

Fire Research Report

Fire incidents resulting in deaths of New Zealand children aged under 15 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 under 15 years in domestic fire incidents.

The study finds high risk rates for males, and particularly Maori. The most common heat sources involved in fatalities among children are lighters and matches. While most fatalities occurred in permanent private dwellings, a significant number are found to have occurred in temporary accommodation. A significant identified risk factor is when children are either visiting an unfamiliar house, or there are visitors to the family home. Operating smoke alarms were not present in nearly every incident involving fatalities among children.

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Table of contents

- Introduction 4
- Acknowledgements 5
- Executive Summary..... 6
- Recommendations..... 7
- Background 9
- Study aim and objectives..... 10
- Methods 10
- Data sources 10
- Inclusion criteria 10
- Analysis..... 10
- Results 11
- Fatal fire incidents involving children under 15 years..... 11
- Unintentional domestic fire deaths 11
- Personal characteristics..... 11
- Fire characteristics 13
- Environmental characteristics..... 17
- Non-domestic fire deaths 20
- Discussion 21
- Data issues..... 21
- Study implications..... 22
- Raising awareness..... 22
- Addressing disparities..... 23
- Access to lighters and matches 24
- Safe heating and lighting..... 26
- Fabric combustibility 27
- Smoke alarms..... 28
- Disruption and isolation..... 29
- Conclusion 29
- References 30

Introduction

This report to the New Zealand Fire Service Commission describes features of structural fire incidents in Aotearoa New Zealand which resulted in the deaths of children aged under 15 years from 1991 to 1997. Children have been considered 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 previously 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 describe fire-related mortality among adults aged 15-64 years.

Acknowledgements

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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 under 15 years in domestic fire incidents.

In the years 1991 to 1997 the study identified 39 unintentional domestic fire incidents which resulted in the deaths of 53 New Zealanders aged under 15 years. There were 27 incidents resulting in one child fatality, and 12 incidents resulting in multiple child fatalities. The mortality rates for males exceeded that for females by a factor of two (RR 2.2; 95% CI 1.3-3.9). Using all available sources to ascertain ethnicity the number of Māori fatalities from fire and flame aged under 15 years outnumbered the number of non-Māori, non-Pacific children. From 1991 to 1994 mortality rates as a result of injury from fire and flame for Māori were eleven times higher than rates for nonMāori among New Zealanders aged under 15 years (RR 11.3; 95% CI 5.2-24.6).

The most common heat sources for unintentional domestic fire incidents resulting in the deaths of New Zealand children aged under 15 years were matches or lighters (14 incidents, 36 per cent) and heaters or fireplaces (10 incidents, 26 per cent). The most significant scenarios associated with deaths of New Zealand children from fire and flame were matches or lighter igniting bedding or combustible materials in dwelling; matches or lighter igniting motor vehicle interior; heater placed too close to and igniting bedding or combustible materials in dwelling; candle igniting bedding or combustible materials in dwelling; stove top igniting abandoned cooking materials; and unsafe discarding of cigarettes or smoking materials with ignition of bedding or combustible materials in a bedroom. Fatal fire incidents also resulted from unsafe fireplaces, inappropriate use of flammable liquid, and overloading of electrical outlets or use of unsafe electrical appliances.

Although most fatal unintentional domestic fire incidents involving New Zealand children aged under 15 years occurred in permanent private dwellings, a significant minority (10 incidents, 26 per cent) occurred in temporary accommodation including caravans and makeshift overnight accommodation. Adults were known to be present in the dwelling or nearby in 33 incidents (85 per cent). Four fatal unintentional domestic fire incidents involving New Zealand children aged under 15 years occurred in circumstances where there were no adults present. Smoke alarms were noted to be absent in 23 of the 33 incidents (70 per cent) which occurred in private dwellings. Two dwellings had non-functioning alarms installed and there was no information about presence or absence of alarms in the remaining 8 dwellings (24 per cent). Over 80 per cent of the incidents occurred within 10 kilometres of the nearest attending fire appliance. An unexpected observation was that 11 incidents (29 per cent) occurred when children were staying away from home, or when there were visitors to the family home.

The observations of this research project highlight the importance of raising awareness of fire safety issues among all sectors concerned with the health and well being of New Zealand children, 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 Zealand children.

Recommendations

That the New Zealand Fire Service Commission ensure that findings of this study are disseminated among government departments, agencies and individuals concerned with the well-being of New Zealand children. Such groups will include the Office of the Commissioner for Children, Te Puni Kokiri, Ministry of Pacific Island Affairs, Department of Child Youth and Family Services, Ministry of Health, Ministry of Social Policy, Ministry of Women's Affairs, Plunket, Tipu Ora, 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 agencies and individuals concerned with the well-being of New Zealand children aged under 15 to incorporate fire safety strategies in individual and population based health promotion strategies for this age group. Such groups will include the Office of the Commissioner for Children, Te Puni Kokiri, Ministry of Pacific Island Affairs, Department of Child Youth and Family Services, Ministry of Health, Ministry of Education, Ministry of Social Policy, Ministry of Women's Affairs, Plunket, Tipu Ora, 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 families with children aged under 15 years.

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 closely monitor and report on the proportion of domestic structural fire incidents, injuries and fatalities resulting from children playing with cigarette lighters in order to assess the impact of the mandatory product standards for disposable lighters introduced in 1998.

That the New Zealand Fire Service Commission investigate the possibility of child resistant packaging for matches sold in New Zealand.

That the New Zealand Fire Service undertake market research among current smokers to identify realistic options to reduce access of children to lighters and matches. Such options could include smokefree homes, limited number of lighters in the dwelling, or encouraging smokers to keep matches or lighters on their person rather than unattended in a dwelling or motor vehicle.

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 support the development and provision of juvenile fire intervention programmes for pre-school children who habitually play with matches or lighters. Further, that the New Zealand Fire Service Commission liaise with health professionals, educational bodies and other groups and organisations concerned with the health and wellbeing of New Zealand children to promote awareness of the availability of fire intervention programme for children who habitually play with matches or lighters.

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 children aged under 15 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.

That the New Zealand Fire Service Commission support the maintenance of fire safety standards for children's nightwear by the Ministry of Consumer Affairs.

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

That the New Zealand Fire Service Commission investigate the feasibility of developing less flammable interiors in motor vehicles.

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 which intentionally include households with children under 15 years.

That the New Zealand Fire Service Commission support 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 investigate with the Ministry of Housing the possibility of mandatory installation of smoke alarms in rental accommodation, particularly accommodation being used for households including children aged under 15 years.

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.

Background

Injury has been described as ‘the last remaining plague of the young’ (National Academy of sciences cited by Kypri, Chalmers, Langley, & Wright (2000). New Zealand children have high rates of death from injury compared with other developed countries (UNICEF, 2001). In this country injuries account for over one third of all deaths of children aged 1-14 years (Kypri et al., 2000). Injury from fire and flame is a significant cause of childhood death in New Zealand, particularly for children aged under five years. In 1997 injuries from fire and flame accounted for almost one-fifth of all unintentional preschool injury deaths; over three-quarters of the deceased were preschool boys (Table 1). The vast majority of deaths from fire and flame occur in private dwellings, in contrast with motor vehicle crashes and a proportion of drownings.

Table 1. Number and percentage of unintentional injury deaths of New Zealand children aged less than 5 years in 1997 by cause of injury and gender. Data source: New Zealand Health Information Service website.

Cause of injury	Male (%)	Female (%)	Total (%)
Drowning and suffocation	12 (40)	7 (39)	19(40)
Motor vehicle crashes	8 (27)	7 (39)	15 (31)
Accidents caused by fires and flames	7 (23)	2 (11)	9 (19)
All other external causes	3(10)	2 (11)	5 (10)
Total deaths from accidents and poisoning	30 (100)	18 (100)	48 (100)

This report has a narrower focus than a previous investigation of childhood thermal injury in New Zealand (Waller & Marshall, 1993). The focus of the report is on structural fire incidents which occurred in domestic locations. This includes fire incidents which occur in a structure, or in mobile property being used as a structure, occupied by a household of one or more people. This definition of a structure is consistent with the census definition of a private dwelling (temporary or permanent). In this report on child fatalities fire incidents which occur in stationary motor vehicles on a property containing a private structure have also been included. The focus on injury from fire and flame allows characterisation of incidents affecting a high risk population group, with a view to development of appropriate intervention strategies. Linkage of Fire Service data, coronial records and Health Service data has allowed description of the characteristics of the fatal fires as well as of the victims.

Study aim and objectives

The overall aim of the study was to understand and identify factors associated with deaths of New Zealanders aged under 15 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 Zealand children aged under 15 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 under 15 years who died in a fire incident on 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 motor vehicles parked on 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 children under 15 years

In the years 1991 to 1997, the study process identified 59 New Zealanders aged under 15 years who died as a result of injury from fire and flame. Six of the deaths were intentional (homicide or suicide), or occurred in public places or on farms. This leaves a total of 53 unintentional fire deaths from fire and flame in the domestic location in the time period 1991 – 1997. These 53 deaths occurred in 39 incidents, in private dwellings or in motor vehicles on residential property. Twelve incidents resulted in multiple child fatalities. Because of relatively small numbers 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 gender and ethnicity

The 53 children aged under 15 years who died as a result of unintentional injury from fire and flame in a domestic fire incident were predominantly in the pre-school age group. Two thirds of the deceased were aged under five years. This age group also had the highest mortality rates; the mortality rate for the under five age group was more than three times the rate for the 5-9 age group, and almost four times the rate for the 10-14 age group. Because of the relatively low numbers of fatalities the statistical precision of these rates leaves room for some uncertainty which is illustrated by the 95 per cent confidence intervals (95%CI) shown in Table 2. For those aged 0-4 years the true rate is most likely to lie between 1.2 and 2.3 deaths per 100,000 person years. More boys than girls aged under 15 years died in domestic fire incidents in the 1991-1997 time frame. Age standardised rates for male deaths were 2.2 times those for female deaths (Rate Ratio 2.2, 95% Confidence Interval 1.3 – 3.9).

Table 2. Numbers and rates of fatalities as a result of injuries from fire and flame in private dwellings among adults aged under 15 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)*
0-4	26	9	35	1.7 (1.1-2.3)
5-9	6	4	10	0.5 (0.2-0.8)
10-14	5	3	8	0.4 (0.1-0.7)
Total/Overall	37	16	53	1.0 (0.7-1.2)#

*per 100,000 person years

Age standardised rate

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. The striking observation is the high proportion of the deceased who were NZ Māori (59 per cent) or Pacific (11 per cent) children (Table 3).

Table 3. Ethnic group of New Zealand children aged under 15 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	59
Pacific	6	11
Pakeha/Palagi/Other	14	26
Not stated	2	4
Total	53	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 exceeded nonMāori by 11 times. Even allowing for statistical variability as a result of the small sample size, the death rate from fire among Māori children is likely to be at least five times that of nonMāori children, and may be as high as 25 times that of nonMāori children (RR 11.3; 95%CI 5.2-24.6). 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 children is higher than the threefold risk indicated by health data alone (Duncanson, Woodward, Reid, & Langley, 2000).

Because of the low numbers of Pacific children, and potential identification of individuals, Māori and Pacific children were combined to describe ethnicity of the deceased by Fire Region. Incidents were assigned to Fire Region according to the current management structure using the station code within the incident key. Fatal incidents involving Māori or Pacific children occurred in all fire regions; most deaths, and most deaths of Māori and Pacific children, occurred in Auckland and Bay of Plenty (see Table 4). In Northland and Arapawa regions, although numbers were relatively small, all the children who died in unintentional domestic fire incident in the study time frame were Māori or Pacific.

Table 4. Total number of deaths from unintentional injury from fire and flame in the domestic location 1991-1997 for children aged under 15 years by ethnicity and fire region. Data Sources: New Zealand Health Information Service, Coronial files, Fire Incident Recording System.

Fire region	Total child deaths	Māori or Pacific child deaths
Northland	4	4
Auckland	14	12
Bay-Waikato	13	9
Eastern	6	4
Western	5	2
Arapawa	3	3
Transalpine & Southern	8	3
	53	37

Fire characteristics

Time of incident

FIRS data, including time of the alarm being received by the Fire Service, were available for 37 fatal unintentional fire incidents involving children aged under 15 years between 1991 and 1997. These fatal incidents occurred predominantly at night and during the morning (Figure 1). Almost two thirds of the incidents occurred over a weekend (13 on a Friday, 3 on a Saturday and 8 on a Sunday).

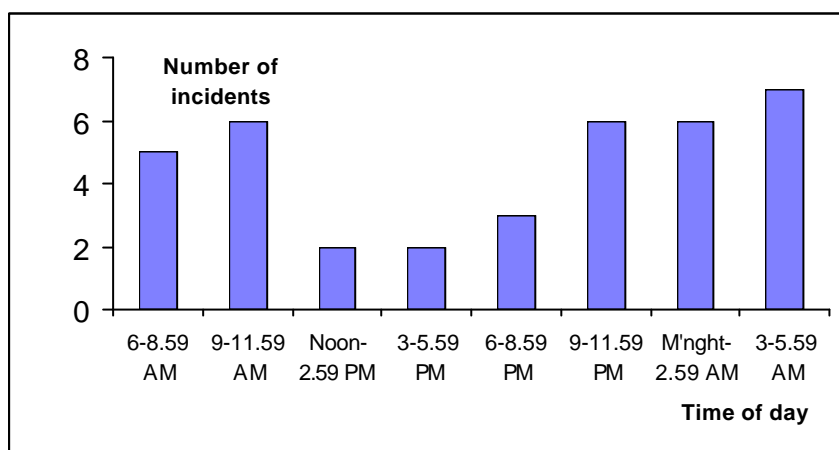


Figure 1. Alarm times of unintentional fatal domestic fire incidents involving New Zealand children aged under 15 years, 1991-1997. Data source: Fire Incident Recording System.

Room of origin

Room of origin in permanent private dwellings, and in temporary dwellings with defined living spaces was obtained from FIRS data or from reading coronial files. Where there was doubt the usual use of the room was used to categorise it, for example a shed used as a youngster's play area would be categorised as a living area, a shed regularly used as sleeping accommodation was categorised as a sleeping area. A separate category was used for fire incidents which occurred in a caravans (where sleeping and living areas cannot be distinguished, or motor vehicles being used for overnight sleeping accommodation at the time of the incident).

The fatal fires affecting children aged under 15 years started most commonly in a bedroom or sleeping area, and less commonly in the lounge. Two incidents started in the kitchen and both resulted in multiple fatalities. Of particular note are the high proportion of fatal incidents occurring in stationary motor vehicles. This may be because of a strict case definition which considers only structure fires in descriptive epidemiological studies. The proportion of incidents began in caravans, or motor vehicles being used as sleeping areas, was similar to the proportion of incidents which occurred in stationary motor vehicles.

Table 5. Number and percentage of unintentional fires in private dwellings resulting in deaths of New Zealanders aged under 15 years 1991-1997, by room of origin. Data sources Fire Incident Reporting System; Coronal Files.

Room of origin	Number of incidents	Percentage of incidents
Bedroom/ sleeping area	17	44
Lounge/living area	8	21
Kitchen	2	5
Caravan/MV used to sleep	6	15
Stationary MV	6	15
Total	39	100

Heat source

The source of ignition was unable to be determined in 4 (10 per cent) of incidents. Where the most likely cause was determined the most striking finding was the high proportion of fires resulting in the death of New Zealand children aged under 15 years in which matches or lighters were the source of ignition (see Table 6).

Table 6. Number and percentage of unintentional fires in private dwellings resulting in deaths of New Zealanders aged under 15 years 1991-1997, by presumed source of ignition. Data sources Fire Investigation Reports; Coronial Verdicts.

Heat source	Number of incidents (%)	Number of fatalities (%)
Lighter/matches	14 (36)	17 (32)
Heater/fireplace	10 (26)	12 (23)
Candle	5 (13)	7 (13)
Stove top	2 (5)	5 (9)
Electrical overload/malfunction	2 (5)	2 (4)
Cigarette/smoking materials	2 (5)	3 (6)
Unknown	4 (5)	7 (13)
Total	39 (100)	100

Between one and three fatal incidents per year had lighters or matches as the ignition source, with an average of two incidents per year. The six fatal fire incidents in stationary motor vehicles occurred when children were playing during the day, and all resulted from play with matches or lighters. A further eight incidents resulted from children playing with matches or lighters in permanent or temporary private dwellings. In five of the 14 incidents where the presumed heat source was matches or lighters there were comments in the files that the deceased or a sibling had previously been known to play with matches or lighters. As this information was not gathered systematically it is possible that previous play with matches or lighters also occurred in other incidents. Coronial files also indicated that even very young children are capable of striking a match, particularly if they live in a household where matches or lighters are frequently used. Nine of the fatal fire incidents involving children under 15 years which were started by matches or lighters were in households including a smoker; in four incidents the smoking status of the household could not be determined, and one occurred in a non-smoking household.

For some time now I have had a problem with M playing with matches and cigarette lighters. He has a bad habit of playing with them. I have tried to stop him but he keeps doing it. There are several cigarette lighters in the house and although I have been trying to keep them out of his way, he still manages to find them sometimes.

Caregiver 1995

The only question then remaining was could a child aged 18 months be capable of lighting a match. There had been a directly related case only one month earlier...the Fire Service attended a fire in a motor vehicle which had been caused by a child of a similar age lighting matches. While many children of this age would be incapable of striking a match this other case was direct evidence that it was possible and it is assumed from enquiries that children brought up in an environment where they have an opportunity to regularly observe adults using matches or cigarette lighters are easily capable of learning the procedure involved.

Witness testimony 1992

Over one quarter of the fatal incidents resulted from heating appliances. The majority of these appliances were electric heaters, but there were also defective fireplaces and gas heaters in the sample. Each year in the series there was at least one fatal fire involving children under 14 years with a heating appliance as the heat source. The majority of unintentional fatal domestic fire incidents where a heater was the presumed heat source resulted from the heater being in close proximity to combustible materials, usually in a bedroom. Heaters were associated with three of the four fatal caravan fires involving children aged under 15 years.

Before I went to sleep I turned the small bar heater on and put it at the foot of the beds. I had recently purchased the heater about two weeks ago from the second-hand shop ...

Caregiver 1997

Unintentional fire incidents associated with candles and with abandoned cooking sources resulted in multiple fatalities. Candles were associated with five fatal incidents and the deaths of seven children. Three of these incidents associated with use of a candle were in structures without an electricity supply. Two cooking related fire incident resulted in five child deaths. Of all heat sources, incidents started from abandoned cooking had the highest number of child fatalities per incident. The cooking related fire incidents were associated with alcohol consumption by adults in the household. Other heat sources included malfunctioning electrical appliances or overloaded power outlets, and cigarettes or smoking materials. The latter incidents involved older children who were known to smoke, or to share a room with smokers. One incident resulted in multiple child and adult fatalities.

Items ignited

The items ignited was abstracted from coronial records and fire investigation reports. The item ignited was not able to be determined in one case, and items were described as ‘combustible materials’ in several incidents. As in the report on older people, combustible materials have been classified by room of origin to give increased specificity to the findings listed in Table 7. Reflecting the location of fire origin, almost half the 39 fatal fire incidents involving children under 15 years resulted from ignition of bedding or combustible materials in a bedroom. A further six incidents (15 per cent) resulted from ignition of motor vehicle interiors. Ignition of furniture or combustible materials in the lounge, and ignition of dwelling structure or finishings accounted for five incidents each. The latter category included ignition of fireplace linings, carpets and wall linings. Other materials included clothing being worn, and abandoned cooking utensils.

Table 7. Number and percentage of unintentional fires in private dwellings resulting in deaths of New Zealanders aged under 15 years 1991-1997, by presumed items ignited. Data sources Fire Incident Reporting System; Coronal Verdicts.

Item ignited	Number of incidents	Percentage of incidents
Bedding/ combustible materials bedroom	19	49
Motor vehicle interior	6	15
Combustible materials lounge	5	13
Dwelling fixtures/structure	5	13
Other materials	3	8
Undetermined	1	3
Total	39	100

Fire scenarios resulting in child fatalities

For the 35 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. A common theme in accounts of fire incidents involving children was the rapidity with which the fire took hold.

It was quiet, so I thought I would go and check on the children. They had been alone in my room for about seven minutes. In that time I had done some dishes and checked on the washing machine...When I went to my bedroom I could see a lot of black smoke. I couldn't see any of the children.

Caregiver 1993

This ugly flame just swept across real fast between me and my children. My children were gone in front of my eyes. I was so close, so close and yet so far.

Caregiver 1998

The child had only been put of his mother's sight for four to five minutes

Witness testimony 1994

The information rings so true to me, that when there is silence for several minutes you start wondering...

Coroner 1993

A further theme was the almost irresistible lure of matches or lighters to an inquisitive child

Children have always played and will continue to play with matches or other source of flame. These are irresistible attractions for children just as water is, and I do not speak from conjecture. I speak from my own experience...

Coroner 1993

Scenarios for unintentional childhood death from fire and flame in a domestic location in New Zealand 1991 to 1997 are listed below with the first six scenarios accounting for over three-quarters of the fatalities where both the heat source and item ignited were determined:

- Matches or lighter igniting bedding or combustible materials in dwelling
- Matches or lighter igniting motor vehicle interior
- Heater igniting bedding or combustible materials in dwelling
- Candle igniting bedding or combustible materials in dwelling
- Stove top igniting abandoned cooking materials
- Unsafe discarding of cigarettes or smoking materials with ignition of bedding or combustible materials in a bedroom
- Unsafe construction or maintenance of fireplaces with ignition of wall linings and dwelling structure
- Use of flammable materials such as petrol to revive a dying fire with ignition of clothing
- Overloading of electrical outlets or use of unsafe electrical appliances with ignition of furniture or combustible materials in dwelling.

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 39 incidents, 26 occurred between July 1993 and December 1997 (a time frame appropriate to analyse using NZDep96). Over half (54%) of the fatal fire incidents involving children under 15 years occurred in the twenty per cent of meshblocks with the highest levels of social and material deprivation, as shown in Figure 2.

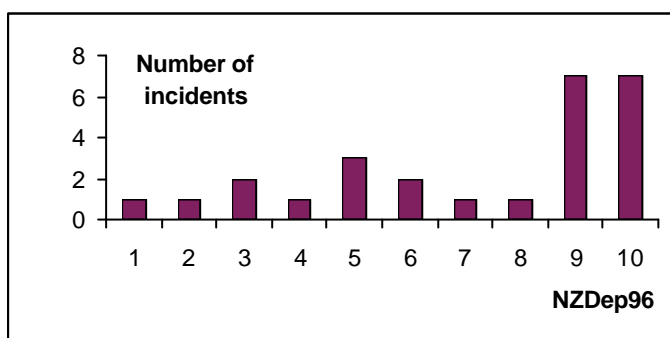


Figure 2. Fatal fire incidents in Aotearoa New Zealand in which children aged under 15 years died, July 1993 - December 1997 by decile of social and material deprivation. Data Sources FIRS, NZHIS, Statistics New Zealand.

Approximate rates of fatal incidents were calculated using denominator data from the 1996 census for households with children under 5 years (Statistics New Zealand, 1998). Although this denominator figure will not be entirely accurate, due to aging of the child cohort within the time frame, there is no reason to expect any systematic bias in changing population patterns over this time frame. Despite the low numerator numbers (20 fatal incidents involving children under 5 years in the time period July 1993-December 1997) a strong and statistically significant socioeconomic gradient was observed. The risk of a fatal fire incident among households with children under 5 years in NZDep deciles 9 and 10 was over five times the risk of a fatal fire incident of households in deciles 1 to 8 (possible range between 2 and 14 times the rate).

Table 8. Number and estimated rate of fatal fire incidents involving children under the age of five years July 1993-December 1997, by aggregated deciles of social and material deprivation. Data sources New Zealand Fire Service, New Zealand Health Information service and Statistics New Zealand.

NZDep96 decile	Incidents involving children under 5 years July 1993-December 1997	Estimated annual rate* per 100,000 households (95% CI)
1 to 8	7	1.0 (0.3-1.8)
9 and 10	13	5.7 (2.6-8.8)
Rate Ratio		5.6 (2.2-14.1)

*Estimated using number of households with children under 5 years from 1996 census.

Household composition

Information about household composition was abstracted from coronial files. Adults were present in most of the households where fatal fire related incidents occurred. There were two incidents in which information about household composition could not be obtained. In two incidents the household was crowded, with multiple adults staying overnight. There were 12 incidents (31 per cent) where there was no adult in the same dwelling space as the child

fatalities, although in eight of these incidents there was one or more adult in an adjacent building.

Table 9. Number and percentage of fatal unintentional domestic fire incidents involving New Zealand children aged under 15 years 1991-1997, with number and percentage of deaths in this age group by degree and proximity of caregiver presence. Data sources Fire Investigation reports, Coronial files.

Adults present	Number of incidents (%)	Number of fatalities (%)
1 adult present	11 (28)	18 (34)
2-3 adults present	12 (31)	16 (30)
Many adults present	2 (5)	3 (6)
1 adult nearby	4 (10)	6 (11)
2-3 adults nearby	4 (10)	4 (8)
No adults in dwelling	4 (10)	4 (8)
Unknown	2 (5)	2 (4)
Total	39 (100)	53 (100)

Alcohol, drugs and presence of disability

Post-mortem blood alcohol levels were available for 25 (47 per cent) of the deceased; alcohol was detected in only one of these cases and then at a relatively low level (less than 80mg/dL). Results of testing for other drugs were not systematically reported in the data sources, however levels of toluene and benzene sufficient to impair judgement were recorded in one case. Information about caregiver's alcohol consumption was not gathered systematically, but there were indications in the descriptions of incidents that caregivers had consumed substantial quantities of alcohol in three incidents, in which seven children under 15 years of age died. Information about disability was not recorded systematically in the data sources. One deceased child was noted to have a learning disability. In addition the very young victims would have had limited mobility as a result of their age and inability to walk independently.

Disruption to routine

The term disruption has been coined to describe a theme which recurred throughout the records of fatal fire incidents involving children under 15 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. Eleven of the reports indicated that the household composition or circumstances at the time of the fatal fire incident involving children aged under 15 years were changed from the usual circumstances. These 11 incidents resulted in the deaths of 13 children. Five of the deceased children died in four fire incidents where they were away from their home (staying with friends or relatives). In other situations there were visitors to the family home at the time of the incident. 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 distraction of adults, through use of makeshift sleeping arrangements (e.g. in stationary vehicles) and through lack of familiarity with the dwelling and means of escape.

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.

The majority of incidents occurred in permanent private dwellings. However between 1991 and 1997 over one quarter of the fatal domestic fire incidents affecting children under 15 years occurred in temporary dwellings.

We had built our home here until we were able to build a permanent house

Caregiver 1993

The family moved into the caravan next door about three weeks ago

Witness testimony 1997

Fire incidents occurring in temporary accommodation accounted for over one third of the child fatalities in this time frame, and thus disproportionately resulted in multiple fatalities. At the time of the 1996 census there were 7335 New Zealand households living in caravans or temporary accommodation, less than one percent of private dwellings nation-wide. Although the proportion of those households with children under 15 years living in temporary accommodation is not known, it is likely to be significantly lower than the 26 per cent of fatal fire incidents occurring in such circumstances.

The category stationary motor vehicle refers to motor vehicles parked within the confines of a private dwelling. This does not include motor vehicles parked in public places such as shopping mall car parks. Neither does it include vehicles being used as overnight accommodation (these are included in temporary accommodation). If the two incidents where stationary motor vehicle were used as overnight sleeping accommodation are removed, the proportion of fatal fire incidents occurring in temporary accommodation remains disproportionately high at 21 per cent.

Table 10. Number and percentage of fatal fire incidents involving New Zealand children aged under 15 years 1991-1997 by type of dwelling. data sources Fire Investigation reports, Coronial files.

Dwelling type	Number of incidents (%)	Number of fatalities (%)
Permanent private dwelling	23 (59)	29 (55)
Temporary dwelling	10 (26)	18 (34)
Stationary motor vehicle	6 (15)	6 (11)
Total	39 (100)	53 (100)

Domestic smoke alarms

Information about the presence or absence of smoke alarms was not gathered systematically. However in 23 of the 33 fatal incidents (70 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 and 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 children died as a result of injury from fire and flame were therefore less likely to provide adequate means of warning occupants of a fire starting, and thereby allowing time for escape.

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 37 incidents (two incidents were recorded in health service data only). As shown in Table 11, over two-thirds of the fatal fire incident involving children aged under 15 years occurred within 5 km, and over 80 per cent occurred within 10 kilometres of the nearest attending fire appliance. Five incidents occurred between 17 and 90 kilometres from the attending fire appliance. Four of these five incidents were fires during the night (from 10 p.m. to 6 am) and two resulted in multiple fatalities. However most of the multiple fatalities occurred within 10 kilometres of the attending appliance.

Table 11. 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 (%)
0-5 km	26 (70)
5-10 km	6 (16)
>10 km	5 (14)
Total	37 (100)

Non-domestic fire deaths

Six children under 15 years died as a result of injury from fire and flame in non-domestic locations in the time period 1991-1997. These six children died in five incidents and locations included public places, farms and streets or highways. Two of these fatal non-domestic incidents shared features in common with the domestic incidents, namely play with matches or lighters, or use of flammable materials such as petrol on an open fire. The remaining four deaths resulted from car explosions while the vehicle was being driven, or recently stopped.

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 children aged under 15 years, created for this study, there were only two incidents identified from NZHIS data which were not able to be identified by date in the FIRS data. For one there was a CAD record, but the delayed death was not notified to the Fire Service. No further information was available for the other incident.

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, even in this age group, and are likely to be of particular value in the investigation of adult (aged 16-64) fire-related mortality based on findings from overseas studies (Ballard, Koepsell, & Rivara, 1992; Brennan, 1998; Marshall et al., 1998). Identified shortcomings in the coronial service (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 the particular challenges to fire safety for households with children aged under 15 years, and particularly households with pre-school children. The excess deaths among male children in the present study are consistent with the observation that male children are at greater risk of death from all modes of injury in all developed countries.

...being born male or female can be an even bigger factor in the risk of injury death than the country of birth. A boy born in the United States or New Zealand, for example, has a higher chance of dying from injury in childhood than a girl born in Mexico.

UNICEF, 2001

Key issues with implications for prevention policy include:

- Raising awareness of child injury from fire and flame
- Ethnic and socioeconomic disparities in fire risk
- Access of children to lighters and matches
- Increased risk associated with heating appliances
- Increased risks associated with use of naked flames
- Combustibility of bedding and of motor vehicle interiors
- Absence of smoke alarms
- Increased risks associated with disruption of usual routines and with geographic isolation.

Raising awareness

The pattern of increased mortality risk among pre-schoolers has been noted internationally (Ballard, Koepsell, Rivara, & van Belle, 1992, Barillo & Goode, 1996; Marshall et al., 1998; Mierley & Baker, 1983; Warda, Tenenbein, & Moffatt, 1999). As such young children are unable to initiate improved fire safety practices it is essential that intervention strategies continue to be developed. Interventions to reduce the incidence and impact of domestic fire incidents among children aged under 15 years must therefore address not only individual factors, but also those operating in society more generally. Raising awareness of fire risk among households with young children, and providing information about appropriate strategies to reduce that risk, are important first steps to preventing fires from starting. Education can be directed to parents, to children via kindergarten, kohanga reo and childcare services, and to agencies and organisations concerned with their welfare.

Recommendations

That the New Zealand Fire Service Commission ensure that findings of this study are disseminated among government departments, agencies and individuals concerned with the well-being of New Zealand children. Such groups will include the Office of the Commissioner for Children, Te Puni Kokiri, Ministry of Pacific Island Affairs, Department of Child Youth and Family Services, Ministry of Health, Ministry of Social Policy, Ministry of Women's Affairs, Plunket, Tipu Ora, 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 agencies and individuals concerned with the well-being of New Zealand children aged under 15 to incorporate fire safety strategies in individual and population based health promotion strategies for this age group. Such groups will include the Office of the Commissioner for Children, Te Puni Kokiri, Ministry of Pacific Island Affairs, Department of Child Youth and Family Services, Ministry of Health, Ministry of Education, Ministry of Social Policy, Ministry of Women's Affairs, Plunket, Tipu Ora, Māori and mainstream health service providers including Public Health service providers, and Māori and mainstream Social Service providers.

Addressing disparities

Ethnic disparity

The increased risk of fire mortality experienced by Māori in New Zealand has been demonstrated previously (Duncanson, Woodward et al, 2000), and is particularly marked among New Zealand children aged under 15 years. Improving the safety of Māori children in our communities 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 children have occurred in all fire regions, and it is urgent that appropriate cultural advice is readily available throughout the country. 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 children also appear to be over represented in fire mortality statistics and appropriate cultural advice needs to be obtained by the Fire Service at all levels to improve fire safety for Pacific peoples. In Australia a campaign has focussed on the needs of specific ethnic immigrant communities (Young, Camit, & Mihajlovic, 1999), and investigation of the need for such programmes among minority immigrant 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 families with children aged under 15 years.

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 (Duncanson, Woodward, & Reid, 1999, in press), and is of particular concern for New Zealand households with young children. 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 children aged under 15 years described in this study, where over half the fatal incidents between 1993 and 1998 occurred in the most deprived quintile. The small numbers of incidents involving children under 5 years in the current study made it necessary to aggregate levels of social and economic deprivation. If the data previously presented for all fire incidents (Duncanson et al., 1999, in press) are aggregated in the same way, the rate ratio for fatal fire incidents between households in NZDep deciles 9 and 10 compared with deciles 1 to 8 is 2.7 (95%CI 1.8-4.0). The confidence intervals overlap with those found in this study for households with children aged under 5 years (RR 5.6; 95%CI 2.2-14.1). Nevertheless the risk of experiencing a fatal fire incident for households with young children in census meshblocks with high levels of socioeconomic deprivation is at least the same as, and may exceed, that for households in general in meshblocks with high levels of socioeconomic deprivation.

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.

Access to lighters and matches

One of the most striking observations in this study was the high proportion of childhood fire deaths caused by play with matches or lighters. Similar findings were reported in an account of child fatalities in Scotland, where 30 per cent of house fires in which children died were started by children playing with matches or lighters or other heat sources (Squires & Busittil, 1995). A mandatory product safety for cigarette lighters (requiring them to be child resistant) was introduced in New Zealand in 1998 (Ministry of Consumer Affairs, 1998). In the 1999-2000 corporate year FIRS data recorded two fatal incidents resulting from the use of matches and none from the use of lighters (personal communication, Roger Chang, New Zealand Fire Service, March 2001). Further monitoring of the impact of cigarette lighter legislation on childhood deaths from fire and flame will provide valuable injury prevention data. However a significant proportion of incidents in the current series resulted from play with matches rather than lighters. The observation that children are capable of using matches at a very young age raises the possibility of requiring matches to be packaged in a child resistant manner, as recommended in Scotland:

If it is inevitable that the behaviour of a child cannot be observed and regulated on a continual basis, it follows that the environment in which a child is free to act should be rendered as objectively safe as possible...The most frequently observed example of an unsafe environment was access to matches...It is interesting to note that whereas prescribed medicines are available in childproof containers, parents usually keep matches in flimsy cardboard boxes.

Squires and Busittil (1995)

Fire play is inherently attractive to children, who are likely to experiment with matches or lighters if they find them within easy reach. Most of the incidents where children ignited

combustible materials occurred in a bedroom or in a stationary motor vehicle, with only one incident in a lounge. Almost all these incidents occurred in households which included smokers of tobacco products. The emphasis in the New Zealand smoking cessation guidelines on assisting smokers to reduce the negative health impacts of tobacco on their households would also contribute to a reduction in fire risk from matches and lighters:

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)

Emphasis must be put on safe storage of matches and lighters, and on encouraging children to give any matches or lighters that they find to an adult. This message is graphically presented in the current national 'Firewise' fire safety campaign. It is important that all rooms used by children, even when they are supposed to be sleeping, are kept fire safe with no access to matches or lighters. Possible strategies would include keeping only one lighter or opened packet of matches within a dwelling – and this in a kitchen or other room where children are not likely to play unsupervised, or encouraging smokers to keep lighters or matches on their person (in a pocket or handbag) rather than leaving them with cigarettes. This may be particularly important where adults other than the usual caregivers are present in the household. The phenomenon of fire incidents resulting from children playing in stationary motor vehicles has been reported in Australia (Byard, Lipsett, & Gilbert, 2000) but has not been reported in literature from other countries. The proportion of fatal childhood fire incidents in parked cars in the present study (15 per cent) is similar to the finding that three of the 23 deaths (13 per cent) of children aged 0-16 years in South Australia from 1989 to 1998 occurred when children were playing in motor vehicles (Byard et al., 2000). Removal of all smoking materials from motor vehicles, and restricting access of children to parked vehicles, would reduce the risk of fatal fire incidents resulting from ignition of motor vehicle interiors while playing with matches or lighters.

The observation that several of the children who died in unintentional fire incidents, or their siblings, had previously engaged in fire play also highlights the potential value in making juvenile fire intervention programmes more readily available even at young ages (Coleman, 1998). Parents often see dissuading children from habitual play with matches or lighters as a personal responsibility, but may benefit from professional expertise if they are aware of appropriate programmes. The findings of this study suggest that fire play should be taken seriously, and parents would be likely to benefit if education and health professionals were alert to possible problems and aware of appropriate intervention programmes to promote safe play.

Fires started by inappropriately discarded cigarettes are also a risk for households including smokers. Two fires in the present series were possibly started by abandoned cigarettes, and more recent FIRS data identify a further two incidents where children under 15 years died in domestic fires probably ignited by discarded cigarettes (personal communication, Roger Chang, New Zealand Fire Service, March 2001). The greatest impact of a mandatory fire safety standard for cigarettes would be in the 15-44 year old age group (University of Otago Fire-related injury research group, 2001). However such a standard would also impact

positively on children, especially if it prevented the deaths of their parents or other adult family members.

Recommendations

That the New Zealand Fire Service Commission closely monitor and report on the proportion of domestic structural fire incidents, injuries and fatalities resulting from children playing with cigarette lighters in order to assess the impact of the mandatory product standards for disposable lighters introduced in 1998.

That the New Zealand Fire Service Commission investigate the possibility of child resistant packaging for matches sold in New Zealand.

That the New Zealand Fire Service undertake market research among current smokers to identify realistic options to reduce access of children to lighters and matches. Such options could include smokefree homes, limited number of lighters in the dwelling, or encouraging smokers to keep matches or lighters on their person rather than unattended in a dwelling or motor vehicle.

That the New Zealand Fire Service Commission support the development and provision of juvenile fire intervention programmes for pre-school children who habitually play with matches or lighters. Further, that the New Zealand Fire Service Commission liaise with health professionals, educational bodies and other groups and organisations concerned with the health and wellbeing of New Zealand children to promote awareness of the availability of fire intervention programme for children who habitually play with matches or lighters.

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.

Safe heating and lighting

Maintaining a warm home environment is important for the physical health of children, (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 all 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 heating of children's bedrooms. The involvement of portable heaters in three of the four fatal incident in caravans highlights the particular importance of safe heating in temporary accommodation. Wall mounted heaters are likely to be safer in these circumstances. The development and distribution of appropriate smoke alarms for caravans (or one roomed dwellings) would also assist in allowing occupants to exit safely in the event of an unintentional fire incident.

A community survey, including camping ground operators, and occupants of caravans on permanent sites, to assess how commonly free standing electric heaters are used would provide a measure of the magnitude of the issue. 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 children under 15 years in the current series. Lack of electricity was a factor in five fatalities in the current series. Since the time frame of the current study media reports have linked at least three fires involving New Zealand children 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 children aged under 15 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.

Fabric combustibility

There was only one clothing ignition in the present series, and the incident involved flammable liquids used to revive an open fire. Measures to regulate for children's nightwear to be styled to reduce fire risk (i.e. fitting rather than loose) and manufactured from less flammable appear to have been effective, particularly as use of home sewn night attire is possibly decreasing (McLoughlin, Langley, & Laing, 1986). Over one third of the fatal fire incidents in this series resulted from ignition of bedding or other combustible materials in a bedroom. Some of these incidents would have been prevented by ensuring safer heating appliances in bedrooms, and by effective strategies to reduce children's access to matches and lighters. However it may also be timely to consider flammability standards for bedding. In relation to deaths of children in fires started in motor vehicles Byard, Lipsett & Gilbert (2000) also recommend that car manufacturers should develop less flammable interiors in motor vehicles.

Recommendations

That the New Zealand Fire Service Commission support the maintenance of fire safety standards for children's nightwear by the Ministry of Consumer Affairs.

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

That the New Zealand Fire Service Commission investigate the feasibility of developing less flammable interiors in motor vehicles.

Smoke alarms

Lack of a smoke detector in a dwelling is an important risk factor for fatal fires, particularly when children are present in the dwelling (DiGuseppi, Roberts, & Li, 1998; Runyan, Bangdiwala, Linzer, Sacks, & Butts, 1992). The value of domestic smoke alarms is potentially greater in homes where matches and lighters are commonly used, as alarms may alert adult(s) in a nearby room of ignition of combustible materials by children playing with matches or lighters and allow time for the occupant(s) to leave the dwelling. Injury prevention counselling, particularly in the context of well child care, may increase smoke alarm ownership (DiGuseppi & Higgins, 2000). Prevalence of smoke detectors is inversely associated with socioeconomic disadvantage (DiGuseppi, Roberts, & Spiers, 1999; Forjuoh, Coben, Dearwater, & Weiss, 1997; Roberts, 1996). 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). It is also important that all members of a household recognise the smoke alarm signal and know what action to take if activated. Escape plans must include actual egress from the dwelling and ideally be tested for efficacy.

Occupants of rental accommodation have little power to insist on fire safety measures being installed in their homes. The nature of the tenant-landlord may create an actual or perceived barrier to improving household fire safety. 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 (Duncanson, Lawrence, & Simpson, 2000), can greatly improve fire safety and reduce the cost to society of property damage, hospital treatment and the consequences of bereavement. The improvement in smoke alarm installation rates demonstrated in Table 12 persisted, with over 70 per cent of the installed alarms functioning at follow-up 6 months to three years later (Duncanson, Lawrence, Simpson, & Woodward, 2000).

Table 12. Smoke alarm coverage at baseline and after Auahi Whakatūpato programme in Eastern Bay of Plenty. Data source NZ Fire Service Bay-Waikato region.

Community	Dwellings visited	Dwellings with alarms before programme (%)	Dwellings with alarms after programme (%)
1	560	367(66)	551 (98)
2	2288	1032(45)	2196 (96)
3	235	103 (44)	234 (99)
4	539	144 (27)	519 (99)
5	172	15 (9)	170 (99)
6	220	62 (28)	218 (99)
7	292	37 (13)	291 (99)
8	147	40 (27)	145 (99)
Total/Overall	4453	1800 (40)	4324 (97)

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 which intentionally include households with children under 15 years.

That the New Zealand Fire Service Commission support 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 investigate with the Ministry of Housing the possibility of mandatory installation of smoke alarms in rental accommodation, particularly accommodation being used for households including children aged under 15 years.

Disruption and isolation

The observation that over a quarter of the fatal domestic fire incident involving children under 15 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.

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.

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.

Conclusion

This descriptive analysis has identified personal, fire-related and environmental factors associated with the 39 unintentional domestic fire incidents which resulted in the deaths of 53 New Zealanders aged under 15 years from 1991 to 1997. Interventions to improve fire safety for New Zealand children will need to address the quality of housing, the availability of safe means of heating and light, and curtailing access of young children to matches and lighters. Fire safety can be incorporated within many services available to households with young children, and intersectoral raising of awareness fire risks and of effective intervention strategies is a key component in reducing the injury toll.

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