Residential Fire Injury and Death Rates in British Columbia

A Statistical Analysis Pre and Post 1975

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January 2018

UNIVERSITY OF THE FRASER VALLEY
SCHOOL OF CRIMINOLOGY & CRIMINAL JUSTICE

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Executive Summary

- This research note focuses on the risk that older homes and those living in them face from fires and assesses whether there is a greater risk of fire-related deaths and injuries for those living in homes built before 1975 compared to those built after 1975.
- This data for this research note is derived from 39,724 residential fire incidents reported to the British Columbia Office of the Fire Commissioner (OFC) between 1988 and 2016.
- Of the 39,724 fires, 40.1% occurred in structures built before 1975, and 59.9% were in structures built in 1975 or later.
- During the periods under consideration, there were a total of 4,023 reported injuries and 490 deaths.
- 98.1% of all deaths related to a fire in a building constructed prior to 1975 had no sprinkler system compared to 95.3% of fire-related deaths in building constructed in 1975 or later.
- 37.9% of all injuries occurred in buildings constructed prior to 1975 had no smoke alarm, the proportion was 26.9% for buildings constructed in 1975 or after.
- 38.5% of all deaths related to a fire in a building constructed prior to 1975 had no smoke alarm compared to 36.5% of fire-related deaths in buildings constructed in 1975 or later.
- When there were complete sprinkler protection systems, the injury rate in buildings constructed prior to 1975 was 17.8% higher than in buildings built in 1975 or later, the injury rate in buildings without sprinkler protection was 5.6% higher, and the overall injury rate was 7.3% higher in building constructed prior to 1975.
- The death rates from fires in buildings constructed in 1975 or later were lower for both buildings with partial sprinkler protection (-27.1%) and no sprinkler protection (-38.7%).
- The injury rate in buildings without a smoke detection installed was 7.9% higher in buildings constructed prior to 1975.
- For fires that occurred in buildings with a complete sprinkler system and the smoke alarm was activated had a death rate of 2.7. If the building did not have a complete sprinkler system and also did not have a smoke alarm installed, the death rate was 15.8, an increase of 485.2%.
- For all buildings, the most common causes of fires were human failing, mechanical or electrical failure or malfunction, and incendiary fires.
- The injury rate for human failing fires was 6.5% higher, for mechanical or electrical failure or malfunction, the injury rate was 20.8% higher, and the injury rate was 15.5% higher for incendiary fires in buildings constructed before 1975 compared to those built in 1975 or later.
- The death rate for human failing fires was 31.9% higher, it was 56.5% higher for mechanical or electrical failure or malfunction fires, and it was 45.3% higher for incendiary fires in buildings constructed before 1975 compared to those built in 1975 or later.
- The data points to the need for fire services and municipal governments to increase their fire prevention efforts and communication strategies, especially in those areas and communities that have many buildings constructed prior to 1975 to ensure that all residents are aware of the

risks, and take the necessary steps to ensure that they have functioning smoke alarms and fire suppression devices.

Introduction

With routine changes to building codes, the use of educational campaigns, and the technological advancements associated with smoke and fire detectors and alarms, it is much more common nowadays for homes to have functioning smoke and fire detectors, alarms, and suppression systems. However, this was not always the case for homes built decades ago. Given this, this research note focuses on the risk that older homes and those living in them face from fires and assesses whether there is a greater risk of fire-related deaths and injuries for those living in homes built before 1975 compared to those built after 1975.

Building standards have changed over time to address the advancements made in fire safety science, which has included the use of different building materials and construction techniques in both residential and commercial structures. Among fire safety professionals and insurance industry experts, 1975 is typically identified as a watershed year in terms of this trend. Despite building code changes relating to construction techniques and materials, the primary mechanisms for trying to prevent injuries and deaths due to fires remain sprinkler systems and smoke alarms.

Currently, in British Columbia, sprinklers are mandated in residential buildings that are four storeys and higher, and in office buildings that are more than six storeys. Since the mid-1990s, sprinklers have been required in all care facilities, regardless of height. Residential structures under four stories are not required to have sprinklers, and, except in instances of major renovations, some older buildings above that level do not have retrofitted sprinkler systems.

Smoke alarms were partially mandated by the British Columbia Building Code in 1979. While the BC Fire Code required smoke alarms in all existing hotels and public buildings, it did not require them in private homes until 2010. The installation of a smoke alarm is relatively simple, and, while units hard-wired into the building are preferred, battery-operated units have been installed in a significant proportion of both older and newer structures.

This research note examines the effect that these safety features have had on fire-related injuries and deaths. This note focuses on the differential rates of injuries and deaths across different types of structures built before or after 1975 based on the existence of sprinkler protection or smoke alarms to argue that more attention must be placed on ensuring that older residences and buildings have functioning smoke alarms, as this will reduce injuries, fatalities, and structural damage.

Methods

This data for this research note is derived from 39,724 residential fire incidents reported to the British Columbia Office of the Fire Commissioner (OFC) between 1988 and 2016.

Of the 39,724 fires, 15,943 (40.1 per cent) occurred in structures built before 1975, while the other 23,781 fires (59.9 per cent) were in structures built in 1975 or later. During the periods under consideration, there were a total of 4,023 reported injuries and 490 deaths.

The analyses in this research note combines all available records from the BC OFC using PC code 3100 – Residential – row, garden, town housing, condominium, 3400 – Residential – single detached, and 3500 – Residential, duplex, 3-plex, 4-plex. Moreover, all data was removed where the area that the fire originated from could not be determined or if there were multiple areas of origin, and all data was removed where the sprinkler protection code indicated that the fire involved a vehicle or an outside area. Finally, all data in which it was not possible to determine what year the fire occurred in was also removed from the analysis.

Data Analysis

As demonstrated in Table 1, when considering the raw number of fire incidents, injuries, and deaths before 1975 compared to in 1975 and onward, based on whether the building had some form of sprinkler protection system present and active, there was a slightly greater proportion of both injuries and deaths in buildings that were built prior to 1975 compared to after 1975. More specifically, of the 15,943 fires in building built prior to 1975, 10.6% resulted in some injury and 1.6% resulted in someone dying.

For building constructed in 1975 or after, 9.8% of the fires resulted in an injury and 1% resulted in a death. Of note, these differences, even though they are small in number, could be the result of the finding that, in buildings constructed prior to 1975, 94.2% of the fires examined for this research note occurred in constructions that did not have any sprinkler protection, compared to the buildings constructed after 1975 (90.3 per cent). Moreover, of all of the injuries that occurred in fires in building constructed prior to 1975, 96.3% occurred in buildings with no sprinkler protection (see Table 1). In buildings built in 1975 or after, this proportion dropped to slightly to 93.9%.

In the buildings constructed before 1975 with complete sprinkler systems, there were no deaths reported, and only one death was reported in fires where the building was constructed in 1975 or later. Few deaths were also registered where there was partial sprinkler protection, with three being reported in buildings constructed prior to 1975 and four reported in buildings constructed in 1975 or later. Having no sprinkler protection, however, was associated with 252 deaths in the buildings constructed prior to 1975 and 222 deaths in the post 1974 constructed buildings.

Therefore, while it is evident that an installed sprinkler system had a small effect on reducing injuries, it had an overwhelming impact on reducing deaths. In effect, 98.1% of all deaths related to a fire in a building constructed prior to 1975 had no sprinkler system, which was a slightly higher proportion than the proportion of fire-related deaths in building constructed in 1975 or later (95.3

per cent). In a relatively small number of instances (3.3 per cent for building constructed prior to 1975 and 2.6 per cent for building built in 1975 or later), it was not possible to determine the functional status of the protective equipment in the building that suffered a fire.

TABLE 1: TOTAL FIRES, DEATHS, AND INJURIES IN BUILDINGS BUILT BEFORE AND AFTER 1975 CONSIDERING SPRINKLER SYSTEM

	Before 1975			1975 Onward		
	Total # of Fires	Injuries	Deaths	Total # of Fires	Injuries	Deaths
Complete Sprinkler Protection	**165**	**13**	**-**	**1,158**	**75**	**1**
		7.9%	0.0%		6.5%	0.1%
Partial Sprinkler Protection	**209**	**29**	**3**	**380**	**33**	**4**
		13.9%	1.4%		8.7%	1.1%
Sprinkler Protection - Unclassified	**28**	**6**	**-**	**146**	**13**	**-**
		21.4%	0.0%		8.9%	0.0%
No Sprinkler Protection	**15,019**	**1,625**	**252**	**21,474**	**2,192**	**222**
		10.8%	1.7%		10.2%	1.0%
Cannot be Determined	**522**	**15**	**2**	**623**	**22**	**6**
		2.9%	0.4%		3.5%	1.0%
Total	**15,943**	**1,688**	**257**	**23,781**	**2,335**	**233**
		10.6%	1.6%		9.8%	1.0%

Table 2 presents similar data, but considers the presence of a smoke alarm in the building. Similar to the findings above, when considering all of the fires that occurred in buildings built before 1975, one-third did not have a smoke alarm installed. This proportion dropped to 23.9% for building constructed in 1975 or later. This lends further support for the notion that it is important for communities to ensure that all older buildings have a functioning smoke alarm.

Moreover, of all of the injuries that occurred in fires in buildings constructed prior to 1975, 37.9% occurred in buildings with no smoke alarm, while another 18.4% occurred in buildings in which the smoke alarm did not activate. In buildings built in 1975 or after, this proportion dropped to 26.9% where there was no smoke alarm, and was similar to the pre-1975 finding at 18.3% where the smoke alarm did not activate.

With respect to deaths, 38.5% of all deaths related to a fire in a building constructed prior to 1975 had no smoke alarm, which was a slightly higher proportion than the proportion of fire-related deaths in buildings constructed in 1975 or later (36.5 per cent). Interestingly, the proportion of fires that resulted in death where there was a smoke alarm that was not activated was slightly higher in buildings built in 1975 or later (21.9 per cent) compared to buildings built before 1975 (16.0 per cent). Nonetheless, these findings again support the need to ensure that all buildings must have a functioning smoke alarm.

TABLE 2: TOTAL FIRES, DEATHS, AND INJURIES IN BUILDINGS BUILT BEFORE AND AFTER 1975 CONSIDERING SMOKE ALARM

	Before 1975			1975 Onward		
	Total # of Fires	Injuries	Deaths	Total # of Fires	Injuries	Deaths
Alarm Activated	**3,977**	**466**	**44**	**7,228**	**828**	**42**
		11.7%	1.1%		11.5%	0.6%
Alarm Not Activated	**3,238**	**311**	**41**	**4,607**	**428**	**51**
		9.6%	1.3%		9.3%	1.1%
No Smoke Alarm Installed	**5,315**	**639**	**99**	**5,680**	**629**	**85**
		12.0%	1.9%		11.1%	1.5%
Cannot be Determined / Not Applicable	**3,413**	**272**	**73**	**6,266**	**450**	**55**
		8.0%	2.1%		7.2%	0.9%
Total	**15,943**	**1,688**	**257**	**23,781**	**2,335**	**233**
		10.6%	1.6%		9.8%	1.0%

While the raw numbers of incidents provide some insight into the issue and allow for some comparisons between the two time frames, another important way to consider the data is to consider injury and death rates for the two time periods because there are considerably more fires in the 1975 and later period. Tables 3 and 4 present the data for fire-related deaths and injuries in rates per 1,000 fires.

For both buildings built prior to 1975 and for those built in 1975 or later, where complete sprinkler protection exists, both injuries and deaths were lower compared to when there was only partial protection or no protection. For the buildings constructed before 1975, the injury rate was 43.2% lower when there was complete sprinkler protection as opposed to only partial sprinkler protection. Rates of injuries were also substantially lower with complete sprinkler protection compared to where there were no sprinklers by about 27.2%. This is a substantial difference. The same pattern held true for buildings constructed in 1975 or later.

Those buildings with complete sprinkler protection had an injury rate 25.4% lower than those with only partial sprinkler protection, and 36.5% lower than buildings with no sprinkler protection. Critically, even when there were complete sprinkler protection systems, the injury rate in buildings constructed prior to 1975 was 21.6% higher than in buildings built in 1975 or later, the injury rate in buildings without sprinkler protection was 6.0% higher, and the overall injury rate was 7.8% higher in building constructed prior to 1975.

In considering the death rate data, it is important to note that the highest death rates in buildings constructed prior to 1975 were in buildings that had no sprinkler protection, followed by buildings with only partial sprinkler protection (see Table 3). Moreover, the death rates from fires in buildings constructed in 1975 or later were lower for both buildings with partial sprinkler protection (27.1 per cent) and no sprinkler protection (38.7 per cent), again pointing to the need for communities to focus on older buildings.

TABLE 3: DEATHS AND INJURIES RATES DUE TO FIRE IN BUILDINGS BUILT BEFORE AND AFTER 1975 – SPRINKLER PROTECTION

	Before 1975			1975 Onward		
	Total # of Fires	Injury Rate	Death Rate	Total # of Fires	Injury Rate	Death Rate
Complete Sprinkler Protection	165	78.8	-	1,158	64.8	0.9
Partial Sprinkler Protection	209	138.8	14.4	380	86.8	10.5
No Sprinkler Protection	15,019	108.2	16.8	21,474	102.1	10.3
Sprinkler Protection - Unclassified	28	214.3	-	146	89.0	-
Cannot be Determined	522	28.7	3.8	623	35.3	9.6
Total	15,943	105.9	16.1	23,781	98.2	9.8

While sprinklers have been mandated as potential fire suppression mechanisms in a relatively limited set of structures, smoke alarms are far more prevalent regardless of the age of the building. Also, as indicated previously, smoke alarms have been mandated in all structures in British Columbia since 2010. For both buildings built prior to 1975 and for those built in 1975 or later, both injuries and deaths were lower when there was a smoke alarm activated compared to buildings where there was no smoke alarm installed.

Interesting, for the buildings constructed before 1975, the injury rate was 22.0% higher when a smoke alarm was activated as opposed to when the smoke alarm was not activated. A possible explanation for this is that the fire was less serious in buildings that had a smoke alarm, and so the alarm did not activate. It is also possible that the smoke alarm alerted people to the fire, which they stayed to try to suppress, resulting in a higher rate of injury. Of note, rates of injuries were lower when the smoke alarm activated compared to fires in which there was no smoke alarm installed (2.5 per cent). The same pattern held true for buildings constructed in 1975 or later. Those buildings that had fires in which the smoke alarm activated had an injury rate 23.3% higher than those fires in which the smoke alarm did not activate, but an injury rate that was 3.5% lower than buildings with no smoke alarm.

When comparing the injury rates from the pre-1975 period to the 1975 and later time frame, the injury rate for fires in which a smoke alarm activated was 2.2% higher in the pre-1975 period, and the injury rate in buildings without a smoke detection installed was 7.9% higher in buildings constructed prior to 1975. Given this, it appears that, among the fires in buildings built both prior to 1975 and in 1975 and later, the presence of a smoke alarm has a slight positive effect on the rate of injuries, except for the pattern that fires in newer buildings with no smoke alarm installed resulted in substantively fewer injuries than those with functioning smoke alarms. Most likely, the lower fire-related injury incident rates in the newer buildings without smoke alarms installed is due to code-related structural differences.

In considering the death rate data, it is important to note that the highest death rate in buildings constructed prior to 1975 and in 1975 or later were in buildings without a smoke alarm installed followed by buildings with a smoke alarm that did not activate during the fire (see Table 4). Importantly, the death rates from fires in building constructed in 1975 were lower for both buildings that had a smoke alarm installed, but did not activate during the fire (12.6 per cent) and had no smoke alarm installed (19.4 per cent) again pointing to the need to pay particular attention to buildings built before 1975. Given this, the effect of smoke alarms on death rates across the two periods of construction is substantively important.

For fires in buildings constructed prior to 1975, there is a substantial difference between structures that had a smoke alarm, either activated or not, and those that had no alarm installed. In buildings constructed from 1975 onward, the overall rate of death in all instances is lower than in buildings constructed prior to 1975. It is also evident that having an active alarm further reduced the likelihood of death in a fire incident over having an inactive or no smoke alarm. Overall, this would suggest that the combination of newer construction techniques plus the existence of an active smoke alarm has a profound effect on reducing deaths related to fires.

TABLE 4: DEATHS AND INJURIES RATES DUE TO FIRE IN BUILDINGS BUILT BEFORE AND AFTER 1975 – SMOKE ALARMS

	Before 1975			1975 Onward		
	Total # of Fires	Injury Rate	Death Rate	Total # of Fires	Injury Rate	Death Rate
Alarm Activated	3,977	117.2	11.1	7,228	114.6	5.8
Alarm Not Activated	3,238	96.0	12.7	4,607	92.9	11.1
No Smoke Alarm Installed	5,315	120.2	18.6	5,680	110.7	15.0
Cannot be Determined / Not Applicable	3,413	79.7	21.4	6,266	71.8	8.8
Total	15,943	105.9	16.1	23,781	98.2	9.8

In effect, for fires that occurred in buildings with a complete sprinkler system and the smoke alarm was activated had a death rate of 2.7. By comparison, if the building did not have a complete sprinkler system and also did not have a smoke alarm installed, the death rate was 15.8, an increase of 485.2%. Since it is less common for buildings prior to 1975 to have a complete sprinkler system or a smoke detector, it is important for fire prevention programs to target these older buildings.

Another important consideration is the act or omission that was the primary cause of the fire. In building constructed prior to 1975, the leading causes of fires were human failing (32.5 per cent), mechanical or electrical failure or malfunction (13.6 per cent), and incendiary fires (12.1 per cent). These three causes resulted in 1,005 injuries or 59.5% of all injuries, and 104 deaths or 40.5% of all deaths. These were the same three leading causes of fire in building constructed in 1975 or later, with only minor changes in the distributions. Specifically, for buildings constructed in 1975 or later, human failing was the main cause of 36.4% of fires, mechanical or electrical failure or malfunction was responsible for 12.6% of fires, and incendiary fires contributed to 11.3% of fires. For these

buildings, these three causes resulted in 1,426 injuries or 61.1% of all injuries, and 99 deaths or 42.5% of all deaths.

Critically, while the distribution of causes was very similar, the injury and death rates were not. In effect, the injury rate for human failing fires was 7% higher in buildings constructed prior to 1975 than in building built in 1975 or later (see Table 5). Moreover, when considering mechanical or electrical failure or malfunction, the injury rate was 26.3% higher when the fire occurred in building constructed before 1975. Similarly, the injury rate was 18.4% higher for incendiary fires in buildings constructed before 1975 compared to those built in 1975 or later.

This same general pattern was evident when considering death rates; however, the differences were much more substantial. The death rate for human failing fires was 31.9% higher in buildings constructed prior to 1975 than in buildings built in 1975 or later, 56.5% higher for mechanical or electrical failure or malfunction fires, and 45.3% higher for incendiary fires in buildings constructed before 1975 compared to those built in 1975 or later. Of note, after human failing fires, the highest number of deaths, for both construction periods, was when the fire was the result of a misuse of the source of ignition (53 deaths in buildings constructed before 1975 and 51 deaths in buildings constructed in 1975 or later). Again, the data presented in Table 5 points to the importance of ensuring that fire prevention education and strategies focus on buildings constructed prior to 1975.

TABLE 5: NUMBER OF FIRES, AND DEATH AND INJURY RATES BY ACT OR OMISSION

	Before 1975			1975 Onward		
	Total # of Fires	Injury Rate	Death Rate	Total # of Fires	Injury Rate	Death Rate
Incendiary Fires	1,937	77.4	15.0	2,692	65.4	8.2
Misuse of Source of Ignition	1,674	148.1	31.7	2,377	119.9	21.5
Misuse of Material Ignited	831	163.7	4.8	1,381	141.9	0.7
Mechanical/Electrical Failure or Malfunction	2,165	83.6	6.9	3,008	66.2	3.0
Construction Design or Installation Deficiency	837	37.0	8.4	1,093	37.5	11.9
Misuse of Equipment	725	17.9	2.8	801	21.2	-
Human Failing	5,188	129.9	11.6	8,658	121.4	7.9
Vehicle Accident	5	-	-	20	-	-
Miscellaneous Act or Omission	268	74.6	3.7	440	97.7	6.8
Cannot be Determined or Not Applicable	2,313	101.6	37.2	3,311	98.8	19.9
Total	15,943	105.9	16.1	23,781	98.2	9.8

Conclusion

This research note examined the effects of sprinkler systems and smoke alarms on the incidence of injuries and deaths in buildings constructed prior to 1975 and from 1975 onward. While it is clear that the presence of a complete sprinkler system and an installed and functioning smoke alarm can reduce the rates of injuries and deaths resulting from a fire, another critical finding is that rates of injuries and deaths are higher (7.3 per cent and 39.1 per cent) in buildings constructed prior to 1975 when compared to those built in 1975 or later.

Moreover, buildings constructed in 1975 and later, in addition to the benefits of enhanced building codes, building materials, and safety requirements, also had a greater proportion of installed sprinkler systems (+79.6 per cent) and smoke alarms (+18.1 per cent). All of this points to the need for fire services and municipal governments to increase their fire prevention efforts and communication strategies, especially in those areas and communities that have many buildings constructed prior to 1975 to ensure that all residents are aware of the risks, and take the necessary steps to ensure that they have functioning smoke alarms and fire suppression devices.

Undertaking these steps will result in a reduction in the number of injuries and deaths if a fire were to occur in these older buildings.

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Acknowledgements

Special thanks to Gordon Anderson, BC Fire Commissioner, for the provision of the BC data discussed in this report.

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