Fire Research Report

Overview of fire-related mortality data for New Zealand 1991-1997

University of Otago

December 2001

A methodology is developed for collating fire fatality data from the Fire Incident Recording System and New Zealand Health Information Service and linking with coroners' files to provide a comprehensive account of fire-related deaths in Aotearoa New Zealand.

Fire-related injury is found to be the leading cause of unintentional death from injury in the domestic environment for young people and adults aged 15-64 years, and one of the top three causes of unintentional death from injury in that environment for children and seniors.

Fire mortality rates are highest for children under five years, and seniors aged over 74 years, although the rates for seniors declined over the study period. Fire fatality rates are higher for male children and male adults aged under 55 years. There are marked disparities in fire mortality rates between Maori and non-Maori, and Maori are more likely to be involved in multiple fatality incident.

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Introduction

This report to the New Zealand Fire Service Commission provides background and context for the analysis of fire-related fatality data in Aotearoa New Zealand. The report draws on analysis of existing mortality and structural fire data. The report is one of a series contracted for in the New Zealand Fire Service Commission Contestable Research Fund for the 2001-2002 research year. This report describes the dataset as a whole, with examination of patterns over time drawing on population group specific factors identified in previous reports. Previous reports have included descriptions of

- fire-related mortality among children aged under 15 years
- fire-related mortality among young people and adults aged 15-64 years
- fire-related mortality among adults aged over 64 years
- child injury from fire and flame in the Auckland region
- fire-related mortality in the workplace
- relative socio-economic deprivation and fatal fire incident
- Auahi Whakatüpato fire safety programme in eastern Bay of Plenty

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Executive Summary

The descriptive study approached unintentional injury from fire and flame in Aotearoa New Zealand from a public health and injury prevention perspective. Fire fatality data from the Fire Incident Recording System and New Zealand Health Information Service were collated and linked with coroners' files to provide a comprehensive account of fire-related deaths in Aotearoa New Zealand.

Fire–related injury is the leading cause of unintentional death from injury in the domestic environment for young people and adults aged 15-64 years, and one of the top three causes of unintentional death from injury in that environment for children and seniors. Unintentional injury from fire and flame accounted for 1464 potential years of life lost in 1996.

Combined data sources identified 191 deaths which occurred in 155 unintentional domestic fire incidents in Aotearoa New Zealand from 1991 to 1997 inclusive. The New Zealand Fire Service attended 141 (91 per cent) of these 155 fatal unintentional domestic fire incidents.

- Incidents attended by the Fire Service accounted for 177 (93 per cent) of the 191 fatalities in the study series.
- FIRS fatality data contained records for 154 (87 per cent) of the 177 fatalities attended by the New Zealand Fire Service between 1991 and 1997. These 154 records in FIRS fatality data represented 81 per cent of the total number of deaths as a result of injury from fire and flame in an unintentional domestic fire incident in the study time frame.
- Fire details for a further 15 unintentional domestic fire incidents which resulted in a total of 17 fatalities were included in FIRS residential structure fire data.
- There were five single fatality incidents for which no FIRS record was located, despite evidence in the coroners' files that the Fire Service had attended the incident.
- Fourteen single fatality incidents not attended by the New Zealand Fire Service were identified from Health Information Service unintentional injury data.
- FIRS fatality data also included six individuals for whom death could not be confirmed using New Zealand Health Information Service data and coronial files.

All unintentional domestic deaths from fire and flame between 1991 and 1997 in Aotearoa New Zealand were included in the NZHIS unintentional fatality dataset, although only 175 (92 per cent) were correctly coded as injury from fire and flame in a domestic location. Eight percent of cases were coded to non-domestic locations, or to related modes of injury.

Fire mortality rates were highest for children aged under five years, and adults aged over 74 years. Annual mortality rates for seniors (aged over 64 years) declined over the study period. Fire fatality rates were higher for male children and male adults aged under 55 years. Marked disparities in fire mortality rates were observed between Mäori and non Mäori. Fatal fire incidents involving Mäori were more likely than incidents not known to involve Mäori to result in multiple fatalities. A similar pattern was observed for Pacific peoples.

Accurate and comprehensive data collection is essential to monitor patterns of fire-related injury, and to monitor the impact of population based fire prevention strategies. Current Fire Service data can be used with confidence, yet could be improved with education of fire-fighters regarding importance of data, inclusion of additional data fields, and linking with health service data to increase case ascertainment. Separate coding of fire-related deaths in the index to coroners' files would also assist case identification and retrieval of data.

Recommendations

That the New Zealand Fire Service Commission ensure ongoing education of fire-fighters concerning the value of accurate and complete data entries to inform fire prevention strategies, including accurate description of nature of injury, and positive or negative entries in all data fields (e.g. full information about the presence or absence of smoke alarms). For background see page 21.

That the New Zealand Fire Service place increased emphasis on prevention of fire related injury and property damage in the collation and publication of statistics through documentation of specific heat sources and items ignited in fire incidents, documentation of the ethnicity of deceased using the ethnicity variables from the 2001 census, and use of age groupings which allow ready review of trends in domestic fire fatalities with particular reference to adults aged over 64 years and children aged under 15 years. For details see page 21.

That the New Zealand Fire Service Commission formally request the Department of Courts to review the coding categories used to index coronial files, and further request that a specific code be applied to deaths from injury where the external cause of injury was fire and flame. Such coding should apply whether the death occurs immediately, or occurs later as a complication of the original injury and that the New Zealand Fire Service explore and develop appropriate methods to link with New Zealand Health Information Service to ensure that fire fatality datasets are as comprehensive as possible. For details see page 21 - 22.

That the New Zealand Fire Service Commission develop a bicultural policy and continue to support efforts in each region to develop culturally appropriate services, including the appointment of Iwi liaison officers and engagement with Mäori networks to promote fire safety, and that the New Zealand Fire Service Commission encourage the development of effective fire safety strategies for Pacific peoples and other ethnic minority groups. For details see page 24.

That the New Zealand Fire Service Commission investigate the costs and benefits to society of standard development, implementation and enforcement for consumer products involved in the ignition of domestic fire incidents. Such consumer products include cigarettes, heaters, upholstered furniture and adult clothing. For details see page 24.

That the New Zealand Fire Service Commission continue to participate in intersectoral strategies to improve the wellbeing of New Zealand households, including consideration of the impact of social and economic policy on fire safety particularly among households at greatest risk of fire-related injury. For details see page 24.

Background

This research project approaches injury from fire and flame from a public health and injury prevention perspective. A public health perspective uses the science of epidemiology to describe the incidence and patterns of injury, and is interested in the influences of society on health. Injury prevention and treatment is a branch of public health that seeks to understand personal, mechanism related and environmental factors which affect the incidence and severity of human injury. Events which result in injury are subdivided into unintentional, self-inflicted and assaults, with fatal outcomes in the latter two categories defined as suicide and homicide. Unintentional injury is the leading cause of death for New Zealanders aged 1-34 years, and is overall the fourth leading cause of death in New Zealand, resulting in over 1000 deaths per annum (Baxter, 2000)

The impact of injury related deaths can also be assessed on the basis of potential years of life lost (pyll) – which calculates the years the deceased would have contributed to society if they had lived to 75 years. In 1996 it was estimated that unintentional injury resulted in the loss of 32,415 potential life years (Baxter, 2000). Within these data almost two thirds of the potential years of life lost resulted from motor traffic injuries (20162 pyll; 62 per cent). Drowning accounted for a further 11 per cent (3676 pyll). Unintentional injury from fire and flame accounted for the loss of 1464 pyll (5 per cent of the total), a proportion similar to that contributed by falls (1517 pyll; 5 per cent), suffocation (1325 pyll; 4 per cent) and other transport injuries (1457 pyll; 4 per cent). All other modes of injury combined accounted for the remaining nine per cent of unintentional injury related deaths.

The domestic environment

The Accident Compensation Commission notes that 161 New Zealanders died as a result of unintentional injury at home in 2000 and go on to say:

> Home is a place we retreat to. It is a place of comfort, a place where we relax, a place where we feel safe. Where, every two days, somebody dies – needlessly, unnecessarily – from an accident. And home goes beyond the house and the backyard. It is our [parks and playgrounds, our schools, our friend's house next door. Places where we should be safe. And where we, quite clearly, aren't (ACC, 2001).

In the housing and health literature (Mood, 1993) identifies four features of a healthy residential environment:

- Protection from physiological extremes (warm and dry)
- Protection from infectious disease (adequate space, clean food and water provision)
- Protection from physical injury (well-lit, fire-resistant materials, guards on stairs, etc) and
- Promoting mental and emotional well-being (adequate space for all occupants, adequate resources to meet daily needs)

Protection of occupants from fire-related injury, including death, is part of the third feature of healthy housing. Reference to this model signals that many dwellings and households at risk for fire related injury also pose dangers to health in terms of damp, mould, lack of adequate sanitation, crowding and lack of aesthetics. Using Mood's model, the issue of fire safety can be considered as one component of improving the health of households. However

intersectoral action to improve housing standards and quality, such as that demonstrated in the current whole of government approach in Northland and East Coast, is likely to be necessary to impact significantly on the health of the occupants.

Public health importance of fire-related injury

Within the domestic environment, fire related injury is the leading cause of unintentional death from injury for New Zealanders aged 15-64 years (see Table 1). Although significantly outweighed by falls as a mode of fatal injury among adults aged over 64 years, injury from fire and flame remained the third leading cause of fatal injury in the domestic environment in this age group. Collated data concerning unintentional fire-related mortality in the domestic environment demonstrate the relative youth of lives lost, with over three-quarters of the deceased aged under 65 years and 45 per cent aged under 25 years (Duncanson, Woodward, Reid, & Langley, 2000).

Table 1. Numbers of deaths as a result of unintentional injury in the domestic environment by age group and mode of injury, 1993-1997. Data source: New Zealand Health Information Service.

Age group Mode of injury	0-14 years n (%)	15-64 years n (%)	Over 64 years n (%)
Fire and Flames	21 (24)	30 (29)	8 (4)
Accidental Poisoning	3 (3)	25 (24)	3 (2)
Falls	2 (2)	18 (17)	144 (79)
Submersion/Suffocation	54 (61)	12 (12)	9 (5)
Natural/Environmental	0 (0)	4 (4)	5 (3)
Motor Vehicle (not crashes)	4 (5)	2 (2)	2 (1)
Other accidents in the home	4 (5)	12 (12)	11 (6)
Total	**88 (100)**	**103**	**182**

The marked socio-economic gradient associated with fire-related mortality (Duncanson, Woodward, & Reid, 1999), and the ethnic disparities in mortality rates especially for children (Duncanson et al., 2000), highlight this mode of injury as one which requires interventions at a population level to identify and eliminate the social pressures producing a state of increased fire injury risk. Although individual level counselling, particularly of parents with young children, may have some positive effect on increasing smoke alarm use (DiGuiseppi & Roberts, 2000), results from controlled trials of smoke detector distribution programmes in the UK have been disappointing in relatively low impact on injury and death rates (DiGuiseppi et al., 1999; personal communication Carolyn DiGuiseppi 2001). The public health importance of injury from fire and flame is further demonstrated by the high case fatality rate and the preventability of fire-related injury.

As shown in Table 2, injury from fire and flame shows a high case fatality rate compared with other modes of injury such as motor vehicle crashes, poisoning, falls and scalding. More severe modes of injury are rail accidents, submersion or drowning, firearm injury, and suffocation, which show very high case fatality rates.

Existence of effective preventive strategies, particularly the presence of a smoke alarm, indicates the preventability of a high proportion of fire-related injuries and deaths (Dowswell, Towner, Simpson, & Jarvis, 1996; Runyan, Bangdiwala, Linzer, Sacks, & Butts, 1992; Warda, Tenenbein, & Moffatt, 1999). Functioning smoke alarms serve to provide early warning of a fire incident, and allow occupants time to evacuate the dwelling. However given

"the varied causes of fire and flame injuries it is likely that diverse interventions …may be required to address this important public health issue" (DiGuiseppi, Edwards, Godward, Roberts, & Wade, 2000).

Table 2. Number and percentage (rounded to nearest whole number) of deaths and hospital admissions for non-fatal injury, with case fatality rates (percentage of injuries resulting in death) for selected modes of injury in Aotearoa New Zealand 1993-1997 inclusive. Data Source New Zealand Health Information Service.

Mode of injury	Deaths (% of all injury deaths)	Admissions (% of all injury admissions)	Case-fatality rate
Pedestrian/Rolling stock	42 (0.5)	19 (<1)	68.9%
Suffocation	1213 (13.8)	948 (0.4)	56.1%
Firearm	400 (4.5)	322 (0.1)	55.4%
Drowning/submersion	562 (6.4)	592 (0.2)	48.7%
Fire/Flame burn	187 (2.1)	1342 (0.5)	12.2%
Motor Vehicle traffic	2850 (32.4)	28592 (11.5)	9.1%
Poisoning	1213 (13.8)	17035 (6.9)	6.6%
Non traffic (excluding pedestrian/ rolling stock)	256 (2.9)	13286 (5.4)	1.9%
Machinery	88 (1.0)	5079 (2.0)	1.7%
Fall	1201 (13.6)	79429 (32.1)	1.5%
Natural environment	49 (0.6)	4533 (1.8)	1.1%
Cut/pierce	157 (1.8)	19275 (7.8)	0.8%
Struck by/ against	166 (1.9)	20865 (8.4)	0.8%
Hot object/ substance	18 (0.2)	3454 (1.4)	0.5%
Over exertion	2 (<1)	5940 (2.4)	0.0%
Other/ Unspecified	402 (4.6)	47087 (19.0)	0.8%
Total/Overall	**8806 (100)**	**247798 (100)**	**3.4%**

Aims and objectives

The descriptive account of fire-related deaths in New Zealand sought to understand and identify factors associated with injury and death in fire incidents through careful and systematic evaluation of available documents.

The specific objectives of the descriptive study were:

1. To collate existing information about domestic fatal fire incidents in New Zealand and describe personal, fire related, social and physical environmental factors relevant to prevention policy; and

2. To advise the Fire Service on improving current fire injury surveillance systems.

Methods

Definitions

Injury from fire and flame includes injuries caused by conflagration, smoke and fumes, conflagration not in building or structure at home, accidental ignition of clothing from controlled fire at home, and other injuries caused by controlled fires.

In this report the domestic environment is taken to be a private residential dwelling (rented or owner-occupied) and the immediate environs. Fires occurring in outbuildings such as detached garages or sheds, outdoors, or in stationary vehicles on private residential property, have been included as occurring in the domestic environment. Fires occurring in commercial premises (e.g. hotels, motels), institutions (e.g. rest homes, prisons), workplaces including farms, and public places were excluded from the study.

Intentional fires, intentional deaths (homicide and suicide) and deaths resulting from illegal activity were excluded from the study.

Explanatory note

The epidemiological term relative risk (RR) is used in this report to compare outcomes in different population groups. The RR is a ratio of the frequency of an outcome in the two groups being compared. The size of the RR gives an indication of the strength of the association; a relative risk of 1 would indicate no difference between the two groups, whereas a RR of 5 indicates a fivefold difference. Each RR calculation has a 95 per cent confidence interval that describes the range within which the true RR is likely to lie.

Results

Fire related deaths

Identifying fire-related deaths

In the time period 1991-1997 a total of 293 fire-related deaths were identified from the fire service and health service data sources. Figure 1 shows that the majority of cases (79 per cent) were linked in both datasets. There were 246 deaths recorded in FIRS fatality data from 1991 to 1997. These data included deaths in structural fires, and in mobile property fires. In the earlier years in the series caravan and mobile home fires were coded as mobile property fires. NZHIS mortality data identified 192 deceased who were recorded as dying from injuries from fire and flame in the domestic location. An additional 26 deaths from fire and flame were identified from NZHIS data with other location codes. A further 23 deceased were identified by searching the NZHIS intentional injury mortality dataset for codes that could be used for fire related injury, and 19 by searching text fields for the words fire/ignition/burns/conflag/smould. The final dataset included all those with an NZHIS diagnosis of injury from fire and flame (ICD-9 external cause of injury codes 890-899), together with cases identified in the subsequent searches where review of the text field EVENTDES could not exclude an unintentional domestic fire incident. One final case was identified in NZHIS data using personal identifying information.

Overall 232 of the deceased were linked in the two datasets, with 33 identified from the FIRS data but not linked with NZHIS data, and 28 identified from NZHIS data but not linked to FIRS data. Coronial records were identified for 276 (94 per cent) of these deceased. Eligibility for inclusion in the study was determined from coronial files. Where no coronial file was found, eligibility was determined by examining relevant fields in the source data. More complete details of the data linking process are shown in Table 3. A further deceased in an assault fire was mentioned in a media report but could be found in neither FIRS nor NZHIS data.

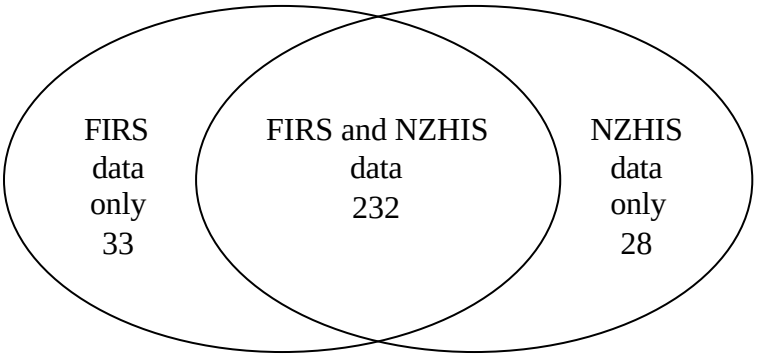


Figure 1. Data sources for identification of deaths as a result of injury from fire and flame in New Zealand 1991-1997.

Table 3. Data linkages process for linking of FIRS, NZHIS and coronial files, with number of deceased found to be eligible for inclusion in study. Eligibility determined from coronial file, event description in NZHIS data, and FIRS data.

Stage 1. Linking FIRS records with NZHIS records	**Linked files**	**Coronial files**	**Eligible**
NZHIS data for deaths from fire and flame in domestic location linked with 160 FIRS fatality records. Coronial files found for 156 of these fatalities. Exclusions: Intentional (9), Hotel/motel (3), Farm (1), Medical cause (1).	160	156	146
NZHIS data for deaths from fire and flame with a non-domestic location code (included unspecified) included 15 of remaining 86 FIRS fatalities. Coronial files found for all 15 of these fatalities. Exclusions: Intentional (1), Hotel/motel (2), Rest Home (6), MV explosion (1).	15	15	5
NZHIS relevant codes (e.g. self-immolation or assault by fire, explosions etc) included 21 of remaining 71 total fatalities. Coronial files found for all 21 of these fatalities. Exclusions: Intentional (16), Occupational (3).	21	21	2
NZHIS text search included 16 of remaining 49 fatalities. Coronial files found for all 16 of these fatalities. Exclusions: Intentional (1), Motor vehicle crash or explosion (14), Occupational (1)	16	16	0
Search of NZHIS data by name found 1 person coded as scald from contact with hot object. Coronial file found for this fatality.	1	1	1
Stage 2. Linking NZHIS data with FIRS data			
FIRS Structure Fire data linked with 19 additional fatalities identified from NZHIS data (all codes). Coronial files found for all 19 of these fatalities. One homicide excluded from study.	19	19	18
Stage 3. Unlinked data			
33 fatalities were recorded in only in the FIRS fatality dataset. Coronial files were found for 27 of these deceased, who all died in motor traffic crashes. For the remaining 6 death could not be confirmed.	33	27	0
28 fatalities were recorded only in NZHIS data (all codes). Coronial files found for 25 of these deceased. Exclusions: Illegal activity (1), Institutional (4), Public place (1), Medical cause (1), Motor vehicle crash (2). For the remaining 3 deceased the text field EVENTDES provided sufficient information for inclusion.	28	25	19
Total	**293**	**279**	**191**

Identifying domestic unintentional fire-related deaths

Of the 293 identified fire-related deaths, 191 were eligible for inclusion in the study. As shown in Table 4 most of the remainder were deaths attributable to motor vehicle crashes or explosions, intentional deaths, and deaths in commercial premises, institutions, workplaces, public places or farms. Coroners' verdicts for seven of the deceased indicated that they died of medical causes. In two cases the inquest details clearly describe a fire incident *preceding* the death from complicating medical causes, and in these cases have been included in the mortality dataset. In two cases it was clear that the fire occurred subsequent to the death (i.e. a fire occurred after sudden death because the deceased was unable to attend to a heat source). In the remaining three cases the coroner's verdict has been accepted, although the lack of inquest details make it difficult to be certain of events. Two of these three cases were coded as domestic deaths from fire and flame in NZHIS data, and it is possible that a medical cause of death was ascribed by a coroner despite a history of a preceding fire incident.

Six fatalities recorded in FIRS data could be linked with neither a coronial record nor a health mortality record. A search of current health service data indicated three of these people had current health identifiers and were likely to be still alive (one had a recent admission to hospital). The remaining three could not be linked date of death or by address with any record in the combined NZHIS dataset (i.e. the dataset including all relevant codes and all incidents identified by a text search). All six were therefore excluded from the study, as the deaths could not be confirmed.

Table 4. Number and percentage (rounded to nearest whole number) of fire-related deaths in Aotearoa New Zealand 1991-1997 with inclusion and exclusion details, as identified from Fire Incident Reporting System and New Zealand Health Information Service data.

Details	Number of fatalities	Percentage of fatalities
Domestic fire incident	191	65
Motor Vehicle crash or explosion	39	13
Intentional	26	9
Suicide	16	6
Homicide/arson/illegal activity	10	3
Hotel/Motel	10	3
Institutional	10	3
Workplace/farm/public place	6	2
Medical cause	5	2
Death not confirmed	6	2
Total	**293**	**100**

Data sources for study group

As shown in Table 5, most of the study deceased were linked in FIRS and NZHIS datasets. Over three-quarters were linked in the two primary datasets, with a further 5 per cent linked when wider criteria were used for NZHIS data, for example non-domestic location, other codes which could include injury from fire and flame, and a text search for relevant words.

Table 5. Number and percentage (rounded to nearest whole number) of fatalities occurring as a result of injury from fire and flame in the domestic location, Aotearoa New Zealand 1991-1997 that were identified and linked in each data source. Eligibility criteria established from collated data and review of coronial records. Data sources New Zealand Health Information Service (NZHIS), Fire Incident Reporting System (FIRS).

NZHIS codes	890-899, domestic location	890-899, other location	Other codes, any location	Total
FIRS fatality data	146 (76)	5 (3)	3 (2)	154 (81)
FIRS structure fire data	18 (9)	-	-	18 (9)
Attended by Fire Service	4 (2)		1 (1)	5 (3)
Not attended by Fire Service	7 (4)	7 (4)	-	14 (7)
Total	**175 (92)**	**12 (6)**	**4 (2)**	**191 (100)**

FIRS

FIRS fatality data included 154 (81 per cent) of the 191 domestic deaths as a result of unintentional injury from fire and flame in the present series. FIRS fatality data also included 37 deaths resulting from motor vehicle crashes and explosions, 45 deaths in non-domestic or intentional fire incidents, four deaths attributed by the coroner to a medical cause and six individuals for whom death could not be confirmed.

Fourteen fatalities that were identified from NZHIS mortality data occurred in single fatality incidents that were not attended by the New Zealand Fire Service (the Fire Service). The Fire Service therefore attended 141 (91 per cent) of the 155 unintentional domestic incidents in this series, and 177 (93 per cent) of the 191 fire-related fatalities included in the study. FIRS fatality data included records for 121 (86 per cent) of the 141 study incidents attended by the Fire Service, and for 154 (87 per cent) of the 177 study fatalities that occurred in those incidents. In one incident there was a second fatality that was not recorded in FIRS fatality data. A further 15 unintentional fire incidents that resulted in 17 fatalities were found in the FIRS structural fire dataset although the occurrence of fatalities was not recorded. These structural fire incidents were found by manually linking information abstracted from NZHIS and coronial files with FIRS data. The five fatalities attended by the Fire Service that were not included anywhere in FIRS structure fire data occurred in single fatality incidents in remote areas (3), or where death was delayed after a fire contained by household members before arrival of the Fire Service (2).

Ethnicity was not recorded in FIRS data. Other recorded demographic details were consistent for the 154 unintentional domestic fatalities included in both FIRS and NZHIS datasets. Gender was the same for 151 (98 per cent) of the deceased; FIRS data incorrectly recorded two females as male, and one male as female. Age was recorded in 153 of the 154 fatalities in the FIRS fatality dataset. In 123 (79 per cent) of these entries recorded age was within one year of the age in NZHIS data. In a further 25 (16 per cent) age was within 8 years of the age recorded in health data. For the final 7 (5 per cent) the age entered in FIRS differed from the age in NZHIS data by more than 10 years. In five of these entries FIRS data recorded the deceased as aged over 90 years of age, when the age in NZHIS data was under 65 years, and review of the data suggests that an abbreviation for the year of death may have been entered in the age field in error. In the remaining two records FIRS data incorrectly recorded an adult aged over 65 years as an adult 15-64 years, and an young person or adult aged 15-64 years as a child aged under 15 years.

NZHIS data

As shown in Table 5, all of the 191 deceased in the final dataset were recorded in health data with 175 (92 per cent) correctly coded as deaths occurring in a domestic location with fire and flame as the external cause of injury. This domestic coding group also included 11 intentional deaths, and deaths occurred in non-domestic locations such as hotels (3), farms (1), or were determined by the coroner to be a medical cause (2). Of the total 192 NZHIS records of fire and flame related domestic deaths, 175 (91 per cent) were eligible for inclusion in the study.

NZHIS data included a further 12 deaths (6 per cent) in the study dataset as a result of injury from fire and flame, but not with a domestic location code. The non-domestic group also included 14 deaths which were not eligible for inclusion in the study; 11 deaths were correctly coded to a non-domestic location, two resulted from intentional fires, and one from a motor vehicle explosion. In this series use of the NZHIS codes 890-899, with all location codes, would have identified 98 per cent of the unintentional domestic fire deaths in the time frame. Of the total 218 records with NZHIS coding as deaths with fire and flame as the external cause of injury, 187 (86 per cent) were eligible for inclusion in the study.

The remaining four deceased (2 per cent) were found in NZHIS data with other codes representing injury from explosion, fire or burning in a boat, from explosive gases, or from contact with a hot object.

Coronial files

The electronic index to the coronial database was incomplete, with fields for the coronial file number and names of the deceased the only fields with data entered for each record. This was the principal reason for needing to use identifying data to link records. Despite these limitations, coroners' records were found for 183 (96 per cent) of the deceased in the study group. Five of the remaining 8 deceased were recorded in both NZHIS and FIRS data, and three in NZHIS data alone, but with sufficient detail to classify them as unintentional domestic incidents.

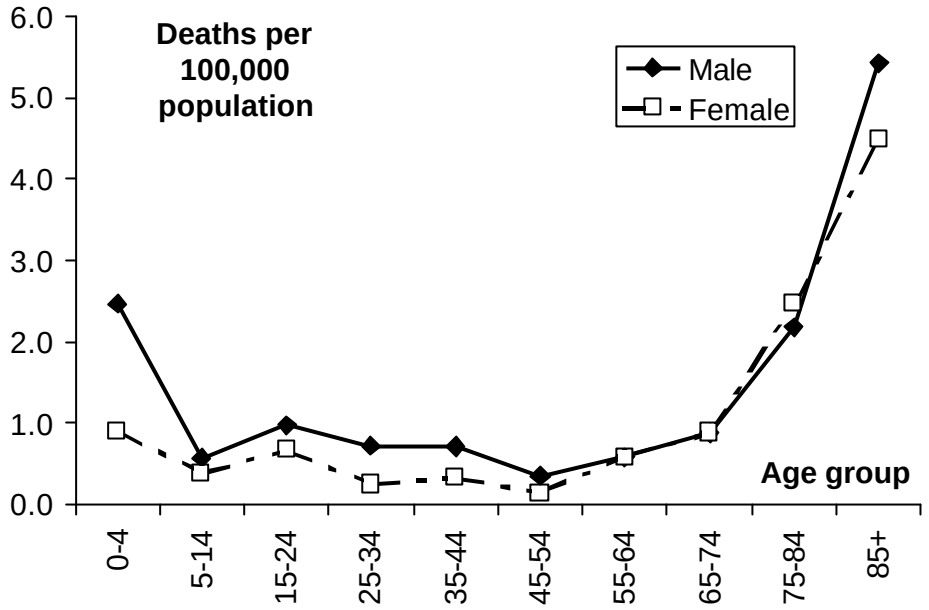
Unintentional domestic fire-related deaths

Personal characteristics of the deceased – age, gender, ethnicity

The final dataset includes the cases described in previous reports (Duncanson, Ormsby, Reid, Langley, & Woodward, 2001a, 2001b, 2001c), together with an additional 10 deceased aged over 64 years identified from ongoing review of NZHIS data sources. The fire service attended two of these fatalities, although the deaths were not included in FIRS fatality data. Six of the additional 10 deceased were female, and 4 male. Four were aged between 65 and 74 years, four between 75 and 84 years, and two aged over 84 years. Ethnicity was not stated for one of the deceased, the remaining seven were classified as nonMäori in NZHIS data. Inclusion of these additional 10 deceased alters the Mäori: nonMäori rate ratio in the over 64 age group from a six-fold to a five-fold increase in risk (RR 5.2, 95% CI 1.8-14.9). Fire scenarios were described for eight of these additional senior fatalities. Scenarios were similar to those previously described with cigarettes or smoking materials igniting clothing or bedding (3 fatalities), means of heating igniting clothing or other combustibles (3 fatalities), oven fire igniting clothing and a naked flame igniting inflammable gases in an enclosed space.

As indicated in previous reports there are differences in fire death rates among different groups in the population. As shown in Figure 2, the highest rates of unintentional domestic fire deaths are observed among adults aged over 65 years, and children aged under 5 years. The age structure of the population, however, means that despite the high rates among seniors, the greatest number of deaths occur among youth and adults aged 15-64 years. Almost half the deceased in this series were aged under 25 years, and three-quarters were aged under 65 years. Figure 3 shows that age related patterns of fire-related mortality rates have changed over the time of the study period with a statistically significant decline in death rates among seniors (Chi square test for trend $p<0.01$). The number of child fatalities was very high in the final year of the study, but a statistically significant upward trend in child mortality rates was not observed within this time series (Chi square test for trend $p = 0.1$)

Discrepancies were observed between mortality rates by gender and by ethnicity. Age-standardised rates for males exceeded rates for females by a factor of about 1.7; this discrepancy was most marked among children aged under 5 (RR 2.7, 95% CI 1.3-5.8), and in the 25-54 age groups (RR 2.5; 95% CI 1.3-4.8). The greatest discrepancy of all was observed between mortality rates for Mäori and nonMäori New Zealanders. Changes to death registration requirements in 1995, and to the ethnicity question in the 1996 census have made analysis of trends in the Mäori population over time difficult to monitor. However in the time period 1991-1994, using coronial files as well as health data to determine a proxy for ethnicity, the age-standardised rates for Mäori exceeded rates for nonMäori by a factor of almost 7 (RR 6.9; 95% CI 5.1-9.3). This ratio is considerably larger than that previously calculated from health data alone, principally because of the significant undercount of Mäori in the 1991-1994 mortality data. The Mäori-nonMäori discrepancy in age-standardised mortality rates was most marked among children aged under 5 years (RR 13.2; 95% CI 6.4-27.2). Analysis of data after 1995 is problematic because Mäori populations (sole Mäori, mixed Mäori, and Mäori ethnic group) identified from the ethnicity questions in the 1996 census are not comparable with Mäori populations identified in previous censuses. The research team secured sponsorship from Te Puni Kokiri (Ministry of Mäori Development) to enable a medical student to examine this question in greater detail over the summer of 2001-2002.



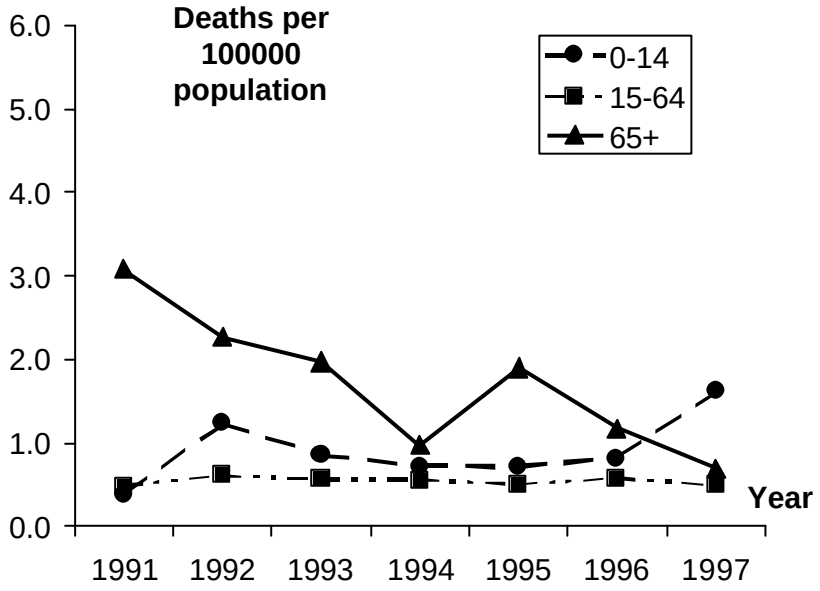


Figure 2. Age-specific mortality rates per 100,000 population for unintentional injury from fire and flame in the domestic location in Aotearoa New Zealand 1991-1997, by gender. Data sources: New Zealand Health Information Service, New Zealand Fire Incident Reporting System, Coronial files

Incident characteristics - fatalities

The 191 unintentional deaths from fire and flame in Aotearoa New Zealand from 1991-1997 occurred in 155 domestic incidents. FIRS data included details of 136 (88 per cent) of these incidents which resulted in 171 (90 per cent) of the fatalities in the study dataset. There was one incident with seven fatalities. Deceased in this incident included children aged under 15 years and adults aged 15-64 years. Eight incidents resulted in triple fatalities; two triple fatality incidents involved children aged under 15 years only, four involved children and adults, and two involved adults only. Fourteen incidents resulted in double fatalities. Six involved only children aged under 15 years, two involved children and adults, and six involved only young people or adults aged over 14 years. The remaining 132 incidents (85 per cent) resulted in single fatalities of 24 children, 63 young people and adults aged 15-64 years, and 45 seniors aged over 64 years.

Most of the multiple fatality incidents involved both males and females (15 incidents, 65 per cent), six (26 per cent) involved only males and two (9 per cent) involved only females. Ethnicity data were missing for five deceased who all died in single fatality incidents. Among the remainder, Mäori were over represented in multiple fatality incidents. Sixteen of the 48 fatal incidents involving Mäori resulted in more than one death, compared with seven of the 102 incidents which did not involve Mäori. When a fatal fire involved Mäori it was approximately five times more likely to result in multiple fatalities than if Mäori were not involved (RR 4.9, 95% CI 2.1-11). A similar pattern was observed for Pacific peoples, for whom nine individuals died in three multiple fatality and three single fatality incidents. The likelihood of a fatal fire involving Pacific peoples resulting in multiple fatalities is approximately three and a half times the likelihood of multiple fatalities in a fatal fire which does not involve Pacific peoples (RR 3.6, 95% CI 1.5-8.8).

Incident characteristics – scenarios

The heat sources and items ignited have been described in detail in each of the age group specific fire research reports. The most significant heat sources in the current series were cigarettes or smoking materials (31 per cent of incidents), means of heating (28 per cent of incidents), stove top or oven (15 per cent of incidents), electrical appliances (8 per cent of incidents) and candles (6 per cent of incidents). The items most commonly ignited were bedding (17 per cent of incidents), undefined combustibles in bedroom or lounge (14 per cent of incidents), clothing being worn (10 per cent of incidents), abandoned cooking materials (9 per cent of incidents), lounge furniture (6 per cent of incidents), and motor vehicle interiors (5 per cent of incidents).

Before the immediate fire scenarios, there had been some form of disruption (e.g. guests in the household, staying away from home, partying) in a large proportion of incidents. Overall some form of disruption was documented for one fifth of the fatalities, however this increased to over 50 per cent for adults aged 15-44 years, and 25 per cent for children aged under 15 years and for adults aged 45-64 years. Alcohol was considered to be associated with fatal fire incidents when a deceased person had a blood alcohol level over 80 mmol per decilitre, or where there was a confirmed history of excessive alcohol consumption by the deceased or by occupants of the affected household in the hours immediately preceding the fatal fire incident. Using these criteria alcohol was associated with 62 (40 per cent) of unintentional fatal fire incidents overall, and with 65 per cent of incidents involving young people and adults aged 15-64 years.

Incident characteristics - socio-economic deprivation

A previous report detailed the discrepancy in fire fatality rates according socio-economic status (Duncanson et al., 1999). The previous study used the New Zealand index of socio-economic deprivation (NZDep96), which gives an indication of socio-economic position based on data from the 1996 census, and FIRS fatality address data. Repeating this analysis on the full dataset derived for this study revealed a very similar pattern, with households in the most socio-economically deprived decile experiencing fatal fire incidents at a rate five times that of households in the least deprived decile. The socio-economic gradient was observed in all age groups, but was more marked for children and for youth and adults aged 15-64 years. In the study data set 56 per cent of fatal incidents involving children, 47 per cent of incidents involving adults aged 15-64 years, and 27 per cent of incidents involving adults aged over 65 years occurred in dwellings in the quintile of meshblocks with the highest relative socio-economic deprivation, as assessed by NZDep96.

Geocoded data for all unintentional residential structural fires from 1995-1997 were obtained from the New Zealand Fire Service. From 1995-1997 there were 9345 unintentional structural fire incidents recorded in FIRS, and 9320 (99 per cent) of these incidents were geocoded to census meshblock level. Analysis of structural fire data in the study period showed a socio-economic gradient for occurrence of residential structure fires which is similar to that observed for fatal unintentional domestic fire incidents (see Figure 4).

A subset of the fatality study data from 1995 to 1997 were analysed to determine whether fire incidents were disproportionately fatal at higher levels of socio-economic deprivation. In this restricted time frame 66 residential structural fire incidents resulted in 79 fatalities. There were therefore 7.1 fatal fires (95% CI 5.4-8.8), and 8.5 fatalities (95% CI 6.6-10.3) per 1000 structural residential fire incidents. Rates of fatalities per 1000 unintentional fire incidents were unstable, due to the low numbers involved, and this study was therefore unable to show any discernible pattern for the lethality of fire incidents (deaths per 1000 structural fires) by socio-economic deprivation (Chi square test for trend p = 0.4).

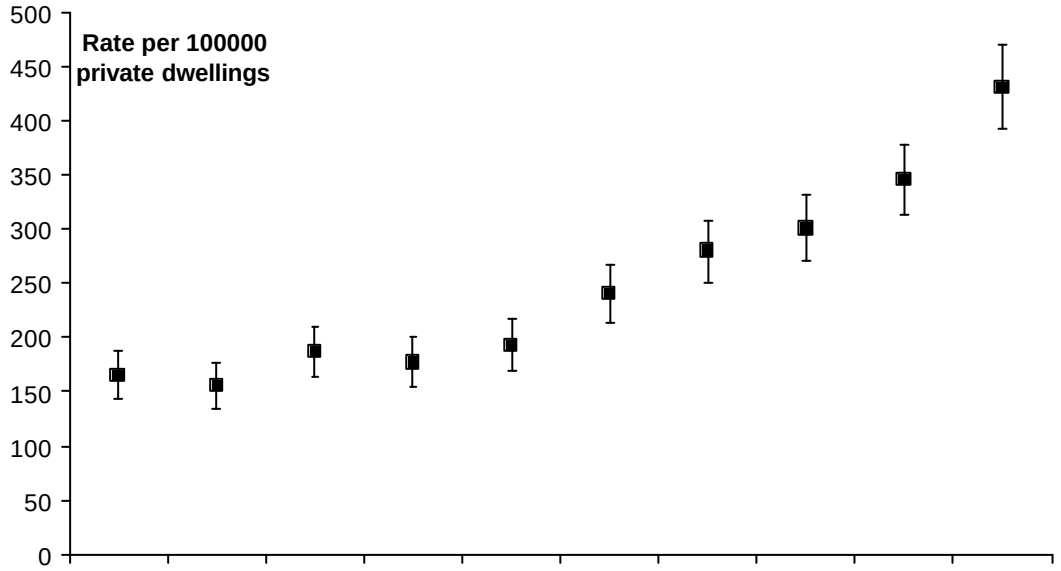


Figure 4. Rates per 100,000 private dwellings of unintentional structural residential fire incidents in Aotearoa New Zealand 1995-1997 by decile of socioeconomic deprivation as assessed using New Zealand 1996 Index of Deprivation (NZDep96). Data sources: New Zealand Fire Service, Statistics New Zealand.

Discussion

Fire-related deaths

One of the striking observations from this review of fire-related fatality data is that although almost two-thirds of the fatalities occurred in unintentional domestic incidents, a significant minority occurred in other circumstances. Reports concerning workplace fire-related injury, and injury in fires resulting from motor vehicle crashes have resulted from the contestable research fund (Bailey & Bailey, 2001; Kool, 2001). Incidents involving children that occur in non-domestic locations (e.g. on a farm or in a public place) are not included in the definitions of either workplace or domestic fatalities. There were two such incidents in the 1991-1997 series. It is also notable that 27 (9 per cent) of the 246 fire-related deaths were intentional or occurred in deliberately lit fires. Given that nationally there were 3542 deaths by suicide and 445 deaths by homicide in the study period (IPRU website, injury statistics), fire and flame would seem to be a relatively uncommon mode of self-harm or assault, accounting for fewer than one per cent of intentional injuries. Nevertheless there may be value in identifying factors associated with intentional injury from fire and flame as they form a small but not insignificant proportion of fire-related deaths. A particular factor to investigate would be the contribution of access to flammable gases or liquids to deaths in intentional fire incidents.

Data sources

New Zealand Health Information Service mortality data with external cause of injury codes 890-899 provided the most comprehensive and accurate data source for deaths from unintentional injury from fire and flame in the domestic location. The use of a free text field (EVENTDES) to describe the incident resulting in injury assisted in identifying incidents which occurred in domestic locations. NZHIS data alone will, however, miss a small proportion of fire-related deaths which occur in explosions or unusual locations (two per cent of unintentional domestic deaths in the current study). It is also of note that, in this series, seven per cent of deaths as a result of injury from fire and flame in a domestic location occurred in incidents that were not attended by the New Zealand Fire Service. Over the seven years of the study this meant that 14 domestic deaths in unintentional fire incidents were not included in FIRS data. Capturing such deaths would require linkage with NZHIS data, or coding of fire deaths by the coroner and extraction of files, for comparison with the FIRS database. Such linkage would also detect deaths as a result of incidents which are attended by the Fire Service, in which the casualty survives initially, but dies some time later after treatment in hospital.

The FIRS data provided for this study were obtained prior to recent review and upgrading of the FIRS system. It is likely that currently available data is even more accurate than that used in this study. The similarity between personal details in the FIRS fatality dataset and in NZHIS data mean that FIRS demographic details can be used with confidence. However in published data we recommend using age groupings which allow separate identification of children aged under 15 years and adults aged over 64 years (e.g. 0-4 years, 5-9 or 5-14 years, 15-24 years …65-74 years, 75-84 etc). We further recommend gathering of ethnicity data by the Fire Service, particularly in fire incidents which result in injury. Use of the ethnicity question in the 2001 census will enable use of census data in the calculation of rates of injury.

Inclusion of ethnicity data in FIRS is important to monitor the effectiveness of current strategies to address the ethnic disparities in fire-related injury rates.

Accurate data is essential to understand patterns of fire-related injury, and such understanding is a prerequisite to the planning, development and testing of new fire safety strategies to complement existing measures. As a primary tool for analysis of fire injury data the electronic Fire Incident Reporting System requires comprehensive and accurate data entries. While data entry can be regarded as 'paperwork' divorced from the real work of on-the-scene firefighting, it is an essential component of understanding patterns of fire occurrence and of fire prevention. For example, installation and maintenance of domestic smoke alarms is a key fire prevention strategy in New Zealand and internationally. In this regard it is important to monitor whether or not a domestic smoke alarm was present in dwellings which experience a fire, and the functional status of any alarms so present. A negative entry (i.e. no alarm present) is of more value than a blank space, as the latter could represent failure to consider the question. Fields in FIRS data need to contain information which is sufficiently detailed to identify potential areas for intervention, yet simple enough to allow timely and accurate data entry at brigade level. The recent addition of a 'Heat Source' field in FIRS data has increased the value of using routine FIRS data in analyses, without the need to manually identify and search supporting documentation.

Limitations of the coronial service in New Zealand have been documented by the Law Commission (Law Commission, 2000). The current study has highlighted the difficulty in linking files where there is a large amount of missing data. Completion of the date of death and date of birth fields, for example, would have enabled ready matching with NZHIS data without the need for use of names of the deceased. From the perspective of the Fire Service Commission, the value of coronial files would be increased by the use of fire related injury as a separate coding field. Such separate coding of drowning deaths, if included in an electronic database, allows ready identification and extraction of relevant files, without the need to access personal identifying information. A further issue identified in this study is the lack of consistency in determining the cause of death when death occurs during treatment for the injury. In some cases the coroner's verdict was of a medical cause of death when it is probable that the injury incident set in train a course of events that culminated in the death. A study in the United Kingdom showed that 64 coroners' judgements agreed in only two of 16 clinical scenarios, including three scenarios where death resulted from a combination of trauma and natural disease (Roberts, Gorodkin, & Benbow, 2000). Comments indicated that variations in judgements reflected the lack of a definition for natural causes, together with differences in the personal attitudes of each coroner.

Recommendations

That the New Zealand Fire Service Commission ensure ongoing education of fire-fighters concerning the value of accurate and complete data entries to inform fire prevention strategies, including accurate description of nature of injury, and positive or negative entries in all data fields (e.g. full information about the presence or absence of smoke alarms).

That the New Zealand Fire Service place increased emphasis on prevention of fire related injury and property damage in the collation and publication of statistics through documentation of specific heat sources and items ignited in fire incidents, documentation of the ethnicity of deceased using the ethnicity variables from the 2001 census, and use of age groupings which allow ready review of trends in domestic fire fatalities with particular reference to adults aged over 64 years and children aged under 15 years.

Recommendation

That the New Zealand Fire Service Commission formally request the Department of Courts to review the coding categories used to index coronial files, and further request that a specific code be applied to deaths from injury where the external cause of injury was fire and flame. Such coding should apply whether the death occurs immediately, or occurs later as a complication of the original injury and that the New Zealand Fire Service explore and develop appropriate methods to link with New Zealand Health Information Service to ensure that fire fatality datasets are as comprehensive as possible.

Prevention of deaths in unintentional domestic fire incidents

The demographic groups at increased risk of fire related injury have been described previously, with recommendations to ensure that fire safety strategies are delivered effectively to households with young children and to older adults. The overview of all data has also highlighted that most fire-related deaths occur in the 15-64 age group, among whom promotion of host responsibility and safe alcohol consumption is an important fire safety strategy best accomplished in collaboration with other agencies. Ongoing review of data will be needed to determine whether the apparent declining mortality trend for seniors is maintained, and whether there is any upward trend in child mortality rates. A preliminary look at FIRS fatality data for 1998-2000 suggests that the decline in fire mortality rates for seniors was not maintained, with deaths of 8 seniors in 1998, 4 in 1999 and 8 again in 2000. FIRS fatality data 1998-2000 showed 4 child deaths in 1998, 8 in 1999 and 1 in 2000.

Ethnic disparities in fire related injury rates highlight the urgent need to continue the work begun by Iwi liaison officers in the Arapawa, Bay-Waikato and Northland regions to identify fire safety strategies for Mäori. Addressing ethnic disparities in fire-related injury rates is an obligation under the Treaty of Waitangi. It is likely that strategies which are effective for Mäori will also be effective for mainstream New Zealand, although the converse approach has not always delivered results in the past.

The review of coronial files has revealed the high proportion of fatal fire incidents which occur in the context of household disruption, particularly among young people and adults aged 15-44 years. This is an important observation for fire prevention programmes, as there is a need to ensure that households consider fire safety not just in the ordinary round of daily activities, but when guests stay overnight, or when they host a social occasion. Use of alcohol may be associated with some of these social activities, and alcohol was associated with almost two-thirds of the unintentional fatal domestic fire incidents involving young people and adults aged 15-54 years. Collaboration of the New Zealand Fire Service Commission with other service agencies to promote host responsibility on the part of those who serve alcohol is likely to be an important contributor to improved fire safety in the future.

A tenet of injury prevention is that passive strategies (which work automatically) are most likely to result in a sustained decrease in injuries (Rivara, Grossman, & Peter, 1997a). Rivara et al (1997) define active strategies as those which require people to change their behaviour, and to remember to repeat this new behaviour every time they are exposed to risk. In relation to fire safety, active prevention strategies are less likely to be used in circumstances of household disruption or alcohol consumption. For example, a non-smoking parent may not notice that a guest in the home has left smoking materials in easy reach of children; an escape route planned for a household of one or two people may not be effective when guests in an infrequently used room also need evacuation; the usually careful smoker may fall asleep while smoking after consuming alcohol.

The key advantage of domestic smoke alarms is that correctly installed and maintained alarms will activate regardless of the heat source, and allow occupants time to evacuate the dwelling. Installation and maintenance of domestic smoke alarms will undoubtedly remain the principal baseline fire safety intervention in private dwellings. A cost benefit analysis of a smoke alarm distribution programme in Oklahoma reported net savings of $US15 million for an expenditure of $US 531,000. The benefit to cost ratio from a society perspective for this study was 28:1 (i.e. $28 dollars of benefit for every dollar invested in the programme). From the health service perspective alone, the costs of the programme were offset by savings in medical costs after two years (Haddix, Mallonee, Waxweiler, & Douglas, 2001).

However, successful evacuation of occupants also requires an active response. Occupants must hear and correctly interpret the alarm signal, and then be able to exit the dwelling. Thus it is probable that additional passive measures could enhance the effectiveness of domestic smoke alarm installation. Further work is needed to identify the cost-effectiveness and feasibility of possible passive strategies in the New Zealand context. Those identified in injury prevention and fire safety literature include reducing the ignition potential of abandoned cigarettes (Barillo, Brigham, Kayden, Heck, & McManus, 2000), and use of flammability standards for children's nightwear (McLoughlin, Langley, & Laing, 1986), and for upholstered furniture (Brereton & Laing, 1992). In the light of the present study all three measures are likely to be of value, although their relative merit would depend on the magnitude of the costs and benefits associated with each.

Within the current series the category 'cigarettes or smoking materials' was the most common ignition source. International studies listed in Table 6, although based on different population groups and using different definitions of injury, consistently show that a significant proportion of fire-related injuries are associated with cigarette use. Households which experience a fatal fire are more likely to include smokers than households which do not experience a fatal fire (Ballard, Koepsell, & Rivara, 1992). Fires started by discarded cigarettes disproportionately result in fatalities; a fatal fire is approximately 7.7 times more likely than a non-fatal fire to have been started by smoking materials (Runyan et al., 1992). Interest in a fire-safe cigarette goes back to the 1920s in the US Congress, and emerged again in the 1970s (Botkin, 1988). Reducing ignition potential of abandoned cigarettes is likely to be a cost effective fire safety strategy. A US study estimated the unit cost to be $US0.0001 per pack of cigarettes, and the total benefits per pack to be $US0.05 – a benefit-cost ratio of 505. This was the highest benefit-cost ratio of 84 injury prevention measures reviewed by Miller & Levy (2000). A key advantage of regulating cigarettes is their short life span since they are manufactured to be consumed and replaced constantly (Halbert, 1999). Thus any impact of reducing ignition potential would be reflected in fire incidence within a relatively short time frame.

Within the present series only one of the clothing ignitions involved children. This suggests that the longstanding regulation of children's nightwear in respect of fire safety has been effective (McLoughlin et al., 1986). The issue of flammability standards for adult clothing, particularly for seniors, has been raised in injury prevention literature (Ryan et al., 1997). This could certainly be incorporated in advice to seniors and those involved in their care.

In addition to a fire safety standard for cigarettes, the State of New York introduced legislation to reduce the flammability of fabrics (New York State Senate Research Service, 2000). Only 10 (6 per cent) of the fatal unintentional domestic fire incidents in the 1991-1997 series of unintentional domestic fire incidents resulted from ignition of upholstered furniture. However 24 incidents (15 per cent) began in a lounge, and 49 (31 per cent) in a bedroom,

where upholstered furniture could have contributed to the fire loading of the room of origin. An analysis of FIRS data from 1996 to 2000 has suggested that upholstered furniture may have contributed to over one third (35.4 per cent) of residential fire fatalities (Wong, 2001). There is likely to be a significant time delay between promulgation of mandatory standards for furnishing flammability and use of less flammable furniture in private dwellings, due principally to the long life of upholstered furniture (Halbert, 1999). Any action taken in the immediate future would therefore take many years to result in a reduction in fire incidents. Nevertheless such standards are widely used in the USA and the UK, and recent UK review suggests significant impact on fire injury incidence. The value of such regulations in New Zealand warrants investigation.

Other heat sources and items ignited in the current series also present possibilities for active or passive prevention strategies. Heaters (mostly electric), and unattended cooking sources were heat sources for over a third of the fatalities in this series. In two cases the recent purchase of the heater from a second hand outlet shortly before the fatal fire was noted in the coronial files. Heaters most commonly ignited bedding or clothing being worn. Cooking related fires included two multigenerational incidents, and alcohol was a significant contributing factor (Duncanson, 2001). Smoke alarms may have alerted household occupants in these circumstances, but consideration could also be given to the commercial development of devices to automatically switch off elements after a pre-set time.

At a higher level social and economic policy can significantly affect fire risk. The increased risk of fire observed among occupants of temporary dwellings highlights the importance of national housing policies. The particular needs of households who choose to live in mobile homes include appropriate fire safety strategies. Decisions which affect household availability of basic utilities such as electricity also have an effect on fire risk. Twelve fatalities in ten incidents in the current series resulted from use of naked flame, and many of these were in the context of a dwelling without electricity. Education programmes may be able to improve safety of households in such circumstances in the short term, but real progress in improving injury rates will require a revisiting of basic policy issues. Such factors disproportionately affect households living in small areas characterised by relative social and material deprivation. Addressing fire risk, as well as other factors affecting health, will require attention to wider social issues such as housing quality, education, employment, taxation and income distribution.

Recommendations

That the New Zealand Fire Service Commission develop a bicultural policy and continue to support efforts in each region to develop culturally appropriate services, including the appointment of Iwi liaison officers and engagement with Mäori networks to promote fire safety, and that the New Zealand Fire Service Commission encourage the development of effective fire safety strategies for Pacific peoples and other ethnic minority groups.

That the New Zealand Fire Service Commission investigate the costs and benefits to society of standard development, implementation and enforcement for consumer products involved in the ignition of domestic fire incidents. Such consumer products include cigarettes, heaters, upholstered furniture and adult clothing.

That the New Zealand Fire Service Commission continue to participate in intersectoral strategies to improve the wellbeing of New Zealand households, including consideration of the impact of social and economic policy on fire safety particularly among households at greatest risk of fire-related injury.

Table 6. International studies showing proportion of fires started by cigarettes

Years	Location	Injuries attributable to cigarettes or smoking materials	Reference
1973-1974	USA, Baltimore	40 per cent of fires with casualties, and 65 per cent of fatal fires, were due to 'careless smoking' as determined by the fire investigator's office.	(Levine & Radford, 1977)
1976-1978	USA, Baltimore	55 per cent of fatal fires attributed to cigarettes	(Mierley & Baker, 1983)
1978-1987	New Zealand, National	37.3 per cent of adult fatalities in residential fires resulted from 'smoking materials'	(Waller, Marshall, & Langley, 1998)
1978-1987	Germany, Hanover	37 per cent of accidental burn or fire deaths were from smoking	(Leistikow, Martin, & Milano, 2000)
1980-1990	Scotland, National	Smoking materials accounted for 52 per cent of fatal fires with victims under 75 years, and 34 per cent of fatal fires with victims over 75 years.	(Elder, Squires, & Busuttil, 1996)
1985-1991	USA, New Jersey	Smoking or smoking materials accounted for 41 per cent of fatal fires.	(Barillo & Goode, 1996)
1986-1987	USA, King County, Washington	Households with a smoker present were between 3 and 8 times more likely to experience a fatal or non-fatal residential fire injury compared with households with no smokers present.	(Ballard et al., 1992)
1988-1989	USA, North Carolina	Smoking was the cause of 31 per cent of fatal fires and 6 per cent of non-fatal fires.	(Runyan et al., 1992)
1988-1993	Denmark	Smoking was the ignition source for 51 per cent of home fire fatalities	(Leistikow et al., 2000)
1989	Austria	Cigarettes and matches ignited 4.1 per cent of "significant fires"	(Leistikow et al., 2000)
1989	Holland	Smoking materials ignited 4.5 per cent of building fires, and were "the leading cause of fire deaths."	(Leistikow et al., 2000)
1989	UK	Smoking materials and matches caused 37 per cent of home fire deaths and 26 per cent of all fire deaths	(Leistikow et al., 2000)
1990	Hungary	Smoking caused 14 per cent of "fires with losses" and 40 per cent of all fire deaths.	(Leistikow et al., 2000)
1990-1995	Australia, Victoria	42 per cent of non-intentional fatal fire incidents were caused by smoking, including the careless disposal of cigarettes. In the same series 46 per cent of the fatalities were attributable to smoking.	(Brennan, 1998)
1993	Australia	25 per cent of fire injuries caused by smoking materials	(Leistikow et al., 2000)
1994-1995	UK, Manchester and Midlands.	Smoking materials were responsible for 41 per cent of fatal fires in a twelve-month period. In contrast 13 per cent of all fires not just fatal fires were started by smoking materials in 1993.	(Reynolds, 1997)
1995-1997	Taiwan	17 per cent of fires from smoking	(Leistikow et al., 2000)
1996	Japan	Cigarettes caused 21 per cent of residential fire deaths	(Leistikow et al., 2000)
1996-1997	UK, London	18 per cent of fire related injuries occurring in occupied dwelling that resulted in emergency department visit, hospitalisation, or death were caused by cigarettes.	(DiGuiseppi et al., 2000)
1997 - 1998	UK, National	Smoking related materials accounted for 35 per cent of ignitions causing accidental dwelling fire deaths in 1998, and 39 per cent in 1997. For non-fatal casualties the injury rate was highest for fires caused by smokers' materials and matches (367 casualties per 1000 fires).	(Watson & Gamble, 1999)

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