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Health service utilisation cost associated with residential fire incidents in New South Wales, Australia

Fahmida Saadia Rahman[1*], Wadad Kathy Tannous[1], Kingsley Emwinyore Agho[2], Gulay Avsar[1] and Lara Ann Harvey[3]

Abstract

Background Fire is a major contributor to global fatalities and disabilities and remains a prevalent threat to individuals in Australia. New South Wales (NSW) experiences over one-third of all structure fires, including residential ones, in the country and one-quarter of all associated deaths and hospital admissions. In an atmosphere of rising healthcare cost and heightened demand for its services, obtaining total cost data for residential fires is essential. The study aims to estimate the cost of health service utilisation, including ambulance, emergency, and hospital admission, resulting from residential fire incidents in NSW, Australia.

Method This population-based cohort study uses response and health service administration data from 1 January 2005 to 31 December 2014. The data sources are Australian Computer Aided Dispatch system, Fire and Rescue NSW Australian Incident Reporting System, NSW Ambulance datasets, NSW Emergency Department Data Collections, and NSW Admitted Patient Data Collection which are administrative datasets that have been linked. Cost figures were expressed in constant 2023 Australian dollars.

Results The estimated annual average cost for ambulance use was AU$75 thousand, with the average cost per use of AU$945. The average annual cost for emergency department visits was AU$137 thousand, and the average cost per visit was AU$890. The average total length of stay in hospital was nine days. The average annual cost of episodes of care in hospital was estimated at AU$4 million, with the average cost per episode of care of AU$16,140. The study assessed the total cost for health service use relevant to residential fire incidents and associated injuries at AU$46 million over time, averaging approximately AU$5 million annually.

Conclusion This study provided, for the first time, total and average costs of health service utilisation per type for ambulance use, ED visits, and hospital admissions associated with residential fire incidents and related injuries using linked administrative data in NSW. Our study will assist the government and stakeholders in making informed decisions that prioritise funding for healthcare service and improve the quality of overall fire safety and public health outcomes.

Keywords Residential fire, Health service use, Injury, Ambulance, Emergency department, Hospital admission

*Correspondence:
Fahmida Saadia Rahman
f.rahman@westernsydney.edu.au
[1]School of Business, Western Sydney University, Parramatta, NSW 2150, Australia
[2]School of Health Sciences, Western Sydney University, Penrith, NSW 2751, Australia
[3]Falls, Balance and Injury Research Centre, Neuroscience Research Australia, Randwick, NSW 2031, Australia

Introduction

Fires, both wildfires and residential fires, are major environmental and public health hazards globally [1–3]. In developed countries, it is one of the leading contributors to fatalities and disabilities [1], resulting in an estimated 300,000 lives lost every year, while millions endure lifelong injuries and disabilities [4], mostly occurring in residential settings [2, 3, 5–7]. Major regulatory changes and preventive measures, including the mandatory installation of working smoke alarm in residential premises, have been introduced since 1980s to reduce residential fire incidents and its impacts [8–12]. This has been further reinforced through continuous fire safety messaging, passive fire prevention strategies, and improved fire management systems [10, 11, 13, 14]. However, there has been a steady change in the residential fire environment due to modern architectural designs, increased synthetic fuel loads, and changing construction materials, over the past several decades [15–17]. These changes lead to shorter flashover time that reduces the time for occupants to safely evacuate and for firefighters to respond [15, 18, 19]. In addition, global rise in temperature [20, 21], coupled with increased use of highly flammable materials [22, 23] and an ageing population [24–26], are leading to higher incidences of residential fires, and related injuries and fatalities [20, 27]. As a result, when residential fires do occur, they pose greater risks to individuals' health and lead to increased demand for healthcare service.

In Australia, fire remains a prevalent threat to individuals [28], with 79,063 fire incidents in 2022/23 period, resulting in 129 fatalities and 2,200 injuries requiring hospitalisation [29]. Of these fire incidents, 21% were structural including residential fires [29]. New South Wales (NSW), Australia's most populous state with more than eight million residents [30], experiences over one-third of all structure fires in the country [29] and one-quarter of all associated deaths and hospital admissions [3, 29, 31]. However, the number of residential fire incidents, and related hospital admissions and deaths are under-reported [29, 32].

Residential fire injuries are primarily burns and smoke inhalations [7, 33, 34]. Treatment and care of burns have been determined as one of the costliest areas of healthcare [35–39]. Severe burns require complex management usually with specialist services, and are associated with prolonged morbidity, and mortality [40–42]. In NSW, rate of emergency ambulance call-outs has been growing [43] with a protocol of requiring ambulance attendance to residential fires to support residents, fire service, and other first responders [8]. Emergency departments, hospital admissions and outpatient treatments are increasingly being stretched in providing services with limited resources [39, 44–47].

A recent systematic review on economic costs by Rahman et al. [32] found limited literature on cost of health service utilisation related, specifically, to residential fires internationally [11, 48–50]. The studies reviewed provided health service costing information for ambulance use [48], emergency department (ED) [50], hospital admissions [11, 48–51], and burns unit treatment [48, 50, 52]. However, none of the studies presented a full picture of cost for health service utilisation including all the service providers. In Australia, specifically, there was no studies that estimated the total costs of healthcare and health service use associated with residential fires [11, 32]. In an atmosphere of rising healthcare costs and heightened demand for healthcare services, obtaining total cost data for residential fires is vital. Economic data on the treatment cost of injuries is important for the planning and delivery of health services and informing safety messaging [53, 54]. This study aims to estimate cost of health service utilisation, including ambulance, emergency, and hospital admissions, resulting from residential fire incidents in NSW, Australia. The estimated cost will provide an important tool to guide decision-making regarding resource allocation, quality programs, and prevention strategies.

Method

Study population and data sources

This is a population-based cohort study using response and health service administration data from 1 January 2005 to 31 December 2014. Data sources are Australian Computer Aided Dispatch (CAD) system, Fire and Rescue NSW (FRNSW) Australian Incident Reporting System (AIRS), NSW Ambulance datasets, NSW Emergency Department Data Collections (EDDC), and NSW Admitted Patient Data Collection (APDC) administrative datasets that have been linked as detailed elsewhere [8, 51, 55–57]. Study cohorts were identified using the AIRS and the five other datasets and reported by health service use of ambulance, emergency, and hospital admissions (Fig. 1). The AIRS data includes information on circumstances, management, and consequences of all fires attended by FRNSW. Data processing and cohort selection have been detailed in Rahman et al. [8]. Variables used in this study from the AIRS data were project person number (PPN), alarm date (when reporting authority was first notified of fire incident), and duties completion date (when reporting authority's involvement at the incident was terminated). Incident date (alarm date) was the primary variable used to link with other datasets to identify records related to residential fires.

For ambulance use, the CAD, which records emergency dispatch system for '000' (Australian emergency phone number) calls, was used to identify all NSW residential addresses that experienced a fire event. This was linked

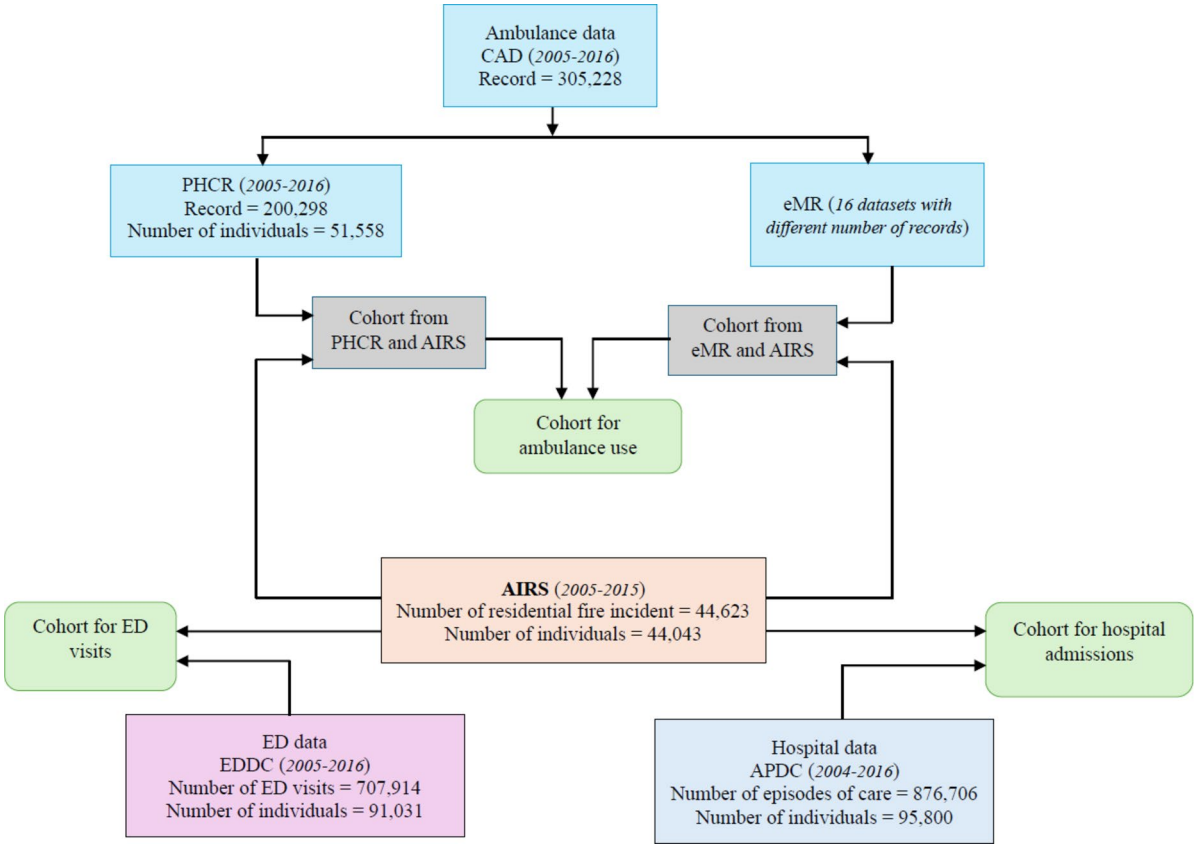

Fig. 1 Datasets used to identify cohorts for cost estimation of health service use

with ambulance operational and clinical data, that comprise of paper-based Patient Health Care Record (PHCR) until 2011 and electronic Medical Record (eMR) from 2011 onwards [58]. The PHCR and eMR include information about the incident (reason for call and scene location), patient information (demographics, injury/illness characterisation, vital signs and assessment results), treatment details (pharmacology and interventions), and outcomes (transported, not transported, and died).

Emergency department (ED) presentations to NSW public hospitals are captured in the EDDC data containing patient management data such as demographics, arrival and departure date/time, reasons for admission, and mode of arrival and discharge. Hospital data, recorded in APDC data, describes administrative information of hospital admission. It includes primary and secondary reasons for admission, date/time of admission, transfer to other departments/sections within hospital and across hospitals, and date/time of discharge. The APDC records all inpatient separations (discharges, transfers, and deaths) from all public, private, psychiatric and repatriation hospitals in NSW, public multi-purpose services, private day procedure centres and public nursing homes.

For costing of health service use, publicly available information was used, including NSW ambulance [43], Independent Health and Aged Care Pricing Authority (IHACPA) [59], and Australian Bureau of Statistics (ABS) [60]. For ambulance, information about call-out charge and rate per km was obtained from NSW Ambulance [43]. We sourced costing information for ED presentation from the National Hospital Cost Data Collection (NHCDC) [61] for 2012/13. To estimate hospital admission cost, we used 2012/13 NHCDC cost data [62], with Australian Refined Diagnostic Related Groups (AR-DRGs) version 6.0x as it matched with the AR_DRG version provided in hospital data. The AR-DRG is a measure of resources required by hospitals to treat individuals, including all in-hospital medical and allied health treatment, nursing, diagnostics, and pharmaceuticals [59].

Identification of study cohorts

The cohort selection strategy was designed to capture all eligible records associated with residential fire incidents as comprehensively as possible. The flow diagrams for cohort identification are presented in detail in the Appendix (*Figures A1-A4*). A three-step process was used to identify the study cohorts. *Step 1*, eligible records from ambulance datasets were selected by burn, smoke

inhalation, and other codes applicable to residential fires and related injuries. Across NSW, ED data is coded using three different classification systems– International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) [63], International Statistical Classification of Diseases and Related Health Problems, 10th Revision, Australian Modification (ICD-10-AM) [64, 65], and Systemized Nomenclature of Medicine-Clinical Terms (SNOMED CT) [66, 67]. We identified relevant cases from ED and hospital datasets using diagnosis codes recorded in the ICD-9-CM, ICD-10-AM, and SNOMED CT. From the ICD-9-CM, we used diagnosis codes '906' and '940–949' to identify burns, '506' and '508' to identify smoke inhalation, and 'E890-E899' to identify any injuries linked to residential fires [68–70]. From ICD-10-AM, we used diagnosis codes 'T20-T31' to identify burns, 'T59' to identify smoke inhalation, and 'X00' and 'X02' to identify any injuries related to residential fires [56]. A range of SNOMED CT codes was applied to identify burns, smoke inhalation, and any injuries related to residential fires (*Table A1* in the Appendix) [56]. *Step 2*, we merged the AIRS data with ambulance, ED, and hospital datasets to determine how many records from each of the datasets were identified by the AIRS data. For ambulance datasets, the condition considered to select the cohorts was that the date of residential fire incident and the date of ambulance transportation to ED was the same. Whilst we presumed that any ED visit or hospital admission occurring within 14 days of a residential fire incident as the criteria to identify the cohorts. *Step 3* merged the selected cohorts from *Steps 1* and *2*. Finally, data was restricted to between 1 January 2005 and 31 December 2014 to finalise the study cohorts.

Analysis

Estimation of costs for the health service uses

Total cost of health service use includes cost of ambulance, ED visits and hospital admissions. Cost estimation for ambulance use followed the method described in Campbell et al. [21], Wang et al. [71], and NSW Ambulance fee estimates [43]. The PHCR data has information about distance travelled by ambulance, while the eMR data does not have such information. Therefore, if not given, we utilised a median value of distance (11 km) measured from the PHCR data. We applied ambulance call-out charge and rate per km for travelling, at AU$840 and AU$7.58 respectively, provided by NSW Ambulance [43]. The formula used for quantifying cost of the identified cohort for using ambulance is as follows:

$$\text{Cost of each ambulance use} = \text{Call-out charge} + (\text{distance travelled*rate per km})$$

To calculate cost of ED visits, we applied the method 'cost of emergency department presentation by separation mode' described by Reeve and Haas (2014) [72]. We classified our selected cohort of ED visits into two mode of separations– admitted to hospital and non-admitted [73]. We allotted two separate average costs provided by NHCDC data [61] for admitted (AU$1,128) and non-admitted (AU$423) ED visits. These figures represent average costs for Round 17 (2012–2013). The following formula was used to estimate cost of the selected cohort for ED visits-.

$$\text{Cost of each ED visit} = \text{ED visit*corresponding cost}$$

Cost estimation of hospital admissions used the method described in the disease expenditure study by Australian Institute of Health and Welfare (AIHW) [74]. We determined length of stay (LOS) in hospital by taking the difference between episode of care start and end date from hospital data. An episode of care ends when a patient ends a period of stay in hospital (for instance, by discharge, transfer or death), or transitions to a different "type" of patient within the same period of stay [75]. We merged the NHCDC cost data [62] with the selected final cohort for hospital admissions by the AR_DRG to obtain corresponding cost values. Some costs are proportional to LOS, for example, ward costs and meals, while some are not dependent on LOS, for instance, theatre cost [47, 73, 74]. Therefore, we calculated total variable costs (TVC) that are dependent on LOS and total non-variable costs that are not dependent on LOS. To estimate TVC, we summed all ward costs given in the NHCDC cost data. Variable cost (VC) per day was then measured by dividing the estimated TVC by average length of stay (ALOS) given in cost data. We further calculated total non-variable costs by summing up other given cost items in the bucket [47]. Cost of the identified cohort for hospital admissions was estimated using the following formula:

$$\text{Cost of each episode of care} = (\text{VC per day*LOS estimated from hospital data}) + \text{total non-variable costs}$$

Other statistical analysis

The study provided demographic statistics of individuals in the selected cohorts for health service use (Table 1, and *Tables A2-A4* in the Appendix). We derived age-specific injury rate per 100,000 population described in Berry and Harrison (2005) [76] (Table 1). To calculate age-specific injury rate, we divided the number of injuries in each age group by the estimated population [60] of that age group and then converted the result to a rate per 100,000 population. Age group classification followed the life stages approach illustrated in the National Injury

Table 1 Cohort characteristics, ambulance use, ED visits, and hospital admissions, by age group

Basic characteristics	Age group								
	Infant (< 1 year)	Toddler (1–4 years)	Child (5–14 years)	Youth (15–24 years)	Young adult (25–44 years)	Adult (45–64 years)	Older adult (65–84 years)	Oldest adult (85 + years)	Total
Ambulance use									
N† (%)¶	*	*	*	98(13.3)	258(35.0)	210(28.5)	112(15.2)	44(6.0)	737‡ (100.0)
Sex									
Male	*	*	*	61(62.2)	132(51.2)	120(57.1)	67(59.8)	17(38.6)	406(55.1)
Female	*	*	*	37(37.8)	126(48.8)	88(41.9)	45(40.2)	27(61.4)	329(44.6)
Emergency department visit									
N† (%)¶	*	*	23(1.7)	123(9.2)	472(35.1)	392(29.2)	250(18.6)	73(5.4)	1344*(100.0)
Age-specific injury rate per 100,000 population	2.0	2.3	2.5	12.5	22.2	21.1	24.8	46.1	17.8
Sex									
Male	*	*	17(73.9)	66(53.7)	251(53.2)	233(59.4)	131(52.4)	28(38.4)	734(54.6)
Female	*	*	*	57(46.3)	221(46.8)	159(40.6)	119(47.6)	45(61.6)	610(45.4)
Type of injury									
Burn only	*	*	11(47.8)	61(49.6)	125(26.5)	101(25.8)	33(13.2)	10(13.7)	342(25.4)
Smoke inhalation only	*	*	*	15(12.2)	84(17.8)	76(19.4)	68(27.2)	24(32.9)	269(20.0)
Other	*	*	11(47.8)	47(38.2)	263(55.7)	215(54.8)	149(59.6)	39(53.4)	733(54.5)
Hospital admission									
N† (%)¶	41(2.1)	45(2.3)	88(4.4)	246(12.3)	632(31.6)	527(26.3)	325(16.2)	97(4.8)	2001(100.0)
Age-specific injury rate per 100,000 population	41.7	11.4	9.5	25.0	29.7	28.3	32.2	61.3	26.5
Sex									
Male	21(51.2)	30(66.7)	53(60.2)	161(65.4)	413(65.3)	320(60.7)	184(56.6)	30(30.9)	1212(60.6)
Female	20(48.8)	15(33.3)	35(39.8)	85(34.6)	219(34.7)	207(39.3)	141(43.4)	67(69.1)	789(39.4)
Type of injury									
Burn only	26(63.4)	26(57.8)	49(55.7)	138(56.1)	303(47.9)	218(41.4)	87(26.8)	13(13.4)	860(43.0)
Smoke inhalation only	15(36.6)	16(35.6)	30(34.1)	66(26.8)	172(27.2)	164(31.1)	147(45.2)	61(62.9)	671(33.5)
Burn + smoke inhalation	*	*	*	13(5.3)	45(7.1)	47(8.9)	20(6.2)	*	139(7.0)
Other	*	*	*	29 (11.8)	112 (17.7)	98 (18.6)	71 (21.8)	15 (15.5)	331 (16.5)
Total LOS‼									
1–7 days	38(92.7)	44(97.8)	79(89.8)	205(83.3)	504(79.7)	397(75.3)	217(66.8)	66(68.0)	1550(77.5)
8–28 days	*	*	*	34(13.8)	84(13.3)	83(15.7)	70(21.5)	21(21.6)	301(15.0)
> 28 days	*	*	*	*	44(7.0)	47(8.9)	38(11.7)	10(10.3)	150(7.5)
ICU admission	*	*	*	40(16.3)	88(13.9)	93(17.6)	42(12.9)	13(13.4)	287(14.3)

†Asterisk used when N < 10 by ethics approval

¶Row percentage for age group, all else column percentage

‡33(4.5%) missing frequency and 2 undetermined sex. "One missing frequency

‼Total LOS for each hospital admission: Mean = 9, SD = 25, number of hospital admission (*n*) = 2,133. LOS for each episode of care: Mean = 7, SD = 18, number of episode of care (*n*) = 2,713

Prevention Strategy 2020–2030 [77] and LOS was categorised as per Moller et al. [78]. Cost figures were expressed in terms of constant 2023 Australian dollars (AU$) using the consumer price index (CPI) based on all groups in Australia [79]. Temporal changes in cost were modelled and reported as Percentage Annual Change (PAC) with 95% confidence intervals (CIs). Both confidence interval and hypothesis testing methods were applied to test statistical significance of the outcomes. The software SAS Enterprise Guide version 7.1 (SAS Institute Inc., Cary, NC, USA) was used for data analysis.

Results

Selected study cohorts of health service use due to residential fire incidents

The number of records identified in each cohort is detailed in the Appendix (*Figure A1–A4*). We found that many individuals in the identified cohorts had records for multiple ambulance use, ED visits and hospital admissions over time. For ambulance use, we identified a cohort of 474 records by 463 individuals from the PHCR data (*Figure A1*), and a cohort of 317 records by 307 individuals from the eMR data (*Figure A2*). Therefore, a total record of 791 ambulance use by 770 individuals were finalised. The selected final cohort for ED visits included 1,540 records of ED visit by 1,345 people (*Figure A3*) and the final cohort for hospital admissions included 2,713 episodes of care received by 2,001 individuals (*Figure A4*). Some hospital admissions required several episodes of care. Therefore, we found a total of 2,133 hospital admissions (*Table A5* in Appendix). Of the identified ambulance use, 122 records were found from ambulance datasets and 669 from the AIRS data. Of the selected ED visits, 104 records were reported from ED data and 1442 from the AIRS data. Of the identified hospital admissions, 1,596 were determined by hospital data and 696 by the AIRS data. The AIRS data captured most of the total ambulance use and ED visits, 85% and 94%, respectively, while it could identify only 33% of the total hospital admissions (*Table A5*).

Figure 2 illustrates the trend in health service use overtime. We found that the ambulance use and hospital admissions declined between 2007 and 2010, but began increasing again after 2010. Previous studies reported a gradual decline in residential fire incidents after 2006, attributed to regulatory changes in NSW between 2006 and 2010, which helped reduce residential fire related casualties during that period [8, 9, 80]. However, the fire service response time to structural fires slightly increased over time, leading to more injuries [80, 81]. In addition, NSW experienced major residential fire incidents in 2011, including one in November at a residential facility for elderly people [81, 82]. In this incident, 88 sick and frail residents - many reliant on vital medical equipment and some bedridden - were rescued [81]. These factors contributed to the rise in ambulance use, ED visits, and

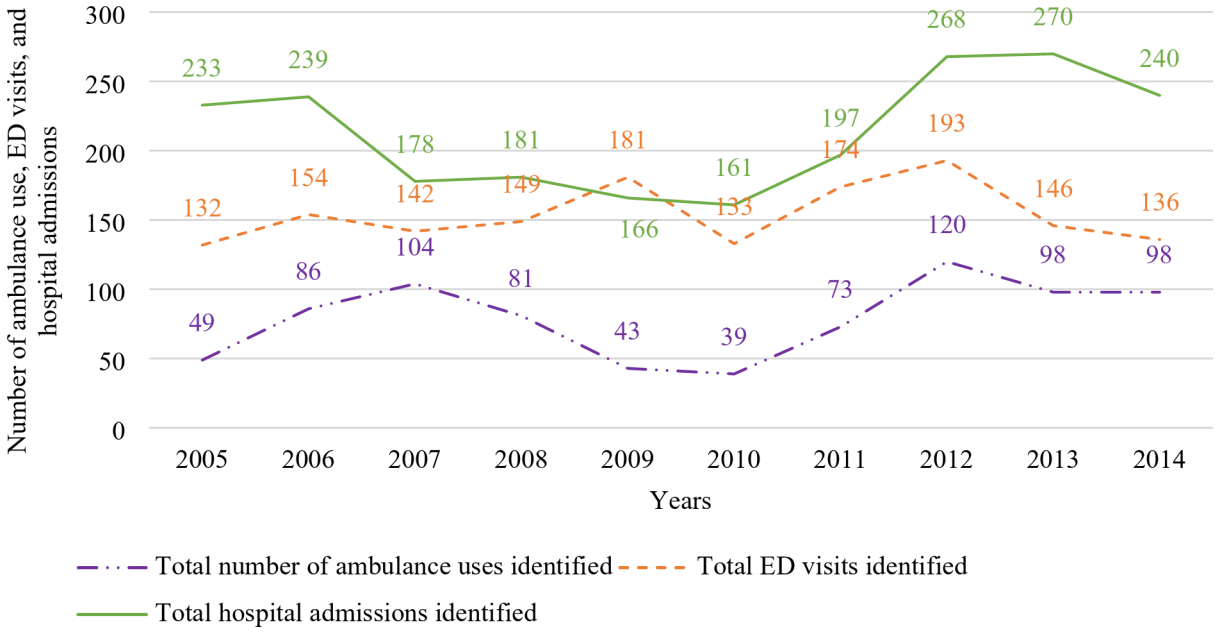

Fig. 2 Trend over time of total number of ambulance use, ED visits, and hospital admissions, identified. Total ambulance use – 2005–2010: percentage annual change = –11.0%, 95% CI (–28.6, 6.6), $p = 0.219$ | 2010–2014: percentage annual change = 19.9%, 95% CI (3.0, 37.0), $p = 0.021$ | 2005–2014 (over time): percentage annual change = 4.2%, 95% CI (–2.7, 11.2), $p = 0.238$. Total ED visits – 2005–2010: percentage annual change = 1.8%, 95% CI (–3.2, 6.8), $p = 0.475$ | 2010–2014: percentage annual change = –1.5%, 95% CI (–10.9, 7.9), $p = 0.751$ | 2005–2014 (over time): percentage annual change = 1.1%, 95% CI (–1.7, 3.9), $p = 0.452$. Total hospital admissions – 2005–2010: percentage annual change = –8.6%, 95% CI (–11.9, –5.2), $p < 0.001$ | 2010–2014: percentage annual change = 10.9%, 95% CI (3.0, 18.9), $p = 0.007$ | 2005–2014 (over time): percentage annual change = 2.0%, 95% CI (–1.6, 5.6), $p = 0.275$

hospital admissions after 2010, culminating in a sharp increase in 2012.

The identified number of ambulance use ranged from 39 to 120, peaking in 2012 from its lowest in 2010. The trend analysis showed an average annual increase of 4.2% over time, which was not statistically significant ($p = 0.238$). The lowest number of ED visits (132) was found in 2005 and the highest number (193) in 2012. The average annual change from 2005 to 2014 indicated a 1.1% increase that was observed as not significant ($p = 0.452$). For hospital admissions, the number varied between 161 in 2010, and 270 in 2013. The average annual change increased by 2% for the overall period (2005–2014) and was also not significant ($p = 0.275$). We divided the study period in two sections, 2005–2010 and 2010–2014, and measured percentage change of the total number of each health service use. We were unable to report any significant change for ambulance use and ED visits. However, there was a significant 8.6% decrease in the number of hospital admissions between 2005 and 2010 ($p < 0.001$), that rose significantly from 2010 to 2014 by 10.9% ($p = 0.007$).

Demographic characteristics of selected study cohorts

Of individuals who used health service, one-third were young adults aged between 25 and 44 years followed by adults aged between 45 and 64 years (26–29%), and older adults aged between 65 and 84 years (15–19%) (Table 1). However, infants, aged below one year, (age-specific injury rate of 41.7 per 100,000 population), and the oldest adults, aged above 85 years, (age-specific injury rates of 46.1 for ED visits, and 61.3 for hospital admissions, per 100,000 population), were the most vulnerable groups to residential fire related injuries (Table 1). The majority (55–61%) of people who used health service were male (*Table A2*). In most age groups except the oldest adults, the male proportion (range 51 – 74%) was higher than their female counterparts (range 33 – 49%). The scenario was reversed for the oldest adults, where females (61 – 69%) outnumbered males (31 – 39%) (Table 1). More than 50% of both males and females visited ED for other injuries associated with residential fires (*Table A2*).

Of individuals admitted to hospitals, 43% were admitted for burns, 34% with smoke inhalation, 7% due to both burn and smoke inhalation, and 16% for other related injuries (*Table A3*). The majority (77%) stayed in hospital for a week (1–7 days), 15% for more than a week (8–28 days), and 8% for more than a month (> 28 days) (*Table A4*). Across age groups, 22% of older adults and the oldest adults stayed for more than a week, while 11% of them stayed for more than a month (Table 1). Of those who stayed for more than a month, the highest 13% were admitted for other injuries including fractures, aches and pain, respiratory problems, and mental health issues (*Table A3*). About 14% of all individuals who were admitted to hospital, required an Intensive Care Unit (ICU) admission anytime during the period of care (Table 1). The highest 42% of all burn plus smoke inhalation admissions, involved an ICU admission (*Table A3*). Around 45% of all individuals who stayed for more than a month, needed an ICU admission (*Table A4*).

Estimated cost for health service use due to residential fire incidents

The estimated total cost for health service use including cost for ambulance use, ED visits, and hospital admissions have been described in Table 2, and in the Appendix (*Table A6*). Cost for ambulance use ranged between AU$35 thousand and AU$112 thousand over the study period. Total cost was estimated at AU$746.9 thousand with an annual average of AU$74.7 thousand, and cost per ambulance use was AU$944. Cost figures for ED visits fluctuated within AU$110 thousand to AU$165 thousand. Total cost was quantified at AU$1.4 million and annual average cost was AU$136.7 thousand, and cost per ED visit was calculated at AU$888. For

Table 2 Total cost (at constant 2023 AU$) for health service use

Year	Total cost for ambulance use (number of use identified = 791)	Total cost for ED visit (number of visits identified = 1,540)	Total cost for hospital admissions (number of episodes of care identified = 2,713)	Total cost for health service use
2005	47,504	121,161	3,747,712	3,916,377
2006	84,429	144,257	3,867,747	4,096,433
2007	99,458	120,245	3,765,018	3,984,721
2008	78,788	136,925	4,595,119	4,810,832
2009	40,054	163,687	4,005,320	4,209,060
2010	36,444	112,546	3,311,754	3,460,744
2011	68,013	146,090	5,842,112	6,056,215
2012	111,351	162,954	4,737,550	5,011,854
2013	90,309	139,858	5,765,824	5,995,991
2014	90,529	119,695	4,146,229	4,356,453
Total	746,879	1,367,418	43,784,384	45,898,681

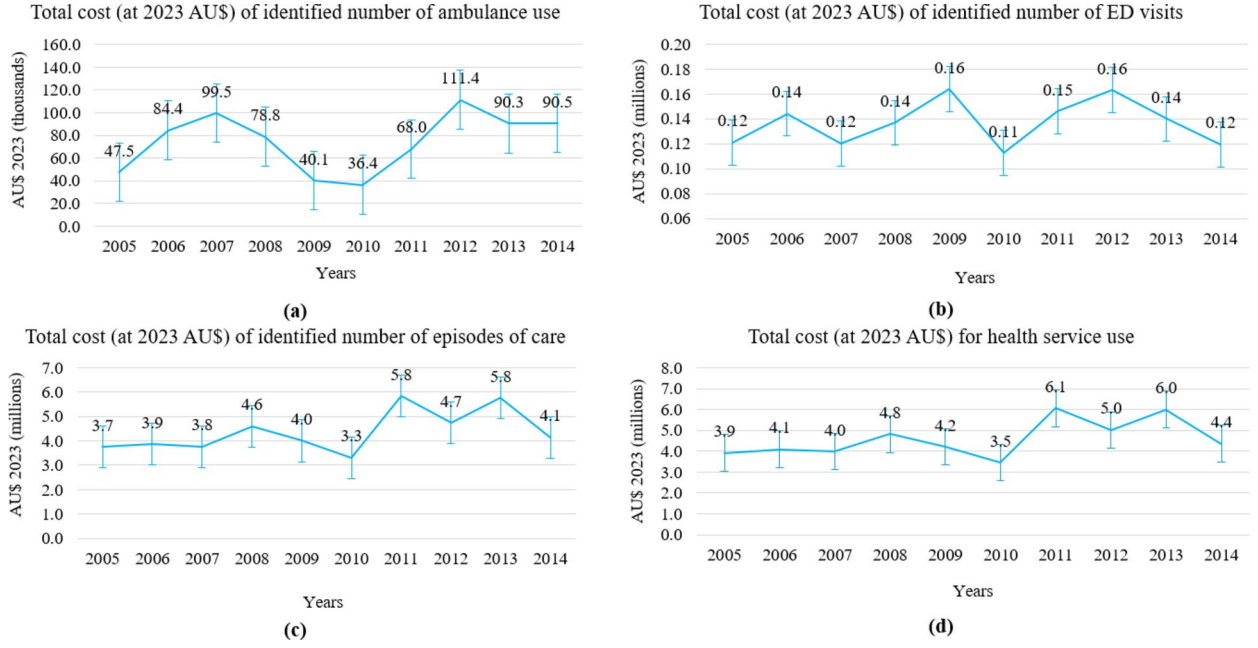

Fig. 3 Trend over time and standard deviation of total cost (at 2023 AU$) for health service use. **a** Total cost for ambulance use – 2005–2014 (over time): percentage annual change = 3.5%, 95% CI (−3.7, 10.6), $p = 0.342$ | (**b**) Total cost for ED visits – 2005–2014 (over time): percentage annual change = 0.7%, 95% CI (−2.1, 3.4), $p = 0.628$ | (**c**) Total cost of episodes of care for hospital admission – 2005–2014 (over time): percentage annual change = 3.5%, 95% CI (0.3, 6.7), $p = 0.035$ | (**d**) Total cost for health service use – 2005–2014 (over time): percentage annual change = 3.4%, 95% CI: (0.2, 6.6), $p = 0.036$

hospital admissions, cost of episodes of care varied from AU$3 million to AU$6 million. Total cost was estimated at AU$43.8 million with an average of AU$4.4 million, annually, and AU$16,139 per episode of care. Therefore, total cost for health service use associated with residential fire incidents has been assessed at AU$45.9 million, approximately, from 2005 to 2014 with an annual average of AU$4.6 million (Table 2, A6).

Figure 3 shows a 3.5% annual increase in total cost for ambulance use; however, the increasing trend was not significant ($p = 0.342$). Although non-significant ($p = 0.628$), total cost for ED visits raised by 0.7%. The study estimated a significant 3.5% rise in total cost of episodes of care for hospital admissions ($p = 0.035$). Therefore, total cost for health service use was observed to be increased significantly by 3.4% over time ($p = 0.036$).

Discussion

Findings

This study provided, for the first time, total and average costs of health service utilisation per type for ambulance use, ED visits, and hospital admissions associated with residential fire incidents and related injuries using linked administrative data from 2005 to 2014 in NSW. There is limited literature on health service cost to support the findings [11, 32, 48–50]. Ambulance use and associated cost have been predominantly ignored in existing literature [11, 32, 49, 50]. Banfield et al. [48] reported the cost of ambulance service for patient transportation to the provincial burn centre in their cost analysis of burn or inhalation injuries due to residential fires in Ontario, Canada, during 1995–2012. They estimated health service cost for ambulance service and hospital admissions only for the provincial burn centre and did not include cost for ED visits. Lawrence et al. [50] provided the cost of medically treated injuries associated with residential fires through different health service - ED, and hospital inpatient and outpatient cares in the United States. Yellman et al. [49] modelled the economic effectiveness of smoke alarm installation in Dallas, the United States and showed cost figures for ED visits and hospital admissions. Neither Lawrence et al. [50] nor Yellman et al. [49] estimated cost for ambulance use. Tannous et al. [11] quantified health system costs related to residential fires, but they used estimated costing figures from other published literature of costings, and it was unclear whether they included ambulance use, ED visits, and/or hospital admissions. None of the literature used linked administrative data.

In our study, we described the trend analysis for the total number and total cost of each health service use over time. These outcomes add value in the literature as they have not been included in studies conducted on cost of health service due to residential fire incidents [11, 32, 48–51]. The study further supports previous findings that the official figures of residential fire incidents by fire services are underreported [56], as the AIRS figures were only able to identify one-third of hospital admissions.

The finding is consistent with existing literature [11, 56, 83, 84]. We observed a reduction in the number of health service use from 2007 to 2010. The reason may be explained by a decrease in residential fire incidents overtime [8], which coincides with changes in regulations that include mandatory smoke alarm installation at residential premises that commenced on 1 May 2006 in NSW [8, 80, 85], and a mandatory standard for reduced fire risk cigarettes implemented in 2010– cigarettes begin a major source of ignition in fatal fires [8, 9, 80, 81]. The rise in health service use in 2011 and 2012 may be linked to a major fire incident at an aged care facility in NSW on 18 November 2011, described as a firefighter's worst nightmare [81, 82]. Additionally, the increasing response time to structural fire incidents may have contributed to more injuries [80, 81]. The fire service suggests that modifications to firefighter personal protective equipment and occupational health and safety requirements have slightly extended mobilisation times, thereby impacting response times [80, 81].

Our study categorised individuals identified in the cohorts by age group, sex, types of injuries, and total LOS in hospitals. The outcomes of demographic characteristics will be helpful for policy implications. We found that infants, less than one year, and the oldest adults, above 85 years, were more vulnerable to residential fire-related injuries, as they are less mobile compared to other age groups. We reported that males dominated females in most age groups for using health service, except in the oldest adult group. The reason may be that older (65 years and over) female proportion in Australian population is greater than older male, 88.1 males for every 100 females in 2020 [60, 86], as women in Australia typically have a higher life expectancy than men, 81.2 years for males and 85.3 years for females in 2020–2022 [86, 87]. Most individuals, who visited ED, visited for other injuries associated with residential fires. This is because we tried to be broad to capture a variety of injuries beyond burns and smoke inhalation, to select as many eligible records as possible. We included fractures, aches and pain, respiratory problems, and mental health issues as other injuries that could be related to residential fires. Older people tended to have longer hospital stays (more than a week). The highest proportion of those who remained in hospitals for more than a month were admitted due to other injuries. One possible reason may be the inclusion of mental health issues, that often require time to treat [88]. In addition, nearly 50% of patients who stayed for more than a month in hospitals required an ICU admission, likely due to severe injuries that necessitate intensive care admission.

This study's contribution to the literature is the methodology for identification of the cohorts from the datasets. The cohort-identifying search strategies were extensive enough to capture all possible records from ambulance, ED, and hospital datasets to make the cohorts robust to estimate cost. However, the study found that none of the corresponding health service datasets, nor the AIRS data, individually recognised the total number of ambulance use, ED visits, and hospital admissions. Each health service has their own system for data collection. From ambulance datasets, the PHCR data lacks adequate information to find records appropriate to residential fires, and only a couple of the eMR datasets record certain information related to residential fires. Therefore, we were unable to determine any relevant record of ambulance use identified in ambulance datasets before 2011, when the eMR data was introduced [58]. While selecting the cohort for ambulance use, a two-day allowance between the residential fire incident date and the ambulance transportation date was made, but no additional records were obtained. To select the cohort for ED visits, it was challenging to identify ED visits associated with residential fires using the diagnosis code ICD-9-CM and ICD-10-AM, whereas the SNOMED CT code helped capture some records relevant to residential fires. ED data has no record of the SNOMED CT code before 2007. Consequently, no ED visits associated with residential fires were found in ED data until 2008.

Policy implications

The study provides evidence on total cost of health service utilisation related to residential fire incidents in NSW from 2005 to 2014. We found a significant 3% increasing trend for total cost of health service use over time. This significant rise in cost suggests a need for healthcare systems, including ambulances, emergency departments, and hospitals, to plan for capacity building and resource allocation for equipment, staff, and facilities. Infants and the oldest adult population are identified as vulnerable groups who suffer more likely from severe outcomes caused by residential fires. Older people have longer hospital stays for treatment and management of their injuries. Community safety messaging and programs should focus on providing these groups with enhanced fire safety systems in their homes, including the installation of an adequate number of smoke alarms and fire extinguishers, regular testing and maintenance, and a well-practiced escape plan [13]. The study highlights implications for mental health support for fire victims, with sufficient funding and access to services. The financial burden of residential fires on healthcare service can justify stricter fire safety regulations and building codes involving use of fire-resistant building materials in new construction and renovations. Understanding the long-term impact of residential fires on healthcare service can help policymakers to develop strategies for sustainable economic planning. This includes building emergency

funds and creating contingency plans for large-scale fire incidents that strain healthcare resources. With the insight of estimated cost per ambulance use, per ED visit, and per episode of care for hospital admissions, policymakers can evaluate cost-effectiveness of existing fire prevention and response programs, adjust funding levels, and implement new initiatives that are grounded in evidence. Communicating cost of health service use due to residential fires to public can enhance awareness about the significance of fire safety. It can influence behaviour and encourage safety measures.

Strengths and limitations

Use of the linked administrative datasets is the main strength of our study. The administrative datasets are at the population level for NSW over a 10-year period. The study cohorts were identified using the actual fire incidents recorded in the AIRS data. We calculated the actual LOS in hospitals from hospital data and applied that to estimate cost of hospital admissions. Similarly, we used the actual travel distance from ambulance data to measure cost of ambulance use. None of the existing literature provides a complete cost estimation including ambulance use, ED visits, and hospital admissions associated with residential fires and related injuries.

Our study has some limitations that are inherent in data linkage studies relying on administrative data. Quality of the administrative data and their coding is the main limitation. Another limitation is that we do not have information about fire incidents attended by NSW Rural Fire Service (NSWRFS), that usually covers fire incidents in remote and rural areas. This might have an impact on the total number of fire incidents recorded in the AIRS data that consequently impacted the identified cohorts. Additionally, we lacked the information needed to distinguish the proportion of the population living in metropolitan and rural areas who used health service. Moreover, there are underreported residential fire incidents as well [56, 84]. In addition, we did not include those who experienced a residential fire incident and accessed only general practitioners (GPs), medical centres, or pharmacies to treat their injuries, as the data was not linked to the linked administrative data. Data regarding GPs and medical centres belongs to the federal health department, access of which is time consuming and expensive [56]. For severe burns, NSW has special burn units and proper guidelines for assessment and management of burn injuries, and transfer of NSW patients to those designated burn units [89]. Unfortunately, we were unable to incorporate outpatient data from the burn units, as we did not have adequate information to identify how many times an individual visited the burn units after being impacted by an incident. Therefore, cost for visiting outpatient burn units was not estimated. The data used in this study is old, and expensive and time consuming to obtain and link, requiring several data custodian agreements and thesis committees' approvals, as detailed elsewhere [8, 55].

Future direction for research

Building on our study, future studies could include additional linkage of the NSWRFS data, GPs' usage from the Medicare Benefit Schedule (MBS) and medication use from the Pharmaceutical Benefits Scheme (PBS) to our existing data. Additionally, future studies using more recent data and accessing data from outpatient burn units are required. This would be beneficial for proper cohort identification and correct estimation of individuals' healthcare use and long-term outcomes following residential fire incidents and associated injuries.

Conclusion

The study provides the total cost for use of three healthcare service due to residential fire incidents using linked administrative datasets in NSW, Australia, over a decade. It demonstrates a comprehensive strategy to identify the cohorts for ambulance use, ED visits, and hospital admissions. It included and estimated cost of ambulance use as a part of healthcare service. Estimated cost shows a substantial burden to healthcare service. However, it underestimates the true cost due to the limitations of the study mentioned above. The knowledge generated in our study will assist the government and stakeholders to make informed decisions that not only reduce financial burden on healthcare service but also enhance overall fire safety and public health outcomes.

Abbreviations

ABS	Australian Bureau of Statistics
AIHW	Australian Institute of Health and Welfare
AIRS	Australian Incident Reporting System
ALOS	Average Length of Stay
APDC	Admitted Patient Data Collection
AR	DRG-Australian Refined Diagnostic Related Group
AU$	Australian Dollars
CAD	Computer Aided Dispatch
CheRel	Centre for Health Record Linkage
CI	Confidence Interval
CPA	Consumer Price Index
DHCRC	Digital Health Cooperative Research Centre
ED	Emergency Department
EDDC	Emergency Department Data Collections
eMR	electronic Medical Record
FRNSW	Fire and Rescue NSW
GP	General Practitioner
ICD-9-CM	International Classification of Diseases, 9th Revision, Clinical Modification
ICD-10-AM-	International Statistical Classification of Diseases and Related Health Problems, 10th Revision, Australian Modification
ICU	Intensive Care Unit
IHACPA	Independent Health and Aged Care Pricing Authority
LOS	Length of Stay
MBS	Medicare Benefit Schedule
NHCDC	National Hospital Cost Data Collection
NSW	New South Wales

NSWRFS	NSW Rural Fire Service
PAC	Percentage Annual Change
PBS	Pharmaceutical Benefits Scheme
PHCR	Patient Health Care Record
PPN	Project Person Number
SNOMED CT	Systemized Nomenclature of Medicine-Clinical Terms
SURE	Secured Unified Research Environment
TVC	Total Variable Cost
VC	Variable Cost

Supplementary Information

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Supplementary Material 1.

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Patient and public/animal involvement
Patients and/or the public/animal were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Authors' contributions
WKT and LAH conceived and designed the study. LAH guided the study at every step. FSR provided data analytics with the supervision of LAH. FSR wrote the manuscript. LAH, WKT, KEA, and GA reviewed and edited the manuscript. FSR, WKT, KEA, GA and LAH reviewed and approved the final version of the study and agreed to take any accountability for all aspect of the work.

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Data availability
The data presented in the study are not publicly availability due to its' sensitive health and personal data, and medical confidentiality.

Declarations

Ethics approval and consent of participate
This study does not involve human participants and animal subjects. Meanwhile, ethical approval for the PhD study has been provided by the NSW Population and Health Service Research Ethics Committee (HREC/16/CIPHS/36) and Western Sydney University Human Research Ethics Committee (RH12399).

Consent for publication
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Competing interests
The authors declare no competing interests.

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References

1. World Health Organization. Injuries and Violence: The Facts 2014. Geneva: World Health Organization; 2014 2014.
2. Mailstop F, Prevention AF, Grants S. Global Concepts in Residential Fire Safety Part 3–Best Practices from Canada, Puerto Rico, Mexico, and Dominican Republic. 2009.
3. Coates L, Kaandorp G, Harris J, van Leeuwen J, Avci A, Evans J et al. Preventable Residential Fire Fatalities in Australia July 2003 to June 2017. 2019.
4. World Health Organization. Burn Prevention: Success Stories and Lessons Learned. Geneva: World Health Organization; 2011.
5. The World Bank. Country classification by income: The World Bank. 2024. Available from: https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups. Cited 2024 12 January.
6. Australasian Fire and Emergency Services Authorities Council. Residential fire fatality and injury prevention strategy: towards zero fatalities. East Melbourne, Vic: Australia: AFAC Ltd; 2020.
7. Saramago P, Cooper NJ, Sutton AJ, Hayes M, Dunn K, Manca A, et al. Cost-effectiveness of interventions for increasing the possession of functioning smoke alarms in households with pre-school children: a modelling study. BMC Public Health. 2014;14:1–11.
8. Rahman FS, Harvey LA, Agho KE, Avsar G, Tannous WK. Economic costs of responders for responding to residential fire incidents in New South Wales, Australia. Fire Saf J. 2024;146:104176. https://doi.org/10.1016/j.firesaf.2024.104176.
9. Ghassempour N, Tannous WK, Agho KE, Avsar G, Harvey LA. The impact of reduced fire risk cigarettes regulation on residential fire incidents, mortality and health service utilisation in new South Wales, Australia. Int J Environ Res Public Health. 2022;19(19):12481.
10. Taylor M, Appleton D, Keen G, Fielding J. Assessing the effectiveness of fire prevention strategies. Public Money Manage. 2019;39(6):418–27.
11. Tannous WK, Whybro M, Lewis C, Broomhall S, Ollerenshaw M, Watson G, et al. Home fire safety checks in new South Wales: an economic evaluation of the pilot program. J Risk Res. 2018;21(8):1052–67.
12. McLoughlin E, Marchone M, Hanger L, German P, Baker SP. Smoke detector legislation: its effect on owner-occupied homes. Am J Public Health. 1985;75(8):858–62.
13. Tannous WK, Agho K. Domestic fire emergency escape plans among the aged in NSW, Australia: the impact of a fire safety home visit program. BMC Public Health. 2019;19:1–10.
14. Nystedt F. Deaths in Residential Fires-An Analysis of Appropriate Fire Safety Measures. 2003.
15. Kerber S. Analysis of changing residential fire dynamics and its implications on firefighter operational timeframes. Fire Technol. 2012;48(4):865–91.
16. Moon M-H, Kim H-J, Min S-G, Kim S-C, Park W-J. Simulation of indoor fire dynamics of residential buildings with full-scale fire test. Sustainability. 2021;13(9):4897.
17. Sakib FS, Ahmed R, Khan EA. Study of Fire Growth Behavior in a Residential Apartment using Fire Dynamic Simulator. Chem Eng Res Bull. 2020:99–105. https://doi.org/10.3329/cerb.v22i1.54307.
18. Lee YI, Kim HJ. Analysis of the flashover characteristics of residential fire. J Korean Soc Hazard Mitigation. 2018;18(4):219–24.
19. Babrauskas V, Peacock RD, Reneke PA. Defining flashover for fire hazard calculations: part II. Fire Saf J. 2003;38(7):613–22.
20. Borchers Arriagada N, Bowman DM, Palmer AJ, Johnston FH. Climate change, wildfires, heatwaves and health impacts in Australia. Extreme Weather Events Hum Health: Int Case Stud. 2020:99–116. https://doi.org/10.1007/978-3-030-23773-8_8.
21. Campbell SL, Remenyi T, Johnston FH. Methods of assessing health care costs in a changing climate: A case study of heatwaves and ambulance dispatches in Tasmania. Australia GeoHealth. 2023;7(10):e2023GH000914.
22. Thevega T, Jayasinghe JASC, Robert D, Bandara CS, Kandare E, Setunge S. Fire compliance of construction materials for Building claddings: A critical review. Constr Build Mater. 2022;361:129582.
23. John Rakic. So Called Cladding; A Regulatory Minefield. Australia. 2021.
24. Hood J. Emerging risks in the 21st century: an agenda for action. Risk Manage. 2005;7:69–70.

25. Sekizawa A. Challenges in fire safety in a society facing a rapidly aging population. Fire Prot Eng. 2015;1:31–8.
26. Fernández-Vigil M, Echeverría Trueba B. Elderly at home: a case for the systematic collection and analysis of fire statistics in Spain. Fire Technol. 2019;55:2215–44.
27. Nilson F, Bonander C. Household fire protection practices in relation to sociodemographic characteristics: evidence from a Swedish National survey. Fire Technol. 2020;56(3):1077–98.
28. Ashe B, McAneney KJ, Pitman A. Total cost of fire in Australia. J Risk Res. 2009;12(2):121–36.
29. Productivity Commission. Report on government services 2024, emergency services for fire and other events. Australia; 2024.
30. The Australian Bureau of Statistics. National, state and territory population Australia. 2023. Available from: https://www.abs.gov.au/statistics/people/population/national-state-and-territory-population/latest-release#states-and-territories. Cited 2024 12 January.
31. National Coronial Information System. NCIS fact sheet: residential fire-related deaths in Australia. Australia; 2022.
32. Rahman FS, Tannous WK, Avsar G, Agho KE, Ghassempour N, Harvey LA. Economic costs of residential fires: A systematic review. Fire. 2023;6(10):399.
33. DiGuiseppi C, Edwards P, Godward C, Roberts I, Wade A. Urban residential fire and flame injuries: a population based study. Inj Prev. 2000;6(4):250.
34. U.S. Fire Administration. Civilian fire injuries in residential buildings (2017–2019). The United States; 2021.
35. Sanchez JLA, Bastida JL, Martínez MM, Moreno JMM, Chamorro JJ. Socio-economic cost and health-related quality of life of burn victims in Spain. Burns. 2008;34(7):975–81.
36. Farina A Jr, de Almeida C, Barros M, Martinez R. Reduction of mortality in burned patients: a multifactorial approach. Rev Bras Queimaduras. 2014;13(1):2–5.
37. Ahuja RB, Goswami P. Cost of providing inpatient burn care in a tertiary, teaching, hospital of North India. Burns. 2013;39(4):558–64.
38. Moiemen NS, Lee KC, Joory K. History of Burns: the past, present and the future. Burns Trauma. 2014;2(4):169–80.
39. Ahn CS, Maitz PK. The true cost of burn. Burns. 2012;38(7):967–74.
40. Anderson SR, Sensing TA, Thede KA, Johnson RM, Fox JP. Hospital-based, acute care within 30 days following discharge for acute burn injury. Burns. 2021;47(6):1265–73.
41. Toppi J, Cleland H, Gabbe B. Severe burns in Australian and new Zealand adults: epidemiology and burn centre care. Burns. 2019;45(6):1456–61.
42. Moradi N, Moradi K, Bagherzadeh R, Aryankhesal A. Rate and causes of inappropriate stays and the resulting financial burden in a single specialty burns hospital. BMC Health Serv Res. 2022;22(1):1538.
43. NSW Ambulance, Accounts, Fees NSW, Australia. NSW Government; 2024. Available from: https://www.ambulance.nsw.gov.au/our-services/accounts-and-fees.
44. Baltussen R, Mwalim O, Blanchet K, Carballo M, Eregata GT, Hailu A, et al. Decision-making processes for essential packages of health services: experience from six countries. BMJ Global Health. 2023;8(Suppl 1):e010704.
45. Leslie HH, Ndiaye Y, Kruk ME. Effective coverage of primary care services in eight high-mortality countries. BMJ Global Health. 2017;2(3):e000424.
46. Randall SM, Wood FM, Rea S, Boyd JH, Duke JM. An Australian study of long-term hospital admissions and costs comparing patients with unintentional burns and uninjured people. Burns. 2020;46(1):199–206.
47. Mitchell RJ, Herkes G, Nikpour A, Bleasel A, Shih P, Vagholkar S, et al. Examining health service utilization, hospital treatment cost, and mortality of individuals with epilepsy and status epilepticus in new South Wales, Australia 2012–2016. Epilepsy Behav. 2018;79:9–16.
48. Banfield J, Rehou S, Gomez M, Redelmeier DA, Jeschke MG. Healthcare costs of burn patients from homes without fire sprinklers. J Burn Care Res. 2015;36(1):213–7.
49. Yellman MA, Peterson C, McCoy MA, Stephens-Stidham S, Caton E, Barnard JJ, et al. Preventing deaths and injuries from house fires: a cost–benefit analysis of a community-based smoke alarm installation programme. Inj Prev. 2018;24(1):12–8.
50. Lawrence BA, Zaloshnja E, Miller TR, Jones PR. Estimates of the incidence and costs of fire-related injuries. The United States of America: Pacific Institute for Research & Evaluation; 2009.
51. Ghassempour N, Tannous WK, Agho KE, Avsar G, Harvey LA. Factors associated with residential fire-related hospitalisations and deaths: a 10-year population-based study. Burns. 2023;49(8):1854–65. https://doi.org/10.1016/j.burns.2023.02.012.
52. Purcell LN, Bartley C, Purcell ME, Cairns BA, King BT, Charles A. The effect of neighborhood area deprivation index on residential burn injury severity. Burns. 2021;47(2):447–54.
53. Curtis K, Lam M, Mitchell R, Black D, Taylor C, Dickson C, et al. Acute costs and predictors of higher treatment costs of trauma in new South Wales, Australia. Injury. 2014;45(1):279–84.
54. Spronk I, Edgar DW, Van Baar ME, Wood FM, Van Loey NE, Middelkoop E, et al. Improved and standardized method for assessing years lived with disability after burns and its application to estimate the non-fatal burden of disease of burn injuries in Australia, new Zealand and the Netherlands. BMC Public Health. 2020;20:1–15.
55. Harvey LA, Ghassempour N, Whybro M, Tannous WK. Health impacts and economic costs of residential fires (RESFIRES study): protocol for a population-based cohort study using linked administrative data. BMJ Open. 2020;10(9):e037709.
56. Ghassempour N, Tannous WK, Avsar G, Agho KE, Harvey LA. Estimating the total number of residential fire-related incidents and underreported residential fire incidents in new South Wales, Australia by using linked administrative data. Int J Environ Res Public Health. 2021;18(13):6921.
57. Centre for Health Record Linkage. Master Linkage Key NSW, Australia: Centre for Health Record Linkage. 2023. Available from: https://www.cherel.org.au/master-linkage-key. Cited 2024 17 August.
58. Centre for Health Record Linkage. Data dictionaries: NSW ambulance data collections Australia: Centre for Health Record Linkage. 2023. Available from: https://www.cherel.org.au/datasets. Cited 2024 27 July.
59. Independent Health and Aged Care Pricing Authority (IHACPA). Fair Pricing in Australian Health and Aged Care Sector Australia: Independent Health and Aged Care Pricing Authority (IHACPA). 2024. Available from: https://www.ihacpa.gov.au/about-ihacpa. Cited 2024 15 March.
60. The Australian Bureau of Statistics. Population clock and pyramid: New South Wales age structure in 2014 Australia. 2023. Available from: https://www.abs.gov.au/statistics/people/population/population-clock-pyramid. Cited 2024 12 January.
61. Independent Health and Aged Care Pricing Authority (IHACPA). National Hospital Cost Data Collection Australian Public Hospitals Cost Report 2012–2013, Round 17 Australia: Independent Health and Aged Care Pricing Authority (IHACPA). 2015. Available from: https://www.ihacpa.gov.au/sites/default/files/2022-05/National%20Hospital%20Cost%20Data%20Collection%2C%20Public%20Hospitals%20Cost%20Report%20Tables%2C%20Round%2017%20%28Financial%20year%202012-13%29.pdf. Cited 2024 15 March.
62. Independent Health and Aged Care Pricing Authority (IHACPA). National Hospital Cost data Collection 2012–2013 Australia. 2013. Available from: https://www.ihacpa.gov.au/resources/national-hospital-cost-data-collection-nhcdc-public-sector-report-2012-13. Cited 2024 15 March.
63. U.S. Department of Health and Human Services (HHS). ICD-9-CM Codes The United States of America: U.S. Department of Health and Human Services; 1979. Available from: http://www.icd9data.com/2015/Volume1/default.htm.
64. Independent Health and Aged Care Pricing Authority (IHACPA). ICD-10-AM/ACHI/ACS Australia. 2017. Available from: https://www.ihacpa.gov.au/health-care/classification/icd-10-amachiacs.
65. U.S. Department of Health and Human Services (HHS). ICD-10-CM Codes The United States of America: U.S. Department of Health and Human Services. 2015. Available from: https://www.icd10data.com/ICD10CM/Codes.
66. SNOMED International. Systemized Nomenclature of Medicine-Clinical Terms (SNOMED) London, the United Kingdom: International Health Terminology Standards Development Organisation (IHTSDO). 1999. Available from: https://www.snomed.org/. Cited 2024 15 March.
67. Find-A-Code. Systematized Nomenclature of Medicine (SNOMED) Codes. 2024. Available from: https://www.findacode.com/snomed/. Cited 2024 15 March.
68. McDermott KW, Weiss AJ, Elixhauser A. Burn-related hospital inpatient stays and emergency department visits, 2013. 2017.
69. Gulaid JA, Sattin RW, Waxweiler RJ. Deaths from residential fires, 1978–1984. MMWR Surveill Summ. 1988;37:39–45. https://www.jstor.org/stable/44784785.
70. Haikonen K, Lillsunde PM, Lunetta P, Lounamaa A, Vuola J. Fire-related injuries with inpatient care in Finland: a 10-year nationwide study. Burns. 2013;39(4):796–802.
71. Wang Y, Srikanth V, Snowdon DA, Ellmers S, Beare R, Moran C, et al. Quantifying the economic benefit of the personal alarm and emergency response system in Australia: a cost analysis of the reduction in ambulance attendances. Aust Health Rev. 2020;45(1):51–8.

72. Reeve R, Haas M. Estimating the cost of Emergency Department presentations in NSW. CHERE Working Paper 2014/01. 2014.
73. Bloom JE, Nehme E, Paratz ED, Dawson L, Nelson AJ, Ball J, et al. Healthcare and economic cost burden of emergency medical services treated non-traumatic shock using a population-based cohort in Victoria, Australia. BMJ Open. 2024;14(4):e078435.
74. Australian Institute of Health and Welfare. Disease Expenditure Study: Overview of analysis and methodology 2018–19 Canberra: Australian Institute of Health and Welfare. 2021. Available from: https://www.aihw.gov.au/getmedia/8d59f718-c336-4b2d-85e8-e8f02977c773/aihw-hwe-82-disease-expenditure-study-overview-of-analysis-and-methodology-2018-19.pdf.aspx. Cited 2023 31 August.
75. Centre for Health Record Linkage (CHeRel). NSW Admitted Patient Data Collection NSW Australia: NSW Ministry of Health. 2023. Available from: https://www.cherel.org.au/datasets.
76. Berry J, Harrison J. A guide to statistical methods for injury surveillance. Adelaid Australian Institute of Health and Welfare; 2005.
77. Department of Health. National injury prevention strategy: 2020–2030. Canberra ACT, AUstralia: Department of Health; 2020.
78. Möller H, Harvey L, Falster K, Ivers R, Clapham KF, Jorm L. Indigenous and non-Indigenous Australian children hospitalised for burn injuries: a population data linkage study. Med J Aust. 2017;206(9):392–7.
79. The Australian Bureau of Statistics. Consumer price index, Australia Australia. 2023. Available from: https://www.abs.gov.au/statistics/economy/price-indexes-and-inflation/consumer-price-index-australia/latest-release.
80. Fire and Rescue New South Wales. Annual report 2010-11. Australia. 2011.
81. Fire and Rescue New South Wales. Annual Report 2011-12. Australia. 2012.
82. Fire and Rescue New South Wales. Lessons from the Quakers Hill Nursing Home fire Australia. 2024. Available from: https://www.fire.nsw.gov.au/page.php?id=9134. Cited 2025 26 February.
83. Tannous WK, Agho KE. Factors associated with home fire escape plans in new South Wales: multinomial analysis of high-risk individuals and new South Wales population. Int J Environ Res Public Health. 2018;15(11):2353.
84. Tannous WK, Agho K. Socio-demographic predictors of residential fire and unwillingness to call the fire service in new South Wales. Prev Med Rep. 2017;7:50–7.
85. This Regulation is the Residential Tenancies (Residential Premises) Amendment (Smoke Alarms) Regulation 2006. 2006.
86. Australasian Institute of Health and Welfare. Older Australians Australia: Australian Government; 2024. Available from: https://www.aihw.gov.au/reports/older-people/older-australians/contents/demographic-profile. Cited 2024 12 June.
87. The Australian Bureau of Statistics. Statistics about life tables and life expectancy at birth estimates for Australia, states and territories and sub-state regions Australia: The Australian Bureau of Statistics; 2020–2022. Available from: https://www.abs.gov.au/statistics/people/population/life-expectancy/latest-release#:~:text=Life%20expectancy%20at%20birth%20for,and%20females%20is%204.1%20years. Cited 2024 27 July.
88. Siddiqui N, Dwyer M, Stankovich J, Peterson G, Greenfield D, Si L, et al. Hospital length of stay variation and comorbidity of mental illness: a retrospective study of five common chronic medical conditions. BMC Health Serv Res. 2018;18:1–10.
89. Agency for Clinical Innovation. NSW Burn transfer guidelines Australia: NSW Government. 2024. Available from: https://aci.health.nsw.gov.au/__data/assets/pdf_file/0004/162634/ACI-Burn-transfer-guidelines.pdf. Cited 2024 12 June.

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