Smoke Alarms Work, But Not Forever: Revisited

Successes and Ongoing Challenges from BC's Working Smoke Alarm Campaign

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Executive Summary

1. This report builds the 2012 report, "Smoke alarms work, but not forever," which made three main points: present, functioning smoke alarms save lives; smoke alarm functionality deteriorates with time; and targeted prevention and education efforts increase functioning smoke alarm coverage. The conclusion of the 2012 report was to issue a challenge to the communities of BC to work collaboratively to ensure there is a present, functioning smoke alarm in every home in the province.

2. Building on these three points and in response to this challenge, the BC Smoke Alarm Movement was launched in October 2012. Over that 3 year period, more than 41,000 smoke alarms have been distributed and installed across BC, roughly 20,000 of which have been provided to BC First Nations communities. Momentum has gathered to include commitments from many agencies across the province including fire services, police, BC Ambulance, municipal and provincial governments, and non-government agencies. Over $500,000 has been contributed to support the movement. As a consequence of this activity, the state of play for present, functioning smoke alarms in BC is revisited, with this report summarising the findings.

3. Since 2007, the percentage of residential structure fires that had present, functioning smoke alarms increased by 12 percentage points from 29% in 2007 to 41% in 2014. Over the same time period, the annual number of residential structure fires in BC has declined by 4%.

4. In 2007, the death rate per 1,000 residential structure fires in BC was 15.2. This fell by 42% to 8.9 deaths per 1,000 residential structure fires in 2014. For all residential structure fires in BC between 2007 and 2014 the death rate was 16.7 per 1,000 fires in the absence of a working smoke alarm and 6.0 in the presence of a working smoke alarm: a difference of 177%.

5. With respect to residential structure fires and the Smoke Alarm Movement that commenced in 2012, comparing the time period between 2007-11 with the time between 2012-14:
    - Deaths per 100,000 citizens declined by 65%;
    - Deaths per 1,000 fires declined by 37%;
    - Present, functioning smoke alarms per 1,000 fires increased by 26%; and
    - Fires without any smoke alarms decreased by 17%.

6. There is a large variation in the extent to which smoke alarm coverage has increased across the province for residential structure fires. Compared to the pre-movement time period, some communities have increased their working smoke alarm coverage by as much as 36 to 40 percentage points. Other areas have shown a 20 to 23 percentage point reduction in the percentage of fires that had working alarms in the event of a fire.

7. In effort to reduce the elevated risks of fatality for First Nations people in the event of a residential structure fire (29.1 per 1,000 fires between 2007-14 compared to 12.8 per 1,000 fires for the remainder of BC), part of the BC Working Smoke Alarm Movement has involved distribution and installation of smoke alarms to BC First Nations communities. Approximately 75% of BC First Nations communities have participated in this exercise to date and the relative frequency of present, functioning smoke alarms in the event of residential fires has increased from 2012-14.

8. From 2007 to 2014, fire related fatalities in BC were disproportionately likely to be aged 65 years or older at the time of the fire (28%, compared to an estimated 15% of the population). In effort to reduce the risks for older BC residents, targeted home visits have been undertaken in selected areas over the last 3 years. These visits, which were made in parallel with health checks and fall-prevention programs, have demonstrated the benefits of education and smoke alarm installation for elderly BC citizens, resulting in increased smoke alarm coverage, more regular maintenance and checking of alarms, and the installation of additional fire safety devices in homes for vulnerable elderly people.

9. In aggregate, these findings are very positive with respect to the activity that has already taken place. This said, there is still a lot of room for improvement and there is no room for complacency. Data-driven, targeted interventions and an ongoing commitment to maintenance are fundamental to ensuring the ongoing reductions in fire-related fatalities in BC.

Background to this Research

In 2012 the report, "Smoke alarms work, but not forever" [1], presented the argument that a comprehensive, whole-of-government commitment was required to ensure every dwelling in Canada possesses a present, functioning smoke alarm. Through analysis of fire data from Alberta, British Columbia (BC), and Ontario, this 2012 research estimated that the death rate per 1,000 fires in the absence of a present, functioning smoke alarm was 74% greater than when a functioning smoke alarm was present. These provinces combined represent approximately 62% of the Canadian population. Extrapolating these trends it was estimated that 100% coverage of functioning smoke alarms in residential properties could prevent around 69 deaths per year in Canada: reducing the annual fatalities from residential structure fires by 32%.

The "Smoke alarms work, but not forever" report also discussed peer reviewed research demonstrating that the risks of residential structure fire fatality are unevenly distributed across society, with elevated risks for households with at least one young child, older adult, or person with disability, rental units, households in low-income areas, and houses in rural communities also experience elevated risk [2, 3]. Previous research in BC has also indicated increased risk of casualty for fires reported by First Nations communities, with suggestion that the death rate from residential structure fire for BC First Nations communities was 2.4 times greater that for the remainder of the province [4].

The focus of the 2012 research was to make three main points. First, present and functioning smoke alarms saves lives in the event of residential fires. Second, the functionality of smoke alarms deteriorates with time due to the presence of airborne contaminants, meaning that they must be replaced every 10 years as per NFPA recommendations. Third, it is possible to increase the likelihood of a present, functioning smoke alarm in the event of a fire through targeted prevention and education efforts. However, this third point has the caveat that typical approaches that have positively influenced the presence of functioning smoke alarms have suffered from a lack of an unconditional, systematic, ongoing commitment, meaning that positive impacts typically diminish with time and the problem re-emerges. With these three findings in mind, the research posed the challenge of ensuring that smoke alarm presence and functionality is monitored in a comprehensive, consistent, ongoing manner. It was argued that this objective could only be achieved through the simultaneous implementation of a range of strategies, with an emphasis on interagency approaches, leveraging existing resources, and making a commitment to ongoing process and impact evaluation.

The BC Smoke Alarms Movement and the Purpose of this Research

Shortly after the publication of the 2012 report, in March 2012, the BC Smoke Alarm Movement was launched by the then Justice Minister and Attorney General of BC, the Honourable Shirley Bond and Minister of Children and Family Development, the Honourable Stephanie Cadieux. This step signified the commitment the provincial government had made in providing leadership to ensure there was a working smoke alarm in every home in BC. In October 2012, the inaugural BC Provincial Smoke Alarm Awareness Day was announced.

By November 2013 the movement had gained significant momentum. Over 41,000 smoke alarms had been distributed and installed across BC, with a focus on the most vulnerable members of the community. In addition to engaging support from over 60 fire departments in BC, commitments for interagency partnerships had been made from provincial and local governments, as well as over 24 other key stakeholders including the Royal Canadian Mounted Police (RCMP), BC Ambulance, BC Hydro, United Way, the BC Real Estate Association, Aboriginal Affairs and Northern Development, the Red Cross, and local health services. In addition to this, over $545,000 had been generated in financial support for the purchasing and installation of smoke alarms, media coverage, and sustainability of the movement. Into 2014, targeted home visit

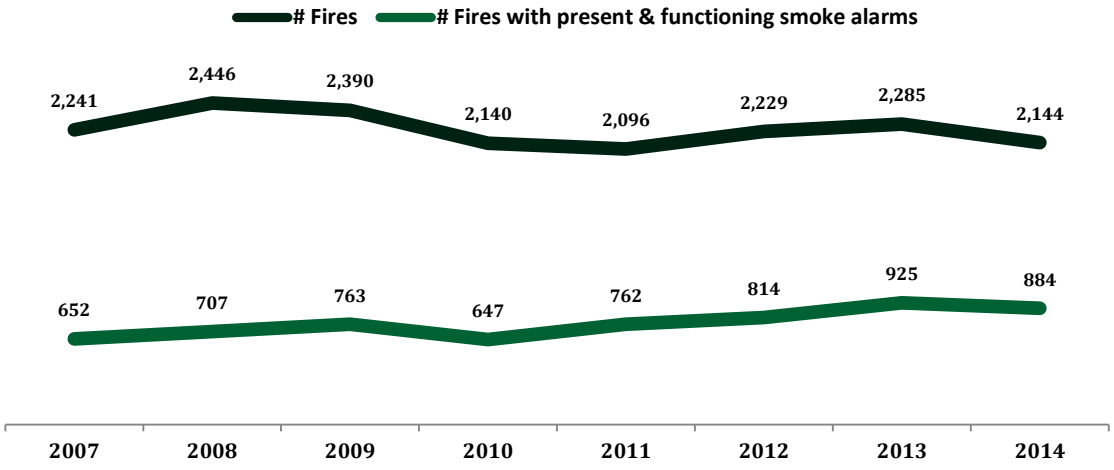
interventions were evaluating the functionality of smoke alarms in the homes of elderly people with mobility limitations and other chronic health issues. In addition to this, over 20,000 of the total smoke alarms distributed so far have been provided to First Nations communities in BC.

In light of all of this activity and consistent with the initial challenge to undertake ongoing evaluation of the smoke alarm functionality in BC, this report provides some statistical analysis of the state of play for residential structure fires in BC up to the end of 2014. The analysis examines provincial trends for fires, fire-related casualties, and smoke alarm functionality. Further to this, some preliminary findings are presented relating to the targeted delivery of smoke alarms to First Nations communities and on the potential benefits of education and testing smoke alarms as part of residential visits for elderly people who are receiving a range of out-care health services. Finally, some data is presented relating to carbon monoxide casualties, as an example of new, related areas that could benefit from this type of coordinated activity. To preview the findings, the initial trends are very positive, but there is still work to do.

Provincial Trends for Residential Structure Fires: 2007-2014

This section examines the provincial trends in residential fires over an eight year period between 2007 and 2014. The data presented here is based on fires reported to the BC Office of the Fire Commissioner (BC OFC). There were 17,971 residential structure fires reported to the BC OFC over this time period.[1] Figure 1 demonstrates there was a 4% reduction in the total number of fires reported in 2014 relative to 2007 and a 36% increase in the number of residential fires that occurred in the presence of functioning smoke alarms.

FIGURE 1. RESIDENTIAL STRUCTURE FIRES (TOTAL AND NUMBER WITH PRESENT, FUNCTIONING SMOKE ALARM), REPORTED TO THE BC OFC, 2007-2014



Over this eight year period the population in BC increased by 8%. This means that the absolute numbers presented in Figure 1 translate to an 11% reduction in the rate of residential structure fires per 100,000 people over the eight year period (Figure 2). Furthermore, the percentage of residential structure fires that had present, functioning smoke alarms increased by 12 percentage points from 29% in 2007 to 41% in 2014.

[1] The data presented here is based on fires reported to the BC Office of the Fire Commissioner (BC OFC). To be classified as a residential structure fire, the fire incidence reports must have classified the property complex as residential (PC3100 to PC3900).

FIGURE 2. RATE OF RESIDENTIAL STRUCTURE FIRES (PER 100,000 PEOPLE)[2] AND PERCENTAGE OF FIRES WITH PRESENT, FUNCTIONING SMOKE ALARMS, REPORTED TO THE BC OFC, 2007-2014

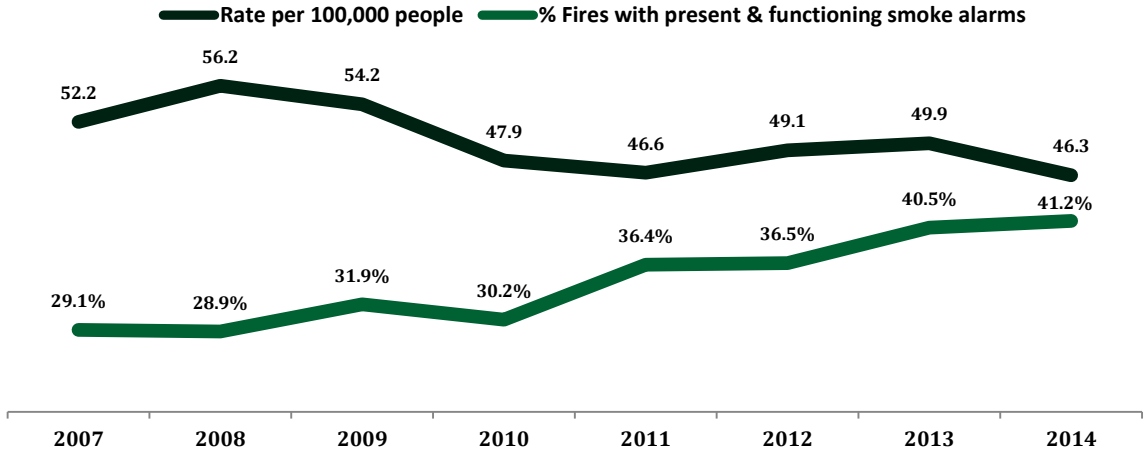
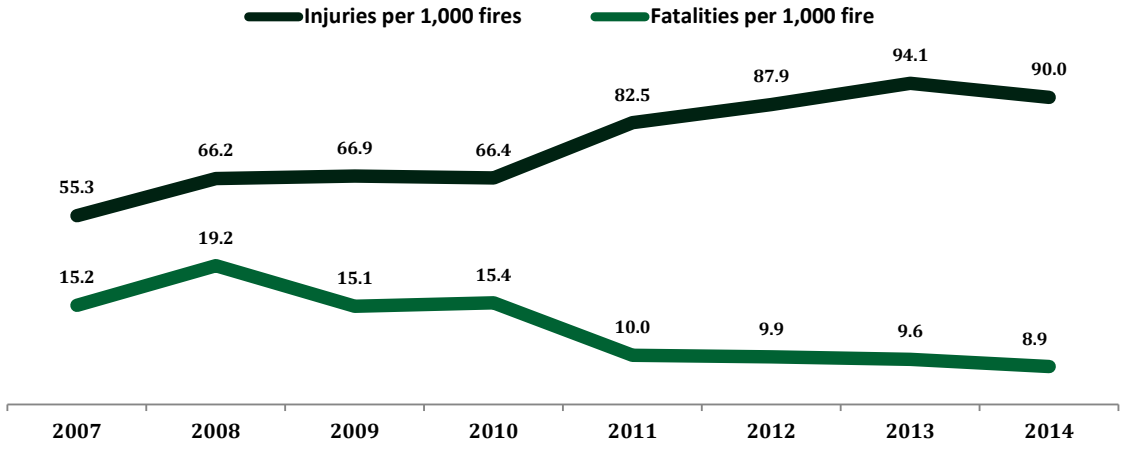


Figure 3 shows two main findings which interact with each other. On the one hand, there was a 42% reduction in the death rate per 1,000 fires over the eight year period (15.2 per 1,000 fires in 2007 reduced to 8.9 per 1,000 fires in 2014). Over the same period of time there was a 63% increase in the injuries sustained as a result of residential structure fires in BC (55.3 per 1,000 fires in 2007 up to 90.0 per 1,000 fires in 2014). In conjunction with the patterns displayed in Figure 2, these findings can be interpreted as consistent with the 2014 National Fire Protection Association report, "Smoke Alarms in U.S. Home Fires" [5], which showed a much larger death rate from fires in homes without working smoke alarms and elevated rates of injuries in the presence of operating smoke alarms as a consequence of civilians intervening to control the fires themselves, resulting in non-fatal injuries.

FIGURE 3. RATE OF RESIDENTIAL STRUCTURE FIRE CASUALTIES (INJURIES AND DEATHS PER 100,000 PEOPLE), REPORTED TO THE BC OFC, 2007-2014



[2] Population estimates taken from: http://www.bcstats.gov.bc.ca/StatisticsBySubject/Demography/PopulationEstimates.aspx

Smoke Alarms and Residential Structure Fires: BC 2007 to 2014

Overall, 17,971 residential structure fires which resulted in 234 deaths were included in this analysis. For all residential structure fires that occurred in BC between 2007 and 2014, the death rate was 16.7 per 1,000 fires in the absence of a working smoke alarm and 6.0 per 1,000 fires in the presence of a working smoke alarm: a statistically significant increase of 177% without an alarm ($Z = 5.69$, $p < .001$). Given the timing of the smoke alarm movement, the BC OFC data was separated into two time periods: fires reported between 2007 and 2011 formed one group (pre-movement), while fires reported between 2012 and 2014 formed the other group (post-movement). Table 1 displays the frequencies of fires and deaths as a function of smoke alarm status across these two time periods.

TABLE 1. FREQUENCY OF RESIDENTIAL STRUCTURE FIRES, DEATHS, AND DEATH RATE PER 1,000 FIRES BY SMOKE ALARM STATUS AND TIME PERIOD OF FIRES, REPORTED TO THE BC OFC, 2007-2014

Time period for fires[3]	Smoke alarm status	# Fires	% Fires in time period	# Deaths	% Deaths in time period	Deaths per 1,000 fires
2007 - 2011	Present and functioning	3,531	31%	30	18%	8.5
(BC population estimated at 4.403 million)	Alarm present, not activated	2,616	23%	35	20%	13.4
	No alarm	1,927	17%	26	15%	13.5
	Cannot be determined	3,239	29%	80	47%	24.7
	Sub-total	*11,313*	*100%*	*171*	*100%*	*15.1*
2012 - 2014	Present and functioning	2,623	39%	7	11%	2.7
(BC population estimated at 4.585 million)	Alarm present, not activated	1,500	23%	16	25%	10.7
	No alarm	938	14%	9	14%	9.6
	Cannot be determined	1,597	24%	31	49%	19.4
	Sub-total	*6,658*	*100%*	*63*	*100%*	*9.5*
Total		**17,971**		**234**		**13.0**

* Residential structure fires as determined based on OFC property complex codes: PC3100 to PC3900.

The death rate per 100,000 people declined by 65% from 3.9 (pre-movement) to 1.4 (post-movement). The other important statistically significant findings from the patterns presented in Table 1 are as follows:[4]

- The rate of fatalities fell by 37%, from 15.1 per 1,000 fires pre-movement down to 9.5 per 1,000 fires post-movement;
- The rate of present, functioning smoke alarms increased by 26%, from 312.1 per 1,000 fires pre-movement to 394.0 per 1,000 fires post-movement;
- The rate of fatalities in the presence of functioning smoke alarms decreased by 69%, from 8.5 per 1,000 fires pre-movement to 2.7 per 1,000 fires post-movement;
- The rate at which residential fires occurred in buildings without any smoke alarms reduced by 17%, from 170.3 per 1,000 fires pre-movement down to 140.9 per 1,000 post-movement; and
- The rate at which alarm status was recorded as undetermined decreased by 16%, from 286.3 per 1,000 fires pre-movement to 239.9 per 1,000 fires post-movement.

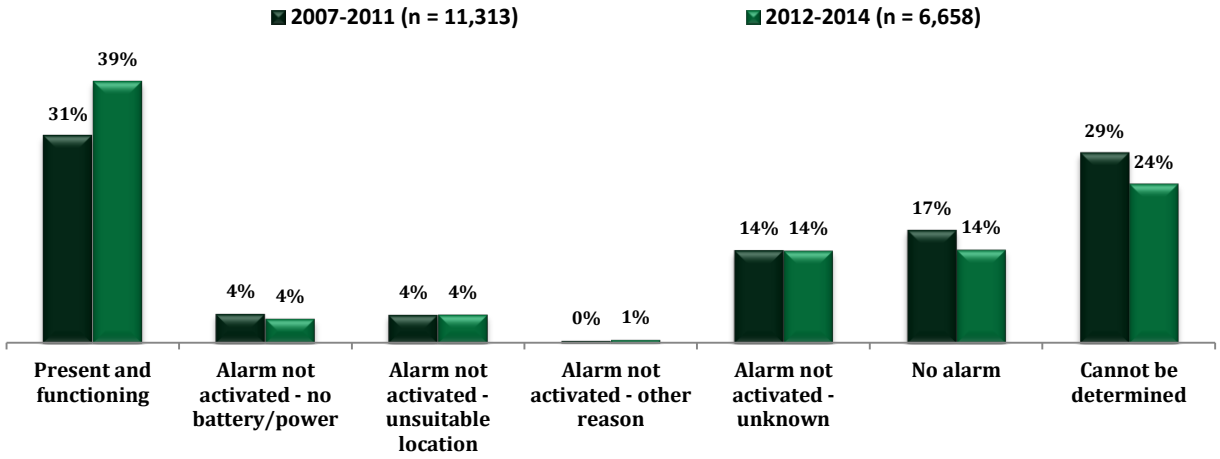
[3] BC population estimates based on BCStats data averaged from the time periods 2007-11 and 2012-14.

[4] All differences in rates discussed here are statistically significant, $Z > |1.96|$, $p < .05$.

Overall, the increase in the presence of working alarms, the reduction in the number of fires without alarms, and the reduction in the number of fires where it could not be determined if an alarm was present are all indicative of increased installation, maintenance, and awareness of these factors when undertaking post-fire inspections. Furthermore, the reduction in fatalities in the event of present, functioning alarms might be to do with the installation of additional alarms. All of these trends are consistent with the messages of the BC smoke alarm movement.

The smoke alarm activation percentages within each time period that were displayed in Table 1 are reproduced in Figure 4, along with the reasons as to why the smoke alarms were present and non-functioning in each case. It can be seen from this figure that there is no noticeable change in the reasons why smoke alarms were present and non-functioning across the two time periods.

FIGURE 4. SMOKE ALARMS FUNCTIONALITY FOR RESIDENTIAL STRUCTURE FIRES BY TIME PERIOD OF FIRES, REPORTED TO THE BC OFC, 2007-2014



Geographic Variations in Smoke Alarm Functionality: BC 2007 to 2014

To demonstrate the extent to which the BC Smoke Alarm Movement has been supported across the province, the percentages of fires for which smoke alarms were present and functioning at the time of a fire was examined by smaller geographic areas across the two time periods. To avoid the volatility of small number variations, communities must have experienced be included in this analysis a municipality must have experienced an average of at least five residential structure fires per year in both time periods (2009-11 and 2012-14).

Using this community inclusion rule, Figure 5 displays the percentages of fires that occurred between 2009-11 with working smoke alarms across eligible areas of BC. This map demonstrates the substantial variation between municipalities with respect to the percentage of fires that had working smoke alarms, ranging from 20% and less up to 61% and above. Remembering that Table 1 demonstrated the rate of present, functioning smoke alarms was 31% for the province over this time period, Figure 5 clearly demonstrates the majority of the municipalities in the lower mainland were consistent with this overall provincial rate. It is also worth noting that the majority of the province did not report enough residential structure fires to be included in this figure.

FIGURE 5. PERCENTAGE OF RESIDENTIAL STRUCTURE FIRES WITH A PRESENT, FUNCTIONING SMOKE ALARM, BC OFC, 2007-2011

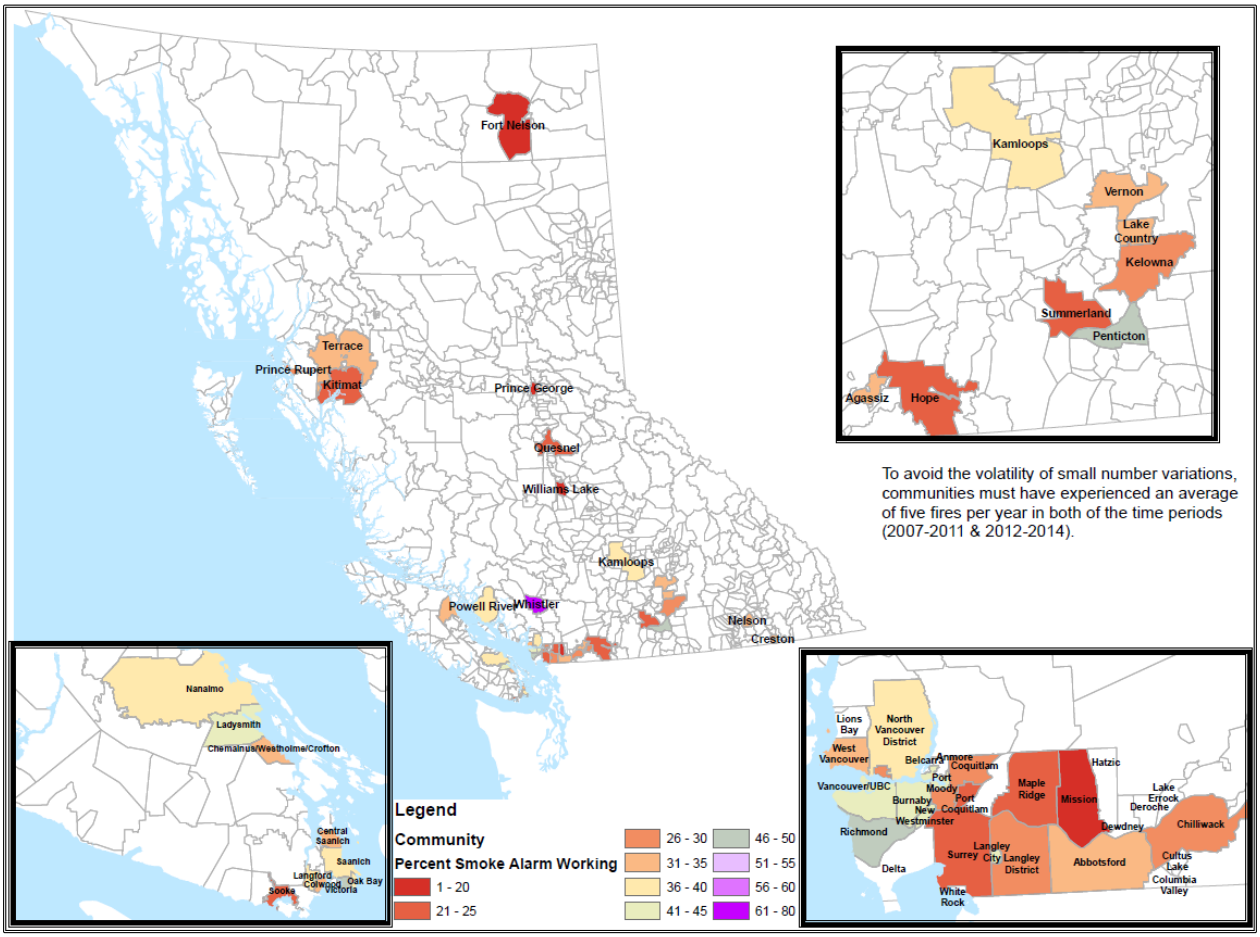
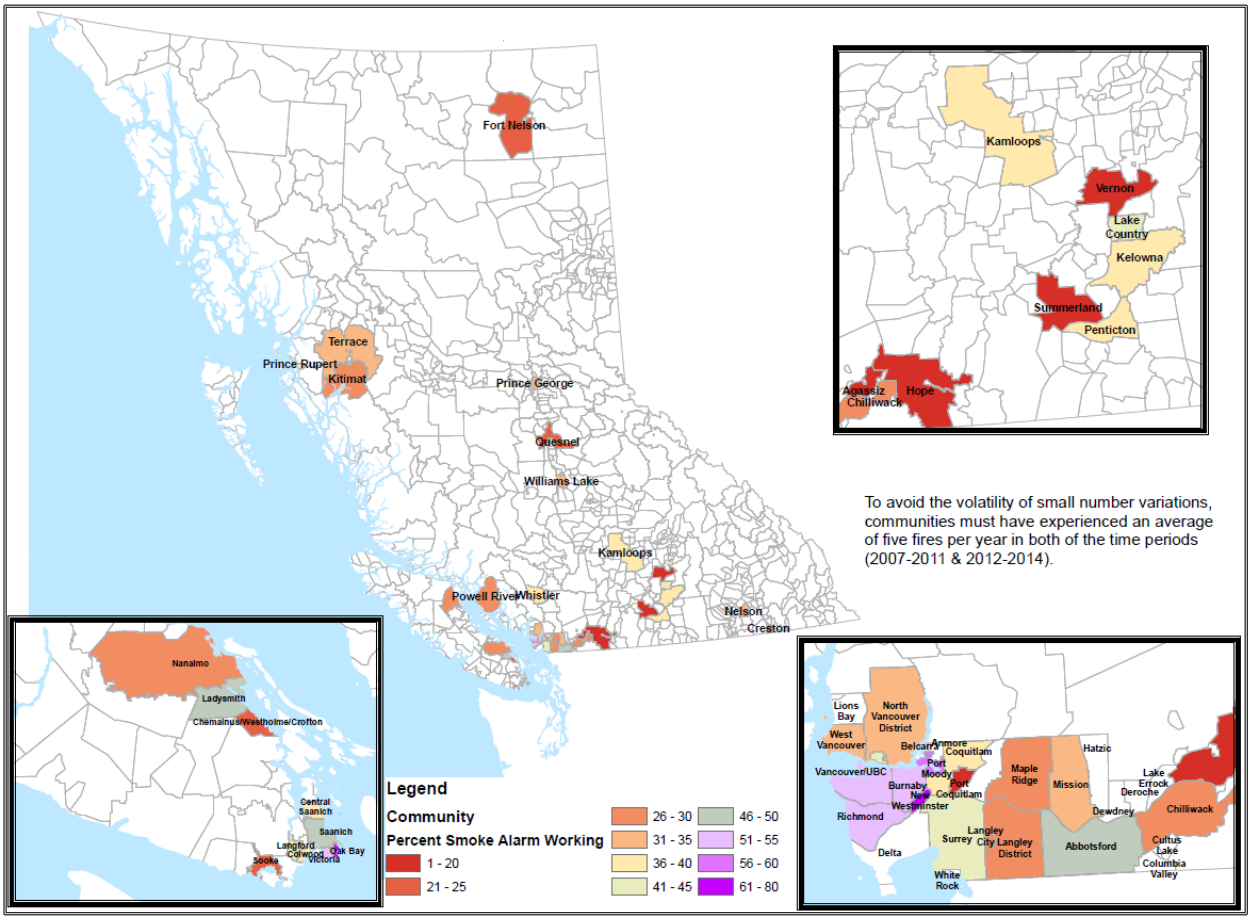


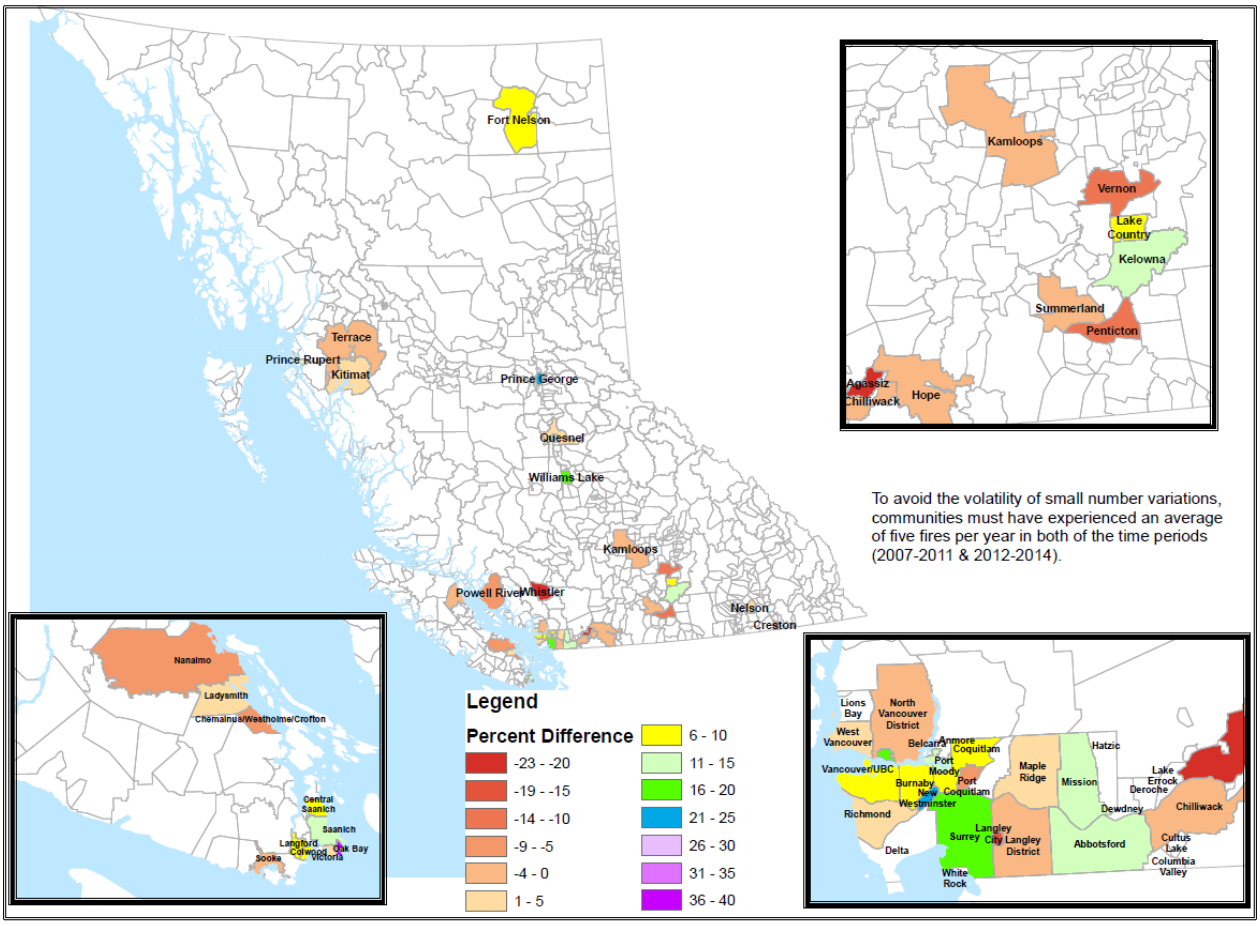
Figure 6 shows the percentages of fires that occurred between 2012-14 with working smoke alarms across eligible areas of BC. As with Figure 5, this map also demonstrates the substantial variation between municipalities with respect to the percentage of fires that had working smoke alarms, ranging from 20% and less up to 61% and above. Remembering that Table 1 demonstrated the rate of present, functioning smoke alarms had increased to 39% for the province over this time period, Figure 6 clearly demonstrates the increased smoke alarm coverage in the majority of the municipalities in the lower mainland relative to the 2009-11 time period. As before, it is also worth noting that the majority of the province did not report enough residential structure fires to be included in this figure.

FIGURE 6. PERCENTAGE OF RESIDENTIAL STRUCTURE FIRES WITH A PRESENT, FUNCTIONING SMOKE ALARM, BC OFC, 2012-2014



To emphasise the differences between Figure 5 and Figure 6, Figure 7 displays the percentage point difference in the rate of present, functioning smoke alarms for each of these municipalities across the two time periods. This figure demonstrates very different patterns with respect to improved smoke alarm coverage, with some municipalities demonstrating an increase of between 36 and 40 percentage points, while others showed a net decline in the percentage of fires that occurred in the presence of working smoke alarms (up to a decline of between 20 to 23 percentage points).

FIGURE 7. PERCENTAGE POINT DIFFERENCE IN RESIDENTIAL STRUCTURE FIRES WITH A PRESENT, FUNCTIONING SMOKE ALARM, BC OFC, 2007-2011 VS. 2012-2014



Smoke Alarms and Residential Structure Fires Fatalities: BC 2007 to 2014

The previous section has demonstrated the overall increase in smoke alarm coverage across the province, concomitant to the activities of the Smoke Alarm Movement. Despite this success, however, as displayed in Table 1, there were still 63 deaths in the 2012-14 time period. Furthermore, over the whole period of analysis, there were also 37 deaths in the presence of a functioning smoke alarm. The following section examines these trends with a view to identifying what can be learned to enhance the prevention efforts moving forward.

With respect to the age and sex of fire-related fatalities in this time period, the following summarise the main findings:

- 59% of the fire fatalities across the time period were male;
- When the fires occurred in the presence of a working smoke alarm, this trend reversed, where 65% of fatalities were female;
- The age of the fatality was known in 230 of the 234 cases. Overall, 28% of the 230 fire fatalities were aged 65 years or over at the time of the fire;
- When the fires occurred in the presence of a working smoke alarm, 46% of the fatalities were aged 65 years of older (and 59% of these were female); and

- When the fires occurred in the absence of a working smoke alarm, 29% of the fatalities were aged 65 years or over (41% of which were female).

This interaction between fatality, victim sex, and working smoke alarms is worthy of additional examination, particularly given that only 15% of the BC population was estimated to be 65 years and over in 2010 [6]. This issue may be compounded by hearing loss that results from ageing [7], and as the National Fire Protection Association [8] discuss, smoke alarms that use flashing lights or vibration alerts should be considered in instances where households contain residents who are deaf or have diminished hearing.

Table 2 shows the condition of the fire fatalities by smoke alarm status across the two time periods. A major limitation associated with this variable is that 45% of all fatalities were coded as 'unknown' with respect to the condition of the fatality. When these cases were excluded from the analysis, 44% of the remaining fatalities (n = 129) were asleep at the time of the fire. Overall, 27% of fatalities were considered to have been under the influence of alcohol/drugs at the time of the fire, with this number ranging between 19% for present, functioning smoke alarms and increasing up to 29% for fatalities that occurred in the absence of working alarms. Beyond these differences as a consequence of smoke alarm functionality, there were no major differences between time periods with respect to the condition of the casualties.

TABLE 2. CONDITION OF RESIDENTIAL STRUCTURE FIRE FATALITIES BY SMOKE ALARM STATUS AND TIME PERIOD OF FIRES, REPORTED TO THE BC OFC, 2007-2014

		Activated smoke alarm			No activated smoke alarm		
Time period of fires	**Condition of casualty**	**# Deaths**	**% Deaths within time period**	**Avg. Age***	**# Deaths**	**% Deaths within time period**	**Avg. Age***
2007 - 2011	010 - Condition unknown	8	27%	61	62	44%	55
	011 - Asleep at time of fire	10	33%	41	36	26%	48
	012 - Bedridden or other physical handicap	0	0%	na	3	2%	61
	013 - Impairment alcohol/drugs	4	13%	49	24	17%	49
	014 - Awake, no physical/mental impairment	5	17%	77	7	5%	68
	016 - Too young to react to fire emergency	1	3%	1	0	0%	na
	018 - Child left unattended	2	7%	4	1	1%	1
	019 - Unclassified	0	0%	na	8	6%	58
	Sub-total	*30*	*100%*	*49*	*141*	*100%*	*53*
2012-2014	010 - Condition unknown	3	43%	71	32	57%	48
	011 - Asleep at time of fire	2	29%	76	9	16%	51
	012 - Bedridden or other physical handicap	0	0%	na	1	2%	81
	013 - Impairment alcohol/drugs	1	14%	38	6	11%	49
	014 - Awake, no physical/mental impairment	1	14%	21	4	7%	55
	016 - Too young to react to fire emergency	0	0%	na	0	0%	na
	018 - Child left unattended	0	0%	na	0	0%	na
	019 - Unclassified	0	0%	na	4	7%	52
	Sub-total	*7*	*100%*	*60*	*56*	*100%*	*50*
Total		**37**			**197**		

* Unknown ages were excluded from this calculation

As can be seen from Table 3, there were also a lot of unknown responses when attempting to determine the action of fire fatalities over the time period. When these cases were removed, it was found that casualties were more likely to have been incurred in the presence of working smoke alarms when the victims were attempting to escape (35% compared to 31% of fatalities without alarms). Furthermore, fatalities were more likely to have voluntarily entered or remained in the fire (all reasons combined) in the presence of working alarms (15% compared to 8% for fires without alarms). Relatively more victims were considered to have suffered a loss of judgment or panicked in the cases involving present, functioning alarms (15% vs. 7% for fires without working smoke alarms). Beyond these differences as a consequence of smoke alarm functionality, there were no major differences between time periods with respect to the condition of the casualties.

TABLE 3. ACTION OF RESIDENTIAL STRUCTURE FIRE FATALITIES BY SMOKE ALARM STATUS AND TIME PERIOD OF FIRES, REPORTED TO THE BC OFC, 2007-2014

		Activated smoke alarm			No activated smoke alarm		
Time period of fires	Action of casualty	# Deaths	% Deaths within time period	Avg. Age*	# Deaths	% Deaths within time period	Avg. Age*
2007 - 2011	020 - Action of casualty unknown	13	43.3%	53	79	56.0%	53
	021 - Injured while attempting escape	6	20.0%	57	21	14.9%	49
	022 - Over-exertion, heart attack	0	0.0%	na	1	0.7%	60
	023 - Voluntarily enter/remain rescue	1	3.3%	44	4	2.8%	54
	024 - Voluntarily enter/remain fire fighting	1	3.3%	18	1	0.7%	64
	025 - Voluntarily enter/remain save personal property	0	0.0%	na	1	0.7%	40
	026 - Loss of judgement/panic	3	10.0%	47	4	2.8%	69
	027 - Received delayed warning	0	0.0%	na	6	4.3%	64
	028 - Did not act	5	16.7%	41	19	13.5%	50
	029 - Unclassified	1	3.3%	44	5	3.5%	52
	Sub-total	*30*	*100%*	*49*	*141*	*100%*	*53*
2012-2014	020 - Action of casualty unknown	4	57.1%	40	31	55.4%	52
	021 - Injured while attempting escape	1	14.3%	21	6	10.7%	52
	022 - Over-exertion, heart attack	0	0.0%	na	1	1.8%	70
	023 - Voluntarily enter/remain rescue	0	0.0%	na	1	1.8%	60
	024 - Voluntarily enter/remain fire fighting	1	14.3%	83	0	0.0%	na
	025 - Voluntarily enter/remain save personal property	0	0.0%	na	0	0.0%	na
	026 - Loss of judgement/panic	0	0.0%	na	2	3.6%	26
	027 - Received delayed warning	0	0.0%	na	0	0.0%	na
	028 - Did not act	1	14.3%	74	7	12.5%	43
	029 - Unclassified	0	0.0%	na	8	14.3%	45
	Sub-total	*7*	*100%*	*60*	*56*	*100%*	*50*
Total		**37**			**197**		

* Unknown ages were excluded from this calculation

As was the case with the 2012 report, previously, this analysis demonstrates that fire fatalities were more likely to have died as a consequence of smoke inhalation in the absence of a functioning smoke alarm (see Table 4). When unknown causes of death were removed from the calculations, 67% of deaths in the presence of a functioning smoke alarm occurred due to smoke inhalation and 30% resulted from burns from fire/flames. In comparison, when the unknown cases were removed, 78% of deaths in the absence of a functioning smoke alarm occurred due to smoke inhalation and 19% resulted from burns from fire/flames.

TABLE 4. CAUSE OF RESIDENTIAL STRUCTURE FIRE FATALITIES BY SMOKE ALARM STATUS AND TIME PERIOD OF FIRES, REPORTED TO THE BC OFC, 2007-2014

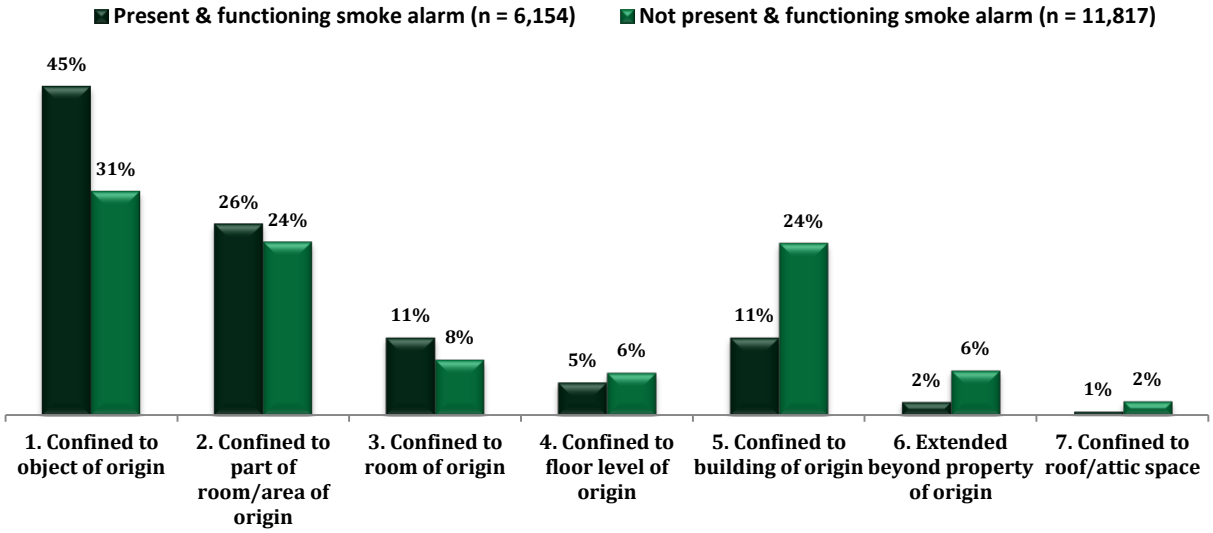
Time period of fires	Cause of casualty	Activated smoke alarm			No activated smoke alarm		
		# Deaths	% Deaths within time period	Avg. Age*	# Deaths	% Deaths within time period	Avg. Age*
2007 - 2011	100 - Smoke inhalation	15	50.0%	49	70	49.6%	51
	101 - Burns resulting from fire/flames	8	26.7%	49	13	9.2%	60
	102 - Burns resulting hot substances	0	0.0%	na	1	0.7%	74
	103 - Struck by objects or persons	0	0.0%	na	0	0.0%	na
	105 - Injury caused by explosives	1	3.3%	21	0	0.0%	na
	107 - Unclassified	0	0.0%	na	1	0.7%	45
	108 - Unknown	6	20.0%	56	56	39.7%	55
	Sub-total	*30*	*100%*	*49*	*141*	*100%*	*53*
2012-2014	100 - Smoke inhalation	5	71.4%	53	26	46.4%	53
	101 - Burns resulting from fire/flames	1	14.3%	74	10	17.9%	66
	102 - Burns resulting hot substances	0	0.0%	na	0	0.0%	na
	103 - Struck by objects or persons	0	0.0%	na	1	1.8%	75
	105 - Injury caused by explosives	0	0.0%	na	0	0.0%	na
	107 - Unclassified	0	0.0%	na	1	1.8%	na
	108 - Unknown	1	14.3%	82	18	32.1%	36
	Sub-total	*7*	*100%*	*60*	*56*	*100%*	*50*
Total		**37**			**197**		

* Unknown ages were excluded from this calculation

Smoke Alarms Reduce the Spread of Fires

Consistent with the findings from the 2012 study [1], analysis of the 17,971 residential structure fires which occurred between 2007 and 2014 revealed that the presence of a functioning smoke alarm resulted in significantly less property damage (see Figure 8). The differences in percentages displayed in Figure 8 are all statistically significant ($|Z| > 3.66$, $p < .001$ in all cases). These patterns indicate that fires in the presence of a working smoke alarm are more likely to be confined to at least the room of origin (82% vs. 62% of fires without working smoke alarms).

FIGURE 8. EXTENT OF RESIDENTIAL STRUCTURE FIRE SPREAD BY SMOKE ALARM STATUS, REPORTED TO THE BC OFC, 2007-2014



The Focus on First Nations Communities

Previous BC research [4] that indicated between 1991 and 2001 the fatality rate from residential fires for First Nations people in BC was 2.4 times greater than the remainder of the BC residents. The 2012 study [1] provided support for these findings and analysis of the rates between 2007 to 2014 demonstrate deaths are still more likely in the event of fires on First Nations lands (29.1 deaths per 1,000 fires) compared to elsewhere in the province (12.8 deaths per 1,000 fires).[5] Given these previous findings, a key motivation of the BC Smoke Alarm Movement was to work in partnership with First Nations communities to increase smoke alarm coverage and reduce residential fire risks.

This approach was implemented with the following goals [9]:

- Engage First Nations leaders and organizations, along with provincial and federal governments, in a movement to bolster fire safety on reserve;
- Leverage all available stakeholders and partners, including media and First Nation people themselves;
- Explore youth engagement, utilizing students of First Nations studies or First Nations youth, to act as 'ambassadors' for spreading the key messages of this campaign; and
- Create widespread multi-generational awareness among First Nations people about the importance of accepting the responsibility to install, maintain and replace working smoke alarms in their homes.

The intent of this component of the larger BC Smoke Alarm Movement was to operate on four tiers:

- Working in partnership with First Nations leadership, including key organisations such as First Nations Emergency Services (FNESS), the First Nations Leadership Council, First Nations Health Authority (FNHA), Aboriginal Firefighters Association of Canada (AFAC), First Nations Schools Association (FNSA), and the Union of BC Indian Chiefs (UBCIC);

[5] Rate ratio produced a significant difference, $Z = 1.98$, $p < .05$.

- Developing messaging building on First Nations imagery and voice principles, aligned with the ways of teaching and learning followed by First Nations people for generations,
- Producing a multifaceted suite of educational materials, including information boards, web sites, school handouts, social media postings, emails, and newsletters; and
- Sponsorship and partnership, accessing funding and in-kind contributions from agencies with capacity to create and distribute educational material, as well as securing smoke alarm donations from Kidde Canada.

These efforts were launched in October 2013 and the distribution of smoke alarms to First Nations Communities commenced immediately and as of August 2015, over 20,000 smoke alarms (intended for approximately 11,500 homes) had been distributed to 140 of BC's First Nations communities.[6] Previous process evaluation concluded that of the first 75 First Nations communities who participated, approximately 90% reported that smoke alarms were installed in community homes. Smoke alarms provided/installed were the newest generation of Kidde "Worry-Free" models that feature sensors less-likely to false alarm, and, contain sealed lithium batteries that last 10 years (the same as the alarm lifespan) without ever needing to be changed.

Analysis of the BC OFC data revealed that there are indications of improvement in risk of fatality from fire for First Nations people as a consequence of the Smoke Alarm Movement. No fatalities were recorded by the OFC after January, 2012 – keeping in mind that the movement was launched in October of that year. The relative frequency of present, functioning smoke alarms increased from 21% between 2007-11 to 24% for fires that occurred between 2012-14. This is still significantly below the rate for the rest of the province.[7] In combination these patterns emphasize two important points: first, through this targeted intervention and effort, the situation is improving, and second, there is still a great deal of room for improvement and concerted effort must be maintained.

Examination of the available information the six fire fatalities recorded in First Nations communities between 2007 and 2014 demonstrated the following:

- None of the fatalities occurred in the presence of a working smoke alarm (with non-functioning alarms present in five of the six cases, and the other fire alarm status could not be determined);
- Where the cause of death was known, all of these victims died from smoke inhalation;
- Two of the six fatalities occurred at the same fire; and
- When the condition of the casualty was known, two were asleep and one was impaired by alcohol, drugs, or medication.

The Strategies and Actions for Independent Living (SAIL) Evaluation Study

Previous research has also demonstrated that there is a particularly elevated risk of fatality from residential structure fires for older members of the community [1, 2]: findings supported by the results discussed, above. Given these patterns, another key motivation of the BC Smoke Alarm Movement was to work in partnership with available agencies to increase smoke alarm coverage and reduce residential fire risks for the elderly in BC.

[6] See http://fness.bc.ca/fire/smoke-alarm-campaign/

[7] Significant difference in the rate ratio: $Z = -2.01$, $p < .05$.

As part of a targeted initiative to achieve this goal, the Strategies and Actions for Independent Living (SAIL) evaluation study commenced in 2012.[8] For the most part, this study was focused on assessing the fall risk for home care clients, who are at particularly high risk for falls and related injuries by virtue of their degree of frailty, lack of independent mobility and presence of multiple chronic conditions. The objective of this study was to determine the impact, cost effectiveness, and sustainability of SAIL program, and the sub component of the SAIL program – the Home Activity Program (HAP), as strategies for reducing falls and their consequences among home care clients. The SAIL interventions included staff training, fall and injury surveillance, individualized client prevention plans, and a Home Activity Program. This study was designed to fill a gap in the current evidence regarding how to best support Community Care decision-makers in making informed choices about implementing a fall prevention program for home support clients.

The study incorporated a three-arm, non-randomized intervention design, with 950 clients contacted through Home Care offices in the Fraser Health (FH) and Vancouver Coastal Health (VCH) Authorities. One arm received the full SAIL program, another arm received the SAIL Home Activity Program (HAP) alone, and a third arm served as the control with routine home support service delivery.

The participants were older adults over the age of 65 living in the community and receiving regular home care from the local health authorities.[9] Recruitment was targeted for community dwelling adults who receive active, publically funded long term care-home support (LTC-HS) service, a completed Resident Assessment Instrument for Home Care (RAI_HC) within 24 months and could ambulate with or without a mobility aid. Participants were collected over a 9-month period and were followed and measured for a time period of one year or greater. In addition to collecting a range of mobility, fall-risk, and frailty measures, participants in all groups were offered a free smoke alarm[10] and calendar magnets as incentives to adhere to the health promotion program/fall prevention program. Baseline assessments commenced between January 2013 and September 2013. The 6-month follow-up questionnaire was administered between July 2013 and May 2014. The final (12-month) follow-up questionnaire commenced in January 2014 and concluded in October 2014. Working in partnership with the Surrey Fire Service, a questionnaire was developed to collect smoke alarm information at all of these instances, covering the following areas:

- At the initial contact, participants were asked about
    (a) The number, age, and location of smoke alarms and type of dwelling;
    (b) Whose responsibility it was to ensure smoke alarm was working;
    (c) If smoke alarms were checked at least once per year; and
    (d) The type of housing they live in.

[8] See the Acknowledgements section of this paper for the list of SAIL Team members and the sources of funding and material support for this project.

[9] Ineligible criteria included cognitive impairment if identified by the health authority staff and if a family member was unavailable or unwilling to assist with proxy consent or the research procedures. Other exclusions included receiving home support from a contracted out private agency, regular home support services on hold, and may or may not be limited to: blind, deaf, communicable or infectious disease.

[10] To receive a free smoke alarm, clients would call the number on the coupon. The original number was a long distance number (1-250-920-3365) to Victoria News. This information was passed on to the local fire service responsible for the area that the resident lived in. The local fire department would then set up an appointment with the client to install the free smoke alarm and at the same time do a fire safety home inspection.

- At the follow up assessments, in addition to the original questions, participants were also asked questions regarding:
    (e) The utility of the fire safety resources provided at the initial assessment;
    (f) Whether they had redeemed the free smoke alarm; and
    (g) Whether they had made any additional changes to increase fire safety.

Through this process, initial contact was made with 950 participants. With respect to smoke alarms and fire safety, this initial visit displayed the following patterns:

- Almost all home support clients had a smoke alarm (96%);[11]
- Most home support clients only had one alarm (67%);
- Most home support clients did not know how old the alarm was (48%);
- When clients did know the alarm age, 15% of alarms are over 10 years old; and
- For those properties with alarms at the initial visit, 19% of alarms had no light visible to show the alarm was working.

To test the influence of the education component of the initial visit, the 617 who were involved in a follow-up assessment were compared on a number of fire safety items. The key patterns are identified in Table 5. This table demonstrates significant increases in the percentage of clients who were undertaking ongoing smoke alarm maintenance and a significant reduction in the percentage of clients who indicated they did not know who was responsible for checking the functionality of their smoke alarms.

TABLE 5. RESPONSES TO FIRE SAFETY QUESTIONS AT INITIAL VISIT (N = 913) AND FOLLOW-UP VISIT (N = 617) FOR SAIL PROGRAM PARTICIPANTS

Fire safety question	Response options	Initial visit (n = 913)	Follow-up visit (n = 617)
Responsibility to maintain smoke alarm	Occupant	15%	12%
	Family/friend	9%	18%
	Building manager/strata	34%	43%
	Fire department	7%	13%
	No one	2%	6%
	Do not know/missing	33%	6%
Ongoing smoke alarm maintenance	Replace batteries at least once a year	41%	71%
	Look at power light at least once a year	42%	74%
	Test button for 'beep' at least once a year	44%	74%

With respect to other elements of the SAIL initiative, clients were also offered the opportunity to have someone from their local fire service to visit their house and install a free smoke alarm. At the initial visit, 681 of the clients indicated that they did want someone from the local fire service to install an alarm and 8% of these clients redeemed their free smoke alarm coupon by the time of the follow-up visit. In addition to this, at the time of follow-up assessments, almost 20% of the participants indicated that in addition to installing and monitoring their smoke alarms they had made changes to increase their fire safety. The most common

[11] Of the 37 clients who did not have a smoke alarm installed when they were visited at the baseline stage of this study, 2 redeemed the coupon offering a free, installed alarm, 21 clients did not redeem the coupon, 13 clients were withdrew from participating in the study before the follow-up interview, and the status of 1 client was unknown.

changes that were made include purchasing a fire extinguisher (17% of the participants who had made additional improvements), developing an emergency/evacuation plan (13%), and undertaking fire drills (9%).

Carbon Monoxide: A Potential Addition to the BC Movement

In addition to continuing to prioritise the fire safety of the elderly and BC's First Nations communities, it is worth exploring the benefits of expanding the scope of the Smoke Alarm Movement to incorporate carbon monoxide (CO) alarms. Recent amendments to the Ontario *Fire Protection and Prevention Act, 1997*, have mandated that CO are installed in all residences with a fuel-burning appliance or an attached garage. This objective was supported by the National Fire Protection Association, the Fire Fighters Association of Ontario, members of the medical community, and carbon monoxide survivor groups and their families.

Centre for Disease Control (CDC) statistics indicate that in the US between 1999 and 2010, 5,149 deaths resulted from unintentional CO poisoning, at an average of 430 deaths per year [10]. The average annual death rate from CO poisoning is three times higher for males than females (0.22 per 100,000 people, compared to 0.07 per 100,000). As with fire-related fatalities discussed previously, the death rates from CO poisoning were highest among those aged 65 years and over.[12]

Although CO alarms do not eliminate the need to maintain and use fuel-burning appliances in a safe manner, installing and maintaining CO alarms is a key step to reducing the risks that lead to unintentional CO poisoning. CO alarms have the potential to provide early warning about CO exposure, without which people are unable to detect concentrations of CO as this gas has no colour, odour, or taste.

It is unclear from available data the extent to which CO is influence injury and death in BC. Extrapolating the CDC statistics for US-rates to the BC population of approximately 4.631 million, it is anticipated that approximately 10 males and 3 females would die each year from CO poisoning, with the highest rates for these being citizens aged 65 years and above. To some idea of the current geographic distribution of CO poisoning in BC, Figure 9 and Figure 10, show the relative frequencies of hospitalization and death from CO poisoning in recent times. To this extent, given the overlap with the high-risk members of the community for fire-related death in the absence of working smoke alarms, it would be worth considering whether the BC Smoke Alarm Movement should be expanded to include CO alarm coverage.

[12] The CDC defines unintentional, non–fire-related carbon monoxide poisoning is defined both as 1) accidental poisoning by and exposure to gases or vapors (code X47) listed as the underlying cause, and 2) toxic effect of carbon monoxide (code T58) listed as the contributing cause, according to the International Classification of Diseases, 10th Revision. All deaths caused by intentional exposure (X67), exposure of undetermined intent (Y17), or fire-related exposure to carbon monoxide (codes X00–X09, X76, X97, and Y26) were excluded.

FIGURE 9. HOSPITALIZATIONS FROM CO POISONING (OCCURRENCE AT HOME) BY LOCAL HEALTH AUTHORITY, BC 2001-2011

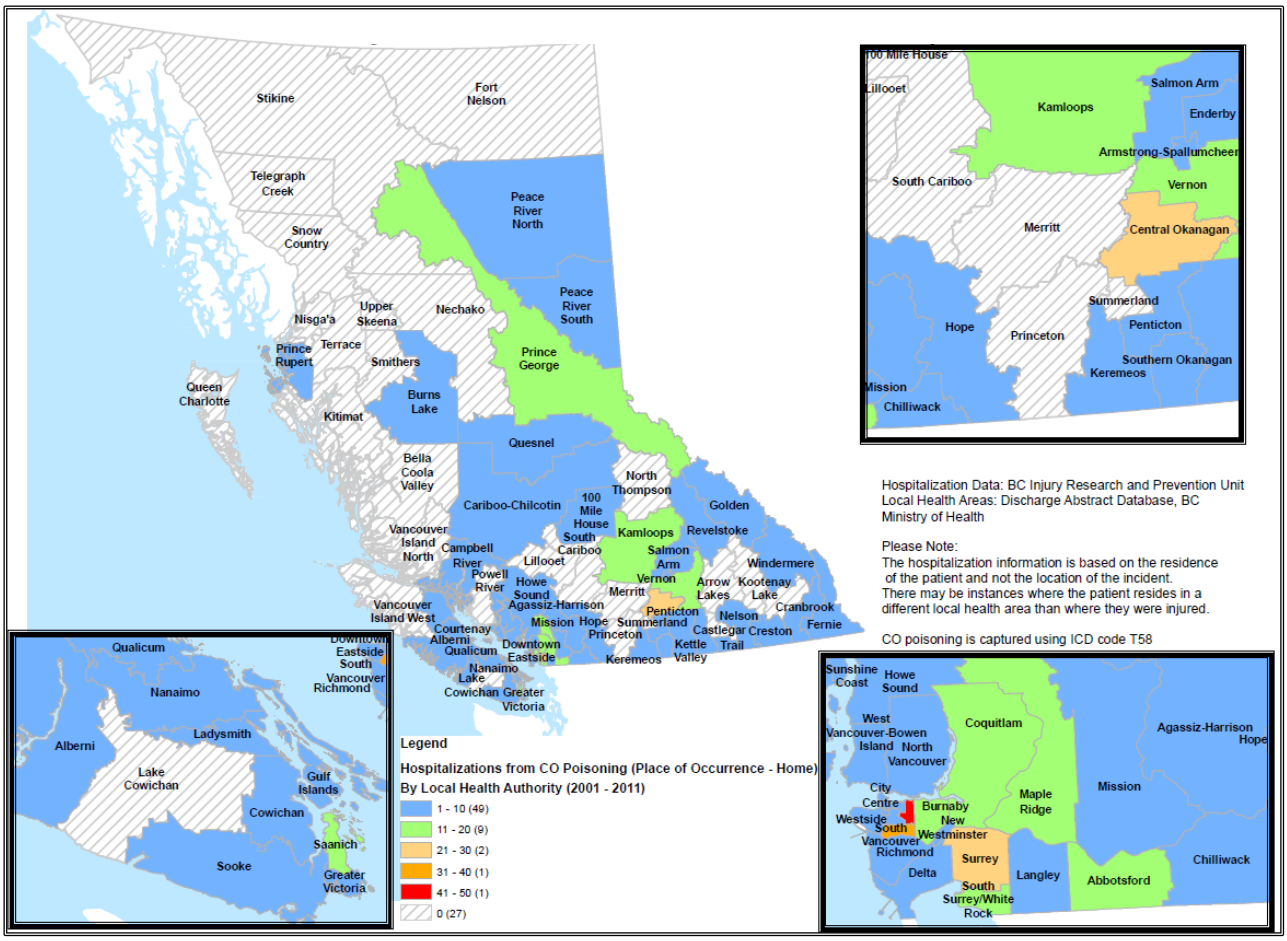
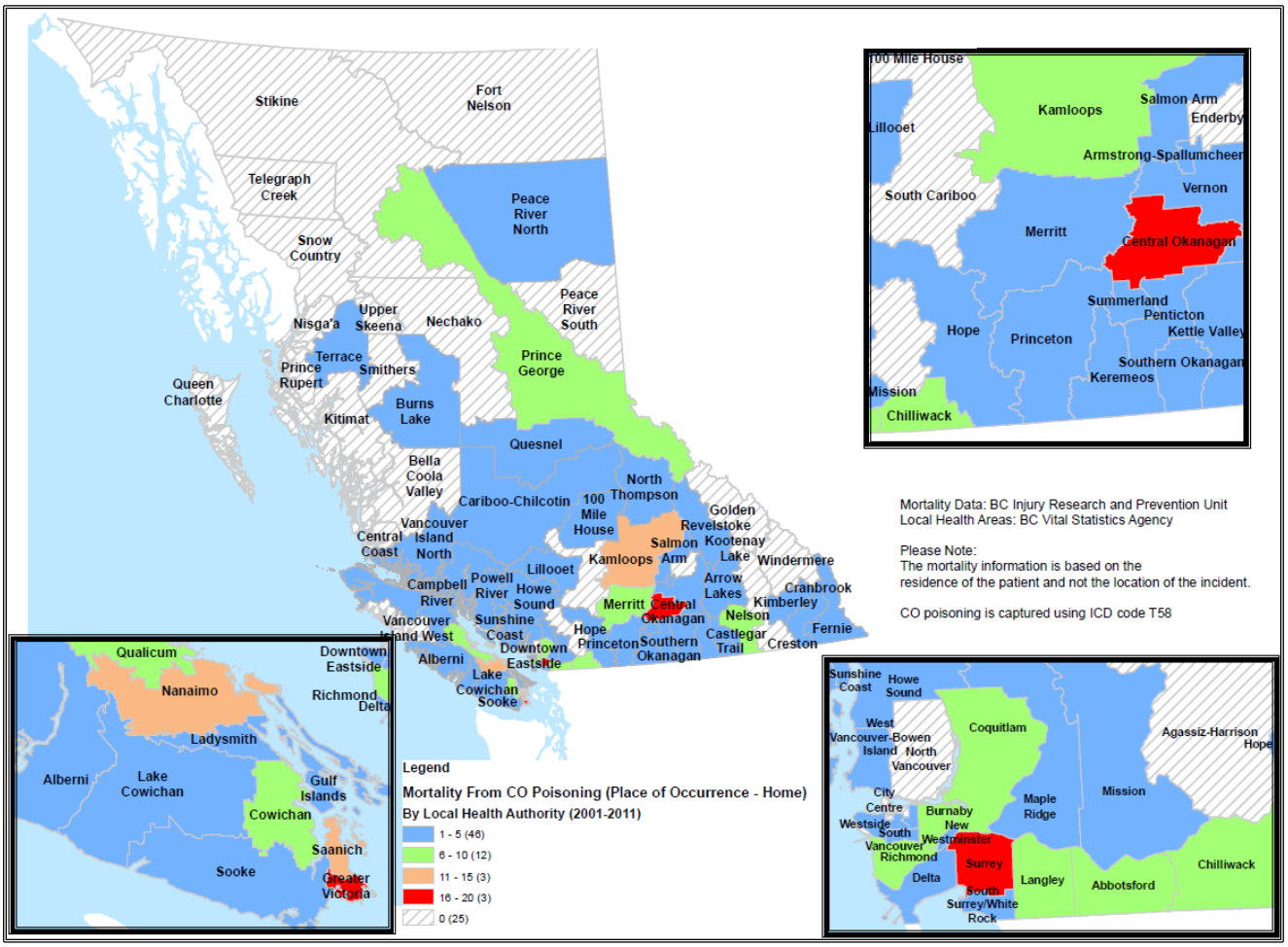


FIGURE 10. MORTALITY FROM CO POISONING (OCCURRENCE AT HOME), BY LOCAL HEALTH AUTHORITY, BC 2001-2011



Discussion and Conclusions

Consistent with the findings of other research in this area, smoke alarms have been demonstrated to save lives and reduce fire-related fatality in BC. As before, the fatality information analysed here produced patterns consistent with previous research about high-risk sections of the community, with respect to age and substance use, and also demonstrated some qualitative differences between reasons why victims died in the presence and absence of a functioning smoke alarm.

Responding to the challenge that was set in 2012, it can also be seen that the initial findings with respect to smoke alarms in BC are very positive. Research has shown that it is possible to increase the likelihood of residential properties possessing a functioning smoke alarm in the event of a fire through targeted intervention and inter-agency collaboration. The findings displayed in this report make it clear that things have improved in BC as a consequence of the Smoke Alarm Movement. Residential structure fires have declined, the rate of working smoke alarms has increased, and there have been significantly fewer fire-related fatalities.

There is a lot of variation in the extent to which the coverage of working smoke alarms has improved across the province. As suggested in the 2012 report, given the broad range of potential approaches to maximizing the likelihood of dwellings possessing present, functioning smoke alarms, the authors pose the challenge to those in positions of authority to ensure that smoke alarm presence and functionality is monitored in a comprehensive, consistent, ongoing manner. Every community is capable of taking up this challenge, utilizing a context-specific, appropriate methodology. Given the evidence and strategies available, there are no excuses for failing to address this issue.

The findings with respect to First Nations communities are very encouraging, but can be enhanced moving forward. Roughly three-quarters of the First Nations communities in BC have participated in this program so far. Centralising the data collection across communities and accessing the communities which have not participated to date should be a priority, particularly if there are communities that the BC OFC data shows have experienced fires and have not currently opted to participate in the smoke alarm delivery program. Further to this, ensuring the alarms that have been installed are checked regularly and replaced every 10 years, whether hardwired or battery powered, is crucial to the sustainability of this approach.

The combination of a smoke alarm awareness initiative with the delivery of other in-home health promotion services looks very positive, with these findings highlighting the scope for inter-agency partnership and the benefits of fire safety education. The trend that older citizens are even more likely to die in the event of a fire when their smoke alarm is working is one worthy of additional action, particularly in light of research that demonstrates the risk for older people living alone can be significantly influenced by hearing loss and insufficient cognitive awareness about the need to install and maintain smoke alarms.

It is worth concluding this paper by emphasizing that it is a fact that smoke alarm functionality deteriorates with time due to airborne contaminants and so they must be replaced every 10 years, and second, it is possible to increase the likelihood of residential properties possessing a functioning smoke alarm in the event of a fire. The key to consolidating the successes of smoke alarm installation campaigns is to ensure their longevity. Support for smoke alarm installation and functionality strategies is often unsustained, resulting in diminishing positive impacts of programs over time stemming from a loss of funding. In some ways these programs can become victims of their own success, whereby success drops perceived demand, ignoring the findings from the research discussed, previously, about the diminishing effectiveness of smoke alarms with time. To ensure long-term, ongoing change, the holistic governmental commitment that has been displayed so far must continue, operating in an iterative manner to address smoke alarm functionality. Now is the time to work harder and continue to build on this initial success.

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