Fire Risk in Senior Population

Analysis of Canadian Fire Incidents

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Executive Summary

- According to provincial and territorial annual fire statistics, the senior population accounted for 40% of the fatalities between 2012 and 2016 (297 out of 696 fatalities). This proportion is consistent across jurisdictions which reported statistics publicly. Variations are found across jurisdictions in terms of the percentages of fire injuries, ranging from over 5% to 49%.
- From the National Fire Information Database, over the 10-year period 2005 to 2014, we determined that the prevalence of fire-related fatalities is the highest in the senior population with 1.33 fatalities per 100,000 population. This makes them 2.5 times more likely to have died at all fires than the adult population. The risk of fatality is even higher for seniors at structure fire events (2.8 times more likely to have died than the general population).
- Over the 10-year period, the casualty rates at structure fires have declined for both age groups (less than 65 years old and 65 years old or over). Starting in 2009, the casualty rates of the senior population pass beyond the rates of its younger peers.
- The presence of a working smoke alarm has a significant impact on fire fatalities and injuries for different populations. Seniors living at home with a working smoke alarm are 55% less likely to have died at a residential fire than those living at homes without working smoke alarm.
- Fire fatalities among seniors are expected to increase as the baby-boom population enters its senior years. Currently, there are approximately 50 fire-related deaths per year occurring in our senior population. This represents 30 percent of the annual fire-related deaths in Canada despite seniors only being 14% of the population. Without a focused effort to ensure senior residents have the appropriate operational safety equipment, the annual fire-related death rate of seniors is expected to climb to between 90 and 140 fatalities in the next 25 years.
- A reduction of fire fatalities among seniors is expected if those seniors are in 100% compliance of having a working smoke alarm. With this assumption, the expected fire-related deaths could be reduced to be between 60 and 90 fatalities per year in the next 25 years.
- Little information on fire-related fatalities among seniors can be found in the annual statistics of the Offices of Fire Marshals and Fire Commissioners despite the magnitude of fire-related fatalities among this population. Therefore, an annual report on this matter is necessary to better monitor the trends.
- The results from this study underline the importance of life-saving mechanisms and fire prevention strategies for those seniors living in the community and also draw attention to policy makers to improve access by providing them as a part of public health care coverage and services.

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Purpose of this Research

This research explores the risk of casualties (fatalities and injuries) among the senior population (aged 65 and over) in the event of a fire compared to the general population. The researchers analysed data available through the National Fire Information Database (NFID). The research also explores variations in risks of fatalities and injuries as a function of life safety systems and analyzes the action and condition of casualties at fire incidents. We then create a forecast of the expected number of casualties based on the expected growth in the senior population.

Background

In general, the population aged 65 years old or over are known to have greater mental and physical health limitations in comparison with the overall population. These limitations likely influence the chance of seniors' survival should a fire occur. Furthermore, the population in this age group will increase significantly in the coming years as the baby-boom generation starts to enter that age group. Statistics Canada predicts 25% of the Canadian population will be over 65 years old in the next 25 years compared with the current proportion of 17%[1.]

The recent Camp Fire in Paradise, California during November, 2018 is an example of how vulnerable this population can be in the event of fire. The fire was among the deadliest and most destructive wildfires in California history, and claimed 86 fatalities, 3 missing persons, and 17 injuries[2.] The Butte County Sherriff's Department reported the names and ages of 67 people who died in the fire, and over two-third of them were 65 years old or over[3].

The 2016 Fire Statistics from the USFA National Fire Data Center stated that the risk of death from fire increases significantly for the elderly. In 2016, people aged 65 or older had a risk of dying in a fire that was 2.5 times higher than for the population as a whole. The oldest adults (aged 85 or older) had a risk of dying in a fire that was 3.4 times higher than the general population[4.]

In Canada, Clare and Kelly studied the fire risk for vulnerable populations by analyzing the Canadian NFID and found that older residents (65-79 years old) are more likely die in fires with relative risk of 1.6 times higher than the overall population rate, and that residents 80 years and over had a risk 2.4 times greater than the population overall[5].

Method

The analysis starts with an exploration of both the provincial/territorial annual fire statistics that are posted on the websites of the Office of Fire Marshals and Fire Commissioners (10 provinces and 3 territories), and the National Fire Information Database (NFID).

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[1] See Reference 6
[2] See References 1, 2
[3] See Reference 1
[4] See Reference 3
[5] See Reference 4

Our research found very little information with respect to the number of casualties for Canada's senior population from the Office of Fire Marshals and Fire Commissioners annual publications. The following Table 1 shows a summary of fire casualties for various Canadian jurisdictions.

TABLE 1: SUMMARY OF STRUCTURE FIRE CASUALTIES FOR SENIOR POPULATION BY JURISDICTIONS 2012 - 2016)6

Province/Territory	Year	Number of Fires	Number of injuries	Number of Fatalities	Injuries 65 and over	Fatalities 65 and over
Ontario	2012-2016	42,504	3,740	371	395 (11%)	147 (40%)
British Columbia	2012-2016	15,114	1,014	108	500 (49%)	46 (43%)
Alberta	2012-2016	37,566	N/A		N/A	22* (NA)
Quebec	2012-2015	29,043	1,172**	210	130 (11%)	82**(40%)
Nunavut	2013-2016	395	54	7	3 (5.5%)	0 (0%)

Note: * from 2012 to 2014; ** from 2012 to 2015

The provincial and territorial annual reports demonstrate that the fatalities for the population aged 65 or above is overrepresented among deaths.

Using the NFID, the researchers found more complete and detail information for the years 2005 to 2014 inclusive. Overall, the NFID reported 439,256 fire incidents with a focus on key characteristics of structural fire incidents (e.g., fire spread and fire department intervention) as well as fire-related casualties (i.e., deaths and persons injured) resulting from those incidents. A total of 1,736 fire-related deaths (10 among firefighters) and 12,682 persons injured (3,308 among firefighters) were reported in the ten-year period. For this reason, the researchers used the NFID as a basis for their analysis.

Over the 10-year period, 56 out of every 100 fire incidents in Canada are reported as structural fires (primarily, but not limited to buildings), and 62 of those 100 structural fires occurred in residential buildings. Within the same period, structural fires claimed over 75% and 85% of fire fatalities and injuries respectively in Canada, with the majority (over 80%) taking place in residential buildings. Thus, the analysis of the NFID data focuses on the structure fires[7] and residential structure fires[8].

The NFID incident data were merged with the NFID victim data to enable the association of the victim to the fire incident. Some limitations were found in that not all jurisdictions reported the information about victims for their structure fire incidents. Only Ontario, British Columbia, and Alberta consistently reported from the years 2005 to 2014. Saskatchewan only reported the two

[6] See References 12 to 19
[7] Classified as Structure in the Property Types
[8] Classified as "Residential – row, garden, town housing, condominium:,:Residential-apartment, tenement", "Residential-single detached", "Residential-duplex, 3-plex,4-plex", "Camp site/RV Park", "Residential-with business/mercantile, up to 3 stories"

periods of 2012 and 2013. As a result, only the population rates from those three jurisdictions were used to forecast the national number of fatalities.

Population data from Statistics Canada have been used to estimate the expected populations for each jurisdiction. The population rate will be used as denominator to calculate the rates of casualties, fatalities, and injuries. Finally, the study creates a forecast of potential fire fatalities among the senior population based on the expected increase in this age group.

Fire Casualties in Canada (2005 -2014)

The NFID data from 2005 to 2014 records that senior citizens (65 years old and over) represented 30% and 8% of total fire-related fatalities and injuries at all fire incidents (see Table 2).

TABLE 2: SUMMARY OF FIRE FATALITY AND INJURY AT ALL FIRES BY AGE GROUPS, 4 JURISDICTIONS, 2005 TO 2014 (5)

	Children		Youth		Adults		Senior Citizens	
	number	percent	number	percent	number	percent	number	percent
Fatality	124	8.2%	32	2.1%	912	60.3%	444	29.4%
Injury	740	6.5%	516	4.6%	9151	80.7%	933	8.2%

NOTE:
1. Four jurisdictions provided 10 years of casualty data: Ontario, British Columbia, Alberta, and Manitoba.
2. Children (11 years old and under), Youth (12 – 17 years old), Adults (18-64 years old), senior citizens (65 years old and over).

Table 3 presents fire-related fatality and injury rates for specific age-population groups. Detail analyses by multiple years are presented in Tables 10 and 11 in AppendixA.

TABLE 3: SUMMARY OF FIRE FATALITY AND INJURY RATES AT ALL FIRES BY AGE GROUPS, 4 JURISDICTIONS, 2005 TO 2014 (5)

	Children		Youth		Adults		Senior Citizens	
	number	rate	number	rate	number	rate	number	rate
Fatality	124	3.8	32	1.7	912	5.8	444	13.3
Injury	740	22.8	516	28	9151	57.9	933	27.9

NOTE:
1. Four jurisdictions provided 10 years of casualty data: Ontario, British Columbia, Alberta, and Manitoba.
2. Children (11 years old and under), Youth (12 – 17 years old), Adults (18-64 years old), senior citizens (65 years old and over).
3. Rates are calculated on the basis of 100,000 population.

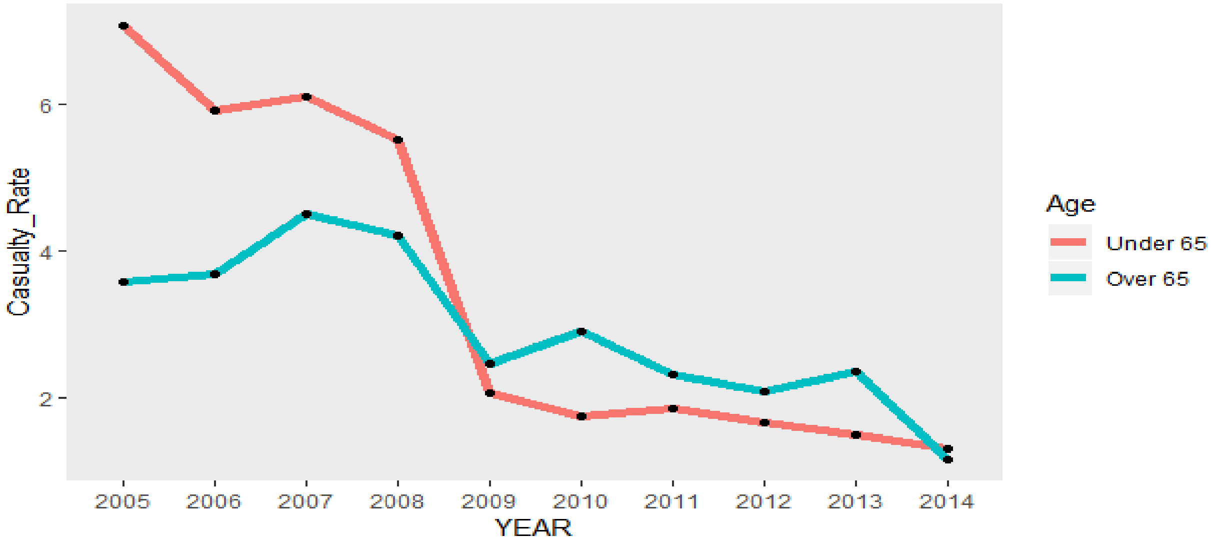
Table 3 demonstrates that the fatality rates of senior citizens surpasses the fatality rates of other age groups. It shows that the seniors are between 2 and 8 times more likely to die in fires relative to other age groups. Nonetheless, the likelihood of getting injured at fires for seniors is similar to that of youth with 2.8 injuries per 100,000 population.

This preliminary review of the NFID data show a higher fatality and injury risk among senior citizens compared with other population age-groups should fires occur. With these observations in mind, there is clearly a need to further explore the fire-related fatality and injury of senior citizens.

Casualties at Structure Fires

Figure 1 shows the number of casualties (combination of fatalities and injuries) per 100,000 population at any structure fires.

FIGURE 1: STRUCTURE FIRE RELATED CASUALTY (DEATH AND INJURY) RATES BY AGE GROUP OF UNDER 65 VS OVER 65



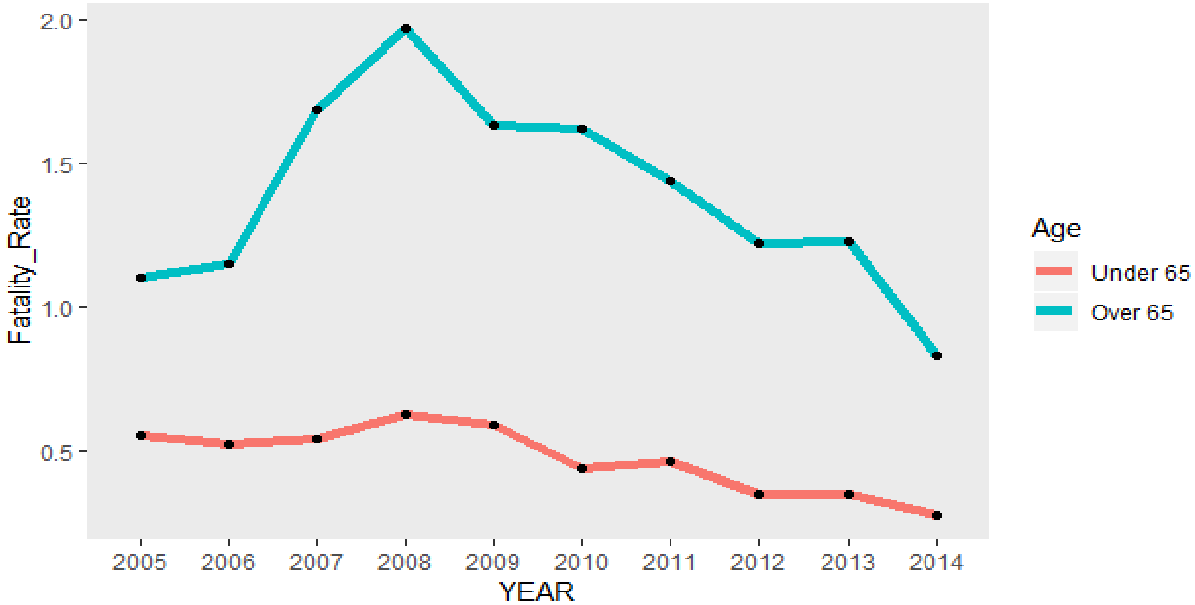
Note:
Ontario, BC, and Alberta provided data from 2005 to 2014
Saskatchewan provided data from 2012 and 2013

Among the key conclusions we can draw from Figure 1 are that: over the 10-year time period (2005-2014), the casualty rates for both age groups (less than 65 and 65 or over) at any structure fires showed a declining trend with a significant drop occurring in 2009. Furthermore, the casualty rate for the age group of less than 65 years old is significantly higher than for the senior population until 2008. From 2009 onwards, the casualty rates for the younger population reversed and became lower than for the older population until 2014, where there seems to be no difference between both groups.

Fatalities at Structure Fires

Figure 2 presents the number of fatalities per 100,000 population at structure fires.

FIGURE 2: STRUCTURE FIRE RELATED FATALITY RATES BY AGE GROUP OF UNDER 65 VS OVER 65



Note:
Ontario, BC, and Alberta provided data from 2005 to 2014
Saskatchewan provided data from 2012 and 2013

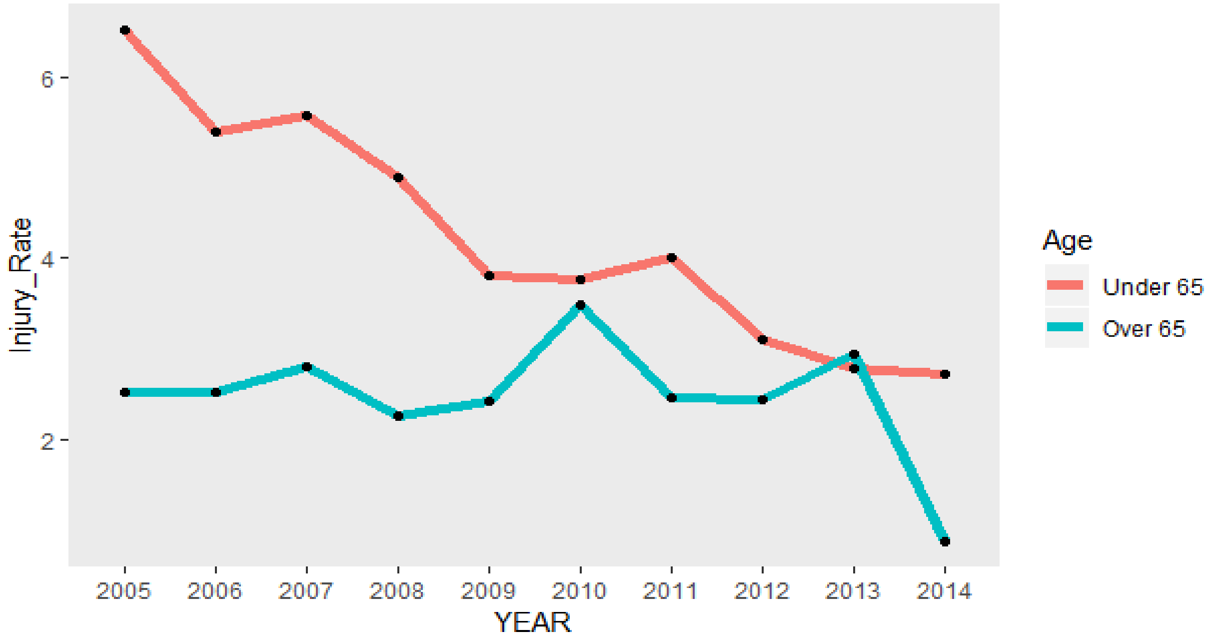
Here, we can see that the trend of fatality rates over the 10-year period shows the significant difference between the fatality rates of senior population and the rates of population less than 65 years old. Nonetheless, there is a declining trend of fatalities for the senior population starting from 2008. It is also the case that seniors are 2.8 more likely to have died at structural fires than those under 65 years old (see Table 13 in AppendixC). A test of statistical inference also indicates that this relative risk is statistically significant[9].

[9] t = 7.91, p-value = 1.75 e-06

Injuries at Structure Fires

Figure 3 presents the number of injuries per 100,000 population at structure fires.

FIGURE 3: STRUCTURE FIRE RELATED INJURY RATES BY AGE GROUP OF UNDER 65 VS OVER 65



Note:
Ontario, BC, and Alberta provided data from 2005 to 2014
Saskatchewan provided data from 2012 and 2013

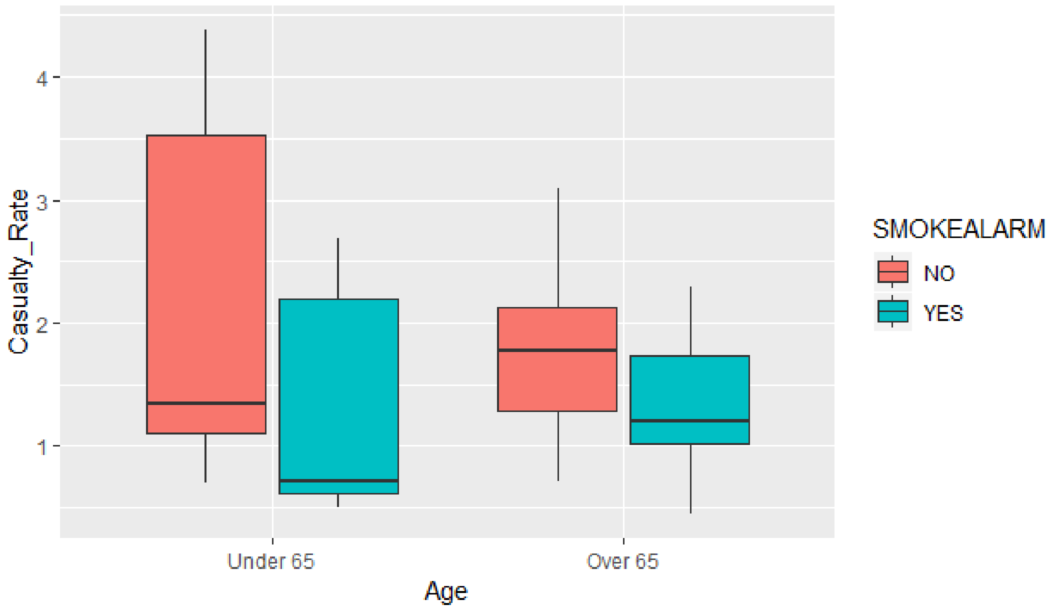
From Figure 3 it can be seen that the injury rates for the senior population do not seem to be declining except for the last year (2014). On the other hand, injury rates for the population less than 65 years old declined by half, from over 6 injuries per 100,000 population in 2005 to around 3 injuries per 100,000 population in 2014. Furthermore, those aged over 65 years old are 1.9 less likely to get injured at structure fires than their peer of under 65 years old (see Table 14 in Appendix C).

Impact of Smoke Alarm on Fire-related Casualties, Fatalities & Injuries

IMPACT OF SMOKE ALARMS ON CASUALTY RATES AT RESIDENTIAL FIRES

The following analyses focus on the impact of life safety systems, such as smoke alarms, on casualties among the senior population at the event of residential fires.

FIGURE 4: DISTRIBUTION OF CASUALTY (DEATH AND INJURY) RATES BY AGE GROUP AT THE PRESENCE OF WORKING SMOKE ALARM



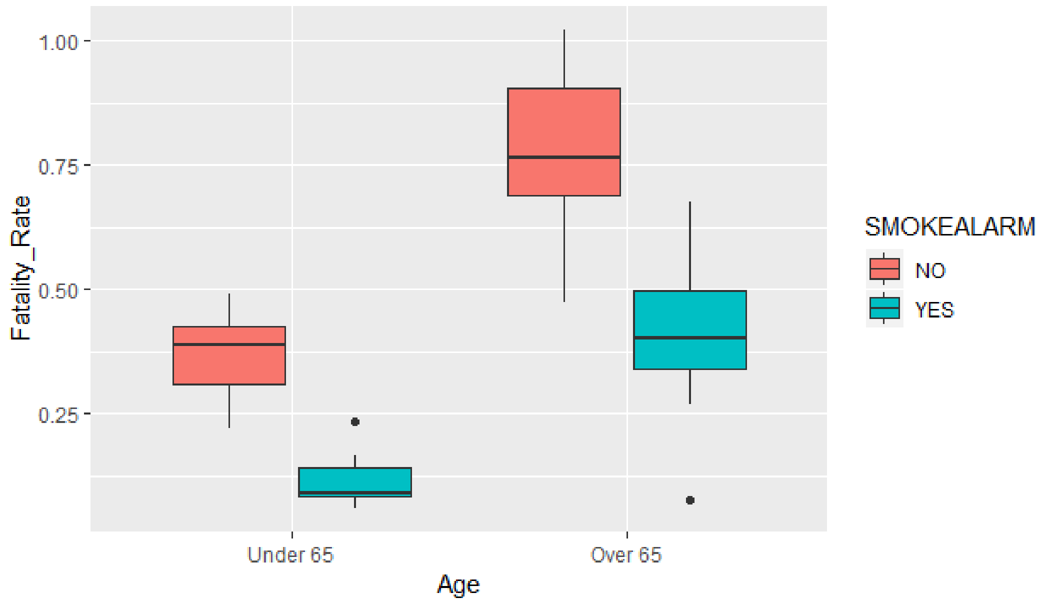
Note:
Ontario, BC, and Alberta provided data from 2005 to 2014
Saskatchewan provided data from 2012 and 2013

As Figure 4 indicates, the casualties at fires for those living in residential buildings without working smoke alarm seem to be higher than those with the presence of a working smoke alarm. This trend is consistent in both age groups. Nonetheless, the statistical tests suggest that the differences are not statistically significant with p-values of 0.18 and 0.06 for cohort 65 years old or above, and less than 65 years old respectively. Figure 4 also indicates that seniors living at homes without a working smoke alarm are 1.2 more likely to be among casualties than those living with working smoke alarm (see Table 15 in Appendix D). Nonetheless, there is no significant difference statistically between those two groups.

IMPACT OF SMOKE ALARM ON FATALITY RATES AT RESIDENTIAL FIRES

Figure 5 focuses on the impact of working smoke alarms on the fatality rates of the senior population in the event of residential fires.

FIGURE 5: FATALITY RATES WITH OR WITHOUT SMOKE ALARM



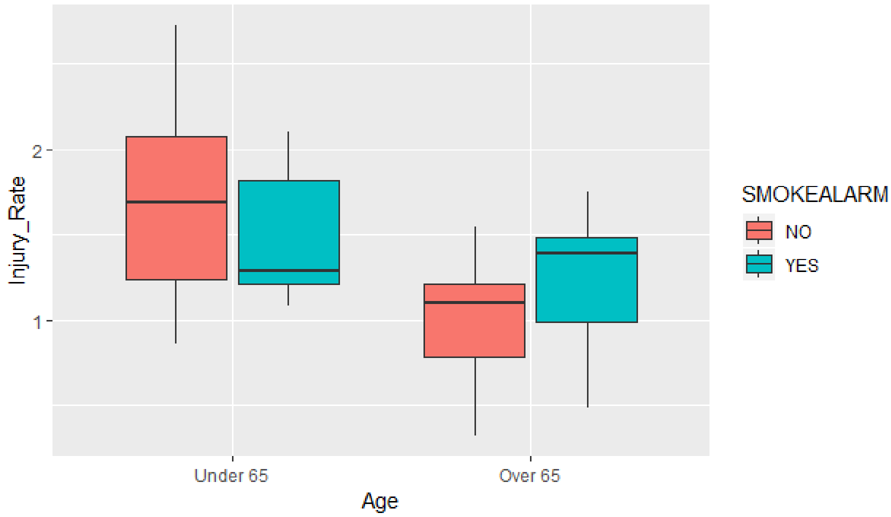
Note:
Ontario, BC, and Alberta provided data from 2005 to 2014
Saskatchewan provided data from 2012 and 2013

Among the conclusions to be drawn from Figure 5 are that fatalities at fires among those living in homes without working smoke alarm are higher than those living with the presence of working smoke alarm. This trend is consistent for both age groups. This finding is supported by the results from the statistical tests that indicate significant differences for both age groups10. From the calculation of relative risk, those seniors living at homes without working smoke alarm seem to be 1.9 times more likely to die than those living at homes with working smoke alarms (55% less likely of fatality on those living with working smoke alarms). This finding is supported by the results from the statistical tests that show significant differences for both groups11.(see Table 16 in Appendix E for details). Furthermore, among the senior population living at homes with working smoke alarm, the trend of fatality rates shows a decline since 2007 whereas for those living without working smoke alarm, the declining trend started in 2010 (see Figure 18 in Appendix E for details).

[10] p-values of 2.468e-05 and 1.505e-07 for cohort 65 years old or above, and less than 65 years old respectively
[11] p-value: 9.13 e-05

Figure 6 illustrates the impact of working smoke alarm on injury rates of senior population at the event of residential fires.

FIGURE 6: INJURY RATES WITH OR WITHOUT SMOKE ALARM



Note:
Ontario, BC, and Alberta provided data from 2005 to 2014
Saskatchewan provided data from 2012 and 2013

Based on the results presented in Figure 6, it appears that injuries at fires for those younger than 65 years old living at homes without working smoke alarm seem to show no differences than those living with the presence of working smoke alarm. In contrast, senior populations living at homes with working smoke alarm show higher injury rates (1.2 times more) than those living without working smoke alarm (see Table 17 in Appendix F). However, the statistical test shows no significant differences for both age groups[12]. Finally, statistical tests also suggest that injury rates for senior population are significantly lower than those in younger cohorts with no working smoke alarm present. [13]

[12] p-value=0,15 and 0.39 for senior population and population less than 65 years old respectively
[13] T = -3.2769, p-value=0.002175

ACTION OF FIRE CASUALTY AT SENIOR POPULATION

ACTION OF FIRE CASUALTY AT FATALITIES OF SENIOR POPULATION

Table 4 shows the fire-related fatality rates of those living with and without working smoke alarm by categories of actions. The analysis displays that over half of the incidents occurred at homes without working smoke alarm (51.9%) have 'unknown' category as opposed to only over 27% for the same category occurred at homes with working smoke alarm.

Differences are found between both groups in the frequency of those categories. Nonetheless, they share similar categories 90% of the time, i.e. injured while attempting to escape, did not act, and loss of judgement or panic.

TABLE 4: ACTION OF CASUALTY FOR FATALITIES AT SENIOR POPULATION (65 YEARS OLD OR OVER)

WORKING SMOKE ALARM					NO WORKING SMOKE ALARM				
ACTION OF CASUALTY	NO. FATALITIES	PCT OF FATALITIES	TOTAL INCIDENTS	RATE PER 1,000 INCIDENTS WITH FATALITIES	ACTION OF CASUALTY	NO. FATALITIES	PCT OF FATALITIES	TOTAL INCIDENTS	RATE PER 1,000 INCIDENTS WITH FATALITIES
UNKNOWN	35	27.1%	122	286.9	UNKNOWN	122	51.9%	219	557.1
INJURED WHILE ATTEMPTING TO ESCAPE	34	26.4%	122	278.7	INJURED WHILE ATTEMPTING TO ESCAPE	37	15.7%	219	168.9
UNCLASSIFIED	18	14.0%	122	147.5	DID NOT ACT	22	9.4%	219	100.5
DID NOT ACT	15	11.6%	122	123.0	UNCLASSIFIED	19	8.1%	219	86.8
LOSS OF JUDGEMENT, PANIC	15	11.6%	122	123.0	LOSS OF JUDGEMENT, PANIC	16	6.8%	219	73.1
FIRE SETTER	4	3.1%	122	32.8	CIVILIAN ATTEMPTED SURPRESSION	6	2.6%	219	27.4
CIVILIAN ATTEMPTED SURPRESSION	4	3.1%	122	32.8	FIRE SETTER	4	1.7%	219	18.3
ENTERED OR REMAINED FOR FIRE FIGHTING	2	1.6%	122	16.4	ENTEREED OR REMAINED TO SAVE PERSONAL PROPERTY	3	1.3%	219	13.7
ENTERED OR REMAINED FOR RESCUE PURPOSES	2	1.6%	122	16.4	ENTERED OR REMAINED FOR RESCUE PURPOSES	2	0.9%	219	9.1
					RECECIVED DELAY WARNING	2	0.9%	219	9.1
					ENTERED OR REMAINED FOR FIRE FIGHTING	1	0.4%	219	4.6
					OVER-EXERTION HEART ATTACK	1	0.4%	219	4.6

ACTION OF FIRE CASUALTY AT INJURIES OF SENIOR POPULATION

Table 5 shows the fire-related injury rates of those living at homes with and without working smoke alarms by categories of actions. The analysis displays that both groups share similar categories; that is,. the category of entered or remained for fire-fighting, injured while attempting to escape, and loss of judgement or panic despite slight differences in the frequencies.

TABLE 5: ACTION OF CASUALTY FOR INJURIES AT SENIOR POPULATION (65 YEARS OLD OR OVER)

WORKING SMOKE ALARM					NO WORKING SMOKE ALARM				
ACTION OF CASUALTY	NO. INJURIES	PCT OF INJURIES	TOTAL INCIDENTS	RATE PER 1,000 INCIDENTS WITH INJURIES	ACTION OF CASUALTY	NO. INJURIES	PCT OF INJURIES	TOTAL INCIDENTS	RATE PER 1,000 INCIDENTS WITH INJURIES
ENTERED OR REMAINED FOR FIRE FIGHTING	53	22.9%	195	271.8	ENTERED OR REMAINED FOR FIRE FIGHTING	43	22.5%	165	260.6
INJURED WHILE ATTEMPTING TO ESCAPE	51	22.1%	195	261.5	INJURED WHILE ATTEMPTING TO ESCAPE	42	22.0%	165	254.5
UNKNOWN	37	16.0%	195	189.7	UNKNOWN	36	18.8%	165	218.2
DID NOT ACT	31	13.4%	195	159.0	UNCLASSIFIED	22	11.5%	165	133.3
LOSS OF JUDGEMENT, PANIC	23	10.0%	195	117.9	LOSS OF JUDGEMENT, PANIC	19	9.9%	165	115.2
UNCLASSIFIED	16	6.9%	195	82.1	ENTERED OR REMAINED TO SAVE PERSONAL PROPERTY	9	4.7%	165	54.5
ENTERED OR REMAINED TO SAVE PERSONAL PROPERTY	8	3.5%	195	41.0	ENTERED OR REMAINED FOR RESCUE PURPOSES	8	4.2%	165	48.5
ENTERED OR REMAINED FOR RESCUE PURPOSES	8	3.5%	195	41.0	DID NOT ACT	6	3.1%	165	36.4
RECEIVED DELAYED WARNING	3	1.3%	195	15.4	OVER-EXERTION, HEART ATTACK	4	2.1%	165	24.2
OVER-EXERTION, HEART ATTACK	1	0.4%	195	5.1	RECEIVED DELAYED WARNING	2	1.0%	165	12.1

CONDITION OF FIRE CASUALTY AT SENIOR POPULATION

CONDITION OF FIRE CASUALTY AT FATALITIES OF SENIOR POPULATION

Table 6 shows the fire-related fatality rates of those living at homes with and without working smoke alarm by categories of conditions. The analysis displays that one third of the incidents occurred at homes with working smoke alarm (31%) have ‘awake and no physical/mental impairment’ category as opposed to only one quarter of incidents with the same category occurred at homes without working smoke alarm (24.7%).

Differences can be observed in the frequency of the categories between both groups. Nonetheless, they share similar categories 90% of the time; that is, awake and no physical/mental impairment, bedridden, and asleep.

TABLE 6: CONDITION OF CASUALTY FOR FATALITIES AT SENIOR POPULATION (65 YEARS OLD OR OVER)

WORKING SMOKE ALARM					NO WORKING SMOKE ALARM				
CONDITION OF CASUALTY	NO. FATALITIES	PCT OF FATALITIES	TOTAL INCIDENTS	RATE PER 1,000 INCIDENTS WITH FATALITIES	CONDITION OF CASUALTY	NO. FATALITIES	PCT OF FATALITIES	TOTAL INCIDENTS	RATE PER 1,000 INCIDENTS WITH FATALITIES
AWAKE AND NO PHYSICAL OR MENTAL IMPAIRMENT	40	31.0%	122	327.9	UNKNOWN	82	34.9%	219	374.4
UNKNOWN	26	20.2%	122	213.1	AWAKE AND NO PHYSICAL OR MENTAL IMPAIRMENT	58	24.7%	219	264.8
BEDRIDDEN OR OTHER PHYSICAL HANDICAP	25	19.4%	122	204.9	ASLEEP	28	11.9%	219	127.9
ASLEEP	16	12.4%	122	131.1	BEDRIDDEN OR PHYSICAL HANDICAP	25	10.6%	219	114.2
IMPAIRMENT BY ALCOHOL	8	6.2%	122	65.6	UNCLASSIFIED	15	6.4%	219	68.5
UNCLASSIFIED	6	4.7%	122	49.2	IMPAIRMENT BY ALCOHOL	10	4.3%	219	45.7
MENTAL HANDICAP	5	3.9%	122	41.0	HEARING IMPAIRED	7	3.0%	219	32.0
VISUALLY IMPAIRED	3	2.3%	122	24.6	MENTAL HANDICAP	6	2.6%	219	27.4
					VISUALLY IMPAIRED	3	1.3%	219	13.7
					UNDER RESTRAINT OR DETENTION	1	0.4%	219	4.6

CONDITION OF FIRE CASUALTY AT INJURIES OF SENIOR POPULATION

Table 7 shows that almost half of the fire incidents have the category of awake and no physical/mental impairment at the time of fires for both groups living at homes with and without working smoke alarm. Furthermore, they share similar categories 90% of the time, i.e. awake and no physical/mental impairment, bedridden, and asleep.

TABLE 7: CONDITION OF CASUALTY FOR INJURIES AT SENIOR POPULATION (65 YEARS OLD OR OVER)

WORKING SMOKE ALARM					NO WORKING SMOKE ALARM				
CONDITION OF CASUALTY	NO. INJURIES	PCT OF INJURIES	TOTAL INCIDENTS	RATE PER 1,000 INCIDENTS WITH INJURIES	CONDITION OF CASUALTY	NO. INJURIES	PCT OF INJURIES	TOTAL INCIDENTS	RATE PER 1,000 INCIDENTS WITH INJURIES
AWAKE AND NO PHYSICAL OR MENTAL IMPAIRMENT AT THE TIME OF FIRE	114	49.4%	195	584.6	AWAKE AND NO PHYSICAL OR MENTAL IMPAIRMENT AT THE TIME OF FIRE	95	49.7%	165	575.8
UNKNOWN	42	18.2%	195	215.4	UNKNOWN	41	21.5%	165	248.5
ASLEEP	34	14.7%	195	174.4	ASLEEP	35	18.3%	165	212.1
BEDRIDDEN OR OTHER PHYSICAL HANDICAP	19	8.2%	195	97.4	UNCLASSIFIED	7	3.7%	165	42.4
IMPAIRMENT BY ALCOHOL, DRUGS, MEDICATION	9	3.9%	195	46.2	BEDRIDDEN OR OTHER PHYSICAL HANDICAP	7	3.7%	165	42.4
UNCLASSIFIED	7	3.0%	195	35.9	IMPAIRMENT BY ALCOHOL	4	2.1%	165	24.2
MENTAL HANDICAP	5	2.2%	195	25.6	MENTAL HANDICAP	2	1.0%	165	12.1
UNDER RESTRAINT	1	0.4%	195	5.1					

RISK OF FATALITIES FOR SENIOR POPULATION BY 5-YEAR AGE GROUP

The fatality rate at structural fires is significantly higher for the senior population than those aged less than 65 years old as it is shown in Figure 2. The analysis suggests that the risk of dying at fires for the senior population is increasing along with the age increment. Table 8 shows the risk of fatalities for the population of 65 years old or greater in increments of 5-year age groupings relative to the population aged less than 65 years old.

TABLE 8: RELATIVE RISK OF FATALITIES FOR POPULATION AGED 65 YEARS OLD OR OVER IN 5 YEARS AGE

Age Group	Risk of Fatalities	Confidence Interval	p-value
Less than 65 years old	1		
65 - 69	**2.02**	**(1.2 - 3.5)**	**0.01215334**
70 - 74	**2.61**	**(1.6 - 4.4)**	**0.00054984**
75 - 79	**3.98**	**(2.5 - 6.6)**	**0.0000009**
80 - 84	**4.71**	**(2.9 - 7.8)**	**0.00000005**
85+	**4.75**	**(3 - 7.9)**	**0.00000004**

Note: Age group in bold font shows significance of risk based on its p-value

The Table 8 shows that those seniors aged 65-69 are 2 times more likely to have died at the event of residential fires than their younger peers. The risk is increasing for those cohorts in the groups of 70-74, 75-79, and 80-84 years of age, with the highest risk occurring for the seniors in the age group of 85+. These seniors are 4.75 times more likely to have died at residential fires relative to their peers of less than 65 years old.

IMPACT OF WORKING SMOKE ALARM ON RISK OF FATALITIES FOR SENIOR POPULATION

The subsequent analyses look beyond the relative risk of fatalities of the senior population but explore them in relation to the presence of working smoke alarm.

TABLE 9: RELATIVE RISK OF FATALITIES FOR SENIOR POPULATION WITH WORKING SMOKE ALARM PRESENCE

Age Group	Risk of Fatalities	Confidence Interval	p-value
65 - 69 with working smoke alarm	1.58	(0.6 - 4.6)	0.38
70 - 74 with working smoke alarm	1.75	(0.7 - 4.9)	0.26
75 - 79 with working smoke alarm	2.37	(0.98 - 4.68)	0.07
80 - 84 with working smoke alarm	**3.1**	**(1.29 - 8.35)**	**0.018**
85+ with working smoke alarm	1.55	(0.64 - 4.24)	0.35

Note: Age group in bold font shows significance of risk based on its p-value

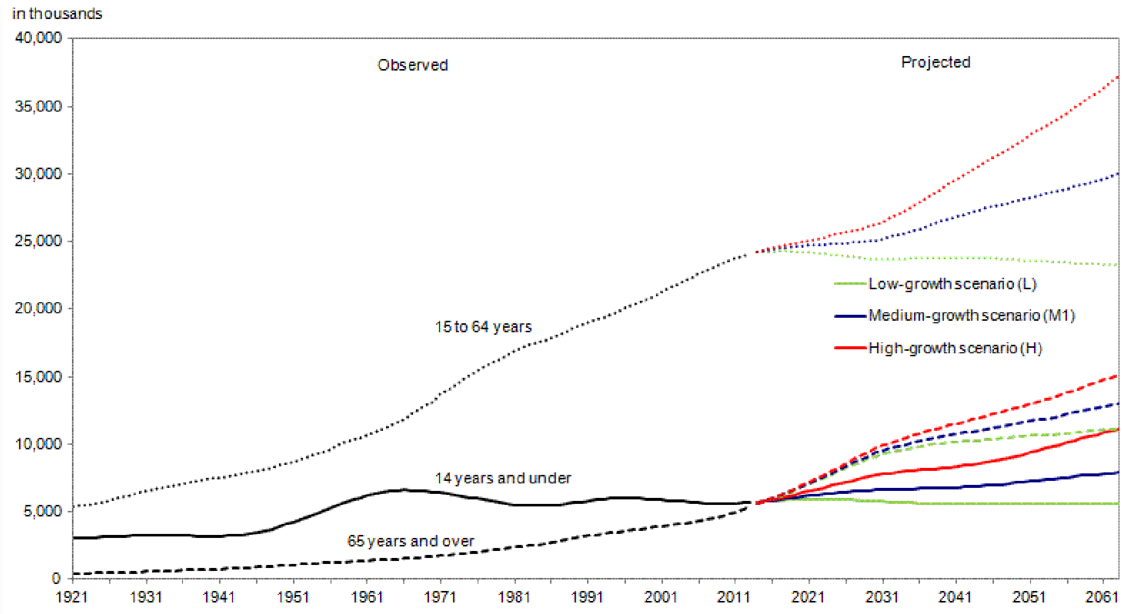
In Table 9, the relative risks of those senior populations are not only reduced in the presence of working smoke alarm (from the range of 20% for population aged 65-69 to 200% for population aged 85+), but also the risk increases relative to population less than 65 years old become statistically insignificant.

PROJECTION OF FATALITIES OF SENIORS AT RESIDENTIAL FIRES

GROWTH OF CANADIAN SENIORS

In 2013, Canada had 5.4 million seniors, more than triple the number recorded in 1963. The growth of this group would accelerated in time as the large baby-boom cohort aged (6). In 2063, it is projected that the number of seniors will be double that found in 2013, ranging from 11.1 million to 15.1 million depending on the scenario (see Figure 7 for details).

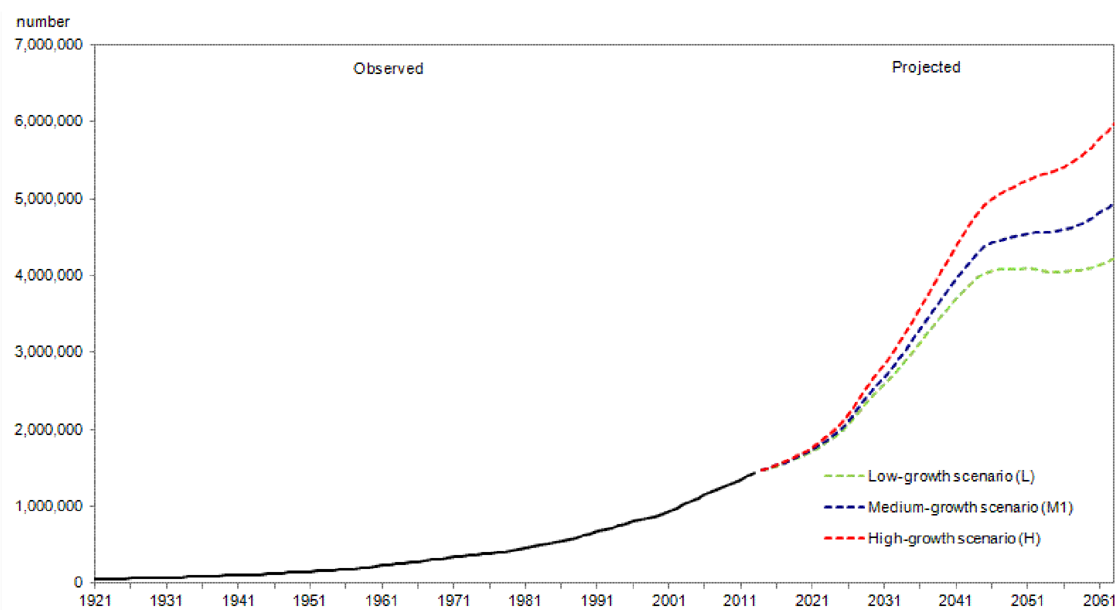
FIGURE 7: PROJECTED CANADA POPULATION (2014 TO 2063) ACCORDING TO VARIOUS SCENARIOS (6)



Source: Statistics Canada, Demography Division.

For older seniors (aged 80 or over), the population has been increasing continuously with time. In 2013, there were about 1.4 million seniors over 80 years of age which is 5 times more than in 1963. Members of baby-boom generation will enter this age group between 2026 and 2045 (6). It is projected that in 2063, the number of older seniors would reach between 4.2 million and 6 million (see Figure 8 for details).

FIGURE 8: PROJECTED OLDER SENIORS POPULATION (80+) ACCORDING TO VARIOUS SCENARIOS (6)



Source: Statistics Canada, Demography Division.

IMPACT OF GROWTH OF THE CANADIAN SENIOR POPULATION ON FIRE FATALITIES

The increasing growth of population of seniors will impact the fire fatalities for this population. For the purpose of determining the impact of their population growth on the expected number of fire fatalities in incoming years, the research uses various projection methods based on various assumptions on fatality rates (see Appendix G for details).

Method 1: 2014 Fatality Rate as Baseline

This method uses the assumption that future fatality rates should be approximately similar to the 2014 fatality rates for senior population. The rationale for using this assumption is that the 2014 fatality rates are the lowest in 10-year period, 2005 -2014, and there is currently no expectation of any reduction in future rates.

Based on this assumption, the analysis shows that the expected fire fatalities among seniors would reach between 84 and 94 per year in 2040, depending on the growth scenarios. In 2063, fire fatalities would be expected to reach between 92 and 125 fatalities per year depending upon the scenarios of population growth (see Figure 9 for details).

Method 2: Average Weighted Fatality Rate as Baseline

This method uses the assumption that future fatality rates should be approximately the result of the weighted average of fatality rates from 2008 to 2014, with a greater weight applied to the rate of the recent year, 2014, and lesser weights applied to the rates of the years from 2008 to 2012. The rationale of using this assumption is that the fatality rates for 2008 and 2014 belong to the highest and the lowest respectively, so future rates might be expected to range between those rates. As the rates declined from 2008 to 2014, the tendency of future rates should be closer to the rate for 2014.

Using this method, the analysis shows that the fire fatalities among seniors would reach between 130 and 146 per year in 2040, depending on the growth scenarios. In 2063, the fire fatalities could reach over 2.5 times the fatalities in 2014, ranging from 142 and 194 fatalities per year, depending upon the scenarios of population growths (see Figure 10 for details).

FIGURE 9: PROJECTED FIRE FATALITIES AMONG SENIORS POPULATION WITH 2014 FATALITY RATES

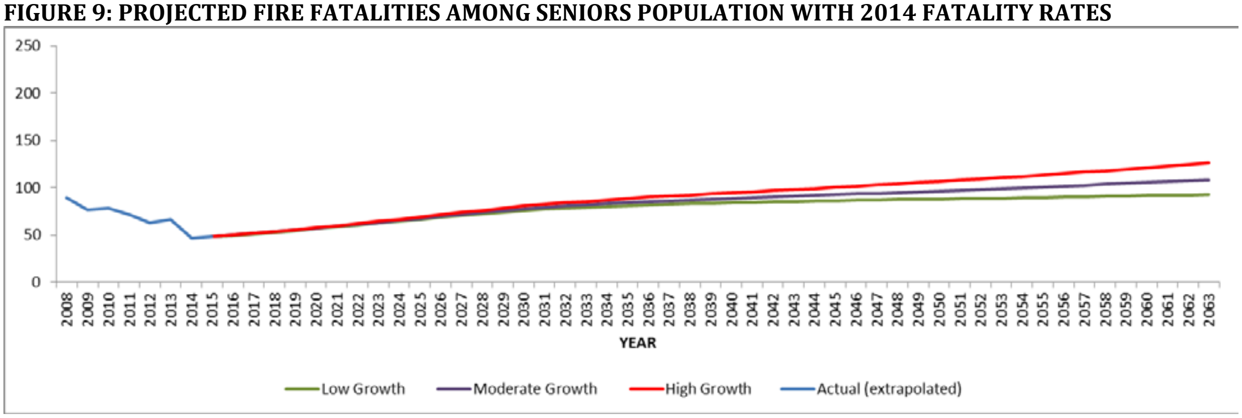
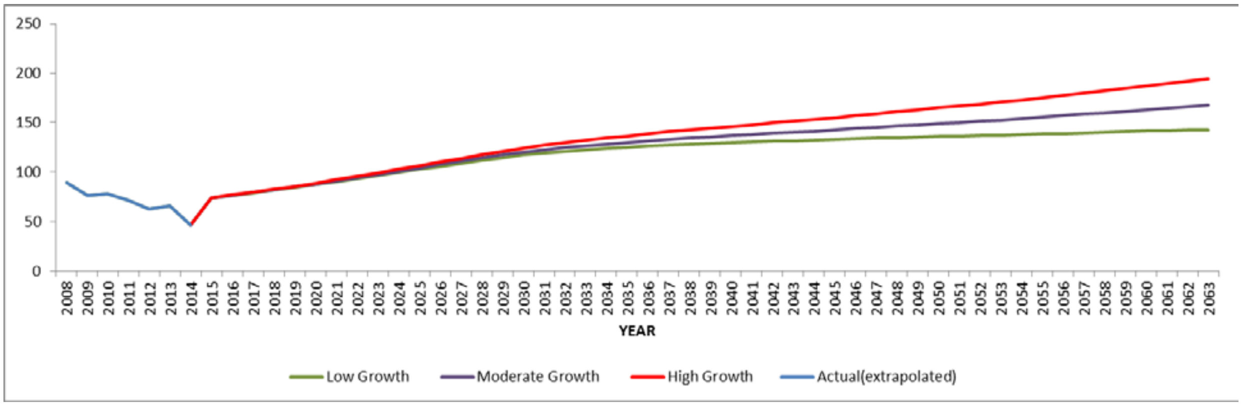


FIGURE 10: PROJECTED FIRE FATALITIES AMONG SENIORS POPULATION WITH WEIGHTED FATALITY RATES

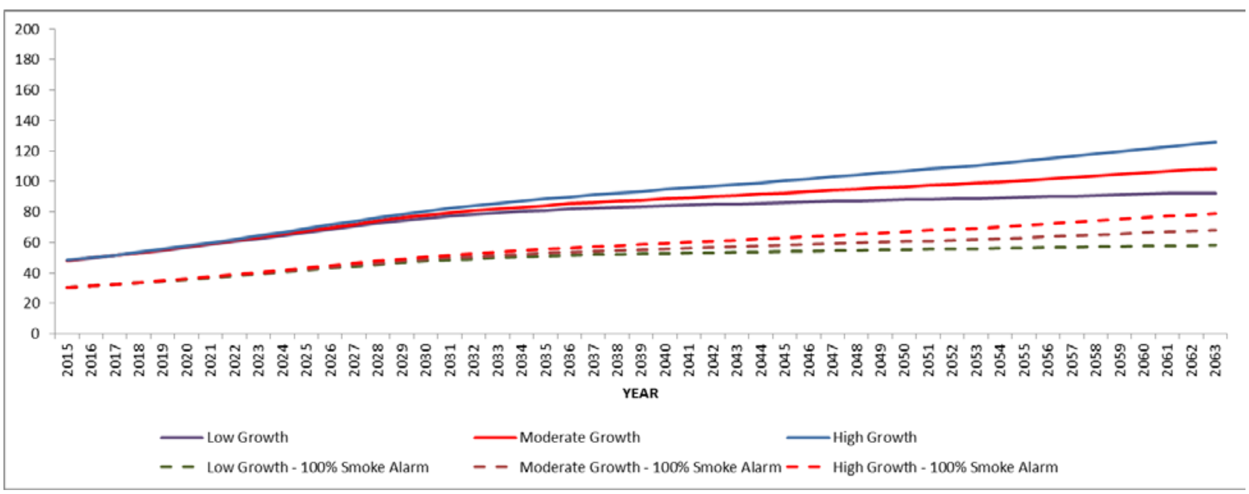


IMPACT OF WORKING SMOKE ALARM ON FUTURE FIRE FATALITIES OF CANADIAN SENIORS

The previous analysis showed that seniors living at homes with working smoke alarm have a 55% less likelihood of dying at the event of a residential fire. The research applies this estimated likelihood to the existing fatality rates of the senior population with the assumption that all seniors would have lived at homes with working smoke alarm. The new rates are used to project the expected fatalities under this assumption (see Appendix G for details).

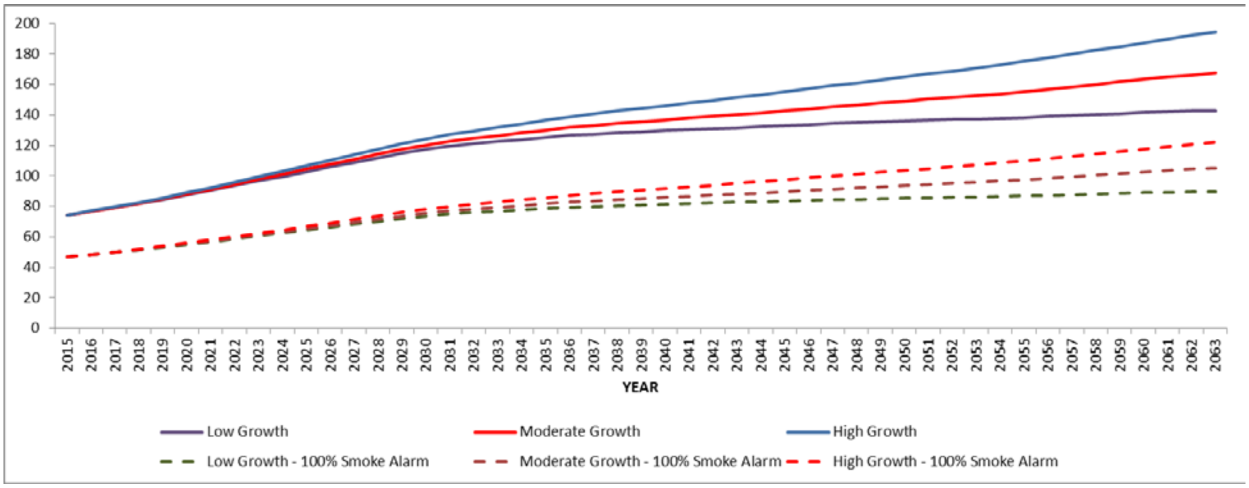
Figure 11 displays how the expected fatality rates would be impacted as a result of all seniors living at homes with a working smoke alarm. The impact would be the reduction of expected fatalities to between 50 and 60 expected fire fatalities per year among seniors in 2040, compared with 84 and 94 per year for the same period if there were no further efforts in reducing the fatality rates. In 2063, the expected fire fatalities would be reduced to 58 to 79 per year compared with 92 and 125 fatalities per year if there are no changes in the system.

FIGURE 11: PROJECTED FIRE FATALITIES AMONG SENIORS (2014 RATES WITH 100% WORKING SMOKE ALARM)



More fire fatalities could likely be prevented if the weighted average of fatality rates is used to project the expected number of fatalities. By applying the lesser fatality risk for those seniors living at homes with working smoke alarms, a significant reduction in expected fatality rates could be achieved. Figure 12 shows the greater impact on the expected fire fatalities among seniors. In 2040, the expected fatality rate would become between 80 and 90 seniors per year as a result of 100% compliance of a working smoke alarm in every residential building in which seniors lived (compared to 130 and 146 fatalities per year should no changes occur). In 2063, the projection shows the expected rate of 90 to 122 fatalities per year (compared to 142 to 194 annual fatalities if no further efforts are underway).

FIGURE 12: PROJECTED FIRE FATALITIES AMONG SENIORS (WEIGHTED RATES WITH 100% WORKING SMOKE ALARM)



DISCUSSION AND CONCLUSIONS

Previous studies have shown elevated fatality risks among senior populations (aged 65 years old or over) at any fire incidents[14]. Nonetheless, this research provides more detail and a deeper analysis of fire risks among Canadian seniors in relation to the general population by analysing the National Fire Information Database (NFID). The study also offers a conservative projection on the expected number of fire fatalities among this vulnerable population in the future.

The data indicates that 30% of fire-related fatalities occurred among the senior population despite their being only 14% of the population, and that 8% of fire-related injuries happen within the same population. This number should be examined further considering the high percentages of fire injuries that were recorded in the "unknown" age group category (40%).

The 10-year trend demonstrates a declining pattern of fire-related fatalities, but stable rates of fire injuries among seniors. The fire fatalities among seniors are twice the rate of the population aged less than 65 years old. The relative fatality risk is increasing significantly along with the age increments, with the oldest group (85 years old or over) being 4.75 times more likely to have died at the event of a residential fires than their peers who are less than 65 years old. This pattern of a high fatality rates among seniors is consistent in every jurisdiction. With respect to fire-related injuries, no statistically significant difference between the senior population and those aged less than 65 years old was discovered, although without the presence of working smoke alarm, the injury rates for the younger population is significantly higher than the senior population. This

[14] See References 3, 4, 7

finding confirms the fact that deaths and injuries in fires are drawn from different populations. Populations that are prone to die in fires are unlikely to be injured in fires and vice versa. This finding is consistent with the NIST study[15]. In general, the overall finding related to fire fatalities and injuries is consistent with findings from various other studies[16].

The study identifies different impacts of working smoke alarms on fire-related fatalities and fire-related injuries among seniors. For those living in homes with the presence of a working smoke alarm, there is a 55% less likelihood of having died at a residential fire. The impact of working smoke alarms on the fire-related fatalities of the senior population is consistent across the age increments, where the relative risks are reduced and become insignificant with the presence of working smoke alarms for those seniors.

Without any further interventions in reducing the fatality rates among seniors, we can expect approximately 90 fire fatalities among seniors annually in the next 25 years. This shows that the effect of declining fatality rates that occurred over the 10 years between 2005 and 2014 could actually be diminished when the population growth among seniors continues and influences fire fatality rates. The further estimate even shows significant concern in forecasts when weighted average of fatality rates is used to project the expected number of fatalities. The expected fire fatalities could reach over 140 fatalities annually in the same period.

The projections made here highlight the importance of life saving mechanisms for this vulnerable population as other studies have articulated[17]. In Reference 7, Garis, et.al mentioned an evaluation study that was done among a senior population who lived in the community, received home support services, and underwent education on fatality and injury prevention strategies including awareness of working smoke alarms. The study showed the impact of increasing awareness of the presence and ongoing smoke alarm maintenance after the education program. The US Fire Administration and the National Fire Protection Association in their campaign materials also emphasized the importance of working smoke alarms in providing extra time for seniors to escape fires[18].

With this in mind, the study makes an effort to generate a "what-if" scenario by projecting the number of fire fatalities in case where all seniors are in 100% compliance of having working smoke alarm in their homes. Both projections consistently show a greater impact in reducing fire fatalities in which approximately 600 to 900 fire fatalities among seniors that could be prevented in the next 25 years.

The results from this study and other similar studies should not only emphasize the importance of life-saving mechanisms and fire prevention strategies for those seniors who live in the community, but also provide awareness for policy makers to improve the access of those mechanisms and strategies to the vulnerable population, including bringing them into public health care coverage and services.

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[15] See References 8 and 9
[16] See References 3 and 4
[17] See References 2, 7, 8, and 9
[18] See References 10, 11

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Appendix A

TABLE 10: FIRE-RELATED FATALITY RATES AT ALL FIRES BY ANY AGE GROUPS , 4 JURISDICTIONS, 2005 TO 2014 (5)

Year	Children		Youth		Adults		Senior Citizens	
	number	rate	number	rate	number	rate	number	rate
2005	6	1.9	5	2.6	101	6.8	32	10.9
2006	9	2.8	9	4.7	86	5.7	33	10.9
2007	6	1.9	2	1.1	111	7.2	46	14.9
2008	15	4.7	5	2.7	119	7.7	58	18.4
2009	10	3.1	3	1.6	116	7.4	53	16.3
2010	4	1.2	4	2.2	86	5.4	57	17.1
2011	11	3.4	0	0	89	5.5	48	14
2012	6	1.8	3	1.7	74	4.5	42	11.7
2013	14	1.2	1	0.6	70	4.3	43	11.5
2014	43	12.8	0	0	60	3.6	32	8.2
Total	**124**	**3.8**	**32**	**1.7**	**912**	**5.8**	**444**	**13.3**

Note:

4. Four jurisdictions provided 10 years of casualty data: Ontario, British Columbia, Alberta, and Manitoba
5. Children (11 years old and under), Youth (12 – 17 years old), Adults (18-64 years old), senior citizens (65 years old and over)

TABLE 11: FIRE-RELATED INJURY RATES AT ALL FIRES BY ANY AGE GROUPS , 4 JURISDICTIONS, 2005 TO 2014 (5)

Year	Children		Youth		Adults		Senior Citizens	
	number	rate	number	rate	number	rate	number	rate
2005	196	61	44	23.3	1037	69.5	73	24.8
2006	143	44.6	40	21.1	886	58.6	72	23.9
2007	130	40.7	44	23.2	937	61.1	78	25.3
2008	91	28.4	54	28.7	824	53	68	21.5
2009	21	6.5	71	38	976	62	99	30.5
2010	34	10.5	58	31.3	931	58.4	118	35.5
2011	33	10.1	46	25.1	903	56.1	110	32.1
2012	41	12.5	56	31	971	59.7	95	26.5
2013	24	7.2	52	29.4	830	50.5	113	30.2
2014	27	8.1	51	29.3	856	51.5	107	27.6
Total	**740**	**22.8**	**516**	**28**	**9151**	**57.9**	**933**	**27.9**

Note:

1. Four jurisdictions provided 10 years of casualty data: Ontario, British Columbia, Alberta, and Manitoba
2. Children (11 years old and under), Youth (12 – 17 years old), Adults (18-64 years old), senior citizens (65 years old and over)

Appendix B

TABLE 12: CASUALTY RATES OF POPULATION OVER 65 VS UNDER 65

Year	Over 65 Years		Under 65 Years	
	Person	Rate	Person	Rate
2005	91	3.6	1238	7.1
2006	96	3.7	1048	5.9
2007	120	4.5	1094	6.1
2008	115	4.2	998	5.5
2009	69	2.5	377	2.1
2010	84	2.9	351	1.7
2011	69	2.3	374	1.8
2012	68	2.1	325	1.7
2013	80	2.4	298	1.5
2014	39	1.2	262	1.3
Total	**831**	**2.8**	**6365**	**3.4**

*rate is calculated per 100,000 population

FIGURE 13: DISTRIBUTION OF CASUALTY RATES BY JURISDICTIONS

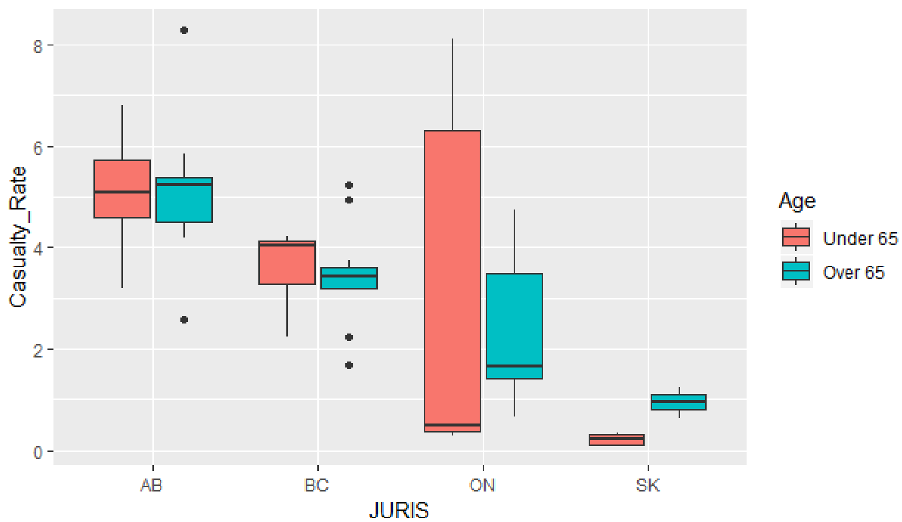
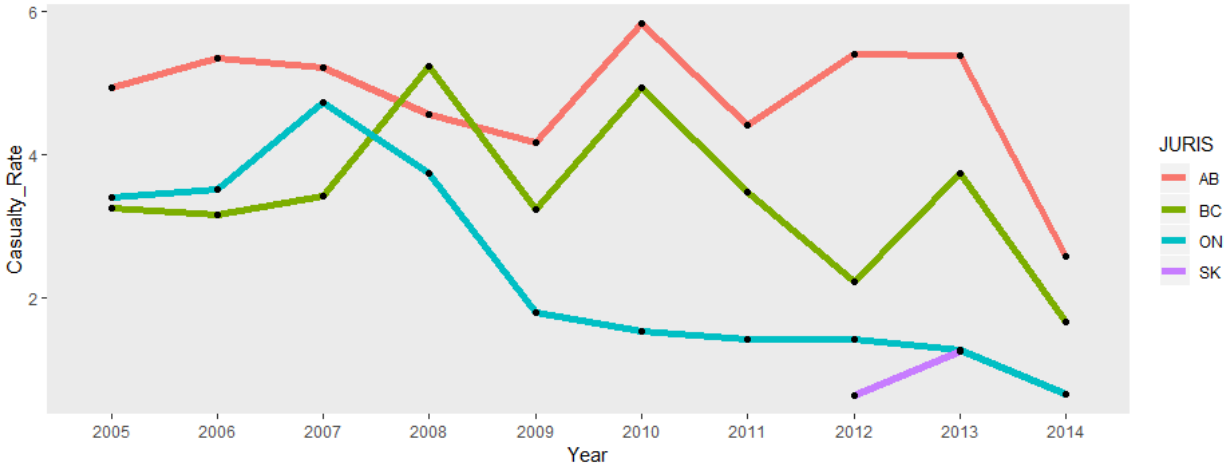


FIGURE 14: CASUALTY RATES OF POPULATION AGED 65 YEARS OR OVER BY JURISDICTIONS IN 10 YEARS



Appendix C

TABLE 13: FATALITY RATES OF POPULATION OVER 65 VS UNDER 65

Year	Over 65 Years		Under 65 Years	
	Person	Rate	Person	Rate
2005	27	1.1	97	0.6
2006	30	1.2	93	0.5
2007	45	1.7	98	0.5
2008	53	1.9	114	0.6
2009	44	1.6	108	0.6
2010	47	1.6	82	0.4
2011	42	1.4	86	0.4
2012	40	1.2	69	0.4
2013	40	1.2	66	0.3
2014	28	0.8	56	0.3
Total	**396**	**1.4**	**869**	**0.5**

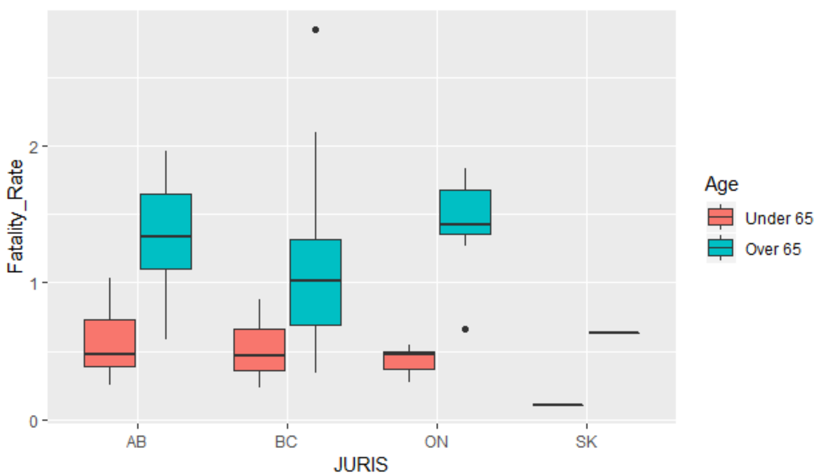
*rate is calculated per 100,000 population

TABLE 14: INJURY RATES OF POPULATION OVER 65 VS UNDER 65

Year	Over 65 Years		Under 65 Years	
	Person	Rate	Person	Rate
2005	64	2.5	1141	6.5
2006	66	2.5	955	5.4
2007	75	2.8	996	5.6
2008	62	2.3	884	4.9
2009	25	2.4	269	3.8
2010	37	3.5	269	3.8
2011	27	2.5	288	4.0
2012	28	2.4	256	3.1
2013	40	3.0	232	2.8
2014	11	0.9	206	2.7
Total	**435**	**2.5**	**5496**	**4.7**

*rate is calculated per 100,000 population

FIGURE 15: DISTRIBUTION OF FATALITY RATES BY JURISDICTIONS



Appendix D

TABLE 15: CASUALTY RATES OF SENIOR POPULATION LIVING AT HOMES WITH WORKING SMOKE ALARM VS NO SMOKE ALARM

Year	Smoke Alarm Presence		No Smoke Alarm	
	Person	Rate	Person	Rate
2005	46	1.8	45	1.8
2006	43	1.7	53	2.0
2007	61	2.3	59	2.2
2008	45	1.6	70	2.6
2009	29	1.0	40	1.4
2010	29	1.0	55	1.9
2011	26	0.9	43	1.4
2012	34	1.0	34	1.0
2013	41	1.2	39	1.1
2014	15	0.4	24	0.7
Total	**369**	**1.3**	**462**	**1.6**

FIGURE 16: TREND OF CASUALTY RATES FOR SENIOR POPULATION WITH OR WITHOUT SMOKE ALARM

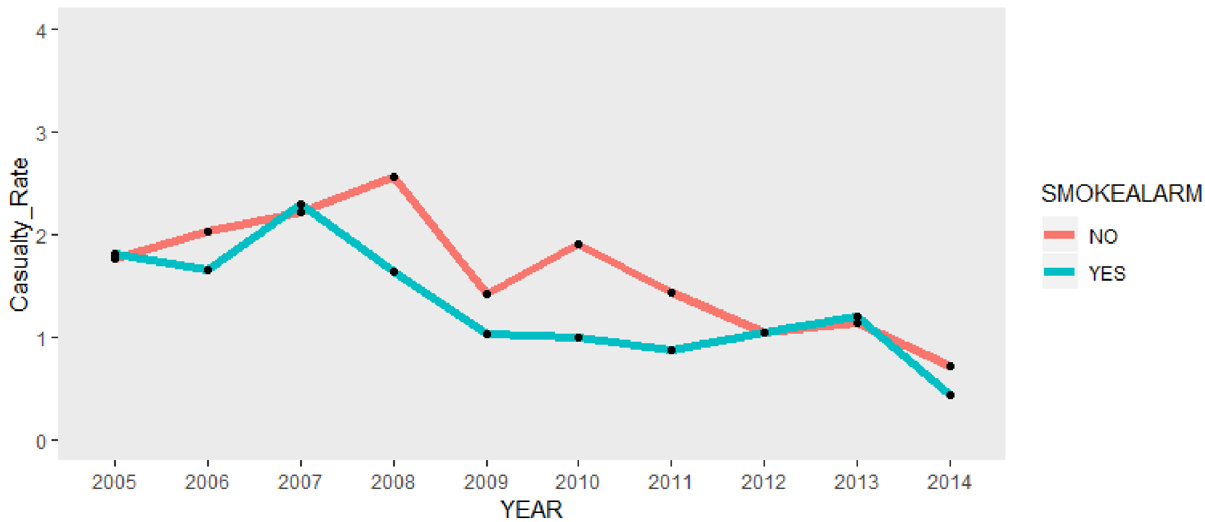
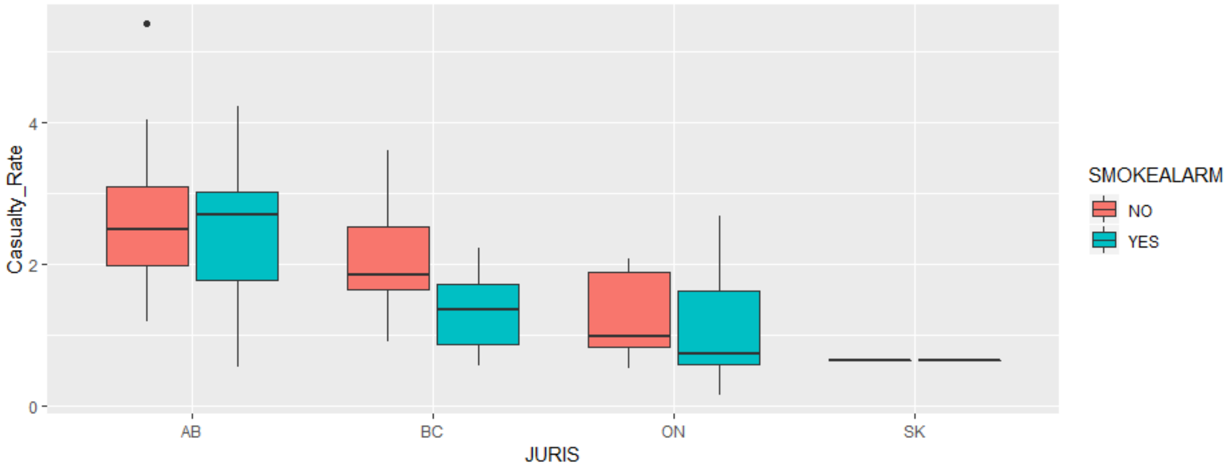


FIGURE 17: CASUALTY RATES FOR SENIOR POPULATION WITH OR WITHOUT SMOKE ALARM BY JURISDICTION



Appendix E

TABLE 16: FATALITY RATES OF SENIOR POPULATION LIVING AT HOMES WITH WORKING SMOKE ALARM VS NO SMOKE ALARM

Year	Smoke Alarm Presence		No Smoke Alarm	
	Person	Rate	Person	Rate
2005	8	0.3	17	0.7
2006	13	0.5	15	0.6
2007	18	0.7	25	0.9
2008	16	0.6	28	1.0
2009	14	0.5	20	0.7
2010	13	0.4	29	1.0
2011	12	0.4	26	0.9
2012	12	0.4	25	0.8
2013	13	0.4	23	0.7
2014	9	0.3	16	0.5
Total	**128**	**0.4**	**224**	**0.8**

*rate is calculated per 100,000 population

FIGURE 18: FATALITY RATES FOR SENIOR POPULATION WITH OR WITHOUT SMOKE ALARM

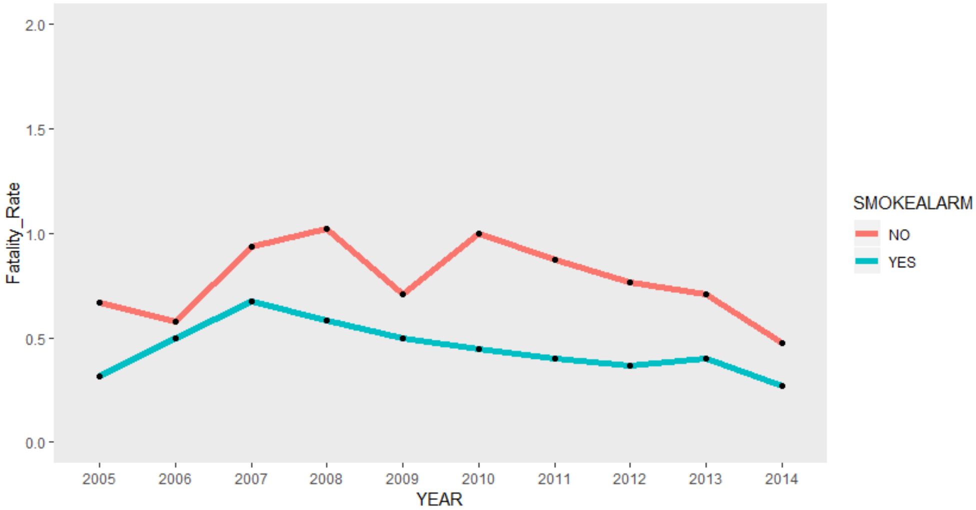
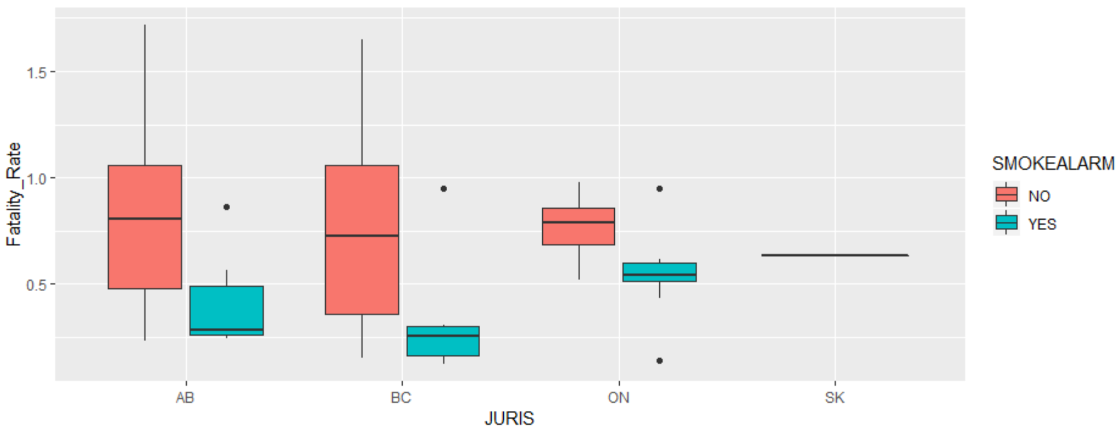


FIGURE 19: FATALITY RATES FOR SENIOR POPULATION WITH OR WITHOUT SMOKE ALARM BY JURISDICTION



Appendix F

TABLE 17: INJURY RATES OF SENIOR POPULATION LIVING AT HOMES WITH WORKING SMOKE ALARM VS NO SMOKE ALARM

Year	Smoke Alarm Presence		No Smoke Alarm	
	Person	Rate	Person	Rate
2005	36	1.4	23	0.9
2006	26	1.0	32	1.2
2007	37	1.4	28	1.0
2008	27	1.0	30	1.1
2009	10	1.0	12	1.2
2010	15	1.4	15	1.4
2011	12	1.1	13	1.2
2012	20	1.7	5	0.4
2013	22	1.6	9	0.7
2014	6	0.5	4	0.3
Total	**211**	**1.2**	**171**	**1.0**

*rate is calculated per 100,000 population

FIGURE 20: INJURY RATES FOR SENIOR POPULATION WITH OR WITHOUT SMOKE ALARM

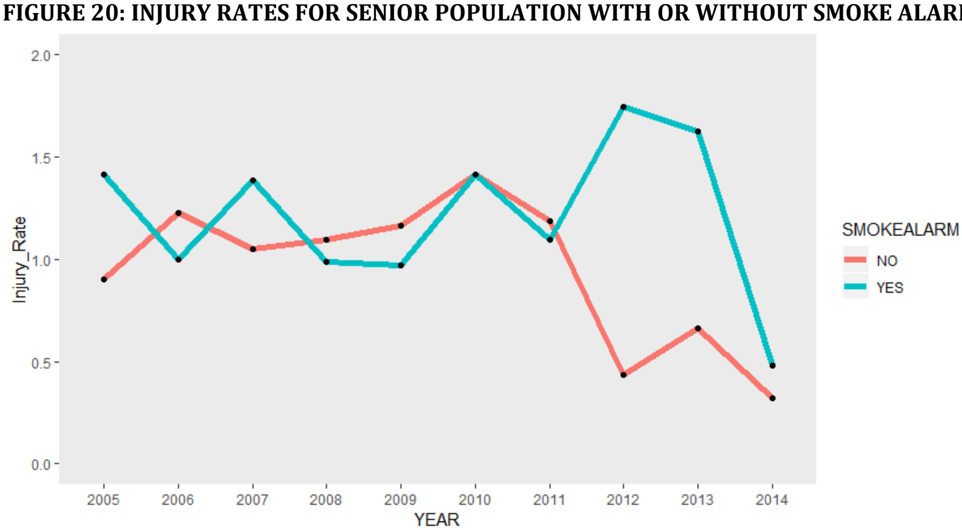
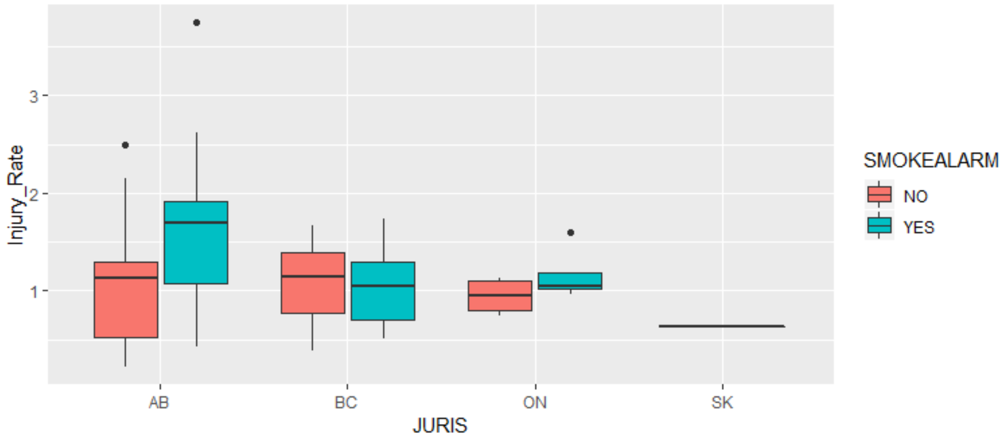


FIGURE 21: INJURY RATES FOR SENIOR POPULATION WITH OR WITHOUT SMOKE ALARM BY JURISDICTION



Appendix G

Projection of Fire-related Fatalities

Method 1: 2014 Fatality Rate as Baseline (0.831 fatalities per 100,000 population)

Projected Fatalities among seniors at particular Year = 2014 Fatality Rate/100,000 x Projected Population of 65 years and over at particular Year (Low Growth, Moderate Growth, High Growth)

e.g. Projected Fatalities for Seniors at Year 2040 (low growth scenario)= 0.831/100,000 * 10,096,300 = 83.9

Method 2: Average Weighted Fatality Rates as Baseline

Weighted Fatality Rates:

Year	Fatality Rate per 100,000	Weight
2008	1.971	10%
2009	1.634	10%
2010	1.624	10%
2011	1.44	10%
2012	1.223	10%
2013	1.233	20%
2014	0.831	30%
Average	**1.285**	**100%**

Average: (1.971* 10%) + (1.634*10%) + (1.624*10%) + (1.44*10%) + (1.223*10%) + (1.233*20%) + (0.831*30%) = 1.285

Projected Fatalities among seniors at particular Year = Average Weighted Fatality Rate/100,000 x Projected Population of 65 years and over at particular Year (Low Growth, Moderate Growth, High Growth)

e.g. Projected Fatalities for Seniors at Year 2040 (low growth scenario)= 1.285/100,000 * 10,096,300 = 129.8

Projection of Fire-related Fatalities Assuming 100% Compliance of Working Smoke Alarms among Seniors

Method 3: 2014 Fatality Rate as Baseline

For those living at homes with the presence of a working smoke alarm, there is a 55% less likelihood of having died at a residential fire. This means for 100 people who died in 2014 at homes without working smoke alarm, 55 of their fatalities could actually be prevented if they lived at homes with working smoke alarm.

In 2014, there are 19 fire-related fatalities at homes without working smoke alarms. If those people lived at homes with working smoke alarms, the fatalities of over 10 of them could actually be prevented. This results in 9 fatalities instead of 19 fatalities in that year. This new figure produces 0.521 as a new fatality rate per 100,000 population (compared to 0.831).

Projected Fatalities among seniors at particular Year = Adjusted 2014 Fatality Rate/100,000 x Projected Population of 65 years and over at particular Year (Low Growth, Moderate Growth, High Growth)

e.g. Projected Fatalities for Seniors at Year 2040 (low growth scenario)= 0.521/100,000 * 10,096,300 = 52.6

Method 4: Average Weighted Fatality Rates as Baseline

By applying the same methodology of adjusting fatality rate as described in the method 3 for all fatalities in all years since 2008, a new adjusted fatality rate can be shown as follows:

Year	Fatality Rate per 100,000	Adjusted Fatality Rate per 100,000	Weight
2008	1.971	1.232	10%
2009	1.634	1.055	10%
2010	1.624	0.977	10%
2011	1.44	0.872	10%
2012	1.223	0.785	10%
2013	1.233	0.792	20%
2014	0.831	0.521	30%
Average	**1.285**	**0.807**	**100%**

Average: (1.232* 10%) + (1.055*10%) + (0.977*10%) + (0.872*10%) + (0.785*10%) + (0.792*20%) + (0.521*30%) = 0.807

Projected Fatalities among seniors at particular Year = Adjusted Average Weighted Fatality Rate/100,000 x Projected Population of 65 years and over at particular Year (Low Growth, Moderate Growth, High Growth)

e.g. Projected Fatalities for Seniors at Year 2040 (low growth scenario)= 0.807/100,000 * 10,096,300 = 81.4

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