

Fire Research Report

Fire incidents resulting in deaths of New Zealanders aged 15-64 years 1991-1997

University of Otago

September 2001

A methodology is outlined 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 New Zealanders aged between 15 and 64 years in domestic fire incidents.

The study finds high risk rates for males, and particularly Maori. The most common fire scenarios are unattended cooking materials igniting on a stove top or in an oven, and smoking materials igniting combustibles. Alcohol is a probable factor in most of the fatal incidents for this age group. Another significant factor identified in the study is disruption to usual routine for the deceased, including attendance at a social function, returning home after midnight, being away from home or having overnight guests. Other identified risk factors are temporary accommodation, and the absence of smoke alarms.

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Fire injury research team

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Table of contents

Introduction	4
Acknowledgements	5
Executive Summary.....	6
Recommendations.....	7
Study aim and objectives.....	9
Methods	9
Data sources	9
Inclusion criteria	9
Analysis.....	9
Results	10
Fatal fire incidents involving New Zealanders aged 15-64 years.....	10
Unintentional domestic fire deaths	10
Personal characteristics.....	10
Fire characteristics	12
Environmental characteristics - social.....	17
Environmental characteristics - physical	19
Non-domestic structural and intentional fire deaths	22
Discussion	23
Data issues.....	23
Study implications.....	24
Raising awareness.....	24
Addressing disparities.....	25
Safe use and disposal of smoking materials	26
Appropriate use of alcohol and host responsibility	30
Safe cooking practices.....	30
Safe heating and lighting.....	30
Safe furnishing materials.....	31
Smoke alarms.....	32
Disruption and isolation.....	32
Disability.....	33
Conclusion	33
References	34

Introduction

This report to the New Zealand Fire Service Commission describes features of structural fire incidents in Aotearoa New Zealand from 1991 to 1997, which resulted in the deaths of individuals aged between 15 and 64 years. Incidents involving New Zealanders aged 15-64 years, and seniors aged over 64 years have been reported separately because it is likely that different factors are important for prevention policy in different age groups in the population.

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. Reports have also been presented on child injury from fire and flame in the Auckland region, and on fire-related mortality among adults aged over 64 years. A concurrent report describes fire-related mortality among children aged under 15 years.

Acknowledgements

The research was funded by the New Zealand Fire Service Commission Contestable Research Fund. Shaun Stephenson in the Injury Prevention Research Unit, University of Otago, Elizabeth Grieve and Roger Chang of the New Zealand Fire Service, and Craig Leahy at the Coroner's Court provided the basic data for this research and were extremely helpful in answering numerous questions. Critchlow Associates geocoded addresses to census meshblock level. The study was considered and approved by the Wellington, Auckland and Otago Ethics Committees.

Executive Summary

Data from the computerised Fire Incident Reporting System (FIRS) and New Zealand Health Information Service (NZHIS) were augmented by Fire Investigation Reports and coronial records to understand and identify personal, fire related, and environmental factors associated with deaths of New Zealanders aged between 15 and 64 years in domestic fire incidents.

In the years 1991 to 1997 the study identified 77 unintentional domestic fire incidents which resulted in the deaths of 89 New Zealanders aged 15-64 years. There were 69 single fatality incidents, and eight multiple fatality incidents. The mortality rates for males exceeded that for females by a factor of 1.7 (rate ratio 1.7; 95% confidence interval 1.1-2.6). Between 1991 and 1994 the rate of fire-related mortality for Māori aged 15-64 years for Māori was 5 times the rate for non-Māori of the same age (rate ratio 5.3; 95% confidence interval 3.0-9.4).

The most common scenarios for unintentional domestic fire incidents resulting in the deaths of New Zealanders aged 15-64 years were unattended cooking materials igniting on a stove top or in an oven, and cigarettes or smoking materials igniting bedding or combustible materials in a dwelling. Other identified scenarios were heaters or solid fuel burners in close proximity to combustible materials, unattended or malfunctioning electric appliances igniting furnishings or other combustibles, ignition of flammable gas or liquid by naked flame or heat from cigarette lighter, candle, barbecue, or heater, slow burning from faulty fireplace or electrical wiring with eventual ignition of dwelling structure, clothing ignitions from cooking or heater, and ignition of combustibles or interior furnishings by candles.

Alcohol was a probable factor in almost two thirds of the fatal unintentional domestic fire incidents involving New Zealanders aged 15-64 years (58 incidents, 65 per cent), and detectable blood alcohol levels or a confirmed history of alcohol consumption were reported for over two-thirds of the deceased (61 cases, 69 per cent). Alcohol consumption was a particularly important factor in fires resulting from unattended stove top or oven cooking and inappropriately discarded cigarettes or smoking materials. Reports indicated some disturbance of usual routine for almost half of the deceased (41 cases, 46 per cent), including attendance at a party or social function, returning home after midnight, being away from home or having overnight guests.

Most of the fatal unintentional domestic fire incidents involving New Zealanders aged 15-64 years occurred in permanent private dwellings, with 54 incidents (70 per cent) in detached dwellings and 14 incidents (18 per cent) in flats or apartments; however a significant minority (8 incidents, 10 per cent) occurred in temporary accommodation including caravans, tents and garages. Smoke alarms were noted to be absent in 44 of the 68 incidents (65 per cent) which occurred in private dwellings. Three dwellings had non-functioning or inadequate alarms installed, and there was no information about presence or absence of alarms in the remaining 21 dwellings (31 per cent).

The observations of this research project highlight the importance of addressing ethnic and socioeconomic disparities in the incidence of fire-related deaths, and of promoting specific fire safety strategies to improve fire safety among New Zealanders. Addressing key factors in fire-related deaths, such as tobacco and alcohol consumption, will require ongoing intersectoral co-operation. In addition to increased use of domestic smoke alarms and escape plans, passive interventions such as reduced ignition potential of cigarettes and reduced flammability of household contents are likely to reduce domestic fire incidence and impact.

Recommendations

That the New Zealand Fire Service Commission ensure that findings of this study are disseminated among relevant government departments, agencies and individuals. Such groups will include Te Puni Kokiri, Ministry of Pacific Island Affairs, Ministry of Health, Ministry of Social Policy, Ministry of Women's Affairs, Māori and mainstream health service providers including Public Health service providers, and Māori and mainstream Social Service providers.

That the New Zealand Fire Service Commission liaise with relevant agencies and individuals to incorporate fire safety strategies in individual and population based health promotion strategies for this age group. Such groups will include Te Puni Kokiri, Ministry of Pacific Island Affairs, Ministry of Health, Ministry of Education, Ministry of Social Policy, Ministry of Women's Affairs, Māori and mainstream health service providers including Public Health service providers, and Māori and mainstream Social Service providers.

That the New Zealand Fire Service Commission give urgent priority to the development of bicultural policy, with reference to the Treaty of Waitangi, and of a partnership between the Fire Service Commission (as a Crown entity) and Māori. Primary goals for the partnership would be to address the Māori: nonMāori disparity in fire fatality rates, and to develop a service which is able to deliver effective services to Māori.

That the New Zealand Fire Service Commission give urgent attention to the appointment of adequately resourced Māori liaison staff in each fire region, with skills to develop and implement appropriate fire safety programmes for Māori with particular focus on adolescents and young adults.

That the New Zealand Fire Service Commission consult with the Ministry of Pacific Island Affairs and other government and non-government organisations to determine appropriate strategies to improve fire safety among Pacific peoples.

That the New Zealand Fire Service Commission liaise with other government and non-governmental agencies and organisations to address socioeconomic disparities in New Zealand society, and to ensure that fire safety is incorporated in programmes designed to improve outcomes for households living in relative social and material deprivation.

That the New Zealand Fire Service Commission actively support the development of a fire-safety standard for cigarettes sold in New Zealand to reduce the occurrence of fires started by inappropriately discarded cigarettes.

That the New Zealand Fire Service Commission liaise with and support the Ministry of Health, Action on Smoking and Health and public health providers to support programmes to reduce smoking rates among New Zealanders, in conjunction with fire safety programmes.

That the New Zealand Fire Service Commission liaise with and support the Ministry of Health, the Alcohol Advisory Council of New Zealand and public health providers to promote appropriate use of alcohol and develop host responsibility programmes which encourage provision of savoury food prior to guests or patrons returning home from social events.

That the New Zealand Fire Service Commission liaise with public health providers to develop community injury prevention initiatives which explore ways to promote cooking practices which are safer, particularly when household occupants have been consuming alcohol. Such safer practices will include alternatives to cooking with fat or oil, and replacement of aluminium pots with stainless steel pots.

That the New Zealand Fire Service Commission make strong representation to the Ministry of Social Policy and Ministry of Housing regarding the importance of ensuring that all private dwellings are safely constructed with safe means of heating and lighting and that the New Zealand Fire Service Commission determine characteristics of safe home heating systems and develop fire safety promotion programmes to promote heating safety.

That the New Zealand Fire Service Commission liaise with the Ministry of Consumer Affairs regarding the possibility of flammability standards for bedding materials and upholstered furniture.

That the New Zealand Fire Service Commission continue to promote the use of smoke alarms in domestic dwellings through public education and community based fire safety programmes.

That the New Zealand Fire Service Commission indicate support to the Building Industry Authority for mandatory installation of smoke alarms in new dwellings, with a longer term view to mandatory alarms in all private dwellings.

That the New Zealand Fire Service Commission ensure that fire safety campaigns recognise the mobility of the New Zealand population and promote fire safety for guests in a home as well as usual occupants and fire safety when on holiday away from home.

The New Zealand Fire Service Commission investigate issues associated with increased geographical distance from Fire Stations with a view to improving fire safety in geographically isolated areas.

That the New Zealand Fire Service Commission intentionally include people living with disability in fire safety intervention programmes, with particular emphasis on improving early warning of and prompt escape from a fire incident.

Study aim and objectives

The overall aim of the study was to understand and identify factors associated with deaths of New Zealanders aged 15-64 years in domestic fire incidents, through careful and systematic evaluation of available data and documents.

The specific objective of the study was to collate existing information from the New Zealand Health Information Service, The New Zealand Fire Service, and the Coroners' Court concerning domestic fatal fire incidents affecting New Zealanders aged 15-64 years, and describe personal, fire related, and environmental factors relevant to prevention policy.

Methods

Data sources

Data on fatal incidents attended by the New Zealand Fire Service were obtained from the national computerised database Fire Incident Reporting System (FIRS).

Deaths from injury caused by fire and flame in the domestic location were identified from the New Zealand Health Information Service (NZHIS) mortality database using the following International Classification of Disease 9th edition (ICD 9 CM) codes:

- E codes E890-899 (Accidents caused by fire and flames);
- E code E988 (Undetermined injury by burns or fire)
- Event field matching using the following key words fire, ignition, burn, conflag, and smoulder

These ICD-9 codes do not include deaths as a result of acts of suicide or homicide which have different E codes.

Identifying information from the two databases was matched electronically with the index to coronial files to locate coroners' verdicts on people who died in fatal fire events.

Inclusion criteria

Inclusion criteria for the investigation of fatal domestic fire incidents were all people aged 15-64 years who died in a fire incident on a private residential property in the years 1991-1997. The term private residential property included mobile homes, caravans that were being lived in as a home (but not those being driven or towed) at the time of the incident, and recreational activities occurring on private residential property.

Analysis

Rates were calculated using New Zealand census population data and intercensal population estimates. The sole Māori denominator was used to calculate Māori rates, using 1991-1994 data only. Rate ratios and confidence intervals were calculated using EpiInfo statistical software (CDC 1996).

Results

Fatal fire incidents involving New Zealanders aged 15-64 years

In the years 1991 to 1997, the study process identified 120 New Zealanders aged 15-64 years who died as a result of injury from fire and flame (excluding deaths in motor vehicle crashes). Twenty-six (22 per cent) of the deaths resulted from incidents which were intentional (homicide or suicide or arson), or occurred in occupational or institutional settings. This leaves a total of 89 unintentional fire deaths from fire and flame in the domestic location in the time period 1991–1997. These 89 deaths occurred in 77 incidents, in private dwellings or on private residential property. Eight incidents resulted in multiple fatalities in this age group. The study included one multiple fatality fire in which 5 adolescents and 2 younger children died. The dwelling involved in the fire was attached to a residential institution, but was not designated as a craft workshop and storage area. The dwelling was being used as accommodation without the knowledge of local authorities, and has been classified as temporary accommodation in the study. Occupants of the site included multi-generational members of one family, and description of the premises suggested a domestic rather than commercial operation. However, where relevant, analyses have indicated the effect of excluding this event and these fatalities. Because of relatively small numbers in the overall study individuals are potentially identifiable. To protect privacy categories have been combined to ensure that there are at least two individuals or incidents in each cell of a table.

Unintentional domestic fire deaths

Personal characteristics

Age and gender

The 89 adolescents and adults aged 15-64 years who died as a result of unintentional injury from fire and flame in a domestic fire incident were predominantly in the under 45 age group, with two thirds of the deceased aged 15-44 years. The highest mortality rates were observed in the 15-24 and 60-64 age groups, even if the multiple fatality event is excluded. The 95 per cent confidence intervals (95%CI) shown in Table 1 indicate that for those aged 15-24 years the true rate is most likely to lie between 0.5 and 1.1 deaths per 100,000 person years. More males than females aged 15-64 years died in domestic fire incidents in the 1991-1997 time frame. Age standardised rates for male deaths were 1.7 times those for female deaths (Rate Ratio 1.7, 95% Confidence Interval 1.1 – 2.6). The rate ratio reduced to 1.6 if the multiple fatality event is excluded.

Table 1. Numbers and rates of fatalities as a result of injuries from fire and flame in private dwellings among adults aged 15-64 years in New Zealand 1991-1997, by age and gender. Data source New Zealand Health Information Service.

Age group	Male deaths	Female deaths	Total deaths	Rate (95%CI)*
15-24	18	13	31	0.8 (0.5-1.1)**
25-34	15	5	20	0.5 (0.3-0.7)
35-44	11	6	17	0.5 (0.2-0.7)
45-54	7	2	9	0.3 (0.1-0.5)
55-64	6	6	12	0.6 (0.3-0.9)
Total/Overall	57	32	89	0.5 (0.4-0.7)#

*per 100,000 person years # Age standardised rate ** Reduces to 0.7 (0.4-0.9) if exclude multiple fatality event

Ethnicity

Ethnicity is not recorded in FIRS data. Ethnicity is not recorded systematically in coronial files, but is often stated by witnesses (including relatives of the deceased) in their evidence, or noted on the post mortem examination. Health data include fields for full race and race. Prior to 1995 the race field included only two variables, M (Māori) and O (nonMāori). For the overall sample ethnicity was ascertained from Health Service data and from coronial records and showed that 35 per cent of the deceased were Māori (Table 2).

Table 2. Ethnic group of New Zealanders aged 15-64 years who died as a result of injury from fire and flame sustained in domestic fire incidents 1991-1997. Data sources: New Zealand Health Information Service, Coronial Files.

Ethnic Group	Number	Percentage
Māori	31	35
Pacific	3	3
Pakeha/Palangi/Other	52	59
Not stated	3	3
Total	89	100

The manner in which ethnicity data was ascertained in the census has changed each census since 1986. Accordingly a restricted time frame has been used for analysis of ethnicity data, using the years 1991-1994 only. Using the combined data sources from 1991-1994 the rate of Māori deaths was five times that of nonMāori. Even allowing for statistical variability as a result of the small sample size, the death rate from fire among Māori adolescents and working age adults is likely to be at least three times that of nonMāori, and may be as high as nine times that of nonMāori (RR 5.3; 95%CI 3.0-9.4). This rate ratio reduces to 5.0 (95%CI 3.0-9.4) if the multiple fatality event is excluded. Although there may be numerator bias in these data, due to possible misclassification from reading and interpreting the coronial files, it is likely that the excess fire mortality risk for Māori aged 15-64 years is higher than the threefold risk indicated by health data alone (Duncanson, Woodward, Reid, & Langley, 2000).

Fatal unintentional domestic fire incidents involving Māori aged 15-64 years occurred in almost all fire regions (see Table 3), with the highest proportion of incidents resulting in Māori fatalities in this age group occurring in the Bay-Waikato, Western, Southern and Northland regions. A multiple fatality incident in Christchurch meant increased the proportion of Māori fatalities occurring in the Transalpine region above the proportion occurring in Northland.

Table 3. Unintentional fire-related deaths of Māori aged 15-64 years in Aotearoa New Zealand 1991-1997 by fire region. Data sources: NZHIS, FIRS.

Fire region	Number of incidents involving Māori (%)	Number of Māori deaths (%)
Bay-Waikato	9 (39)	13 (42)
Western	5 (22)	7 (23)
Southern	4 (17)	4 (13)
Northland/ Auckland	3 (13)	3 (10)
Transalpine	2 (9)	4 (13)
Total	23 (100)	31 (100)

Fire characteristics

Time of incident

FIRS data, including time of the alarm being received by the Fire Service, were available for 72 (94 per cent) of the 77 fatal unintentional fire incidents involving people aged 15-64 years between 1991 and 1997. These fatal incidents occurred predominantly at night with over 60 per cent of fatal incidents occurring between midnight and 6 a.m. (Figure 1). Month and day for all 77 incidents were determined from coronial records, with use of a multi-year calendar where necessary. Figure 2 shows that over two-thirds of all incidents occurred over a weekend (10 on a Friday, 18 on a Saturday and 26 on a Sunday). Figure 3 shows that unintentional fatal domestic fire incidents involving New Zealanders aged 15-64 years occurred more frequently in the winter and spring (51 incidents; 65 per cent between June and November) compared with summer and autumn (28 incidents; 35 per cent between December and May).

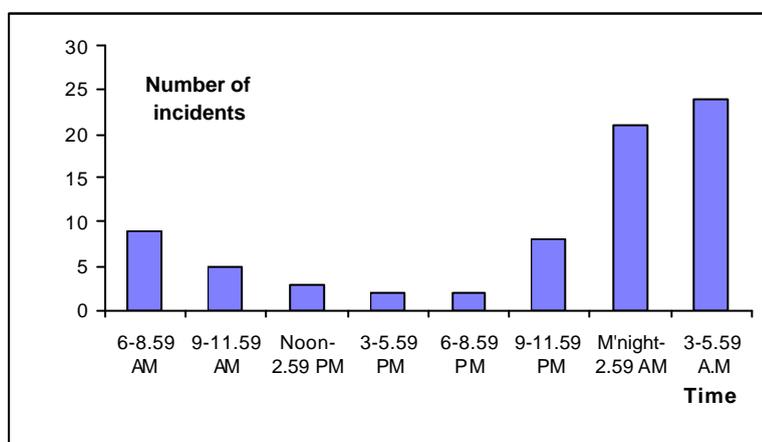


Figure 1. Alarm times of unintentional fatal domestic fire incidents involving New Zealanders aged 15-64 years, 1991-1997. Data source: Fire Incident Recording System.

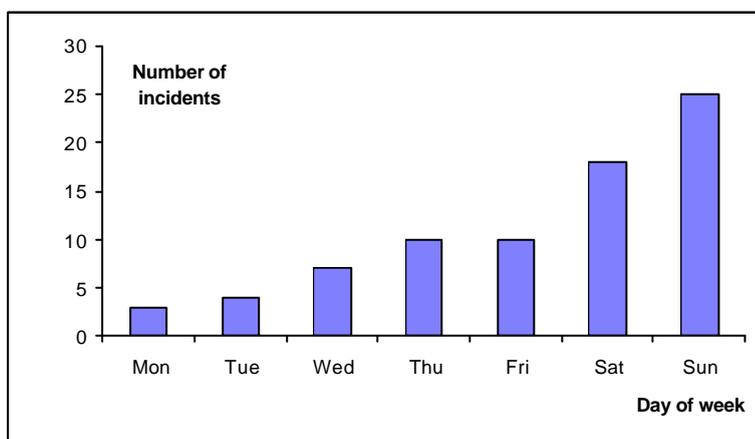


Figure 2. Day of week of occurrence of unintentional fatal domestic fire incidents involving New Zealanders aged 15-64 years, 1991-1997. Data sources: Fire Incident Recording System, Coronial records.

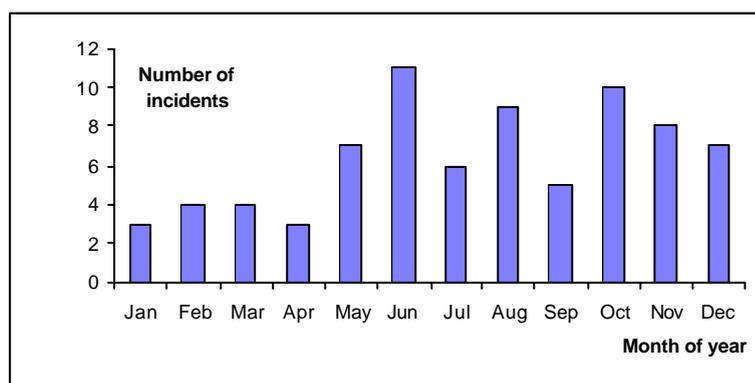


Figure 3. Month of occurrence of unintentional fatal domestic fire incidents involving New Zealanders aged 15-64 years, 1991-1997. Data source: Fire Incident Recording System.

Room of origin

Room of origin in permanent private dwellings, and in temporary dwellings with defined living spaces or uses was obtained from FIRS data or from reading coronial files. A separate category was used for fire incidents which occurred in a caravans or one room dwellings where sleeping and living areas cannot be distinguished. The fatal fires affecting New Zealanders aged 15-64 years started most commonly in a bedroom, sleeping area, kitchen or lounge, with fewer incidents in other rooms or outdoors. The location of origin for one incident was unknown and four incidents (five per cent) occurred in caravans or one roomed dwellings.

Table 4. Number and percentage of unintentional fires in private dwellings resulting in deaths of New Zealanders aged 15-64 years 1991-1997, by room of origin. Data sources Fire Incident Reporting System; Coronial Files.

Room of origin	Number of incidents	Percentage of incidents
Bedroom/ sleeping area	24	31
Kitchen	24	31
Lounge/living area	18	23
Caravan/ one room dwelling	4	5
Other room*	4	5
Outdoors	2	3
Unknown	1	1
Total	77	100

*e.g. laundry, study, dining room, garage

Heat source

The source of ignition was unable to be determined in 10 (13 per cent) of incidents. Among incidents where the most likely cause was determined, the most common heat sources for unintentional domestic fires resulting in the death of New Zealanders aged 15-64 years were discarded cigarettes or smoking materials, oven or stove tops, and heaters or fireplaces (see Table 5).

Table 5. Number and percentage of unintentional fires in private dwellings resulting in deaths of New Zealanders aged 15-64 years 1991-1997, by presumed source of ignition. Data sources Fire Investigation Reports; Coronial Verdicts.

Heat source	Number of incidents (%)	Number of adult fatalities (%)
Cigarettes/ smoking materials	25 (32)	31 (35)
Oven/ Stove top/barbecue	17 (22)	18 (20)
Heater/ Fireplace/ Solid fuel burner	14 (18)	18 (20)
Electric appliance/ wiring	8 (10)	8 (9)
Candle	3 (4)	3 (3)
Unknown	10 (13)	11 (12)
Total	77 (100)	89 (100)

Almost one-third of the incidents, and over a third of the fire-related fatalities involving New Zealanders aged 15-64 years occurred in fires started by cigarettes or smoking materials. A cigarette was considered the most likely heat source in 20 of the 25 incidents. For the remainder the broader category 'smoking materials' describes the situation where it could not

be determined if the cigarette, lighter or matches started the fire. In three incidents in this latter category incense sticks, electric blanket or a naked flame light source could not be discounted as possible alternative heat sources. Fires ignited by smoking materials were typically preceded by a period of slow smouldering prior to the flaming stage.

It was suggested by the presence of lighters, ashtrays and cigarettes that the victim was a smoker. As there were no appliances at the point of fire origin, and the point of fire origin was in the approximate area of the victims head, the assumed cause of the fire was that the victim fell asleep with a lit cigarette. In its early stages the fire was of a slow smouldering type ... The smouldering process would have preceded a free burning, flaming fire by no more than 15 minutes.

Fire Investigation Report 1997

A smouldering cigarette could have been dropped unintentionally on the clothes and smouldered away, then catching fire and spreading to other combustibles in the room. This would account for the deep burning down into the floor boards.

Fire investigation report 1995

The supposed cause I concluded was that the deceased had fallen asleep while smoking a cigarette. The cigarette had then smouldered amongst bedding, releasing large quantities of toxic smoke.

Witness testimony 1992

Over one fifth of the fatal fire incidents, and one fifth of fatalities from injury from fire and flame among New Zealanders aged 15-64 years were associated with cooking sources. In three incidents the deceased was directly involved with the fire and in the remainder the cooking source had been abandoned, often while the deceased was asleep. Alcohol use, confirmed by post-mortem blood levels or a conformed history, was associated with 14 of the 17 cooking related fires in the current study (82 per cent).

It would appear that a pot of food has been put on the stove to heat up. The deceased appears to have fallen asleep. The pot has boiled dry and overheated. The wall lining adjacent has ignited spreading up the wall across the ceiling. There would have been quite a lot of smoke generated by the burning food and also the lining adjacent to the stove.

Fire Investigation report 1991

... they left the hotel and attended a party before returning home in the early hours of the morning. It appears that they prepared something to eat before going to bed.

Fire Investigation report 1997

Almost one fifth of the fatal fire incidents, and a fifth of the fire-related fatalities involving New Zealanders aged 15-64 years resulted from heating appliances. The majority of these appliances were electric heaters, but there were also defective fireplaces, kerosene and solid fuel burners in the sample. One heater was noted to have been purchased second hand shortly before the fatal fire incident. The majority of unintentional fatal domestic fire incidents where a heater or solid fuel burner was the presumed heat source resulted from the heating appliance being in close proximity to combustible materials, usually in a bedroom. In other incidents poor fireplace construction was associated with slow burning of the dwelling structure over time, and inappropriate disposal of solid fuel resulted in ignition of dwelling contents.

...the man returned home about midnight and turned on his two-bar, electric “old-fashioned” heater, which was placed only millimetres from his bedding. “The most likely scenario is that he fell asleep and the squab he was sleeping on caught fire”.

Media report 1994

It was found that some structured timber directly beneath the fireplace had burnt away. This burning had occurred over a period of time. Although the timber was under a concrete fire pad there were cracks in the concrete which permitted transfer of the heat. At some stage of the evening the timber beneath the fireplace began to smoulder. Later on in the evening the smouldering timber reached ignition temperature and began to flame. The V patterns traced the movement of the fire back to beneath the fireplace.

Witness testimony 1993

A variety of electric appliances, other than heaters, collectively contributed to around one tenth of the fatal unintentional domestic fire incidents involving New Zealanders aged 15 – 64 years. Such incidents resulted from appliances being left unattended (irons, electric blankets, electric jugs or deep fryers), from kinking of the electric appliance cords, or from some other cause such as overloading of electricity outlets. In one incident slow burning from a faulty electric light fitting had probably been occurring for some time prior to the fire incident.

I believe that the iron was left ‘on’, while it was on the ironing board, it heated to melting point, with the heat from the iron being conducted to the ironing board... I believe the deceased either used the iron and left it ‘on’, or as it was a cold night, put the iron plug in thinking it was the heater; as the remains of the heater were found alongside the iron.

Fire Investigation report 1996

The only probable ignition source in this area was the television set. The extent of burn damage to the set is indicative of a fire having started in the set or in very close proximity to it.

Fire Investigation report 1997

Pursuant to section 15 (1)(b) of the Coroners Act 1988 I make the following recommendations or comments: that purchasers of all electrical appliances should be warned of the potential danger of fire from electric cables which may have been folded for some time prior to purchase.

Coroner 1997

We now know that the downlight had been illuminated for several days leading up to the time of the fire. Given the fact that there is a probability of pyrolising activity under way for some days prior to the fire, the light, having been left on for an extended period, would have been virtually the straw that broke the camel’s back and ignition commenced.

Witness testimony 1997

In the current study candles were the most likely heat source for three incidents. Two of the three incidents occurred in dwellings without an electricity supply. A further incident in a dwelling without electricity, in which smoking materials were considered the most likely source of ignition, could also possibly have been caused by a naked flame light source.

...because the mains power was not connected to the house, candles etc were being used for lighting.

Fire Investigation report 1993

A candle was always taken to the tent for lighting purposes.

Fire Investigation Report 1993

Items ignited

The item ignited was abstracted from coronial records and fire investigation reports. The item ignited was not able to be determined in ten incidents (13 per cent), and items were described as 'combustible materials' in several incidents. As in previous reports, combustible materials have been classified by room of origin to give increased specificity to the findings listed in Table 6. Reflecting the location of fire origin, almost half the 77 fatal fire incidents involving New Zealanders aged 15-64 years resulted from ignition of bedding or combustible materials in a bedroom, food on a stove top, or furniture or combustibles in a lounge. Ignition of dwelling structure or interior furnishings, of flammable gas or liquid, of clothing being worn and of combustible materials in a kitchen together accounted for a quarter of the fatal fire incidents. In this context ignition of dwelling structure or interior furnishings included ignition of fireplace linings, carpets and wall linings.

Table 6. Number and percentage of unintentional fires in private dwellings resulting in deaths of New Zealanders aged 15-64 years 1991-1997, by presumed items ignited. Data sources Fire Incident Reporting System; Coronal Verdicts.

Item ignited	Number of incidents (%)	Number of fatalities (%)
Bedding/ combustible materials bedroom	23 (30)	28 (31)
Food being cooked	14 (18)	15 (17)
Combustible materials lounge	11 (14)	14 (16)
Dwelling fixtures/structure	8 (10)	9 (10)
Flammable gas or liquid	5 (6)	5 (6)
Clothing being worn	3 (4)	3 (3)
Combustible materials in kitchen	3 (4)	3 (3)
Undetermined	10 (13)	12 (13)
Total	77 (100)	89 (100)

Fire scenarios resulting in deaths of people aged 15-64 years

For the 65 incidents where both the presumed heat source and presumed item ignited were determined, scenarios were developed and ranked according to the number of incidents and the number of fatalities. Scenarios for unintentional death from fire and flame in a domestic location in New Zealand 1991 to 1997 for adolescents and adults aged 15-64 years are listed below with the first three scenarios accounting for 60 per cent of all fatalities. The disproportionate number of fatalities resulting from smoking materials is observed principally because of the multiple fatality incident in which 5 deaths occurred.

- Cigarettes or smoking materials igniting bedding or combustible materials in dwelling (21 incidents, 26 adult fatalities)
- Stove top or oven igniting unattended cooking materials (14 incidents, 15 adult fatalities)
- Heater or solid fuel burner placed too close to combustible materials and resulting in ignition of bedding or combustible materials in dwelling (10 incidents, 12 fatalities)
- Unattended or malfunctioning electric appliances igniting furnishings or other combustibles in dwelling (7 single fatality incidents)
- Ignition of flammable gas or liquid by naked flame or heat from cigarette lighter, candle, barbecue, or heater (5 single fatality incidents)
- Unsafe construction or maintenance of fireplaces with ignition of wall linings and dwelling structure (2 incidents, 3 adult fatalities)
- Clothing ignitions from cooking or heater (3 single fatality incidents)
- Candle igniting bedding or combustible materials in dwelling (2 incidents, 3 fatalities)
- Unsafe installation or maintenance of electrical wiring with ignition of wall linings and dwelling structure (1 single fatality incident).

Environmental characteristics - social

Socio-economic deprivation

Despite the low numbers in this series it was possible to gain some impression of distribution of incidents using the New Zealand index of socioeconomic deprivation based on the 1996 census (NZDep96). Of the 77 incidents, 57 occurred between July 1993 and December 1997 (a time frame appropriate to analyse using NZDep96) and 55 of these (96 per cent) could be geocoded to census meshblock level. Over 40 per cent the fatal fire incidents involving New Zealanders 15-64 years occurred in the twenty per cent of meshblocks with the highest levels of social and material deprivation, as shown in Figure 4.

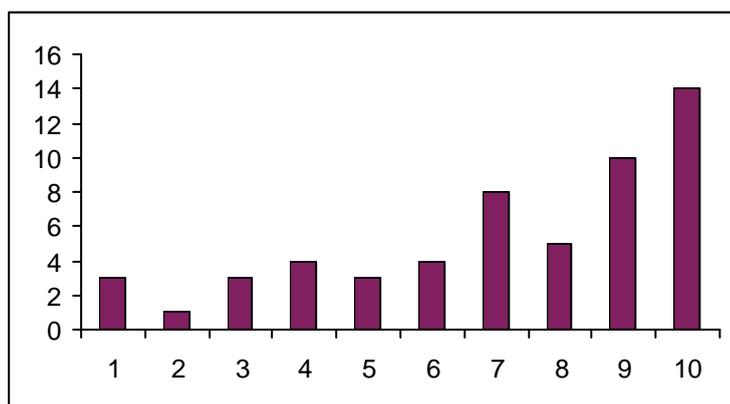


Figure 4. Fatal fire incidents in Aotearoa New Zealand involving adolescents and adults aged 15-64 years, July 1993-December 1997 by decile of social and material deprivation. Data Sources FIRS, NZHIS, Statistics New Zealand.

Household composition

Information about household composition was abstracted from coronial files and fire investigation reports. This information was not complete. However in 33 of the 77 (43 per cent) fatal unintentional domestic fire incidents involving New Zealanders aged 15-64 years in the study time frame) the deceased was at home alone at the time of the incident. Three incidents occurred in dwellings which were crowded – with more than five adults present at the time of the fire. Other household members were apparently present in most of the remaining incidents.

Alcohol, drugs and presence of disability

Post-mortem blood alcohol levels were available for 54 (61 per cent) of the deceased; and a confirmed history of alcohol consumption prior to the fatal fire incident was recorded for a further 21 deceased (24 per cent). For 14 of the deceased (16 per cent) there was no information about alcohol consumption around the time of the fatal fire incident.

Recorded blood alcohol levels ranged from 20 to 390 mg/100ml, as summarised in Table 7. Overall alcohol was involved in over two-thirds of the unintentional fatal domestic fire incidents involving New Zealand adolescents and adults aged 15-64 years, from 1991 to 1997. When analysed by heat source, alcohol was disproportionately associated with fires started by abandoned or unattended cooking sources, cigarettes, electrical appliances, fireplaces, and solid fuel burners. These heat sources commonly give rise to a slow smouldering fire – it is probable that the effects of alcohol consumption reduce the victims' awareness of the fire, and impeded escape. A smoke alarm would be likely to detect the slow build up of smoke in such an incident, and provide timely warning to the occupant or a passer-by to the danger.

Table 7. Alcohol consumption as indicated by post-mortem blood levels or confirmed history for New Zealand adolescents and adults aged 15-64 years who died in unintentional domestic fire incidents 1991-1997. Data source: Coronial records.

Alcohol status	Number of deceased (%)
Blood level < 5 mg/100 ml	14 (16)
Blood level 20-99 mg/100ml	5 (6)
Blood level 100-199 mg/100ml	25 (28)
Blood level 200 + mg/100ml	10 (11)
History of alcohol consumption	21 (24)
No information	14 (16)
Total	89 (100)

Results of testing for other drugs were not systematically reported in the data sources, however blood levels of prescribed and other drugs sufficient to impair judgement, or a history of such drug consumption, were reported for eight of the deceased (9 per cent). The substances listed included promethazine, medication for epilepsy, toluene, benzene, cannabis, benzodiazepines, morphine, dextropropoxyphene, and norpropoxyphene. Sniffing petrol or glue also contributed directly to at least two incidents by increasing the fire load and increasing the likelihood of ignition.

Information about disability was not recorded systematically. However there was mention that ten of the deceased (11 per cent) were living with disability at the time of the fatal fires which claimed their lives. Disabilities included restricted mobility, intellectual disability, psychiatric disability, and significant chronic medical conditions. Three of the deceased

living with disability had no detectable blood alcohol, and for the remaining four the alcohol level was not recorded. None of the deceased living with disability had a history of alcohol consumption prior to the incident. Medication prescribed for the condition giving rise to disability may have impaired response for two of the deceased. Four of the ten deceased living with disability died in fires where the likely heat source was discarded cigarettes or smoking materials.

Disruption to routine

The term disruption has been coined to describe factors which recurred throughout the records of fatal fire incidents involving New Zealanders aged 15-64 years. Although this information was not gathered systematically, it was inherent within the statements about owners and occupants of dwellings which were included in most coronial reports. In this age group the term disruption includes partying, returning after midnight from social activities, being away from home or having guests staying overnight, or being at home alone because usual household members were absent. Many of these 'disruptions' were associated with alcohol consumption. Such circumstances are of course common place, and may have occurred by coincidence in association with fatal fire incidents. However they may also contribute to risk of death in a fire incident through impaired ability to respond to fire and lack of familiarity with the dwelling and means of escape.

...deceaseds had been drinking in company with some friends...They then left the residence of their friends and went a short distance to a cottage where they were living. It then seems that sometime later a fire broke out in this cottage...the fire could have been the result of a cigarette. The deceaseds appear to have become aware of their predicament, aware of the fire and tried to exit the dwelling. ...at that stage they were both to some degree intoxicated and no doubt also affected by the very volatile situation that they found themselves in, the very stressful situation and the smoke, fire that sort of thing. Unfortunately they did not manage to exit the building.

Coroner 1994

The evacuation was slow and disorderly. Three of the four occupants had been drinking heavily prior to the fire. The two male occupants were not familiar with the layout of the premises. All three occupants who were intoxicated had difficulty in escaping. The deceased was trying to evacuate the building, became disoriented and was trapped in the bedroom

Fire Investigation report 1992

Environmental characteristics - physical

Dwelling type

Dwelling type was determined from FIRS data, from fire investigation reports, and from coronial records. Dwellings were categorised as permanent private dwellings if they were detached single dwellings, or apartments, constructed of permanent materials. The category temporary dwelling included caravans, sheds or other structures not intended as a private dwelling but being used for that purpose. This category included a multiple fatality fire in a workshop on a residential property which was being used as a sleeping area.

The majority of incidents occurred in permanent private dwellings, as shown in Table 8. However between 1991 and 1997 eight (10 per cent) of the fatal domestic fire incidents affecting New Zealanders aged 15-64 years occurred in caravans or other temporary dwellings. Incidents in temporary accommodation were started by cigarettes or smoking materials (3-4 incidents), heating appliances (3 incidents) and naked flames (1-2 incidents). Three incidents occurred in dwellings without electricity (two temporary and one permanent dwelling); and candles were the most likely heat source for two of these incidents and a naked flame light source was a possible cause for the third.

Almost one fifth of fatal domestic fire incidents in the 15-64 year old age group occurred in flats or apartments. This reflects lifestyle choices and available options, particularly for younger people. However there are particular risks associated with multi household dwellings, particularly where compliance with the Building Act is not achieved.

Deceased and relative slept in the tent whilst awaiting proper rental accommodation. There was no power in the tent or two other structures on the property which were also used as accommodation.

Fire Investigation Report 1993

Pursuant to Section 15 (1) (b) of the Coroners Act 1988 I make the following recommendations or comments: Drew attention to the need for care in caravans, most of which carry a very high fire loading.

Coroner 1994

A great concern is the fact that this premises does not have an approved evacuation scheme pursuant to the Fire Safety and Evacuation of Buildings Regulations 1992...Urgent action should be taken to force compliance by recalcitrant owners of such residential properties with the Fire Safety and Evacuation of Buildings Regulations 1992

Fire Investigation Report 1994

Table 8. Number and percentage of fatal fire incidents involving New Zealanders aged 15-64 years 1991-1997 by type of dwelling. Data sources Fire Investigation reports, Coronial files.

Dwelling type	Number of incidents (%)	Number of fatalities (%)
Permanent detached dwelling	53 (69)	58 (65)
Permanent apartment/ flats	14 (18)	15 (17)
Temporary dwelling	8 (10)	14 (16)
Outdoors	2 (3)	2 (2)
Total	77 (100)	89 (100)

Domestic smoke alarms

Information about the presence or absence of smoke alarms was not gathered systematically. However in 44 of the 68 fatal incidents (65 per cent) which occurred in private dwellings there was stated to be no smoke alarm present. In two incidents the dwelling was noted to have a non-functioning smoke alarm, or insufficient alarms for the size of the dwelling. There was no information about the presence or absence of smoke alarms in the remaining eight incidents. It seems likely, but cannot be stated categorically, that most of these homes were without smoke alarms. At the time of the incidents described in this study up to 65 per cent of New Zealand homes had smoke alarms fitted (CM Research, 1998). The dwellings in which

adolescents and adults aged 15-65 years died as a result of injury from fire and flame were therefore less likely to provide adequate means of warning occupants of a fire and allowing time for escape. Fire investigation reports and coronial records repeatedly emphasised the importance of domestic smoke alarms.

The advantages of domestic smoke alarms is highlighted by incidents of this nature
Fire Investigation Report 1991

...had smoke alarms been installed in the flat, they may have alerted the occupant or passers-by to the presence of the fire, thereby averting this tragic loss of life.
Fire investigation report 1992

... tragedy might have been avoided had smoke alarms been installed
Coroner 1994

Exits from dwelling

Review of documents did not provide enough data to comment directly on the dwelling plans and adequacy of exit provision. However concerns were raised about the lack of availability of adequate exits in several cases. Caravans are, of course, also characterised by having only one exit and this may impede escape, especially if the seat of the fire is near the doorway.

An alternate exit stairway or ladder from the first floor would have allowed escape from this level without having to use the internal stairs
Fire investigation report 1994

Deceased was trying to evacuate the building, became disorientated and was trapped in bedroom
Fire Investigation report 1992

Distance from Fire Service

As a measure of rurality and isolation the distance travelled by the nearest attending fire appliance was obtained from FIRS data for 72 of the 77 incidents (94 per cent). As shown in Table 9, almost two-thirds of the fatal fire incidents involving New Zealanders aged 15-64 years occurred within 5 km of the nearest attending fire appliance. A further nine incidents (13 per cent) occurred between 5 and 9 kilometres from the attending fire appliance, and 17 incidents occurred between 10 and 50 kilometres of the nearest attending fire appliance. Concern about the adequacy of fire services in rural areas was raised in two coronial reports.

Rural fire risk concerns coroner. ...coroner is concerned about delays in getting water to rural fires. During an inquest on Wednesday [a] station officer said there was always a delay in getting water to a rural fire.
Media report 1995

Access for fire appliances in rural areas ... is made extremely difficult and sometimes impossible due to bush-clad driveways which are low and narrow.
Coroner 1996

Table 9. Number and percentage of fatal fire incidents, and of incidents with multiple fatalities, by distance travelled by nearest responding fire appliance. Data source: Fire Information Recording System.

Distance travelled	Number of incidents (%)
0-4 km	46(64)
5-9 km	9 (12)
10-14	7 (10)
>14 km	10 (14)
Total	74 (100)

Non-domestic structural and intentional fire deaths

Thirty-one New Zealanders aged 15-64 years died as a result of injury from fire and flame in intentional fire incidents or in non-domestic locations in the time period 1991-1997. Thirteen died in fires which were deliberately lit, five of them in a single hotel fire, and three in incidents which resulted in a criminal conviction. Thirteen people completed suicide using fire and flame as the agent of injury; suicide deaths frequently involved use of flammable liquids. Two incidents resulted from home based manufacture of cannabis oil. Five people in this age group died in non-domestic institutional or occupational settings.

The non-domestic incidents highlight the varied living circumstances of adolescents and adults aged 15-64 years, and the importance of compliance with the Building Act in order to avert premature deaths. Adequate warning and evacuation plans can be effective in intentional fire incidents where the deceased is not in immediate contact with the heat source.

Discussion

Data issues

The datasets used in this study are the most reliable sources available. The NZHIS provides the most comprehensive data available regarding mortality in New Zealand. During the study period, coding was carried out according to internally and externally audited coding standards. Nevertheless some coding errors do occur in such a large dataset with multiple data entry staff. Searching by non-domestic location, by additional E codes, and by key words in the event field identified several eligible cases.

FIRS data are recorded manually by fire-fighters at fire scenes and entered into a national database which provides the most comprehensive record of fire incidents in New Zealand. In the combined dataset of New Zealanders aged 15-64 years, created for this study, there were five deceased identified from NZHIS data for which an incident could not be identified by date and location in the FIRS data. Three deceased in FIRS data could not be identified in NZHIS mortality data, and are believed to have recovered from the fire injury as individuals of the same age and name have current unique health identifiers.

Coronial records were reviewed for 86 of the 89 deceased in this series. Three individuals were identified from both FIRS and NZHIS data, but no coronial record could be located, however there were sufficient data in the combined data sources to include these cases in the study. Coronial records were extremely variable in the degree of detail about the deceased and the incident resulting in death. Blood alcohol levels were taken relatively systematically and were available for over 60 per cent of the deceased. Identified shortcomings in the coronial service identified by the (Law Commission, 2000) have been confirmed by this study. Appointment of a Chief Coroner, and adequate training and resourcing of the coronial service, will be needed to achieve the systematisation of enquiries that could add value to the records. In addition the inclusion of fire-related deaths as a separate category within the coronial records would assist the NZ Fire Service Commission in surveillance of their area of statutory responsibility.

Use of three principal data sources has increased the information available about each fatality. In particular the use of NZHIS data has provided accurate information about the age and gender of the person. Ethnicity data in the health sector continues to undercount Māori (Te Rōpu Rangahau Hauora a Eru Pōmare (Eru Pōmare Māori Health Research Centre), 2000), as shown in this study using a Māori Health researcher to ascertain ethnicity from all sources.

Study implications

This review of multiple data sources highlights tobacco and alcohol consumption as particular challenges to fire safety for households with New Zealanders aged 15-64 years. Other key issues with implications for prevention policy include:

- Raising awareness of risks of injury from fire and flame among adolescents and adults aged 15-64 years
- Ethnic and socioeconomic disparities in fire risk
- Increased fire injury risk associated with heating appliances
- Increased fire injury risks associated with inappropriate use of flammable gases and liquids
- Fire injury risk associated with combustibility of bedding and upholstered furniture
- Fire injury risk associated with absence of smoke alarms
- Fire injury risk associated with disruption of usual routines and with geographic isolation.

Raising awareness

Events during the winter of 2001 have raised community awareness of fire risks. The New Zealand Fire Service media strategy has ensured that press releases associated with fire-related deaths also include fire safety messages. The government has recently announced a whole of government initiative to improve substandard housing, including installation of 9000 domestic smoke alarms (personal communication, Ministry of Health, September 2001). In addition to this increase awareness at central government level, increased awareness of risks associated with fire at community and household level is also important to further reduce fire injury and death rates.

Recommendations

That the New Zealand Fire Service Commission ensure that findings of this study are disseminated among relevant government departments, agencies and individuals. Such groups will include Te Puni Kokiri, Ministry of Pacific Island Affairs, Ministry of Health, Ministry of Social Policy, Ministry of Women's Affairs, Māori and mainstream health service providers including Public Health service providers, and Māori and mainstream Social Service providers.

That the New Zealand Fire Service Commission liaise with relevant agencies and individuals to incorporate fire safety strategies in individual and population based health promotion strategies for this age group. Such groups will include Te Puni Kokiri, Ministry of Pacific Island Affairs, Ministry of Health, Ministry of Education, Ministry of Social Policy, Ministry of Women's Affairs, Māori and mainstream health service providers including Public Health service providers, and Māori and mainstream Social Service providers.

Addressing disparities

Ethnic disparity

Addressing the increased risk of fire mortality experienced by Māori in New Zealand, which has been demonstrated previously (Duncanson, Woodward et al, 2000), is a clear priority indicated by the findings of this research project. The investment by the New Zealand Fire Service Commission in research to address this disparity (Thomas, Rayner, & Moroney, 2000), and the appointment of Iwi liaison officers in key fire regions are timely actions to begin addressing this issue. However deaths of Māori have occurred in almost all fire regions, with over half the Māori fatalities in the current series occurring in regions other than those with appointed Iwi liaison officers in June 2001. Appropriate cultural advice must be readily available throughout Aotearoa New Zealand. These measures need to be underpinned by strategic moves to further develop bicultural awareness within the Fire Service at all levels.

There is also a need for recognition of the ethnic diversity of the New Zealand population. Pacific peoples are also believed to be undercounted in health data. Although numbers were small in the current study, Pacific children do appear to be over represented in fire mortality statistics. It is important for the Fire Service to obtain appropriate cultural advice to improve fire safety for Pacific peoples and other ethnic minority groups. In Australia, for example, a campaign has focussed on the needs of Arab, Chinese and Vietnamese immigrants (Young, Camit, & Mihajlovic, 1999). Investigation of the need for such programmes among minority ethnic communities in New Zealand is also warranted.

Recommendations

That the New Zealand Fire Service Commission give urgent priority to the development of bicultural policy, with reference to the Treaty of Waitangi, and of a partnership between the Fire Service Commission (as a Crown entity) and Māori. Primary goals for the partnership would be to address the Māori: nonMāori disparity in fire fatality rates, and to develop a service which is able to deliver effective services to Māori.

That the New Zealand Fire Service Commission give urgent attention to the appointment of adequately resourced Māori liaison staff in each fire region, with skills to develop and implement appropriate fire safety programmes for Māori with particular focus on adolescents and young adults.

That the New Zealand Fire Service Commission consult with the Ministry of Pacific Island Affairs and other government and non-government organisations to determine appropriate strategies to improve fire safety among Pacific peoples.

Socioeconomic disparity

Increased risk of fire fatality with increasing socioeconomic deprivation has been demonstrated previously. Over one third of fire fatalities recorded in FIRS from 1993 to 1998 occurred in the most socioeconomically deprived small areas of New Zealand; the proportion is even higher for the fatal incidents involving adolescents and adults aged 15-64 years described in this study, where forty per cent of the fatal incidents between 1993 and 1997 occurred in the most deprived quintile. Specific fire fatality risk factors identified in the current study are known to vary with increasing socioeconomic deprivation. Such variation has been described for tobacco consumption (Crampton, Salmond, Woodward, & Reid, 2000). Other factors that may contribute to the socio-economic gradient for fire fatality risk include housing tenure and quality; differential community prevalence of smoke detector

installation; social conditions promoting smoking and alcohol use; lack of support for sole parents; and educational underachievement. Addressing such issues requires an intersectoral approach such as that of the Cabinet committee on social equity, which seeks to develop a whole of government approach to reducing socioeconomic disparities in society.

Recommendation

That the New Zealand Fire Service Commission liaise with other government and non-governmental agencies and organisations to address socioeconomic disparities in New Zealand society, and to ensure that fire safety is incorporated in programmes designed to improve outcomes for households living in relative social and material deprivation.

Safe use and disposal of smoking materials

One of the most striking observations in this study was the high proportion of adolescent and working age adult fire deaths caused by smoking materials. Fires started by inappropriately discarded cigarettes are a significant risk for households including smokers. Ignition of clothing, bedding, lounge furnishings or contents of rubbish bins by discarded cigarettes can result in slow smouldering fires that are not noticed for many hours (Baker, 1992). Fires started by discarded cigarettes are disproportionately result in injury or death. FIRS data for 1995 – 2000 indicated that although cigarettes were the probable cause for only three per cent of all fires, they were associated with between 10 and 17 per cent of fatal fires (personal communication, Roger Chang, New Zealand Fire Service, March 2001). A fatal fire is therefore approximately three times more likely than a non-fatal fire to have been started by a cigarette. If those fires possibly started by cigarettes are included in the calculation a fatal fire is approximately six times more likely than a non-fatal fire to possibly have been started by a cigarette. This is consistent with the finding in the USA that a fatal fire is approximately 7.7 times more likely than a non-fatal fire to have been started by smoking materials (Runyan, Bangdiwala et al. 1992).

The international medical literature, including injury prevention literature, has highlighted the role of cigarettes in causing fires that result in human injury for several decades. Key studies are listed in Table 10. Although based on different population groups, and using different definitions of injury, the striking common factor is 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). This is likely to relate not only to fires started by discarded cigarettes, but to the greater access of children in such households to matches and lighters. Reducing the risk of fire and fire related injury in smoking households is a clear area for action identified in this study.

Manufacture of self-extinguishing or non-flammable cigarettes is possible (Barillo, Brigham et al. 2000), and production of ‘fire-safe’ cigarettes is assessed to have a high benefit-cost ratio in preventing injury (Miller & Levy, 2000). Advocacy for cigarettes to be required to have lowered capacity to ignite household furnishings has a long history in the injury prevention and legal literature (Aligne & Stoddard, 1997; Barillo, Brigham, Kayden, Heck, & McManus, 2000; Botkin, 1988; Brigham & McGuire, 1995; McGuire, 1999), but has been steadfastly resisted by the tobacco industry (Halbert, 1999). Tobacco companies operating in New Zealand opposed the Cigarette (Fire Safety) Bill 2000. A key argument was that “smokers should use common sense and take care to dispose of their cigarettes and smoking materials wisely” (Imperial Tobacco New Zealand, 2001). However the vast majority of cigarettes are already extinguished safely and responsibly. Each year more than 2.5 billion

cigarettes are consumed by New Zealand smokers (British American Tobacco New Zealand, 2001). Since cigarettes account for the ignition of around 600 fires per year, over 4 million cigarettes are disposed of appropriately for every cigarette which ignites a fire. Education of smokers is unlikely to be effective in those relatively rare situations where a smoker is distracted, under the influence of alcohol, or otherwise disposes of a cigarette inappropriately.

The current study suggests that a mandatory fire safety standard for cigarettes would have greatest impact in the 15-64 year age group. New Zealand is in an ideal position to learn from the protracted and tortuous legal battles related to improving cigarette fire safety in the United States, and to act decisively for the protection of population health through speedy implementation of standard development requiring all cigarettes sold to have lowered propensity to ignite combustible materials. Standards have already been developed in the United States and could be adapted to our context. Such action can proceed alongside strategies to enable smokers to quit, and reduce the flammability of furnishing materials, thus resulting in both short and long term improvements in fire injury risk at household and community levels.

Behaviour of smokers can also be modified to reduce risk of fire. In the follow up survey, which was a component of the evaluation of the Auahi Whakatūpato fire safety programme in Bay of Plenty, the query about smokers in the household was sometimes answered positively but annotated with the words 'smokefree home'. Such households included smokers, however smoking was allowed only outside the dwelling. At a hui to review risk factors for Māori, members of smoking households suggested strategies such as having only one lighter in a dwelling – kept in a safe location (Rau Hoskins, personal communication November 2000). A further strategy could be to encourage smokers to keep matches or lighters on their person, and not leave them lying about. Community based fire safety programmes can usefully incorporate discussions about the fire risks associated with smoking, and encourage local solutions to reduce such risk. Such local strategies would include smoking cessation programmes, but also strategies to reduce risks for those who continue to smoke in the immediate further.

Remember, smokers aren't the problem. Tobacco is the problem. Smokers can be part of the solution even if they can't quit at this time. Smokers can provide a smokefree environment for their family and fellow workers by smoking outside and not smoking in the car. This reduces the 'vertical transmission' of smoking-related illness and puts smokers in a win:win situation, assisting them to become active participants in a smokefree strategy.

(National Health Committee, 1999)

Recommendations

That the New Zealand Fire Service Commission actively support the development of a fire-safety standard for cigarettes sold in New Zealand to reduce the occurrence of fires started by inappropriately discarded cigarettes.

That the New Zealand Fire Service Commission liaise with and support the Ministry of Health, Action on Smoking and Health and public health providers to support programmes to reduce smoking rates among New Zealanders, in conjunction with fire safety programmes.

Table 10. 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, Bangdiwala, Linzer, Sacks, & Butts, 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.	(DiGuseppi, Edwards, Godward, Roberts, & Wade, 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)

Appropriate use of alcohol and host responsibility

Aggressive campaigns by the Land Transport Safety Authority have raised the awareness of New Zealanders about the risks associated with drinking alcohol and driving motor vehicles. However it is probable that the risks of fire-related injury that arise from drinking alcohol and smoking or cooking are less well publicised. Although alcohol consumption is not in itself an independent risk factor for fire related fatalities (Ballard et al., 1992); in association with smoking or cooking the risk of death is increased. Many of the deceased in the current study had very high blood alcohol levels, consistent with a pattern of 'binge' drinking. Community based interventions have resulted in reduced high-risk alcohol consumption and reductions in motor vehicle crashes and violent assaults (Holder, Gruenewald, Ponicki, & Treno, 2000). Treatment for problem drinking is also likely to result in reduced injury rates (Dinh-Zarr, DiGuiseppi, Heitman, & Roberts, 1999).

Recommendation

That the New Zealand Fire Service Commission liaise with and support the Ministry of Health, the Alcohol Advisory Council of New Zealand and public health providers to promote appropriate use of alcohol and develop host responsibility programmes which encourage provision of savoury food prior to guests or patrons returning home from social events or bar facilities.

Safe cooking practices

The strong association between cooking related fatalities and use of alcohol is indicated by direct or indirect involvement of alcohol in 82 per cent of the cooking related fatalities in the current study. Previous analysis of all cooking related fatalities (in all age groups) found that oil or fat was being used in at least half of the incidents where alcohol was associated with an unintentional fatal fire as a result of unattended cooking. This is consistent with the common observation that savoury food is craved after alcohol consumption. Including "food for the road" in host responsibility programmes is therefore an appropriate strategy to reduce household fire injury. There are also increased fire risks associated with the use of aluminium rather than stainless steel cooking utensils. Public awareness of the propensity of aluminium to melt and fuel household fires is low. Outdated aluminium pots may also be given to young people who are leaving parental homes to establish independent living arrangements. Community consultation to develop alternative cooking patterns after alcohol consumption may therefore be of value. For example preparation of food prior to going out and reheating in a microwave oven could be promoted (personal communication, Rau Hoskins, IRI, Auckland University, November 2000). Similarly it may be possible to encourage replacement of aluminium pots with safer stainless steel products through hotel-based product promotion initiatives.

Recommendation

That the New Zealand Fire Service Commission liaise with public health providers to develop community injury prevention initiatives which explore ways to promote cooking practices which are safer, particularly when household occupants have been consuming alcohol. Such safer practices will include alternatives to cooking with fat or oil, and replacement of aluminium pots with stainless steel pots.

Safe heating and lighting

Maintaining a warm home environment is important for the physical health and well being (Isaacs & Donn, 1993). However the means of achieving this must not increase risk of

physical injury. Use of free-standing heaters is a characteristic of New Zealand homes, where central heating is unusual. The use of electric bar heaters, kerosene or gas heaters exposes household members to increased fire risk. It is of particular concern that safety standards do not apply to heaters purchased from second hand outlets. In one coronial verdict the coroner highlighted risks associated with gas heaters, however the issue seems to apply to any type of heating, particularly in bedrooms. In the USA heating fires are more frequent in rural areas, where central heating systems are less prevalent (U.S. Fire Administration, 2001a, 2001b).

Use of candles was also associated with fatal fire incident involving New Zealanders 15-64 years in the current study. Lack of electricity was a factor in five fatalities in the current study. Since the time frame of the current study media reports have linked at least three fires involving New Zealanders to lack of electricity (Jackson & Gee, 2001; Jackson & Larkin, 2001; NZPA, 2000). It is uncertain how many homes in New Zealand are without electricity, but it seems recent changes in the electricity market may have exacerbated the situation. The New Zealand Herald reported in June that 100 houses in Northland have the electricity supply disconnected each week (Northern Advocate, 2001). Safe and affordable means of heating and lighting should be key components of housing policy for all New Zealanders. There could be a case for arguing that electricity supply be regarded as a public good in much the same way as all dwellings must have an adequate water supply. Some households choose alternative means of providing power to reflect lifestyle priorities. In all situations where alternative means of heating and lighting are used, householders have a right to access realistic advice about safe options.

Recommendations

That the New Zealand Fire Service Commission make strong representation to the Ministry of Social Policy and Ministry of Housing regarding the importance of ensuring that all private dwellings are safely constructed with safe means of heating and lighting, with particular reference to households including New Zealanders aged 15-64 years.

That the New Zealand Fire Service Commission undertake a community survey to determine the types of heating used in private dwellings, including caravans and other temporary dwellings, to assess the extent of use of unsafe heating appliances.

That the New Zealand Fire Service Commission determine characteristics of safe home heating systems and develop fire safety promotion programmes to promote heating safety, with particular reference to heating of caravans.

Safe furnishing materials

Almost half the fatal fire incidents in this series resulted from ignition of combustible materials in a bedroom or lounge. Some of these incidents would have been prevented by use of safer heating appliances, or by self extinguishing cigarettes. However it may also be timely to consider flammability standards for bedding and upholstered furniture, recognising that the effects are likely to be long-term “given the proliferation of upholstery manufacturers and the slow rate at which consumers replace furniture” (Halbert, 1999). Such regulation of upholstered furniture exists in the United Kingdom, and has been introduced in the State of New York (New York State Senate Research Service 2000), and could also be considered in New Zealand. Action taken in the immediate future would therefore take many years to result in a reduction in fire incidents. It is also probable that households in socioeconomically deprived areas are more likely to use second-hand furniture, and thus any benefits of

regulation will take much longer to impact positively on their increased risk of fire. Cost-benefit analyses of flammability regulations can take this delayed benefit into account.

Recommendation

That the New Zealand Fire Service Commission liaise with the Ministry of Consumer Affairs regarding the possibility of flammability standards for bedding materials and upholstered furniture.

Smoke alarms

Lack of a smoke detector in a dwelling is an important risk factor for fatal fires (DiGuseppi, Roberts, & Li, 1998; Runyan et al., 1992). Prevalence of smoke detectors is inversely associated with socioeconomic disadvantage (DiGuseppi, Roberts, & Spiers, 1999; Forjuoh, Coben, Dearwater, & Weiss, 1997; Roberts, 1996). This may be partly due to the cost of alarms, but barriers to universal fire alarm installation in New Zealand homes also include regulatory caution and limited landlord responsibility. Smoke detector legislation has been enacted in many countries (ISCAIP Smoke Detector Legislation Collaborators, 1999), and extension to include detached private dwellings is being considered in New Zealand (Building Industry Authority, 2000). Occupants of rental accommodation have little power to insist on fire safety measures being installed in their homes. Under the Residential Tenancies Acts (1986) the landlord's responsibilities include presenting clean premises in a good state of repair. However there is no requirement to provide safe means of heating, nor to provide smoke alarms or fire extinguishers. Rental accommodation in New Zealand has no secure tenure, which under the present system could mean that tenants would be liable not for a "one-off" cost to install smoke alarms, but repeated costs when moving to new premises.

There is considerable benefit to society of having universal smoke alarm installation, above the benefit that accrues to individual households. The benefit-cost ratio for mandatory smoke alarm installation has been estimated at 9:1; that is 9 dollars of benefit for every dollar spent (Building Industry Authority, 1998). A community approach to fire safety, such as that used in the Auahi Whakatūpato programme in Eastern Bay of Plenty, can greatly improve fire safety and reduce the cost to society of property damage, hospital treatment and the consequences of bereavement (Duncanson, Lawrence, & Simpson, 2000, Duncanson, Lawrence, Simpson, & Woodward, 2000).

Recommendations

That the New Zealand Fire Service Commission continue to promote the use of smoke alarms in domestic dwellings through public education and community based fire safety programmes.

That the New Zealand Fire Service Commission indicate support to the Building Industry Authority for mandatory installation of smoke alarms in new dwellings, with a longer term view to mandatory alarms in all private dwellings.

Disruption and isolation

The observation that over a quarter of the fatal domestic fire incident involving New Zealanders 15-64 years occurred in a situation where the usual routine was disrupted has not been reported previously. The estimate is probably conservative, as it did not include incidents where a household had been out for the evening and returned to the usual dwelling. However it is important that fire safety campaigns include issues such as taking responsibility for guests and visitors in one's home, and being safe "wherever you are". Particular issues

associated with geographical isolation may require further investigation to develop appropriate fire safety strategies. Installation of smoke alarms is clearly of particular importance in such circumstances, perhaps in association with enhanced capacity to begin fire-fighting action before the arrival of emergency services.

Disability

The proportion of the deceased living with disability is comparable with the 8.2 per cent of New Zealanders aged 15-64 years who are reported to live with disability requiring assistance (Health Funding Authority & Health,). Acknowledging that the HFA figure includes people living in institutional settings, who were excluded from the fire data, there is a suggestion that the presence of disability may be associated with some increased risk of fire related death.

Recommendations

That the New Zealand Fire Service Commission ensure that fire safety campaigns recognise the mobility of the New Zealand population and promote fire safety for guests in a home as well as usual occupants and fire safety when on holiday away from home.

That the New Zealand Fire Service Commission investigate issues associated with increased geographical distance from Fire Stations with a view to improving fire safety in geographically isolated areas.

That the New Zealand Fire Service Commission intentionally include people living with disability in fire safety intervention programmes, with particular emphasis on improving early warning of and prompt escape from a fire incident.

Conclusion

This descriptive analysis has identified personal, fire-related and environmental factors associated with the 77 unintentional domestic fire incidents which resulted in the deaths of 89 New Zealanders aged 15-64 years from 1991 to 1997. Interventions to improve fire safety for adolescents and working age adults in New Zealand will need to take account of patterns of alcohol consumption in this age group, and the prevalence of smoking. Fire safety can be incorporated within many services available to New Zealand households, and intersectoral raising of awareness of fire risks and of effective intervention strategies is a key component in reducing the injury toll.

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