592	2.345		

Statistical significance: ****p* <.001, ** *p* < .01, * *p* < .05

The logistic regression model was statistically significant ($X^2(11) = 78.024$, p<.001). The model was not a poor fit (*p* = .970) and had outstanding discrimination (ROC AUC = .999). The odds of preventable fatality:

Response
- Increased 24.5 times when the call source was a Triple Zero call compared to other call sources

Mosaic Type
- Decreased 0.02 times when the fire occurred in Mosaic Type M47 compared to other Mosaic Types

Ignition Source
- Decreased 0.02 times when the ignition source was radiated heat compared to other ignition sources

Area of Origin
- Decreased 0.02 times when the fire originated in multiple areas compared to other areas of origin

Confinement
- Decreased 0.03 times when the fire was confined to the room of origin compared to fire extension

10.3.1.3 Injury

Table 66. Injury Omnibus Tests of Model Coefficients				
		Chi-square	**df**	**Sig.**
Step 61	Step	2.650	1	.104
	Block	1733.277	61	.000***
	Model	1733.277	61	.000***

Statistical significance: ****p* <.001, ** *p* < .01, * *p* < .05

Table 67. Injury Model Summary			
Step	**-2 Log likelihood**	**Cox & Snell R Square**	**Nagelkerke R Square**
61	12618.896	.055	.147

Table 68. Injury Classification Table					
			Predicted		
			Injury		Percentage Correct
Observed			No	Yes	
Step 61	Injury	No	28940	26	99.9
		Yes	1889	25	1.3
	Overall Percentage				93.8

*The cut value is .500

Table 69. Injury ROC Curve				
Test Result Variable(s)				
Area	**Std. Error**	**Asymptotic Sig.**	**Asymptotic 95% Confidence Interval**	

			Lower Bound	Upper Bound
.764	.005	.000	.754	.774

*A moderate area value indicates that the model has acceptable discrimination

Figure 84. Injury ROC Curve

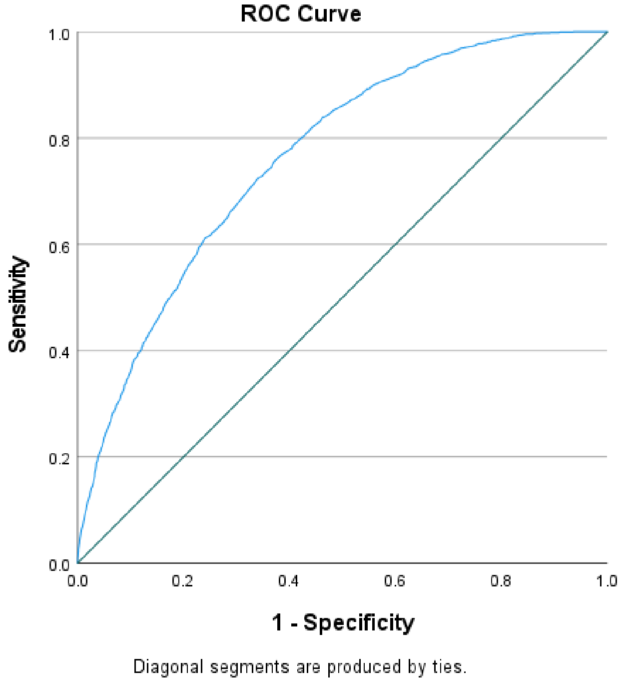


Table 70. Hosmer and Lemeshow Test			
Step	**Chi-square**	**df**	**Sig.**
61	20.258	8	.009

*A small *p* value indicates that the model is a poor fit.

Table 71. Injury Variables in the Equation								
Variable	**B**	**S.E.**	**Wald**	**df**	**Sig.**	**Exp(B)**	**95% CI Exp(B) Lower**	**Upper**
Call Source=Call to Station	-.552	.216	6.514	1	.011*	.576	.377	.880
Call Source=ICEMS	.693	.101	46.988	1	<.001***	2.001	1.641	2.439
Reason Alarm not Operating=Battery missing or disconnected (Battery only detector/alarm)	.557	.175	10.078	1	.002**	1.745	1.237	2.461
Reason Alarm not Operating=Fire not within designed range of detector/alarm	-.330	.108	9.334	1	.002**	.719	.582	.889
Reason Alarm not Operating=Fire too small to operate	-.416	.132	9.933	1	.002**	.660	.509	.854
Cause Determination=Accidental	.974	.092	111.001	1	<.001***	2.649	2.210	3.175

Cause Determination=Undetermined	.584	.117	24.900	1	<.001***	1.794	1.426	2.256
Ignition Source=Candle, taper	.372	.127	8.548	1	.003**	1.451	1.131	1.862
Ignition Source=Cutting or Welding or Heating torch	1.136	.222	26.085	1	<.001***	3.113	2.013	4.813
Ignition Source=Hot ember, ash	-.530	.204	6.781	1	.009**	.588	.395	.877
Ignition Source=Re-kindle, re-ignition	-1.813	.508	12.748	1	<.001***	.163	.060	.441
Ignition Source=Static discharge	1.849	.629	8.648	1	.003**	6.350	1.853	21.769
Material Ignited First=Atomised, vaporised liquid	2.103	.431	23.782	1	<.001***	8.192	3.518	19.076
Material Ignited First=Audio/visual and entertainment - televisions, stereos, projectors, speakers, gaming consoles	23.184	40192.969	.000	1	1.000	11712746702.385	.000	.
Material Ignited First=Bedding, blanket, sheet, comforter	.694	.122	32.085	1	<.001***	2.001	1.574	2.544
Material Ignited First=Cleaning supplies and products	.999	.383	6.789	1	.009**	2.715	1.281	5.755
Material Ignited First=Clothing not on a person	.454	.149	9.266	1	.002**	1.574	1.175	2.108
Material Ignited First=Clothing on a person worn at the time of fire	3.270	.713	21.022	1	<.001***	26.299	6.501	106.395
Material Ignited First=Electric bike, mobility scooter, ride-on toy	2.568	1.239	4.296	1	.038*	13.035	1.150	147.744
Material Ignited First =Fixed deep fat fryer	.950	.345	7.572	1	.006**	2.585	1.314	5.084
Material Ignited First =Fixed stationary surface unit	.977	.351	7.755	1	.005**	2.655	1.335	5.280
Material Ignited First =Fuel or gas system component	.746	.291	6.583	1	.010*	2.109	1.193	3.728
Material Ignited First =Gas lines	.872	.345	6.389	1	.011*	2.392	1.216	4.705
Material Ignited First =Gas outlet	1.128	.393	8.241	1	.004**	3.089	1.430	6.671
Material Ignited First =LPG	1.441	.227	40.411	1	<.001***	4.226	2.710	6.591
Material Ignited First =Natural gas	1.150	.463	6.178	1	.013*	3.159	1.275	7.824

Material Ignited First =Other Flammable Liquid	1.125	.226	24.650	1	<.001***	3.079	1.975	4.799
Material Ignited First =Petrol	1.206	.222	29.580	1	<.001***	3.339	2.162	5.157
Material Ignited First =Petroleum fuelled engine	1.543	.473	10.629	1	.001**	4.678	1.850	11.827
Material Ignited First =Portable gas cooker	1.136	.288	15.606	1	<.001***	3.115	1.773	5.473
Material Ignited First =Sofa, chair, seating	.437	.175	6.249	1	.012*	1.548	1.099	2.181
Material Ignited First =Supplies or stock in basket, barrel	2.405	1.210	3.951	1	.047*	11.079	1.034	118.683
Material Ignited First =Washing machine	.997	.272	13.426	1	<.001***	2.711	1.590	4.621
Area of Origin=Bedroom/Sleeping area for five or more persons	.691	.230	9.043	1	.003**	1.996	1.272	3.131
Area of Origin =Bedroom/Sleeping area for under five persons	.722	.086	70.127	1	<.001***	2.059	1.739	2.438
Area of Origin =Ceiling cavity, roof space	-1.095	.266	16.951	1	<.001***	.335	.199	.564
Area of Origin =Cell/Secure confinement area	1.283	.394	10.601	1	.001**	3.608	1.667	7.812
Area of Origin =Chimney/flue	-1.279	.323	15.668	1	<.001***	.278	.148	.524
Area of Origin =Electricity, Gas, Water areas, etc	-1.150	.228	25.418	1	<.001***	.317	.203	.495
Area of Origin=Exterior roof surface	-17.938	2665.686	.000	1	.995	.000	.000	.
Area of Fire Origin=Garage, Workshop	.359	.099	13.251	1	<.001***	1.432	1.180	1.737
Area of Fire Origin=Lawn, field, open area.	-.676	.251	7.274	1	.007**	.509	.311	.831
Area of Fire Origin=Lounge Room, Family Room, Living Area	.426	.098	18.739	1	<.001***	1.531	1.263	1.857
Area of Fire Origin=Office, Study	.689	.254	7.358	1	.007**	1.991	1.211	3.275
Area of Fire Origin=On or near highway, roadway, street, public way, parking lot	-2.498	1.013	6.080	1	.014*	.082	.011	.599
Building code =Class 1a (attached)	.233	.077	9.314	1	.002**	1.263	1.087	1.467
Building code =Class 1a (detached)	.342	.064	28.384	1	<.001***	1.408	1.242	1.597

Type of Owner2=Local Government	-.843	.292	8.333	1	.004**	.430	.243	.763
Type of Owner2=State Government	.178	.068	6.806	1	.009**	1.194	1.045	1.365
Mosaic Type=C08	-.491	.189	6.751	1	.009**	.612	.422	.886
Mosaic Type=Unknown/Not applicable	-.219	.061	12.723	1	<.001***	.803	.712	.906
Remote Index =Outer Regional Australia	-.631	.137	21.315	1	<.001***	.532	.407	.695
Remote Index =Remote Australia	-1.226	.466	6.938	1	.008**	.293	.118	.731
SEIFA Decile=1.0	.234	.071	10.745	1	.001**	1.264	1.099	1.454
Hoarding	.544	.204	7.107	1	.008**	1.722	1.155	2.569
Mental Impairment	.758	.098	60.192	1	<.001***	2.133	1.761	2.583
Confinement Collated=To room	-.320	.065	24.462	1	<.001***	.726	.640	.825
Confinement Collated= Not assigned	-.844	.147	32.826	1	<.001***	.430	.322	.574
Evacuations	.509	.052	95.735	1	<.001***	1.663	1.502	1.842
Fatalities	1.016	.265	14.734	1	<.001***	2.763	1.644	4.642
Constant	-3.700	.120	948.890	1	<.001***	.025		

Statistical significance: ****p* <.001, ** *p* < .01, * *p* < .05

The logistic regression model was statistically significant ($X^2(61) = 1733.277$, p<.000). Although the model was a poor fit (*p* = .009), it had acceptable discrimination (ROC AUC = .764). Future analyses should explore other logistic regression models to determine best fit. Based on this model, the odds of injury:

Response
- Increased 2.0 times when the call source was an ICEMS (inter-agency CAD electronic messaging system)
- Decreased 0.58 times when the call source was a call to station

Each compared to other call sources.

Human Behaviour
- Increased 1.7 times when there was evidence of hoarding compared to no hoarding
- Increased 2.1 times when there was evidence of mental impairment compared to no mantal impairment

Mosaic Type
- Decreased 0.61 times when the fire occurred in Mosaic Type C08
- Decreased 0.80 times when the fire occurred in Mosaic Type unknown

Each compared to other Mosaic Types

Remoteness
- Decreased 0.53 times when the fire occurred in an Outer Regional Area
- Decreased 0.30 times when the fire occurred in a Remote Area

Each compared to other remoteness structures

SEIFA Decile
- Increased 1.3 times when the fire occurred in SEIFA Decile 1 compared to other SEIFA Deciles

Smoke Alarms
- Increased 1.7 times when the alarm did not operate because the battery was missing or disconnected
- Decreased 0.72 times when the alarm did not operate because the fire was not within the designed range of the detector
- Decreased 0.66 times when the alarm did not operate because the fire was too small

Each compared to other reasons for failure.

Cause Determination
- Increased 2.6 times when the fire was accidental
- Increased 1.8 times when the fire was of undetermined cause

Each compared to other cause determinations.

Building Class
- Increased 1.3 times when the fire occurred in a Class 1a (attached) building
- Increased 1.4 times when the fire occurred in a Class 1a (detached) building

Each compared to other building classes.

Type of Owner
- Decreased 0.43 times when the fire occurred in a property owned by the Local Government
- Increased 1.2 times when the fire occurred in a property owned by the State Government

Each compared to other types of owners.

Ignition Source
- Increased 1.5 times when the fire was ignited by a candle or taper
- Increased 3.1 times when the fire was ignited by a cutting, welding, or heating torch
- Decreased 0.59 times when the fire was ignited by hot ember or ash
- Decreased 0.16 times when the fire was ignited by a re-kindle or re-ignition
- Increased 6.4 times when the fire was ignited by static discharge

Each compared to other ignition sources.

Material Ignited First
- Increased 8.2 times when the material ignited first was an atomised, vapourised liquid
- Increased 2.0 times when the material ignited first was bedding, blanket, sheet, or comforter
- Increased 2.7 times when the material ignited first was cleaning supplies and products
- Increased 1.6 times when the material ignited first was clothing not on a person
- Increased 26.3 times when the material ignited first was clothing on a person worn at the time of the fire
- Increased 13.0 times when the material ignited first was an electric bike, mobility scooter, ride on toy
- Increased 2.6 times when the material ignited first was a fixed deep fat fryer
- Increased 2.7 times when the material ignited first was fixed stationary surface unit
- Increased 2.1 times when the material ignited first was fuel or gas system component
- Increased 2.4 times when the material ignited first was gas lines
- Increased 3.1 times when the material ignited first was a gas outlet
- Increased 4.2 times when the material ignited first was LPG
- Increased 3.2 times when the material ignited first was natural gas
- Increased 3.1 times when the material ignited first was other flammable liquid
- Increased 3.3 times when the material ignited first was petrol

- Increased 4.7 times when the material ignited first was petroleum fuelled engine
- Increased 3.1 times when the material ignited first was a portable gas cooker
- Increased 1.5 times when the material ignited first was a sofa, chair, or seating
- Increased 11.1 times when the material ignited first was supplies or stock in a basket or barrel
- Increased 2.7 times when the material ignited first was a washing machine

Each compared to other materials ignited first.

Area of Origin

- Increased 2.0 times when the fire originated in a bedroom for five or more persons
- Increased 2.1 times when the fire originated in a bedroom for less than five persons
- Decreased 0.34 times when the fire originated in a ceiling cavity, roof space
- Increased 3.6 times when the fire originated in a cell or secure confinement area
- Decreased 0.28 times when the fire originated in a chimney or flue
- Decreased 0.32 times when the fire originated in an electricity, gas, or water area
- Increased 1.4 times when the fire originated in a garage or workshop
- Decreased 0.51 times when the fire originated in a lawn, field, or open area
- Increased 1.5 times when the fire originated in a lounge or living room
- Increased 2.0 times when the fire originated in an office or study
- Decreased 0.08 times when the fire originated on a highway, roadway, public way

Each compared to other areas of origin.

Other Outcomes

- Decreased 0.73 times when the fire was confined to the room of origin compared to extension
- Increased 1.7 times when evacuations occurred compared to no evacuations
- Increased 2.8 times when fatality occurred compared to no fatality

10.3.1.4 Evacuation

Table 72. Evacuation Omnibus Tests of Model Coefficients

		Chi-square	**df**	**Sig.**
Step 108	Step	4.167	1	.041
	Block	4178.224	106	.000***
	Model	4178.224	106	.000***

Statistical significance: ****p* <.001, ** *p* < .01, * *p* < .05

Table 73. Evacuation Model Summary

Step	**-2 Log likelihood**	**Cox & Snell R Square**	**Nagelkerke R Square**
108	29218.090	.127	.191

Table 74. Evacuation Classification Table

			Predicted		
			Evacuation		Percentage Correct
Observed			No	Yes	
Step 108	Evacuation	No	23004	736	96.9
		Yes	6186	954	13.4
	Overall Percentage				77.6

*The cut value is .500

Table 75. Evacuation ROC Curve

Test Result Variable(s)

Area	Std. Error	Asymptotic Sig.	Asymptotic 95% Confidence Interval	
			Lower Bound	Upper Bound
.734	.003	.000	.728	.740

*A moderate area value indicates that the model has acceptable discrimination

Figure 85. Evacuation ROC Curve

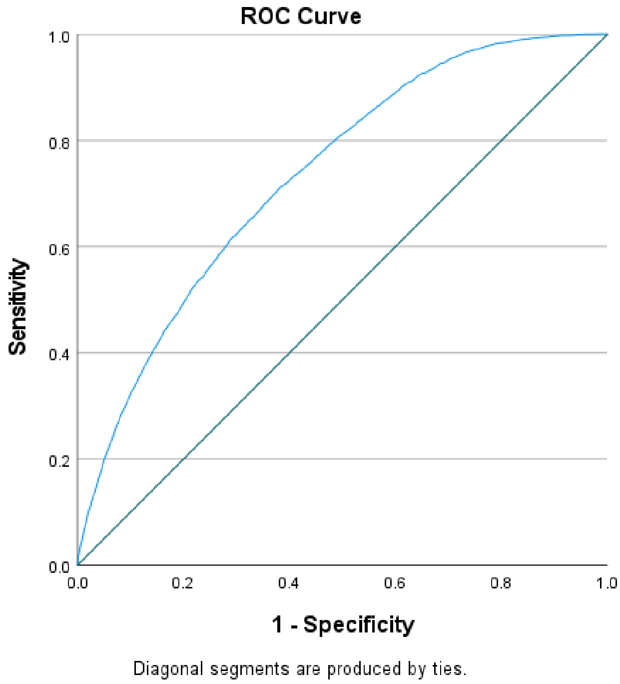


Table 76. Hosmer and Lemeshow Test			
Step	**Chi-square**	**df**	**Sig.**
108	29218.090	.127	.191

*A non-significant *p* value indicates that the model is not a poor fit.

Table 77. Evacuation Variables in the Equation								
Variable	**B**	**S.E.**	**Wald**	**df**	**Sig.**	**Exp(B)**	**95% CI Exp(B)**	
							Lower	**Upper**
Call Source=000	.375	.073	26.383	1	<.001***	1.456	1.261	1.680
Call Source=AFASP	.533	.097	30.349	1	<.001***	1.704	1.410	2.061
Call Source=Call to Station	-.438	.133	10.882	1	<.001***	.646	.498	.837
Season=Summer	-.073	.034	4.543	1	.033*	.930	.869	.994
Time of Week=Weekday	.079	.032	6.131	1	.013*	1.082	1.017	1.151
Type of Alarm=Not assigned	-.624	.045	189.736	1	<.001***	.536	.490	.586
Type of Alarm=Smoke detector	-.152	.035	18.487	1	<.001***	.859	.801	.921
Type of Alarm=Sprinkler system	.398	.171	5.395	1	.020*	1.488	1.064	2.082
Reason Alarm not Operating=Battery missing or	.444	.128	12.073	1	<.001***	1.560	1.214	2.004

disconnected (Battery only detector/alarm)								
Reason Alarm not Operating =Defective	.342	.098	12.276	1	<.001***	1.408	1.163	1.705
Reason Alarm not Operating =Fire not within designed range of detector/alarm	-.132	.056	5.591	1	.018*	.877	.786	.978
Reason Alarm not Operating =Fire too small to operate	-.492	.069	50.796	1	<.001***	.612	.534	.700
Cause Determination=Accidental	.467	.150	9.756	1	.002**	1.595	1.190	2.139
Cause Determination =Deliberate	-.378	.159	5.670	1	.017*	.685	.502	.935
Cause Determination =Undetermined	.328	.156	4.400	1	.036*	1.388	1.022	1.887
Ignition Source=Heat from electrical equipment, overloaded	.135	.062	4.791	1	.029*	1.145	1.014	1.293
Ignition Source =Heat from properly operating electrical equipment	-.129	.041	9.689	1	.002**	.879	.810	.953
Ignition Source =Hot ember, ash	-.301	.101	8.864	1	.003**	.740	.607	.902
Ignition Source =Molten, hot material	.417	.186	5.002	1	.025*	1.517	1.053	2.185
Ignition Source =Open fire, Camp fire and bonfire, Rubbish fires, Burn-off Fires, Windows/Slash/Fire	-1.092	.317	11.854	1	<.001***	.336	.180	.625
Ignition Source =Re-kindle, re-ignition	-1.945	.279	48.567	1	<.001***	.143	.083	.247
Ignition Source =Suns heat, unusually concentrated	-1.153	.486	5.614	1	.018*	.316	.122	.819
Material Ignited First=Cooking materials, food stuff	-.412	.046	79.183	1	<.001***	.662	.605	.725
Material Ignited First Material Ignited First =Dryer	.464	.191	5.908	1	.015*	1.590	1.094	2.310
Material Ignited First =Electrical Wiring - fixed	-.661	.233	8.043	1	.005**	.516	.327	.815
Material Ignited First =Fence, pole, sign	-.834	.241	11.963	1	<.001***	.434	.271	.697
Material Ignited First =Fixed fans (cooling fans, exhaust fans)	.512	.189	7.333	1	.007**	1.669	1.152	2.419
Material Ignited First =Floor covering, surface.	-.763	.229	11.077	1	<.001***	.466	.297	.731
Material Ignited First =Grass, bush, and	-.643	.203	9.993	1	.002**	.526	.353	.783

forests, whether growing or dead								
Material Ignited First =Interior covering or permanently affixed surface item	-.858	.430	3.986	1	.046*	.424	.183	.984
Material Ignited First =Inverters, converters, rectifiers, capacitors	-1.282	.538	5.688	1	.017*	.277	.097	.796
Material Ignited First=LPG	.416	.197	4.452	1	.035*	1.515	1.030	2.229
Material Ignited First=Lighting - fixed	-.528	.260	4.122	1	.042*	.590	.354	.982
Material Ignited First=Local heating unit - Fixed, stationary	-.878	.422	4.325	1	.038*	.416	.182	.951
Material Ignited First=Local refrigerator unit - Fixed, stationary	.730	.275	7.040	1	.008**	2.076	1.210	3.561
Material Ignited First=Not assigned	-.667	.088	57.594	1	<.001***	.513	.432	.610
Material Ignited First=Other (appliances, home equipment)	-.515	.217	5.642	1	.018*	.598	.391	.914
Material Ignited First=Other (other object)	-.521	.193	7.248	1	.007**	.594	.407	.868
Material Ignited First=Other (structural component, finish)	-.764	.260	8.661	1	.003**	.466	.280	.775
Material Ignited First=Outdoor cooking equipment	-.545	.255	4.571	1	.033*	.580	.352	.956
Material Ignited First=Petrol	-.505	.213	5.634	1	.018*	.604	.398	.916
Material Ignited First=Power switch gear, over-current protection devices	-.725	.338	4.597	1	.032*	.484	.250	.940
Material Ignited First=Rubbish, trash, waste, chimney waste, vent waste	-.316	.076	17.309	1	<.001***	.729	.628	.846
Material Ignited First=Solid Fuel	-.601	.200	9.012	1	.003**	.548	.370	.812
Material Ignited First=Structural member, framing	-.503	.173	8.496	1	.004**	.605	.431	.848
Material Ignited First=Supplies or stock in box, carton, bag	.554	.265	4.369	1	.037*	1.741	1.035	2.928
Material Ignited First=Undetermined	-.338	.060	32.060	1	<.001***	.713	.634	.802
Area of Origin=Bedroom/Sleeping area for under five persons	.433	.059	53.948	1	<.001***	1.542	1.374	1.731

Area of Origin=Ceiling cavity, roof space	.257	.089	8.376	1	.004**	1.293	1.087	1.539
Area of Origin=Cell/Secure confinement area	1.175	.272	18.687	1	<.001***	3.239	1.901	5.519
Area of Origin=Chute and conveyors	1.057	.274	14.842	1	<.001***	2.877	1.681	4.925
Area of Origin=Closed carpark, for more than 40 cars	.871	.396	4.839	1	.028*	2.390	1.100	5.193
Area of Origin=Closed carpark, for up to 40 cars	.954	.293	10.568	1	.001**	2.595	1.460	4.611
Area of Origin=Court, terrace, patio	-.418	.106	15.486	1	<.001***	.658	.535	.811
Area of Origin=Dining area, lunchroom, cafeteria.	-.339	.170	3.964	1	.046*	.712	.510	.995
Area of Origin=Duct.	.720	.191	14.236	1	<.001***	2.055	1.414	2.987
Area of Origin=Fire stairway	1.751	.612	8.191	1	.004**	5.759	1.736	19.103
Area of Origin=Garage, Workshop	.294	.069	18.204	1	<.001***	1.342	1.172	1.537
Area of Origin=Interior stairway.	.780	.247	9.937	1	.002**	2.180	1.343	3.540
Area of Origin=Kitchen, cooking area	-.168	.047	12.559	1	<.001***	.845	.770	.928
Area of Origin=Laboratory	.972	.415	5.479	1	.019*	2.644	1.171	5.968
Area of Origin=Lawn, field, open area.	-.941	.165	32.425	1	<.001***	.390	.282	.540
Area of Origin=Lifts	1.071	.497	4.651	1	.031*	2.919	1.103	7.727
Area of Origin=On or near highway, roadway, street, public way, parking lot	-.838	.252	11.082	1	<.001***	.433	.264	.709
Area of Origin=Process, manufacturing area	.425	.165	6.613	1	.010*	1.529	1.106	2.113
Area of Origin=Recreational Area	-.991	.281	12.464	1	<.001***	.371	.214	.644
Area of Origin=Storage area, Greater than 2000 sqm	.899	.352	6.516	1	.011*	2.456	1.232	4.896
Area of Origin=Vacant structural area with no current use	-.825	.321	6.618	1	.010*	.438	.234	.822
Building code =#	-1.090	.100	119.256	1	<.001***	.336	.276	.409
Building code =Class 10a	-.665	.117	32.517	1	<.001***	.514	.409	.646
Building code =Class 1a (detached)	-.216	.035	38.292	1	<.001***	.806	.752	.863
Building code =Class 3	.348	.101	11.965	1	<.001***	1.417	1.163	1.726

Building code =Class 4	-.643	.294	4.784	1	.029*	.526	.296	.935
Building code =Class 7a	-.813	.287	8.022	1	.005**	.444	.253	.779
Building code =Class 7b	-.601	.132	20.699	1	<.001***	.548	.423	.710
Building code =Class 9b	.291	.091	10.144	1	.001**	1.338	1.119	1.601
Type of Owner=Local Government	-.563	.137	17.009	1	<.001***	.569	.436	.744
Type of Owner=Other	.707	.334	4.475	1	.034*	2.028	1.053	3.903
Type of Owner=Private	.100	.045	4.814	1	.028*	1.105	1.011	1.208
Type of Owner=Unoccupied/ Not being used for any purpose	-1.549	.519	8.920	1	.003**	.213	.077	.587
Region=ME	.188	.038	24.630	1	<.001***	1.207	1.121	1.300
Region=MW	.092	.039	5.504	1	.019*	1.097	1.015	1.185
Region=RW	.325	.068	22.689	1	<.001***	1.384	1.211	1.582
Mosaic Type=A04	.235	.095	6.088	1	.014*	1.265	1.050	1.525
Mosaic Type=B05	*.412	.145	8.110	1	.004**	1.510	1.137	2.006
Mosaic Type=D16	24.152	40192.969	.000	1	1.000	30845701555.615	.000	.
Mosaic Type=C08	-.202	.092	4.877	1	.027*	.817	.682	.977
Mosaic Type=C09	-.408	.181	5.054	1	.025*	.665	.466	.949
Mosaic Type=D11	-.458	.226	4.122	1	.042*	.632	.406	.984
Mosaic Type=G21	.198	.094	4.414	1	.036*	1.219	1.013	1.466
Mosaic Type=J33	.495	.241	4.214	1	.040*	1.641	1.023	2.632
Mosaic Type=K35	.328	.153	4.567	1	.033*	1.388	1.028	1.874
Mosaic Type=L41	-.254	.112	5.151	1	.023*	.775	.622	.966
Mosaic Type=L42	-.207	.091	5.135	1	.023*	.813	.680	.972
Mosaic Type=N50	-1.023	.407	6.333	1	.012*	.359	.162	.797
Remote Index =Outer Regional Australia	-.642	.079	65.982	1	<.001***	.526	.451	.614
Remote Index =Remote Australia	-1.124	.233	23.349	1	<.001***	.325	.206	.513
Remote Index ==Very Remote Australia	-3.100	1.021	9.227	1	.002**	.045	.006	.333
Time of Day=Day	-.122	.031	15.165	1	<.001***	.886	.833	.941
SEIFA Decile=3.0	-.132	.062	4.552	1	.033*	.876	.776	.989
Cultural	.363	.167	4.730	1	.030*	1.437	1.036	1.993
Hoarding	.556	.161	11.946	1	<.001***	1.744	1.272	2.391
Mental Impairment	.462	.074	38.485	1	<.001***	1.587	1.371	1.836
Confinement Collated=Beyond room	.555	.043	170.106	1	<.001***	1.741	1.602	1.893
Confinement Collated=Not assigned	-.480	.076	40.058	1	<.001***	.619	.534	.718
Injuries	.498	.053	89.462	1	<.001***	1.645	1.484	1.824
Constant	-1.322	.176	56.580	1	<.001***	.267		

Statistical significance: ****p* <.001, ** *p* < .01, * *p* < .05

The logistic regression model was statistically significant ($X^2(108) = 4178.224$, p=.000). The model was not a poor fit (*p* = .191) and had acceptable discrimination (ROC AUC = .734). The odds of evacuation:

Response

- Increased 1.5 times when the call source was a Triple Zero call
- Increased 1.7 times when the call source was an AFA (Automatic Fire Alarm)
- Decreased 0.65 times when the call source was a call to station

Each compared to other call sources.

Temporal

- Decreased 0.93 times when the fire occurred in Summer compared to other seasons
- Increased 1.1 times when the fire occurred on a weekday compared to a weekend
- Decreased 0.89 times when the fire occurred during the day compared to during the night

Human Behaviour

- Increased 1.7 times when there was evidence of hoarding compared to no hoarding
- Increased 1.6 times when there was evidence of mental impairment compared to no mental impairment
- Increased 1.4 times when there was evidence of cultural practices compared to no cultural practices

Mosaic Type

- Increased 1.3 times when the fire occurred in Mosaic Type A04
- Increased 1.5 times when the fire occurred in Mosaic Type B05
- Decreased 0.82 times when the fire occurred in Mosaic Type C08
- Decreased 0.67 times when the fire occurred in Mosaic Type C09
- Decreased 0.63 times when the fire occurred in Mosaic Type D11
- Increased 1.2 times when the fire occurred in Mosaic Type G21
- Increased 1.6 times when the fire occurred in Mosaic Type J33
- Increased 1.4 times when the fire occurred in Mosaic Type K35
- Decreased 0.78 times when the fire occurred in Mosaic Type L41
- Decreased 0.81 times when the fire occurred in Mosaic Type L42
- Decreased 0.36 times when the fire occurred in Mosaic Type N50

Each compared to other Mosaic Types.

Region

- Increased 1.2 times when the fire occurred in Metro East
- Increased 1.1 times when the fire occurred in Metro West
- Increased 1.4 times when the fire occurred in Regional West

Each compared to other regions.

Remoteness

- Decreased 0.53 times when the fire occurred in an Outer Regional Area
- Decreased 0.33 times when the fire occurred in a Remote Area
- Decreased 0.89 times when the fire occurred in a Very Remote Area

Each compared to other remoteness structures.

SEIFA Decile

- Decreased 0.88 times when the fire occurred in SEIFA Decile 3 compared to other SEIFA Deciles

Smoke Alarms

- Decreased 0.54 times when the type of alarm was not assigned
- Decreased 0.86 when the type of alarm was smoke detection
- Increased 1.5 times when the type of alarm was a sprinkler system

Each compared to other smoke alarm types.

- Increased 1.6 times when the alarm did not operate because the battery was missing or disconnected
- Increased 1.4 times when the alarm did not operate because it was defective
- Decreased 0.88 times when the alarm did not operate because the fire was not within the designed range of the detector
- Decreased 0.61 times when the alarm did not operate because the fire was too small

Each compared to other reasons for failure.

Cause Determination

- Increased 1.6 times when the fire was accidental
- Increased 1.4 times when the fire was of undetermined cause
- Decreased 0.68 times when the fire was deliberate

Each compared to other cause determinations.

Building Class

- Decreased 0.34 times when the fire occurred in an unknown class
- Decreased 0.51 times when the fire occurred in a Class 10a (non-habitable) building
- Decreased 0.81 times when the fire occurred in a Class 1a (detached) building
- Increased 1.4 times when the fire occurred in a Class 3 (other residential) building
- Decreased 0.53 times when the fire occurred in a Class 4 (dwelling in another class) building
- Decreased 0.44 times when the fire occurred in a Class 7a (carpark) building
- Decreased 0.55 times when the fire occurred in a Class 7b (storage) building
- Increased 1.3 times when the fire occurred in a Class 9b (assembly) building

Each compared to other building classes.

Type of Owner

- Decreased 0.57 times when the fire occurred in a property owned by the Local Government
- Increased 2.0 times when the fire occurred in a property owned by other
- Increased 1.1 times when the fire occurred in a property owned by private
- Decreased 0.21 when the fire occurred in a property that was unoccupied

Each compared to other types of owners.

Ignition Source

- Increased 1.2 times when the fire was ignited by heat from overloaded electrical equipment
- Decreased 0.88 times when the fire was ignited by heat from properly operating electrical equipment
- Decreased 0.74 times when the fire was ignited by hot ember or ash
- Increased 1.5 times when the ignition source was molten, hot material
- Decreased 0.34 times when the fire was ignited by an open fire, campfire, or rubbish fire
- Decreased 0.14 times when the fire was ignited by a re-kindle or re-ignition
- Decreased 0.32 times when the fire was ignited by the suns heat, unusually concentrated

Each compared to other ignition sources.

Material Ignited First

- Decreased 0.66 times when the material ignited first was cooking materials or food stuffs
- Increased 1.6 times when the material ignited first was a dryer

- Decreased 0.52 times when the material ignited first was electrical wiring fixed
- Decreased 0.43 times when the material ignited first was a fence, pole, or sign
- Increased 1.7 times when the material ignited first was fixed fans (cooling or exhaust)
- Decreased 0.47 times when the material ignited first was floor covering, surface
- Decreased 0.53 times when the material ignited first was grass, bush, and forests
- Decreased 0.42 times when the material ignited first was interior covering or permanently affixed surface item
- Decreased 0.28 times when the material ignited first was inverters, converters, rectifiers, capacitors
- Increased 1.5 times when the material ignited first was LPG
- Decreased 0.59 times when the material ignited first was fixed lighting
- Decreased 0.42 times when the material ignited first was local heating unit, fixed stationary
- Increased 2.1 times when the material ignited first was local refrigeration unit, fixed stationary
- Decreased 0.51 times when the material ignited first was not assigned
- Decreased 0.60 times when the material ignited first was other (appliances, home equipment)
- Decreased 0.59 times when the material ignited first was other (other object)
- Decreased 0.47 times when the material ignited first was other (structural component, finish)
- Decreased 0.58 times when the material ignited first was outdoor cooking equipment
- Decreased 0.60 times when the material ignited first was petrol
- Decreased 0.48 times when the material ignited first was power switch gear, over-current protection devices
- Decreased 0.73 times when the material ignited first was rubbish, trash, waste
- Decreased 0.55 times when the material ignited first was solid fuel
- Decreased 0.61 times when the material ignited first was structural member, framing
- Increased 1.7 times when the material ignited first was supplies or stock in a box, carton, or bag
- Decreased 0.71 times when the material ignited first was undetermined

Each compared to other materials ignited first.

Area of Origin

- Increased 1.5 times when the fire originated in a bedroom for less than five persons
- Increased 1.3 times when the fire originated in a ceiling cavity, roof space
- Increased 3.2 times when the fire originated in a cell or secure confinement area
- Increased 2.9 times when the fire originated in a chute or conveyor
- Increased 2.4 times when the fire originated in a closed carpark for more than 40 cars
- Increased 2.6 times when the fire originated in a closed carpark for up to 40 cars
- Decreased 0.66 times when the fire originated in a court, patio, terrace
- Decreased 0.71 times when the fire originated in a dining area, lunchroom, cafeteria
- Increased 2.1 times when the fire originated in a duct
- Increased 5.8 times when the fire originated in a fire stairway
- Increased 1.3 times when the fire originated in a garage or workshop
- Increased 2.2 times when the fire originated in an interior stairway
- Decreased 0.85 times when the fire originated in a kitchen or cooking area
- Increased 2.6 times when the fire originated in a laboratory
- Decreased 0.39 times when the fire originated in a lawn, field, open area
- Increased 2.9 times when the fire originated in a lift
- Decreased 0.43 times when the fire originated on a highway, roadway, public way
- Increased 1.5 times when the fire originated in a process, manufacturing area
- Decreased 0.37 times when the fire originated in a recreational area

- Increased 2.5 times when the fire originated in a storage area greater than 2000 sqm
- Decreased 0.44 times when the fire originated in a vacant structural area

Each compared to other areas of origin.

Other Outcomes

- Increased 1.7 times when the fire extended beyond the room of origin compared to confinement
- Increased 1.7 times when injury occurred compared to no injury

10.3.1.5 Fire Extension

Table 78. Fire Extension Omnibus Tests of Model Coefficients				
		Chi-square	**df**	**Sig.**
Step 101	Step	4.328	1	.037
	Block	8364.615	99	.000***
	Model	8364.615	99	.000***

Statistical significance: ****p* <.001, ** *p* < .01, * *p* < .05

Table 79. Fire Extension Model Summary			
Step	**-2 Log likelihood**	**Cox & Snell R Square**	**Nagelkerke R Square**
101	18471.948	.271	.425

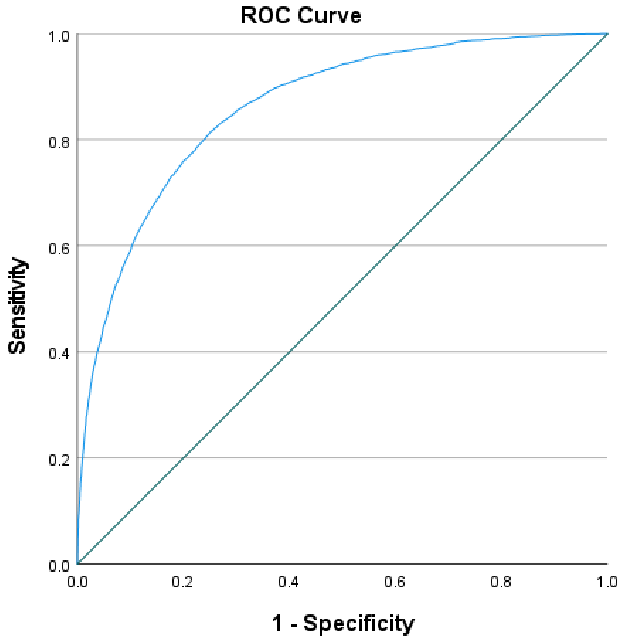
Table 80. Fire Extension Classification Table					
			Predicted		
			Fire Extension		Percentage Correct
Observed			No	Yes	
Step 101	Fire Extension	No	19969	1101	94.8
		Yes	2951	2466	45.5
	Overall Percentage				84.7

*The cut value is .500

Table 81. Fire Extension ROC Curve				
Test Result Variable(s)				
Area	**Std. Error**	**Asymptotic Sig.**	**Asymptotic 95% Confidence Interval**	
			Lower Bound	**Upper Bound**
.863	.003	.000	.857	.868

*A moderate-large area value indicates that the model has excellent discrimination

Figure 86. Fire Extension ROC Curve



Diagonal segments are produced by ties.

Table 82. Hosmer and Lemeshow Test			
Step	**Chi-square**	**df**	**Sig.**
101	6.842	8	.554

*A large *p* value indicates that the model is not a poor fit.

Table 83. Fire Extension Variables in the Equation								
Variable	**B**	**S.E.**	**Wald**	**df**	**Sig.**	**Exp(B)**	**95% CI Exp(B)**	
							Lower	**Upper**
Call Source=000	.707	.090	61.146	1	<.001***	2.027	1.698	2.420
Call Source=ICEMS	.249	.121	4.220	1	.040*	1.283	1.012	1.628
Alarms Detectors Operating=True	-.388	.045	75.579	1	<.001***	.679	.622	.741
Type of Alarm=Manual Call Point (MCP)	1.463	.618	5.608	1	.018*	4.318	1.287	14.490
Type of Alarm=Smoke alarm - battery powered	.138	.065	4.547	1	.033*	1.148	1.011	1.303
Reason Alarm not Operating=Fire not within designed range of detector/alarm	-.902	.080	127.741	1	<.001***	.406	.347	.475
Reason Alarm not Operating=Fire too small to operate	-1.945	.153	162.388	1	<.001***	.143	.106	.193
Reason Alarm not Operating=Hard wire power failure, shutoff or disconnect - back up battery discharged/dead	.900	.232	15.022	1	<.001***	2.459	1.560	3.876

Cause Determination=Accidental	-.238	.068	12.313	1	<.001***	.788	.690	.900
Cause Determination=Undetermined	.356	.073	23.522	1	<.001***	1.428	1.236	1.648
Ignition Source=Cutting or Welding or Heating torch	.447	.193	5.339	1	.021*	1.564	1.070	2.284
Ignition Source=Form of heat of ignition undetermined	.509	.063	64.936	1	<.001***	1.663	1.470	1.882
Ignition Source=Heat from flying brand, ember, spark	.908	.214	18.034	1	<.001***	2.480	1.631	3.771
Ignition Source=Heat from properly operating electrical equipment	-.254	.075	11.488	1	<.001***	.775	.669	.898
Ignition Source=Hot ember, ash	.323	.102	9.949	1	.002**	1.381	1.130	1.687
Ignition Source=Incendiary device	.517	.152	11.602	1	<.001***	1.677	1.245	2.258
Ignition Source=Match, Lighter (flame type)	.345	.073	22.471	1	<.001***	1.412	1.224	1.629
Material Ignited First=Cabinetry	.595	.186	10.185	1	.001**	1.813	1.258	2.613
Material Ignited First=Charger (device), battery charger	.662	.190	12.077	1	<.001***	1.939	1.335	2.816
Material Ignited First=Chemical process equipment	2.249	.885	6.459	1	.011*	9.480	1.673	53.722
Material Ignited First=Clothing not on a person	-.505	.142	12.606	1	<.001***	.604	.457	.798
Material Ignited First=Cooking materials, food stuff	-.687	.085	65.860	1	<.001***	.503	.426	.594
Material Ignited First=Decoration for special event	-19.586	8162.837	.000	1	.998	.000	.000	.
Material Ignited First=Electrical system component, wiring, or outlet	.229	.082	7.812	1	.005**	1.258	1.071	1.477
Material Ignited First=Exterior covering or permanently affixed surface item	.683	.336	4.128	1	.042*	1.980	1.024	3.825
Material Ignited First=Exterior roof covering, surface, finish	.892	.428	4.347	1	.037*	2.440	1.055	5.642

Material Ignited First=Exterior side wall covering, cladding, surface, finish	.755	.218	12.015	1	<.001***	2.128	1.388	3.261
Material Ignited First=Fixed, stationary oven	-.809	.399	4.121	1	.042*	.445	.204	.972
Material Ignited First=Flooring, trim, or upholstery material	.642	.207	9.601	1	.002**	1.900	1.266	2.852
Material Ignited First=Grass, bush, and forests, whether growing or dead	.632	.164	14.791	1	<.001***	1.882	1.363	2.597
Material Ignited First=Heat-treating equipment	-19.880	10192.291	.000	1	.998	.000	.000	.
Material Ignited First=Interior wall covering, surface items permanently affixed to wall and door surface.	.974	.250	15.151	1	<.001***	2.650	1.622	4.328
Material Ignited First=Lighting - fixed	-1.226	.526	5.437	1	.020*	.293	.105	.822
Material Ignited First=Not assigned	-1.175	.263	19.962	1	<.001***	.309	.184	.517
Material Ignited First=Other (books, papers, recreational material, decorations)	-.682	.225	9.191	1	.002**	.506	.325	.786
Material Ignited First=Other (furniture)	.383	.149	6.634	1	.010*	1.466	1.096	1.961
Material Ignited First=Other (mobile property component)	.794	.334	5.655	1	.017*	2.212	1.150	4.255
Material Ignited First=Other (structural component, finish)	1.019	.197	26.759	1	<.001***	2.770	1.883	4.075
Material Ignited First=Other (supplies, stock)	.874	.384	5.192	1	.023*	2.397	1.130	5.086
Material Ignited First=Packing, wrapping material	-.686	.251	7.458	1	.006**	.504	.308	.824
Material Ignited First=Petrol	.569	.172	10.991	1	<.001***	1.766	1.262	2.471
Material Ignited First=Small cooking appliance - toasters, pie makers, waffle irons	-1.796	1.016	3.122	1	.077	.166	.023	1.217
Material Ignited First=Structural member, framing	.654	.141	21.408	1	<.001***	1.923	1.458	2.536
Material Ignited First=Television, monitor and visual displays	1.030	.463	4.960	1	.026*	2.802	1.131	6.937

Material Ignited First=Torches, welding and cutting equipment	1.768	.838	4.452	1	.035*	5.861	1.134	30.294
Material Ignited First=Undetermined	1.053	.060	311.909	1	<.001***	2.867	2.550	3.222
Material Ignited First=Water cooling device, tower	22.769	40192.969	.000	1	1.000	7733075304.837	.000	.
Area of Origin=Bathroom, Lavatory, locker room, cloakroom	-1.534	.160	92.102	1	<.001***	.216	.158	.295
Area of Origin=Ceiling cavity, roof space	.267	.094	8.036	1	.005**	1.305	1.086	1.570
Area of Origin=Cell/Secure confinement area	-1.828	.738	6.135	1	.013*	.161	.038	.683
Area of Origin=Chimney/flue	-1.285	.139	85.297	1	<.001***	.277	.211	.363
Area of Origin=Court, terrace, patio	-.343	.123	7.770	1	.005**	.709	.557	.903
Area of Origin=Dining area, lunchroom, cafeteria.	-.577	.204	8.017	1	.005**	.562	.377	.837
Area of Origin=Electricity, Gas, Water areas, etc	-1.151	.135	72.362	1	<.001***	.316	.243	.412
Area of Origin=Engine compartment	-1.020	.532	3.671	1	.055	.361	.127	1.024
Area of Origin=Exterior roof surface	-.680	.243	7.854	1	.005**	.507	.315	.815
Area of Origin=Kitchen, cooking area	-1.008	.068	217.548	1	<.001***	.365	.319	.417
Area of Origin=Laundry room, area	-.714	.113	39.895	1	<.001***	.490	.392	.611
Area of Origin=Lawn, field, open area.	-.578	.127	20.676	1	<.001***	.561	.437	.720
Area of Origin=Lobby, entrance way	-.978	.211	21.537	1	<.001***	.376	.249	.568
Area of Origin=Multiple Areas of Origin	.907	.202	20.104	1	<.001***	2.476	1.666	3.681
Area of Origin=Medium-sized assembly area (from 20 to 100 persons)	-1.017	.449	5.139	1	.023*	.362	.150	.871
Area of Origin=On or near highway, roadway, street, public way, parking lot	-1.710	.329	27.078	1	<.001***	.181	.095	.344
Area of Origin=Open air carpark, for more than 40 cars	-20.704	11093.624	.000	1	.999	.000	.000	.
Area of Origin=Recreational Area	-.678	.249	7.375	1	.007**	.508	.311	.828

Area of Origin=Retail or Sales Area	-1.097	.346	10.082	1	.001**	.334	.170	.657
Area of Origin=Undetermined	2.653	.280	89.862	1	<.001***	14.197	8.203	24.570
Area of Origin=Waste Recycling/ Disposal Area	-.437	.182	5.752	1	.016*	.646	.452	.923
Building code=	2.961	1.176	6.343	1	.012*	19.312	1.928	193.424
Building code=Class 10a	1.176	.097	147.807	1	<.001***	3.241	2.682	3.918
Building code=Class 1a (detached)	.404	.043	89.145	1	<.001***	1.498	1.377	1.629
Building code=Class 3	-.681	.192	12.517	1	<.001***	.506	.347	.738
Building code=Class 7a	.554	.255	4.712	1	.030*	1.740	1.055	2.870
Building code=Class 7b	.526	.119	19.420	1	<.001***	1.692	1.339	2.138
Building code=Class 9a	-1.769	.551	10.293	1	.001**	.170	.058	.502
TypeofOwner2=Local Government	-.541	.122	19.641	1	<.001***	.582	.459	.740
Region=MW	.196	.050	15.505	1	<.001***	1.216	1.103	1.341
Region=RN	-.232	.067	11.963	1	<.001***	.793	.696	.904
Mosaic Type=C08	-.538	.183	8.618	1	.003**	.584	.408	.836
Mosaic Type=C10	-1.139	.372	9.397	1	.002**	.320	.154	.663
Mosaic Type=G21	-.947	.220	18.465	1	<.001***	.388	.252	.598
Mosaic Type=H26	-.588	.149	15.511	1	<.001***	.556	.415	.744
Mosaic Type=J32	.219	.098	5.012	1	.025*	1.244	1.028	1.507
Mosaic Type=L41	-.529	.175	9.182	1	.002**	.589	.419	.830
Mosaic Type=L42	.397	.086	21.393	1	<.001***	1.487	1.257	1.759
Mosaic Type=M45	-.665	.265	6.294	1	.012*	.514	.306	.865
Mosaic Type=N48	.593	.299	3.935	1	.047*	1.809	1.007	3.249
Remote Index=Major Cities of Australia	-.226	.053	18.045	1	<.001***	.798	.719	.885
Remote Index=Outer Regional Australia	.331	.074	20.003	1	<.001***	1.392	1.204	1.610
Remote Index=Very Remote Australia	1.247	.305	16.744	1	<.001***	3.480	1.915	6.323
Time of Day=Day	-.425	.039	121.859	1	<.001***	.654	.606	.705
SEIFA Decile=1.0	.138	.056	5.977	1	.014*	1.148	1.028	1.282
SEIFA Decile=8.0	-.183	.073	6.367	1	.012*	.832	.722	.960
Fatalities	1.179	.308	14.615	1	<.001***	3.251	1.776	5.951

Statistical significance: ****p* <.001, ** *p* < .01, * *p* < .05

The logistic regression model was statistically significant ($X^2(99) = 8364.615$, p=.000). The model was not a poor fit ($p = .554$) and had excellent discrimination (ROC AUC = .863). The odds of fire extension beyond the room of origin:

Response

- Increased 2.2 times when the call source was a Triple Zero call
- Decreased 0.64 times when the call source was an ICEMS

Each compared to other call sources.

Temporal

- Decreased 0.65 times when the fire occurred during the day compared to during the night

Smoke Alarms

- Decreased 0.68 times when smoke alarms were operating compared to not operating

- Increased 4.3 times when the alarm was a Manual Call Point
- Increased 1.1 times when the alarm was a battery-powered smoke alarm

Each compared to other smoke alarm types.

- Decreased 0.41 times when the alarm did not operate because the fire was not within the designed range of the detector
- Decreased 0.14 times when the alarm did not operate because the fire was too small
- Increased 2.5 times when the alarm did not operate because of a hard-wire power failure and a discharged or dead back-up battery

Each compared to other reasons for failure.

Remoteness

- Decreased 0.80 times when the fire occurred in a major city area
- Increased 1.4 times when the fire occurred in an outer regional rea
- Increased 3.5 times when the fire occurred in a very remote area

Each compared to other remoteness structures.

SEIFA Decile

- Increased 1.1 times when the fire occurred in SEIFA Decile 1
- Decreased 0.83 times when the fire occurred in SEIFA Decile 8

Each compared to other SEIFA Deciles.

Mosaic Types

- Decreased 0.58 times when the fire occurred in Mosaic Type C08
- Decreased 0.32 times when the fire occurred in Mosaic Type C10
- Decreased 0.39 times when the fire occurred in Mosaic Type G21
- Decreased 0.56 times when the fire occurred in Mosaic Type H26
- Increased 1.2 times when the fire occurred in Mosaic Type J32
- Decreased 0.59 times when the fire occurred in Mosaic Type L41
- Increased 1.5 times when the fire occurred in Mosaic Type L42
- Decreased 0.51 times when the fire occurred in Mosaic Type M45
- Increased 1.8 times when the fire occurred in Mosaic Type N48

Each compared to other Mosaic Types.

Cause Determination

- Decreased 0.79 times when the fire was accidental
- Increased 1.4 times when the fire was of undetermined cause

Region

- Increased 1.2 times when the fire occurred in Metro West
- Decreased 0.79 times when the fire occurred in Regional North

Each compared to other regions.

Building Class

- Increased 19.3 times when the fire occurred in a non-applicable building
- Increased 3.2 times when the fire occurred in a Class 10a (non-habitable) building
- Increased 1.5 times when the fire occurred in a Class 1a (detached) building
- Decreased 0.51 times when the fire occurred in a Class 3 (other residential) building

- Increased 1.7 times when the fire occurred in a Class 7a (carpark) building
- Increased 1.7 times when the fire occurred in a Class 7b (storage) building
- Decreased 0.17 times when the fire occurred in a Class 9a (health care) building

Each compared to other building classes.

Type of Owner

- Decreased 0.58 times when the fire occurred in a property owned by Local Government compared to other types of owners

Ignition Source

- Increased 1.6 times when the fire was ignited by a cutting, welding, or heating torch
- Increased 1.7 times when the fire was ignited by a form of heat ignition undetermined
- Increased 2.5 times when the fire was ignited by heat from a flying brand, ember, or spark
- Decreased 0.78 times when the fire was ignited by heat from properly operating electrical equipment
- Increased 1.4 times when the fire was ignited by hot ember or ash
- Increased 1.7 times when the fire was ignited by an incendiary device
- Increased 1.4 times when the fire was ignited by match or lighter

Each compared to other ignition sources.

Material Ignited First

- Increased 1.8 times when the material ignited first was cabinetry
- Increased 1.9 times when the material ignited first was a charger (device) or battery charger
- Increased 9.5 times when the material ignited first was chemical process equipment
- Decreased 0.60 times when the material ignited first was clothing not on a person
- Decreased 0.50 times when the material ignited first was cooking materials, food stuffs
- Increased 1.3 times when the material ignited first was electrical system component, wiring, or outlet
- Increased 2.0 times when the material ignited first was exterior covering or permanently affixed surface item
- Increased 2.4 times when the material ignited first was exterior roof covering, surface, finish
- Increased 2.1 times when the material ignited first was exterior side wall covering, cladding, surface, finish
- Decreased 0.45 times when the material ignited first was fixed, stationary oven
- Increased 1.9 times when the material ignited first was flooring, trim, or upholstery material
- Increased 1.9 times when the material ignited first was grass, bush, forests
- Increased 2.7 times when the material ignited first was interior wall covering, surface, items permanently affixed to wall or door surface
- Decreased 0.29 times when the material ignited first was fixed lighting
- Decreased 0.31 times when the material ignited first was not assigned
- Decreased 0.51 times when the material ignited first was other (books, papers, recreational material, decorations)
- Increased 1.5 times when the material ignited first was other (furniture)
- Increased 2.2 times when the material ignited first was other (mobile property component)
- Increased 2.7 times when the material ignited first was other (structural component, finish)
- Increased 2.4 times when the material ignited first was other (supplies, stock)
- Decreased 0.50 times when the material ignited first was packing, wrapping material

- Increased 1.8 times when the material ignited first was petrol
- Increased 1.9 times when the material ignited first was structural member, framing
- Increased 2.8 times when the material ignited first was a television, monitor or visual display
- Increased 5.9 times when the material ignited first was torches, welding, and cutting equipment
- Increased 2.9 times when the material ignited first was undetermined

Each compared to other materials ignited first.

Area of Origin

- Decreased 0.22 times when the fire originated in a bathroom, lavatory, locker room, or cloakroom
- Increased 1.3 times when the fire originated in a ceiling cavity, roof space
- Decreased 0.16 times when the fire originated in a cell or secure confinement area
- Decreased 0.28 times when the fire originated in a chimney or flue
- Decreased 0.71 times when the fire originated in a court, terrace, or patio
- Decreased 0.56 times when the fire originated in a dining area, lunchroom, or cafeteria
- Decreased 0.32 times when the fire originated in an electricity, gas, or water area
- Decreased 0.51 times when the fire originated in an exterior roof surface
- Decreased 0.37 times when the fire originated in a kitchen or cooking area
- Decreased 0.49 times when the fire originated in a laundry room
- Decreased 0.56 times when the fire originated in a lawn, field, or open area
- Decreased 0.38 times when the fire originated in a lobby or entrance way
- Increased 2.5 times when the fire originated in multiple areas of origin
- Decreased 0.36 times when the fire originated in a medium sized assembly area
- Decreased 0.18 times when the fire originated on a highway, roadway, or public way
- Decreased 0.51 times when the fire originated in a recreational area
- Decreased 0.33 times when the fire originated in a retail or sales area
- Increased 14.2 times when the fire originated in an undetermined area
- Decreased 0.65 times when the fire originated in a waste recycling/disposal area

Each compared to other areas of origin.

Other Outcomes

- Increased 3.3 times when fatality occurred compared to no fatality

10.4 Split Analysis Results

The dataset was split by cause determination to identify the risk factors associated with each adverse outcome when that outcome was from either an accidental, deliberate, or undetermined fire. After splitting the dataset, multivariate analyses were re-run.

10.4.1 Fatality by cause determination

10.4.1.1 Fatality x Accidental

Table 84. Fatality x Accidental Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 20	Step	2.581	1	.108
	Block	163.363	20	<.001***
	Model	163.363	20	<.001***

Statistical significance: ***p <.001, ** p < .01, * p < .05

Table 85. Fatality x Accidental Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
20	253.048	.007	.395

Table 86. Fatality x Accidental Classification Table

Observed			Predicted		
			Fatality		Percentage Correct
			No	Yes	
Step 20	Fatality	No	22171	0	100.0
		Yes	27	0	.0
	Overall Percentage				99.9

*The cut value is .500

Table 87. Fatality x Accidental ROC Curve

Test Result Variable(s)

Area	Std. Error	Asymptotic Sig.	Asymptotic 95% Confidence Interval	
			Lower Bound	Upper Bound
.940	.019	.000	.903	.977

*A large area value indicates that the model has outstanding discrimination

Figure 87. Fatality x Accidental ROC Curve

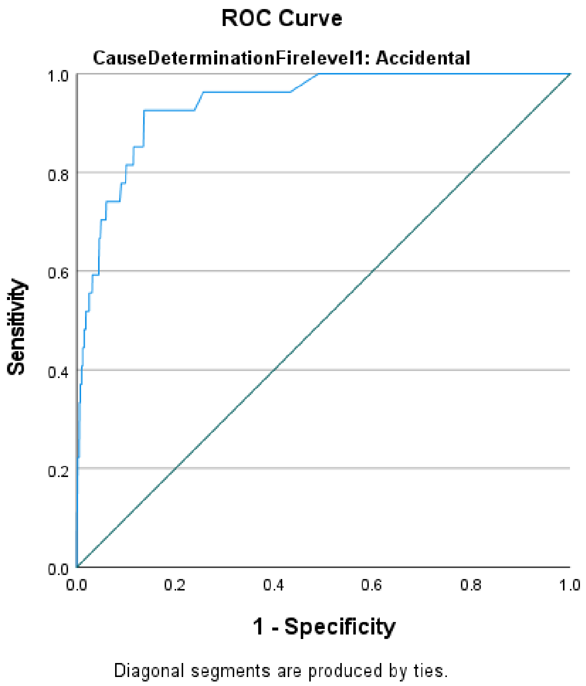


Table 88. Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
20	1.529	5	.910

*A large *p* value indicates that the model is not a poor fit.

Table 89. Fatality x Accidental Variables in the Equation

Variable	B	S.E.	Wald	df	Sig.	Exp(B)	95% CI Exp(B) Lower	Upper
Call Source=ICEMS	1.622	.681	5.677	1	.017*	5.066	1.333	19.243
Season=Winter	1.326	.424	9.796	1	.002**	3.767	1.642	8.642

Type of Alarm=Aspirating Smoke Detection (eg. Vesda)	4.507	1.180	14.581	1	<.001***	90.679	8.969	916.745
Reason Alarm not Operating=Defective	2.479	.555	19.948	1	<.001***	11.933	4.020	35.421
Ignition Source=Electric lamp, light bulbs	2.303	1.130	4.155	1	.042*	10.004	1.093	91.602
Material Ignited First=Air conditioning, refrigeration unit - portable	5.546	1.219	20.690	1	<.001***	256.326	23.489	2797.153
Material Ignited First=Bedding, blanket, sheet, comforter	3.165	.667	22.505	1	<.001***	23.684	6.406	87.563
Material Ignited First=Fixed fans (cooling fans, exhaust fans)	4.250	1.155	13.535	1	<.001***	70.123	7.286	674.872
Material Ignited First=Mattress, pillow	3.914	.896	19.105	1	<.001***	50.117	8.663	289.918
Material Ignited First=Not assigned	3.503	.676	26.870	1	<.001***	33.204	8.831	124.844
Material Ignited First=Outdoor cooking equipment	4.320	1.166	13.736	1	<.001***	75.181	7.655	738.335
Material Ignited First=Undetermined	1.847	.663	7.766	1	.005**	6.338	1.729	23.226
Area of Fire Origin=Kitchen, cooking area	1.650	.590	7.818	1	.005**	5.208	1.638	16.561
Area of Fire Origin=Lounge Room, Family Room, Living Area	2.232	.559	15.946	1	<.001***	9.319	3.116	27.870
Building code =Class 9c	3.171	1.130	7.871	1	.005**	23.839	2.601	218.521
Type of Owner=Commonwealth Government	2.845	1.210	5.526	1	.019*	17.206	1.605	184.466
Mosaic Type=I28	2.572	.815	9.960	1	.002**	13.093	2.650	64.676
Mosaic Type=L40	2.181	.679	10.330	1	.001**	8.856	2.342	33.487
Hoarding	2.697	.697	14.990	1	<.001***	14.838	3.788	58.123
Confinement Collated=Beyond room	2.848	.482	34.933	1	<.001***	17.248	6.709	44.347
Constant	-11.333	.826	188.367	1	<.001***	.000		

Statistical significance: ****p* <.001, ** *p* < .01, * *p* < .05

The logistic regression model was statistically significant ($X^2(20) = 163.363$, p<.001). The model was not a poor fit (*p* = .910) and had outstanding discrimination (ROC AUC = .940). The odds of fatality in an accidental fire increased:

Response

- 5.1 times when the call source was an ICEMS (inter-agency CAD electronic messaging system) compared to other call sources

Temporal
- 3.8 times in Winter compared to other seasons

Human Behaviour
- 14.8 times when there was evidence of hoarding compared to no hoarding

Mosaic Type
- 13.1 times when the Mosaic Type was I28
- 8.9 times when the Mosaic Type was L40

Each compared to other Mosaic Types.

Smoke Alarms
- 90.7 times when the alarm type was aspirating smoke detection compared to other smoke alarm types
- 11.9 times when the alarm did not operate because it was defective compared to other reasons for failure

Building Class
- 23.8 times when the building class was Class 9c compared to other building classes

Type of Owner
- 17.2 times when the property was owned by the Commonwealth Government compared to other types of owners

Ignition Source
- 10.0 times when the fire was ignited by an electric lamp or light bulb compared to other ignition sources

Material ignited First
- 256.33 times when the material ignited first was a portable air conditioning unit
- 23.7 times when the material ignited first was bedding, blanket, sheet, comforter
- 70.1 times when the material ignited first was a fixed fan (cooling or exhaust)
- 50.1 times when the material ignited first was a mattress or pillow
- 33.2 times when the material ignited first was not assigned
- 75.1 times when the material ignited first was outdoor cooking equipment
- 6.3 times when the material ignited first was undetermined

Each compared to other materials ignited first.

Area of Origin
- 5.2 times when the area of origin was a kitchen or cooking area
- 9.3 times when the area of origin was a lounge room or living room

Each compared to other areas of origin

Other Outcomes
- 17.3 times when the fire extended beyond the room of origin compared to confinement

10.4.1.2 Fatality x Deliberate

Table 90. Fatality x Deliberate Omnibus Tests of Model Coefficients

		Chi-square	**df**	**Sig.**
Step 16	Step	2.680	1	.102
	Block	87.433	16	<.001***

	Model	87.433	16	<.001***

Statistical significance: ***p <.001, ** p < .01, * p < .05

Table 91. Fatality x Deliberate Model Summary			
Step	**-2 Log likelihood**	**Cox & Snell R Square**	**Nagelkerke R Square**
16	126.182	.019	.415

Table 92. Fatality x Deliberate Classification Table					
			Predicted		
			Fatality		Percentage Correct
Observed			No	Yes	
Step 16	Fatality	No	4658	0	100.0
		Yes	15	1	6.3
	Overall Percentage				99.7

*The cut value is .500

Table 93. Fatality x Deliberate ROC Curve				
Test Result Variable(s)				
Area	**Std. Error**	**Asymptotic Sig.**	**Asymptotic 95% Confidence Interval**	
			Lower Bound	**Upper Bound**
.909	.029	.000	.853	.965

*A large area value indicates that the model has outstanding discrimination

Figure 88. Fatality x Deliberate ROC Curve

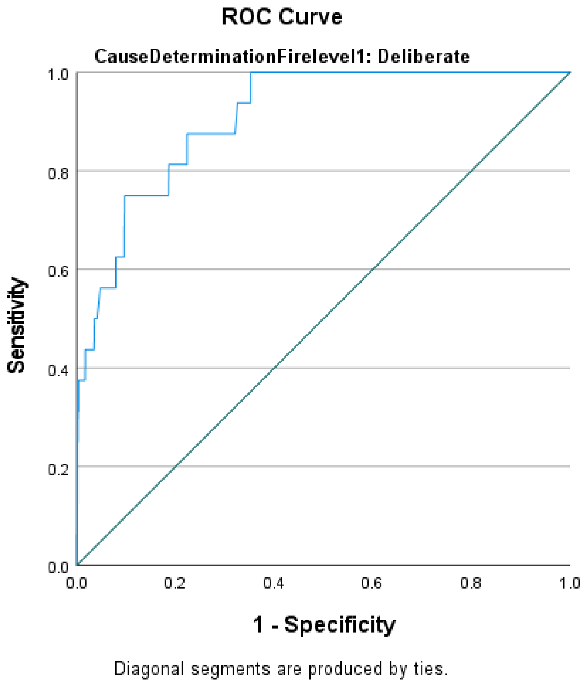


Table 94. Hosmer and Lemeshow Test			
Step	**Chi-square**	**df**	**Sig.**
16	7.565	4	.109

*A non-significant p value indicates that the model is not a poor fit.

Table 95. Fatality x Deliberate Variables in the Equation							
Variable	**B**	**S.E.**	**Wald**	**df**	**Sig.**	**Exp(B)**	**95% CI Exp(B)**

							Lower	Upper
Call Source=ICEMS	1.529	.655	5.446	1	.020*	4.615	1.277	16.672
Material Ignited First=Floor covering, surface.	2.472	1.247	3.933	1	.047*	11.849	1.029	136.390
Material Ignited First=Other (structural component, finish)	4.396	1.350	10.596	1	.001**	81.097	5.748	1144.093
Material Ignited First=Petrol	3.330	1.025	10.557	1	.001**	27.931	3.748	208.159
Material Ignited First=Undetermined	3.196	.771	17.184	1	<.001***	24.435	5.392	110.733
Mosaic Type=B05	4.412	1.386	10.140	1	.001**	82.461	5.455	1246.474
Mosaic Type=B07	6.601	1.222	29.171	1	<.001***	735.621	67.046	8071.090
Mosaic Type=G20	4.421	1.376	10.326	1	.001**	83.180	5.609	1233.470
Mosaic Type=J32	3.923	1.071	13.411	1	<.001***	50.543	6.192	412.548
Mosaic Type=K36	4.817	1.331	13.101	1	<.001***	123.648	9.105	1679.129
Mosaic Type=L39	3.461	1.066	10.540	1	.001**	31.857	3.942	257.458
Mosaic Type=L42	2.207	1.047	4.441	1	.035*	9.087	1.167	70.768
Mosaic Type=M43	3.829	1.298	8.699	1	.003**	46.001	3.612	585.774
Mosaic Type=M44	4.091	1.356	9.099	1	.003**	59.821	4.191	853.857
Mosaic Type=M47	3.700	1.294	8.178	1	.004**	40.445	3.203	510.656
Mental Impairment	1.933	.688	7.889	1	.005**	6.907	1.793	26.607
Constant	-9.985	1.092	83.629	1	<.001***	.000		

Statistical significance: ****p* <.001, ** *p* < .01, * *p* < .05

The logistic regression model was statistically significant ($X^2(16) = 87.433$, p<.001). The model was not a poor fit (*p* = .109) and had outstanding discrimination (ROC AUC = .909). The odds of fatality in a deliberate fire increased:

Response

- 4.6 times when the call source was an ICEMS (inter-agency CAD electronic messaging system) compared to other call sources

Human Behaviour

- 6.9 times when there was evidence of mental impairment compared to no mental impairment

Mosaic Type

- 82.5 times when the Mosaic Type was B05
- 735.6 times when the Mosaic Type was B07
- 83.2 times when the Mosaic Type was G20
- 50.5 times when the Mosaic Type was J32
- 123.6 times when the Mosaic Type was K36
- 31.9 times when the Mosaic Type was L39
- 9.1 times when the Mosaic Type was L42
- 46.0 times when the Mosaic Type was M43

- 59.8 times when the Mosaic Type was M44
- 40.4 times when the Mosaic Type was M47

Each compared to other Mosaic Types.

Material Ignited First

- 11.8 times when the material ignited first was floor covering, surface
- 81.1 times when the material ignited first was other (structural component, finish)
- 27.9 times when the material ignited first was petrol
- 24.4 times when the material ignited first was undetermined

Each compared to other materials ignited first.

10.4.1.3 Fatality x Undetermined

Table 96. Fatality x Undetermined Omnibus Tests of Model Coefficients

		Chi-square	**df**	**Sig.**
Step 25	Step	-2.496	1	.114
	Block	178.278	23	<.001***
	Model	178.278	23	<.001***

Statistical significance: ****p* <.001, ** *p* < .01, * *p* < .05

Table 97. Fatality x Undetermined Model Summary

Step	**-2 Log likelihood**	**Cox & Snell R Square**	**Nagelkerke R Square**
25	263.906	.052	.419

Table 98. Fatality x Undetermined Classification Table

			Predicted		
			Fatality		Percentage Correct
Observed			No	Yes	
Step 25	Fatality	No	3291	3	99.9
		Yes	38	3	7.3
	Overall Percentage				98.8

*The cut value is .500

Table 99. Fatality x Undetermined ROC Curve

Test Result Variable(s)

Area	**Std. Error**	**Asymptotic Sig.**	**Asymptotic 95% Confidence Interval**	
			Lower Bound	**Upper Bound**
.910	.020	.000	.872	.949

*A large area value indicates that the model has outstanding discrimination

Figure 89. Fatality x Undetermined ROC Curve

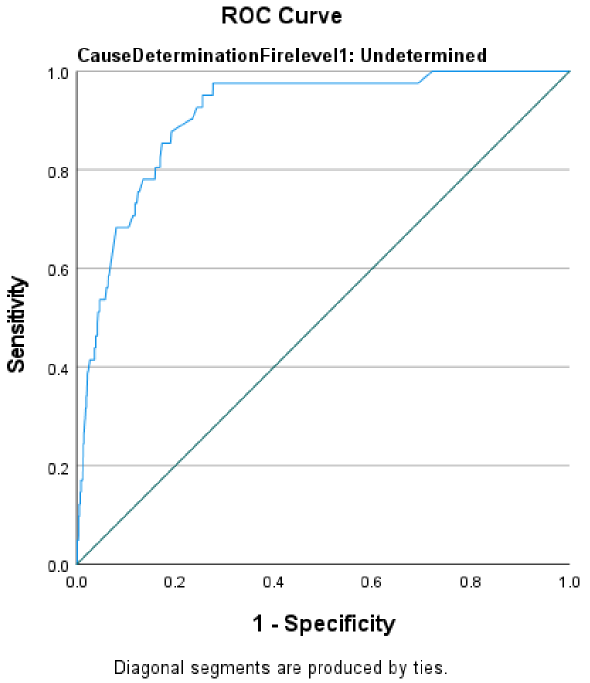


Table 100. Hosmer and Lemeshow Test			
Step	**Chi-square**	**df**	**Sig.**
25	2.618	7	.918

*A large *p* value indicates that the model is not a poor fit.

Table 101. Fatality x Undetermined Variables in the Equation								
Variable	**B**	**S.E.**	**Wald**	**df**	**Sig.**	**Exp(B)**	**95% CI Exp(B)** **Lower**	**Upper**
Type of Alarm=Smoke alarm - hard-wired	1.438	.470	9.374	1	.002**	4.210	1.677	10.567
Material Ignited First=Other (furniture)	3.396	1.101	9.511	1	.002**	29.830	3.447	258.144
Material Ignited First=Undetermined	2.407	.795	9.176	1	.002**	11.099	2.339	52.674
Area of Fire Origin=Bedroom/Sleeping area for under five persons	4.133	1.090	14.365	1	<.001***	62.360	7.357	528.572
Area of Fire Origin=Exterior balcony, open porch, or veranda	3.456	1.289	7.185	1	.007**	31.699	2.532	396.822
Area of Fire Origin=Hallway, corridor	3.415	1.546	4.878	1	.027*	30.413	1.469	629.813
Area of Fire Origin=Kitchen, cooking area	2.560	1.275	4.034	1	.045*	12.939	1.064	157.372
Area of Fire Origin=Lounge Room, Family Room, Living Area	3.720	1.083	11.797	1	<.001***	41.269	4.940	344.795

Area of Fire Origin=Multiple Areas of Origin	4.126	1.315	9.850	1	.002**	61.944	4.709	814.869
Area of Fire Origin=Undetermined	5.235	1.347	15.114	1	<.001***	187.814	13.410	2630.350
Region=RW	-16.514	1674.833	.000	1	.992	.000	.000	.
Mosaic Type=C09	3.073	1.392	4.878	1	.027*	21.614	1.413	330.550
Mosaic Type=D13	1.748	.635	7.583	1	.006**	5.745	1.655	19.938
Mosaic Type=E16	2.963	1.300	5.193	1	.023*	19.351	1.514	247.401
Mosaic Type=F17	4.436	1.582	7.859	1	.005**	84.460	3.799	1877.705
Mosaic Type=G20	4.476	1.333	11.264	1	<.001***	87.843	6.436	1198.888
Mosaic Type=J33	3.849	1.281	9.026	1	.003**	46.939	3.811	578.076
Mosaic Type=L39	1.840	.703	6.851	1	.009**	6.293	1.587	24.951
Mosaic Type=M44	2.339	.872	7.196	1	.007**	10.369	1.878	57.260
Mosaic Type=M45	2.544	1.176	4.679	1	.031*	12.731	1.270	127.633
SEIFA Decile=2.0	-16.646	1467.014	.000	1	.991	.000	.000	.
Confinement Collated=Beyond room	1.215	.525	5.364	1	.021*	3.370	1.205	9.423
Injuries	1.584	.407	15.167	1	<.001***	4.875	2.196	10.818
Constant	-10.700	1.389	59.344	1	<.001***	.000		

Statistical significance: ****p* <.001, ** *p* < .01, * *p* < .05

The logistic regression model was statistically significant (X^2(23) = 178.278, p<.001). The model was not a poor fit (*p* = .918) and had outstanding discrimination (ROC AUC = .910). The odds of fatality in an undetermined fire increased:

Smoke Alarms

- 4.2 times when the smoke alarm was a hard-wire smoke alarm compared to other smoke alarm types

Mosaic Type

- 21.6 times when the Mosaic Type was C09
- 5.7 times when the Mosaic Type was D13
- 19.4 times when the Mosaic Type was E16
- 84.5 times when the Mosaic Type was F17
- 87.8 times when the Mosaic Type was G20
- 46.9 times when the Mosaic Type was J33
- 6.3 times when the Mosaic Type was L39
- 10.4 times when the Mosaic Type was M44
- 12.7 times when the Mosaic Type was M45

Each compared to other Mosaic Types.

Material Ignited First

- 29.8 times when the material ignited first was other (furniture)
- 11.1 times when the material ignited first was undetermined

Each compared to other materials ignited first.

Area of Origin

- 62.4 times when the fire originated in a bedroom for less than 5 persons
- 31.7 times when the fire originated in an exterior balcony, open porch, or veranda
- 30.4 times when the fire originated in a hallway or corridor
- 12.9 times when the fire originated in a kitchen or cooking area
- 41.3 times when the fire originated in a lounge room or living room
- 61.9 times when the fire originated in multiple areas
- 187.8 times when the fire originated in an undetermined area

Each compared to other areas of origin.

Other Outcomes

- 3.4 times when the fire extended beyond the room of origin compared to confinement
- 4.9 times when injury occurred compared to no injury

10.4.2 Preventable Fatality by cause determination

10.4.2.1 Preventable Fatality x Accidental

Table 102. Preventable Fatality x Accidental Omnibus Tests of Model Coefficients				
		Chi-square	**df**	**Sig.**
Step 1	Step	11.722	1	<.001
	Block	11.722	1	<.001***
	Model	11.722	1	<.001***

Statistical significance: ****p* <.001, ** *p* < .01, * *p* < .05

Table 103. Preventable Fatality x Accidental Model Summary			
Step	**-2 Log likelihood**	**Cox & Snell R Square**	**Nagelkerke R Square**
1	19.181	.352	.517

Table 104. Preventable Fatality x Accidental Classification Table					
			Predicted		
			Fatality		Percentage Correct
Observed			No	Yes	
Step 1	Fatality	No	6	1	85.7
		Yes	3	17	85.0
	Overall Percentage				85.2

*The cut value is .500

Table 105. Preventable Fatality x Accidental ROC Curve				
Test Result Variable(s)				
Area	**Std. Error**	**Asymptotic Sig.**	**Asymptotic 95% Confidence Interval**	
			Lower Bound	**Upper Bound**
1.000	.000	.000	1.000	1.000

*A large area value indicates that the model has outstanding discrimination

Figure 90. Preventable Fatality ROC Curve

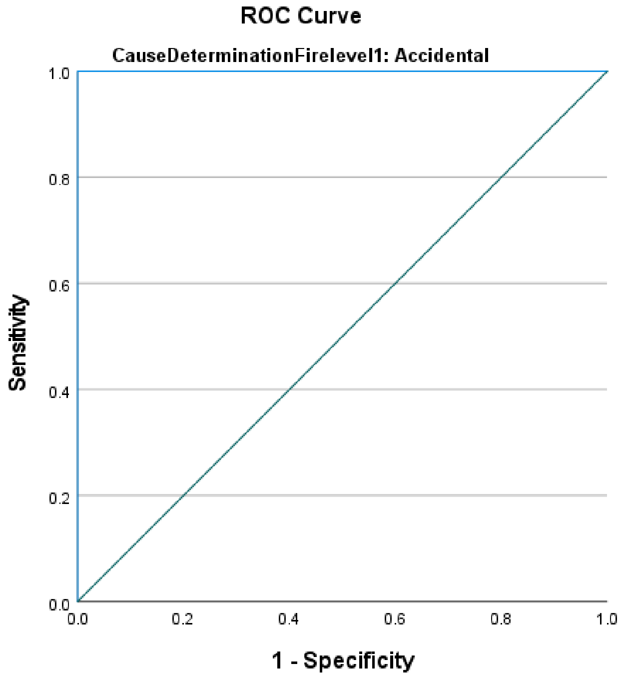


Table 106. Hosmer and Lemeshow Test			
Step	**Chi-square**	**df**	**Sig.**
1	.000	0	.

*Only one variable was included in the model.

Table 107. Preventable Fatality x Accidental Variables in the Equation								
Variable	**B**	**S.E.**	**Wald**	**df**	**Sig.**	**Exp(B)**	**95% CI Exp(B)**	
							Lower	**Upper**
Area of Origin=Kitchen, cooking area	-3.526	1.249	7.977	1	.005**	.029	.003	.340
Constant	2.833	1.029	7.581	1	.006**	17.000		

Statistical significance: ****p* <.001, ** *p* < .01, * *p* < .05

The logistic regression model was statistically significant ($X^2(1) = 11.722$, p<.001). There was only one variable included in the model. The model was had outstanding discrimination (ROC AUC = 1.000). The odds of preventable fatality in an accidental fire:

Area of Origin

- Decreased 0.03 times when the fire originated in a kitchen or cooking area compared to other areas of origin

10.4.2.2 Preventable Fatality x Deliberate

The model could not identify any variables in the equation.

10.4.2.3 Preventable Fatality x Undetermined

Table 108. Preventable Fatality x Undetermined Omnibus Tests of Model Coefficients				
		Chi-square	**df**	**Sig.**
Step 2	Step	4.462	1	.035

	Block	10.308	2	.006**
	Model	10.308	2	.006**

Table 109. Preventable Fatality x Undetermined Model Summary			
Step	**-2 Log likelihood**	**Cox & Snell R Square**	**Nagelkerke R Square**
2	35.246	.222	.331

Table 110. Preventable Fatality x Undetermined Classification Table					
			Predicted		
			Fatality		Percentage Correct
Observed			No	Yes	
Step 2	Fatality	No	4	6	40.0
		Yes	2	29	93.5
	Overall Percentage				80.5

*The cut value is .500

Table 111. Preventable Fatality x Undetermined ROC Curve				
Test Result Variable(s)				
Area	**Std. Error**	**Asymptotic Sig.**	**Asymptotic 95% Confidence Interval**	
			Lower Bound	**Upper Bound**
.997	.005	.000	.986	1.000

*A large area value indicates that the model has outstanding discrimination

Figure 91. Preventable Fatality x Undetermined ROC Curve

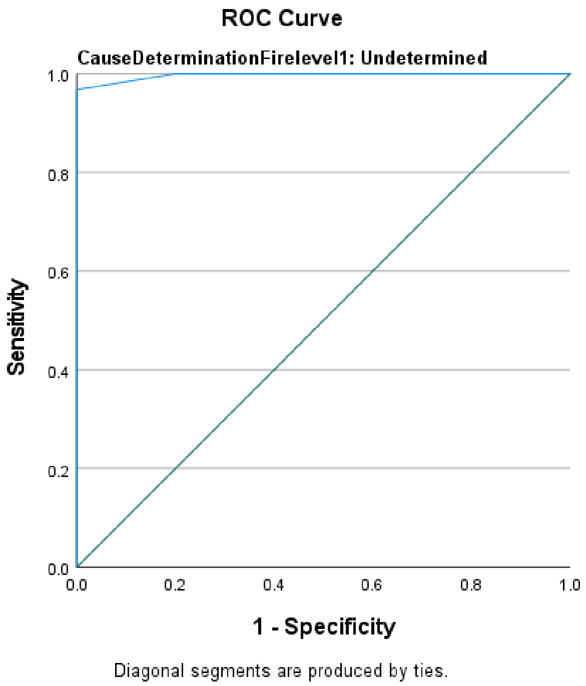


Table 112. Hosmer and Lemeshow Test			
Step	**Chi-square**	**df**	**Sig.**
2	.000	1	1.000

*A large *p* value indicates that the model is not a poor fit.

Table 113. Preventable Fatality x Undetermined Variables in the Equation							
Variable	**B**	**S.E.**	**Wald**	**df**	**Sig.**	**Exp(B)**	**95% CI Exp(B)**

							Lower	Upper
Region=MN	-2.159	1.019	4.491	1	.034*	.115	.016	.850
Confinement Collated=Beyond room	2.853	1.059	7.254	1	.007**	17.333	2.174	138.175
Constant	-.693	.866	.641	1	.423	.500		

Statistical significance: ****p* <.001, ** *p* < .01, * *p* < .05

The logistic regression model was statistically significant ($X^2(2) = 10.308$, p=.006). The model was not a poor fit ($p = 1.000$) and had outstanding discrimination (ROC AUC = .997). The odds of preventable fatality in an undetermined fire:

Region

- Decreased 0.12 times when the fire occurred in Metro North compared to other regions

Confinement

- Increased 17.3 times when the fire extended beyond the room of origin compared to confinement

10.4.3 Injury by cause determination

10.4.3.1 Injury x Accidental

Table 114. Injury x Accidental Omnibus Tests of Model Coefficients				
		Chi-square	**df**	**Sig.**
Step 53	Step	2.478	1	.115
	Block	1171.797	53	<.001***
	Model	1171.797	53	<.001***

Statistical significance: ****p* <.001, ** *p* < .01, * *p* < .05

Table 115. Injury x Accidental Model Summary			
Step	**-2 Log likelihood**	**Cox & Snell R Square**	**Nagelkerke R Square**
53	10068.778	.051	.129

Table 116. Injury x Accidental Classification Table					
			Predicted		
			Injury		Percentage Correct
Observed			No	Yes	
Step 53	Injury	No	20629	19	99.9
		Yes	1529	21	1.4
	Overall Percentage				93.0

*The cut value is .500

Table 117. Injury x Accidental ROC Curve				
Test Result Variable(s)				
Area	**Std. Error**	**Asymptotic Sig.**	**Asymptotic 95% Confidence Interval**	
			Lower Bound	**Upper Bound**
.740	.006	.000	.728	.752

*A moderate area value indicates that the model has acceptable discrimination

Figure 92. Injury x Accidental ROC Curve

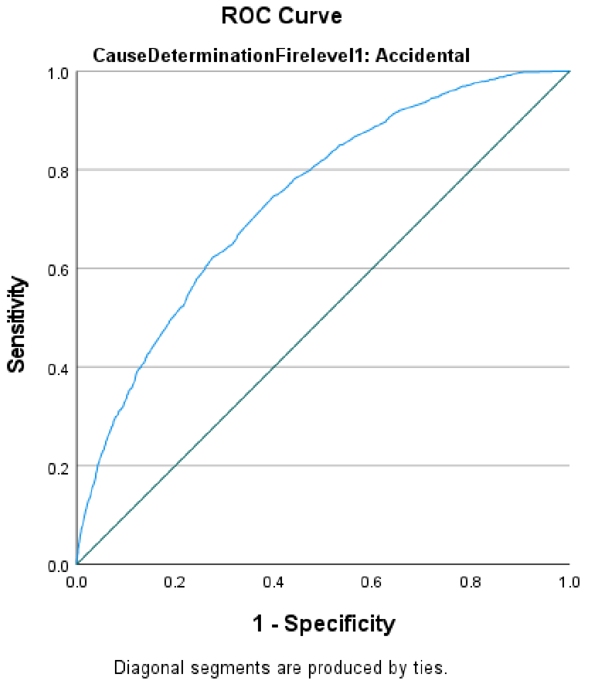


Table 118. Hosmer and Lemeshow Test			
Step	**Chi-square**	**df**	**Sig.**
53	12.704	8	.122

*A non-significant *p* value indicates that the model is not a poor fit.

Table 119. Injury x Accidental Variables in the Equation								
Variable	**B**	**S.E.**	**Wald**	**df**	**Sig.**	**Exp(B)**	**95% CI Exp(B) Lower**	**Upper**
Call Source=Call to Station	-.711	.244	8.515	1	.004**	.491	.305	.792
Call Source=ICEMS	.812	.121	44.859	1	<.001***	2.252	1.776	2.856
Alarms Detectors Operating=True	-.177	.066	7.313	1	.007**	.837	.736	.952
Type of Alarm=Infrared Detector	1.921	.920	4.360	1	.037*	6.827	1.125	41.424
Reason Alarm not Operating=Battery missing or disconnected (Battery only detector/alarm)	.479	.194	6.076	1	.014*	1.615	1.103	2.364
Reason Alarm not Operating=Fire not within designed range of detector/alarm	-.455	.123	13.578	1	<.001***	.635	.498	.808
Reason Alarm not Operating=Fire too small to operate	-.585	.147	15.912	1	<.001***	.557	.418	.743
Ignition Source=Candle, taper	.394	.130	9.217	1	.002**	1.483	1.150	1.913
Ignition Source=Cutting or	1.026	.230	19.973	1	<.001***	2.789	1.779	4.374

Welding or Heating torch								
Ignition Source=Hot ember, ash	-.640	.217	8.676	1	.003**	.527	.344	.807
Ignition Source=Re-kindle, re-ignition	-1.868	.589	10.049	1	.002**	.154	.049	.490
Ignition Source=Static discharge	1.619	.714	5.140	1	.023*	5.047	1.245	20.457
Material Ignited First=Alcohol	1.974	.892	4.896	1	.027*	7.203	1.253	41.402
Material Ignited First=Atomised, vaporised liquid	1.792	.514	12.130	1	<.001***	6.000	2.189	16.445
Material Ignited First=Audio/visual and entertainment - televisions, stereos, projectors, speakers, gaming consoles	23.098	40192.969	.000	1	1.000	10749054624.814	.000	.
Material Ignited First=Bedding, blanket, sheet, comforter	.727	.144	25.462	1	<.001***	2.069	1.560	2.745
Material Ignited First=Cleaning supplies and products	1.030	.407	6.406	1	.011*	2.801	1.262	6.217
Material Ignited First=Clothing on a person worn at the time of fire	2.569	.912	7.933	1	.005**	13.055	2.185	78.015
Material Ignited First=Fixed deep fat fryer	.979	.346	7.979	1	.005**	2.661	1.349	5.247
Material Ignited First=Fixed stationary surface unit	.999	.351	8.099	1	.004**	2.714	1.365	5.399
Material Ignited First=Gas lines	.880	.346	6.465	1	.011*	2.412	1.224	4.755
Material Ignited First=Gas outlet	1.274	.400	10.143	1	.001**	3.573	1.632	7.825
Material Ignited First=Heat-treating equipment	1.547	.641	5.823	1	.016*	4.697	1.337	16.500
Material Ignited First=LPG	1.408	.233	36.403	1	<.001***	4.088	2.588	6.460
Material Ignited First=Natural gas	1.176	.465	6.398	1	.011*	3.241	1.303	8.060
Material Ignited First=Other Flammable Liquid	1.226	.271	20.514	1	<.001***	3.409	2.005	5.796
Material Ignited First=Other Gas	1.175	.512	5.261	1	.022*	3.237	1.186	8.831
Material Ignited First=Petrol	1.709	.276	38.337	1	<.001***	5.524	3.216	9.488
Material Ignited First=Petroleum fuelled engine	1.948	.491	15.758	1	<.001***	7.013	2.681	18.347

Material Ignited First=Portable gas cooker	1.131	.288	15.378	1	<.001***	3.099	1.761	5.455
Material Ignited First=Supplies or stock in basket, barrel	3.103	1.420	4.775	1	.029*	22.273	1.377	360.243
Material Ignited First=Washing machine	.914	.299	9.379	1	.002**	2.495	1.390	4.479
Area of Origin=Bedroom/Sleeping area for under five persons	.756	.101	55.966	1	<.001***	2.130	1.747	2.597
Area of Origin=Ceiling cavity, roof space	-1.084	.276	15.395	1	<.001***	.338	.197	.581
Area of Origin=Chimney/flue	-1.242	.325	14.633	1	<.001***	.289	.153	.546
Area of Origin=Electricity, Gas, Water areas, etc	-1.257	.239	27.596	1	<.001***	.285	.178	.455
Area of Origin=Exterior roof surface	-18.167	3103.281	.000	1	.995	.000	.000	.
Area of Origin=Lawn, field, open area.	-.843	.295	8.155	1	.004**	.430	.241	.768
Area of Origin=Lounge Room, Family Room, Living Area	.541	.112	23.237	1	<.001***	1.718	1.379	2.142
Area of Origin=Office, Study	.684	.290	5.567	1	.018*	1.982	1.123	3.497
Area of Origin=On or near highway, roadway, street, public way, parking lot	-2.569	1.010	6.466	1	.011*	.077	.011	.555
Building code=Class 1a (attached)	.295	.086	11.916	1	<.001***	1.343	1.136	1.589
Building code=Class 1a (detached)	.517	.070	54.129	1	<.001***	1.677	1.461	1.925
Building code=Class 7a	1.000	.424	5.574	1	.018*	2.719	1.185	6.240
Type of Owner=State Government	.240	.080	8.987	1	.003**	1.271	1.087	1.487
Mosaic Type=Unknown/Not applicable	-.215	.069	9.593	1	.002**	.807	.704	.924
Remote Index =Outer Regional Australia	-.546	.157	12.039	1	<.001***	.579	.425	.788
SEIFA Decile=1.0	.280	.081	12.080	1	<.001***	1.324	1.130	1.550
Mental Impairment	***.678	.119	32.403	1	<.001***	1.970	1.560	2.488
Confinement Collated=Beyond room	.395	.075	27.588	1	<.001***	1.484	1.281	1.720
Confinement Collated=Not assigned	-.641	.154	17.298	1	<.001***	.527	.390	.713
Evacuation	.357	.058	37.443	1	<.001***	1.429	1.275	1.602
Constant	-2.991	.085	1229.396	1	<.001***	.050		

Statistical significance: ****p* <.001, ** *p* < .01, * *p* < .05

The logistic regression model was statistically significant ($X^2(53) = 1171.797$, p<.001). The model was not a poor fit (*p* = .122) and had acceptable discrimination (ROC AUC = .740). The odds of injury in an accidental fire:

Response

- Increased 2.3 times when the call source was an ICEMS (inter-agency CAD electronic messaging system)
- Decreased 0.49 times when the call source was a call to station

Each compared to other call sources.

Human Behaviour

- Increased 2.0 times when there was evidence of mental impairment compared to no mental impairment

Mosaic Type

- Decreased 0.81 times when the fire occurred in Mosaic Type unknown compared to other Mosaic Types

Remoteness

- Decreased 0.58 times when the fire occurred in an Outer Regional Area compared to other remoteness structures

SEIFA Decile

- Increased 1.3 times when the fire occurred in SEIFA Decile 1 compared to other SEIFA Deciles

Smoke Alarms

- Decreased 0.84 times when alarms were operating compared to not operating
- Increased 6.9 times when the alarm was an infrared detector compared to other smoke alarm types

- Increased 1.6 times when the alarm did not operate because the battery was missing or disconnected
- Decreased 0.64 times when the alarm did not operate because the fire was not within the designed range of the detector
- Decreased 0.56 times when the alarm did not operate because the fire was too small

Each compared to other reasons for failure.

Building Class

- Increased 1.3 times when the fire occurred in a Class 1a (attached) building
- Increased 1.7 times when the fire occurred in a Class 1a (detached) building
- Increased 2.7 times when the fire occurred in a Class 7a (carpark) building

Each compared to other building classes.

Type of Owner

- Increased 1.3 times when the fire occurred in a property owned by the State Government compared to other types of owners

Ignition Source

- Increased 1.5 times when the fire was ignited by a candle or taper
- Increased 2.8 times when the fire was ignited by a cutting, welding, or heating torch
- Decreased 0.53 times when the fire was ignited by hot ember or ash
- Decreased 0.15 times when the fire was ignited by a re-kindle or re-ignition

- Increased 5.0 times when the fire was ignited by static discharge

Each compared to other ignition sources.

Material Ignited First

- Increased 7.2 times when the material ignited first was alcohol
- Increased 6.0 times when the material ignited first was an atomised, vapourised liquid
- Increased 2.1 times when the material ignited first was bedding, blanket, sheet, or comforter
- Increased 2.8 times when the material ignited first was cleaning supplies and products
- Increased 13.1 times when the material ignited first was clothing on a person worn at the time of the fire
- Increased 2.7 times when the material ignited first was a fixed deep fat fryer
- Increased 2.7 times when the material ignited first was fixed stationary surface unit
- Increased 2.4 times when the material ignited first was gas lines
- Increased 3.6 times when the material ignited first was a gas outlet
- Increased 4.7 times when the material ignited first was heat treating equipment
- Increased 4.1 times when the material ignited first was LPG
- Increased 3.2 times when the material ignited first was natural gas
- Increased 3.4 times when the material ignited first was other flammable liquid
- Increased 5.5 times when the material ignited first was petrol
- Increased 7.0 times when the material ignited first was petroleum fuelled engine
- Increased 3.1 times when the material ignited first was a portable gas cooker
- Increased 22.3 times when the material ignited first was supplies or stock in a basket or barrel
- Increased 2.5 times when the material ignited first was a washing machine

Each compared to other materials ignited first.

Area of Origin

- Increased 2.1 times when the fire originated in a bedroom for less than five persons
- Decreased 0.34 times when the fire originated in a ceiling cavity, roof space
- Decreased 0.29 times when the fire originated in a chimney or flue
- Decreased 0.29 times when the fire originated in an electricity, gas, or water area
- Decreased 0.43 times when the fire originated in a lawn, field, or open area
- Increased 1.7 times when the fire originated in a lounge or living room
- Increased 2.0 times when the fire originated in an office or study
- Decreased 0.08 times when the fire originated on a highway, roadway, public way

Each compared to other areas of origin.

Other Outcomes

- Increased 1.5 times when the fire extended beyond the room of origin compared to confinement
- Increased 1.4 times when evacuations occurred compared to no evacuations

10.4.3.2 Injury x Deliberate

Table 120. Injury x Deliberate Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 26	Step	2.656	1	.103
	Block	369.834	26	<.001***
	Model	369.834	26	<.001***

Statistical significance: ****p* <.001, ** *p* < .01, * *p* < .05

Table 121. Injury x Deliberate Model Summary			
Step	**-2 Log likelihood**	**Cox & Snell R Square**	**Nagelkerke R Square**
26	1129.763	.076	.277

Table 122. Injury x Deliberate Classification Table					
			Predicted		
			Injury		Percentage Correct
Observed			No	Yes	
Step 26	Injury	No	4494	4	99.9
		Yes	167	9	5.1
	Overall Percentage				96.3

*The cut value is .500

Table 123. Injury x Deliberate ROC Curve				
Test Result Variable(s)				
Area	**Std. Error**	**Asymptotic Sig.**	**Asymptotic 95% Confidence Interval**	
			Lower Bound	**Upper Bound**
.826	.013	.000	.800	.853

*A moderate-large area value indicates that the model has excellent discrimination

Figure 93. Injury x Deliberate ROC Curve

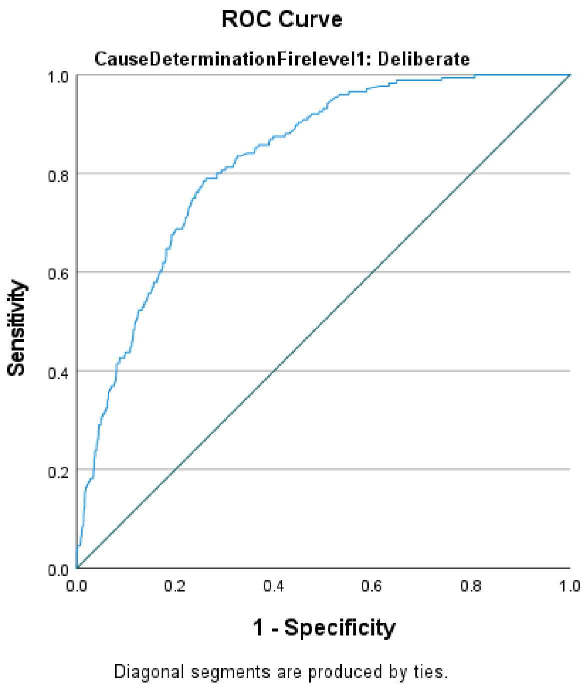


Table 124. Hosmer and Lemeshow Test			
Step	**Chi-square**	**df**	**Sig.**
26	7.438	6	.282

*A large *p* value indicates that the model is not a poor fit.

Table 125. Injury x Deliberate Variables in the Equation								
Variable	**B**	**S.E.**	**Wald**	**df**	**Sig.**	**Exp(B)**	**95% CI Exp(B)**	
							Lower	**Upper**
Call Source=ICEMS	.689	.217	10.108	1	.001**	1.991	1.302	3.045

Alarms Detectors Operating=Not assigned	-1.072	.196	29.873	1	<.001***	.342	.233	.503
Ignition Source=Cutting or Welding or Heating torch	4.377	1.244	12.388	1	<.001***	79.623	6.957	911.314
Material Ignited First=Agricultural product	2.499	1.089	5.268	1	.022*	12.174	1.441	102.878
Material Ignited First=Atomised, vaporised liquid	3.485	.750	21.577	1	<.001***	32.611	7.496	141.879
Material Ignited First=Bedding, blanket, sheet, comforter	.988	.262	14.167	1	<.001***	2.685	1.605	4.491
Material Ignited First=Charger (device), battery charger	24.628	40192.969	.000	1	1.000	49614402767.800	.000	.
Material Ignited First=Clothing not on a person	1.010	.322	9.833	1	.002**	2.744	1.460	5.158
Material Ignited First=Clothing on a person worn at the time of fire	3.688	1.217	9.181	1	.002**	39.953	3.678	434.022
Material Ignited First=Electrical equipment, domestic appliance	2.732	1.311	4.345	1	.037*	15.370	1.177	200.632
Material Ignited First=Fixed, stationary oven	2.644	1.188	4.951	1	.026*	14.074	1.370	144.533
Material Ignited First=Insulation within wall, partition, or floor/ceiling space	2.631	1.134	5.381	1	.020*	13.881	1.504	128.130
Material Ignited First=Other (other fuel)	1.507	.477	9.983	1	.002**	4.514	1.772	11.498
Material Ignited First=Other (soft goods, wearing apparel)	2.482	.810	9.395	1	.002**	11.963	2.447	58.484
Material Ignited First=Other (special form)	2.670	1.270	4.419	1	.036*	14.437	1.198	174.014
Material Ignited First=Supplies or stock in box, carton, bag	2.439	1.220	3.997	1	.046*	11.457	1.049	125.109
Material Ignited First=Toy, game	2.907	1.160	6.281	1	.012*	18.303	1.884	177.782
Area of Origin=Bedroom/Sleeping area for under five persons	.538	.207	6.746	1	.009**	1.713	1.141	2.572
Area of Origin=Rubbish tip	2.521	.828	9.266	1	.002**	12.443	2.454	63.084

Building code=#	-1.663	.612	7.374	1	.007**	.190	.057	.630
Mosaic Type=J32	1.169	.430	7.379	1	.007**	3.220	1.385	7.487
Mosaic Type=K35	1.674	.703	5.668	1	.017*	5.331	1.344	21.143
Mosaic Type=L39	1.220	.315	14.955	1	<.001***	3.387	1.825	6.284
Mosaic Type=M43	1.502	.481	9.766	1	.002**	4.490	1.751	11.517
Mental Impairment	.606	.203	8.939	1	.003**	1.834	1.232	2.729
Evacuations	1.394	.183	58.355	1	<.001***	4.033	2.820	5.767
Constant	-3.747	.176	451.424	1	<.001***	.024		

Statistical significance: ****p* <.001, ** *p* < .01, * *p* < .05

The logistic regression model was statistically significant ($X^2(26) = 369.834$, p<.001). The model was not a poor fit (*p* = .282) and had excellent discrimination (ROC AUC = .826). The odds of injury in a deliberate fire:

Response
- Increased 2.0 times when the call source was an ICEMS (inter-agency CAD electronic messaging system) compared to other call sources

Human Behaviour
- Increased 1.8 times when there was evidence of mental impairment compared to no mental impairment

Mosaic Type
- Increased 3.2 times when the fire occurred in Mosaic Type J32
- Increased 5.3 times when the fire occurred in Mosaic Type K35
- Increased 3.4 times when the fire occurred in Mosaic Type L39
- Increased 4.5 times when the fire occurred in Mosaic Type M43

Each compared to other Mosaic Types.

Smoke Alarms
- Decreased 0.34 times when alarm operation was unknown compared to known operation

Building Class
- Decreased 0.19 times when the fire occurred in an unknown class compared to other building classes

Ignition Source
- Increased 79.6 times when the fire was ignited by a cutting, welding, or heating torch compared to other ignition sources

Material Ignited First
- Increased 12.2 times when the material ignited first was an agricultural product
- Increased 32.6 times when the material ignited first was an atomised, vapourised liquid
- Increased 2.7 times when the material ignited first was bedding, blanket, sheet, or comforter
- Increased 2.7 times when the material ignited first was clothing not on a person
- Increased 40.0 times when the material ignited first was clothing on a person worn at the time of the fire
- Increased 15.4 times when the material ignited first was electrical equipment, domestic appliance
- Increased 14.1 times when the material ignited first was fixed stationary oven

- Increased 13.9 times when the material ignited first was insulation within a wall or space
- Increased 4.5 times when the material ignited first was other (other fuel)
- Increased 12.0 times when the material ignited first was other (soft goods, wearing apparel)
- Increased 14.4 times when the material ignited first was other (special form)
- Increased 11.5 times when the material ignited first was supplies or stock in a box, carton, or bag
- Increased 18.3 times when the material ignited first was a toy or game

Each compared to other materials ignited first.

Area of Origin

- Increased 1.7 times when the fire originated in a bedroom for less than five persons
- Increased 12.4 times when the fire originated in a rubbish tip

Each compared to other areas of origin.

Other Outcomes

- Increased 4.0 times when evacuations occurred compared to no evacuations

10.4.3.3 Injury x Undetermined

Table 126. Injury x Undetermined Omnibus Tests of Model Coefficients

		Chi-square	**df**	**Sig.**
Step 27	Step	2.674	1	.102
	Block	296.049	27	<.001***
	Model	296.049	27	<.001***

Statistical significance: ****p* <.001, ** *p* < .01, * *p* < .05

Table 127. Injury x Undetermined Model Summary

Step	**-2 Log likelihood**	**Cox & Snell R Square**	**Nagelkerke R Square**
27	1116.426	.085	.246

Table 128. Injury x Undetermined Classification Table

			Predicted		
			Injury		Percentage Correct
Observed			No	Yes	
Step 27	Injury	No	3147	6	99.8
		Yes	166	16	8.8
	Overall Percentage				94.8

*The cut value is .500

Table 129. Injury x Undetermined ROC Curve

Test Result Variable(s)				
Area	**Std. Error**	**Asymptotic Sig.**	**Asymptotic 95% Confidence Interval**	
			Lower Bound	**Upper Bound**
.790	.015	.000	.761	.819

*A moderate area value indicates that the model has acceptable discrimination

Figure 94. Injury x Undetermined ROC Curve

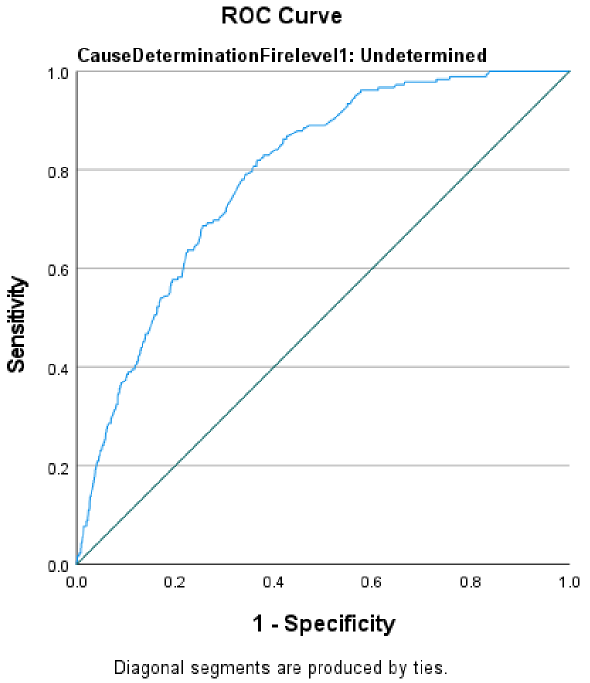


Table 130. Hosmer and Lemeshow Test			
Step	**Chi-square**	**df**	**Sig.**
27	2.652	7	.915

*A large *p* value indicates that the model is not a poor fit.

Table 131. Injury x Undetermined Variables in the Equation								
Variable	**B**	**S.E.**	**Wald**	**df**	**Sig.**	**Exp(B)**	**95% CI Exp(B) Lower**	**Upper**
Alarms Detectors Operating=True	.605	.175	12.003	1	<.001***	1.831	1.300	2.577
Reason Alarm not Operating=Battery discharge or dead (Battery only detector/alarm)	2.025	.646	9.843	1	.002**	7.578	2.138	26.855
Ignition Source=Form of heat of ignition undetermined	.938	.238	15.477	1	<.001***	2.554	1.601	4.075
Ignition Source=Lightning discharge	25.028	40192.969	.000	1	1.000	74062496654.727	.000	.
Material Ignited First=Alcohol	4.122	1.655	6.206	1	.013*	61.694	2.409	1580.275
Material Ignited First=Battery (starter lights ignition, lead-acid)	25.710	40192.969	.000	1	.999	146470226554.952	.000	.
Material Ignited First=Chemical process equipment	3.049	1.234	6.109	1	.013*	21.093	1.880	236.695
Material Ignited First=Cleaning supplies and products	2.827	1.524	3.443	1	.064	16.901	.853	334.909

Material Ignited First=Clothing on a person worn at the time of fire	24.226	40192.969	.000	1	1.000	33201057626.978	.000	.
Material Ignited First=Dust, fibre, lint	2.669	1.455	3.365	1	.067	14.421	.833	249.606
Material Ignited First=Electrical system component, wiring, or outlet	1.041	.420	6.133	1	.013*	2.832	1.242	6.456
Material Ignited First=Electronic devices, battery powered	2.732	.907	9.066	1	.003**	15.368	2.595	91.001
Material Ignited First=Furnace, oven, kiln	24.830	40192.969	.000	1	1.000	60777749070.755	.000	.
Material Ignited First=Irons	3.023	1.442	4.395	1	.036*	20.552	1.218	346.898
Material Ignited First=LPG	3.060	1.643	3.470	1	.062	21.335	.852	533.942
Material Ignited First=Other (general form)	1.590	.662	5.772	1	.016*	4.905	1.340	17.950
Material Ignited First=Other electric motor driven equipment	2.797	1.049	7.101	1	.008**	16.388	2.095	128.174
Material Ignited First=Small cooking appliance - toasters, pie makers, waffle irons	3.463	1.473	5.526	1	.019*	31.905	1.778	572.378
Mosaic Type=D12	1.064	.443	5.762	1	.016*	2.899	1.216	6.914
Remote Index =Inner Regional Australia	1.092	.495	4.874	1	.027*	2.982	1.130	7.864
Remote Index =Major Cities of Australia	1.807	.471	14.714	1	<.001***	6.090	2.419	15.330
SEIFA Decile=3.0	.642	.266	5.844	1	.016*	1.901	1.129	3.201
Mental Impairment	1.762	.424	17.271	1	<.001***	5.821	2.536	13.361
Confinement Collated=To room	1.971	.766	6.615	1	.010*	7.175	1.598	32.213
Confinement Collated=Beyond room	2.724	.758	12.924	1	<.001***	15.246	3.452	67.325
Evacuations	.880	.173	25.947	1	<.001***	2.410	1.718	3.381
Fatalities	1.808	.370	23.892	1	<.001***	6.099	2.954	12.593
Constant	-8.285	.900	84.738	1	<.001***	.000		

Statistical significance: ****p* <.001, ** *p* < .01, * *p* < .05

The logistic regression model was statistically significant ($X^2(27) = 296.049$, p<.001). The model was not a poor fit (*p* = .915) and had acceptable discrimination (ROC AUC = .790). The odds of injury in an undetermined fire:

Human Behaviour

- Increased 5.8 times when there was evidence of mental impairment compared to no mental impairment

Mosaic Type

- Increased 2.9 times when the fire occurred in Mosaic Type D12 compared to other Mosaic Types

Remoteness
- Increased 3.0 times when the fire occurred in an Inner Regional area
- Increased 6.1 times when the fire occurred in a Major City

Each compared to other remoteness structures.

SEIFA Decile
- Increased 1.9 times when the fire occurred in SEIFA Decile 3 compared to other SEIFA Deciles

Smoke Alarms
- Increased 1.8 times when alarms were operating compared to not operating
- Increased 7.6 times when alarms failed to operate because the battery was discharged or dead compared to other reasons for failure

Ignition Source
- Increased 2.6 times when the fire was ignited by a form of heat ignition undetermined compared to other ignition sources

Material Ignited First
- Increased 61.7 times when the material ignited first was alcohol
- Increased 21.1 times when the material ignited first was chemical process equipment
- Increased 2.8 times when the material ignited first was electrical system, component, wiring, or outlet
- Increased 15.4 times when the material ignited first was electronic devices, battery powered
- Increased 20.6 times when the material ignited first was irons
- Increased 4.9 times when the material ignited first was other (general form)
- Increased 16.4 times when the material ignited first was other electric motor driven equipment
- Increased 31.9 times when the material ignited first was small cooking appliance

Each compared to other materials ignited first.

Other Outcomes
- Increased 7.2 times when the fire was confined to the room of origin compared to fire extension
- Increased 15.2 times when the fire extended beyond the room of origin compared to confinement
- Increased 2.4 times when evacuations occurred compared to no evacuation
- Increased 6.1 times when fatality occurred compared to no fatality

10.4.4 Evacuation by cause determination

10.4.4.1 Evacuation x Accidental

Table 132. Evacuation x Accidental Omnibus Tests of Model Coefficients

		Chi-square	**df**	**Sig.**
Step 87	Step	3.748	1	.053
	Block	2336.058	87	.000***
	Model	2336.058	87	.000***

Statistical significance: ***p <.001, ** p < .01, * p < .05

Table 133. Evacuation x Accidental Model Summary			
Step	**-2 Log likelihood**	**Cox & Snell R Square**	**Nagelkerke R Square**
87	23114.828	.100	.146

Table 134. Evacuation x Accidental Classification Table					
			Predicted		
			Evacuation		Percentage Correct
Observed			No	Yes	
Step 87	Evacuation	No	15809	613	96.3
		Yes	4973	803	13.9
	Overall Percentage				74.8

*The cut value is .500

Table 135. Evacuation x Accidental ROC Curve				
Test Result Variable(s)				
Area	**Std. Error**	**Asymptotic Sig.**	**Asymptotic 95% Confidence Interval**	
			Lower Bound	**Upper Bound**
.695	.004	.000	.688	.703

*A moderate area value indicates that the model has acceptable discrimination

Figure 95. Evacuation x Accidental ROC Curve

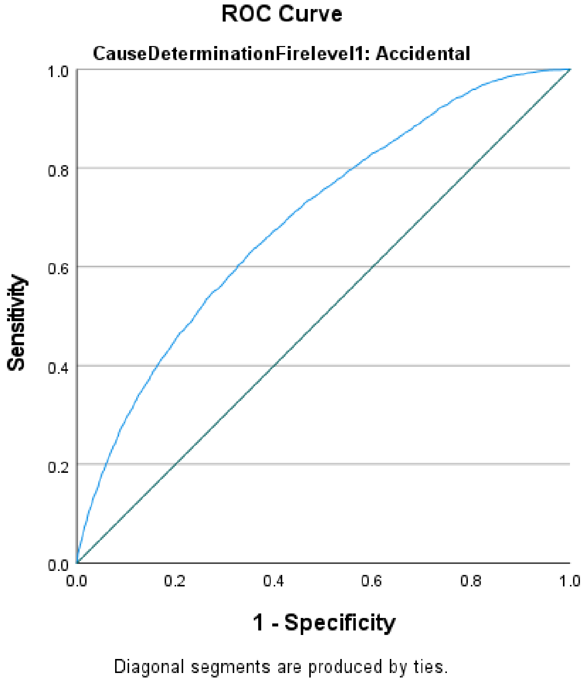


Table 136. Hosmer and Lemeshow Test			
Step	**Chi-square**	**df**	**Sig.**
87	9.390	8	.310

*A non-significant *p* value indicates that the model is not a poor fit.

Table 137. Evacuation x Accidental Variables in the Equation								
Variable	**B**	**S.E.**	**Wald**	**df**	**Sig.**	**Exp(B)**	**95% CI Exp(B)**	
							Lower	**Upper**
Call Source=AFASP	.154	.072	4.566	1	.033*	1.167	1.013	1.344

Call Source=Call to Station	-.793	.120	43.692	1	<.001***	.452	.358	.572
Call Source=ICEMS	-.317	.102	9.664	1	.002**	.728	.596	.889
Time of Week=Weekend	-.087	.036	5.988	1	.014*	.917	.855	.983
Alarms Detectors Operating=Not assigned	-.486	.051	91.712	1	<.001***	.615	.557	.679
Type of Alarm=Smoke detector	-.166	.038	18.671	1	<.001***	.847	.785	.913
Type of Alarm=Sprinkler system	.370	.192	3.733	1	.053	1.448	.995	2.108
Reason Alarm not Operating=Battery discharge or dead (Battery only detector/alarm)	.529	.185	8.141	1	.004*	1.697	1.180	2.441
Reason Alarm not Operating=Battery missing or disconnected (Battery only detector/alarm)	.595	.140	18.055	1	<.001***	1.814	1.378	2.387
Reason Alarm not Operating=Defective	.511	.112	20.995	1	<.001***	1.668	1.340	2.075
Reason Alarm not Operating=Fire too small to operate	-.459	.073	39.625	1	<.001***	.632	.548	.729
Reason Alarm not Operating=Hard wire power failure, shutoff or disconnect - back up battery discharged/dead	.585	.262	4.990	1	.026*	1.795	1.074	2.999
Reason Alarm not Operating=Hard wire power failure, shutoff or disconnect - back up battery missing	.574	.272	4.463	1	.035*	1.775	1.042	3.023
Ignition Source=Heat from electrical equipment, overloaded	.201	.065	9.666	1	.002**	1.223	1.077	1.388
Ignition Source=Heat from improperly operating electrical equipment	.159	.069	5.346	1	.021*	1.173	1.025	1.342
Ignition Source=Hot ember, ash	-.270	.107	6.302	1	.012*	.764	.619	.943
Ignition Source=Molten, hot material	.410	.188	4.768	1	.029*	1.507	1.043	2.178
Ignition Source=Open fire, Camp fire and bonfire, Rubbish fires, Burn-off Fires, Windows/Slash/Fire	-1.008	.334	9.109	1	.003**	.365	.190	.702
Ignition Source=Re-kindle, re-ignition	-2.009	.332	36.567	1	<.001***	.134	.070	.257

Ignition Source=Suns heat, unusually concentrated	-1.301	.631	4.257	1	.039*	.272	.079	.937
Material Ignited First=Air conditioning unit - fixed, stationary local	.346	.165	4.394	1	.036*	1.413	1.023	1.953
Material Ignited First=Cooking materials, food stuff	-.378	.041	83.936	1	<.001***	.685	.632	.743
Material Ignited First=Dryer	.591	.197	9.019	1	.003**	1.807	1.228	2.657
Material Ignited First=Electrical Wiring - fixed	-.581	.252	5.314	1	.021*	.559	.341	.917
Material Ignited First=Fence, pole, sign	-1.218	.352	11.944	1	<.001***	.296	.148	.590
Material Ignited First=Fixed fans (cooling fans, exhaust fans)	.451	.202	4.993	1	.025*	1.570	1.057	2.332
Material Ignited First=Floor covering, surface.	-.974	.347	7.852	1	.005**	.378	.191	.746
Material Ignited First=Grass, bush, and forests, whether growing or dead	-.517	.231	5.029	1	.025*	.596	.379	.937
Material Ignited First=Inverters, converters, rectifiers, capacitors	-1.830	.736	6.182	1	.013*	.160	.038	.679
Material Ignited First=LPG	.531	.203	6.831	1	.009**	1.701	1.142	2.532
Material Ignited First=Local refrigerator unit - Fixed, stationary	.718	.276	6.767	1	.009**	2.050	1.194	3.522
Material Ignited First=Not assigned	-.737	.126	34.267	1	<.001***	.479	.374	.613
Material Ignited First=Other (appliances, home equipment)	-.563	.230	5.983	1	.014*	.569	.363	.894
Material Ignited First=Other (books, papers, recreational material, decorations)	.531	.190	7.776	1	.005**	1.700	1.171	2.468
Material Ignited First=Other (other object)	-.440	.208	4.462	1	.035*	.644	.428	.969
Material Ignited First=Other (structural component, finish)	-1.026	.389	6.953	1	.008**	.359	.167	.769
Material Ignited First=Outdoor cooking equipment	-.523	.266	3.865	1	.049*	.593	.352	.998
Material Ignited First=Rubbish, trash,	-.253	.098	6.699	1	.010*	.776	.641	.940

waste, chimney waste, vent waste								
Material Ignited First=Sofa, chair, seating	.374	.156	5.788	1	.016*	1.454	1.072	1.972
Material Ignited First=Solid Fuel	-.605	.221	7.474	1	.006**	.546	.354	.843
Material Ignited First=Supplies or stock in box, carton, bag	.633	.285	4.941	1	.026*	1.883	1.078	3.291
Material Ignited First=Undetermined	-.349	.086	16.526	1	<.001***	.706	.597	.835
Area of Origin=Bathroom, Lavatory, locker room, cloakroom	.337	.109	9.479	1	.002**	1.401	1.130	1.736
Area of Origin=Bedroom/Sleeping area for under five persons	.623	.070	78.679	1	<.001***	1.865	1.625	2.141
Area of Origin=Ceiling cavity, roof space	.336	.097	11.996	1	<.001***	1.400	1.157	1.693
Area of Origin=Chimney/flue	.222	.103	4.635	1	.031*	1.249	1.020	1.529
Area of Origin=Chute and conveyors	.990	.307	10.416	1	.001**	2.692	1.475	4.913
Area of Origin=Court, terrace, patio	-.450	.122	13.658	1	<.001***	.638	.502	.810
Area of Origin=Duct.	.713	.201	12.581	1	<.001***	2.041	1.376	3.026
Area of Origin=Fire stairway	23.188	40192.969	.000	1	1.000	11758205336.701	.000	.
Area of Origin=Garage, Workshop	.304	.082	13.605	1	<.001***	1.355	1.153	1.592
Area of Origin=Laboratory	1.307	.486	7.230	1	.007**	3.694	1.425	9.573
Area of Origin=Lawn, field, open area.	-.776	.198	15.377	1	<.001***	.460	.312	.678
Area of Origin=On or near highway, roadway, street, public way, parking lot	-1.217	.351	12.063	1	<.001***	.296	.149	.588
Area of Origin=Process, manufacturing area	.397	.188	4.459	1	.035*	1.487	1.029	2.149
Area of Origin=Recreational Area	-.938	.316	8.800	1	.003**	.391	.211	.727
Area of Origin=Storage area, Greater than 2000 sqm	.849	.393	4.669	1	.031*	2.336	1.082	5.044
Building code=#	-.777	.113	47.490	1	<.001***	.460	.368	.573
Building code=Class 10a	-.612	.145	17.758	1	<.001***	.542	.408	.721
Building code=Class 3	.349	.117	8.908	1	.003**	1.417	1.127	1.782
Building code=Class 5	.428	.126	11.506	1	<.001***	1.534	1.198	1.965

Building code=Class 6	.280	.067	17.352	1	<.001***	1.323	1.160	1.509
Building code=Class 8	.379	.127	8.930	1	.003**	1.461	1.139	1.874
Building code=Class 9b	.638	.103	38.035	1	<.001***	1.893	1.545	2.318
Type of Owner=Private	.128	.049	6.937	1	.008**	1.137	1.033	1.250
Region=ME	.184	.041	19.898	1	<.001***	1.203	1.109	1.304
Region=MW	.090	.045	3.905	1	.048*	1.094	1.001	1.196
Region=RN	.181	.065	7.727	1	.005**	1.199	1.055	1.362
Region=RW	.512	.082	39.291	1	<.001***	1.669	1.422	1.959
Mosaic Type=B05	.446	.160	7.800	1	.005**	1.563	1.142	2.138
Mosaic Type=C09	-.426	.198	4.650	1	.031*	.653	.443	.962
Mosaic Type=D11	-.551	.244	5.093	1	.024*	.576	.357	.930
Mosaic Type=G21	.293	.100	8.581	1	.003**	1.340	1.102	1.630
Mosaic Type=H26	.173	.085	4.150	1	.042*	1.189	1.007	1.404
Mosaic Type=K35	.329	.167	3.879	1	.049*	1.389	1.002	1.927
Mosaic Type=N50	-1.431	.531	7.266	1	.007**	.239	.084	.677
Remote Index =Outer Regional Australia	-.712	.095	56.367	1	<.001***	.491	.408	.591
Remote Index =Remote Australia	-1.292	.296	19.008	1	<.001***	.275	.154	.491
Remote Index =Very Remote Australia	-20.721	7754.260	.000	1	.998	.000	.000	.
Time of Day=Day	-.135	.035	14.627	1	<.001***	.873	.815	.936
SEIFA Decile=6.0	-.107	.049	4.719	1	.030*	.899	.816	.990
Cultural	.406	.177	5.242	1	.022*	1.500	1.060	2.123
Hoarding	.657	.187	12.383	1	<.001***	1.929	1.338	2.780
Mental Impairment	.325	.093	12.262	1	<.001***	1.383	1.154	1.659
Confinement Collated=Beyond room	.622	.051	148.831	1	<.001***	1.863	1.685	2.058
Confinement Collated=Not assigned	-.492	.086	32.929	1	<.001***	.611	.517	.723
Injuries	.337	.059	32.736	1	<.001***	1.401	1.248	1.573
Constant	-.863	.068	159.641	1	<.001***	.422		

Statistical significance: ****p* <.001, ** *p* < .01, * *p* < .05

The logistic regression model was statistically significant ($X^2(87) = 2336.058$, p=.000). The model was not a poor fit (*p* = .310) and had acceptable discrimination (ROC AUC = .695). The odds of evacuation in an accidental fire:

Response

- Increased 1.2 times when the call source was an AFA (Automatic Fire Alarm)
- Decreased 0.45 times when the call source was a call to station
- Decreased 0.73 times when the call source was an ICEMS

Each compared to other call sources

Temporal

- Decreased 0.92 times when the fire occurred on a weekend compared to a weekday
- Decreased 0.87 times when the fire occurred during the day compared to during the night

Human Behaviour

- Increased 1.9 times when there was evidence of hoarding compared to no hoarding

- Increased 1.4 times when there was evidence of mental impairment compared to no mental impairment
- Increased 1.5 times when there was evidence of cultural practices compared to no cultural practices

Mosaic Type
- Increased 1.6 times when the fire occurred in Mosaic Type B05
- Decreased 0.65 times when the fire occurred in Mosaic Type C09
- Decreased 0.58 times when the fire occurred in Mosaic Type D11
- Increased 1.3 times when the fire occurred in Mosaic Type G21
- Increased 1.2 times when the fire occurred in Mosaic Type H26
- Increased 1.4 times when the fire occurred in Mosaic Type K35
- Decreased 0.24 times when the fire occurred in Mosaic Type N50

Each compared to other Mosaic Types.

Region
- Increased 1.2 times when the fire occurred in Metro East
- Increased 1.1 times when the fire occurred in Metro West
- Increased 1.2 times when the fire occurred in Regional North
- Increased 1.7 times when the fire occurred in Regional West

Each compared to other regions.

Remoteness
- Decreased 0.49 times when the fire occurred in an Outer Regional Area
- Decreased 0.28 times when the fire occurred in a Remote Area

Each compared to other remoteness structures.

SEIFA Decile
- Decreased 0.90 times when the fire occurred in SEIFA Decile 6 compared to other SEIFA Deciles.

Smoke Alarms
- Decreased 0.62 times when alarm operation was not assigned compared to assigned operation
- Decreased 0.85 when the type of alarm was smoke detection compared to other smoke alarm types

- Increased 1.7 times when the alarm did not operate because the battery was discharged or dead
- Increased 1.8 times when the alarm did not operate because the battery was missing or disconnected
- Increased 1.7 times when the alarm did not operate because it was defective
- Decreased 0.63 times when the alarm did not operate because the fire was too small
- Increased 1.8 times when the alarm did not operate because of a hard-wire power failure and dead or discharged back-up battery
- Increased 1.8 times when the alarm did not operate because of a hard-wire power failure and missing back-up battery

Each compared to other reasons for failure.

Building Class
- Decreased 0.46 times when the fire occurred in an unknown class
- Decreased 0.54 times when the fire occurred in a Class 10a (non-habitable) building
- Increased 1.4 times when the fire occurred in a Class 3 (other residential) building
- Increased 1.5 times when the fire occurred in a Class 5 (office) building

- Increased 1.3 times when the fire occurred in a Class 6 (shop) Building
- Increased 1.5 times when the fire occurred in a Class 8 (laboratory) Building
- Increased 1.9 times when the fire occurred in a Class 9b (assembly) building

Each compared to other building classes.

Type of Owner

- Increased 1.1 times when the fire occurred in a property owned by private compared to other types of owners.

Ignition Source

- Increased 1.2 times when the fire was ignited by heat from overloaded electrical equipment
- Increased 1.2 times when the fire was ignited by heat from improperly operating electrical equipment
- Decreased 0.76 times when the fire was ignited by hot ember or ash
- Increased 1.5 times when the ignition source was molten, hot material
- Decreased 0.37 times when the fire was ignited by an open fire, campfire, or rubbish fire
- Decreased 0.13 times when the fire was ignited by a re-kindle or re-ignition
- Decreased 0.27 times when the fire was ignited by the suns heat, unusually concentrated

Each compared to other ignition sources.

Material Ignited First

- Increased 1.4 times when the material ignited first was a fixed stationary air conditioning unit
- Decreased 0.69 times when the material ignited first was cooking materials or food stuffs
- Increased 1.8 times when the material ignited first was a dryer
- Decreased 0.56 times when the material ignited first was electrical wiring fixed
- Decreased 0.30 times when the material ignited first was a fence, pole, or sign
- Increased 1.6 times when the material ignited first was fixed fans (cooling or exhaust)
- Decreased 0.38 times when the material ignited first was floor covering, surface
- Decreased 0.60 times when the material ignited first was grass, bush, and forests
- Decreased 0.16 times when the material ignited first was inverters, converters, rectifiers, capacitors
- Increased 1.7 times when the material ignited first was LPG
- Increased 2.1 times when the material ignited first was local refrigeration unit, fixed stationary
- Decreased 0.48 times when the material ignited first was not assigned
- Decreased 0.60 times when the material ignited first was other (appliances, home equipment)
- Increased 1.7 times when the material ignited first was other (books, papers, recreational material, decorations)
- Decreased 0.64 times when the material ignited first was other (other object)
- Decreased 0.36 times when the material ignited first was other (structural component, finish)
- Decreased 0.59 times when the material ignited first was outdoor cooking equipment
- Decreased 0.78 times when the material ignited first was rubbish, trash, waste
- Increased 1.9 times when the material ignited first was a sofa, chair, or seating
- Decreased 0.55 times when the material ignited first was solid fuel
- Increased 1.9 times when the material ignited first was supplies or stock in a box, carton, or bag
- Decreased 0.71 times when the material ignited first was undetermined

Each compared to other materials ignited first.

Area of Origin
- Increased 1.5 times when the fire originated in a bathroom, lavatory, locker, cloakroom
- Increased 1.9 times when the fire originated in a bedroom for less than five persons
- Increased 1.4 times when the fire originated in a ceiling cavity, roof space
- Increased 1.2 times when the fire originated in a chimney or flue
- Increased 2.7 times when the fire originated in a chute or conveyor
- Decreased 0.64 times when the fire originated in a court, patio, terrace
- Increased 2.0 times when the fire originated in a duct
- Increased 1.4 times when the fire originated in a garage or workshop
- Increased 3.7 times when the fire originated in a laboratory
- Decreased 0.46 times when the fire originated in a lawn, field, open area
- Decreased 0.30 times when the fire originated on a highway, roadway, public way
- Increased 1.5 times when the fire originated in a process, manufacturing area
- Decreased 0.39 times when the fire originated in a recreational area
- Increased 2.3 times when the fire originated in a storage area greater than 2000 sqm

Each compared to other areas of origin.

Other Outcomes
- Increased 1.9 times when the fire extended beyond the room of origin compared to confinement
- Increased 1.4 times when injury occurred compared to no injury

10.4.4.2 Evacuation x Deliberate

Table 138. Evacuation x Deliberate Omnibus Tests of Model Coefficients

		Chi-square	**df**	**Sig.**
Step 39	Step	3.285	1	.070
	Block	979.608	39	<.001***
	Model	979.608	39	<.001***

Statistical significance: ****p* <.001, ** *p* < .01, * *p* < .05

Table 139. Evacuation x Deliberate Model Summary

Step	**-2 Log likelihood**	**Cox & Snell R Square**	**Nagelkerke R Square**
39	2438.914	.189	.364

Table 140. Evacuation x Deliberate Classification Table

Observed			**Predicted**		
			Evacuation		Percentage Correct
			No	Yes	
Step 39	Evacuation	No	4033	83	98.0
		Yes	407	151	27.1
	Overall Percentage				89.5

*The cut value is .500

Table 141. Evacuation x Deliberate ROC Curve

Test Result Variable(s)				
Area	**Std. Error**	**Asymptotic Sig.**	**Asymptotic 95% Confidence Interval**	
			Lower Bound	**Upper Bound**
.832	.008	.000	.816	.848

*A moderate-large area value indicates that the model has excellent discrimination

Figure 96. Evacuation x Deliberate ROC Curve

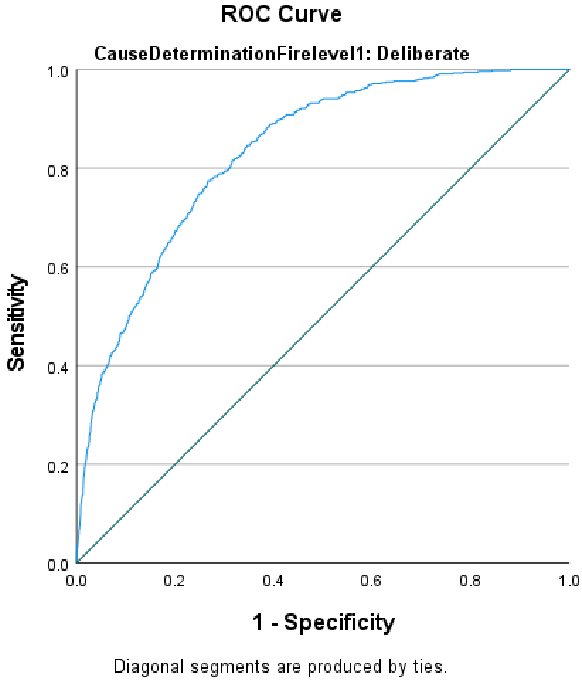


Table 142. Hosmer and Lemeshow Test			
Step	**Chi-square**	**df**	**Sig.**
39	9.365	8	.312

*A non-significant *p* value indicates that the model is not a poor fit.

Table 143. Evacuation x Deliberate Variables in the Equation							95% CI Exp(B)	
Variable	**B**	**S.E.**	**Wald**	**df**	**Sig.**	**Exp(B)**	**Lower**	**Upper**
Call Source=000	.472	.157	8.977	1	.003**	1.603	1.177	2.182
Call Source=AFASP	1.408	.285	24.394	1	<.001***	4.087	2.338	7.146
Alarms Detectors Operating=False	-.439	.154	8.137	1	.004**	.645	.477	.872
Alarms Detectors Operating=Not assigned	-1.351	.126	115.103	1	<.001***	.259	.202	.332
Ignition Source =Explosives	22.650	27590.453	.000	1	.999	6866947671.893	.000	.
Ignition Source=Heat from electrical equipment, overloaded	2.468	.915	7.273	1	.007**	11.800	1.963	70.938
Ignition Source=Heat, spark from friction	-19.944	9517.134	.000	1	.998	.000	.000	.
Material Ignited First=Alcohol	2.287	.983	5.418	1	.020*	9.845	1.435	67.534
Material Ignited First=Central air conditioning, refrigeration equipment	22.635	40192.969	.000	1	1.000	6767890845.736	.000	.

Material Ignited First=Curtain, blind, drapery, tapestry	.917	.352	6.811	1	.009**	2.503	1.257	4.985
Material Ignited First=Electronic devices, battery powered	23.224	40192.969	.000	1	1.000	12192078640.138	.000	.
Material Ignited First=Indoor open fireplace	1.645	.728	5.104	1	.024*	5.181	1.243	21.586
Material Ignited First=Other (furniture)	.597	.294	4.118	1	.042*	1.817	1.021	3.236
Area of Origin=Bedroom/Sleeping area for under five persons	.340	.142	5.721	1	.017*	1.405	1.063	1.857
Area of Origin=Fire stairway	1.565	.709	4.872	1	.027*	4.782	1.192	19.188
Area of Origin=Garage, Workshop	.846	.219	14.871	1	<.001***	2.331	1.516	3.584
Area of Origin=Lawn, field, open area.	-1.917	.589	10.593	1	.001**	.147	.046	.466
Area of Origin=Lifts	3.817	1.401	7.423	1	.006**	45.457	2.919	708.000
Area of Origin=Passenger compartment	1.983	.893	4.927	1	.026*	7.265	1.261	41.853
Area of Origin=Process, manufacturing area	2.599	.997	6.800	1	.009**	13.449	1.907	94.840
Area of Origin=Retail or Sales Area	1.281	.530	5.852	1	.016*	3.600	1.275	10.164
Building code=#	-1.241	.362	11.740	1	<.001***	.289	.142	.588
Building code=Class 1a (attached)	.748	.149	25.035	1	<.001***	2.113	1.576	2.832
Building code=Class 1b	.917	.315	8.473	1	.004**	2.502	1.349	4.639
Building code=Class 2	1.315	.161	66.806	1	<.001***	3.726	2.718	5.108
Building code=Class 3	1.828	.229	63.703	1	<.001***	6.223	3.972	9.750
Building code=Class 9a	1.149	.469	5.995	1	.014*	3.155	1.258	7.915
Type of Owner=Private	.308	.116	7.091	1	.008**	1.361	1.085	1.707
Region=ME	.430	.143	9.069	1	.003**	1.537	1.162	2.033
Mosaic Type=A01	2.921	1.349	4.685	1	.030*	18.552	1.318	261.163
Mosaic Type=A04	1.160	.589	3.882	1	.049*	3.189	1.006	10.106
Mosaic Type=B05	.926	.449	4.253	1	.039*	2.526	1.047	6.092
Mosaic Type=H24	1.261	.602	4.387	1	.036*	3.530	1.084	11.493
Mosaic Type=L40	.643	.288	4.997	1	.025*	1.902	1.082	3.341
Mosaic Type=M45	1.234	.649	3.616	1	.057	3.434	.963	12.244
SEIFA Decile=3.0	-.618	.242	6.521	1	.011*	.539	.336	.866
Mental Impairment	.454	.148	9.376	1	.002**	1.575	1.178	2.107
Confinement Collated=Beyond room	.467	.119	15.521	1	<.001***	1.596	1.265	2.013
Injuries	1.289	.186	47.935	1	<.001***	3.629	2.519	5.227

Constant	-2.652	.206	166.165	1	<.001***	.070		

Statistical significance: ****p* <.001, ** *p* < .01, * *p* < .05

The logistic regression model was statistically significant ($X^2(39) = 979.608$, p<.001). The model was not a poor fit (*p* = .312) and had excellent discrimination (ROC AUC = .832). The odds of evacuation in a deliberate fire:

Response
- Increased 1.6 times when the call source was a Triple Zero call
- Increased 4.1 times when the call source was an AFA (Automatic Fire Alarm)

Each compared to other call sources

Human Behaviour
- Increased 1.6 times when there was evidence of mental impairment compared to no mental impairment

Mosaic Type
- Increased 3.2 times when the fire occurred in Mosaic Type A04
- Increased 2.5 times when the fire occurred in Mosaic Type B05
- Increased 3.5 times when the fire occurred in Mosaic Type H24
- Increased 1.9 times when the fire occurred in Mosaic Type L40

Each compared to other Mosaic Types.

Region
- Increased 1.5 times when the fire occurred in Metro East compared to other regions

SEIFA Decile
- Decreased 0.53 times when the fire occurred in SEIFA Decile 3 compared to other SEIFA Deciles

Smoke Alarms
- Decreased 0.65 times when alarms were not operating compared to operating

Building Class
- Decreased 0.29 times when the fire occurred in an unknown class
- Increased 2.1 times when the fire occurred in a Class 1a (attached) building
- Increased 2.5 times when the fire occurred in a Class 1b (boarding house) building
- Increased 3.7 times when the fire occurred in a Class 2 (unit) building
- Increased 6.2 times when the fire occurred in a Class 3 (other residential) building
- Increased 3.2 times when the fire occurred in a Class 9a (health care) building

Each compared to other building classes

Type of Owner
- Increased 1.4 times when the fire occurred in a property owned by private compared to other types of owners

Ignition Source
- Increased 11.8 times when the fire was ignited by heat from overloaded electrical equipment compared to other ignition sources

Material Ignited First
- Increased 9.8 times when the material ignited first was alcohol

- Increased 2.5 times when the material ignited first was curtains, blinds, drapery, tapestry
- Increased 5.1 times when the material ignited first was an indoor open fireplace
- Increased 1.8 times when the material ignited first was other (furniture)

Each compared to other materials ignited first.

Area of Origin

- Increased 1.4 times when the fire originated in a bedroom for less than five persons
- Increased 4.8 times when the fire originated in a fire stairway
- Increased 2.3 times when the fire originated in a garage or workshop
- Decreased 0.15 times when the fire originated in a lawn, field, open area
- Increased 45.5 times when the fire originated in a lift
- Increased 7.3 times when the fire originated in a passenger compartment
- Increased 13.5 times when the fire originated in a process manufacturing area
- Increased 3.6 times when the fire originated in a retail or sales area

Each compared to other areas of origin.

Other Outcomes

- Increased 1.6 times when the fire extended beyond the room of origin compared to confinement
- Increased 3.6 times when injury occurred compared to no injury

10.4.4.3 Evacuation x Undetermined

Table 144. Evacuation x Undetermined Omnibus Tests of Model Coefficients

		Chi-square	**df**	**Sig.**
Step 38	Step	2.110	1	.146
	Block	683.881	38	<.001
	Model	683.881	38	<.001

Statistical significance: ***p <.001, ** p < .01, * p < .05

Table 145. Evacuation x Undetermined Model Summary

Step	**-2 Log likelihood**	**Cox & Snell R Square**	**Nagelkerke R Square**
38	2861.467	.185	.283

Table 146. Evacuation x Undetermined Classification Table

Observed			**Predicted**		
			Evacuation		Percentage Correct
			No	Yes	
Step 38	Evacuation	No	2488	101	96.1
		Yes	548	198	26.5
	Overall Percentage				80.5

*The cut value is .500

Table 147. Evacuation x Undetermined ROC Curve

Test Result Variable(s)

Area	**Std. Error**	**Asymptotic Sig.**	**Asymptotic 95% Confidence Interval**	
			Lower Bound	**Upper Bound**
.753	.009	.000	.735	.772

*A moderate area value indicates that the model has acceptable discrimination

Figure 97. Evacuation x Undetermined ROC Curve

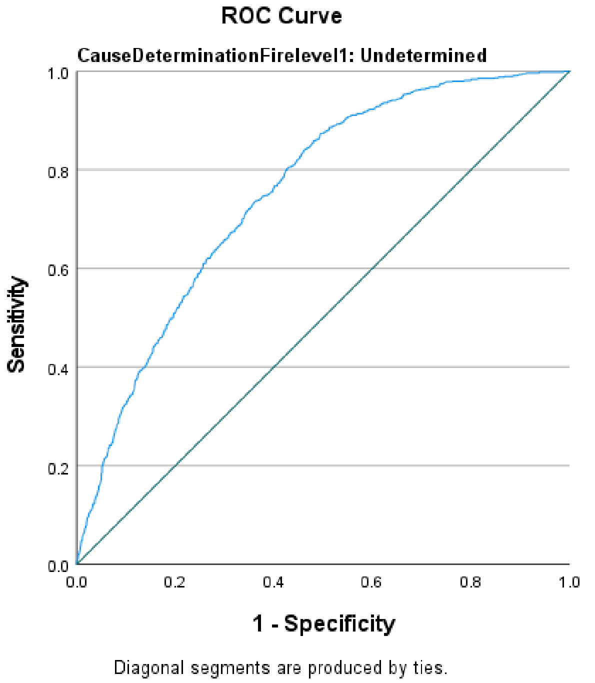


Table 148. Hosmer and Lemeshow Test			
Step	**Chi-square**	**df**	**Sig.**
38	3.949	8	.862

*A large *p* value indicates that the model is not a poor fit.

Table 149. Evacuation x Undetermined Variables in the Equation								
Variable	**B**	**S.E.**	**Wald**	**df**	**Sig.**	**Exp(B)**	**95% CI Exp(B) Lower**	**Upper**
Call Source=Call to Station	-1.857	.689	7.265	1	.007**	.156	.040	.603
Call Source=ICEMS	-.614	.268	5.247	1	.022*	.541	.320	.915
Alarms Detectors Operating=True	.711	.102	48.493	1	<.001***	2.036	1.666	2.486
Type of Alarm=Multicriteria detector - Combination smoke and thermal	1.652	.824	4.025	1	.045*	5.219	1.039	26.221
Ignition Source=Hot ember, ash	-1.136	.544	4.366	1	.037*	.321	.111	.932
Ignition Source=Match, Lighter (flame type)	-.597	.288	4.289	1	.038*	.551	.313	.968
Ignition Source=Re-kindle, re-ignition	-1.678	.527	10.131	1	.001**	.187	.066	.525
Ignition Source=Spontaneous ignition, exothermic chemical reaction	22.834	40192.969	.000	1	1.000	8251089996.576	.000	.
Material Ignited First=Electrical cord, extension lead	22.834	40192.969	.000	1	1.000	8251089996.576	.000	.
Material Ignited First=Electronic	1.564	.804	3.784	1	.052	4.780	.988	23.117

devices, battery powered								
Material Ignited First=Goods, stock, luggage or other stowable item	1.553	.798	3.784	1	.052	4.724	.988	22.575
Material Ignited First=LPG	3.066	1.380	4.938	1	.026*	21.461	1.436	320.756
Material Ignited First=Luggage, bags	23.433	40192.969	.000	1	1.000	15018445114.682	.000	.
Material Ignited First=Mains/Supply Transformer	3.181	.939	11.466	1	<.001***	24.061	3.818	151.648
Material Ignited First=Other (furniture)	.745	.348	4.575	1	.032*	2.107	1.064	4.172
Material Ignited First=Other (power transfer equipment)	2.511	.748	11.268	1	<.001***	12.313	2.843	53.333
Material Ignited First=Outdoor cooking equipment	22.663	28308.289	.000	1	.999	6958844454.086	.000	.
Material Ignited First=Water heater (hot water service)	2.505	1.292	3.759	1	.053	12.242	.973	154.029
Area of Origin=Bedroom/Sleeping area for five or more persons	1.141	.482	5.603	1	.018*	3.130	1.217	8.052
Area of Origin=Bedroom/Sleeping area for under five persons	.395	.150	6.969	1	.008**	1.485	1.107	1.992
Area of Origin=Closed carpark, for up to 40 cars	1.746	.633	7.615	1	.006**	5.729	1.658	19.792
Area of Origin=Duct.	2.213	.697	10.075	1	.002**	9.139	2.331	35.828
Area of Origin=Exterior balcony, open porch, or veranda	.596	.211	7.973	1	.005**	1.815	1.200	2.744
Area of Origin=Lifts	3.430	1.593	4.633	1	.031*	30.874	1.359	701.419
Area of Origin=Railway line	2.035	1.149	3.136	1	.077	7.655	.805	72.830
Building code=#	-.897	.271	10.963	1	<.001***	.408	.240	.693
Building code=Class 1a (attached)	.690	.140	24.252	1	<.001***	1.994	1.515	2.624
Building code=Class 2	1.000	.158	40.136	1	<.001***	2.719	1.995	3.705
Type of Owner=Private	.354	.124	8.106	1	.004**	1.425	1.117	1.819
Mosaic Type=K35	1.256	.617	4.153	1	.042*	3.513	1.049	11.761
Mosaic Type=M47	.819	.326	6.323	1	.012*	2.267	1.198	4.292
Remote Index =Inner Regional Australia	.725	.203	12.772	1	<.001***	2.065	1.387	3.073
Remote Index =Major Cities of Australia	1.324	.191	48.207	1	<.001***	3.759	2.586	5.462
SEIFA Decile=4.0	-.601	.182	10.958	1	<.001***	.548	.384	.782

Confinement Collated=Beyond room	.739	.104	50.683	1	<.001***	2.094	1.708	2.566
Confinement Collated=Not assigned	-.866	.243	12.682	1	<.001***	.421	.261	.677
Injuries	.869	.171	25.939	1	<.001***	2.385	1.707	3.332
Constant	-3.309	.241	188.259	1	<.001***	.037		

Statistical significance: ****p* <.001, ** *p* < .01, * *p* < .05

The logistic regression model was statistically significant ($X^2(38) = 683.881$, p<.001). The model was not a poor fit (*p* = .862) and had acceptable discrimination (ROC AUC = .753). The odds of evacuation in an undetermined fire:

Response
- Increased 1.6 times when the call source was a Triple Zero call
- Increased 4.1 times when the call source was an AFA (Automatic Fire Alarm)

Each compared to other call sources.

Mosaic Type
- Increased 3.5 times when the fire occurred in Mosaic Type K35
- Increased 2.3 times when the fire occurred in Mosaic Type M47

Each compared to other Mosaic Types.

Remoteness
- Increased 2.1 times when the fire occurred in an Inner Regional Area
- Increased 3.8 times when the fire occurred in a Major City

Each compared to other remoteness structures.

SEIFA Decile
- Decreased 0.55 times when the fire occurred in SEIFA Decile 4 compared to other SEIFA Deciles.

Smoke Alarms
- Increased 2.0 times when alarms were operating compared to not operating
- Increased 5.2 times when the type of alarm was a multicriteria detector compared to other smoke alarm types

Building Class
- Decreased 0.41 times when the fire occurred in an unknown class
- Increased 2.0 times when the fire occurred in a Class 1a (attached) building
- Increased 2.7 times when the fire occurred in a Class 2 (unit) building

Each compared to other building classes

Type of Owner
- Increased 1.4 times when the fire occurred in a property owned by private compared to other types of owners

Ignition Source
- Decreased 0.32 times when the fire was ignited by hot ember or ash
- Decreased 0.55 times when the fire was ignited by a lighter
- Decreased 0.19 times when the fire was ignited by a re-kindle

Each compared to other ignition sources.

Material Ignited First

- Increased 21.5 times when the material ignited first was LPG
- Increased 24.1 times when the material ignited first was mains supply, transformer
- Increased 2.1 times when the material ignited first was other (furniture)
- Increased 12.3 times when the material ignited first was other (power transfer equipment)

Each compared to other materials ignited first.

Area of Origin

- Increased 3.1 times when the fire originated in a bedroom for five persons or more
- Increased 1.5 times when the fire originated in a bedroom for less than five persons
- Increased 5.7 times when the fire originated in a closed carpark for up to 40 cars
- Increased 9.1 times when the fire originated in a duct
- Increased 1.8 times when the fire originated in an exterior balcony, open porch, veranda
- Increased 30.9 times when the fire originated in a lift

Each compared to other areas of origin.

Other Outcomes

- Increased 2.1 times when the fire extended beyond the room of origin compared to confinement
- Increased 2.4 times when injury occurred compared to no injury

10.4.5 Fire extension by cause determination

10.4.5.1 Fire Extension x Accidental

Table 150. Fire Extension x Accidental Omnibus Tests of Model Coefficients				
		Chi-square	**df**	**Sig.**
Step 87	Step	6.875	1	.009
	Block	3532.496	87	.000***
	Model	3532.496	87	.000***

Statistical significance: ****p* <.001, ** *p* < .01, * *p* < .05

Table 151. Fire Extension x Accidental Model Summary			
Step	**-2 Log likelihood**	**Cox & Snell R Square**	**Nagelkerke R Square**
87	11388.964	.164	.309

Table 152. Fire Extension x Accidental Classification Table					
			Predicted		
			Fire Extension		Percentage Correct
Observed			No	Yes	
Step 87	Fire Extension	No	16886	305	98.2
		Yes	1988	496	20.0
	Overall Percentage				88.3

*The cut value is .500

Table 153. Fire Extension x Accidental ROC Curve				
Test Result Variable(s)				
Area	**Std. Error**	**Asymptotic Sig.**	**Asymptotic 95% Confidence Interval**	
			Lower Bound	**Upper Bound**
.829	.004	.000	.821	.838

*A moderate-large area value indicates that the model has excellent discrimination

Figure 98. Fire Extension x Accidental ROC Curve

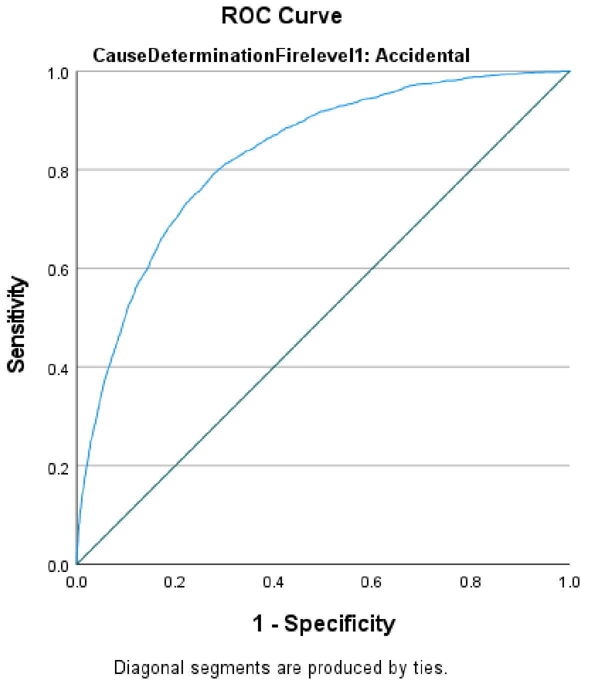


Table 154. Hosmer and Lemeshow Test			
Step	**Chi-square**	**df**	**Sig.**
87	5.169	8	.739

*A large *p* value indicates that the model is not a poor fit.

Table 155. Fire Extension x Accidental Variables in the Equation								
Variable	**B**	**S.E.**	**Wald**	**df**	**Sig.**	**Exp(B)**	**95% CI Exp(B)**	
							Lower	**Upper**
Call Source=000	.517	.094	30.285	1	<.001***	1.676	1.395	2.015
Time of Week=Weekday	-.119	.053	5.126	1	.024*	.888	.801	.984
Alarms Detectors Operating=Not assigned	.317	.060	27.615	1	<.001***	1.373	1.220	1.546
Type of Alarm=Manual Call Point (MCP)	1.574	.662	5.648	1	.017*	4.824	1.318	17.659
Type of Alarm=Smoke alarm - battery powered	.206	.076	7.233	1	.007**	1.228	1.057	1.427
Reason Alarm not Operating=Fire not within designed range of detector/alarm	-.498	.093	28.502	1	<.001***	.608	.506	.730
Reason Alarm not Operating=Fire too small to operate	-1.610	.186	74.860	1	<.001***	.200	.139	.288
Reason Alarm not Operating=Hard wire power failure, shutoff or disconnect - back up battery discharged/dead	.851	.329	6.677	1	.010*	2.342	1.228	4.468

Ignition Source=Conducted heat	-.418	.169	6.096	1	.014*	.658	.473	.917
Ignition Source=Form of heat of ignition undetermined	.579	.097	35.516	1	<.001***	1.785	1.475	2.159
Ignition Source=Heat from flying brand, ember, spark	.704	.229	9.497	1	.002**	2.023	1.292	3.166
Ignition Source=Heat from properly operating electrical equipment	-.265	.080	10.962	1	<.001***	.767	.655	.897
Ignition Source=Heat from smokers' materials (e.g., Cigarettes)	-.276	.104	7.072	1	.008**	.759	.620	.930
Ignition Source=Hot ember, ash	.248	.112	4.883	1	.027*	1.282	1.028	1.598
Ignition Source=Open fire, Camp fire and bonfire, Rubbish fires, Burn-off Fires, Windows/Slash/Fire	.780	.268	8.446	1	.004**	2.182	1.289	3.692
Material Ignited First=Cabinetry	.733	.240	9.362	1	.002**	2.081	1.301	3.328
Material Ignited First=Charger (device), battery charger	.623	.198	9.909	1	.002**	1.865	1.265	2.750
Material Ignited First=Cooking materials, food stuff	-.577	.088	42.773	1	<.001***	.562	.473	.668
Material Ignited First=Decoration for special event	-19.436	8363.972	.000	1	.998	.000	.000	.
Material Ignited First=Exterior covering or permanently affixed surface item	1.097	.566	3.756	1	.053	2.996	.988	9.089
Material Ignited First=Exterior trim	1.220	.589	4.294	1	.038*	3.387	1.068	10.739
Material Ignited First=Fertiliser	2.158	1.031	4.384	1	.036*	8.657	1.148	65.285
Material Ignited First=Floor covering, surface.	.691	.290	5.683	1	.017*	1.995	1.131	3.520
Material Ignited First=Flooring, trim, or upholstery material	1.188	.315	14.224	1	<.001***	3.281	1.769	6.083
Material Ignited First=Grass, bush, and forests, whether growing or dead	.780	.211	13.629	1	<.001***	2.182	1.442	3.302
Material Ignited First=Lighting - fixed	-1.540	.606	6.466	1	.011*	.214	.065	.703
Material Ignited First=Mechanical	2.734	1.433	3.642	1	.056	15.398	.929	255.216

Power transfer equipment								
Material Ignited First=Not assigned	-1.216	.327	13.821	1	<.001***	.296	.156	.563
Material Ignited First=Other (books, papers, recreational material, decorations)	-.973	.387	6.329	1	.012*	.378	.177	.807
Material Ignited First=Other (furniture)	.555	.212	6.849	1	.009**	1.742	1.149	2.639
Material Ignited First=Other (structural component, finish)	.817	.302	7.326	1	.007**	2.264	1.253	4.090
Material Ignited First=Structural member, framing	.778	.178	19.125	1	<.001***	2.177	1.536	3.085
Material Ignited First=Television, monitor and visual displays	1.036	.499	4.306	1	.038*	2.818	1.059	7.496
Material Ignited First=Torches, welding and cutting equipment	1.777	.881	4.069	1	.044*	5.915	1.052	33.265
Material Ignited First=Undetermined	.856	.094	82.893	1	<.001***	2.355	1.958	2.832
Material Ignited First=Water cooling device, tower	22.705	40192.969	.000	1	1.000	7251750285.306	.000	.
Area of Origin=Area under construction or major renovation	.702	.299	5.521	1	.019*	2.017	1.123	3.621
Area of Origin=Bathroom, Lavatory, locker room, cloakroom	-1.327	.219	36.700	1	<.001***	.265	.173	.407
Area of Origin=Ceiling cavity, roof space	.420	.113	13.921	1	<.001***	1.523	1.221	1.899
Area of Origin=Chimney/flue	-1.041	.153	46.595	1	<.001***	.353	.262	.476
Area of Origin=Dining area, lunchroom, cafeteria.	-.995	.322	9.572	1	.002**	.370	.197	.694
Area of Origin=Electricity, Gas, Water areas, etc	-.992	.154	41.610	1	<.001***	.371	.274	.501
Area of Origin=Exterior roof surface	-.893	.346	6.657	1	.010*	.410	.208	.807
Area of Origin=Exterior wall surface	.515	.159	10.505	1	.001**	1.674	1.226	2.286
Area of Origin=Garage, Workshop	.323	.088	13.433	1	<.001***	1.382	1.162	1.642
Area of Origin=Kitchen, cooking area	-1.092	.082	178.954	1	<.001***	.336	.286	.394
Area of Origin=Laundry room, area	-.718	.141	25.924	1	<.001***	.488	.370	.643

Area of Origin=On or near highway, roadway, street, public way, parking lot	-1.380	.610	5.119	1	.024*	.251	.076	.831
Area of Origin=Retail or Sales Area	-1.281	.607	4.457	1	.035*	.278	.085	.912
Area of Origin=Storage area, less than 10 sqm	.445	.195	5.191	1	.023*	1.561	1.064	2.289
Area of Origin=Sub-floor space, concealed floor space	.989	.297	11.118	1	<.001***	2.689	1.504	4.811
Area of Origin=Undetermined	2.260	.401	31.674	1	<.001***	9.579	4.361	21.041
Building code=	3.045	1.196	6.484	1	.011*	21.014	2.016	219.014
Building code=#	.306	.136	5.051	1	.025*	1.358	1.040	1.774
Building code=Class 10a	1.377	.133	106.693	1	<.001***	3.964	3.053	5.149
Building code=Class 1a (detached)	.334	.058	32.792	1	<.001***	1.397	1.246	1.566
Building code=Class 3	-.594	.266	4.965	1	.026*	.552	.328	.931
Building code=Class 5	-.487	.232	4.393	1	.036*	.615	.390	.969
Building code=Class 7b	.692	.161	18.468	1	<.001***	1.997	1.457	2.738
Building code=Class 9a	-18.602	3748.289	.000	1	.996	.000	.000	.
Building code=Class 9b	-.561	.202	7.688	1	.006**	.570	.384	.848
Type of Owner=Local Government	-.863	.262	10.902	1	<.001***	.422	.253	.704
Region=MW	.147	.061	5.824	1	.016*	1.159	1.028	1.306
Region=RS	.213	.088	5.825	1	.016*	1.237	1.041	1.470
Mosaic Type=A03	-.607	.281	4.673	1	.031*	.545	.314	.945
Mosaic Type=C08	-.544	.199	7.502	1	.006**	.580	.393	.857
Mosaic Type=C10	-1.066	.425	6.296	1	.012*	.344	.150	.792
Mosaic Type=D12	-.423	.173	5.956	1	.015*	.655	.466	.920
Mosaic Type=G21	-.987	.277	12.666	1	<.001***	.373	.217	.642
Mosaic Type=H26	-.372	.177	4.402	1	.036*	.689	.487	.976
Mosaic Type=H27	.352	.165	4.540	1	.033*	1.422	1.029	1.966
Mosaic Type=L41	-.860	.301	8.185	1	.004**	.423	.235	.763
Mosaic Type=M43	.422	.161	6.894	1	.009**	1.525	1.113	2.090
Mosaic Type=M45	-.781	.331	5.575	1	.018*	.458	.239	.876
Remote Index=Outer Regional Australia	.325	.099	10.803	1	.001**	1.384	1.140	1.680
Remote Index=Very Remote Australia	1.426	.537	7.052	1	.008**	4.163	1.453	11.929
Time of Day=Night	.332	.051	42.616	1	<.001***	1.393	1.261	1.539
SEIFA Decile=7.0	.206	.082	6.321	1	.012*	1.229	1.047	1.444
SEIFA Decile=8.0	-.292	.090	10.557	1	.001**	.747	.626	.891
Fatalities	2.147	.493	18.923	1	<.001***	8.556	3.253	22.505
Injuries	.461	.079	33.980	1	<.001***	1.585	1.358	1.851
Evacuations	.651	.052	154.009	1	<.001***	1.917	1.730	2.125
Youth misuse of fire	.466	.169	7.625	1	.006**	1.593	1.145	2.217
Hoarding	.472	.218	4.697	1	.030*	1.604	1.046	2.458
Constant	-2.452	.120	418.776	1	<.001***	.086		

Statistical significance: ***p <.001, ** p < .01, * p < .05

The logistic regression model was statistically significant ($X^2(106) = 8352.916$, p=.000). The model was not a poor fit (p = .739) and had excellent discrimination (ROC AUC = .829). The odds of fire extension beyond the room of origin in an accidental fire:

Response
- Increased 1.7 times when the call source was a Triple Zero call compared to other call sources

Temporal
- Decreased 0.89 times when the fire occurred during a weekday compared to the weekend
- Increased 1.4 times when the fire occurred during the night compared to during the day

Human Behaviour
- Increased 1.6 times when there was evidence of youth misuse of fire compared to no youth misuse of fire
- Increased 1.6 times when there was evidence of hoarding compared to no hoarding

Smoke Alarms
- Increased 1.4 times when smoke alarm operation was not assigned compared to assigned

- Increased 4.8 times when the alarm was a Manual Call Point
- Increased 1.2 times when the alarm was a battery-powered smoke alarm

Each compared to other smoke alarm types.

- Decreased 0.61 times when the alarm did not operate because the fire was not within the designed range of the detector
- Decreased 0.20 times when the alarm did not operate because the fire was too small
- Increased 2.3 times when the alarm did not operate because of a hard-wire power failure and a discharged or dead back-up battery

Each compared to other reasons for failure.

Remoteness
- Increased 1.4 times when the fire occurred in an outer regional rea
- Increased 4.2 times when the fire occurred in a very remote area

Each compared to other remoteness structures.

SEIFA Decile
- Increased 1.2 times when the fire occurred in SEIFA Decile 7
- Decreased 0.75 times when the fire occurred in SEIFA Decile 8

Each compared to other SEIFA Deciles.

Mosaic Types
- Decreased 0.55 times when the fire occurred in Mosaic Type A03
- Decreased 0.58 times when the fire occurred in Mosaic Type C08
- Decreased 0.34 times when the fire occurred in Mosaic Type C10
- Decreased 0.66 times when the fire occurred in Mosaic Type D12
- Decreased 0.38 times when the fire occurred in Mosaic Type G21
- Decreased 0.69 times when the fire occurred in Mosaic Type H26

- Increased 1.4 times when the fire occurred in Mosaic Type H27
- Decreased 0.42 times when the fire occurred in Mosaic Type L41
- Increased 1.5 times when the fire occurred in Mosaic Type M43
- Decreased 0.46 times when the fire occurred in Mosaic Type M45

Each compared to other Mosaic Types.

Region

- Increased 1.2 times when the fire occurred in Metro West
- Increased 1.2 times when the fire occurred in Regional South

Each compared to other regions.

Building Class

- Increased 21.0 times when the fire occurred in a non-applicable building
- Increased 1.4 times when the fire occurred in a non-assigned building class
- Increased 3.9 times when the fire occurred in a Class 10a (non-habitable) building
- Increased 1.4 times when the fire occurred in a Class 1a (detached) building
- Decreased 0.55 times when the fire occurred in a Class 3 (other residential) building
- Decreased 0.61 times when the fire occurred in a Class 5 (office) building
- Increased 2.0 times when the fire occurred in a Class 7b (storage) building
- Decreased 0.57 times when the fire occurred in a Class 9c (aged care) building

Each compared to other building classes.

Type of Owner

- Decreased 0.42 times when the fire occurred in a property owned by Local Government compared to other types of owners.

Ignition Source

- Decreased 0.66 times when the fire was ignited by conducted heat
- Increased 1.8 times when the fire was ignited by a form of heat ignition undetermined
- Increased 2.0 times when the fire was ignited by heat from a flying brand, ember, or spark
- Decreased 0.77 times when the fire was ignited by heat from properly operating electrical equipment
- Decreased 0.76 times when the fire was ignited by heat from smokers' materials
- Increased 1.3 times when the fire was ignited by got ember or ash
- Increased 2.2. times when the fire was ignited by an open fire, campfire, or rubbish fire

Each compared to other ignition sources.

Material Ignited First

- Increased 2.1 times when the material ignited first was cabinetry
- Increased 1.9 times when the material ignited first was a charger (device) or battery charger
- Decreased 0.56 times when the material ignited first was cooking materials, food stuffs
- Increased 3.4 times when the material ignited first was exterior trim
- Increased 8.7 times when the material ignited first was fertiliser
- Increased 2.0 times when the material ignited first was floor covering, surface
- Increased 3.3 times when the material ignited first was flooring, trim, or upholstery material
- Increased 2.2 times when the material ignited first was grass, bush, forests
- Decreased 0.21 times when the material ignited first was fixed lighting
- Decreased 0.30 times when the material ignited first was not assigned

- Decreased 0.38 times when the material ignited first was other (books, papers, recreational material, decorations)
- Increased 1.7 times when the material ignited first was other (furniture)
- Increased 2.3 times when the material ignited first was other (structural component, finish)
- Increased 2.2 times when the material ignited first was structural member, framing
- Increased 2.8 times when the material ignited first was a television, monitor or visual display
- Increased 5.9 times when the material ignited first was torches, welding and cutting equipment
- Increased 2.4 times when the material ignited first was undetermined

Each compared to other materials ignited first.

Area of Origin

- Increased 2.0 times when the fire originated in an area under major construction or renovation
- Decreased 0.27 times when the fire originated in a bathroom, lavatory, locker room, or cloakroom
- Increased 1.5 times when the fire originated in a ceiling cavity, roof space
- Decreased 0.35 times when the fire originated in a chimney or flue
- Decreased 0.37 times when the fire originated in a dining area, lunchroom, or cafeteria
- Decreased 0.37 times when the fire originated in an electricity, gas, or water area
- Decreased 0.41 times when the fire originated in an exterior roof surface
- Increased 1.7 times when the fire originated in an exterior wall surface
- Increased 1.4 times when the fire originated in a garage or workshop
- Decreased 0.34 times when the fire originated in a kitchen or cooking area
- Decreased 0.49 times when the fire originated in a laundry room
- Decreased 0.25 times when the fire originated on a highway, roadway. Or public way
- Decreased 0.28 times when the fire originated in a retail or sales area
- Increased 1.6 times when the fire originated in a storage area less than 10 sqm
- Increased 2.7 times when the fire originated un a sub-floor space
- Increased 9.6 times when the fire originated in an undetermined area

Each compared to other areas of origin.

Other Outcomes

- Increased 8.6 times when fatality occurred compared to no fatality
- Increased 1.6 times when injury occurred compared to no injury
- Increased 1.9 times when evacuations occurred compared to no evacuation

10.4.5.2 Fire Extension x Deliberate

Table 156. Fire Extension x Deliberate Omnibus Tests of Model Coefficients

		Chi-square	**df**	**Sig.**
Step 57	Step	2.198	1	.138
	Block	1292.283	55	<.001***
	Model	1292.283	55	<.001***

Statistical significance: ****p* <.001, ** *p* < .01, * *p* < .05

Table 157. Fire Extension x Deliberate Model Summary

Step	**-2 Log likelihood**	**Cox & Snell R Square**	**Nagelkerke R Square**
57	3502.830	.296	.407

Table 158. Fire Extension x Deliberate Classification Table

Observed			Predicted		
			Fire Extension		Percentage Correct
			No	Yes	
Step 57	Fire Extension	No	2035	327	86.2
		Yes	534	781	59.4
	Overall Percentage				76.6

*The cut value is .500

Table 159. Fire Extension x Deliberate ROC Curve				
Test Result Variable(s)				
Area	**Std. Error**	**Asymptotic Sig.**	**Asymptotic 95% Confidence Interval**	
			Lower Bound	**Upper Bound**
.809	.007	.000	.795	.823

*A moderate-large area value indicates that the model has excellent discrimination

Figure 99. Fire Extension x Deliberate ROC Curve

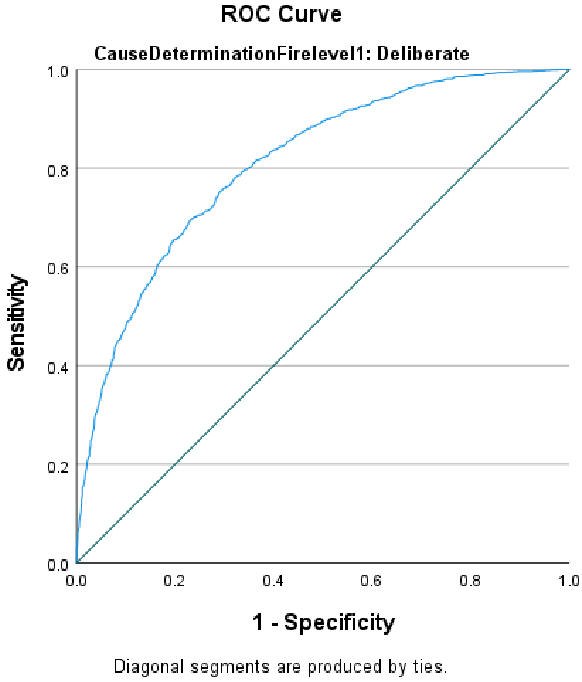


Table 160. Hosmer and Lemeshow Test			
Step	**Chi-square**	**df**	**Sig.**
57	9.355	8	.313

*A non-significant *p* value indicates that the model is not a poor fit.

Table 161. Fire Extension x Deliberate Variables in the Equation								
Variable	**B**	**S.E.**	**Wald**	**df**	**Sig.**	**Exp(B)**	**95% CI Exp(B) Lower**	**Upper**
Call Source=000	.639	.117	29.751	1	<.001***	1.894	1.506	2.382
Season=Autumn	-.204	.098	4.293	1	.038*	.816	.673	.989
Alarms Detectors Operating=True	-.619	.107	33.562	1	<.001***	.539	.437	.664
Reason Alarm not Operating=Fire not	-1.435	.247	33.860	1	<.001***	.238	.147	.386

within designed range of detector/alarm								
Reason Alarm not Operating=Fire too small to operate	-2.257	.488	21.406	1	<.001***	.105	.040	.272
Reason Alarm not Operating=Hard wire power failure, shutoff or disconnect - back up battery discharged/dead	1.564	.509	9.451	1	.002**	4.778	1.763	12.950
Ignition Source=Heat from properly operating electrical equipment	-1.653	.748	4.882	1	.027*	.191	.044	.830
Ignition Source=Open fire, Camp fire and bonfire, Rubbish fires, Burn-off Fires, Windows/Slash/Fire	-1.428	.645	4.902	1	.027*	.240	.068	.849
Material Ignited First=Ceiling covering, surface.	2.063	1.110	3.456	1	.063	7.870	.894	69.270
Material Ignited First=Clothing not on a person	-.776	.289	7.231	1	.007**	.460	.261	.810
Material Ignited First=Cooking materials, food stuff	-2.351	1.030	5.208	1	.022*	.095	.013	.718
Material Ignited First=Curtain, blind, drapery, tapestry	-1.477	.499	8.759	1	.003**	.228	.086	.607
Material Ignited First=Electrical system component, wiring, or outlet	1.833	.694	6.982	1	.008**	6.255	1.606	24.366
Material Ignited First=Exterior trim	-1.422	.671	4.485	1	.034*	.241	.065	.899
Material Ignited First=LPG	3.247	1.321	6.043	1	.014*	25.724	1.932	342.58 8
Material Ignited First=Not assigned	-1.465	.773	3.595	1	.058	.231	.051	1.051
Material Ignited First=Other (furniture)	.511	.259	3.883	1	.049*	1.667	1.003	2.773
Material Ignited First=Other (mobile property component)	2.003	.719	7.750	1	.005**	7.408	1.809	30.341
Material Ignited First=Other (structural component, finish)	1.090	.376	8.398	1	.004**	2.975	1.423	6.218
Material Ignited First=Packing, wrapping material	-1.696	.746	5.174	1	.023*	.183	.043	.791
Material Ignited First=Petrol	.654	.227	8.271	1	.004**	1.923	1.231	3.002
Material Ignited First=Petroleum fuelled engine	2.168	1.092	3.941	1	.047*	8.737	1.028	74.250

Material Ignited First=Supplies or stock in bales	-22.385	20856.480	.000	1	.999	.000	.000	.
Material Ignited First=Supplies or stock in box, carton, bag	1.347	.717	3.533	1	.060	3.847	.944	15.676
Material Ignited First=Television, monitor and visual displays	2.311	1.430	2.610	1	.106	10.084	.611	166.430
Material Ignited First=Undetermined	1.221	.116	109.894	1	<.001***	3.390	2.698	4.259
Area of Origin=Bathroom, Lavatory, locker room, cloakroom	-1.399	.263	28.352	1	<.001***	.247	.148	.413
Area of Origin=Chimney/flue	-1.984	.740	7.197	1	.007**	.138	.032	.586
Area of Origin=Closed carpark, for more than 40 cars	-20.162	10842.526	.000	1	.999	.000	.000	.
Area of Origin=Electricity, Gas, Water areas, etc	-1.880	1.087	2.993	1	.084	.153	.018	1.284
Area of Origin=Exterior wall surface	.653	.214	9.322	1	.002**	1.922	1.264	2.923
Area of Origin=Lawn, field, open area.	-1.130	.238	22.465	1	<.001***	.323	.202	.515
Area of Origin=Lobby, entrance way	-1.002	.282	12.642	1	<.001***	.367	.211	.638
Area of Origin=Multiple Areas of Origin	1.083	.257	17.699	1	<.001***	2.953	1.783	4.890
Area of Origin=Medium-sized assembly area (from 20 to 100 persons)	-1.364	.683	3.990	1	.046*	.256	.067	.975
Area of Origin=On or near highway, roadway, street, public way, parking lot	-1.942	.543	12.771	1	<.001***	.143	.049	.416
Area of Origin=Recreational Area	-2.099	.636	10.881	1	<.001***	.123	.035	.427
Area of Origin=Undetermined	3.529	.801	19.400	1	<.001***	34.091	7.090	163.920
Building code=#	-.474	.169	7.925	1	.005**	.622	.447	.866
Building code=Class 10a	.701	.220	10.121	1	.001**	2.016	1.309	3.105
Building code=Class 10b	-19.963	9448.646	.000	1	.998	.000	.000	.
Building code=Class 1a (detached)	.519	.096	29.115	1	<.001***	1.681	1.392	2.029
Building code=Class 3	-1.431	.363	15.576	1	<.001***	.239	.117	.487
Building code=Class 5	.588	.272	4.663	1	.031*	1.800	1.056	3.068
Type of Owner=State Government	.290	.095	9.239	1	.002**	1.336	1.108	1.610
Region=ME	-.533	.136	15.245	1	<.001***	.587	.449	.767
Region=MS	-.357	.118	9.211	1	.002**	.700	.555	.881

Mosaic Type=F17	2.691	1.408	3.654	1	.056	14.744	.934	232.700
Mosaic Type=I30	-1.329	.592	5.045	1	.025*	.265	.083	.844
Remote Index=Outer Regional Australia	.428	.133	10.363	1	.001**	1.534	1.182	1.990
Remote Index=Remote Australia	.978	.404	5.863	1	.015*	2.659	1.205	5.867
Remote Index=Very Remote Australia	1.268	.438	8.367	1	.004**	3.554	1.505	8.390
Time of Day=Night	.704	.087	66.030	1	<.001***	2.021	1.706	2.395
Evacuations	.513	.128	15.953	1	<.001***	1.670	1.299	2.148
Mental Impairment	-.395	.155	6.524	1	.011*	.674	.498	.912
Constant	-1.622	.154	110.692	1	<.001***	.197		

Statistical significance: ****p* <.001, ** *p* < .01, * *p* < .05

The logistic regression model was statistically significant ($X^2(55) = 1292.283$, p<.001). The model was not a poor fit (*p* = .313) and had excellent discrimination (ROC AUC = .809). The odds of fire extension beyond the room of origin in a deliberate fire:

Response
- Increased 1.9 times when the call source was a Triple Zero call compared to other call sources

Temporal
- Decreased 0.82 times when the fire occurred in Autumn compared to other seasons
- Increased 2.0 times when the fire occurred during the night compared to during the day

Human Behaviour
- Decreased 0.67 times when there was evidence of mental impairment compared to no mental impairment

Smoke Alarms
- Decreased 0.54 times when smoke alarms were operating compared to not operating

- Decreased 0.24 times when the alarm did not operate because the fire was not within the designed range of the detector
- Decreased 0.11 times when the alarm did not operate because the fire was too small
- Increased 4.8 times when the alarm did not operate because of a hard-wire power failure and a discharged or dead back-up battery

Each compared to other reasons for failure.

Remoteness
- Increased 1.5 times when the fire occurred in an outer regional rea
- Increased 2.7 times when the fire occurred in a remote area
- Increased 3.6 times when the fire occurred in a very remote area

Each compared to other remoteness structures.

Mosaic Types
- Increased 14.7 times when the fire occurred in Mosaic Type F17
- Decreased 0.27 times when the fire occurred in Mosaic Type I30

Each compared to other Mosaic Types.

Region
- Decreased 0.59 times when the fire occurred in Metro East
- Decreased 0.70 times when the fire occurred in Metro South

Each compared to other regions.

Building Class
- Decreased 0.62 times when the fire occurred in a non-assigned building class
- Increased 2.0 times when the fire occurred in a Class 10a (non-habitable) building
- Increased 1.7 times when the fire occurred in a Class 1a (detached) building
- Decreased 0.24 times when the fire occurred in a Class 3 (other residential) building
- Increased 1.8 times when the fire occurred in a Class 5 (office) building

Each compared to other building classes.

Type of Owner
- Increased 1.3 times when the fire occurred in a property owned by State Government compared to other types of owners

Ignition Source
- Decreased 0.19 times when the fire was ignited by heat from properly operating electrical equipment
- Decreased 0.24 times when the fire was ignited by an open fire, campfire, or rubbish fire

Each compared to other ignition sources.

Material Ignited First
- Increased 7.9 times when the material ignited first was ceiling covering, surface
- Decreased 0.46 times when the material ignited first was clothing not on a person
- Decreased 0.10 times when the material ignited first was cooking materials, food stuffs
- Decreased 0.23 times when the material ignited first was curtains, blinds, drapery, tapestry
- Increased 6.3 times when the material ignited first was an electrical system component, wiring, or outlet
- Decreased 0.24 times when the material ignited first was exterior trim
- Increased 25.7 times when the material ignited first was LPG
- Decreased 0.23 times when the material ignited first was not assigned
- Increased 1.7 times when the material ignited first was other (furniture)
- Increased 7.4 times when the material ignited first was other (mobile property component)
- Increased 3.0 times when the material ignited first was other (structural component, finish)
- Decreased 0.18 times when the material ignited first was packing, wrapping material
- Increased 1.9 times when the material ignited first was petrol
- Increased 8.7 times when the material ignited first was a petroleum fuelled engine
- Increased 3.4 times when the material ignited first was undetermined

Each compared to other materials ignited first.

Area of Origin
- Decreased 0.25 times when the fire originated in a bathroom, lavatory, locker room, or cloakroom
- Decreased 0.14 times when the fire originated in a chimney or flue
- Increased 1.9 times when the fire originated in an exterior wall surface
- Decreased 0.32 times when the fire originated in a lawn, field, or open area
- Decreased 0.37 times when the fire originated in a lobby or entrance way

- Increased 3.0 times when the fire originated in multiple areas
- Decreased 0.26 times when the fire originated in a medium-sized assembly area
- Decreased 0.14 times when the fire originated on a highway, roadway, or public way
- Decreased 0.12 times when the fire originated in a recreational area
- Increased 34.1 times when the fire originated in an undetermined area

Each compared to other areas of origin.

Other Outcomes

- Increased 1.7 times when evacuations occurred compared to no evacuation

10.4.5.3 Fire Extension x Undetermined

Table 162. Fire Extension x Undetermined Omnibus Tests of Model Coefficients				
		Chi-square	**df**	**Sig.**
Step 66	Step	4.004	1	.045
	Block	1211.884	64	<.001***
	Model	1211.884	64	<.001***

Statistical significance: ****p* <.001, ** *p* < .01, * *p* < .05

Table 163. Fire Extension x Undetermined Model Summary			
Step	**-2 Log likelihood**	**Cox & Snell R Square**	**Nagelkerke R Square**
66	2663.762	.350	.468

Table 164. Fire Extension x Undetermined Classification Table					
			Predicted		
			Fire Extension		Percentage Correct
Observed			No	Yes	
Step 66	Fire Extension	No	922	358	72.0
		Yes	268	1264	82.5
	Overall Percentage				77.7

*The cut value is .500

Table 165. Fire Extension x Undetermined ROC Curve				
Test Result Variable(s)				
Area	**Std. Error**	**Asymptotic Sig.**	**Asymptotic 95% Confidence Interval**	
			Lower Bound	**Upper Bound**
.823	.008	.000	.807	.838

*A moderate-large area value indicates that the model has excellent discrimination

Figure 100. Fire Extension x Undetermined ROC Curve

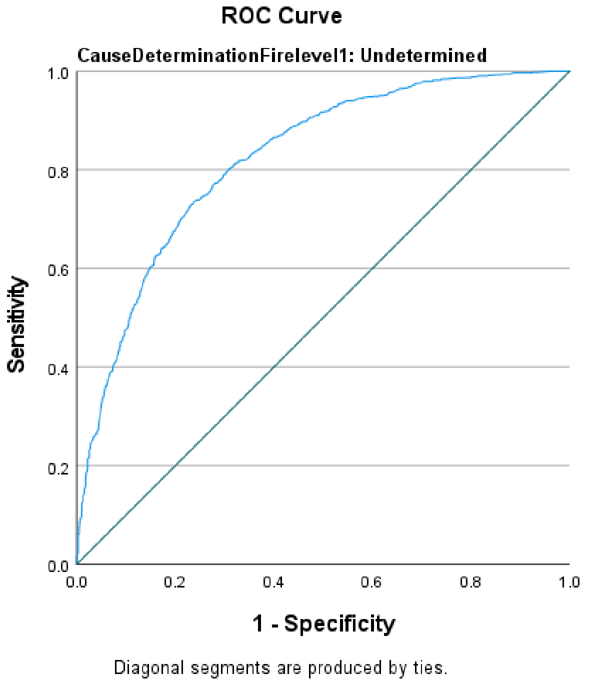


Table 166. Hosmer and Lemeshow Test			
Step	**Chi-square**	**df**	**Sig.**
66	7.228	8	.512

*A large *p* value indicates that the model is not a poor fit.

Table 167. Fire Extension x Undetermined Variables in the Equation								
Variable	**B**	**S.E.**	**Wald**	**df**	**Sig.**	**Exp(B)**	**95% CI Exp(B) Lower**	**Upper**
Call Source=000	.478	.156	9.391	1	.002**	1.613	1.188	2.190
Alarms Detectors Operating=Not assigned	-.759	.309	6.009	1	.014*	.468	.255	.859
Alarms Detectors Operating=True	-1.124	.313	12.926	1	<.001***	.325	.176	.600
Type of Alarm=Gas detector	24.093	40192.969	.000	1	1.000	29079697741.984	.000	.
Type of Alarm=Sprinkler system	-20.197	8792.589	.000	1	.998	.000	.000	.
Reason Alarm not Operating=Defective	-1.676	.435	14.835	1	<.001***	.187	.080	.439
Reason Alarm not Operating=Fire not within designed range of detector/alarm	-1.761	.375	22.062	1	<.001***	.172	.082	.358
Reason Alarm not Operating=Fire too small to operate	-2.807	.489	32.983	1	<.001***	.060	.023	.157
Ignition Source=Conducted heat	1.572	.471	11.121	1	<.001***	4.814	1.911	12.123

Ignition Source=Form of heat of ignition undetermined	.775	.126	38.048	1	<.001***	2.171	1.697	2.777
Ignition Source=Heat from direct flame, convection currents	1.102	.374	8.682	1	.003**	3.010	1.446	6.265
Ignition Source=Heat from electrical equipment, overloaded	.923	.276	11.198	1	<.001***	2.517	1.466	4.321
Ignition Source=Incendiary device	1.348	.608	4.914	1	.027*	3.851	1.169	12.688
Ignition Source=Match, Lighter (flame type)	.581	.267	4.728	1	.030*	1.788	1.059	3.019
Material Ignited First=Chemical process equipment	43.242	20821.492	.000	1	.998	6024628383287590900.000	.000	.
Material Ignited First=Christmas tree (Artificial), artificial / faux plant, faux flowers	25.298	40192.969	.000	1	.999	96992688297.633	.000	.
Material Ignited First=Computer equipment, mains powered	22.354	28274.428	.000	1	.999	5107826876.875	.000	.
Material Ignited First=Dust, fibre, lint	23.157	25391.247	.000	1	.999	11405278006.081	.000	.
Material Ignited First=Electrical Wiring - fixed	1.403	.591	5.633	1	.018*	4.068	1.277	12.958
Material Ignited First=Exterior covering or permanently affixed surface item	2.807	1.151	5.950	1	.015*	16.567	1.736	158.112
Material Ignited First=Gas lines	22.076	28221.795	.000	1	.999	3866856621.144	.000	.
Material Ignited First=Grass, bush, and forests, whether growing or dead	2.267	.826	7.531	1	.006**	9.649	1.911	48.714
Material Ignited First=Interior wall covering, surface items permanently affixed to wall and door surface.	2.764	.910	9.222	1	.002**	15.860	2.664	94.404
Material Ignited First=Mattress, pillow	1.947	.518	14.129	1	<.001***	7.005	2.539	19.330
Material Ignited First=Other (heating systems)	2.304	1.110	4.306	1	.038*	10.014	1.136	88.235
Material Ignited First=Other (structural component, finish)	1.966	.455	18.625	1	<.001***	7.139	2.924	17.432

Material Ignited First=Other (supplies, stock)	1.747	.864	4.087	1	.043*	5.738	1.055	31.215
Material Ignited First=Other Flammable Liquid	4.232	1.583	7.147	1	.008**	68.827	3.093	1531.444
Material Ignited First=Outdoor cooking equipment	-22.171	27628.448	.000	1	.999	.000	.000	.
Material Ignited First=Undetermined	1.368	.113	147.057	1	<.001***	3.927	3.148	4.899
Area of Origin=Bathroom, Lavatory, locker room, cloakroom	-2.722	.638	18.199	1	<.001***	.066	.019	.230
Area of Origin=Ceiling cavity, roof space	.588	.256	5.295	1	.021*	1.801	1.091	2.973
Area of Origin=Chimney/flue	-2.735	.707	14.980	1	<.001***	.065	.016	.259
Area of Origin=Equipment room/area.	-1.379	.567	5.906	1	.015*	.252	.083	.766
Area of Origin=Kitchen, cooking area	-.404	.190	4.517	1	.034*	.668	.460	.969
Area of Origin=Laundry room, area	-.917	.295	9.656	1	.002**	.400	.224	.713
Area of Origin=Lounge Room, Family Room, Living Area	.582	.174	11.232	1	<.001***	1.790	1.273	2.515
Area of Origin=Multiple Areas of Origin	1.879	.590	10.157	1	.001**	6.547	2.062	20.792
Area of Origin=On or near highway, roadway, street, public way, parking lot	-1.335	.691	3.730	1	.053	.263	.068	1.020
Area of Origin=Retail or Sales Area	-2.412	1.141	4.470	1	.034*	.090	.010	.839
Area of Origin=Scrub or bush area, woods, forest	21.059	15699.872	.000	1	.999	1399020165.642	.000	.
Area of Origin=Undetermined	2.088	.161	168.095	1	<.001***	8.067	5.883	11.060
Building code=#	-.617	.231	7.117	1	.008**	.539	.343	.849
Building code=Class 10a	.708	.224	9.952	1	.002**	2.030	1.307	3.151
Building code=Class 1a (detached)	.566	.125	20.607	1	<.001***	1.760	1.379	2.247
Building code=Class 2	-.693	.196	12.529	1	<.001***	.500	.340	.734
Building code=Class 7b	.748	.281	7.094	1	.008**	2.112	1.218	3.663
Building code=Class 8	.823	.301	7.457	1	.006**	2.277	1.262	4.111
Building code=Class 9a	-2.686	1.242	4.679	1	.031*	.068	.006	.777
Building code=Class 9b	-.607	.306	3.937	1	.047*	.545	.299	.993
Region=MW	.512	.141	13.236	1	<.001***	1.669	1.266	2.199

Region=RS	.598	.158	14.332	1	<.001***	1.818	1.334	2.478
Region=RW	.658	.171	14.837	1	<.001***	1.931	1.381	2.699
Mosaic Type=D12	.941	.488	3.714	1	.054	2.563	.984	6.675
Mosaic Type=H26	-.934	.403	5.360	1	.021*	.393	.178	.867
Mosaic Type=J32	1.363	.389	12.244	1	<.001***	3.907	1.821	8.382
Mosaic Type=L42	.723	.252	8.209	1	.004**	2.061	1.257	3.379
Mosaic Type=N48	2.782	.888	9.806	1	.002**	16.146	2.831	92.085
Mosaic Type=N50	1.481	.743	3.976	1	.046*	4.399	1.026	18.869
Remote Index=Remote Australia	-.851	.363	5.484	1	.019*	.427	.210	.870
Remote Index=Very Remote Australia	1.861	.942	3.900	1	.048*	6.428	1.014	40.748
Time of Day=Night	.456	.098	21.731	1	<.001***	1.578	1.303	1.912
SEIFA Decile=1.0	.497	.155	10.247	1	.001**	1.645	1.213	2.230
Evacuations	.809	.120	45.285	1	<.001***	2.245	1.774	2.842
Constant	-1.766	.360	24.103	1	<.001***	.171		

Statistical significance: ****p* <.001, ** *p* < .01, * *p* < .05

The logistic regression model was statistically significant ($X^2(64) = 1211.884$, p<.001). The model was not a poor fit ($p = .512$) and had excellent discrimination (ROC AUC = .823). The odds of fire extension beyond the room of origin in an undetermined fire:

Response
- Increased 1.6 times when the call source was a Triple Zero call compared to other call sources

Temporal
- Increased 1.6 times when the fire occurred during the night compared to during the day

Smoke Alarms
- Decreased 0.47 times when smoke alarm operation was not assigned compared to assigned
- Decreased 0.33 times when smoke alarms were operating compared to not operating or not assigned

- Decreased 0.19 times when the alarm did not operate because it was defective
- Decreased 0.17 times when the alarm did not operate because the fire was not within the designed range of the detector
- Decreased 0.06 times when the alarm did not operate because the fire was too small

Each compared to other reasons for failure.

Remoteness
- Decreased 0.43 times when the fire occurred in a remote area
- Increased 6.4 times when the fire occurred in a very remote area

Each compared to other remoteness structures.

SEIFA Decile
- Increased 1.6 times when the fire occurred in SEIFA Decile 1 compared to other SEIFA Deciles.

Mosaic Types
- Increased 2.6 times when the fire occurred in Mosaic Type D12
- Decreased 0.39 times when the fire occurred in Mosaic Type H26

- Increased 3.9 times when the fire occurred in Mosaic Type J32
- Increased 2.1 times when the fire occurred in Mosaic Type L42
- Increased 16.1 times when the fire occurred in Mosaic Type N48
- Increased 4.4 times when the fire occurred in Mosaic Type N50

Each compared to other Mosaic Types.

Region

- Increased 1.7 times when the fire occurred in Metro West
- Increased 1.8 times when the fire occurred in Regional South
- Increased 1.9 times when the fire occurred in Regional West

Each compared to other regions.

Building Class

- Increased 0.54 times when the fire occurred in a non-assigned building class
- Increased 2.0 times when the fire occurred in a Class 10a (non-habitable) building
- Increased 1.8 times when the fire occurred in a Class 1a (detached) building
- Decreased 0.50 times when the fire occurred in a Class 2 (unit) building
- Increased 2.1 times when the fire occurred in a Class 7b (storage) building
- Increased 2.3 times when the fire occurred in a Class 8 (laboratory) building
- Decreased 0.07 times when the fire occurred in a Class 9a (healthcare) building
- Decreased 0.55 times when the fire occurred in a Class 9b (assembly) building

Each compared to other building classes.

Ignition Source

- Increased 4.8 times when the fire was ignited by conducted heat
- Increased 2.2 times when the fire was ignited by a form of heat ignition undetermined
- Increased 3.0 times when the fire was ignited by heat from a direct flame, convection currents
- Increased 2.5 times when the fire was ignited by heat from overloaded electrical equipment
- Increased 3.9 times when the fire was ignited by heat from an incendiary device
- Increased 1.8 times when the fire was ignited by heat from a match or lighter

Each compared to other ignition sources.

Material Ignited First

- Increased 4.1 times when the material ignited first was electrical wiring, fixed
- Increased 16.6 times when the material ignited first was exterior covering or permanently affixed surface item
- Increased 9.6 times when the material ignited first was grass, bush, forests
- Increased 15.9 times when the material ignited first Interior wall covering or permanently affixed to wall or door surface
- Increased 7.0 times when the material ignited first was a mattress or pillow
- Increased 10.0 times when the material ignited first was other (heating systems)
- Increased 7.1 times when the material ignited first was other (structural component, finish)
- Increased 5.7 times when the material ignited first was other (supplies or stock)
- Increased 68.8 times when the material ignited first was other flammable liquid
- Increased 3.9 times when the material ignited first was undetermined

Each compared to other materials ignited first.

Area of Origin

- Decreased 0.07 times when the fire originated in a bathroom, lavatory, locker room, or cloakroom
- Increased 1.8 times when the fire originated in a ceiling cavity, roof space

- Decreased 0.07 times when the fire originated in a chimney or flue
- Decreased 0.25 times when the fire originated in an equipment room area
- Decreased 0.67 times when the fire originated in a kitchen or cooking area
- Decreased 0.40 times when the fire originated in a laundry room
- Increased 1.8 times when the fire originated in a lounge room or living room
- Increased 6.5 times when the fire originated in multiple areas
- Decreased 0.26 times when the fire originated on a highway, roadway, or public way
- Decreased 0.09 times when the fire originated in a retail or sales area
- Increased 8.1 times when the fire originated in an undetermined area

Each compared to other areas of origin.

Other Outcomes

- Increased 2.2 times when evacuations occurred compared to no evacuation

11 Appendix B

11.1 Monash University Preliminary Methodological Review - July 2022

Reviewers Feedback	Author Response	Page/s
The purpose refers to prevalence and incidence of fires. Incidence is new instances of an outcome whilst prevalence is the total number of the population where the outcome is present at a point in time. For fires, incidence is generally the relevant measure since fires tend to be short-term events and so do not continue on in the community (unlike a long-term health consequence such as cancer). We suggest the analysis presented in Section 5 should be labelled incidence rather than prevalence.	All references to prevalence have been replaced with incidence.	18, 29-34, and throughout
Predictive analysis does not generally provide causal relationships. It only provides associations between risk factors and outcomes.	Purpose of predictive analysis clarified in the methodology.	18-19
The analysis needs to carefully define the risks being assessed. Is it the risk of a fire occurring or the severity of a fire outcome once the fire has occurred? These are very different risks and will have different risk factors. It appears the analysis is focused on the severity of the outcome once the fire has occurred.	Clarified by explicitly stating that the purpose of the report is to assess adverse outcomes of structure fires.	19
Notwithstanding the definitions, the general approach of relating risk factors to a range of outcomes is very useful.	Noted.	NA
As noted in the report, the outcome of injury and the level of detail is often limited in AIRS data and really need to be verified by matching with external data.	Addressed as a recommendation and noted in the Data Limitations section.	17, 28-29
The reasons for the missing and non-matching data need to be explored further, the systematic bias in these	Further information on missing data provided.	22-23

cases explored, and the impact on the overall analysis discussed.		
Bivariate analyses are only of limited use in such risk studies as they only look at associations between variables unadjusted for the (confounding) effects of other variables. Correlations between predictor variables in real world data can mask important associations and present spurious correlations depending on the level of association between predictor variables. These results should be treated with extreme caution. Multivariate analysis is the only viable means of establishing adjusted association between risk factors and outcome variables.	Bivariate analysis was only used to identify associations between variables. The bivariate results were not used to identify risk factors. The limitations of bivariate analyses were detailed in the methodology section. The bivariate results have been moved to Appendix A to avoid confusion.	26, 135
When dealing with a large number of predictor variables in an analysis, it is useful to understand the level of correlation (or collinearity) between predictor variables to be able to interpret the role of the variable in the risk analysis. Inclusion of highly collinear variables in a multivariate analysis can result in inaccurate interpretation of the association between the collinear variables and the outcome. Collinear variables are often representing similar underlying constructs. In this case, including only one of the collinear variable sets in the analysis is adequate to represent the underlying construct. An alternative is to undertake a dimensional reduction of the predictor variable set through methods such as principal component analysis. Stepwise model selection can also avoid this problem. Failing to pre-condition the predictor variable set to eliminate high levels of collinearity can lead to serious misinterpretation of the results of the analysis.	The analysis was re-run using a multiple logistic regression model with a forward likelihood ratio stepwise entry method. This method controlled for collinearity.	27-28
The choice of Cox proportional hazards modelling (CPHM) is a little unusual for this analysis. CPHM is most useful where data is censored	The analysis was re-run using a multiple logistic regression model with a forward likelihood ratio stepwise entry method. This method	27-28

(for example we watch a property for a period of time to see if it has a fire reported). Data in the AIRS system are not censored so CPHM is likely to be more inefficient than simply using a logistic regression model which can also include fixed and stochastic model effects. The CPHM also makes assumptions of proportionality in the hazard curves between included factors which need to be tested to ensure the viability of the model. It is not clear if these tests were made. Using a logistic regression model would eliminate the need to assume hazard proportionality.	eliminated the need for hazard proportionality.	
Causality can only be demonstrated through study replication and detailed pathway analysis between risk factor and outcome. This requires the consideration of intermediate outcomes in the path between risk factor and outcome to demonstrate the causal pathway.	Purpose of predictive analysis clarified. Recommendation to repeat study regularly to contribute to an understanding of causality.	18-19

11.2 Monash University Final Report Full Review - December 2022

Reviewers Feedback	Author Response	Page/s
The analyses focus on identifying risk factors – some of which relate to the risk of a fire occurring in the first place (incidence) and others that focus on limiting adverse outcomes (impact) once a fire has already occurred. It may assist to frame the recommendations in the context of the prevention target – which can be primary, secondary, or tertiary. • Primary prevention (preventing a fire from occurring in the first place) • Secondary prevention (providing an immediate response once a fire has occurred in order to limit impact) • Tertiary prevention (intervening after a fire has occurred to limit long-term harmful effects).	All risk factors relate to adverse outcomes of a structure fire, not the risk of a fire occurring in the first place. The purpose of the study was clarified in the introduction, scope, methodology, results, and discussion sections. Emphasis has been placed on mitigating the consequences of structure fires throughout. As a result, it is not appropriate to reframe the recommendations as described. The framing of the recommendations remains unedited.	12, 14-15, 19, 35-97 and throughout
While we acknowledge that ‘preventable fatalities’ is the	FIRU data defines a fatality as preventable or non-preventable. This	14-15

language that has been adopted in the strategy, it is conceptually at odds with a focus on Towards Zero. In a Towards Zero framework, all fatalities are considered preventable. While not all types of fatalities are necessarily under the prevention responsibilities for fire agencies; the shared responsibility model adopted in a systems approach means that joint initiatives with other organisations can provide distributed benefits (e.g., working with police, family violence services, or mental health services to prevent fire fatalities not under the direct jurisdiction of the fire service).	data was used to determine preventability in accordance with FRNSW policies and practices. While the author agrees that a systems-based/shared responsibility approach means that all fatalities are essentially preventable, given the scope of this report, preventability was bound by the jurisdiction of FRNSW. Further clarification on preventability has been provided in the definitions.	
It has not been described in the report as to how 'preventable fatalities' were defined, except through determination by committee. It is important to articulate the criteria for case inclusion in detail (e.g., excluded homicide only, or excluded intentional ignitions with unintentional deaths etc).	Further information has been provided to describe how preventable fatalities are defined by the committee.	14-15
We note the use of the term 'accidental' in the report. This term is no longer used in safety sciences, with the preferred focus of intention (e.g., intentional, or unintentional). Should the team wish to publish the work in a scientific journal, most will not accept the use of the term accidental, as this implies that the event is random and unpreventable.	The term 'accidental' was used throughout as this is the fire determination term used by FRNSW. By using this term, the report aligns with existing FRNSW policies and practices. Fire determination terms 'accidental', 'deliberate', and 'undetermined' were added to definitions. If the authors wish to publish components of this report in a scientific journal, the term will be explicitly defined as a fire determination term or will be edited as recommended.	14-15
Whilst the term prevalence is sometimes appropriate for describing injury depending on context, it has still been used in different parts of the report where the term incidence should be used. Various instances are outlined as follows. • In discussing data linkages, the description "measure the prevalence,	The terms have been edited accordingly.	4, 5, 7, 17, 18, 19, 26, 29, 30, 56, 59, 61, 63

severity, and mechanisms" of structure fire injuries or fatalities was used. The datasets highlighted for linkage such as the Burns Registry or Coronial data are injury surveillance datasets. For example, one of the stated purposes of the Burns Registry is to "monitor burn injury incidence". As such, linkage will help with measurement of incidence rather than prevalence. • Similarly, in other parts of the report, the stated objective should be to, "deepen understanding of the incidence, characteristics, and risk factors of structure fires and adverse outcomes, and to develop evidence-based Prevention + Education program". As noted, interventions should be designed to prevent the incidence from occurring in the first place, therefore the incidence or number of new cases is the more relevant measure than prevalence for this work. This is consistent with the aim of identifying factors associated with the occurrence of a new incident so that it can be prevented. • Section 10.1 presents the outcomes of various univariate analyses, including the proportion of incidents for different variables. Section 4.5.1, "Univariate Analysis", should describe the use of descriptive statistics as measuring incidence rather than prevalence. • Similarly, Figure 1 under Section 5.1, "Incidence", doesn't show prevalence but rather incidence		
A multivariate logistic regression analysis has been undertaken to identify significant risk factors leading to an adverse outcome, which includes injury, evacuation, and extent of fire. A separate incidence analysis (multivariate logistic regression model) does not appear to have been undertaken. As noted, the risk of an incident occurring in the first place will have different risk factors, e.g., socio-demographic variables. This type of information has only been considered in the	To clarify the scope and purpose of the report, further information has been provided in the Data Limitations section. This information states that the risk factors relating to adverse outcomes likely differ from the risk of a fire occurring in the first place. The purpose of the study was to identify risk factors of adverse outcomes, not of a fire occurring in the first place. The study of risk of a fire occurring requires a different	28-29

context of a fire that has already occurred. However, many of the recommendations are focused on primary prevention, and thus understanding risk factors leading to a fire are important. For example, there is a wide range of socio-demographic data that could be analysed rather than a broad "socioeconomically disadvantaged area" category. Whilst targeting such groups because of the higher risk of injury and extent of fire has merit, this is not as direct as focussing on the risk factors that lead to the fire in the first place. On the other hand, understanding the risk of adverse outcomes is useful for reducing the severity of injury, or level of damage once an incident has occurred (secondary and tertiary prevention).	dataset and was not within the scope of this study. All recommendations pertain to reducing the consequences of structure fire. None of the recommendations relate to primary prevention or reducing the risk of a fire occurring in the first place.	
It would be useful to provide more detailed comments on the quality of injury data. While fatality information is generally well captured, injuries are notoriously difficult for fire services to measure. What exists in eAIRS may represent more serious cases and/or only when firefighters on-scene have sufficient information to determine an injury has occurred.	Further information has been provided on the limitations of eAIRS data. An additional recommendation has been included to suggest data linkages with NSW Ambulance data to measure injuries more accurately.	18-19, 28-29
Some (8) unlinked cases have been examined (and should be referred to as cases, not variables in Section 4.3).	Unlinked cases have been referred to as such.	22-23
In addition, a comment has been added that as there was no discernible pattern to the missing data, it was missing at random. Some further analysis/explanation as to why there is no systematic bias as a result and the impact of deleting cases with missing values on the multivariate analysis should be included.	Further information has been provided. Given the time variable did not meet the assumptions of the test, it was not included in the multivariate model. Missing time data therefore did not influence the relative risk results.	22-23
The report notes that multivariate analyses have been undertaken to identify risk factors. Bivariate analyses have been used to explore various correlations. Such analyses	Incidence of adverse outcomes over time were included to provide context – to demonstrate that the risk of some adverse outcomes (fatality)	9, 30, 80

including the examination of trends over time are of limited usefulness compared to identifying risk factors if the overall aim is to reduce both the incidence and impact of fire events.	increased over time. These correlations will remain for context. Other correlations including at-risk materials over time have been removed to avoid confusion.	
For the multivariate analysis undertaken, the elimination of collinearity has been addressed through the use of a forward stepwise entry method to construct the regression model.	Noted.	NA
Cox proportional hazards modelling has been replaced with multivariate logistic regression analysis, which is appropriate.	Noted.	NA
The recommendations in the report are generally appropriate and supported by the analyses conducted. Structuring the analyses according to incidence/impact, and defining the prevention target (primary, secondary, tertiary) can support the prioritisation of interventions.	As stated above, the purpose of the study focuses on consequences only. This has been clarified throughout. As a result, there are no primary prevention interventions. The framing of the recommendations remains unedited.	3-9 and throughout
One of the recommendations is to link with the Burns Registry to obtain more detailed information on injury. While this is a good option for data linkage, burns represent serious injuries. This excludes all other types of injury that are possible in the event of a fire (e.g., traumatic injuries from trying to escape a fire, falling objects, collapsing structures etc). Thus, it may be helpful to also link to ambulance transfer data. While this also generally captures more serious injuries, there is usually some level of information about treatment on scene without transfer to hospital.	An additional recommendation has been included to suggest data linkages with NSW Ambulance data to measure non-burn related injuries associated with structure fires.	4, 18

11.3 Monash University Peer Review Report - December 2022

MONASH University

ACCIDENT RESEARCH CENTRE

Peer-review of FRNSW Adverse Structure Fire Outcomes Report 2016-2021

Overview

Fire and Rescue NSW (FRNSW) recently undertook analysis of adverse structure fire outcomes. FRNSW requested a peer-review of the report by Monash University Accident Research Centre (MUARC). Preliminary methodological feedback was provided on an initial draft, and this review focuses on the revised draft.

Context

The report covered all structure fires that occurred in FRNSW's jurisdiction between 1 January 2016 and 31 December 2021, and recorded in the electronic Australasian Incident Reporting System (eAIRS). Data were analysed to identify risk factors for "structure fire fatality, preventable fatality, injury, evacuation, and fire extension". This is an important and insightful piece of work, and we congratulate the team on their work. The following review provides additional points for consideration.

Conceptual

This report provides an important analysis of structure fire outcomes in NSW. It follows a public health approach and uses associated epidemiological methods.

The analyses are intended to be used to inform evidence-based approaches to research and resource prioritisation and to the development, implementation, and evaluation of Prevention + Education advocacy, programs, resourcing and messaging.

1. FRAMING THE TYPES OF PREVENTION

The analyses focus on identifying risk factors – some of which relate to the risk of a fire occurring in the first place (incidence) and others that focus on limiting adverse outcomes (impact) once a fire has already occurred. It may assist to frame the recommendations in the context of the prevention target – which can be primary, secondary, or tertiary.

- Primary prevention (preventing a fire from occurring in the first place)

- Secondary prevention (providing an immediate response once a fire has occurred in order to limit impact)
- Tertiary prevention (intervening after a fire has occurred to limit long-term harmful effects)

2. TOWARDS ZERO FATALITIES & PREVENTABILITY

The report focuses on the concept of Towards Zero Fatalities, which is consistent with the AFAC Residential Fire Fatality and Injury Prevention strategy. Zero harm approaches have been initiated across many safety-related domains (including workplace safety and road safety, among many others). These approaches are based on the premise that all serious injuries and fatalities are preventable; people should not die from going to work, or using the transport system. Zero harm takes the approach that everyone should be aware that safety is a shared responsibility, and everyone has a role to play in achieving better safety outcomes. These are known as systems approaches.

While we acknowledge that 'preventable fatalities' is the language that has been adopted in the strategy, it is conceptually at odds with a focus on Towards Zero. In a Towards Zero framework, all fatalities are considered preventable. While not all types of fatalities are necessarily under the prevention responsibilities for fire agencies; the shared responsibility model adopted in a systems approach means that joint initiatives with other organisations can provide distributed benefits (e.g., working with police, family violence services, or mental health services to prevent fire fatalities not under the direct jurisdiction of the fire service).

It has not been described in the report as to how 'preventable fatalities' were defined, except through determination by committee. It is important to articulate the criteria for case inclusion in detail (e.g., excluded homicide only, or excluded intentional ignitions with unintentional deaths etc).

3. TERMINOLOGY

We note the use of the term 'accidental' in the report. This term is no longer used in safety sciences, with the preferred focus of intention (e.g., intentional or unintentional). Should the team wish to publish the work in a scientific journal, most will not accept the use of the term accidental, as this implies that the event is random and unpreventable.

It is not clear from the report exactly how 'preventable' was determined. Suggest changing the language of 'accidental' to 'unintentional'.

Methodological review

The methodological review is provided below. The boxes represent previous comments that were provided in July 2022; included where further comment has been provided.

1. PURPOSE

- *The purpose talks about prevalence and incidence of fires. Incidence is new instances of an outcome whilst prevalence is the total number of the population where the outcome is present at a point in time. For fires, incidence is generally the relevant measure since fires tend to be short-term events and so do not continue on in the community (unlike a long-term health consequence such as cancer). The analysis presented in Section 5 should be labelled incidence not prevalence.*

The analysis presented in Section 5 has now been labelled using the term incidence rather than prevalence. As noted, this is appropriate as incidence provides an examination of the number of new cases, whereas prevalence refers to the total number of cases of a condition *at a certain point in time*. The latter is relevant when referring to a disease (such as the prevalence of cancer in the population). However, for the study of factors associated with event occurrence and possible interventions that could be implemented to prevent the incident from occurring in the first place, the term incidence should be used. Nonetheless, an examination of injury prevalence may be useful within the context, for example, of identifying the treatment needs of those that are already injured.

Whilst the term prevalence is sometimes appropriate for describing injury depending on context, it has still been used in different parts of the report where the term incidence should be used. Various instances are outlined as follows.

- In discussing data linkages, the description "measure the prevalence, severity, and mechanisms" of structure fire injuries or fatalities was used. The datasets highlighted for linkage such as the Burns Registry or Coronial data are injury surveillance datasets. For example, one of the stated purposes of the Burns Registry is to "monitor burn injury incidence". As such, linkage will help with measurement of incidence rather than prevalence.
- Similarly, in other parts of the report, the stated objective should be to, "deepen understanding of the *incidence*, characteristics, and risk factors of structure fires and adverse outcomes, and to develop evidence-based Prevention + Education program". As noted, interventions should be designed to prevent the incidence from occurring in the first place, therefore the incidence or number of new cases is the more relevant measure than prevalence for this work. This is consistent with the aim of identifying factors associated with the occurrence of a new incident so that it can be prevented.
- Section 10.1 presents the outcomes of various univariate analyses, including the proportion of incidents for different variables. Section 4.5.1, "Univariate Analysis", should describe the use of descriptive statistics as measuring incidence rather than prevalence.
- Similarly, Figure 1 under Section 5.1, "Incidence", doesn't show prevalence but rather incidence.

- *The analysis needs to carefully define the risks being assessed. Is it the risk of a fire occurring or the severity of a fire outcome once the fire has occurred? These are very different risks and will have different risk factors. It appears the analysis is focused on the severity of the outcome once the fire has occurred.*
- *Notwithstanding the definitions, the general approach of relating risk factors to a range of outcomes is worthy.*

A multivariate logistic regression analysis has been undertaken to identify significant risk factors leading to an adverse outcome, which includes injury, evacuation, and extent of fire. A separate incidence analysis (multivariate logistic regression model) does not appear to have been undertaken. As noted, the risk of an incident occurring in the first place will have different risk factors, e.g., socio-demographic variables. This type of information has only been considered in the context of a fire that has already occurred. However, many of the recommendations are focused on *primary* prevention, and thus understanding risk factors leading to a fire are important. For example, there is a wide range of socio-demographic data that could be analysed rather than a broad "socioeconomically disadvantaged area" category. Whilst targeting such groups because of the higher risk of injury and extent of fire has merit, this is not as direct as focussing on the risk factors that lead to the fire in the first place. On the other hand, understanding the risk of adverse outcomes is useful for reducing the severity of injury, or level of damage once an incident has occurred (*secondary and tertiary prevention*).

2. DATA COLLECTION

It would be useful to provide more detailed comments on the quality of injury data. While fatality information is generally well captured, injuries are notoriously difficult for fire services to measure. What exists in eAIRS may represent more serious cases and/or only when firefighters on-scene have sufficient information to determine an injury has occurred.

3. DATA CLEANING

- *The reasons for the missing and non-matching data need to be explored further, the systematic bias in these cases explored and the impact on the overall analysis discussed.*

Some (8) unlinked cases have been examined (and should be referred to as cases, not variables in Section 4.3). In addition, a comment has been added that as there was no discernible pattern to the missing data, it was missing at random. Some further analysis/explanation as to why there is no systematic bias as a result and the impact of deleting cases with missing values on the multivariate analysis should be included.

4. DATA ANALYSIS

- *Bivariate analyses are only of limited use in such risk studies as they only look at associations between variables unadjusted for the (confounding) effects of other variables. Correlations between predictor variables in real world data can mask important associations and present spurious correlations depending on the level of association between predictor variables. These results should be treated with extreme caution. Multivariate analysis is the only viable means of establishing adjusted association between risk factors and outcome variables.*

The report notes that multivariate analyses have been undertaken to identify risk factors. Bivariate analyses have been used to explore various correlations. Such analyses including the examination of trends over time are of limited usefulness compared to identifying risk factors if the overall aim is to reduce both the incidence and impact of fire events.

For the multivariate analysis undertaken, the elimination of collinearity has been addressed through the use of a forward stepwise entry method to construct the regression model.

Cox proportional hazards modelling has been replaced with multivariate logistic regression analysis, which is appropriate.

Report recommendations

The recommendations in the report are generally appropriate and supported by the analyses conducted. Structuring the analyses according to incidence/impact, and defining the prevention target (primary, secondary, tertiary) can support the prioritisation of interventions.

One of the recommendations is to link with the Burns Registry to obtain more detailed information on injury. While this is a good option for data linkage, burns represent serious injuries. This excludes all other types of injury that are possible in the event of a fire (e.g., traumatic injuries from trying to escape a fire, falling objects, collapsing structures etc). Thus, it may be helpful to also link to ambulance transfer data. While this also generally captures more serious injuries, there is usually some level of information about treatment on scene without transfer to hospital.

Conclusions

This is an important report that will help NSWFRS to systematically measure their problem and inform prevention activities. The revised analysis methods are appropriate for the analyses conducted. Congratulations to the team.

The review was completed by:

- Dr Carlyn Muir: *Psych(Hons), MA(SocSci), PhD, SFHEA*
- Professor Stuart Newstead: *BSc(Hons), MSc, PhD, A.Stat*
- Dr Angelo D'Elia: *BE(Mech)(Hons), BSc(Hons), PhD*