Municipal Technical Advisory Service
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An Analysis of Civilian Residential Fire Deaths in Tennessee, 2013-2022

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Executive Summary

In 2009, the U.S. Fire Administration conducted a study that examined civilian residential fire death rates in U.S. states. Tennessee was found to have one of the highest rates of civilian fire deaths ranking fourth highest in the nation. Fire professionals in Tennessee took note and re-doubled efforts to reduce the risk of perishing in home fires. The next decade saw the launch of several types of fire prevention efforts and by 2015 the observed rate of civilian residential fire deaths in the state began to decline, falling from 25.5 deaths per million to 13.9 deaths per million by 2019. Fire professionals in Tennessee aim to build upon and continue the progress achieved in reducing home fire deaths.

The purpose of this study is to provide the analytical foundation to inform future actions to help reduce and prevent fatalities that occur in residential structures fires. Home fires are the focus since about three-fourths of all civilian fire deaths in the state occur in these dwellings. Trend analyses of fire incidents from 2013 through 2022 provide the basis for forecasts of residential fire fatalities assuming existing policies continue. These analyses employ fire incident data from the Tennessee Fire Incident Reporting System (TFIRS) and the most recent available 5-year estimates (2017-2021) from the U.S. Census Bureau's American Community Survey.

The most common heat source for residential fire incidents in Tennessee that involve one or more fatalities consists of smoking materials such as tobacco. This finding aligns with national data that show smoking materials are the leading heat source for U.S. residential fire deaths. Understanding the heat sources associated with fire fatalities is critical for prevention efforts. More work is needed in this area especially since the heat source is classified as "unknown" in about 40% of all fatal fires in the state.

This study finds that the expanded use of smoke alarms is strongly correlated with the reduction in home fire deaths during the 2013-2022 study period. In 2013, smoke detectors were present in just 28.8% of fire incidents, but by 2022, smoke detectors were present in 31.1% of all fire incidents, an indicator of progress in smoke detector distribution efforts. The state's "Get Alarmed Tennessee" program launched in 2012 partnered with local fire departments to distribute free smoke alarms to residents across the state, especially in neighborhoods with a higher risk for fire mortalities. The results are clear: fires in homes with smoke detectors are statistically less likely to result in deaths. In fact, the "Get Alarmed" program is credited with saving 450 lives between late 2012 and 2022.

The TFIRS data show that not a single fire fatality occurred in a one-or two-family dwelling equipped with a sprinkler system during the study period. While state law exempts communities from the NFPA 13D standard that requires installation of sprinkler systems in new one- and two-family dwellings, several Tennessee communities enacted an ordinance or resolution to require installation of a sprinkler system in new one or two-family structures. Home sprinkler systems significantly

reduce fire deaths, injuries, and property damage. In the future, sustained reductions in the rate of residential fire mortalities will be realized if more communities choose to adopt the NFPA 13D standard on home sprinklers.

To identify the communities with a higher risk for residential fire moralities, we analyzed ACS data to identify the social, economic, demographic, and housing variables that distinguished the census tracts that had one or more fire mortalities during the study period. The more closely a census tract resembled the tracts with previous fire fatalities, the higher the probability that tract may experience a home fire fatality at some point in the future. Our analysis identified 341 census tracts with "above average" risk, 135 tracts with a "high" risk level, and 33 tracts with the "highest" risk potential for future fire fatalities. This method provides decision makers with a rationale to allocate and deploy scarce resources (e.g. smoke detectors and fire prevention education efforts) where these efforts are likely to have the greatest prospect for reducing the risk of home fire casualties.

Chapter 1. Introduction

The annual number of home fire deaths in the United States is closely related to the number of home fires reported each year. Between 1980 and 2022, the number of reported home fires declined by about half (50.2%), and the number of fire deaths dropped by a similar margin (48%). These impressive reductions in both fire incidents and deaths are testament to the diligent work performed by a diverse network of professionals in fire management and community risk reduction.

Advances in Engineering, Enforcement, and Education (the "Three E's") are at the core of improving fire safety (Folz, Shults, et. al. 2011). Previous decades witnessed a more widespread use of smoke alarms, stronger fire codes and inspections, use of better construction techniques and materials, improved firefighter equipment and training, and creative fire safety education programs delivered to at-risk populations. The challenge for state and local officials in the years ahead concerns how best to deploy limited resources to build upon and continue the record of progress in reducing fire incidents and saving lives.

Historically, only about one-fourth (26%) of all reported fires occur in residential structures, but these incidents account for more than three-quarters (76%) of all civilian fire deaths (U.S. Fire Administration 2022). Accordingly, this study, like its predecessors (Folz, Shults, et al. 2011, 2014) focuses on fire incidents and mortalities in residential structures. Considering the high frequency of fire deaths in residential environments, sustained progress in reducing fire mortalities is an important fire safety priority.

Purpose of the Study

The purpose of this study is to examine the nature, extent and causes of fire fatalities in Tennessee between 2013 and 2022 with the aim of describing and diagnosing the state's fire fatality problem, identifying the populations that have a higher risk of fire mortality, explaining why fire fatality rates vary among the state's census tracts, and providing the basis to advance a strategic plan of action to reduce and prevent civilian deaths in residential fires in the state.

The specific research questions examined in this study include the following as they relate to civilian deaths in residential fires:

- What are the trends in the number and rate of civilian deaths in residential fires and how do these compare to the nation and to other states in the southeast particularly during the 2013 - 2022 period?
- Where and when do civilian residential fire deaths occur?
- What are the characteristics, features and causes of fire fatality incidents?
- Who are the victims of fatal residential fires and how do these profile data compare with that for the nation?
- What are the demographic, social, housing, and economic factors that distinguish those census tracts with fire deaths? Have these changed since previous studies in 2011 and 2014?
- Which census tracts have a higher risk of experiencing fire mortalities?

- What variables help to explain (and predict) the variation in the rate of fire mortality among census tracts?
- What are the study's implications for programs designed to minimize home fire fatalities? Which strategies appear to have promise for preventing fire deaths and reducing the risk of dying among more vulnerable population groups?

This study seeks to provide the type of information and analysis that can inform fire safety policy decisions. The observation made by one of the state's leaders in the fire management community at the inaugural 2010 fire mortality summit in Tennessee remains one of the best explanations for this type of study: "If our collective effort to develop a coordinated, coherent and comprehensive strategic action plan does nothing more than help save the life of one little girl whose body we do not have to carry out of a burned-out dwelling, then the time and energy we invested in this study will have been worth it."

Data and Methods

The source for all data related to fire mortality incidents in Tennessee is the Tennessee Fire Incident Reporting System (TFIRS) managed by the State Fire Marshall's Office. It is part of a national data collection effort, the National Fire Incident Reporting System (NFIRS), that is administered by the US Fire Administration, an agency in the Federal Emergency Management Administration in the US Department of Homeland Security.

The primary dependent variable of interest in this study is the number of civilian deaths in residential structure fires in TN during 2013 through 2022. A residential structure fire includes only those fires confined to an enclosed building or fixed portable or mobile structure with residential property use. Residential buildings include but are not limited to one- or two-family dwellings, multifamily dwellings, manufactured housing, boarding houses or residential hotels, barracks, college dormitories, and sorority/fraternity houses. Although there is a technical difference, the terms "smoke detector" and "smoke alarm" are used interchangeably in this study. NFIRS and TFIRS data do not distinguish between the two concepts.

The TFIRS data on civilian residential fire deaths are the basis for the mortality rate computed in this study. Mortality rates in fire administration are commonly reported as the number of occurrences per million population. Following that convention, we use the number of civilian residential fire deaths that occurred in a particular geography (e.g. census tract, county, city, or state) divided by the population of the geographical unit for the relevant time period, multiplied by 1 million.

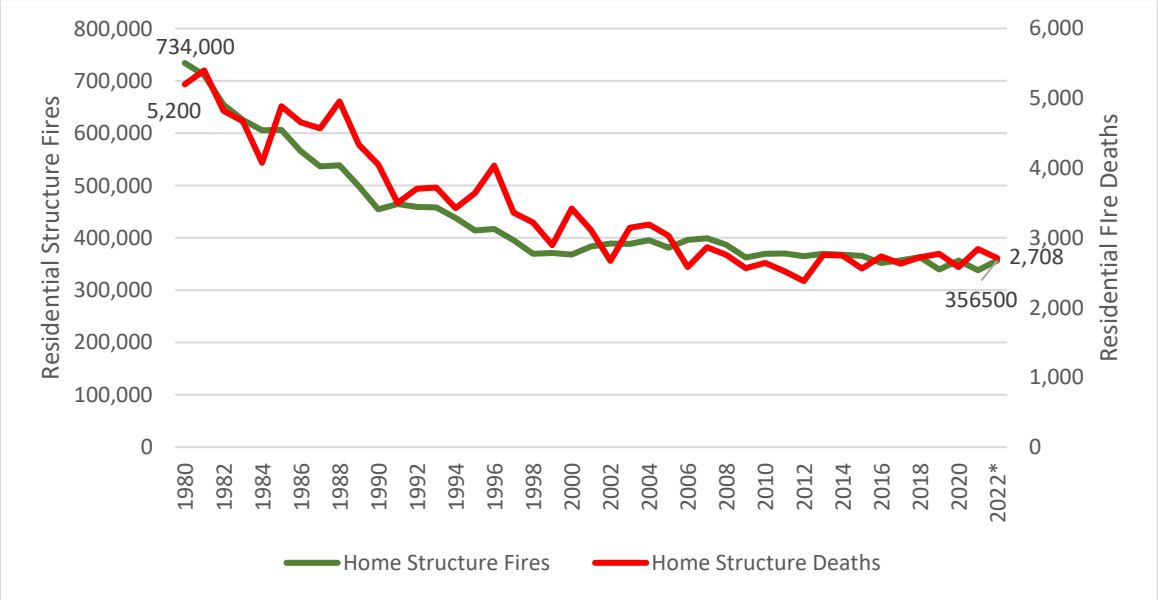
The source for housing, demographic, economic, and social data for various geographic units is the U.S. Census Bureau's 2017-2021 American Community Survey (5-year estimates). These data represent the most recent available at the time of this study. The data analyses reported in this study were performed with one or more of the following software tools: Excel, SPSS and ArcGIS. Excel was used to generate most of the figures and SPSS was used for most of the data analysis. ArcGIS was

used to match fire fatality incidents with census tracts and to identify the census tracts in Tennessee with profiles similar to those with a history of fire fatalities. ArcGIS software was used to geocode incident locations and assess precision in matching these locations to appropriate census tracts. Automated geocoding to current street centerline address was used to create point locations for each incident.

The Residential Fire Fatality Problem and Trends

Nationally, 147,028 civilians lost their lives in residential fires between 1980 and 2022. The annual average death toll was 3420. Figure 1-1 shows a pattern of decline in both home fire incidents and deaths that was most dramatic from 1980 through 2002 before leveling off during the last two decades. This decline in fires and deaths occurred even though the nation's population increased by about 106 million people or 47% (USA Facts 2023).

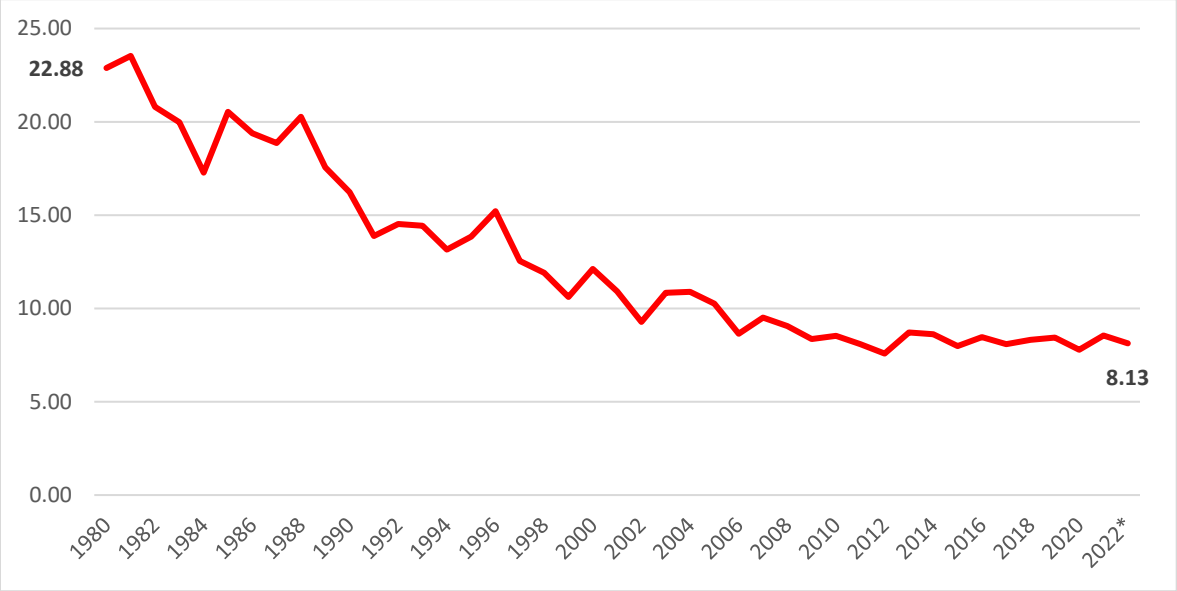
Figure 1-1. U.S. Residential Structure Fires and Fire Deaths, 1980 thru 2022



Source: Hall 2023.

As Figure 1-2 shows, the national fire mortality rate per million population declined from 22.8% in 1980 to about 8.23% in 2022, a nearly two-thirds (64.5%) reduction. Following the pattern in the number of reported home fires and deaths, the mortality rate dropped most steeply during the 1980 to 2002 period (about 59%) and then leveled off during the subsequent two decades. This trend suggests that the "low hanging fruit" in terms of the most impactful actions to reduce mortalities may have been implemented by states and communities during the first twenty years of this era.

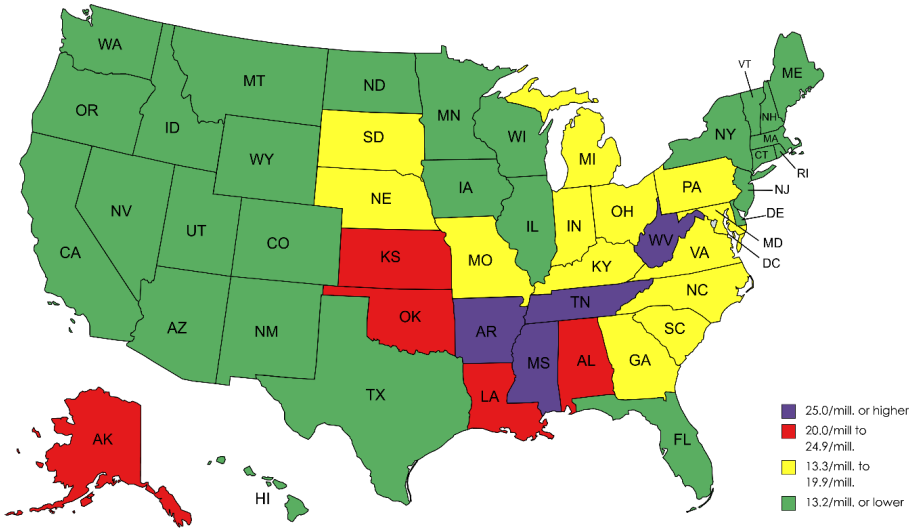
Figure 1-2. U.S. Residential Fire Mortality Rate, 1980 thru 2022



Sources: Hall 2023a; * = estimated based on 2022 media reports of fire fatalities, adjusted for the annual average difference between media reports and actual count by FEMA of fire fatalities. https://apps.usfa.fema.gov/civilian-fatalities/

Figure 1-3 classifies the mean fire fatality rates for each of the states based on NFIRS data for 2004, 2005 and 2007. The mean fire fatality rate for the nation during this period was 13.3 deaths per million. Four states, Mississippi, West Virginia, Tennessee, and Arkansas (in purple) had mean fire fatality rates higher than 25.0 per million population. Tennessee's rate was 25.5 deaths per million, the third highest in the country after Mississippi and West Virginia and about twice as high as the national average.

Figure 1-3. Mean Civilian Residential Fire Death Rates in the States (2004, 2005, & 2007)

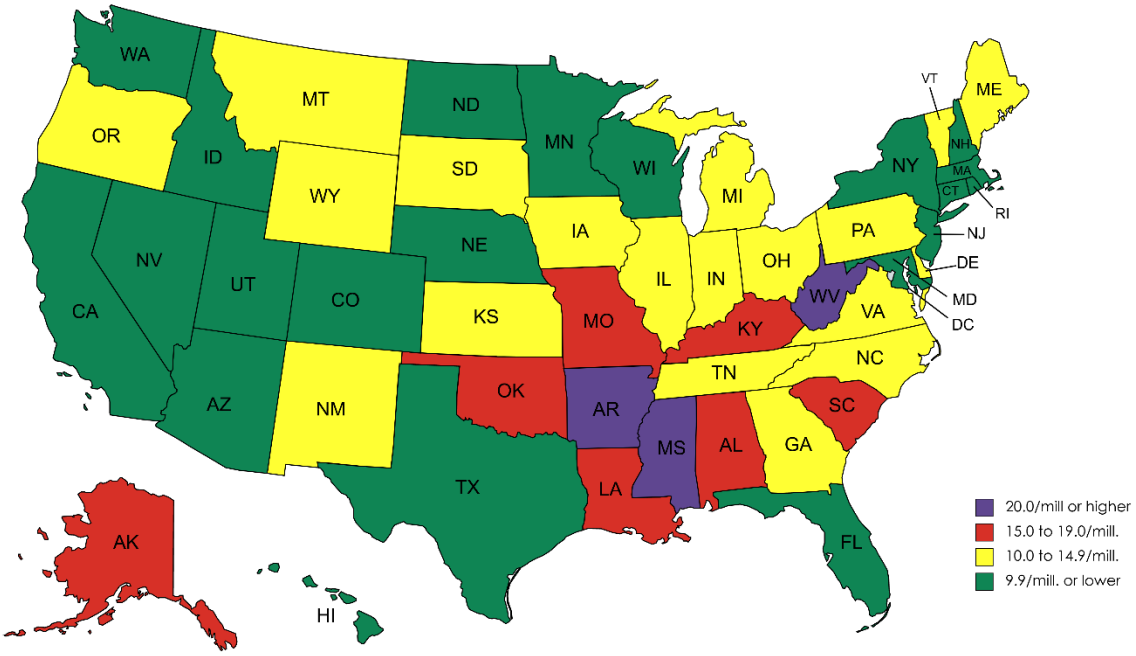


Source: U.S. Fire Administration 2009.

Figure 1-4 compares mean state fire mortality rates for the years 2015 through 2019, the most recent *interstate* data available at the time of this study (Ahrens 2021a). During this period, the national mean fire fatality rate was 10.0 deaths per million, a 25% decline from the 13.3 deaths/ million rate during 2004 -2007.

While nearly every state had fewer fire deaths and lower fire death rates during 2015-2019 compared to 2004-2007, Tennessee's reduction was one of the largest in the country. The decline in the mortality rate from 25.5 deaths per million (based on USFA estimates) to 13.9 deaths per million (based on the most recent data available from the TN State Fire Marshal's Office for this time frame) represents a 45% reduction. This outcome placed Tennessee among those states with a mean just above the national average and resulted in shifting the state's ranking on fire mortality rates from third highest to fifteenth highest in the nation. While sustained reductions of this magnitude are problematic, state, and local fire safety officials remain committed to making continued progress to minimize the loss of life in residential fires.

Figure 1-4. Mean Civilian Residential Fire Death Rates in the States, 2015-2019



Source: Ahrens 2021; TN State Fire Marshal's Office

The most recent fire fatality data for Tennessee available at the time of this study is displayed in Table 1-1. These data indicate that the state's fire deaths and mortality rate declined substantially between 2003 and 2022. During this period, the annual number of deaths in home fires declined from 146 in 2003 to 108 in 2022, a 26% reduction.

Table 1-1. Number and Rate of Civilian Residential Fire Deaths in Tennessee (2003-2022)

Year	Deaths	Population	Fire Mortality Rate
2003	146	5,847,812	25.0
2004	110	5,910,809	18.6
2005	134	5,991,057	22.4
2006	132	6,088,766	21.7
2007	114	6,175,727	18.5
2008	97	6,247,411	15.5
2009	87	6,306,019	13.8
2010	111	6,346,105	17.5
2011	85	6,397,634	13.3
2012	83	6,454,306	12.9
2013	100	6,494,821	15.4
2014	76	6,544,663	11.6
2015	72	6,595,056	10.9
2016	113	6,651,194	17.0
2017	85	6,715,984	12.7
2018	103	6,770,010	15.2
2019	93	6,829,174	13.6
2020	111	6,886,834	16.1
2021	107	6,968,351	15.4
2022	108	7,051,339	15.3

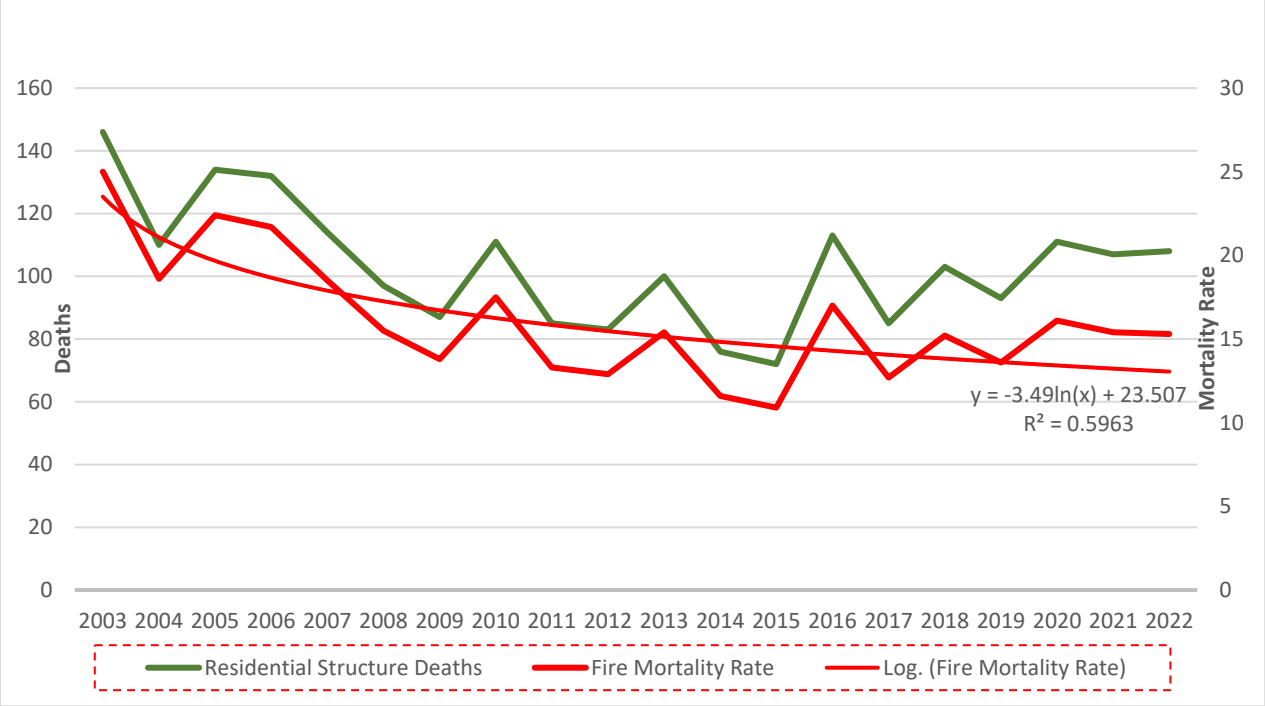
Source: TSFMO 12-3-2023.

During the 2003 – 2022 period, the state's annual fire fatality rate declined from 25.0 to 15.3 per million, a reduction of about 39%. Annual fluctuations in fire deaths and rates are not uncommon in the states. These variations may be caused by changes in population migration, socioeconomic composition, a spike in fire deaths in multi-unit structures, or changes in state and local fire safety policies, codes, or practices. Other variations may be explained by events (either natural or man-made) unique to a particular state. Consequently, longer time frames usually provide a more accurate basis for trend analysis; that is the rationale for the 20-year time frame employed in Table 1-1. Trend analysis helps to reveal the story of what occurred during this era.

The fire mortality rate per million accounts for changes in population size over time. Figure 1-5 confirms the sizeable decline in the state's fire fatality rate between 2003 and 2022. A logarithmic trendline indicates that most of the decline in the state's fire mortality rate occurred during the first ten years. The rate of change in the decline then leveled off during the subsequent ten years. A logarithmic trendline shows the best-fit line appropriate for data that exhibit a more rapid initial rate of change followed by a leveling off. The R-squared value of .59 indicates that this logarithmic trendline is a relatively good fit to the data. Consequently, it is apparent that despite annual fluctuations in fire deaths and the larger rate of change during

the first half of the study period, the fire morality rate in Tennessee continues to decline albeit at a slower rate.

Figure 1-5. Civilian Fire Deaths and Fire Mortality Rate in Tennessee, 2003-2022



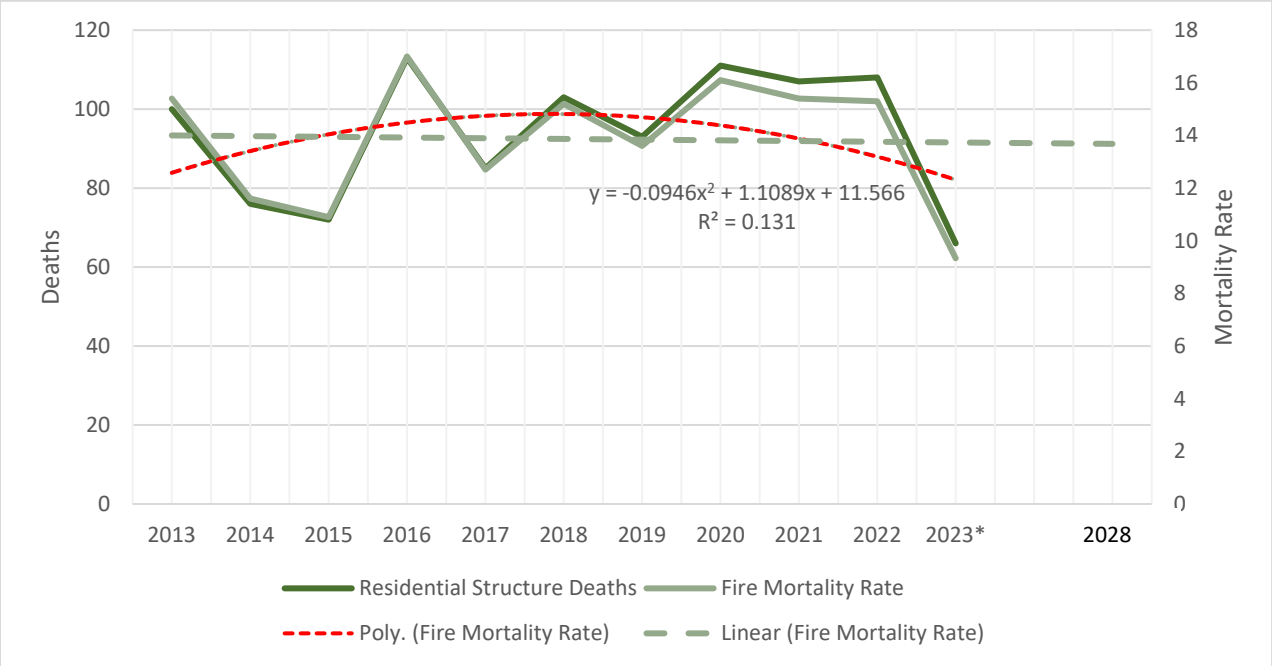
Source: TSFMO 2023.

Shorter time frames, such as the 2013-2022 study period for this study, complicate discernment of an overall data trend because annual variations tend to be magnified. Polynomial trendlines represent the pattern in data more accurately when the data exhibit multiple annual fluctuations (hills and valleys) over a shorter time span. The state's fire mortality rate during the 2013-2022 period certainly mirrors this type of pattern.

Figure 1-6 shows the polynomial trendline for the fire mortality rate from 2013 through 2023 based on available data as of mid-year 2023. This estimate indicates that at least 80 civilians will perish in fires during 2023. A linear projection generates an estimate of about 90-95 deaths during 2023. The actual number is likely to be within the 80 to 95 range. As expected, the polynomial trendline explains only a modest proportion of variance (R^2 = 13%) during a 10-year time frame. The accuracy of this estimate is confirmed by the 88 mortalities posted for 2023 on the TN State Fire Marshall's webpage as of 1-8-2024: https://www.tn.gov/commerce/fire/prevention-education-and-outreach/fire-fatalities-and-mortality-rate-in-tn.html. So, despite the large annual fluctuations in fire deaths during the 2013-2023 period, the principal take-away is clear: since 2018, the fire fatality rate in Tennessee has leveled off and appears likely to continue a slight annual decline. This downward turn suggests sustained, modest progress in the battle to reduce residential fire deaths.

A 5-year linear forecast beyond 2023 indicates that the state's mortality rate may level off at about 13.5 deaths/million by 2028. What accounts for this sustained, albeit modest success, in "turning the curve" in the fire mortality rate? Subsequent sections of this report examine programs launched by the Tennessee State Fire Marshal's Office that help to explain this outcome.

Figure 1-6. Civilian Fire Deaths and Fire Mortality Rate in Tennessee during 2013-2022 with 2023 Forecast



Sources: SFMO 2023 data at https://www.tn.gov/commerce/fire/prevention-education-and-outreach/fire-fatalities-and-mortality-rate-in-tn.html & population forecast from the UT Boyd Center at: https://experience.arcgis.com/experience/511cc776d42545afb2d3684ff90c2e8e

Summary

Residential fire deaths nationally declined significantly during the 1980-2022 period but dropped even more dramatically in Tennessee. While most of this reduction occurred during the first two decades of this era, the continued decline in the fire mortality rate for the nation and for Tennessee during the last two decades indicates a sustained, albeit modest, level of progress in reducing home fire deaths despite significant increases in population size. Though annual fluctuations occurred in the number of home fire deaths in Tennessee, trendline analysis indicated that the state's fire mortality rate exhibited an overall pattern of modest decline, a trend expected to continue for the remainder of this decade. This encouraging trend suggests that efforts by state and local fire officials to minimize fire fatalities have yielded results in the desired direction.

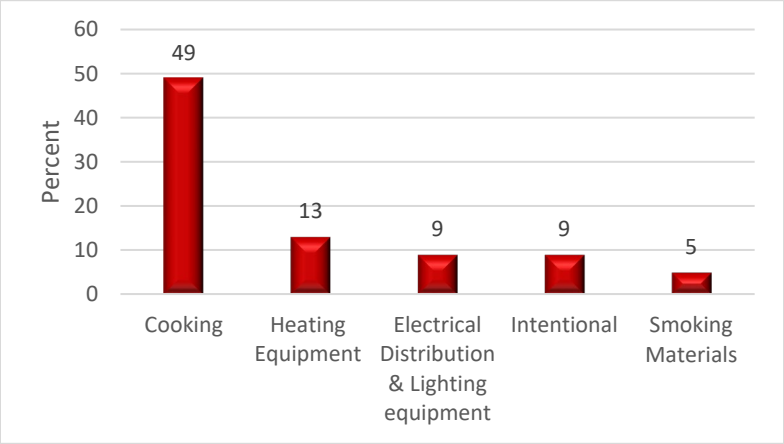
Chapter 2. The Features of Fatal Residential Fires, Involved Structures, Code Regimes, and Fire Death Victims

Causes of Civilian Fire Deaths

During 2016 – 2020, about one fourth (26%) of all reported fires in the U.S. occurred in residential structures, but these fires accounted for three-fourths (75%) of all civilian fire deaths (Hall 2023). During this 5-year period, U.S. fire departments responded to an average of 343,100 home structure fires annually. Each year about 2,610 civilians died in these fires (Hall 2023).

Nationally, the leading causes for these home fires are cooking, heating equipment, electrical distribution and lighting equipment, intentional fire setting, and smoking materials. The data reported by Hall (2023) reflect a proportional allocation of fires with unknown causes among the known causes. Figure 2-1 indicates that cooking was the leading cause of home fires in the U.S. during 2016-2020, a rank it has retained since 1980.

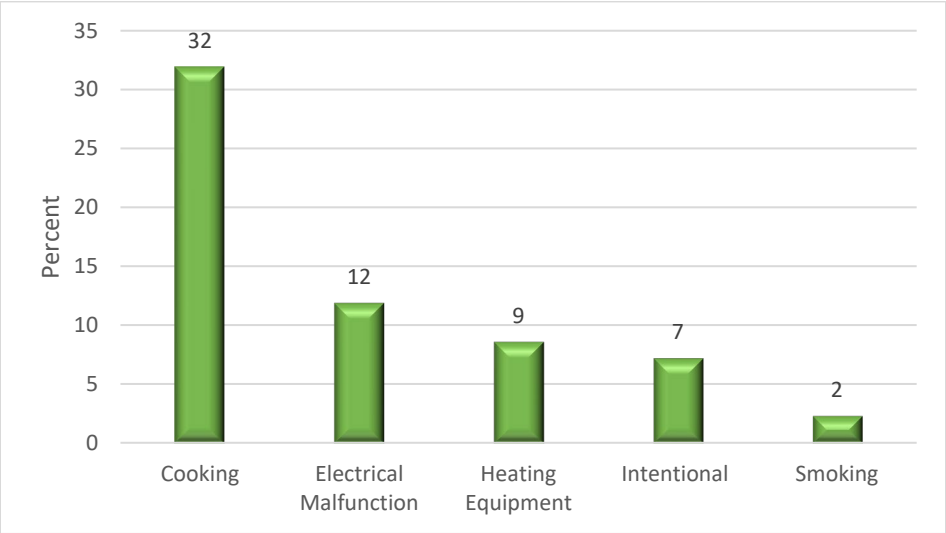
Figure 2-1. Leading Causes (Heat Sources) of Home Structure Fires in U.S. 2016-2020 (in percents)



Source: Hall 2023

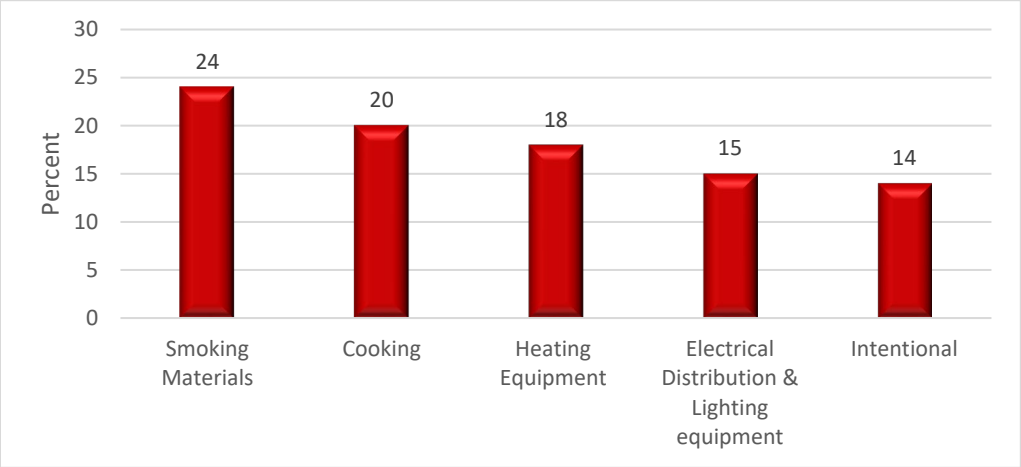
In Tennessee approximately one-fifth of the 68,925 home structure fires during the 2013-2022 study period had unknown causes. Among the remaining fires with an identified cause, the five leading causes are shown in Figure 2-2. Like the U.S.as a whole, cooking is the leading cause of home fires in Tennessee. However, fires caused by electrical malfunctions are somewhat more common than in Tennessee than nationally. Conversely, fires started by heating equipment are somewhat less prevalent than in the nation as a whole.

Figure 2-2. Leading Causes (Heat Sources) of Home Structure Fires in Tennessee, 2013-2022



Of course, not all home fires result in a fatality. The leading causes of *fatal* home fires in the U.S. are displayed in Figure 2-3. Fires started by smoking materials are the leading cause of home fire fatalities and account for an estimated 15,900 fires and 620 deaths nationally (Hall 2023). The heat source for smoking materials may include cigarettes, pipes, cigars, or

Figure 2-3. Leading (Heat Sources) Causes of Home Fire Deaths in U.S. 2016-2020 (in percents)



Source: Hall 2023

other undetermined materials. The NFIRS code for smoking material includes tobacco or marijuana, with the latter being an increasingly likely occurrence since twenty-one states legalized recreational use of this substance.

Figure 2-4 shows the leading causes of fatal fires in Tennessee during 2013 to 2022. While the cause of fatal fires is unknown in approximately 40% of cases, among fatal fires with known causes, the most common is smoking materials, just as

it is for the nation. Almost a fifth (17.9%) of all fire deaths in Tennessee are caused by smoking materials, a somewhat smaller proportion than the national average of 25%). Unlike the nation as a whole, the next most common causes of fire deaths are issues with heating equipment and electrical distribution and lighting. The percentage of fire deaths in Tennessee caused by cooking (nine percent) is half the national average of 18%.

Figure 2-4. Leading Causes (Heat Sources) of Civilian Home Fire Deaths in Tennessee, 2013 – 2022, (in percents)

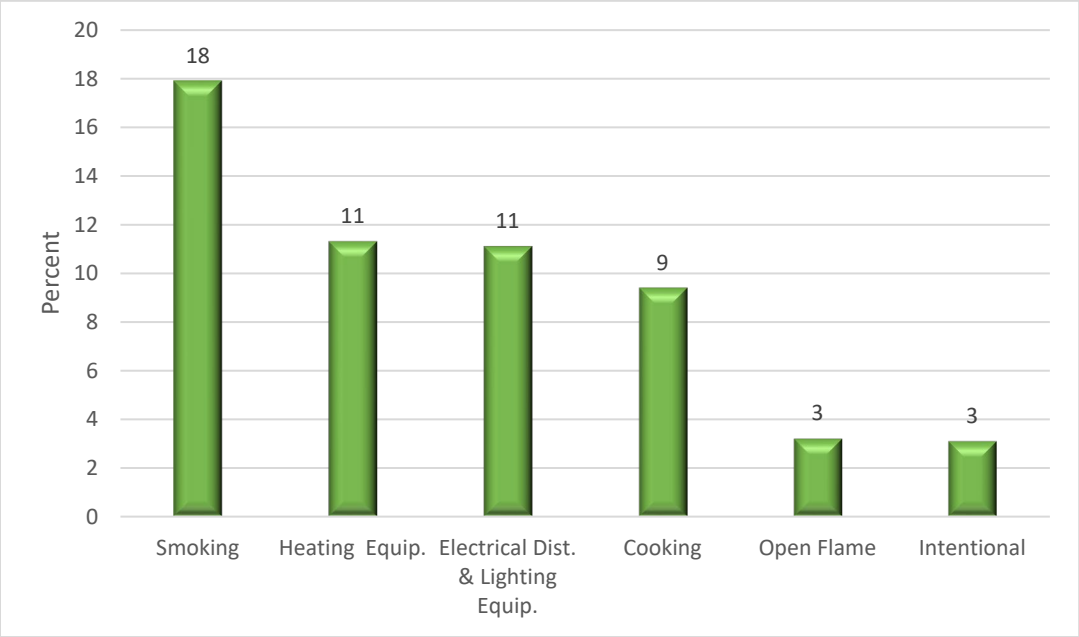
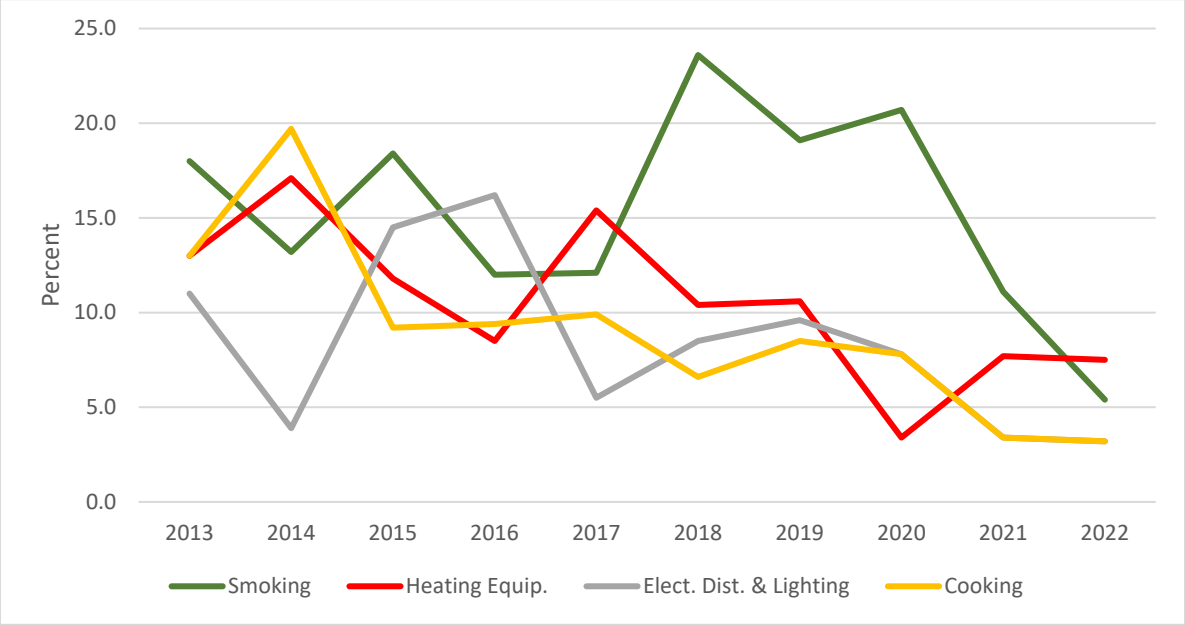


Figure 2-5 shows the pattern of change for each the four principal causes of fatal fires in Tennessee. For three of the four leading causes of fatal fires, the pattern generally indicates a modest, gradual decline over the study period. The trend for fatal fires caused by smoking materials, the cause of the largest proportion of fatal fires, is more erratic. After dips and spikes from 2013 thru 2017, fire deaths due to smoking materials increased sharply in 2018 and remained above 20% in 2020. Then, in a dramatic reversal, fire deaths caused by smokng declined drammatically in 2021 to an historic low of 5.4% of fatal fires in 2022. Since smoking materials is the leading cause of fire fatalities, a continuation of this trend likely will result in a continued reduction in fire fatalities in the state.

Figure 2-5. Trends in the Leading Causes of Fatal Fires in Tennessee, 2013-2022



Area of Fire Origin & Item First Ignited

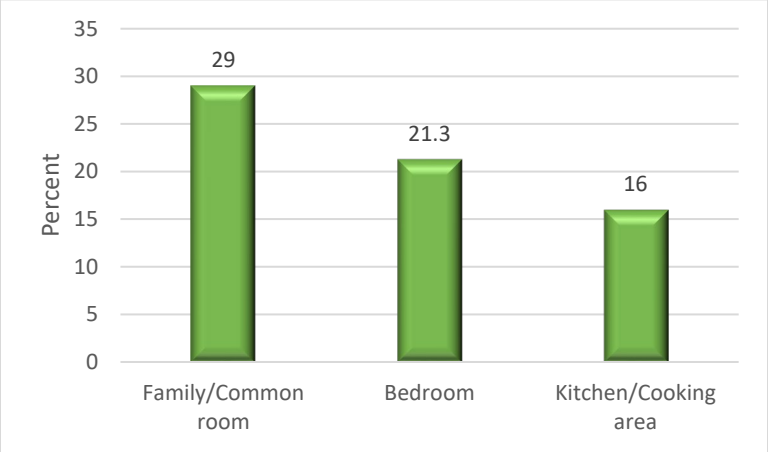
The U.S. Fire Administration (2022) reports that the areas of origin for fatal fires in residential buildings during 2016-2020 consisted of living rooms, bedrooms, and kitchen or cooking areas. As Figure 2-6 indicates, more than two-thirds of all cases in which the fire origin could be identified occurred in these three areas of the residence.

Figure 2-6. Origin of Fatal Residential Fires in the U.S., 2016-2020 (percent)

In Tennessee, the area of origin was undetermined for more than half of the 755 fires recorded by TFIRS that involved a fatality. Among those incidents for which

the area of origin was known, the three most common in Tennessee mirror those for the nation. Figure 2-7 indicates that two-thirds (66.3%) of all fatal fires originated in either a family or common room, a bedroom, and a kitchen/cooking area. Consequently, smoke alarms installed in these spaces should have the most potential for reducing the number of fire fatalities.

Figure 2-7. Origin of Fatal Residential Fires in Tennessee, 2013-2022

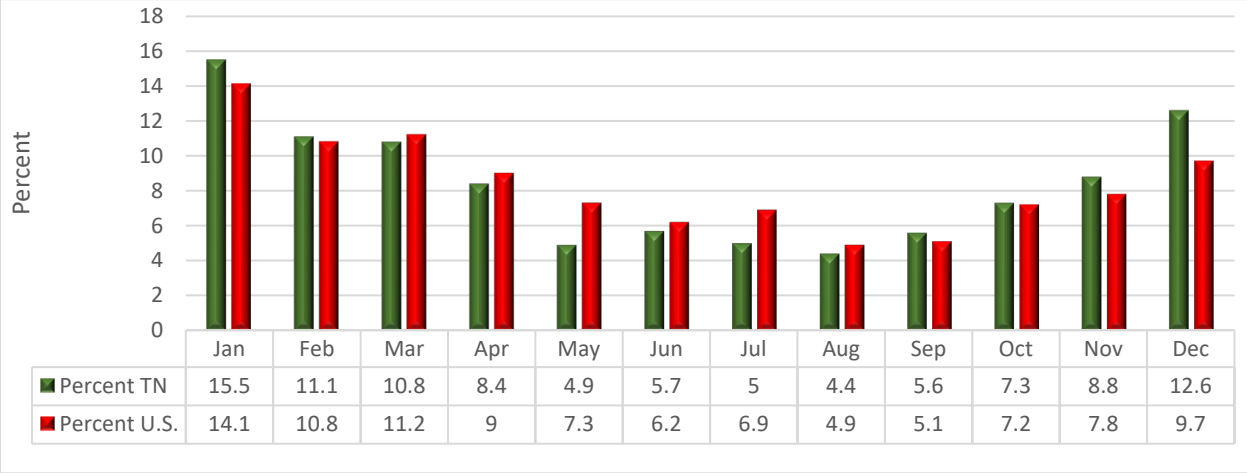


The item first ignited in fire incidents in the U.S. and Tennessee also occurred with similar frequency. Cooking materials, including food, is the type of item first ignited in the largest proportion of fires both nationally and in Tennessee. The next most common item ignited first is electrical wire, including cable insulation. The third most common item ignited first are appliance housings or casings.

The Seasonal Pattern of Fire Fatalities

The seasonal nature of fire fatalities in Tennessee and the U.S. is apparent in Figure 2-8. For both the nation and the state, the most fatal fires occur during the winter months when more people are indoors. December and January typically have twice as many fatal fires as do the summer months. The proportion of fatal fires in TN during these two winter months is significantly higher than the nation as a whole and reflects the prominence of heating equipment and electrical equipment as more frequent causes for fatal fires in Tennessee.

Figure 2-8. Fatal Fires by Month: TN (2013-2022) and U.S. (2018-2020)



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Percent TN	15.5	11.1	10.8	8.4	4.9	5.7	5	4.4	5.6	7.3	8.8	12.6
Percent U.S.	14.1	10.8	11.2	9	7.3	6.2	6.9	4.9	5.1	7.2	7.8	9.7

Source: TSFMO 2023 & US Fire Adm. 2022

In terms of the time of day, the USFA (2022) reports that most fatal residential fires nationally occur during the hours of 11:00pm to 7:00am when more people are likely to be asleep. On the other hand, most nonfatal residential fires occur during afternoon and early evening hours (noon to 9:00pm) when cooking occurs. These patterns are similar to those for the fatal and nonfatal fires in Tennessee during 2013 -2022.

Smoke Detectors and Fire Fatalities

The U.S. Fire administration (2022) estimated that smoke alarms and smoke detectors (these terms are used interchangeably in this report) were present in 33% of all fatal fires in U.S. residential buildings during the 2018-2020 period. In 24.8% of these fatal fires, no smoke alarms were present. In 42.5% of fatal fires nationally, firefighters were unable to determine if a smoke alarm was present.

These national means are very similar to those for Tennessee during 2013-2022. In Tennessee, smoke alarms were present, on average, in 33.1% of fatal fires, not present in 23.6%, and their presence was unknown in 41.2% of fires. In an earlier study by Folz, Shults, et al (2011), smoke detectors were present in just 28.3% of fire incidents during the 2002-2010 period.

In terms of the operational status of smoke alarms nationally during 2018-2020, 16% of smoke alarms present were operational, seven percent were present but did not operate, and the operational status of 11% of detectors was unknown (USFA 2022). In Tennessee during the 2013-2022 period, on average 14.4% of smoke alarms present were operational, 30.4% were present but did not operate, and the operational status of the smoke alarm was unknown in 55.2% of fatal fires. The significantly higher proportion of non-working smoke alarms in Tennessee fatal fires suggests that efforts to continue and expand educational outreach to residents that emphasize the need to test and replace smoke alarm batteries should help to reduce fire fatalities.

Of interest to both fire officials and citizens is whether the presence of smoke alarms actually helps to reduce fire fatalities. The TFIRS data in Figure 2-9 shows the relationship during 2013-2022 between fire detector presence and the fire mortality rate. These polynomial trends clearly show that an increase in smoke detectors parallels the decline in the state's fire mortality rate. During 2021 and 2022, the presence of working smoke detectors in fire incidents appeared large enough to help "bend the curve" in the rate of fire mortalities.

Figure 2-9. Relationship Between Fire Detector Presence and Fire Mortality Rate, 2013-2022

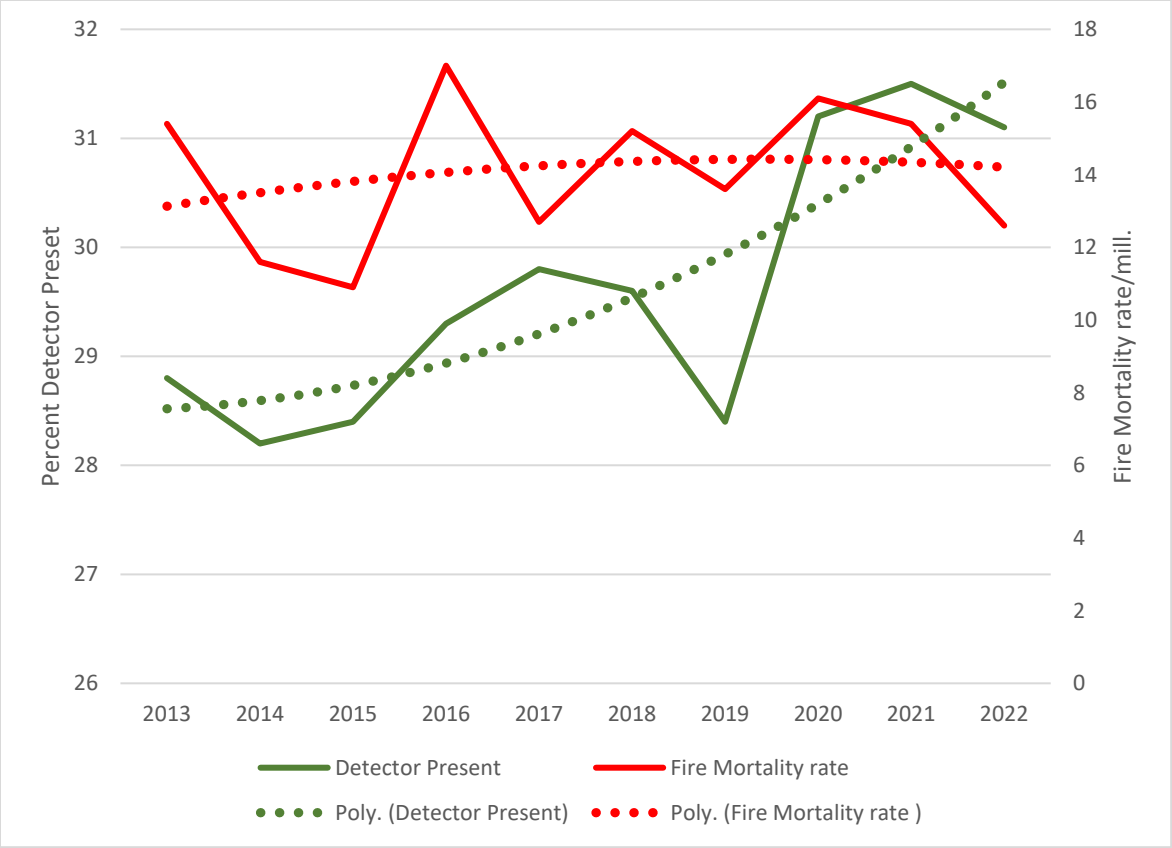


Table 2-2 shows the annual means for TFIRS smoke detector data for 2013-2022. Unfortunately, data on the presence of smoke detectors are available for only a minority of the fire incidents that occur annually. The incidents in which the presence of detectors is either undetermined or missing, while declining over time, still comprise the majority of fire incidents.

Nonetheless, trends in the data in Table 2-2 have several implications for fire safety in Tennessee. First, as the number of fire incidents declines over time, the proportion of fires where smoke detectors are present appears to increase. The data also suggest an inverse relationship between the increase in the presence of smoke detectors and a decline in the state fire mortality rate, a pattern that appears in the trendlines shown in Figure 2-9.

Table 2-2. Available Data for Smoke Detector Presence in Fire Incidents and Trend in the Fire
Mortality Rate in Tennessee, 2013-2022

Status	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Present	28.8	28.2	28.4	29.3	29.8	29.6	28.4	31.2	31.5	31.1
None Present	15.5	14.7	14	14.4	15.4	15.5	14.7	15.8	17	17.3
Undetermined	20.6	20.3	18.8	21.1	20.1	22.3	21.5	19.5	19.7	18.8
Missing	35.1	36.7	38.7	35.2	34.7	32.6	35.3	33.5	31.9	33.3
Fire Incident totals (N)	6884	7782	7515	7357	6686	6822	7143	6718	6588	5430
Fire Mortality rate	15.4	11.6	10.9	17	12.7	15.2	13.6	16.1	15.4	12.6

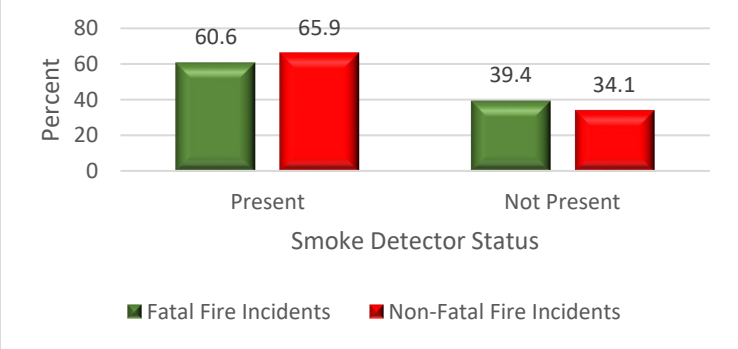
To what extent are smoke detectors present in non-fatal versus fatal fire incidents in Tennessee during 2013-2022? The means reported in Table 2-3 and Figure 2-10 are calculated only for the subset fire incidents that recorded smoke detectors as being present or not present. These means indicate that home smoke detectors are more likely to be *absent* in fatal fires. Smoke detectors were absent in 39.4% of fatal fires compared to 34.1% of nonfatal fires. Conversely, smoke detectors were present in almost two-thirds (65.9%) of nonfatal fire incidents, but they were less likely to be present in fatal fires (60.6%). While this difference is not large, it is nonetheless statistically significant (p=.013, 95% CI). This difference is substantively important because it means that efforts to equip homes with smoke detectors have a measurable and meaningful relationship with an observed reduction in fire fatalities.

Table 2-3. Smoke Detector Status in Non-fatal versus Fatal Fire Incidents for Cases Where Smoke Detector Presence Ascertained in Tennessee, 2013-2022.

Smoke Detector Status	All Fire Incidents	Non-Fatal Fire Incidents	Fatal Fire Incidents
Present	65.8	65.9	60.6
Not Present	34.2	34.1	39.4
N	30,951*	30,423	434

*Missing cases for either smoke detector status or fatality status account for the 94 case difference between all fire incidents and the sum of non-fatal and fatal fires.

Figure 2-10. Smoke Detector Status in Fatal and Non-fatal fires in Tennessee, 2013-2022



Lives Saved by the "Get Alarmed Tennessee!" Smoke Detector Distribution Program

"Get Alarmed, TN!" is a grant-funded fire safety education and smoke alarm installation program administered by the State Fire Marshal's Office (SFMO). Launched in November 2012, the program distributes fire safety education and 10-year sealed battery smoke alarms to those fire departments who apply for program participation. The fire departments then provide fire safety information to households and the install smoke alarms in at-risk homes across the state (SFMO https://www.tn.gov/commerce/fire/prevention-education-and-outreach/get-alarmed-tn.html).

Since the program's inception, staff for the Tennessee SFMO collected incident information from local fire department officials to document all cases in which the presence of a smoke alarm installed in a residence through the "Get Alarmed Tennessee" is credited as the primary factor in saving the life of one or more residents. These incident descriptions specify how installed smoke detectors alerted residents who either were asleep or otherwise unaware of a spreading fire in the structure that most likely would have had fatal consequences if not for the warning that enabled a timely exit or escape (SFMO https://www.tn.gov/content/dam/tn/commerce/documents/fire_prevention/education-outreach/smokealarmprogram/saves/SmokeAlarmProgramSavesDecember2022.pdf).

An example of the type of report that would be collected by SFMO staff is a fire incident that occurred on 10-10-23 in East Knoxville as reported by WVLT-TV (2023):

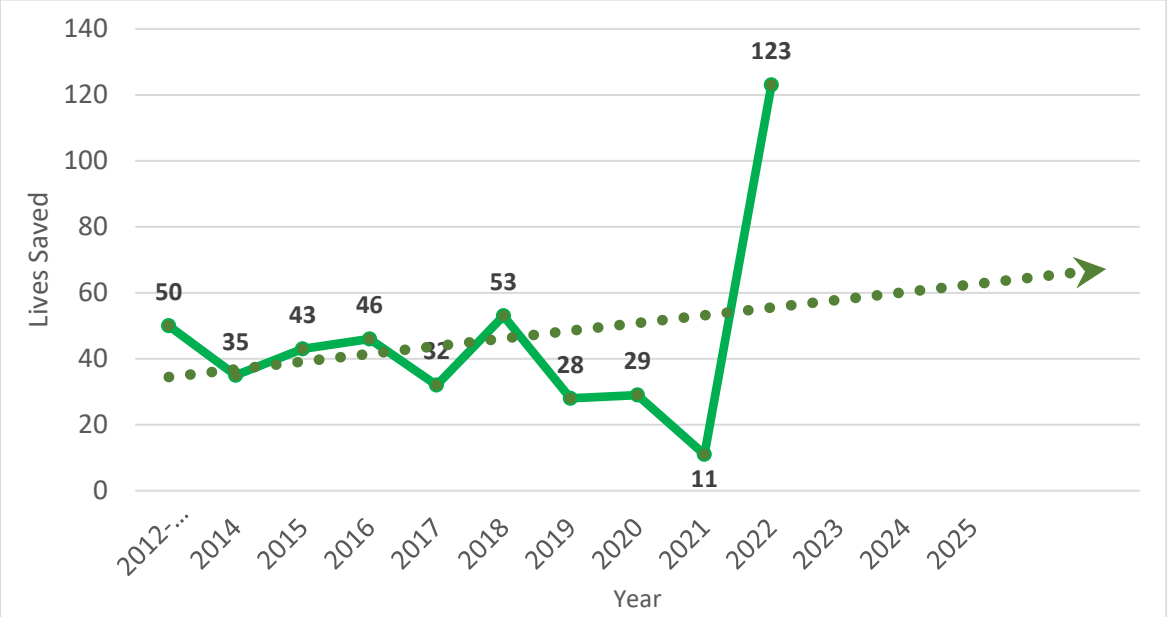
> "Janice Staton was asleep on her couch in her home in East Knoxville when she and her family woke up to the sound of the smoke alarm wailing. 'It was a lifesaver. It really was,' Staton said. 'I just jumped up, and me and my grandson both saw smoke coming out of his room, and we ran back there, and it was on fire.' Staton and her family woke up to the sight of a fire destroying the back half of the house they had called home for nearly a decade. The fire burned most of the family's belongings, but all six people in the house made it out

safe. If the smoke detector didn't wake them up, Staton said it could've been much worse. 'I just thank God nobody was hurt,' Staton said."

In this case, six lives would be recorded as saved by the smoke alarm alert in this fire incident.

Based on similar reports collected since late 2012, smoke detectors installed through the "Get Alarmed Tennessee" program are credited with saving the lives of 450 individuals in 175 distinct fire incidents. Figure 2-11 displays the annual number of lives saved that are attributed to the warnings or alerts provided to occupants from smoke detectors installed through the state's program.

Figure 2- 11. Documented Lives Saved by "Get Alarmed" Program and the Linear Forecast



A linear forecast of the lives saved by smoke alarms is based on the historical rate of smoke alarm installation and the number of lives saved since 2012. The dashed line in Figure 2-11 is a linear projection of the lives expected to be saved by 2025 and beyond. Based on this projection, the "Get Alarmed Tennessee" program should help to save at least an additional 150 lives between 2023 and 2025, resulting in an estimated 600 lives saved since the program's inception. This projection assumes no change in previous levels of program participation. If more fire departments participate, then even more lives will be spared in home fires.

Fire service professionals are well aware of the potential risks associated with lithium-ion batteries that are now prevalent in a number of different devices such as electric bikes, and hoverboards in addition to phones, tools, and laptops. Underwriter's Laboratory (2023) reported that in 2022, these devices were responsible for 2121 fires that resulted in 101 fatalities and 713 injuries. Fires involving lithium-ion batteries are unique because of the high temperature and duration of burn (NFSA 2023). These fires require application of a continuous water supply to

minimize spread (NFSA 2023). To facilitate early detection of these fires, the UL's Fire Safety Research Institute (2023) recommends that residents have properly installed working smoke alarms. Accordingly, it seems prudent that smoke detectors should be located in those areas of the home where lithium-ion batteries are typically stored and charged (e.g., basements or garages) as well as in those rooms where home fires originate (living rooms, kitchens, bedrooms).

Residential Fire Sprinklers and Fire Mortality Risk

The U.S. Fire Administration (USFA 2023) reports that smoke alarms and home sprinkler systems together can "reduce the risk of fire deaths by 82%" and "reduce fire damage by up to 97%." The NC State Fire Marshall's office (2021) also observed that home fire sprinklers save lives and property when coupled with working smoke alarms and fire escape plans. Consequently, the installation of automatic sprinklers in new one-and two-family homes in Tennessee (already required in multifamily and commercial structures) represents an action that can have a very significant cumulative impact on the reduction of civilian fire mortality risk.

Home sprinklers are most often installed in new construction, but existing homes can be retrofitted as well. Pannell (2024) finds that the cost per square foot for a sprinkler system in new construction averages between $1.50 to 3.50 nationally; costs in Tennessee are likely to be near the lower side of this range. The cost to retrofit an existing home with a sprinkler system depends in on several variables including the structure's design, age, and type of piping materials used in the system, but generally estimates range between $2 to $7 per square foot (Team Homeserve 2022).

In operation, home sprinklers keep fire and deadly smoke from spreading. Standard temperature activation occurs between 130 F and 155 F (Weinberger 2023). Typically, only the sprinkler closest to the fire activates and sprays water on the flames; sprinkler heads in other locations that do not reach that temperature do not activate. Compared to a fire department hose, home sprinklers put much less water on the fire and cause much less water damage. Sprinklers also provide residents with extra time to escape from a fire. Particular beneficiaries are children, older adults, and the physically impaired who may not be able to exit swiftly or on their own. In addition, the widespread use of synthetic materials in contemporary household furnishings cause fires to burn hotter, spread faster, and produce more toxic fumes and gases than in the past, leaving homeowners with just a few minutes to escape (Team Homeserve 2022). Homeowners with residential fire suppression systems in place "have greater peace of mind, more safety from fire, and the potential for savings on their home insurance premiums" (Mickelson 2023).

TN Code § 68-120-101 (2019) provides a specific exemption to the NFPA 13 D fire sprinkler system requirements for 1- and 2-family dwellings. NFPA 13D is the building standard for the installation of sprinkler systems in one- and two-family dwellings and manufactured homes. Tennessee's statute provides that the state fire marshal "shall not include mandatory sprinkler requirements for one-family and two-family dwellings; however, notwithstanding this subdivision (a)(8), local governments

may adopt more stringent requirements for one-family and two-family dwellings." A local government that proposes to adopt mandatory sprinkler requirements for one-family and two-family dwellings may do so "upon an affirmative two-thirds (⅔) vote on final reading" (TN Code § 68-120-101 2019).

Some local governments in Tennessee have adopted sprinkler ordinances for newly constructed one- and/or two-family dwellings. Among them are Ashland City (2001, for two- or multi family structures), Kingston Springs (2006), Millersville (2022), Nolensville (2004), and Piperton City (2001, for two- or multi family structures). Some communities have adopted sprinkler ordinances that apply to any residential building that exceeds a specified square footage, e.g. Collierville (2020, 5,500 sq. ft) and Germantown (2022, 5,000 sq. ft), Pleasant View (2013, 5,000 sq. ft.), and Cheatam County (2006, in subdivisions with more than 3 lots). (Pannell 2024).

The evidence is compelling. TFIRS data for 2013 -2022 does not record a single fire fatality in a home equipped with a sprinkler system. Table 2-4 shows that 782 fire fatalities occurred among the 35,769 fire incidents for which both the number of non-fire service fatalities and the status of an automatic sprinkler system were recorded. Zero residents perished in one- or two-family home fires where a sprinkler system was present or partially present. In terms of home fire injuries, the TFIRS data indicated that 1166 persons sustained some type of fire injury, but only 4 (.34%) of these occurred in homes with sprinklers.

In fact, the chances of a fire incident in a home equipped with sprinklers are very small. During the ten-year study period only 280 of 35,769 fire incidents involved one-and two-family dwellings with sprinkler systems. That represents .78% of reported fires.

Table 2-4. Presence of Automatic Sprinkler Systems and Residential Fire Fatalities Among Civilians in TN Fire Incidents, 2013-2022 (excluding missing data)

		Number of Civilian Fire Fatalities								
Status of Auto Sprinkler System		0	1	2	3	4	5	6	10	Totals
Present	N	268	0	0	0	0	0	0	0	268
	%	0.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.7%
Partial System Present	N	12	0	0	0	0	0	0	0	12
	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Not Present	N	31508	489	60	17	7	2	2	1	32086
	%	89.7%	90.2%	95.2%	94.4%	100%	100%	100%	100%	89.7%
Undetermined	N	3346	53	3	1	0	0	0	0	3403
	%	9.5%	9.8%	4.8%	5.6%	0.0%	0.0%	0.0%	0.0%	9.5%
Totals	N	35134	542	63	18	7	2	2	1	35769
	%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Clearly, one-and two-family homes equipped with automatic sprinkler systems provide residents with a high level of assurance that the risk of perishing in a home fire is extremely low. With respect to advancing the public safety of residents, there are comparatively few other strategies that can prevent so many fatalities for such a relatively modest cost.

Characteristics of Structures in Fatal Home Fires in Tennessee

To assist in identifying communities that have a higher risk for fatal fires, it is useful to examine the features of the residential structures involved in previous fatal fires. The year of home construction was ascertained for 722 (73%) of the 992 fatal fire incidents that occurred during 2013-2022. Figure 2-12 shows the number of fire deaths that occurred in homes constructed in a particular decade. The largest number of fire fatalities occurred in homes constructed during the 1970s. However, as Figure 2-13 indicates, homes built during the 1970s also comprise the largest proportion of the state housing stock.

Figure 2-12. Number of Residential Fire Deaths in Tennessee by Decade Structure Built

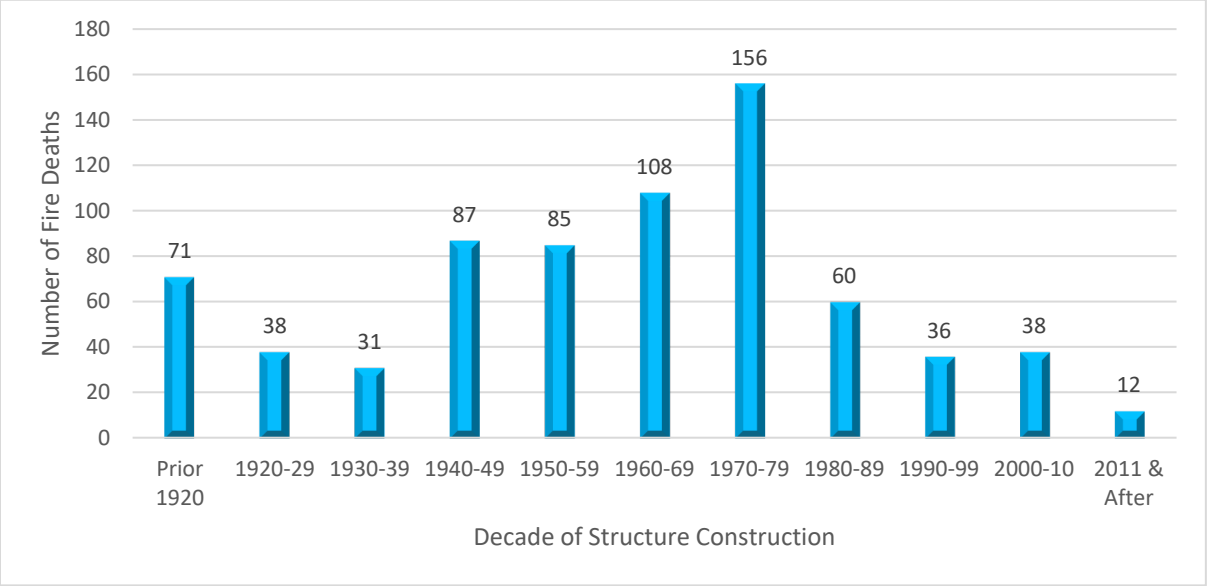
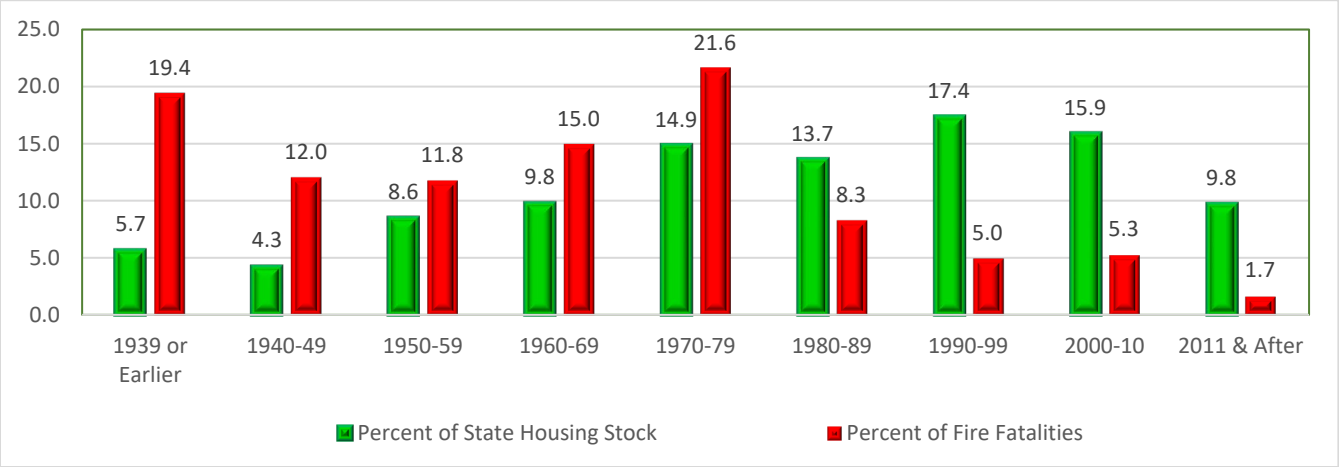


Figure 2-13 shows that fire fatalities are more likely to occur in older homes. The percentage of fire deaths in homes constructed in each decade prior to 1980 is significantly higher than that decade's proportionate share of the state's total housing stock. Homes constructed prior to 1980 comprise about 43.3% of the state's housing stock but fire fatalities in these homes account for almost 80% of all fire fatalities during 2013-2022. Consequently, we hypothesize that those communities with larger proportions of their housing constructed before 1980 are more likely to have a higher risk for fire fatalities.

Our analysis also indicated that homes constructed between 1940 and 1979 were significantly less likely to have a working smoke detector present in fatal fire incidents. Among the fatal fires where the presence of a smoke detector could be

ascertained, smoke detectors were absent in 38% of fatal incidents in those homes built between 1940 to 1979, a proportion about twice as high as occurred in fatal fires in structures built before or after that period.

Figure 2-13. Age of State Housing and Incidence of Home Fire Fatalities, in Percents (2013-2022)



Homes constructed during 1940-1979 also were more likely to have fatal fires caused by malfunctioning appliances, electrical distribution issues, and lighting issues. The homes built during this period were somewhat more likely to be renter- than owner-occupied.

The five-year estimates from the 2017-2021 ACS indicated that the rate of owner-occupied housing units for Tennessee was 66.9% and the rate of non-owner occupants was 30.1% (U.S. Census Quick Facts 2023). Table 2-5 indicates that the structures involved in fatal fires in Tennessee are more likely to be occupied by renters (44.4%) rather than owner-occupants when compared to the statewide means of occupancy by owners versus renters.

Table 2-5. Occupant-Owned Status of Structures in Fatal Home Fires in Tennessee

Status	Number	Percent
Yes	384	55.6
No	306	44.4
Total	690	100

Table 2-6 shows the types of residences involved in fatal fires during 2013-2022. The state profile is similar to that for the nation. Since most residents live in one-and two-family dwellings, it is not surprising that 83.5% of fatal fires occur in these types of residences.

Table 2-6. Property Use of Homes in Fatal Fires in Tennessee 2013-2022, N = 973

Property Use	Percent
One- and two-family dwellings	83.5
Multifamily dwellings	9.7
Other residential buildings	6.3
Hotels & motels	0.5

Code Enforcement Regimes in Tennessee

Local variations in the adoption and enforcement of residential building and electrical codes may impact the level of risk exposure for residents with respect to the likelihood of a fatal fire event. The rationale for adopting and enforcing building construction safety standards is to assure that occupants are protected from a variety of possible hazards that elevate risk of fire, structural failure, electrical and heating systems failure, electrical shock, and other health risks.

The Tennessee Clean Energy Future Act of 2009 as amended by T.C.A. § 68-120-101,
adopted energy efficiency standards and broadened statewide building standards to cover newly constructed one- and two-family dwellings in addition to municipal, county, state and certain private buildings (MTAS 2022). This legislation created three classes of code enforcement across the state:

1. Opt-In: Exempt (local enforcement) — These are cities where local building codes
and local code enforcement meet state minimum standards. Exempt cities adopt and enforce their own building codes. In the TFIRS data, the label used to identify these communities is "locally enforced."

2. Opt-In: Non-exempt (state enforcement) — If a city cannot or decides not to adopt and enforce the minimum standards, the state will enforce the applicable statewide
codes in the city. The commissioner of commerce and insurance is authorized to contract with local governments to use their employees for inspections of one- and two-family residences. These contracts allow inspectors to charge a fee as set out by the state fire marshal's fee schedule. Deputy building inspectors must be state certified as a licensed building inspector, a licensed plumbing inspector, or a licensed mechanical inspector. At the request of the city or upon the department of commerce and insurance's own initiative, the state will enforce state-adopted building codes (MTAS 2022).

3. Opt-out — Whether or not it is enforcing a locally adopted code or has no code at all, a city can completely avoid state regulation of one and two-family dwellings in its jurisdiction by opting out of the statewide standards. This can be accomplished by a specific and recurring resolution process. This requires a city to pass a resolution by a two-thirds vote of the governing body exempting one- and two-family dwellings in its jurisdiction from the applicability of the statewide standards and to forward the resolution to the state fire marshal. The resolution, however, expires 180 days following the date of the next election. Therefore, each new governing body must pass a subsequent resolution to continue avoiding the applicability of the state standards. The counties and cities that opted out of the residential inspection program represent approximately 16% of the state's jurisdictions and about 20% of the state's population (MTAS 2022).

In 2017, the Tennessee General Assembly passed legislation that allows an owner of a building, structure, or premises located within an "opt-out" or "non-code"

jurisdiction to request the State Fire Marshal's Office to inspect the building, structure, or premises to determine if it meets the statewide building construction safety standards (Tenn. Code Ann. § 68-120-101(b)(1)(D). If the one- or two-family dwelling meets the statewide building construction safety standards, the State Fire Marshal's Office will release a Certificate of Occupancy. In addition, owners of one- or two-family dwellings may be able to access lenders and loan programs previously unavailable to them if the lender or loan program requires a Certificate of Occupancy. (TN Dept. Commerce & Insurance 2018).

Table 2-7 shows the distribution of building code regimes for all of the communities (cities and counties) in Tennessee. Most Tennessee communities (almost 62%) are in the exempt category where individual jurisdictions are responsible for adopting and enforcing their own building codes. The most populous cities and counties in the state have this type of building code regime so it is not surprising that this type of code regime has the largest number of civilian fire fatalities. While some communities changed classifications during the study period, membership in a particular category is mainly stable. Metrics to assess any differences in code enforcement among exempt communities are not available.

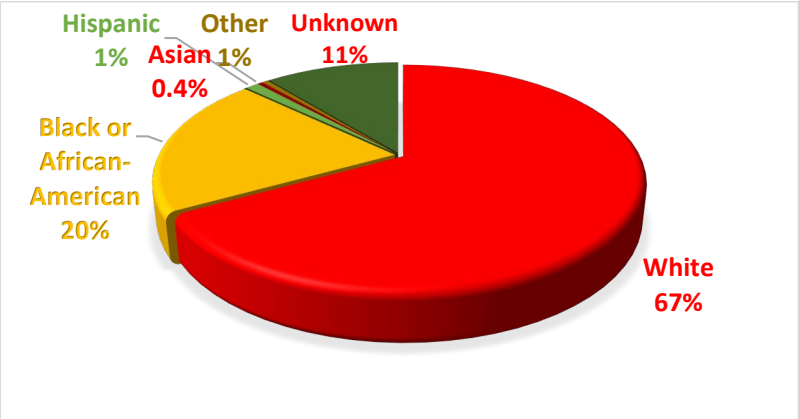
Table 2-7. Distribution of Building Code Regimes in Tennessee, Jan. 2023.

Type	N	Percent	Number of Fire Fatalities
Exempt	292	61.7	544
SRBP	106	22.4	58
Opt Out	75	15.9	54
Total	473	100.0	656

Profiles of Fire Fatality Victims in Tennessee

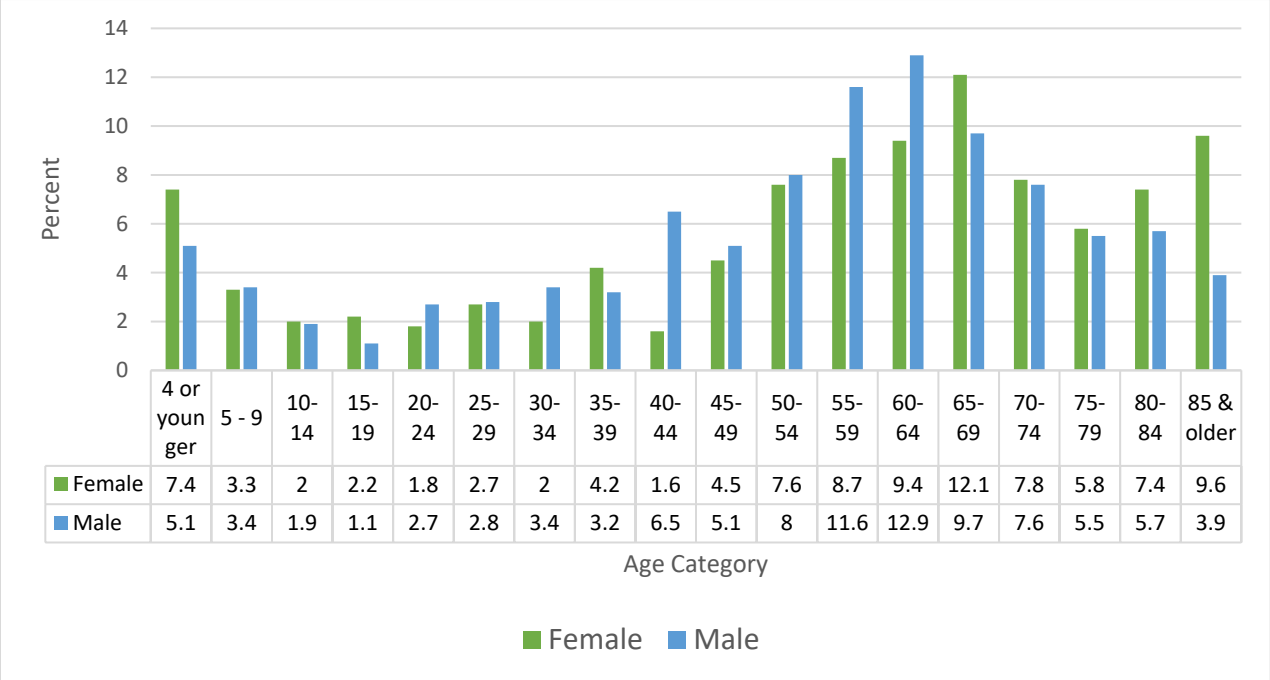
Most victims in residential fires are white (67%) and about 20% are black or African American (Figure 2-14). Statewide, the 2022 proportion of white residents was 78.3% while blacks/African Americans comprised 16.7% of the state's population (Census 2022). The difference between the profiles of fire victims and the state's population as a whole indicates that Black/African American residents in Tennessee are somewhat more likely to perish in residential fires. Overall, the race and ethnicity of fire victims in Tennessee mirror the national profile of residential fire victims. Aherns (2021b), for instance, finds that 69% of fire victims are white and 20% are black/African American.

Figure 2-14. Race/Ethnicity of Fatal Fire Victims, 2013-2022



The age and gender profiles of residential fire victims in Tennessee likewise are similar to those of victims nationally. Figure 2-15 shows that those who perish in home fires tend to be either very young, or 50 or more years old. Regardless of gender, those aged 50 to 74 years are most likely to die in a home fire. Females 85 and older also have a higher risk of dying in a home fire. Males (54.1%) in Tennessee are more likely than females (45.9%) to die in a home fire, proportions not statistically different from the national means (57% male and 43% female).

Figure 2-15. Residential Fire Deaths by Age and Gender



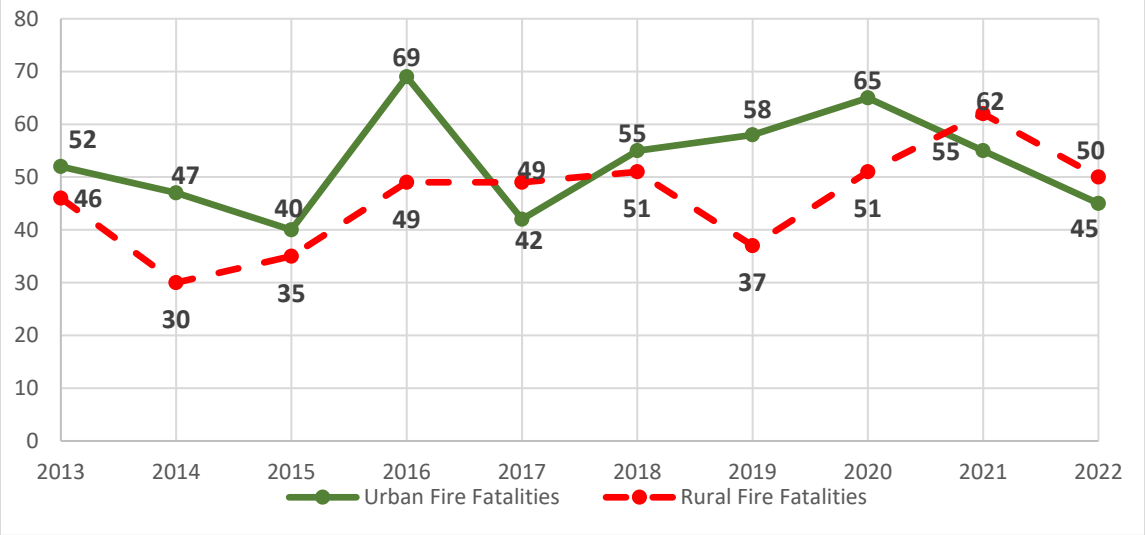
	4 or younger	5 - 9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85 & older
Female	7.4	3.3	2	2.2	1.8	2.7	2	4.2	1.6	4.5	7.6	8.7	9.4	12.1	7.8	5.8	7.4	9.6
Male	5.1	3.4	1.9	1.1	2.7	2.8	3.4	3.2	6.5	5.1	8	11.6	12.9	9.7	7.6	5.5	5.7	3.9

Urban v. Rural Residential Fire Fatalities in Tennessee

Address data for the fire fatalities that occurred during 2013 - 2022 were sufficiently accurate to determine the urban or rural location of 988 of the 992 residential fire deaths that occurred during this time. Urban fatalities occur within the boundaries of an incorporated city or town and rural fatalities occur in the unincorporated area of a county. The number of urban and rural fire deaths during each year of the study period are shown in Figure 2-16.

While more residential fire deaths happened in urban areas compared to the more sparsely populated rural areas of counties, a sizeable proportion of fire deaths occur in the rural areas of the state. Urban fire deaths (528) accounted for 53% of fire fatalities while rural fire deaths (460) comprised 47% of fatalities. As fire officials know very well, fire mortalities are not just a problem for cities. The trendlines for fire deaths in urban and rural locations are somewhat similar, but differences in the peaks and valleys for each during particular year suggest that there may be different reasons that drive changes in the frequency of urban and rural fire deaths. Clearly, efforts to provide higher levels of fire safety and protection should address both the challenges systemic in both urban and rural areas. A noteworthy finding is that the number of home fire deaths in *both* urban and rural areas declined during 2022.

Figure 2-16. Urban and Rural Home Fire Deaths in TN by Year, 2013-2022 (N=988)



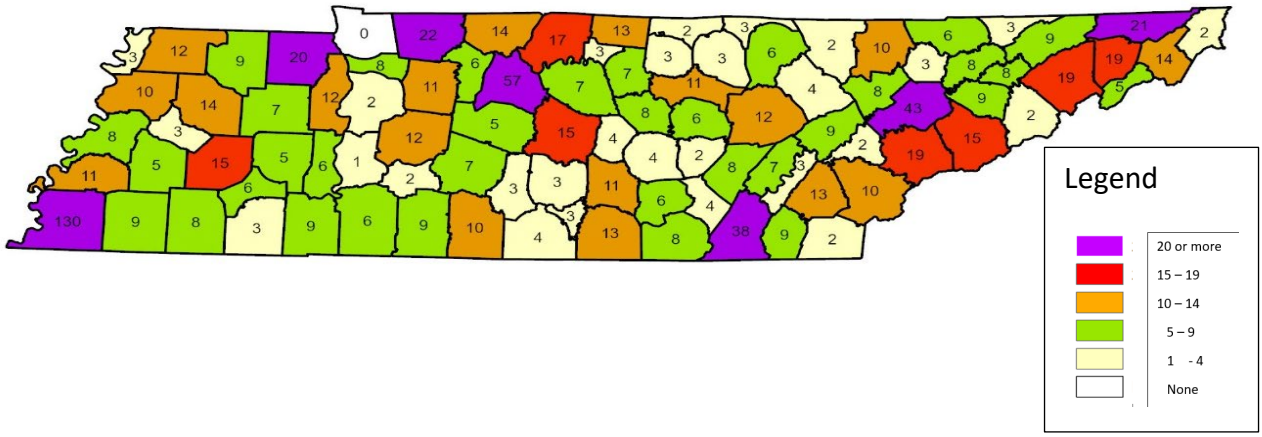
Residential Fire Deaths and Fire Mortality Rates in Tennessee Counties

Figure 2-17 shows the number of residential fire deaths that occurred in each county during 2013-2022. The most populous counties in the state accounted for the largest number of fire deaths. During the study period, Shelby County, for instance, accounted for 130 or 13.2% of all residential fire deaths, a proportion roughly equivalent to its share of the state's population (13.6%). The state's next three largest counties (Davidson, Knox, and Hamilton) recorded 138 fire fatalities, 14% of

the total number of fire deaths in the state, but collectively these three counties comprised 23% of the state's total population of 6,859,497 (U.S. Census 2023).

So, despite roughly comparable levels of fire protection provided by the major cities in these four most populous counties, the disparity between Shelby County and the next three most populous counties in the state with respect to the number of fire deaths and their respective population proportion suggests that factors other than those related to the level of fire protection may account for differences in fire death risk as measured by the fire fatality rate. Shelby County for instance, has a fire mortality rate of 14.19mill. compared to a rate of 8.05/mill. rate for Metro Nashville-Davidson.

Figure 2-17. Number of Civilian Residential Fire Deaths by County (2013-2022), N = 988



While more populous jurisdictions typically experience more fire fatalities (r = .89, p = .001), the risk of perishing in a home fire is actually higher for residents in counties with smaller populations (r = -.321, p = .001). This risk, measured by the mean annual fire death rate per million is computed by dividing the number of fire deaths by county population multiplied by 1 million and then divided by 10, the number of years in the study period. (Rates compare risk among jurisdictions with different populations by using this standard metric).

These data show that many of the state's counties with smaller populations have relatively few fire deaths but higher rates (or risk) of fire deaths given their population size. Table 2-8 reveals that virtually all of the counties with mean annual fire mortality rates of 25.0/million or higher have smaller populations. The mean population size for this group of 36 counties is 22,538. Conversely, as Figure 2-17 illustrates, several counties with the largest populations (e.g., Davidson, Knox, Rutherford, and Williamson) have some of the smallest fire fatality rates (e.g., 8.05, 8.69, 4.16, and 1.92, respectively).

The fact that counties with smaller populations often have higher fire mortality rates is likely attributable to a less expansive level of the elements that advance fire safety. Smaller counties typically have fewer resources, limited public water

distribution systems, and may have other geographical, logistical, and political limitations that represent significant barriers for efforts to elevate the level of fire protection and public safety. Nonetheless, there remains much that can be done to help reduce fire risk for residents that do not involve massive infusions of capital. The SFMO has pursued several such strategies such as the distribution of free smoke alarms and fire safety educational materials for residents of all ages.

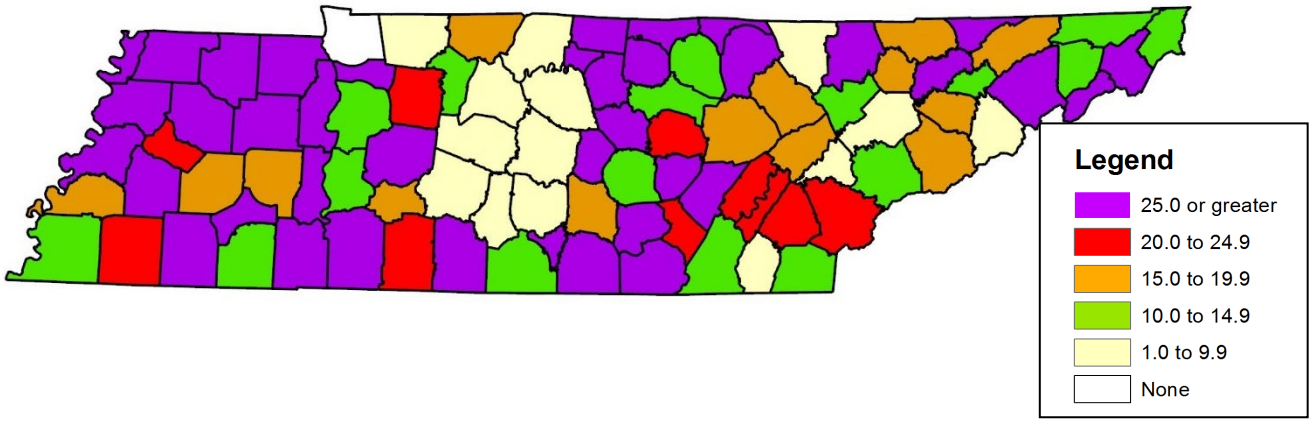
Table 2-8. Fire Deaths and the Rank Order of Mean Annual Fire Fatality Rates Among Tennessee Counties (2013-2022)

County	Population	# Fire Deaths	Mean Annual Fire Death Rate/Million
Houston County	8,219	8	97.34
Benton County	16,002	12	74.99
Henry County	32,379	20	61.77
Pickett County	5,107	3	58.74
Bledsoe County	14,798	8	54.06
Decatur County	11,564	6	51.89
Macon County	26,229	13	49.56
Hickman County	25,455	12	47.14
Lake County	6,507	3	46.10
Moore County	6,742	3	44.50
Hancock County	6,845	3	43.83
Grundy County	13,783	6	43.53
Obion County	30,394	12	39.48
DeKalb County	21,003	8	38.09
Wayne County	16,308	6	36.79
Smith County	20,489	7	34.16
Chester County	17,609	6	34.07
Hardin County	27,077	9	33.24
Grainger County	24,277	8	32.95
Giles County	30,554	10	32.73
Lauderdale County	24,793	8	32.27
Hardeman County	25,529	8	31.34
Van Buren County	6,429	2	31.11
Fentress County	19,332	6	31.04
Franklin County	43,942	13	29.58
Haywood County	17,550	5	28.49
Unicoi County	17,674	5	28.29
Gibson County	50,837	14	27.54
Marion County	29,094	8	27.50
Dyer County	36,410	10	27.46

Weakley County	33,063	9	27.22
Cannon County	14,788	4	27.05
Greene County	71,405	19	26.61
Clay County	7,620	2	26.25
Campbell County	39,584	10	25.26
Jackson County	11,989	3	25.02
Carter County	56,410	14	24.82
Trousdale County	12,111	3	24.77
Carroll County	28,458	7	24.60
McMinn County	54,719	13	23.76
Sequatchie County	16,909	4	23.66
Meigs County	13,272	3	22.60
Crockett County	13,888	3	21.60
White County	28,064	6	21.38
Monroe County	47,740	10	20.95
Rhea County	33,730	7	20.75
Fayette County	43,630	9	20.63
Lawrence County	45,415	9	19.82
Dickson County	55,761	11	19.73
Cumberland County	63,522	12	18.89
Morgan County	21,224	4	18.85
Robertson County	75,470	14	18.55
Claiborne County	32,431	6	18.50
Coffee County	59,728	11	18.42
Henderson County	27,929	5	17.90
Tipton County	61,656	11	17.84
Roane County	55,082	9	16.34
Jefferson County	56,727	9	15.87
Hawkins County	58,043	9	15.51
Lewis County	12,957	2	15.44
Sevier County	98,789	15	15.18
Madison County	99,245	15	15.11
Union County	20,452	3	14.67
Cheatham County	41,830	6	14.34
Shelby County	916,371	130	14.19
Washington County	136,172	19	13.95
Blount County	139,958	19	13.58
Putnam County	82,382	11	13.35
Sullivan County	160,820	21	13.06
Overton County	23,044	3	13.02

Hamblen County	65,168	8	12.28
McNairy County	25,988	3	11.54
Perry County	8,685	1	11.51
Polk County	17,863	2	11.20
Lincoln County	36,004	4	11.11
Johnson County	18,086	2	11.06
Humphreys County	19,106	2	10.47
Hamilton County	374,682	38	10.14
Anderson County	78,913	8	10.14
Warren County	42,026	4	9.52
Montgomery County	235,201	22	9.35
Scott County	22,035	2	9.08
Knox County	494,574	43	8.69
Marshall County	35,878	3	8.36
Sumner County	203,858	17	8.34
Bradley County	110,616	9	8.14
Davidson County	708,144	57	8.05
Maury County	108,159	7	6.47
Bedford County	51,950	3	5.77
Cocke County	36,879	2	5.42
Wilson County	158,555	7	4.41
Rutherford County	360,619	15	4.16
Loudon County	58,181	2	3.44
Williamson County	260,815	5	1.92
Stewart County	14,035	0	0.00

Figure 2-18. Fire Fatality Risk Categories Among Tennessee Counties Based on Fire Fatality Rates (2013-2022)



Summary

Even though residential fires comprise just a fourth of all reported fires in the U.S. they account for three-fourths of all civilian deaths. To understand how best to minimize these catastrophic events, it is important to document the causes of and trends in these fires, the areas of the home where these fires originate and what items are first ignited. While residential fires have declined in Tennessee, the leading causes of home fires have not changed much since the previous study by Folz, Shults, Meyers, et al (2011). Cooking, electrical malfunctions and heating equipment remain the three most common causes of home fires. The three most common causes of home fire fatalities are related to smoking behaviors, heating equipment, and electrical distribution and lighting equipment. The three most common areas of origin of these fatal fires are the living/family room, bedroom, and kitchen. Smoke detectors located in these areas of the home are likely to have the most potential to alert unaware residents of a developing fire and improve the prospects of saving lives.

The presence of smoke detectors in home fires steadily increased between 2013 to 2022. This analysis found a statistically significant difference between the presence of smoke detectors in non-fatal and fatal fires. Smoke alarms are much more likely to be absent in fatal fire incidents. Clearly, the presence of working smoke alarms saves lives. In fact, Tennessee's "Get Alarmed" program is credited with 450 lives saved between late 2012, when the program was launched and 2022. If the current level of participation in this program is sustained, we estimate that an average of about 50 lives will be saved annually during the remaining years of this decade. More extensive program participation in higher risk urban and rural census tracts is likely to result in even more lives saved.

We found that fatal fires are much more likely to occur in homes constructed in the decades before 1980. Homes bult prior to 1980 comprise 43.3% of the state's housing stock but were the locus for about 80% of all fatal fires during the study period. Homes built between 1940 and 1979 were significantly less likely to have a working smoke detector present in fatal fire incidents compared to fatalities that occurred in homes constructed before or after that period.

There are three main types of code enforcement regimes in Tennessee with the most common being the 62% of communities that are in the exempt category. These jurisdictions are responsible for adopting and enforcing their own building codes. The most populous cities and counties in the state have this type of building code regime so it is not surprising that this type of code regime has the largest number of civilian fire fatalities. While variations in enforcement may exist within and between the three code regimes, there are no data available on all of the multiple factors that might help to explain any possible variation.

The race and ethnicity of fire victims in Tennessee mirror the national profile of residential fire victims. While the large majority of fatal fire victims are white, Black/African American individuals are somewhat more likely to be a fatal fire victim than their proportion of the state population would indicate. Those who perish in fires also are more likely to be either very young, or 50 years older or more.

Regardless of gender, those aged 50 and 74 years are most likely to die in a home fire, but females aged 85 and older also are much more likely than their male counterparts to die in a home fire.

More people perished in residential fires in urban areas (53%) rather than in unincorporated rural areas (47%), but it is clear that fires deaths are not just a problem in big cities. The trendlines for fire deaths in urban and rural areas are somewhat similar, but the differences in the peaks and valleys for each during particular year suggest that there may be different reasons that drive the changes in the frequency of urban and rural fire deaths. As of October 2023, TFIRS data indicated that fewer fire deaths occurred in both urban and rural fire areas compared to the same point in the previous year.

The most populous counties in the state accounted for the largest number of fire deaths, but the risk for residents of perishing in a home is generally higher (but not exclusively so) in counties with smaller populations. Smaller counties may confront more daunting challenges with respect to resource and capacity constraints that limit the level of politically feasible fire protection. More populous counties likewise may encounter their own unique set of challenges in advancing public safety and fire protection. Despite local resource and capacity constraints, much can be done to reduce the risk of being a casualty in a home fire. By identifying the features of those communities that historically have a higher risk of fire fatalities, state and local fire officials can target where best to provide smoke alarms and fire safety education to at-risk populations. The methodology for identifying these communities is the focus of the subsequent chapter.

Chapter 3. An Analyses of Fire Mortality Risk Among Census Tracts in Tennessee

Factors that Distinguish Mortality Risk Among Census Tracts

Based on our review of the literature and profile data of fire fatality incidents during the study period, we identified several social, economic, demographic and housing variables that appeared to distinguish census tracts with higher rates of fire mortalities. We cast a broad net and included 52 variables from the American Community Survey (ACS) (2017-2021) for each of the 1685 populated census tracts (16 are not populated) in Tennessee. Of these populated tracts, 597 (35.43%) had at least one civilian residential fire death during the 2013-2022 study period. This proportion of census tracts with at least one fire fatality is significantly lower than the 46.1% of census tracts that had at least one fire fatality during the previous study that examined the 2002-2010 period (Folz, Shults, Meyer, et al. 2011).

As noted, there were 992 civilian residential fire deaths during 2013-2022 in the data received from the SFMO during the fall 2023. Address data on mortality incidents in TFIRS was sufficient to match 984 mortalities to a census tract location. Consequently, the analyses in this section are based on these 984 home fire fatalities in 597 different census tracts.

Table 3-1 shows that while there are more urban than rural census tracts in the state, a reflection of where more people reside, residential fire deaths were more likely to occur in a rural census tract rather than in an urban census tract. Fire fatalities occurred in 41% of rural tracts but just 32.3% of urban census tracts. This relationship is statistically significant at the .001 level (gamma = .184). This association indicates that the risk of a fire mortality is significantly higher in rural census tracts than in urban census tracts, a finding supported by n the large difference observed earlier in the fire mortality rates between larger and smaller counties. In fact, the rate of fire mortalities in rural census tracts during 2013-2022 was 19.86 per million, compared to 15.19 per million in urban census tracts.

Table 3-1. Urban and Rural Census Tracts and Residential Fire Deaths

Fire Deaths	Location		
	Urban tract	Rural tract	Total
No	732	356	1088
	67.7%	59.0%	64.6%
Yes	350	247	597
	32.3%	41.0%	35.4%
Totals	1082	603	1685
	100.0%	100.0%	100.0%

Informed by previous research and correlation analysis of the data for 2013-2022, we focused on 15 variables from the 2017-2021 American Community Census (ACS) for their potential importance in explaining differences in risk exposure among

communities. We devised directional hypotheses that reflected the expected impact on whether a census tract would be more or less likely to experience one or more fire fatalities during the study period. These 15 hypotheses were tested for three groups: all census tracts, just urban census tracts, and just rural census tracts. Analyzing mean differences within each of these three groups enabled us to identify those variables that may have been more important among urban versus rural tracts in understanding fire mortality risk.

We analyzed mean differences for each of the 15 variables among the census tracts that did and did not have a fire fatality during the 2013-2022 study period. Statistical support for a hypothesis indicates that it may have potential utility in models to predict which census tracts are more likely to have a higher risk for fire fatalities. In other words, this method provides a rational process to identify which of the 1088 census tracts without a residential fire death during the study period may have a higher risk for fire mortalities given that they are similar to tracts that did have one or more fatalities.

Hypotheses Tested

The difference of means procedure in SPSS (Statistical Package for the Social Sciences) was used to test 15 hypotheses concerning the expected direction of the difference between the group means (those with and without fire fatalities). The hypotheses tested are:

- Tracts that have a larger percentage of their housing stock comprised of mobile homes are more likely to have had one or more fire fatalities.
- Tracts that have a higher percentage of their housing stock renter-occupied are more likely to have had one or more fire fatalities.
- Tracts with larger proportions of their housing stock built before 1980 are more likely to have had one or more fire fatalities.
- Tracts that have a higher median value of owner-occupied units are less likely to have had one or more fire fatalities.
- Tracts that have a higher median gross monthly rent paid by residents in occupied units are less likely to have had one or more fire fatalities.
- Tracts with higher proportions of people under five years of age are more likely to have had one or more fire fatalities.
- Tracts with higher proportions of people aged 65 to 74 are more likely to have had one or more fire fatalities.
- Tracts with higher proportions of people 85 and older are more likely to have had one or more fire fatalities.
- Tracts with higher proportions of Black/African American people are more likely to have had one or more fire fatalities.
- Tracts with higher proportions of female-headed householders with no spouse present are more likely to have had one or more fire fatalities.
- Tracts with higher proportions of people 25 years and over who have a Bachelor's degree are less likely to have had one or more fire fatalities.
- Tracts in which workers have higher median earnings in 2021 in inflation adjusted dollars are less likely to have had one or more fire fatalities.

- Tracts in which workers have higher mean earnings in 2021 in inflation adjusted dollars are less likely to have had one or more fire fatalities.
- Tracts which have a higher per capita income in 2021 in inflation adjusted dollars are less likely to have had one or more fire fatalities.
- Tracts which have a higher percentage of families and people whose income is below the poverty with related children under 18 are more likely to have had one or more fire fatalities.

In this study, we assume that the more features a census tract shares with those that have recorded a fire fatality in the past, the more likely that tract may also have a fire fatality at some point in the future. In other words, we apply Shakespeare's aphorism that what is past is prologue. The rationale for this process is to provide a reasonable basis for strategic decisions about where to target limited resources for fire safety and prevention education efforts. This analysis suggests where resources might be best deployed *in addition to* those communities where fire fatalities have occurred already. The list of these 597 census tracts that recorded one or more fire fatalities during 2013-2022 is in Appendix A.

Findings:

Table 3-2 indicates which hypotheses are supported or not. Those supported represent mean differences that are statistically significant at least at the .05 level. Supported hypotheses are indicated by the "thumbs-up" symbol and those not supported have a "thumbs down" symbol.

The first column of Table 3-2 indicates that 11 variables had statistically significant mean differences for ***all*** census tracts. For **urban** tracts, support was evident for a slightly different set of 12 variables. Moreover, percent Black/African American instead of the percent aged 65 to 74 proved statistically different. In addition, percent renter-occupied housing was important for distinguishing urban tracts with fire fatalities. For **rural** tracts, 10 hypotheses were supported. For this group of tracts, the percentage aged 65 to 74 was not statistically different.

The results from the analysis of all census tracts indicate that the three population age category variables were not helpful in distinguishing tracts with higher risk of fire mortalities. Consequently, these variables were dropped from further analysis. The remaining statistically significant findings were used to develop "screens" to identify tracts with various levels of fire mortality risk that we label "above average," "high," and "highest."

Table 3-2. Statistically Significant Differences Between Means for the Key Profile Variables in the ACS 2017-2021 that Distinguish TN Census Tracts Without and With Fire Deaths (sig. <.05)

Variable	All Census Tracts		Urban Census Tracts		Rural Census Tracts	
	without Fire Deaths	with Fire Deaths	without Fire Deaths	with Fire Deaths	without Fire Deaths	with Fire Deaths
Percent Housing Comprised of Mobile Homes	7.58	11.43	3.91	5.79	15.16	19.52
Percent Housing Renter-occupied	33.33	34.06	39.94	43.83	19.69	21.21
Percent Housing Built Before 1980	42.95	49.71	46.86	57.27	34.88	39.0
Median Value of Owner-occupied units (dollars)	$223,475	$162,810	$235,462	$161,342	$199020	$164,887
Median Gross Monthly Rent Paid by Occupied Units Paying Rent	$1035.81	$863.70	$1089	$905	$920	$803
Percent Population Under 5 years of age	5.75	5.81	6.05	6.29	4.99	5.1
Percent Population Aged 65 to 74	10.08	10.64	9.24	9.46	11.80	12.31
Percent Population 85 & Older	1.64	1.72	1.67	1.75	1.60	1.68
Percent Population Black/African American	17.19	18.23	22.31	28.13	6.65	4.19
Percent Female householder, no husband present	11.31	12.08	12.72	14.57	8.42	8.56

Variable	All Census Tracts		Urban Census Tracts		Rural Census Tracts	
	without Fire Deaths	with Fire Deaths	without Fire Deaths	with Fire Deaths	without Fire Deaths	with Fire Deaths
Percent Population 25 years and over, bachelor's degree	19.45	13.42	20.95	14.55	16.35	11.82
Median Earnings 2021, inflation adjusted dollars	$37,617	$32,876	$37,616	$32,337	$37,620	$33,639
Mean Earnings 2021, inflation adjusted dollars	$85,820	$70,191	$86,539	$67,987	$84,329	$73,314
Per capita income 2021, inflation adjusted dollars	$34,331	$28,093	$30,072	$27,784	$32,802	$28,531
Percentage of families and people whose income in the past 12 months is below the poverty level; Under 18 years & Related Children of Householder	18.04	24.13	19.99	27.90	15.1	18.79

The relevant means for these housing, social, and economic variables served as the metrics or "cut points" to identify the census tracts with higher "risk exposure" for fire mortalities. To capture the largest group of at-risk census tracts, we employ the following order of screen variables: economic, housing, and social. We chose three economic variables: median earnings (at or below $37,617), mean earnings (at or below $85,820), and percent in poverty (at or above 24.13.

Table 3-3 lists the 341 tracts that have an "Above Average" risk for fire mortalities. These tracts represent 31.3% of the 1088 tracts that did not have any fire deaths during the study period. Because these tracts have profiles on the three economic variables similar to the 597 tracts that have had fire fatalities (listed in Appendix A), we suggest that these two groups of tracts combined (N=938) have a higher risk for fire mortalities. These 938 tracts represent about 55% of all the populated census tracts in Tennessee.

Table 3-3. Census Tracts with "Above Average" Risk for Fire Fatalities (N = 341).

Census Tract 204, Anderson County, Tennessee
Census Tract 205, Anderson County, Tennessee
Census Tract 207, Anderson County, Tennessee
Census Tract 213.04, Anderson County, Tennessee
Census Tract 9503, Bedford County, Tennessee
Census Tract 9531.02, Bledsoe County, Tennessee
Census Tract 106, Blount County, Tennessee
Census Tract 108, Blount County, Tennessee
Census Tract 112.01, Blount County, Tennessee
Census Tract 114.03, Blount County, Tennessee
Census Tract 101, Bradley County, Tennessee
Census Tract 102.01, Bradley County, Tennessee
Census Tract 104, Bradley County, Tennessee
Census Tract 107, Bradley County, Tennessee
Census Tract 113.02, Bradley County, Tennessee
Census Tract 114.02, Bradley County, Tennessee
Census Tract 9501, Campbell County, Tennessee
Census Tract 9502, Campbell County, Tennessee
Census Tract 9503, Campbell County, Tennessee
Census Tract 9506.02, Campbell County, Tennessee
Census Tract 9507.01, Campbell County, Tennessee
Census Tract 9507.02, Campbell County, Tennessee
Census Tract 9508, Campbell County, Tennessee
Census Tract 9620, Carroll County, Tennessee
Census Tract 9625, Carroll County, Tennessee
Census Tract 701, Carter County, Tennessee
Census Tract 702, Carter County, Tennessee
Census Tract 704, Carter County, Tennessee
Census Tract 706, Carter County, Tennessee
Census Tract 709, Carter County, Tennessee
Census Tract 712, Carter County, Tennessee
Census Tract 713.01, Carter County, Tennessee
Census Tract 9701, Claiborne County, Tennessee
Census Tract 9704, Claiborne County, Tennessee
Census Tract 9705, Claiborne County, Tennessee
Census Tract 9708, Claiborne County, Tennessee
Census Tract 9202, Cocke County, Tennessee
Census Tract 9205.01, Cocke County, Tennessee

Census Tract 9206, Cocke County, Tennessee
Census Tract 9207, Cocke County, Tennessee
Census Tract 9702.01, Coffee County, Tennessee
Census Tract 9704.02, Coffee County, Tennessee
Census Tract 9709, Coffee County, Tennessee
Census Tract 9610, Crockett County, Tennessee
Census Tract 9614, Crockett County, Tennessee
Census Tract 9705.01, Cumberland County, Tennessee
Census Tract 9706.02, Cumberland County, Tennessee
Census Tract 103.01, Davidson County, Tennessee
Census Tract 104.01, Davidson County, Tennessee
Census Tract 104.03, Davidson County, Tennessee
Census Tract 106.02, Davidson County, Tennessee
Census Tract 107.02, Davidson County, Tennessee
Census Tract 109.03, Davidson County, Tennessee
Census Tract 109.04, Davidson County, Tennessee
Census Tract 128.01, Davidson County, Tennessee
Census Tract 136, Davidson County, Tennessee
Census Tract 138, Davidson County, Tennessee
Census Tract 139, Davidson County, Tennessee
Census Tract 142, Davidson County, Tennessee
Census Tract 143, Davidson County, Tennessee
Census Tract 154.04, Davidson County, Tennessee
Census Tract 156.13, Davidson County, Tennessee
Census Tract 156.15, Davidson County, Tennessee
Census Tract 156.18, Davidson County, Tennessee
Census Tract 156.19, Davidson County, Tennessee
Census Tract 156.20, Davidson County, Tennessee
Census Tract 156.26, Davidson County, Tennessee
Census Tract 156.32, Davidson County, Tennessee
Census Tract 156.34, Davidson County, Tennessee
Census Tract 156.37, Davidson County, Tennessee
Census Tract 157, Davidson County, Tennessee
Census Tract 158.04, Davidson County, Tennessee
Census Tract 160, Davidson County, Tennessee
Census Tract 174.02, Davidson County, Tennessee
Census Tract 181.01, Davidson County, Tennessee
Census Tract 190.04, Davidson County, Tennessee
Census Tract 191.05, Davidson County, Tennessee

Census Tract 191.08, Davidson County, Tennessee
Census Tract 191.10, Davidson County, Tennessee
Census Tract 193, Davidson County, Tennessee
Census Tract 9550.04, Decatur County, Tennessee
Census Tract 603, Fayette County, Tennessee
Census Tract 605.01, Fayette County, Tennessee
Census Tract 608, Fayette County, Tennessee
Census Tract 9666, Gibson County, Tennessee
Census Tract 5004.01, Grainger County, Tennessee
Census Tract 910.02, Greene County, Tennessee
Census Tract 9551, Grundy County, Tennessee
Census Tract 1002, Hamblen County, Tennessee
Census Tract 1003, Hamblen County, Tennessee
Census Tract 1004, Hamblen County, Tennessee
Census Tract 1005, Hamblen County, Tennessee
Census Tract 1008, Hamblen County, Tennessee
Census Tract 108, Hamilton County, Tennessee
Census Tract 11, Hamilton County, Tennessee
Census Tract 112.04, Hamilton County, Tennessee
Census Tract 114.02, Hamilton County, Tennessee
Census Tract 114.44, Hamilton County, Tennessee
Census Tract 117, Hamilton County, Tennessee
Census Tract 119, Hamilton County, Tennessee
Census Tract 12, Hamilton County, Tennessee
Census Tract 122, Hamilton County, Tennessee
Census Tract 13, Hamilton County, Tennessee
Census Tract 16, Hamilton County, Tennessee
Census Tract 19, Hamilton County, Tennessee
Census Tract 25, Hamilton County, Tennessee
Census Tract 26, Hamilton County, Tennessee
Census Tract 29, Hamilton County, Tennessee
Census Tract 30, Hamilton County, Tennessee
Census Tract 9606, Hancock County, Tennessee
Census Tract 9503, Hardeman County, Tennessee
Census Tract 9504, Hardeman County, Tennessee
Census Tract 9203, Hardin County, Tennessee
Census Tract 9204.02, Hardin County, Tennessee
Census Tract 504, Hawkins County, Tennessee
Census Tract 505.01, Hawkins County, Tennessee
Census Tract 505.02, Hawkins County, Tennessee

Census Tract 506.01, Hawkins County, Tennessee
Census Tract 507, Hawkins County, Tennessee
Census Tract 9303.01, Haywood County, Tennessee
Census Tract 9751, Henderson County, Tennessee
Census Tract 9752, Henderson County, Tennessee
Census Tract 9690.02, Henry County, Tennessee
Census Tract 9694, Henry County, Tennessee
Census Tract 9695.01, Henry County, Tennessee
Census Tract 9695.02, Henry County, Tennessee
Census Tract 9696.02, Henry County, Tennessee
Census Tract 9697, Henry County, Tennessee
Census Tract 9504, Hickman County, Tennessee
Census Tract 1302, Humphreys County, Tennessee
Census Tract 1304, Humphreys County, Tennessee
Census Tract 1305, Humphreys County, Tennessee
Census Tract 9604, Jackson County, Tennessee
Census Tract 702, Jefferson County, Tennessee
Census Tract 704, Jefferson County, Tennessee
Census Tract 9560, Johnson County, Tennessee
Census Tract 9561, Johnson County, Tennessee
Census Tract 9563, Johnson County, Tennessee
Census Tract 9564, Johnson County, Tennessee
Census Tract 20, Knox County, Tennessee
Census Tract 26, Knox County, Tennessee
Census Tract 27, Knox County, Tennessee
Census Tract 28, Knox County, Tennessee
Census Tract 29, Knox County, Tennessee
Census Tract 31, Knox County, Tennessee
Census Tract 39.02, Knox County, Tennessee
Census Tract 45.01, Knox County, Tennessee
Census Tract 46.09, Knox County, Tennessee
Census Tract 46.10, Knox County, Tennessee
Census Tract 46.15, Knox County, Tennessee
Census Tract 49, Knox County, Tennessee
Census Tract 53.02, Knox County, Tennessee
Census Tract 54.02, Knox County, Tennessee
Census Tract 59.11, Knox County, Tennessee
Census Tract 62.08, Knox County, Tennessee
Census Tract 69.01, Knox County, Tennessee
Census Tract 69.03, Knox County, Tennessee

Census Tract 505.03, Lauderdale County, Tennessee
Census Tract 505.04, Lauderdale County, Tennessee
Census Tract 9603, Lawrence County, Tennessee
Census Tract 9609, Lawrence County, Tennessee
Census Tract 602.01, Loudon County, Tennessee
Census Tract 605.03, Loudon County, Tennessee
Census Tract 606, Loudon County, Tennessee
Census Tract 9703.01, Macon County, Tennessee
Census Tract 1, Madison County, Tennessee
Census Tract 15.01, Madison County, Tennessee
Census Tract 2, Madison County, Tennessee
Census Tract 4, Madison County, Tennessee
Census Tract 5, Madison County, Tennessee
Census Tract 6, Madison County, Tennessee
Census Tract 7, Madison County, Tennessee
Census Tract 502.01, Marion County, Tennessee
Census Tract 9555, Marshall County, Tennessee
Census Tract 104.02, Maury County, Tennessee
Census Tract 105, Maury County, Tennessee
Census Tract 109, Maury County, Tennessee
Census Tract 110.04, Maury County, Tennessee
Census Tract 9701.03, McMinn County, Tennessee
Census Tract 9701.04, McMinn County, Tennessee
Census Tract 9702.01, McMinn County, Tennessee
Census Tract 9702.02, McMinn County, Tennessee
Census Tract 9301, McNairy County, Tennessee
Census Tract 9302, McNairy County, Tennessee
Census Tract 9601, Meigs County, Tennessee
Census Tract 9602, Meigs County, Tennessee
Census Tract 9253.02, Monroe County, Tennessee
Census Tract 9255.01, Monroe County, Tennessee
Census Tract 9255.04, Monroe County, Tennessee
Census Tract 1003, Montgomery County, Tennessee
Census Tract 1006.02, Montgomery County, Tennessee
Census Tract 1008, Montgomery County, Tennessee
Census Tract 1011.02, Montgomery County, Tennessee
Census Tract 1012.01, Montgomery County, Tennessee
Census Tract 1016, Montgomery County, Tennessee
Census Tract 1021, Montgomery County, Tennessee

Census Tract 1101, Morgan County, Tennessee
Census Tract 1105, Morgan County, Tennessee
Census Tract 9654, Obion County, Tennessee
Census Tract 9503.02, Overton County, Tennessee
Census Tract 9505.01, Overton County, Tennessee
Census Tract 9506, Overton County, Tennessee
Census Tract 9301, Perry County, Tennessee
Census Tract 9302.01, Perry County, Tennessee
Census Tract 9504, Polk County, Tennessee
Census Tract 1, Putnam County, Tennessee
Census Tract 2.02, Putnam County, Tennessee
Census Tract 3.01, Putnam County, Tennessee
Census Tract 3.04, Putnam County, Tennessee
Census Tract 3.05, Putnam County, Tennessee
Census Tract 304.01, Roane County, Tennessee
Census Tract 307, Roane County, Tennessee
Census Tract 401.05, Rutherford County, Tennessee
Census Tract 401.06, Rutherford County, Tennessee
Census Tract 404.05, Rutherford County, Tennessee
Census Tract 414.04, Rutherford County, Tennessee
Census Tract 417, Rutherford County, Tennessee
Census Tract 418, Rutherford County, Tennessee
Census Tract 422, Rutherford County, Tennessee
Census Tract 9751.01, Scott County, Tennessee
Census Tract 9751.02, Scott County, Tennessee
Census Tract 9752, Scott County, Tennessee
Census Tract 9753, Scott County, Tennessee
Census Tract 602, Sequatchie County, Tennessee
Census Tract 801.03, Sevier County, Tennessee
Census Tract 804.01, Sevier County, Tennessee
Census Tract 806.03, Sevier County, Tennessee
Census Tract 807.02, Sevier County, Tennessee
Census Tract 809.04, Sevier County, Tennessee
Census Tract 810.02, Sevier County, Tennessee
Census Tract 100.01, Shelby County, Tennessee
Census Tract 101.20, Shelby County, Tennessee
Census Tract 101.21, Shelby County, Tennessee
Census Tract 101.22, Shelby County, Tennessee
Census Tract 102.10, Shelby County, Tennessee
Census Tract 105, Shelby County, Tennessee

Census Tract 107.10, Shelby County, Tennessee
Census Tract 107.20, Shelby County, Tennessee
Census Tract 108.20, Shelby County, Tennessee
Census Tract 110.10, Shelby County, Tennessee
Census Tract 110.20, Shelby County, Tennessee
Census Tract 111, Shelby County, Tennessee
Census Tract 112, Shelby County, Tennessee
Census Tract 114.01, Shelby County, Tennessee
Census Tract 114.02, Shelby County, Tennessee
Census Tract 117, Shelby County, Tennessee
Census Tract 12, Shelby County, Tennessee
Census Tract 13, Shelby County, Tennessee
Census Tract 15, Shelby County, Tennessee
Census Tract 2, Shelby County, Tennessee
Census Tract 201.01, Shelby County, Tennessee
Census Tract 203.02, Shelby County, Tennessee
Census Tract 205.23, Shelby County, Tennessee
Census Tract 205.31, Shelby County, Tennessee
Census Tract 205.32, Shelby County, Tennessee
Census Tract 205.44, Shelby County, Tennessee
Census Tract 206.10, Shelby County, Tennessee
Census Tract 206.58, Shelby County, Tennessee
Census Tract 211.11, Shelby County, Tennessee
Census Tract 211.12, Shelby County, Tennessee
Census Tract 211.21, Shelby County, Tennessee
Census Tract 211.22, Shelby County, Tennessee
Census Tract 211.26, Shelby County, Tennessee
Census Tract 213.34, Shelby County, Tennessee
Census Tract 217.10, Shelby County, Tennessee
Census Tract 217.21, Shelby County, Tennessee
Census Tract 217.31, Shelby County, Tennessee
Census Tract 217.52, Shelby County, Tennessee
Census Tract 217.54, Shelby County, Tennessee
Census Tract 217.57, Shelby County, Tennessee
Census Tract 217.58, Shelby County, Tennessee
Census Tract 219, Shelby County, Tennessee
Census Tract 220.23, Shelby County, Tennessee
Census Tract 220.24, Shelby County, Tennessee
Census Tract 220.26, Shelby County, Tennessee
Census Tract 221.30, Shelby County, Tennessee

Census Tract 221.31, Shelby County, Tennessee
Census Tract 221.32, Shelby County, Tennessee
Census Tract 222.10, Shelby County, Tennessee
Census Tract 225, Shelby County, Tennessee
Census Tract 226, Shelby County, Tennessee
Census Tract 27, Shelby County, Tennessee
Census Tract 28, Shelby County, Tennessee
Census Tract 37, Shelby County, Tennessee
Census Tract 45, Shelby County, Tennessee
Census Tract 46, Shelby County, Tennessee
Census Tract 50, Shelby County, Tennessee
Census Tract 53, Shelby County, Tennessee
Census Tract 56, Shelby County, Tennessee
Census Tract 58, Shelby County, Tennessee
Census Tract 59, Shelby County, Tennessee
Census Tract 6, Shelby County, Tennessee
Census Tract 60, Shelby County, Tennessee
Census Tract 70, Shelby County, Tennessee
Census Tract 74, Shelby County, Tennessee
Census Tract 78.10, Shelby County, Tennessee
Census Tract 78.22, Shelby County, Tennessee
Census Tract 80, Shelby County, Tennessee
Census Tract 82, Shelby County, Tennessee
Census Tract 88, Shelby County, Tennessee
Census Tract 91, Shelby County, Tennessee
Census Tract 93, Shelby County, Tennessee
Census Tract 97, Shelby County, Tennessee
Census Tract 98, Shelby County, Tennessee
Census Tract 1102.02, Stewart County, Tennessee
Census Tract 1107, Stewart County, Tennessee
Census Tract 403, Sullivan County, Tennessee
Census Tract 405, Sullivan County, Tennessee
Census Tract 407, Sullivan County, Tennessee
Census Tract 414, Sullivan County, Tennessee
Census Tract 417, Sullivan County, Tennessee
Census Tract 421, Sullivan County, Tennessee
Census Tract 427.03, Sullivan County, Tennessee
Census Tract 428.02, Sullivan County, Tennessee
Census Tract 432.02, Sullivan County, Tennessee
Census Tract 433.02, Sullivan County, Tennessee

Census Tract 203, Sumner County, Tennessee
Census Tract 409, Tipton County, Tennessee
Census Tract 410, Tipton County, Tennessee
Census Tract 804, Unicoi County, Tennessee
Census Tract 401.01, Union County, Tennessee
Census Tract 9301, Warren County, Tennessee
Census Tract 9302.01, Warren County, Tennessee
Census Tract 9302.02, Warren County, Tennessee
Census Tract 9303, Warren County, Tennessee
Census Tract 9305, Warren County, Tennessee
Census Tract 9307, Warren County, Tennessee
Census Tract 9351, White County, Tennessee
Census Tract 601, Washington County, Tennessee
Census Tract 605.01, Washington County, Tennessee
Census Tract 605.03, Washington County, Tennessee
Census Tract 609.02, Washington County, Tennessee
Census Tract 611, Washington County, Tennessee
Census Tract 619.04, Washington County, Tennessee
Census Tract 9504, Wayne County, Tennessee
Census Tract 9683, Weakley County, Tennessee
Census Tract 9687, Weakley County, Tennessee
Census Tract 304.01, Wilson County, Tennessee
Census Tract 304.02, Wilson County, Tennessee
Census Tract 307, Wilson County, Tennessee
Census Tract 308, Wilson County, Tennessee

The group of tracts defined as having a "High Risk" for fire fatalities are those in the above average risk group that also meet criteria on four housing variables. These tracts have *at least*:

- 7.58% or more of their housing stock comprised of mobile homes,
- 43% or more of their housing built before 1980,
- a median value of owner-occupied units of $223,475 or more, and
- a median gross monthly rent paid by occupied units paying rent of $1036 or more.

These housing variable screens yielded 135 tracts with a High Risk for possible fire fatalities. These tracts are listed in Table 3-4.

Table 3-4. Census Tracts with “High Risk” for Fire Fatalities (N = 135)

Census Tract 207, Anderson County, Tennessee
Census Tract 213.04, Anderson County, Tennessee
Census Tract 9503, Bedford County, Tennessee
Census Tract 9531.02, Bledsoe County, Tennessee
Census Tract 112.01, Blount County, Tennessee
Census Tract 114.03, Blount County, Tennessee
Census Tract 101, Bradley County, Tennessee
Census Tract 104, Bradley County, Tennessee
Census Tract 113.02, Bradley County, Tennessee
Census Tract 9502, Campbell County, Tennessee
Census Tract 9503, Campbell County, Tennessee
Census Tract 9506.02, Campbell County, Tennessee
Census Tract 9508, Campbell County, Tennessee
Census Tract 9620, Carroll County, Tennessee
Census Tract 9625, Carroll County, Tennessee
Census Tract 706, Carter County, Tennessee
Census Tract 709, Carter County, Tennessee
Census Tract 712, Carter County, Tennessee
Census Tract 713.01, Carter County, Tennessee
Census Tract 9701, Claiborne County, Tennessee
Census Tract 9704, Claiborne County, Tennessee
Census Tract 9708, Claiborne County, Tennessee
Census Tract 9202, Cocke County, Tennessee
Census Tract 9205.01, Cocke County, Tennessee
Census Tract 9206, Cocke County, Tennessee
Census Tract 9207, Cocke County, Tennessee
Census Tract 9702.01, Coffee County, Tennessee
Census Tract 9704.02, Coffee County, Tennessee
Census Tract 9705, Claiborne County, Tennessee
Census Tract 9709, Coffee County, Tennessee
Census Tract 9610, Crockett County, Tennessee
Census Tract 9614, Crockett County, Tennessee
Census Tract 9706.02, Cumberland County, Tennessee
Census Tract 106.02, Davidson County, Tennessee
Census Tract 9550.04, Decatur County, Tennessee
Census Tract 603, Fayette County, Tennessee
Census Tract 9666, Gibson County, Tennessee
Census Tract 5004.01, Grainger County, Tennessee

Census Tract 910.02, Greene County, Tennessee
Census Tract 9551, Grundy County, Tennessee
Census Tract 1005, Hamblen County, Tennessee
Census Tract 1008, Hamblen County, Tennessee
Census Tract 9606, Hancock County, Tennessee
Census Tract 9503, Hardeman County, Tennessee
Census Tract 9504, Hardeman County, Tennessee
Census Tract 504, Hawkins County, Tennessee
Census Tract 505.01, Hawkins County, Tennessee
Census Tract 505.02, Hawkins County, Tennessee
Census Tract 506.01, Hawkins County, Tennessee
Census Tract 507, Hawkins County, Tennessee
Census Tract 9751, Henderson County, Tennessee
Census Tract 9752, Henderson County, Tennessee
Census Tract 9690.02, Henry County, Tennessee
Census Tract 9694, Henry County, Tennessee
Census Tract 9696.02, Henry County, Tennessee
Census Tract 9697, Henry County, Tennessee
Census Tract 9504, Hickman County, Tennessee
Census Tract 1302, Humphreys County, Tennessee
Census Tract 1305, Humphreys County, Tennessee
Census Tract 9604, Jackson County, Tennessee
Census Tract 702, Jefferson County, Tennessee
Census Tract 704, Jefferson County, Tennessee
Census Tract 9561, Johnson County, Tennessee
Census Tract 9563, Johnson County, Tennessee
Census Tract 9564, Johnson County, Tennessee
Census Tract 53.02, Knox County, Tennessee
Census Tract 54.02, Knox County, Tennessee
Census Tract 62.08, Knox County, Tennessee
Census Tract 9603, Lawrence County, Tennessee
Census Tract 9609, Lawrence County, Tennessee
Census Tract 9703.01, Macon County, Tennessee
Census Tract 502.01, Marion County, Tennessee
Census Tract 9555, Marshall County, Tennessee
Census Tract 109, Maury County, Tennessee
Census Tract 110.04, Maury County, Tennessee
Census Tract 9701.03, McMinn County, Tennessee
Census Tract 9701.04, McMinn County, Tennessee
Census Tract 9702.02, McMinn County, Tennessee

Census Tract 9301, McNairy County, Tennessee
Census Tract 9302, McNairy County, Tennessee
Census Tract 9601, Meigs County, Tennessee
Census Tract 9602, Meigs County, Tennessee
Census Tract 9253.02, Monroe County, Tennessee
Census Tract 9255.01, Monroe County, Tennessee
Census Tract 1016, Montgomery County, Tennessee
Census Tract 1101, Morgan County, Tennessee
Census Tract 1105, Morgan County, Tennessee
Census Tract 9654, Obion County, Tennessee
Census Tract 9505.01, Overton County, Tennessee
Census Tract 9506, Overton County, Tennessee
Census Tract 9301, Perry County, Tennessee
Census Tract 9302.01, Perry County, Tennessee
Census Tract 9504, Polk County, Tennessee
Census Tract 1, Putnam County, Tennessee
Census Tract 2.02, Putnam County, Tennessee
Census Tract 3.05, Putnam County, Tennessee
Census Tract 304.01, Roane County, Tennessee
Census Tract 307, Roane County, Tennessee
Census Tract 414.04, Rutherford County, Tennessee
Census Tract 9751.01, Scott County, Tennessee
Census Tract 9751.02, Scott County, Tennessee
Census Tract 9752, Scott County, Tennessee
Census Tract 9753, Scott County, Tennessee
Census Tract 602, Sequatchie County, Tennessee
Census Tract 801.03, Sevier County, Tennessee
Census Tract 804.01, Sevier County, Tennessee
Census Tract 806.03, Sevier County, Tennessee
Census Tract 807.02, Sevier County, Tennessee
Census Tract 809.04, Sevier County, Tennessee
Census Tract 810.02, Sevier County, Tennessee
Census Tract 110.10, Shelby County, Tennessee
Census Tract 225, Shelby County, Tennessee
Census Tract 78.22, Shelby County, Tennessee
Census Tract 91, Shelby County, Tennessee
Census Tract 1107, Stewart County, Tennessee
Census Tract 414, Sullivan County, Tennessee
Census Tract 417, Sullivan County, Tennessee
Census Tract 421, Sullivan County, Tennessee

Census Tract 432.02, Sullivan County, Tennessee
Census Tract 433.02, Sullivan County, Tennessee
Census Tract 203, Sumner County, Tennessee
Census Tract 409, Tipton County, Tennessee
Census Tract 410, Tipton County, Tennessee
Census Tract 401.01, Union County, Tennessee
Census Tract 9301, Warren County, Tennessee
Census Tract 9302.01, Warren County, Tennessee
Census Tract 9302.02, Warren County, Tennessee
Census Tract 9303, Warren County, Tennessee
Census Tract 9351, White County, Tennessee
Census Tract 605.01, Washington County, Tennessee
Census Tract 619.04, Washington County, Tennessee
Census Tract 9504, Wayne County, Tennessee
Census Tract 9683, Weakley County, Tennessee
Census Tract 9687, Weakley County, Tennessee
Census Tract 304.02, Wilson County, Tennessee

The tracts defined as having the "Highest Risk" for possible fire fatalities are those from the high-risk group that also meet the criteria on two social variables: 12.08% or more of their population headed by a female with no husband present and less than 19.45% of their population without bachelor's degrees. These social variable screens produced a list of 33 census tracts that may have the highest risk for fire fatalities. These tracts meet the criteria on nine economic, housing, and social factors. The profiles of these tracts are most similar to those that have had a history of fire fatalities. These 33 tracts are listed in Table 3-5.

Table 3-5. Census Tracts with "Highest Risk" for Fire Fatalities (N = 33)

Census Tract 104, Bradley County, Tennessee
Census Tract 113.02, Bradley County, Tennessee
Census Tract 9620, Carroll County, Tennessee
Census Tract 9202, Cocke County, Tennessee
Census Tract 9206, Cocke County, Tennessee
Census Tract 9709, Coffee County, Tennessee
Census Tract 9550.04, Decatur County, Tennessee
Census Tract 603, Fayette County, Tennessee
Census Tract 9551, Grundy County, Tennessee
Census Tract 9503, Hardeman County, Tennessee
Census Tract 9504, Hardeman County, Tennessee
Census Tract 506.01, Hawkins County, Tennessee
Census Tract 9694, Henry County, Tennessee
Census Tract 9697, Henry County, Tennessee
Census Tract 9563, Johnson County, Tennessee
Census Tract 9703.01, Macon County, Tennessee
Census Tract 502.01, Marion County, Tennessee
Census Tract 110.04, Maury County, Tennessee
Census Tract 9503.02, Overton County, Tennessee
Census Tract 9504, Polk County, Tennessee
Census Tract 2.02, Putnam County, Tennessee
Census Tract 414.04, Rutherford County, Tennessee
Census Tract 9751.01, Scott County, Tennessee
Census Tract 110.10, Shelby County, Tennessee
Census Tract 225, Shelby County, Tennessee
Census Tract 78.22, Shelby County, Tennessee
Census Tract 1107, Stewart County, Tennessee
Census Tract 414, Sullivan County, Tennessee
Census Tract 417, Sullivan County, Tennessee
Census Tract 421, Sullivan County, Tennessee
Census Tract 203, Sumner County, Tennessee
Census Tract 605.01, Washington County, Tennessee
Census Tract 9683, Weakley County, Tennessee

Models of Fire Mortality Rates in Tennessee Census Tracts

Clearly, there is ample correlational evidence that various socioeconomic factors are associated with whether a census tract has recorded fire fatalities or not during the study period. Might some of these factors or others help to explain the incidence of fire fatalities as measured by the fatality rate in census tracts? In other words, which variables might have independent effects on fire mortality risk? Regression analyses specify the relative import of variables (standardized coefficients) for explaining the observed differences in the fire fatality rates. Three models are presented, one for all tracts, one for urban tracts, and one for rural tracts. Table 3-6 specifies the factors that have a statistically significant impact in explaining variation in the mean fatality rate for tracts during the 2013-2022 study period.

Table 3-6. Regression Models of Fire Fatality Rates in Three Census Tract Groups

	Model #1 All Census Tracts (N=1650) Adj. R^2= .091			Model #2 Urban Census Tracts (N=1056) Adj. R^2= .107			Model #3 Rural Census Tracts (N=594) Adj. R^2= .072		
Variable	Unstandar-dized Coefficient	Stand Coeff.	t	Unstandar-dized Coefficient	Stand Coeff.	t	Unstan-ardized Coefficient	Stand. Coeff.	t
(Constant)	23.91		3.10	16.09		1.97	66.33		4.53
Mean 2021 Earnings	3.85	.044	.954						
Percent families & people with income below Poverty Level	.14	.077	2.53	.141	.091	2.29			
Percent housing comprised of mobile homes	.469	.146	4.43	.174	.039	1.06	.540	.159	3.14
Percent housing built before 1980	.141	.098	3.47	.158	.132	3.81			
Median value owner-occupied units	-1.63	-.061	-1.27	-1.86	-.083	-1.40			
Percent Black/African American	.095	.071	2.30	.086	.078	2.01			
Average HH Size	-6.56	-.067	-2.64	-3.28	-.039	-1.25	-19.59	-.143	3.57
Percent population with bachelor's degree	-.301	-.093	-2.19	-.354	-.124	-2.37	-.329	-.076	-1.50

While each model explains only a modest level of variation (9.1%, 10.7%, and 7.2%) in fatality rates within each of the three groups of census tracts, several factors emerge as statistically significant and substantively important in understanding differences in fatality rates. To assist with interpretation, variables with a "t" value of 2.0 or higher have a statistically significant impact on explaining variation in fire fatalities among tracts. For example, there are six statistically significant variables in Model #1, four in Model #2, and three in Model #3. The absolute value of the standardized coefficient reflects that variable's importance as an independent predictor. The higher the value the greater its import.

So, for all census tracts, the most important statistically significant predictor of whether a census tract will have fire fatalities is the tract's percentage of the housing stock comprised of mobile homes. It is the most important predictor since it has the largest absolute standardized coefficient in the model (.146). To interpret the effect that a one-unit change in the independent (predictor) variable has on the dependent variable (fire fatality rate), we examine the unstandardized regression coefficient. The absence of a negative sign indicates that the relationship is positive meaning that a one percent increase in the percentage of mobile homes in tract's housing stock, results in a .146 increase in the fire fatality rate assuming all other variables in the model are constant. This is the independent effect of a one percent increase in this variable.

In addition to the percentage of mobile homes, five other variables are important (in rank order) for understanding variation in the fire fatality rate when all tracts are examined: the percentage of the housing stock built before 1980, the percentage of tract residents with bachelor's degrees, the percentage of families and people in the tract with incomes below the poverty level, the percentage of the tract population comprised of Black/African Americans, and the tract's average household size. The independent effect of a one percent change in the predictor variable is indicated by the sign and the value of the unstandardized coefficient. For example, the negative sign of the coefficient for percent with a bachelor's degree indicates that for a one percent increase in the proportion of the tract population with a bachelor's degree, the fire fatality rate will *decline* by .093.

Models #2 and #3 for urban and rural tracts indicate differences (as one would expect) in the variables and their relative import for explaining variation in fire fatality rates. Among the 1056 urban census tracts, the age of housing (proportion built before 1980), the percent with a bachelor's degree, the percent in poverty, and the percent comprised of Black/African American residents are the most useful predictors. Among the 594 rural tracts, only two variables proved useful: average household size and the percentage of mobile homes in the housing stock. To assist in applying the findings from these models, descriptive statistics for all of the variables in these regression models are provided in Table 3-7.

Table 3-7. Descriptive Statistics for Variables in the Regression Models

	All Census Tracts (N= 1655 to 1685)			Urban Census Tracts (N = 1060 to 1082)			Rural Census Tracts (N = 595 to 603)		
Variables	Mean	Median	Mode	Mean	Median	Mode	Mean	Median	Mode
Mean 2021 Earnings	$80,249	$70,283	$40,874	$80,510	$68,980	$40,874	$79,779	$71,498	$58,843
Percent families & people with income below Poverty Level	20.45	15.9	0	22.58	17.1	0	16.64	13.80	0
Percent housing comprised of mobile homes	8.96	4.38	0	4.52	1.04	0	16.96	17.05	0
Percent housing built before 1980	45.35	43.30	0	50.24	50.98	0	36.57	37.15	0
Median value owner-occupied units	$201,701	$170,300	$238,600	$211,128	$179,000	$179,400	$184,908	$163,800	$105,400
Percent Black/African American	17.56	5.32	0	24.20	11.38	0	5.64	1.63	0
Average HH Size	2.51	2.51	2.54	2.47	2.46	2.22	2.59	2.57	2.45
Percent population with bachelor's degree	17.31	14.53	0	18.88	16.34	0	14.49	12.09	0
Mean Fire Fatality Rate ('13-'22)	16.86			15.19			19.86		

In sum, the census tracts that had higher fire fatality *rates* were more likely to:

- be rural rather than urban,
- have a higher percentage of mobile homes in the housing stock,
- have a larger proportion of homes constructed prior to 1980,
- have a smaller percentage of residents with bachelor's degrees,
- have a higher poverty level,
- a larger Black/African American population,
- and a smaller household size.

Chapter 4. Summary and Implications of Findings

This study examined the nature, extent and causes of civilian residential fire fatalities in Tennessee between 2013-2022 with the aim of describing the state's fire fatality problem, identifying the populations that have a higher risk of fire mortality, explaining why fire fatality rates vary among the state's census tracts, and providing a basis for continued efforts to prevent and reduce civilian deaths in residential fires.

Fire deaths declined nationally during the last 50 years, but Tennessee's fire mortality rate declined at a faster rate than the nation despite significant state population growth. While annual fluctuations in the number of home fire deaths in Tennessee are normal, trendline analysis indicates that the state's fire mortality rate continues to exhibit a pattern of modest decline, a trend expected to continue for the remainder of the decade. This encouraging trend is dependent upon continued efforts by state and local fire officials to educate and equip residents with the information and means to help minimize the risk of being a fire fatality victim.

Compared to the previous 2011 study of Tennessee fire mortalities, analyses of fire incident data during the 2013 to 2022 study period indicated that not much has changed in terms of the most common causes, heat sources, and area of origin of fatal home fires. Operating equipment including kitchen and cooking equipment and issues with heating and electrical malfunctions (short circuits, arcing, and the like) continue to be prominent ignition sources for fatal fires. Smoking related causes for fatal fires remain the most prevalent cause of fatal fires in Tennessee as they are for the nation. The most common areas of origin for fatal fires are the living/family room, bedroom, and kitchen.

The presence of smoke detectors in home fires in the state steadily increased between 2013 to 2022. This analysis found a statistically significant difference between the presence of smoke detectors in fatal and non-fatal fires. Smoke alarms are much more likely to be absent in fatal fire incidents, a finding that underscores the importance of efforts to equip households with these devices. Having working smoke alarms/detectors in the most common areas of fire origin is an important way to reduce the risk of home fire fatalities.

The victims of fatal fires in Tennessee tend to be disproportionately very young, very old, and minorities. Members of each of these groups die in home fires in proportions that exceed their size in the population. Providing smoke alarms to members of these most vulnerable groups in communities that generally have a higher risk for fatal fires will help continue to "turn the curve" in the trend of home fire deaths in the state.

As a case in point, Tennessee's "Get Alarmed" program is credited for saving 450 lives between late 2012 when the program was launched and 2022. If the current level of participation in this program is sustained, our analysis indicates that about 50 or more lives will be saved in each of the remaining years of this decade. Continuation of and expanded participation in this program, especially by residents in higher risk urban and rural census tracts, is likely to save even more lives.

In the decades ahead, substantial reductions in the state residential fire mortality rate may depend on the extent to which more local governments choose to adopt the NFPA 13 D standards for home sprinkler systems. The TFIRS data for 2013 thru 2022 show that not a single person perished in a home equipped with an automatic sprinkler system.

The value of risk assessment of census tracts is that it provides state and local officials with a means to help deploy limited resources for public education on fire safety and prevention where the impact is likely to be greatest. This analysis assumes that the factors that distinguished the tracts with fire mortalities in the past are likely to prove helpful in identifying other tracts that have a higher risk of fire fatalities.

This type of risk assessment of census tracts is not a means for *predicting* the precise location of any particular fatal fire. Rather, it indicates that the 341 census tracts classified as having at least an above average for fire fatalities are most like the 597 tracts that already recorded one or more fire fatalities during the study period. The similarities among these tracts suggest that fatal fires could occur in any of these 938 census tracts. Of course, it is possible that a home fire death *could* occur in any of the other 747 census tracts that did not have a fire fatality during the study period. People are mobile; they move, travel, and interact socially. Carelessness, misfortune, and lack of smoke alarms are not confined within or by census tract boundaries over time. Nonetheless, this type of risk assessment can provide a useful means for targeting scarce resources strategically for maximum possible benefit from fire safety and prevention education efforts.

Models examined the census tract mortality rates for all, urban, and rural tracts. These analyses indicated that while various economic, housing, and social variables explained small proportions of variation in mortality rates, several factors in each group consistently distinguished tracts with higher fire mortality rates. Tracts that have an older housing stock (more homes constructed before 1980), a higher proportion of mobile homes, a larger population with incomes below the poverty level, a smaller population proportion without college degrees, and a larger proportion of Blacks/African Americans are communities that have a higher risk for fire fatalities.

Reducing the risk of death, injury, and loss in home fires is a daunting task for fire safety officials. The nature of the challenges confronted are different in urban and rural areas. Urban census tracts, for instance, account for the largest number of fire deaths, but the risk for residents of perishing in a home is generally higher in rural census tracts. Rural areas typically confront more issues related to resources and infrastructure that limit their capacity to provide a fully professionalized level of fire protection. Residents in rural communities with little or no professional fire service protection may realize a greater benefit in terms of lower fire mortality risk if their homes are equipped with sprinklers. Urban areas encounter their own unique challenges in advancing public safety and fire protection. These may range from

issues connected to the age, condition, and maintenance of housing, building inspection, and barriers in outreach to and education of residents.

Regardless of residential location, the loss or impairment of family members is a devastating tragedy for affected families and the costs of these incidents extend far beyond the family unit. The loss of a main breadwinner or the impairment of an individual's ability to participate in the workforce may lead to an increased demand for a variety of state and federal social services. These may include for example unemployment compensation, disability, welfare, public housing, TennCare or other programs for which the victim's families or those injured or disabled by in a fire may qualify based on income and disability circumstances.

Fire safety education of vulnerable populations is a crucial strategy for preventing and reducing fire mortalities and for controlling the diverse and costly consequences of fire deaths and injuries. A fire department with the fastest response time, staffed by the most proficient and well-trained personnel, and armed with the latest equipment and technology is an invaluable resource but even this type of department can do little to prevent a fatality before first responders arrive on the scene. Very young children, the elderly, and the disabled require help to make their way to safety in a fire. They are unlikely to receive such help if the occupants of a residence have no warning from a smoke detector or alarm. Equipping more Tennessee homes with operable smoke detectors and sprinkler systems are among the more cost-effective ways to save lives. Efforts to educate residents about the importance of smoke detectors and the value of home sprinklers should continue in the future.

Tennessee is blessed with a very talented and dedicated cadre of professionals in fire management, public safety, and building construction. Strategic efforts by the State Fire Marshall's Office developed in conjunction with key stakeholders should continue to reduce the fire mortality problem in Tennessee. This sustained team effort will continue to distinguish Tennessee as a leader in preventing fires and preserving lives.

Selected References

Aherns, Marty. Dec. 2021a. **US Fire Death Rates by State.** National Fire Protection Association.

Aherns, Marty. Dec. 2021b. **US Fire Death Rates by State, Supporting Tables**. National Fire Protection Association.

Folz, David H., Chris Shults, Mike Meyers, Frances Adams-O'Brian, Leah Festa, & Gary L. West. 2011. **An Analysis of Civilian Residential Fire Deaths in Tennessee, 2002 – 2010**. UT Municipal Technical Advisory Service.

Folz, David H., Mike Meyers, & John Clark. 2014. **The 2014 TN Fire Mortalities Analysis: Methodology and Findings.** UT Municipal Technical Advisory Service.

Hall, Shelby. April 2023a. **Home Structure Fires**. National Fire Protection Association.

Hall, Shelby. April 2023b. **Home Structure Fires Supporting Tables.** National Fire Protection Association.

Mickelson, Stephanie. 2023. "Fire Sprinkler System Cost Factors and Considerations: Why It's Worth It." Accessed 3-6-24 at: https://www.bobvila.com/articles/fire-sprinkler-system-cost/

Municipal Technical Advisory Service. 2022. **Opt-In for Residential Inspections.** Accessed 10-12-23 at: https://www.mtas.tennessee.edu/reference/opt-residential-inspections

National Fire Protection Association. Sept. 2022. **Fire Loss in the United States: Trend Tables.**

National Fire Sprinkler Association. 2023. "Lithium-Ion Battery Fires and Fire Protection." Accessed 3-7-24 at: https://nfsa.org/2023/01/12/lithium-ion-battery-fires/

North Carolina State Fire Marshal's Office. 2021. Home Fire Sprinklers. Accessed 3-7-24 at: https://www.ncosfm.gov/community-risk-reduction/fire-prevention-education/home-fire-sprinklers

Pannell, Donald. 2024. Email communication on 4-5-2024.

State Fire Marshal's Office. Jan. 2023. **Residential Jurisdictions and Inspectors.** TN Dept. of Commerce and Insurance.

State Fire Marshal's Office. 2018. **Statewide Building Construction Code Inspections in "Opt-Out" or "Non-Code" Jurisdictions.** TN Dept. of Commerce and Insurance.

Team Homeserve. 2022. “How Much Does It Cost to Install a Home Fire Sprinkler System?” Accessed 3-6-24 at: https://www.homeserve.com/en-us/blog/cost-guide/residential-fire-sprinkler-system/

Tennessee Code Annotated. Code § 68-120-101 (2019). Accessed 3-8-24 at: https://law.justia.com/codes/tennessee/2019/title-68/safety/chapter-120/part-1/section-68-120-101/

Tennessee State Fire Marshal’s Office. Feb. 2023. **Commissioner’s Annual Report for 2022** https://www.tn.gov/content/dam/tn/commerce/documents/fire_prevention/posts/SFMO-Annual-Report-2022.pdf

TN Dept. Commerce & Insurance. 2018. **Statewide Building Construction Code Inspections in “Opt-Out” or “Non-Code” Jurisdictions. Accessed 10-12-23** at: https://www.tn.gov/content/dam/tn/commerce/documents/fire_prevention/posts/TN_Building_Inspections_Opt-Out_Areas.pdf

TSFMO 12-3-2023. Fire Fatalities and Mortality Rate in Tennessee. Accessed 12-3-23 at: https://www.tn.gov/commerce/fire/prevention-education-and-outreach/fire-fatalities-and-mortality-rate-in-tn.html

Underwriter’s Laboratory. “Lithium-ion Battery Incident Reporting.” 2023. Accessed 3-7-24 at: https://www.ul.com/insights/lithium-ion-battery-incident-reporting

U.S. Fire Administration. 2022. **“**Fatal Fires in Residential Buildings (2018-2020)” **Topical Report Fire Series** Vol. 22, Issue 2. At: https://www.usfa.fema.gov/downloads/pdf/statistics/v22i2.pdf

U.S. Census Bureau 2023. **2017-2021 American Community Survey (5-year estimates)** at: https://www.census.gov/programs-surveys/acs/data.html

USA Facts. 2023. Population. Accessed 5-3-23 at :(https://usafacts.org/data/topics/people-society/population-and-demographics/population-data/population/)

U.S. Fire Administration, National Fire Data Center. 2009. **Fire in the United States 2003-2007** (15th edition). Emmitsburg, MA.

U.S. Fire Administration. 2023. Home Fire Sprinklers. Accessed 3-7-24 at: https://www.usfa.fema.gov/prevention/home-fires/prepare-for-fire/home-fire-sprinklers/

U.S. Census Bureau. 2023. **Quick Facts**. Accessed 10-19-23 at: https://www.census.gov/quickfacts/fact/table/TN/PST045222

Weinberger, Dawn. 2023. “What To Know About Residential Fire Sprinkler Systems.” Accessed 3-7-24 at https://www.familyhandyman.com/article/residential-fire-sprinkler-system-guide/

WVLT-TV2023. Accessed 10-11-23 at: https://www.wvlt.tv/2023/10/11/it-was-lifesaver-smoke- alarm-helps-family-escape-apartment-fire/.

APPENDIX A

Census Tracts with One or More Fire Fatalities During 2013-2022 (N=597)

Census Tract Number and County	Number of Fire Fatalities
Census Tract 201, Anderson County, Tennessee	1
Census Tract 203, Anderson County, Tennessee	1
Census Tract 209.02, Anderson County, Tennessee	1
Census Tract 9504.02, Bedford County, Tennessee	1
Census Tract 9505, Bedford County, Tennessee	1
Census Tract 9506, Bedford County, Tennessee	1
Census Tract 9634, Benton County, Tennessee	1
Census Tract 9530, Bledsoe County, Tennessee	1
Census Tract 9531.01, Bledsoe County, Tennessee	1
Census Tract 110.01, Blount County, Tennessee	1
Census Tract 114.01, Blount County, Tennessee	1
Census Tract 114.04, Blount County, Tennessee	1
Census Tract 116.06, Blount County, Tennessee	1
Census Tract 103, Bradley County, Tennessee	1
Census Tract 106, Bradley County, Tennessee	1
Census Tract 108, Bradley County, Tennessee	1
Census Tract 109, Bradley County, Tennessee	1
Census Tract 111.01, Bradley County, Tennessee	1
Census Tract 112.04, Bradley County, Tennessee	1
Census Tract 113.01, Bradley County, Tennessee	1
Census Tract 9505, Campbell County, Tennessee	1
Census Tract 9506.01, Campbell County, Tennessee	1
Census Tract 9509, Campbell County, Tennessee	1
Census Tract 9601, Cannon County, Tennessee	1
Census Tract 9602.01, Cannon County, Tennessee	1
Census Tract 9602.02, Cannon County, Tennessee	1
Census Tract 9603, Cannon County, Tennessee	1
Census Tract 705, Carter County, Tennessee	1
Census Tract 708, Carter County, Tennessee	1
Census Tract 710, Carter County, Tennessee	1
Census Tract 715, Carter County, Tennessee	1
Census Tract 716, Carter County, Tennessee	1
Census Tract 701.03, Cheatham County, Tennessee	1
Census Tract 702.01, Cheatham County, Tennessee	1
Census Tract 9701.01, Chester County, Tennessee	1
Census Tract 9701.02, Chester County, Tennessee	1
Census Tract 9703.01, Chester County, Tennessee	1
Census Tract 9703, Claiborne County, Tennessee	1
Census Tract 9550, Clay County, Tennessee	1

Census Tract 9551, Clay County, Tennessee	1
Census Tract 9201, Cocke County, Tennessee	1
Census Tract 9203, Cocke County, Tennessee	1
Census Tract 9701, Coffee County, Tennessee	1
Census Tract 9707, Coffee County, Tennessee	1
Census Tract 9708.01, Coffee County, Tennessee	1
Census Tract 9708.03, Coffee County, Tennessee	1
Census Tract 9708.04, Coffee County, Tennessee	1
Census Tract 9612, Crockett County, Tennessee	1
Census Tract 9701.01, Cumberland County, Tennessee	1
Census Tract 9702.02, Cumberland County, Tennessee	1
Census Tract 9704.01, Cumberland County, Tennessee	1
Census Tract 9705.02, Cumberland County, Tennessee	1
Census Tract 9706.03, Cumberland County, Tennessee	1
Census Tract 9707.02, Cumberland County, Tennessee	1
Census Tract 101.05, Davidson County, Tennessee	1
Census Tract 102.02, Davidson County, Tennessee	1
Census Tract 103.03, Davidson County, Tennessee	1
Census Tract 104.04, Davidson County, Tennessee	1
Census Tract 105.01, Davidson County, Tennessee	1
Census Tract 126, Davidson County, Tennessee	1
Census Tract 127.01, Davidson County, Tennessee	1
Census Tract 131, Davidson County, Tennessee	1
Census Tract 132.01, Davidson County, Tennessee	1
Census Tract 132.02, Davidson County, Tennessee	1
Census Tract 133, Davidson County, Tennessee	1
Census Tract 137.01, Davidson County, Tennessee	1
Census Tract 144, Davidson County, Tennessee	1
Census Tract 153, Davidson County, Tennessee	1
Census Tract 154.01, Davidson County, Tennessee	1
Census Tract 154.05, Davidson County, Tennessee	1
Census Tract 155.01, Davidson County, Tennessee	1
Census Tract 156.14, Davidson County, Tennessee	1
Census Tract 156.17, Davidson County, Tennessee	1
Census Tract 156.23, Davidson County, Tennessee	1
Census Tract 156.25, Davidson County, Tennessee	1
Census Tract 156.27, Davidson County, Tennessee	1
Census Tract 156.28, Davidson County, Tennessee	1
Census Tract 158.06, Davidson County, Tennessee	1
Census Tract 159, Davidson County, Tennessee	1
Census Tract 169, Davidson County, Tennessee	1
Census Tract 177.02, Davidson County, Tennessee	1
Census Tract 182.01, Davidson County, Tennessee	1

Census Tract 182.04, Davidson County, Tennessee	1
Census Tract 184.12, Davidson County, Tennessee	1
Census Tract 188.03, Davidson County, Tennessee	1
Census Tract 189.05, Davidson County, Tennessee	1
Census Tract 191.09, Davidson County, Tennessee	1
Census Tract 191.16, Davidson County, Tennessee	1
Census Tract 192, Davidson County, Tennessee	1
Census Tract 196, Davidson County, Tennessee	1
Census Tract 9201.01, DeKalb County, Tennessee	1
Census Tract 9201.02, DeKalb County, Tennessee	1
Census Tract 602.01, Dickson County, Tennessee	1
Census Tract 602.02, Dickson County, Tennessee	1
Census Tract 603, Dickson County, Tennessee	1
Census Tract 9648, Dyer County, Tennessee	1
Census Tract 604.04, Fayette County, Tennessee	1
Census Tract 9650, Fentress County, Tennessee	1
Census Tract 9651, Fentress County, Tennessee	1
Census Tract 9652.02, Fentress County, Tennessee	1
Census Tract 9602.02, Franklin County, Tennessee	1
Census Tract 9604.01, Franklin County, Tennessee	1
Census Tract 9606, Franklin County, Tennessee	1
Census Tract 9607, Franklin County, Tennessee	1
Census Tract 9662, Gibson County, Tennessee	1
Census Tract 9663, Gibson County, Tennessee	1
Census Tract 9664, Gibson County, Tennessee	1
Census Tract 9667.02, Gibson County, Tennessee	1
Census Tract 9669, Gibson County, Tennessee	1
Census Tract 9674, Gibson County, Tennessee	1
Census Tract 9202, Giles County, Tennessee	1
Census Tract 9203.01, Giles County, Tennessee	1
Census Tract 9206, Giles County, Tennessee	1
Census Tract 9207, Giles County, Tennessee	1
Census Tract 5001, Grainger County, Tennessee	1
Census Tract 5003.01, Grainger County, Tennessee	1
Census Tract 908, Greene County, Tennessee	1
Census Tract 911, Greene County, Tennessee	1
Census Tract 912, Greene County, Tennessee	1
Census Tract 1011, Hamblen County, Tennessee	1
Census Tract 23, Hamilton County, Tennessee	1
Census Tract 33, Hamilton County, Tennessee	1
Census Tract 34, Hamilton County, Tennessee	1
Census Tract 101.01, Hamilton County, Tennessee	1
Census Tract 103.03, Hamilton County, Tennessee	1

Census Tract 103.08, Hamilton County, Tennessee	1
Census Tract 103.09, Hamilton County, Tennessee	1
Census Tract 104.11, Hamilton County, Tennessee	1
Census Tract 105.02, Hamilton County, Tennessee	1
Census Tract 109.02, Hamilton County, Tennessee	1
Census Tract 113.11, Hamilton County, Tennessee	1
Census Tract 113.21, Hamilton County, Tennessee	1
Census Tract 113.26, Hamilton County, Tennessee	1
Census Tract 114.11, Hamilton County, Tennessee	1
Census Tract 114.42, Hamilton County, Tennessee	1
Census Tract 116, Hamilton County, Tennessee	1
Census Tract 118, Hamilton County, Tennessee	1
Census Tract 121, Hamilton County, Tennessee	1
Census Tract 123, Hamilton County, Tennessee	1
Census Tract 9206, Hardin County, Tennessee	1
Census Tract 501, Hawkins County, Tennessee	1
Census Tract 502, Hawkins County, Tennessee	1
Census Tract 508, Hawkins County, Tennessee	1
Census Tract 509, Hawkins County, Tennessee	1
Census Tract 9304, Haywood County, Tennessee	1
Census Tract 9755, Henderson County, Tennessee	1
Census Tract 9502.02, Hickman County, Tennessee	1
Census Tract 9503.02, Hickman County, Tennessee	1
Census Tract 1301, Humphreys County, Tennessee	1
Census Tract 1303, Humphreys County, Tennessee	1
Census Tract 9601, Jackson County, Tennessee	1
Census Tract 701.02, Jefferson County, Tennessee	1
Census Tract 703, Jefferson County, Tennessee	1
Census Tract 706, Jefferson County, Tennessee	1
Census Tract 707.01, Jefferson County, Tennessee	1
Census Tract 707.02, Jefferson County, Tennessee	1
Census Tract 709, Jefferson County, Tennessee	1
Census Tract 9562, Johnson County, Tennessee	1
Census Tract 15, Knox County, Tennessee	1
Census Tract 18, Knox County, Tennessee	1
Census Tract 19, Knox County, Tennessee	1
Census Tract 23, Knox County, Tennessee	1
Census Tract 24, Knox County, Tennessee	1
Census Tract 30, Knox County, Tennessee	1
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Census Tract 46.07, Knox County, Tennessee	1
Census Tract 46.08, Knox County, Tennessee	1
Census Tract 46.14, Knox County, Tennessee	1

Census Tract 47, Knox County, Tennessee	1
Census Tract 52.03, Knox County, Tennessee	1
Census Tract 53.01, Knox County, Tennessee	1
Census Tract 54.01, Knox County, Tennessee	1
Census Tract 61.03, Knox County, Tennessee	1
Census Tract 63.02, Knox County, Tennessee	1
Census Tract 64.02, Knox County, Tennessee	1
Census Tract 68, Knox County, Tennessee	1
Census Tract 9602, Lake County, Tennessee	1
Census Tract 505.05, Lauderdale County, Tennessee	1
Census Tract 505.06, Lauderdale County, Tennessee	1
Census Tract 9602, Lawrence County, Tennessee	1
Census Tract 9605.02, Lawrence County, Tennessee	1
Census Tract 9606, Lawrence County, Tennessee	1
Census Tract 9750, Lincoln County, Tennessee	1
Census Tract 9753, Lincoln County, Tennessee	1
Census Tract 9754, Lincoln County, Tennessee	1
Census Tract 9756.02, Lincoln County, Tennessee	1
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Census Tract 603.03, Loudon County, Tennessee	1
Census Tract 9704.01, McMinn County, Tennessee	1
Census Tract 9705, McMinn County, Tennessee	1
Census Tract 9706.01, McMinn County, Tennessee	1
Census Tract 9706.02, McMinn County, Tennessee	1
Census Tract 9707, McMinn County, Tennessee	1
Census Tract 9708.02, McMinn County, Tennessee	1
Census Tract 9305.02, McNairy County, Tennessee	1
Census Tract 9306, McNairy County, Tennessee	1
Census Tract 9307, McNairy County, Tennessee	1
Census Tract 9703.02, Macon County, Tennessee	1
Census Tract 9704, Macon County, Tennessee	1
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Census Tract 11, Madison County, Tennessee	1
Census Tract 16.07, Madison County, Tennessee	1
Census Tract 18, Madison County, Tennessee	1
Census Tract 502.03, Marion County, Tennessee	1
Census Tract 502.04, Marion County, Tennessee	1
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Census Tract 101, Maury County, Tennessee	1
Census Tract 103.01, Maury County, Tennessee	1
Census Tract 104.01, Maury County, Tennessee	1
Census Tract 106, Maury County, Tennessee	1

Census Tract 112, Maury County, Tennessee	1
Census Tract 9250.01, Monroe County, Tennessee	1
Census Tract 9251.01, Monroe County, Tennessee	1
Census Tract 9251.02, Monroe County, Tennessee	1
Census Tract 9252, Monroe County, Tennessee	1
Census Tract 9253.01, Monroe County, Tennessee	1
Census Tract 9254.01, Monroe County, Tennessee	1
Census Tract 9255.03, Monroe County, Tennessee	1
Census Tract 1002, Montgomery County, Tennessee	1
Census Tract 1011.03, Montgomery County, Tennessee	1
Census Tract 1015.01, Montgomery County, Tennessee	1
Census Tract 1018.03, Montgomery County, Tennessee	1
Census Tract 1018.06, Montgomery County, Tennessee	1
Census Tract 1020.08, Montgomery County, Tennessee	1
Census Tract 1102, Morgan County, Tennessee	1
Census Tract 1104, Morgan County, Tennessee	1
Census Tract 9652, Obion County, Tennessee	1
Census Tract 9655, Obion County, Tennessee	1
Census Tract 9501, Overton County, Tennessee	1
Census Tract 9302.02, Perry County, Tennessee	1
Census Tract 9251.02, Pickett County, Tennessee	1
Census Tract 6, Putnam County, Tennessee	1
Census Tract 9753, Rhea County, Tennessee	1
Census Tract 9754.02, Rhea County, Tennessee	1
Census Tract 302.03, Roane County, Tennessee	1
Census Tract 303.01, Roane County, Tennessee	1
Census Tract 303.02, Roane County, Tennessee	1
Census Tract 801.03, Robertson County, Tennessee	1
Census Tract 802, Robertson County, Tennessee	1
Census Tract 803.01, Robertson County, Tennessee	1
Census Tract 804.02, Robertson County, Tennessee	1
Census Tract 806.05, Robertson County, Tennessee	1
Census Tract 806.06, Robertson County, Tennessee	1
Census Tract 402, Rutherford County, Tennessee	1
Census Tract 403.05, Rutherford County, Tennessee	1
Census Tract 406, Rutherford County, Tennessee	1
Census Tract 408.08, Rutherford County, Tennessee	1
Census Tract 409.01, Rutherford County, Tennessee	1
Census Tract 409.04, Rutherford County, Tennessee	1
Census Tract 411.02, Rutherford County, Tennessee	1
Census Tract 419, Rutherford County, Tennessee	1
Census Tract 420, Rutherford County, Tennessee	1
Census Tract 421.01, Rutherford County, Tennessee	1

Census Tract 601.02, Sequatchie County, Tennessee	1
Census Tract 601.04, Sequatchie County, Tennessee	1
Census Tract 805, Sevier County, Tennessee	1
Census Tract 806.01, Sevier County, Tennessee	1
Census Tract 807.01, Sevier County, Tennessee	1
Census Tract 808.03, Sevier County, Tennessee	1
Census Tract 809.01, Sevier County, Tennessee	1
Census Tract 811.01, Sevier County, Tennessee	1
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Census Tract 30, Shelby County, Tennessee	1
Census Tract 31, Shelby County, Tennessee	1
Census Tract 36, Shelby County, Tennessee	1
Census Tract 39, Shelby County, Tennessee	1
Census Tract 67, Shelby County, Tennessee	1
Census Tract 68, Shelby County, Tennessee	1
Census Tract 69, Shelby County, Tennessee	1
Census Tract 75, Shelby County, Tennessee	1
Census Tract 78.21, Shelby County, Tennessee	1
Census Tract 81.20, Shelby County, Tennessee	1
Census Tract 92.01, Shelby County, Tennessee	1
Census Tract 99.01, Shelby County, Tennessee	1
Census Tract 99.02, Shelby County, Tennessee	1
Census Tract 100.02, Shelby County, Tennessee	1
Census Tract 102.20, Shelby County, Tennessee	1
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Census Tract 106.10, Shelby County, Tennessee	1
Census Tract 108.10, Shelby County, Tennessee	1
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Census Tract 205.24, Shelby County, Tennessee	1
Census Tract 205.42, Shelby County, Tennessee	1
Census Tract 211.35, Shelby County, Tennessee	1
Census Tract 211.36, Shelby County, Tennessee	1

Census Tract 213.51, Shelby County, Tennessee	1
Census Tract 217.55, Shelby County, Tennessee	1
Census Tract 221.22, Shelby County, Tennessee	1
Census Tract 223.21, Shelby County, Tennessee	1
Census Tract 223.22, Shelby County, Tennessee	1
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Census Tract 9750, Smith County, Tennessee	1
Census Tract 9752, Smith County, Tennessee	1
Census Tract 9754, Smith County, Tennessee	1
Census Tract 408, Sullivan County, Tennessee	1
Census Tract 410, Sullivan County, Tennessee	1
Census Tract 413, Sullivan County, Tennessee	1
Census Tract 418, Sullivan County, Tennessee	1
Census Tract 425, Sullivan County, Tennessee	1
Census Tract 426, Sullivan County, Tennessee	1
Census Tract 427.02, Sullivan County, Tennessee	1
Census Tract 427.04, Sullivan County, Tennessee	1
Census Tract 428.01, Sullivan County, Tennessee	1
Census Tract 430, Sullivan County, Tennessee	1
Census Tract 432.01, Sullivan County, Tennessee	1
Census Tract 435, Sullivan County, Tennessee	1
Census Tract 201.01, Sumner County, Tennessee	1
Census Tract 201.02, Sumner County, Tennessee	1
Census Tract 202.03, Sumner County, Tennessee	1
Census Tract 206.01, Sumner County, Tennessee	1
Census Tract 206.03, Sumner County, Tennessee	1
Census Tract 207, Sumner County, Tennessee	1
Census Tract 209.01, Sumner County, Tennessee	1
Census Tract 209.04, Sumner County, Tennessee	1
Census Tract 210.06, Sumner County, Tennessee	1
Census Tract 210.08, Sumner County, Tennessee	1
Census Tract 211.03, Sumner County, Tennessee	1
Census Tract 211.06, Sumner County, Tennessee	1
Census Tract 211.07, Sumner County, Tennessee	1
Census Tract 212.04, Sumner County, Tennessee	1
Census Tract 403.03, Tipton County, Tennessee	1
Census Tract 403.04, Tipton County, Tennessee	1
Census Tract 405, Tipton County, Tennessee	1
Census Tract 406.01, Tipton County, Tennessee	1
Census Tract 406.02, Tipton County, Tennessee	1
Census Tract 408, Tipton County, Tennessee	1
Census Tract 902, Trousdale County, Tennessee	1
Census Tract 801, Unicoi County, Tennessee	1

Census Tract 803, Unicoi County, Tennessee	1
Census Tract 401.02, Union County, Tennessee	1
Census Tract 402.01, Union County, Tennessee	1
Census Tract 402.02, Union County, Tennessee	1
Census Tract 9250, Van Buren County, Tennessee	1
Census Tract 9252, Van Buren County, Tennessee	1
Census Tract 9306, Warren County, Tennessee	1
Census Tract 9308, Warren County, Tennessee	1
Census Tract 606.01, Washington County, Tennessee	1
Census Tract 608, Washington County, Tennessee	1
Census Tract 609.01, Washington County, Tennessee	1
Census Tract 610, Washington County, Tennessee	1
Census Tract 613.01, Washington County, Tennessee	1
Census Tract 613.02, Washington County, Tennessee	1
Census Tract 614.04, Washington County, Tennessee	1
Census Tract 615, Washington County, Tennessee	1
Census Tract 617.01, Washington County, Tennessee	1
Census Tract 618, Washington County, Tennessee	1
Census Tract 619.02, Washington County, Tennessee	1
Census Tract 9503, Wayne County, Tennessee	1
Census Tract 9680, Weakley County, Tennessee	1
Census Tract 9681.01, Weakley County, Tennessee	1
Census Tract 9682.01, Weakley County, Tennessee	1
Census Tract 9685, Weakley County, Tennessee	1
Census Tract 9686, Weakley County, Tennessee	1
Census Tract 9354, White County, Tennessee	1
Census Tract 9355, White County, Tennessee	1
Census Tract 501.03, Williamson County, Tennessee	1
Census Tract 511, Williamson County, Tennessee	1
Census Tract 301.02, Wilson County, Tennessee	1
Census Tract 302.03, Wilson County, Tennessee	1
Census Tract 303.04, Wilson County, Tennessee	1
Census Tract 303.11, Wilson County, Tennessee	1
Census Tract 305, Wilson County, Tennessee	1
Census Tract 208, Anderson County, Tennessee	2
Census Tract 9631, Benton County, Tennessee	2
Census Tract 105, Blount County, Tennessee	2
Census Tract 116.01, Bradley County, Tennessee	2
Census Tract 9511, Campbell County, Tennessee	2
Census Tract 707, Carter County, Tennessee	2
Census Tract 711, Carter County, Tennessee	2
Census Tract 717, Carter County, Tennessee	2
Census Tract 701.04, Cheatham County, Tennessee	2

Census Tract 703, Cheatham County, Tennessee	2
Census Tract 9709, Claiborne County, Tennessee	2
Census Tract 9710.02, Coffee County, Tennessee	2
Census Tract 9611, Crockett County, Tennessee	2
Census Tract 103.02, Davidson County, Tennessee	2
Census Tract 118, Davidson County, Tennessee	2
Census Tract 163, Davidson County, Tennessee	2
Census Tract 190.03, Davidson County, Tennessee	2
Census Tract 9550.01, Decatur County, Tennessee	2
Census Tract 9550.03, Decatur County, Tennessee	2
Census Tract 9551.02, Decatur County, Tennessee	2
Census Tract 9203, DeKalb County, Tennessee	2
Census Tract 601, Dickson County, Tennessee	2
Census Tract 9644.02, Dyer County, Tennessee	2
Census Tract 605.02, Fayette County, Tennessee	2
Census Tract 607.02, Fayette County, Tennessee	2
Census Tract 9601, Franklin County, Tennessee	2
Census Tract 9605, Franklin County, Tennessee	2
Census Tract 9608, Franklin County, Tennessee	2
Census Tract 9661, Gibson County, Tennessee	2
Census Tract 9667.01, Gibson County, Tennessee	2
Census Tract 9668, Gibson County, Tennessee	2
Census Tract 9670.02, Gibson County, Tennessee	2
Census Tract 5003.02, Grainger County, Tennessee	2
Census Tract 901, Greene County, Tennessee	2
Census Tract 906, Greene County, Tennessee	2
Census Tract 910.01, Greene County, Tennessee	2
Census Tract 913, Greene County, Tennessee	2
Census Tract 915, Greene County, Tennessee	2
Census Tract 1006, Hamblen County, Tennessee	2
Census Tract 1007, Hamblen County, Tennessee	2
Census Tract 4, Hamilton County, Tennessee	2
Census Tract 8, Hamilton County, Tennessee	2
Census Tract 101.04, Hamilton County, Tennessee	2
Census Tract 114.46, Hamilton County, Tennessee	2
Census Tract 9502, Hardeman County, Tennessee	2
Census Tract 503.01, Hawkins County, Tennessee	2
Census Tract 503.02, Hawkins County, Tennessee	2
Census Tract 9302, Haywood County, Tennessee	2
Census Tract 9303.02, Haywood County, Tennessee	2
Census Tract 9696.01, Henry County, Tennessee	2
Census Tract 9698, Henry County, Tennessee	2
Census Tract 9503.01, Hickman County, Tennessee	2

Census Tract 1201, Houston County, Tennessee	2
Census Tract 1202, Houston County, Tennessee	2
Census Tract 9602, Jackson County, Tennessee	2
Census Tract 14, Knox County, Tennessee	2
Census Tract 21, Knox County, Tennessee	2
Census Tract 40, Knox County, Tennessee	2
Census Tract 43, Knox County, Tennessee	2
Census Tract 67, Knox County, Tennessee	2
Census Tract 70, Knox County, Tennessee	2
Census Tract 71, Knox County, Tennessee	2
Census Tract 9601, Lake County, Tennessee	2
Census Tract 506, Lauderdale County, Tennessee	2
Census Tract 9702, Lewis County, Tennessee	2
Census Tract 9703, McMinn County, Tennessee	2
Census Tract 9708.01, McMinn County, Tennessee	2
Census Tract 3, Madison County, Tennessee	2
Census Tract 9, Madison County, Tennessee	2
Census Tract 10, Madison County, Tennessee	2
Census Tract 503.02, Marion County, Tennessee	2
Census Tract 9553, Marshall County, Tennessee	2
Census Tract 107, Maury County, Tennessee	2
Census Tract 1013.04, Montgomery County, Tennessee	2
Census Tract 1017.02, Montgomery County, Tennessee	2
Census Tract 1103, Morgan County, Tennessee	2
Census Tract 9653, Obion County, Tennessee	2
Census Tract 9504, Overton County, Tennessee	2
Census Tract 9251.01, Pickett County, Tennessee	2
Census Tract 9502.04, Polk County, Tennessee	2
Census Tract 8, Putnam County, Tennessee	2
Census Tract 9, Putnam County, Tennessee	2
Census Tract 9754.01, Rhea County, Tennessee	2
Census Tract 305, Roane County, Tennessee	2
Census Tract 803.02, Robertson County, Tennessee	2
Census Tract 807.02, Robertson County, Tennessee	2
Census Tract 405.01, Rutherford County, Tennessee	2
Census Tract 9750, Scott County, Tennessee	2
Census Tract 601.03, Sequatchie County, Tennessee	2
Census Tract 802.03, Sevier County, Tennessee	2
Census Tract 804.02, Sevier County, Tennessee	2
Census Tract 808.01, Sevier County, Tennessee	2
Census Tract 8, Shelby County, Tennessee	2
Census Tract 14, Shelby County, Tennessee	2
Census Tract 19, Shelby County, Tennessee	2

Census Tract 55, Shelby County, Tennessee	2
Census Tract 62, Shelby County, Tennessee	2
Census Tract 65, Shelby County, Tennessee	2
Census Tract 81.10, Shelby County, Tennessee	2
Census Tract 87, Shelby County, Tennessee	2
Census Tract 89, Shelby County, Tennessee	2
Census Tract 106.20, Shelby County, Tennessee	2
Census Tract 205.41, Shelby County, Tennessee	2
Census Tract 205.43, Shelby County, Tennessee	2
Census Tract 217.59, Shelby County, Tennessee	2
Census Tract 220.25, Shelby County, Tennessee	2
Census Tract 221.11, Shelby County, Tennessee	2
Census Tract 223.10, Shelby County, Tennessee	2
Census Tract 223.30, Shelby County, Tennessee	2
Census Tract 224.10, Shelby County, Tennessee	2
Census Tract 402, Sullivan County, Tennessee	2
Census Tract 406, Sullivan County, Tennessee	2
Census Tract 419, Sullivan County, Tennessee	2
Census Tract 407, Tipton County, Tennessee	2
Census Tract 901, Trousdale County, Tennessee	2
Census Tract 9304, Warren County, Tennessee	2
Census Tract 612, Washington County, Tennessee	2
Census Tract 616.03, Washington County, Tennessee	2
Census Tract 9502, Wayne County, Tennessee	2
Census Tract 9682.03, Weakley County, Tennessee	2
Census Tract 9684, Weakley County, Tennessee	2
Census Tract 9350, White County, Tennessee	2
Census Tract 9352, White County, Tennessee	2
Census Tract 310, Wilson County, Tennessee	2
Census Tract 211, Anderson County, Tennessee	3
Census Tract 9630, Benton County, Tennessee	3
Census Tract 9632, Benton County, Tennessee	3
Census Tract 9633, Benton County, Tennessee	3
Census Tract 113.01, Blount County, Tennessee	3
Census Tract 116.05, Blount County, Tennessee	3
Census Tract 9624, Carroll County, Tennessee	3
Census Tract 703, Carter County, Tennessee	3
Census Tract 9702, Chester County, Tennessee	3
Census Tract 9707, Claiborne County, Tennessee	3
Census Tract 106.01, Davidson County, Tennessee	3
Census Tract 116, Davidson County, Tennessee	3
Census Tract 190.08, Davidson County, Tennessee	3
Census Tract 605.01, Dickson County, Tennessee	3

Census Tract 606.01, Dickson County, Tennessee	3
Census Tract 9646, Dyer County, Tennessee	3
Census Tract 9653, Fentress County, Tennessee	3
Census Tract 9602.01, Franklin County, Tennessee	3
Census Tract 9204, Giles County, Tennessee	3
Census Tract 9205, Giles County, Tennessee	3
Census Tract 903, Greene County, Tennessee	3
Census Tract 909, Greene County, Tennessee	3
Census Tract 9550, Grundy County, Tennessee	3
Census Tract 9552, Grundy County, Tennessee	3
Census Tract 1001, Hamblen County, Tennessee	3
Census Tract 24, Hamilton County, Tennessee	3
Census Tract 105.01, Hamilton County, Tennessee	3
Census Tract 9605, Hancock County, Tennessee	3
Census Tract 9501, Hardeman County, Tennessee	3
Census Tract 9505, Hardeman County, Tennessee	3
Census Tract 9692, Henry County, Tennessee	3
Census Tract 9505, Hickman County, Tennessee	3
Census Tract 708.02, Jefferson County, Tennessee	3
Census Tract 48, Knox County, Tennessee	3
Census Tract 9701.02, McMinn County, Tennessee	3
Census Tract 501.01, Marion County, Tennessee	3
Census Tract 9603, Meigs County, Tennessee	3
Census Tract 9254.02, Monroe County, Tennessee	3
Census Tract 1009, Montgomery County, Tennessee	3
Census Tract 1010.01, Montgomery County, Tennessee	3
Census Tract 1012.02, Montgomery County, Tennessee	3
Census Tract 1015.02, Montgomery County, Tennessee	3
Census Tract 9302, Moore County, Tennessee	3
Census Tract 10, Putnam County, Tennessee	3
Census Tract 11, Putnam County, Tennessee	3
Census Tract 9750, Rhea County, Tennessee	3
Census Tract 411.04, Rutherford County, Tennessee	3
Census Tract 811.04, Sevier County, Tennessee	3
Census Tract 4, Shelby County, Tennessee	3
Census Tract 7, Shelby County, Tennessee	3
Census Tract 11, Shelby County, Tennessee	3
Census Tract 57, Shelby County, Tennessee	3
Census Tract 63, Shelby County, Tennessee	3
Census Tract 206.21, Shelby County, Tennessee	3
Census Tract 208.37, Shelby County, Tennessee	3
Census Tract 222.20, Shelby County, Tennessee	3
Census Tract 431, Sullivan County, Tennessee	3

Census Tract 208, Sumner County, Tennessee	3
Census Tract 401, Tipton County, Tennessee	3
Census Tract 802, Unicoi County, Tennessee	3
Census Tract 9501, Wayne County, Tennessee	3
Census Tract 505.02, Williamson County, Tennessee	3
Census Tract 9623, Carroll County, Tennessee	4
Census Tract 9702.02, Coffee County, Tennessee	4
Census Tract 158.05, Davidson County, Tennessee	4
Census Tract 9202.01, DeKalb County, Tennessee	4
Census Tract 9643, Dyer County, Tennessee	4
Census Tract 606, Fayette County, Tennessee	4
Census Tract 5004.02, Grainger County, Tennessee	4
Census Tract 9202, Hardin County, Tennessee	4
Census Tract 9205.01, Hardin County, Tennessee	4
Census Tract 9754, Henderson County, Tennessee	4
Census Tract 1203, Houston County, Tennessee	4
Census Tract 8, Knox County, Tennessee	4
Census Tract 32, Knox County, Tennessee	4
Census Tract 503, Lauderdale County, Tennessee	4
Census Tract 9702, Macon County, Tennessee	4
Census Tract 9650, Obion County, Tennessee	4
Census Tract 9656, Obion County, Tennessee	4
Census Tract 308.01, Roane County, Tennessee	4
Census Tract 804.01, Robertson County, Tennessee	4
Census Tract 106.30, Shelby County, Tennessee	4
Census Tract 221.21, Shelby County, Tennessee	4
Census Tract 9751, Smith County, Tennessee	4
Census Tract 619.03, Washington County, Tennessee	4
Census Tract 9504, Campbell County, Tennessee	5
Census Tract 32, Hamilton County, Tennessee	5
Census Tract 9693, Henry County, Tennessee	5
Census Tract 9502.01, Hickman County, Tennessee	5
Census Tract 13, Madison County, Tennessee	5
Census Tract 79, Shelby County, Tennessee	5
Census Tract 216.11, Shelby County, Tennessee	5
Census Tract 9532, Bledsoe County, Tennessee	6
Census Tract 101, Blount County, Tennessee	6
Census Tract 9703.01, Cumberland County, Tennessee	6
Census Tract 9605.01, Lawrence County, Tennessee	6
Census Tract 9701, Macon County, Tennessee	7
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