An Analysis of Civilian Residential Fire Deaths in Tennessee, 2002 - 2010

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Executive Summary

Historically, Tennessee's fire mortality rate for civilians has been among the highest in the nation. During 2002-2010, the time period for this study, the national fire mortality rate declined, but the rate in Tennessee increased. The purpose of this study is to provide the analytical foundation for an informed plan of action to help reduce and prevent fatalities that occur in residential structures which is the type of incident that accounts for about three-fourths of all civilian fire deaths in the state.

While most civilian residential deaths occur in the state's largest cities, the residents of rural areas and smaller communities actually experience higher rates of fire mortality. Residential fires in which several individuals perish occur more frequently in Tennessee compared to the nation. The increase in multiple fire death incidents in urban areas during 2010 was one of the reasons why the state's mortality rate spiked while the national rate trended downward.

The most common heat source for fatal residential fires in Tennessee was operating equipment that included HVAC and kitchen and cooking equipment that involved heating and electrical malfunctions (short circuits, arcing, and the like). Smoking related causes for fatal fires are more prevalent in Tennessee in the nation. In fact, the number of deaths attributed to smoking-related causes increased during 2010 suggesting that the state's fire safe cigarette legislation had no impact, at least so far, on reducing the incidence of smoking related fire deaths.

The state's fire incident reports indicated that smoke alarms were present in only 28 percent of cases during the study period. By contrast, smoke alarms were present in about 38 percent of fatal fires nationally suggesting that more lives might be saved if smoke alarms were more widely employed and maintained by Tennessee households. Similar to the nation, the state's residential fire victims tend to be the very young, the very old, and minorities. Members of each of these groups die in fatal fires in proportions that exceed their size in the population.

There are 715 fire departments in Tennessee, 306 that serve cities, 391 that serve some or all of a county outside of an incorporated city, and 18 that serve both a city and county. Less than five percent of these fire departments are classified as "career." About 16 percent are classified as a combination of "career" and "volunteer" but most fire departments (79.3 percent) are "volunteer." Just over half of Tennessee residents enjoy one of the two highest levels of fire protection but more than 30 percent have low or no fire protection service. The level of fire protection provided matters a great deal. Those departments that provide high or moderate plus service levels respond more quickly to fire calls and have lower rates of fire mortality.

The fire chiefs who responded to the statewide survey thought that the top four strategies to prevent and reduce residential fire deaths were (1) smoke alarm distribution and installation, (2) having home sprinkler systems, (3) enforcing applicable codes and (4) presenting fire safety demonstrations and instruction at local schools. In open-ended comments, most fire chiefs thought that the single best approach to reducing fire deaths was to ensure that all structures, residences included, have working smoke/fire alarms. More widespread and regular smoke detector distribution efforts, battery replacement programs, and annual testing, inspection, and installation programs were all suggested to ensure that every residence has an adequate number of working smoke detectors.

The analysis of mortality rates in the state's 1261 populated census tracts indicated that several social, economic and housing variables distinguished those tracts with residential fire deaths. These included educational variables, median household income and persons living in poverty, and the percentage of mobile homes of the housing stock and the median value of the housing units. These variables were used to identify the census tracts in which no fire deaths had yet occurred but were most like those tracts where fire deaths had occurred during 2002-2010. This analysis yielded 358 census tracts as having "above average" risk for fire fatalities, 199 tracts with "high" risk and 78 tracts with the "highest' risk for fire fatalities in addition to those where home fire deaths had already occurred.

Models that regressed census tract mortality rates on particular census variables explained small proportions of the variation in mortality rates indicating that there may be significant potential for various types of policy interventions to prevent/reduce home fire deaths. Another model of fire mortality rates among fire departments based on the fire chiefs survey responses indicates that several policies/practices may help to reduce fire mortalities. These include having a staff person in the department assigned the responsibility to provide fire safety and prevention education, have high level of code enforcement in the community and participating in smoke alarm distribution/installation programs.

Based in part on the findings of this study and in partnership with key stakeholders, the State Fire Marshall's Office has begun the process of developing a strategic action plan to implement the system, policy, procedural, technical, and staffing changes necessary to coordinate and implement a comprehensive approach to preventing and reducing fire mortalities in Tennessee.

Chapter I. Introduction

The national decline in the number and rate of U.S. fires and fire-related injuries and deaths recorded by the US Fire Administration since its inception in 1974 is testament to the significant progress made on a number of different fronts by an extensive network of professionals in the fire management, protection, and prevention communities as well as those in various medical fields and emergency response specialties. Between 1974 and 2008 for instance, US fire fatalities in residential structures, which typically account for 76% to 85% of all fire fatalities, dropped from over 9000 (about 30 deaths per million) to less than 3500 (about 11 deaths per million) (USFA 2011, 2010). This pattern of decline in residential fire deaths has been attributed, at least in part, to the more widespread use of smoke alarms, stronger fire codes and inspections, improved construction techniques, use of better materials, and improved firefighter equipment and training (USFA 2009).

While the progress in reducing the incidence of fire fatalities is laudable, the fact remains that about 2600 civilians perish each year in residential building fires in the US (USFA 2009). Deaths from fires and burns are the third leading cause of fatal home injuries after falls and poisonings (Runyan 2004). In 2009, for example, a civilian fire death occurred somewhere in the US every 175 minutes with home fires accounting for 85% of these 2565 fatalities (Karter 2010) Nationally, most home fire deaths are the result of the inhalation of smoke, fumes or carbon monoxide from uncontrolled residential fires (68.7%), followed by burns from uncontrolled residential fires (15.2%) (Runyan 2004). The risk of being a victim in a residential fire is higher for the very young (under 5 years), the very old (85 or older), African-Americans, men, and populations with lower incomes (USFA 2007).

A comparison of US fire deaths and those that occur in other industrialized nations suggests that more can be done to reduce and prevent fire fatalities. Among the 25 industrial nations examined by the World Fire Statistics Centre (2009), the U.S. has the ninth highest fire death rate, a status that has remained largely unchanged during the previous three decades (International Association for the Study of Insurance Economics 2010)

One reason the US fire mortality rate remains high among industrialized nations may be that historically, more emphasis has been placed on developing fire suppression technologies while comparatively less attention has been given to strategies related to fire safety promotion, home fire prevention education, and the adoption of home sprinkler requirements that have been pursued by other industrialized nations (USFA 2009; System Planning Corporation 2009, 2008, 2007).

The rate of fire deaths varies not only across countries but also among US states. In fact, some states have fire mortality rates that are consistently among the highest in the country. For state and local officials in these jurisdictions, the challenge of reducing fire deaths remains an acute concern. Meeting this challenge requires that state and local officials determine why their state has a persistently high fire death rate and what can or should be done to reduce it. An informed plan of action to reduce or prevent fire fatalities begins with an accurate assessment of the nature, extent, location, and causes of the fire fatalities. It also requires a clear understanding of the characteristics of the victims themselves, the type of fire protection and prevention infrastructure extant in the community, and the relevant features of the places in which fire deaths occur. These descriptive analyses help to answer all of the who, what, when, how and why questions associated with the occurrence of civilian fire deaths in residential structures.

Purpose of the Study

The purpose of this study is to examine the nature, extent and causes of fire fatalities in Tennessee between 2002 and 2010 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 for developing a strategic plan of action to reduce and prevent civilian deaths in residential fires in Tennessee.

A consensus on the purpose of this study was reached by the attendees at an inaugural "Tennessee Fire Mortality Summit" held in Nashville on April 9, 2010. This summit, jointly sponsored by the Tennessee Fire Chief's Association, the Tennessee Fire Safety Inspectors Association, and The University of Tennessee was attended by several dozen stakeholders in the fire prevention, reduction, and investigation communities at all levels of government. The participants at this historic gathering of fire management experts and professionals recognized the need to devise a well-coordinated strategic plan to reduce and prevent fire deaths in Tennessee. The attendees agreed that the foundation for such a plan should consist of a clear understanding and analysis of the scope, nature and causes of the problem and both the potential and limits of governmental action. These stakeholders continued to shape the focus, content, and direction of the study in subsequent meetings with the UT research team held in Knoxville on March 25, 2011 and in Gatlinburg on April 28, 2011.

As a result of the feedback obtained in these stakeholder meetings, the specific research questions examined in this study include the following as they pertain to deaths among civilians in residential fires:

- What are the trends in the number and rate of civilian deaths in residential fires between 2002 and 2010?
- 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 to that for the nation?
- What are the demographic, social, housing and economic factors that distinguish those census tracts that have had fire deaths?; Based on those findings, which census tracts have a higher risk of experiencing fire mortalities?

- What is the fire protection and prevention infrastructure in Tennessee?; Does the type of fire protection classification help to explain any variation in the incidence of fire fatalities?
- What types of education and outreach strategies for fire prevention and fire safety have been attempted in Tennessee and what do the states' fire chiefs think about alternative strategies for reducing/preventing residential fire deaths?
- 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 improvements needed in system reporting, information and data sharing, resource coordination and communication among key stakeholders?

The stakeholders involved in this analysis of civilian residential fire deaths in Tennessee view this report as an important means to an end rather than an end in itself. The stakeholders recognize that the nature, scope, and extent of the problem must be understood clearly in order to facilitate the formulation of strategies that are most appropriate for preventing and reducing fire deaths where they occur and among the groups in the population that are most at risk of dying in a residential fire.

The motivation that has guided this study is perhaps best summarized by an observation made by one of the state's leaders in the fire management community at the inaugural 2010 fire mortality summit: "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 during the 2002 through 2010 period is the Tennessee Fire Incident Reporting System (TFIRS). TFIRS is managed by the State Fire Marshall's Office and 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 the 2002 through 2010 period. To obtain the number of civilian fire deaths, the "CAS_CIVILIAN" module in TFIRS was sorted using the "CC_SEVERITY" variable and all cases coded as "5" or death were identified for each year. These cases were defined as the population of civilian fire deaths.

The term *residential structure* commonly refers to buildings where people live. To coincide with this concept, our definition of a residential structure fire includes only those fires confined to an enclosed building or fixed portable or mobile structure with a 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. To identify these cases among the TFIRS civilian fire causalities, we inspected the TFIRS fire module and selected all cases with a value of "No" for the "FR_NONRESIDENTIAL" variable which indicates whether or not the fire occurred in a non-residential property. To verify that the selected incidents occurred on or in residential structures, we examined the "IN_PROPERTY USE" variable and confirmed that all cases qualified within the definition of a residential building as described above. Fire deaths classified as arson or set intentionally were not included in the definition of residential structure fires since there is very little government officials can do to prevent these types of fires.

TFIRS requests a large number of variables to be reported about each fire incident. We encountered a large number of cases that had a significant proportion of missing values for several variables. In this study, we excluded from analysis any variable in the TFIRS data for which 60% or more or the cases were missing.

While it is not uncommon in some research to assume that missing cases are not unlike cases for which values exist, we did not make that assumption in this study. No attempt was made to apportion values to variables with missing data in proportion to the distribution for cases with completed data entries. In other words, if cases had missing values for particular variables, those variables were treated as having missing values.

The State Fire Marshall's office provided death certificate data from the Tennessee Department of Public Health that the research team used to verify TFIRS data entries and to replace any missing or erroneous data on the victim's age, race and gender. These death certificate data were available for 2002 through the first six months of 2010. Typically, death certificate data were not available for about 20% of the fire death victims during any year.

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 a 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, fire department, or state) divided by the population of the geographical unit for the relevant time period, multiplied by 1 million.

The source for all of the housing, demographic, economic, and social data at the census tract, municipal, and county levels employed in this study is the U.S. Census Bureau's 2005-2009 American Community Survey (5-year estimates). Where appropriate, population counts from the 2010 Census were used.

The information and data on the fire departments in Tennessee were compiled by the fire management consultants at the UT Municipal Technical Advisory Service. The five categories for fire protection classification are based in part on the classification system developed by the Insurances Services Office (ISO) but also include the MTAS consultants' assessments of the level of professionalism, staffing and equipment configurations. Generally, fire departments rated as having a “high” level of fire protection had an ISO rating of of three or lower. Fire departments classified as having a “moderate plus” level of protection had an ISO rating of five or four and a higher than average rating assigned by an MTAS consultant with respect to the department’s equipment configuration, training, staff professionalism, and departmental leadership. Other fire departments with an ISO rating of four, five, or six were categorized as providing a “moderate” level of protection. A fire department was classified as providing a “low” level of fire protection if its ISO rating was seven, eight, or nine. A fire department was considered to provide no fire protection if its ISO rating was a 10.

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 charts and SPSS was used to calculate various descriptive statistics and regression estimates. ArcGIS is designed to manage and analyze data in a geographic information system and was the means for generating the maps included or referenced in this report. The ArcGIS software 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. Approximately 10 incident locations were geocoded manually by researching parcel locations Incidents on the Tennessee Property Assessment Database. The automated geocoding process returned geographic precision for each incident address. Manually geocoded incidents and incidents that automatically geocoded to the address level of precision were matched to the census tract containing the address point location. The “zoom” feature of the software was used to visually ascertain whether or not incidents that geocoded to street, zip code or city levels of precision were assigned to the correct census tract. If the boundaries of the street line features and the city and zip code polygons features crossed multiple census tracts, the case was treated as missing since not enough information was available to locate the incident with the desired level of precision.

Literature Review: Key Studies and Variables Related to Fire Fatalities

Several studies very fine studies by individuals and teams affiliated with government, non-profit, and private organizations have investigated the nature, trends, causes, victims and circumstances related to fire mortalities in the US. There also is a growing number of comparative analyses that investigate the potential of various strategies for reducing the incidence of fatal fires generally and fatal residential fire in particular. This section presents a brief review of several of the key studies in each of these major areas of fire management research and highlights some of the principal findings and conclusions of this research. A more complete annotated bibliography of the pertinent sources in each of the major topics relevant to this research project is located in Appendix A.

Scope of the Problem:

There are many studies that address a broad scope of fire mortality issues. A consistent theme of the literature is that while there has been a decrease in the rate of house fire deaths in most nations including the US during the last 25 years, the US still has one of the higher rates in the developed world. Eisenberg (2002) for instance confirms this by tracking "fire deaths per million persons" rather than the "total number of fires" in order to account for increasing population sizes. Common to much of the literature, Eisenberg finds that the most common type of fire death is the result of a house fire; smoking-related behavior is among the leading causes of *fatal* residential fires; bedrooms and living rooms are where nearly half of all fire deaths occur and older residential structures have much higher death rates then newer ones.

In a study of fire loss in the United States in 2008, Karter (2009) found that residential fires accounted for 78.2% of all structure fires, and of those structure fires 56.5% occurred in one-and two-family homes while 18.5% occurred in apartments. He also analyzed fire incident rates by community size for the 2004-2008 period and found that the smallest communities (population less than 2,500) had the highest rates. In addition, Hall (2011) estimated that the total cost of fires in the US in 2008 was $362 billion. This estimate included a combination of losses caused by fire and the money spent on fire prevention, protection, and mitigation.

Karter (2008) also examined the various fire experiences in the different regions of the US. Among the variables considered were climate, distribution of community size, percent of population in urban versus rural areas, population age distributions, percent of population below poverty level, percent of population with high school education, and a range of housing characteristics. The data indicated that the South and the North Central regions of the US had the highest overall rates of fire and the highest annual average fire death rates for the 2002-2006 period. In fact, the South had the highest civilian death rates for communities with populations of less than 100,000. The Northeast had a higher occurrence of cooking equipment fires than other regions, while the West had a high occurrence of fires involving heating equipment.

A consistent issue in the literature on fire prevention concerns home smoke alarms. Aherns (2008) for instance, performed statistical analyses of actual fire experience data to summarize what is known about the performance and effectiveness of smoke alarms. In 2002-2004, 34% of home structure fire fatalities were in homes with working smoke alarms, whereas 43% occurred in properties with no smoke alarms at all. It was also noted that the percentage of fires spreading beyond the room of origin is lower in fires with hardwired smoke alarms than battery-operated devices.

Fire Death Victims:

There is considerable research on the characteristics of fire death victims. One such study by the National Fire Protection Association (2010) summarized some of the demographics related to fire deaths and injuries. It was found that children under 5 and adults 65 or over faced the highest risk of fire death. The risk of non-fatal injuries was highest for those between the ages of 20 and 49. Higher fire death rates occur in states with larger percentages of one or more of the following characteristics: Black population, population in poverty, population that smokes, lower levels of formal education, and higher proportions that live in rural areas.

There are a number of variables that affect the risk of dying in a residential fire. The US Fire Administration (2009) examined the characteristics of fire death victims for the 2003-2007 period and analyzed the effects of by using variables such as climate, socioeconomic status, education, demographics, property type, behavior, race, gender, age, fire code, and individual ability to react. Several notable discoveries were made. African-Americans and American Indian males had much higher fire death rates than the national average. Approximately 50% more men died in fires than women, and people with limited physical and cognitive abilities, especially older adults, had a higher risk of death from fire than other groups. Marshall et. al. (1998) reported that among those who died versus those survived in the same residential fire 65% were male, 41% were home alone, and 53% were intoxicated according to blood alcohol measures.

Scholer et. al. (1998) examined predictors of fire mortality in children using maternal demographic characteristics to identify young children at high risk of fire-related deaths. The cohort consisted of children born to mothers who resided in Tennessee between 1980 and 1995. Maternal education, age, and number of other children had strong and independent associations with fire-related deaths among young children. The high-risk group was identified as children with mothers who had less than a high school education, more than two other children, and under 20 years of age. These highest-risk children had a fire-related mortality rate that was 150 times that of a lowest risk group.

Causes and Circumstances of Civilian Fire Deaths:

A number of studies investigated the cause and circumstances of civilian fire deaths. Hannon and Shai (2003) for example performed multiple regression analyses on the social and demographic correlates of fire death rates for large metropolitan counties. This study revealed that age of housing, prevalence of mobile homes, and the proportion of the population renting had significant independent effects on fire death rates. In addition, there was a significant multiplicative interaction between the proportion of the population that is African American and median family income.

Veerasathpurush et. al. (2007) studied the risk factors for *rural* household fires. The presence of an occupant with alcohol problems and being married were two circumstances associated with significantly higher odds of reported fire deaths in rural areas. Rural farm households also had higher odds of reporting fire deaths than residences in towns.

Hall (2010) studied instances of smoking-material fires in the US and found that upholstered furniture, mattresses, and bedding were the first items ignited for most home structure fatal fires started by smoking materials. Most of these fires started in the living room or bedroom. In addition, when cigarettes were the cause of fire, one out of four fatal victims was not the smoker whose cigarette started the fire. Another study by Diekman et. al. (2008) used ecological analysis to examine the association between tobacco smoking and residential-fire mortality. Smoking percentages among adults correlated significantly with state-level, population-based residential-fire mortality (after educational attainment and median household income had been controlled for).

Another contributing factor to residential fire deaths was the impairment by alcohol and other drugs. Aherns (2009) estimated that 15% of home fire deaths annually in 2003-2006 were a result of such impairment. 71% of these victims were male, and 81% were over 14 and under 65 years of age. About 45% of these deaths resulted from fires started by smoking materials. At the time of incident, 46% of the victims were in the area of origin and involved in the ignition.

Policies and Strategies for Reducing, Preventing Fire Deaths:

The studies that examined various policies and strategies for reducing or preventing fire deaths are of particular relevance to this study. Eisenberg (2005) for example evaluated various demographic and housing characteristics and found that county fire death rate differences were strongly correlated with the percentage of new housing stock, differences in household wealth, the percentage of minorities, and the percentage of mobile homes. These findings suggested that a particularly effective way to reduce future fire deaths might be to focus prevention efforts in proportion to the level of these four variables in a community, as opposed to using traditional policies that are largely location invariant. Doing otherwise wastes resources and withholds help from those who stand to benefit from it the most.

Schaenman et. al. (1990) suggested that one of the reasons for inadequate emphasis on public fire education in the US is the skepticism about whether public fire education really works. This analysis indicated that *good* public fire education does, in fact, help to prevent fire deaths. . In addition to describing a methodology for evaluating public education, the case studies in this report demonstrated that public education efforts may be among the most productive strategies in terms of reducing causalities and dollar loss. The evidence suggested that tripling the size of public education efforts would produce enormously beneficial results. Another study by Schaenman et. al. (1987) identified barriers to public education within city management, schools, fire service, and insurance. Suggestions for overcoming these barriers included formation of citizens' committee for fire prevention, linkage of prevention to cost reduction or productivity improvement, providing evidence to school administrators about the benefits of equipping children with fire safety knowledge, and training fire department staff to engage groups in fire prevention education.

To assist fire service professionals with the task of penetrating the hard-to-reach at-risk populations, TriData examined fire service programs that appeared to succeed in reaching groups in this population. Kulenkamp et. al. (1994) examined 44 education programs from across the country. An interesting premise of this study was that the hard-to-reach groups of concern for fire officials were mainly the same groups targeted by other public programs such as those involving crime prevention, drug use prevention, public health, and social services. Twenty-five case studies illustrated approaches and techniques used by these other programs. Well over 100 specific program development and implementation ideas were identified.

The “Global Concepts in Residential Fire Safety Part I, II, & III—Best Practices” offered a very interesting comparison of successful community fire programs used in different countries. Examples from (I) England, Scotland, Sweden, Norway (2007), (II) Australia, New Zealand, Japan (2008) and (III) Canada, Puerto Rico, Mexico, and the Dominican Republic (2009) are described in these reports (Tridata). These reports offer insight into innovative, proven fire prevention programs. For instance, the British fire service visits a large percentage of high-risk homes. The visits include installation and testing of smoke alarms, inspections for hazards, mitigation of hazards, and one-on-one education. In Puerto Rico, where music is an integral part of culture, songs have been incorporated into the school fire safety program.

In Ontario fire departments are legally required to report all fires. Volunteer as well as career departments report at close to 100 percent and most provide accurate information about fire causes. These data are then systematically analyzed by cause, population group, geographic area, and age group to identify and prioritize risks and to evaluate prevention programs.

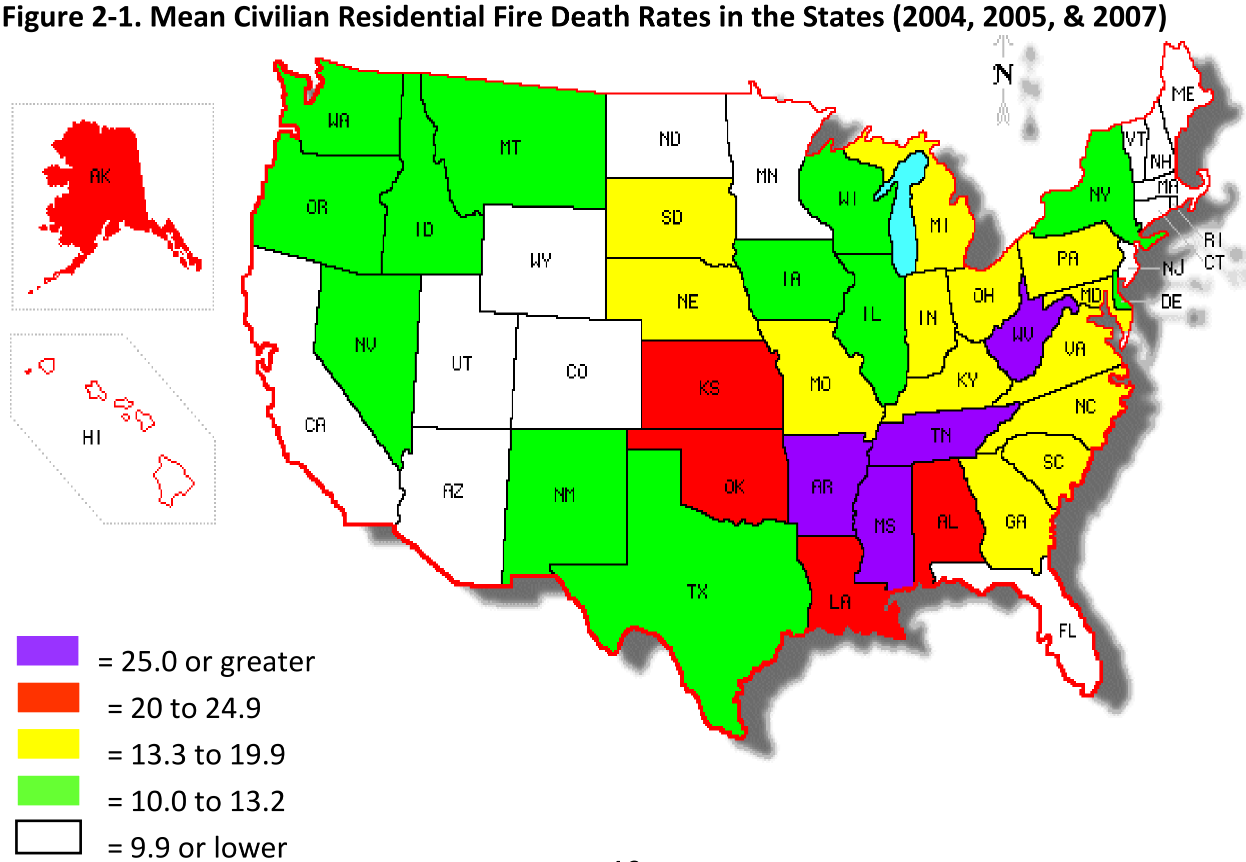
The Vision 20/20 report of National Strategies for Fire Loss Prevention (2008) lists steps for fire loss prevention derived from the collective knowledge of experts across the US. Five main strategy areas were identified by participants, with numerous action items listed for each that can help move prevention efforts forward. This report provides a foundation for improved fire prevention.

Different Definitions of Fire Fatalities in the US

Different organizations define fire deaths in different ways. These variations complicate comparisons among states and between any particular state and the nation as a whole. Assessing progress in reducing the incidence of a problem is always more difficult when there is a risk of comparing a phenomenon for which multiple measures are reported. The broadest definition of fire fatalities is used by the US Fire Administration (USFA) based on an NCHS (National Centers for Health Statistics) definition that includes 19 distinct International Classification of Disease codes (F.63.1, W39-W40, X00 thru X009, X75-76, X96-97, Y25-26, and Y35.1).

Using the USFA definition, **Figure 2-1** illustrates the state fire fatality rates for the three most recent years for which multi-state data are available from the U.S. Fire Administration. The states in purple have a mean fire fatality rate, for these three years, of at least 25 or more people per million. These were Mississippi, West Virginia, Tennessee and Arkansas. Five states had mean fire death rates that are almost as high (between 20 and 24.0 per million): Alabama, Oklahoma, Louisiana, Kansas, and Alaska. Another thirteen states had death rates above the national mean of 13.3 deaths per million for this period. A total of 28 states had death rates below the national mean with 16 of these states having relatively low death rates of less than 10 per million.

Figure 2-1. Mean Civilian Residential Fire Death Rates in the States (2004, 2005, & 2007)



According to the USFA definition, Tennessee had a mean fire mortality rate for 2004, 2005 and 2007 of **25.5** deaths per million, the third highest in the country after Mississippi and West Virginia. That compares with a national average rate for those 3 years of 13.3 deaths per million.

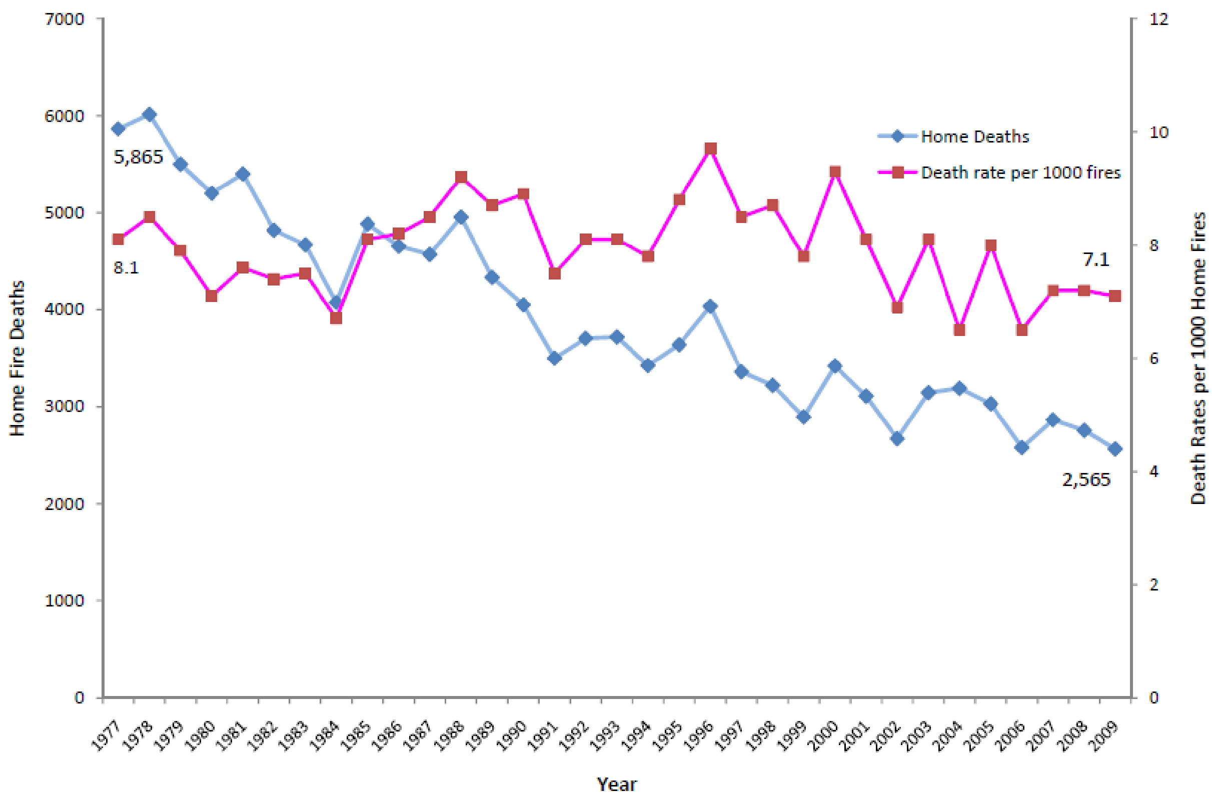
The US Fire Administration does **not** use the NFIRS data it collects from the states to compute or to compare fire fatalities. The ostensible reason is due to the variation in the level of reporting participation among fire departments within the states. In 2007 for instance, the national average participation among fire departments in all states was 59%, but the rate of participation ranged from an average of 14% in Rhode Island to 97% in West Virginia (USFA 2009). In 2007, about 88% of Tennessee fire departments participated, a level that has since been exceeded. If NFIRS data on state fire mortalities were used as the basis for interstate comparisons, the states with higher levels of reporting participation may appear to have higher levels of fire mortalities when in reality, much of the difference may be attributable to the variance in reporting.

Another source for a count of fire deaths in the US is the Center for Disease Control (CDC) and its Web-based Injury Statistics Query and Reporting System or WISQARS. The CDC uses a different set of ICD codes than the US Fire Administration. These codes only partially overlap with the definition developed by the US Fire Administration and include 27 different IDC codes that result in a somewhat smaller count of fire deaths in the states. The WISQARS codes include X00-X19, X76-77, X97-98, Y26-27, Y36.3, U01.3 (CDC, http://webappa.cdc.gov/sasweb/ncipc/mortrate10_sy.html). The data available from the CDC WISQARS as of June 2011 included the years 2002 through 2007 and indicated that there were 809 fire deaths in Tennessee, a figure that translates into an annual mean rate of **22.6** fire deaths per million.

A third source of data on fire deaths in Tennessee are the records from the state Health Department. The state Health Department uses another set of ICD codes for fire deaths that include the X00-X09 codes for exposure to smoke, fire or flames, and also encompass codes for fires caused by lightening and other environmental events, circumstances, and conditions that cause fatal injuries. The state Health Department excludes arson fires in their count, but it includes deaths that may be unattended by, or unreported to fire departments. Data for 2002 through 2008 indicated that there were 820 fire deaths in Tennessee which equated to a fire mortality rate of **19.47** per million.

The National Fire Protection Association (NFPA) also collects survey data from the nation's fire departments and estimates the number of fire deaths in the US. This organization's survey results, shown in **Figure 2-2**, clearly indicate the overall decline nationally in the number of fire deaths between 1977 and 2009.

Figure 2-2. Civilian Home Fire Deaths and Rates 1977-2009 (NFPA)

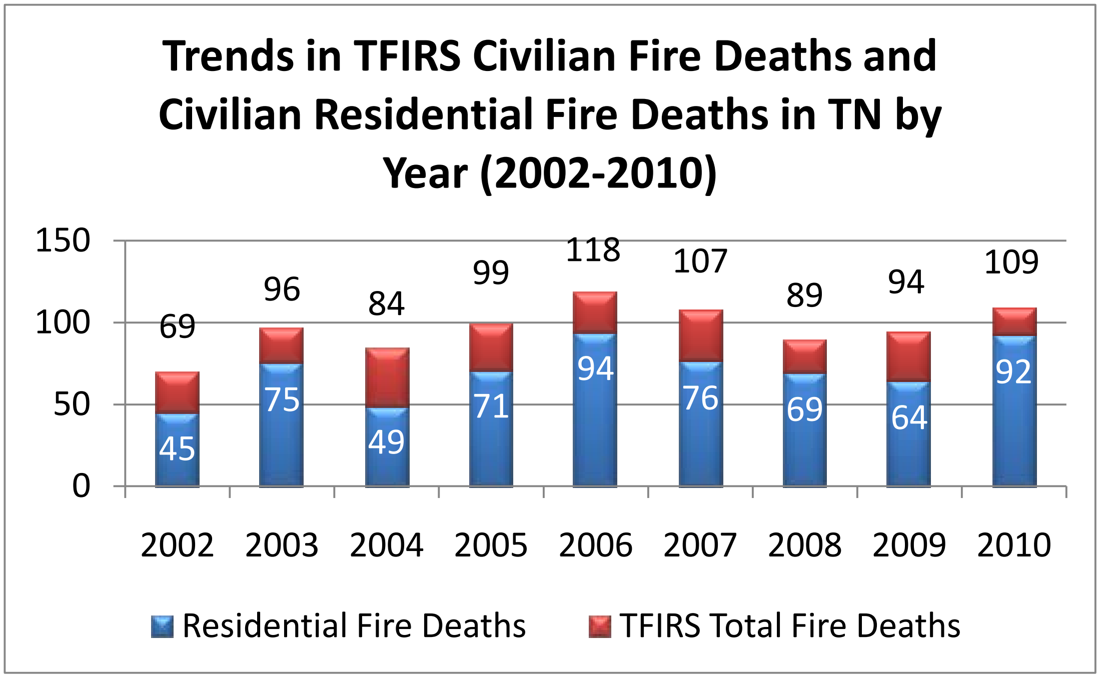


Source: NFPA Survey of Fire Departments (1977-2009)

The TFIRS Data on Fire Mortalities in Tennessee

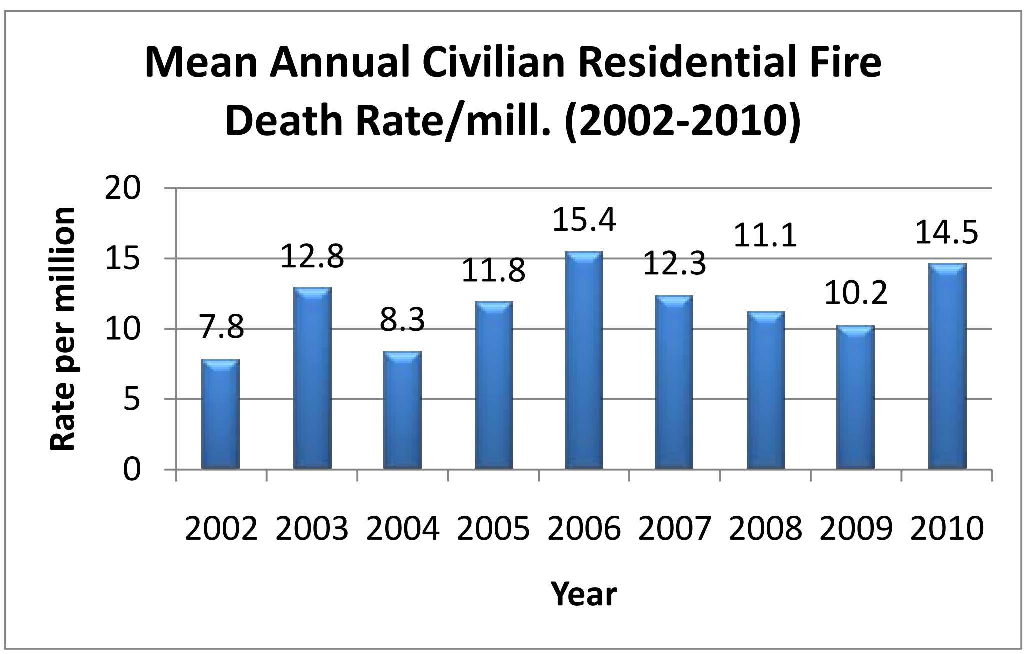
Based on the TFIRS data, a total of 865 civilians died in fires in Tennessee during the 2002 through 2010 study period. Of these civilian fire deaths, 635 or 73.4% occurred in residential structures (based on the definition described in the previous methodology section). As **Figure 2-3** indicates, civilian fire deaths peaked in 2006 and then similar to the nation, civilian fire deaths declined in 2007 and 2008. However, unlike the national trend, fire deaths among Tennessee civilians increased in 2009 and then increased yet again in 2010. In 2010, civilian residential fire deaths increased to 92, a level only surpassed in 2006. Clearly, the recent increase in civilian fire residential fire deaths is undesirable and represents a departure from the overall trend of decline nationally in civilian fire deaths.

Figure 2-3. Trends in TFIRS Civilian Fire Deaths and Civilian Residential Fire Deaths 2002-2010.



To assure an accurate depiction of the trend in civilian fire deaths, population changes during the study period must be accounted for and the data in **Figure 2-4** do this by indicating the annual civilian residential fire death rates per million people in Tennessee during 2002 through 2010. Unlike the downward trend in the national data, the rate pattern in Tennessee for civilian home fire deaths trended in a decidedly upward direction.

Figure 2-4. Mean Annual Civilian Fire Death Rate Per Million (2002-2010).



In order to ascertain why the Tennessee trend in residential fire deaths differs from the nation, the state's mortality data were examined for deaths that occurred inside and outside of incorporated places. We labeled these groups as urban and rural. **Figure 2-5** shows the pattern of fire deaths for this dichotomy during the study period. Obviously, more residential fire deaths occur in cities rather than in the more sparsely populated unincorporated areas of counties. It is also apparent that the two trends generally mirror one another with two exceptions. In 2005, fire deaths in rural areas exceeded those in urban areas. Another anomaly is 2010 when the number of home fire deaths in cities increased while the number of fire deaths in rural areas continued to decline gradually. The 2010 spike in residential fire deaths that occurred in cities is the primary reason for the observed increase in civilian fire deaths during that year.

Figure 2-5. Urban and Rural Home Fire Deaths in Tennessee (2002-2010).

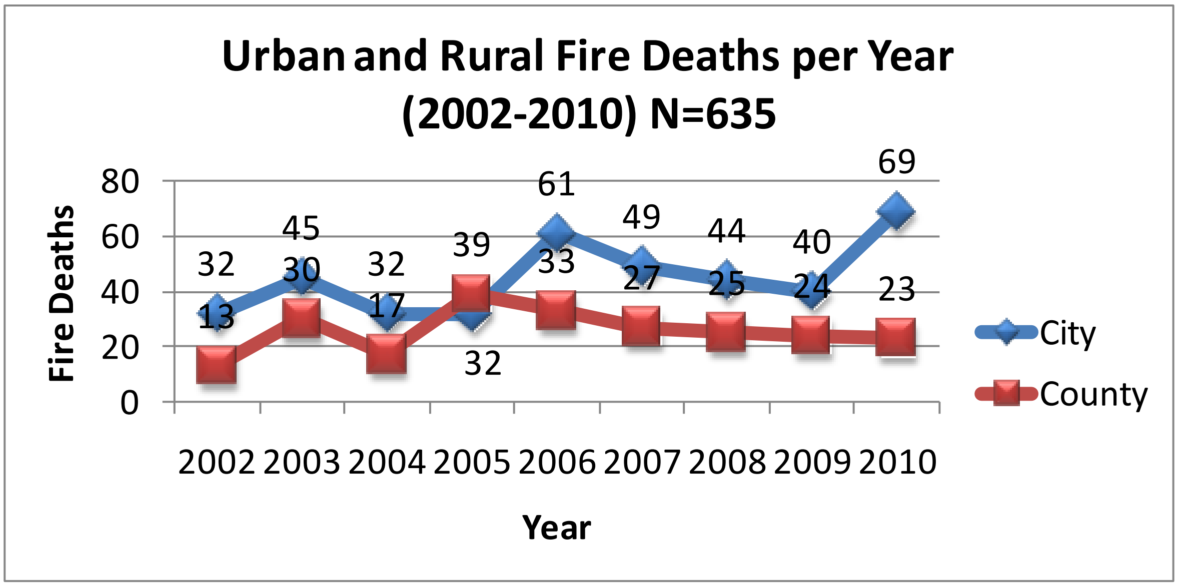
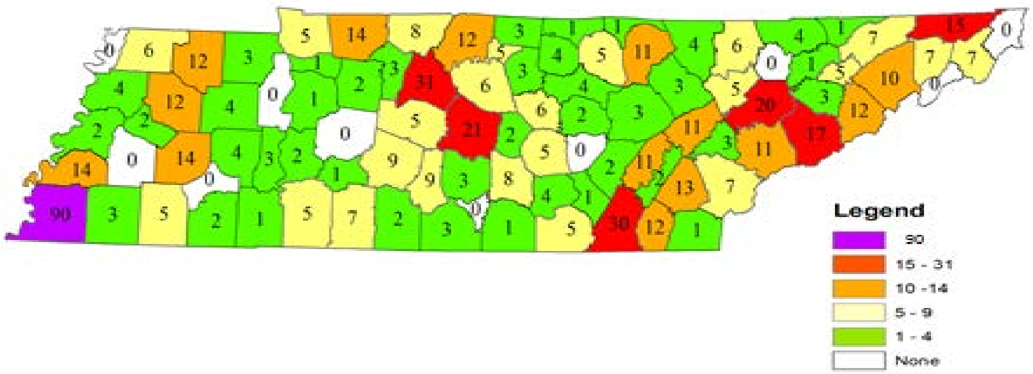


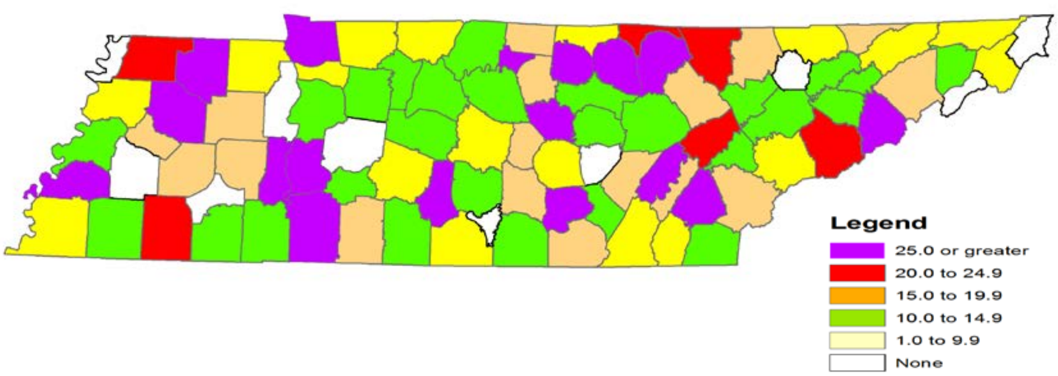
Figure 2-6 shows that the most populous counties in the state account for the largest number of residential fire deaths. During the study period, Shelby County accounted for 90 or 14.2 % of all residential fire deaths, a proportion higher than its share of the state's population (10.2%). During 2002 thru 2010, there were 78 civilian home fire deaths in the City of Memphis or about 19.2% of the 405 fire deaths that occurred inside municipalities. In 2010, there was the unusual occurrence of two multiple fatality incidents in the state in which five people perished in each. One of these was in Nashville-Davidson. In fact, the number people who perished in multiple fire death incidents (in which more than one person died) was almost twice as high in 2010 (26) compared to the number who died in such fires in 2009 (14).

Figure 2-6. Number of Civilian Residential Fire Deaths by County (2002-2010).



Although most fires occur where the population density is highest, **Figure 2-7** shows that the counties that actually have among the highest rates of fire fatalities are those with smaller populations. During the study period, the mean fire death rate was 15.5 persons per million. These data indicate that those who live in some of the state's smaller and more rural counties and communities actually have a higher risk of fire mortality than do those who live in metropolitan areas.

Figure 2-7. Average Annual Fire Death Rate per million in Tennessee Counties



The higher risk of fire mortality in smaller jurisdictions in Tennessee is illustrated by the distribution of mean civilian fire deaths rates by county size during the study period. **Figure 2-8** shows that the population groups with the highest rates of fire deaths are those with populations of 50,000 or less. Those counties with populations under 10,000 have the highest rates of residential fire deaths. Likewise, **Figure 2-9** indicates that for most of the years during the study period, cities with populations under 25,000 had the highest mean rates of residential fire fatalities. Noteworthy too is that cities in most of the population groups recorded an increase in the fire fatality rate for 2010.

Figure 2-8. Mean Civilian Fire Death Rates in Tennessee by County Size and Year (2002-2010)

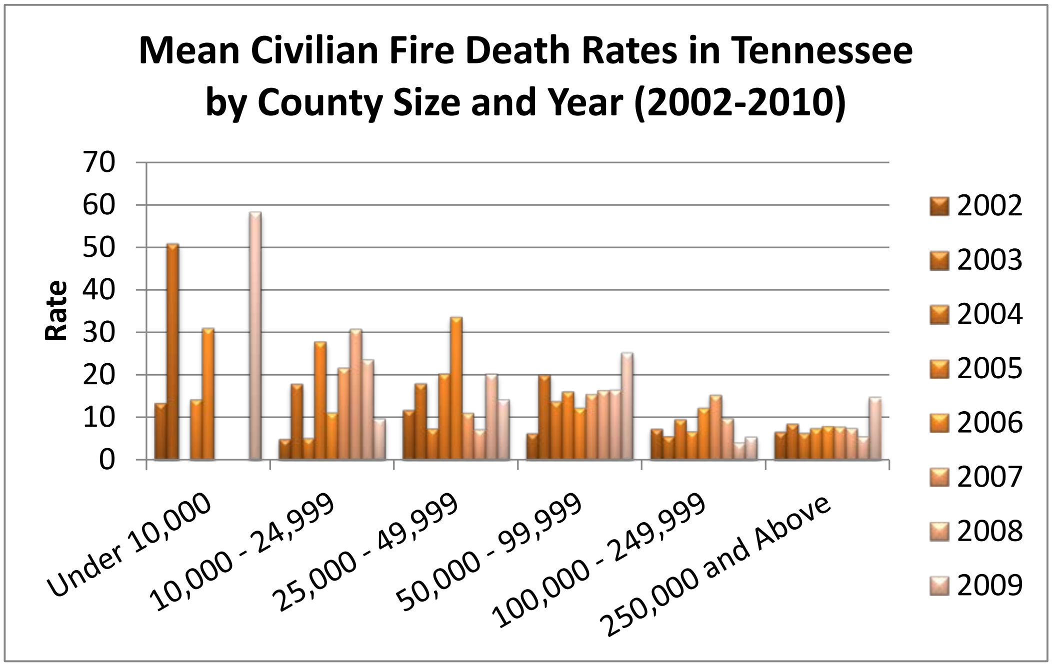
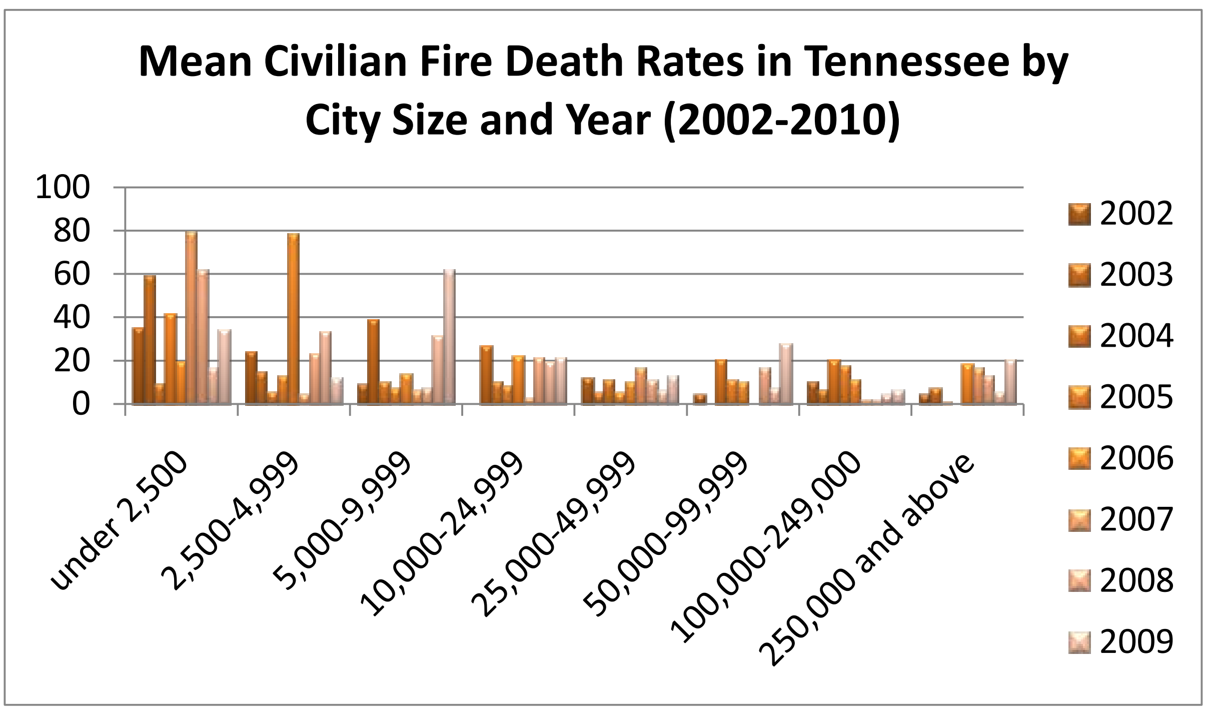
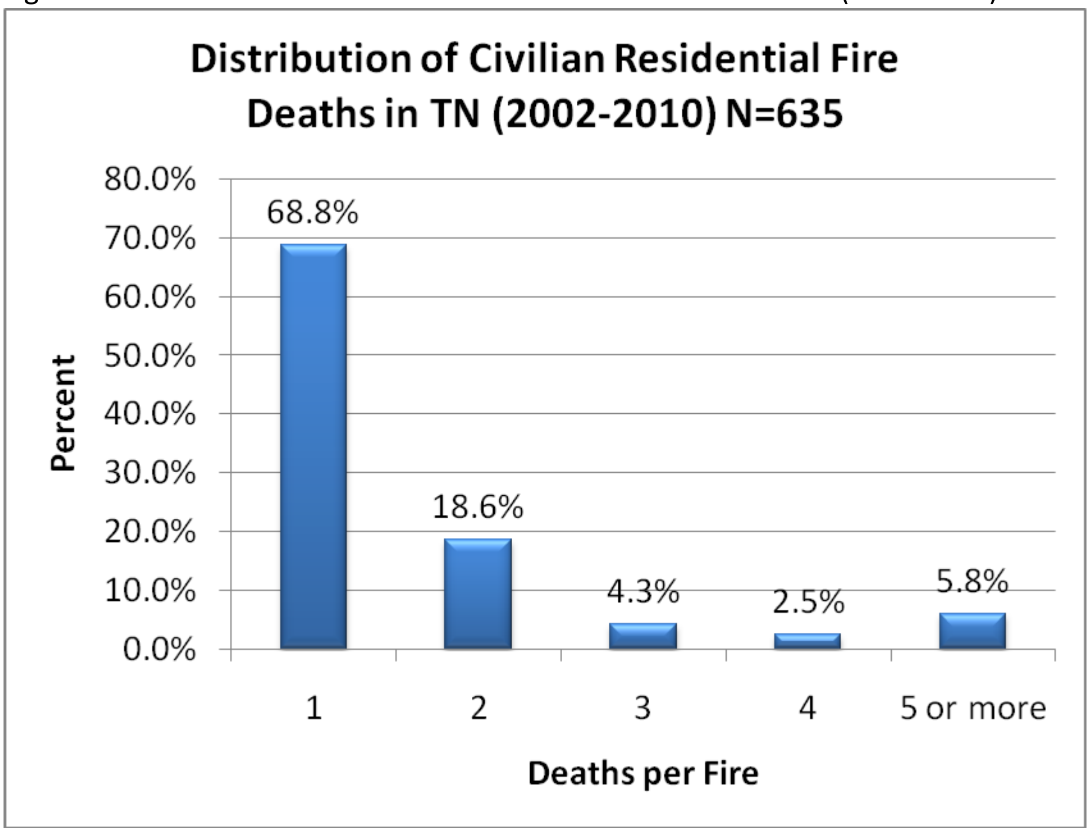


Figure 2-9. Mean Civilian Fire Death Rates in Tennessee by City Size and Year (2002-2010).



Multiple fire death incidents can be a driving force behind high levels of fire fatalities. In 2010 there were more multiple fire incidents in urban areas than usual in the state. **Figure 2-10** shows that over two-thirds (68.8 percent) of fire fatalities in Tennessee involved a single fatality but the state's average for residential fire deaths in which five or more perished during the study period was 5.8 percent, almost twice as high as the national average of 2.9 percent (U.S. Fire Administration 2009).

Figure 2-10. Distribution of Civilian Residential Fire Deaths in TN (2002-2010)



As shown in **Figure 2-11**, civilian residential fire fatalities occur most frequently in winter months, with over 50 percent of civilian residential fire fatalities occurring December through March. Civilian residential fire fatalities peaked in January at 14 percent, and then consistently declined reaching the lowest point in June. The general pattern of when fatal residential fires occur in Tennessee is similar to the national pattern. Nationally, fewer than 46 percent of fatal residential building fires occurred December through March from 2006 through 2008. Fatal residential fire peaked in January and then declined reaching the lowest point in the summer months (U.S. Fire Administration 2010).

Figure 2-11. Civilian Residential Fire Fatalities by Month (2002-2010)

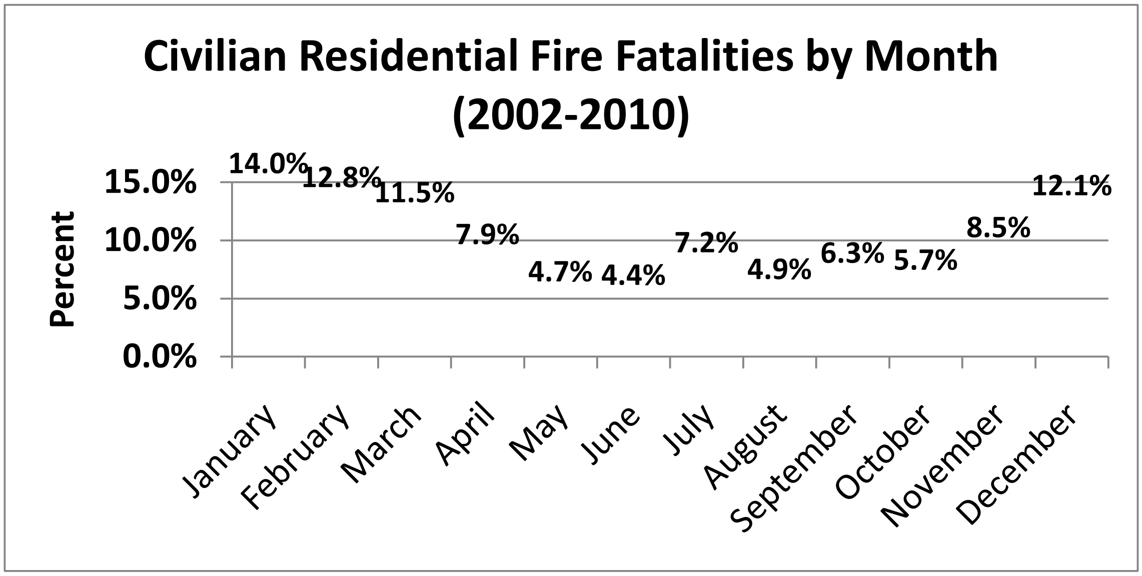


Figure 2-12 illustrates the frequency of different heat sources for residential fire deaths. For this variable, data are reported for about 62 percent of cases. Among those cases, the leading heat source involves operating equipment at 58.2 percent, followed by smoking related heat sources at 26.2 percent. Among the 229 cases that involve an operating equipment heat source **(Figure 2-13)**, the single largest category of operating equipment heat sources involves radiated/conducted heat followed by electrical arching and then sparks, embers, or flames.

Figure 2-12. Heat Source for Fires in Residential Fire Deaths in TN (2002-2010)

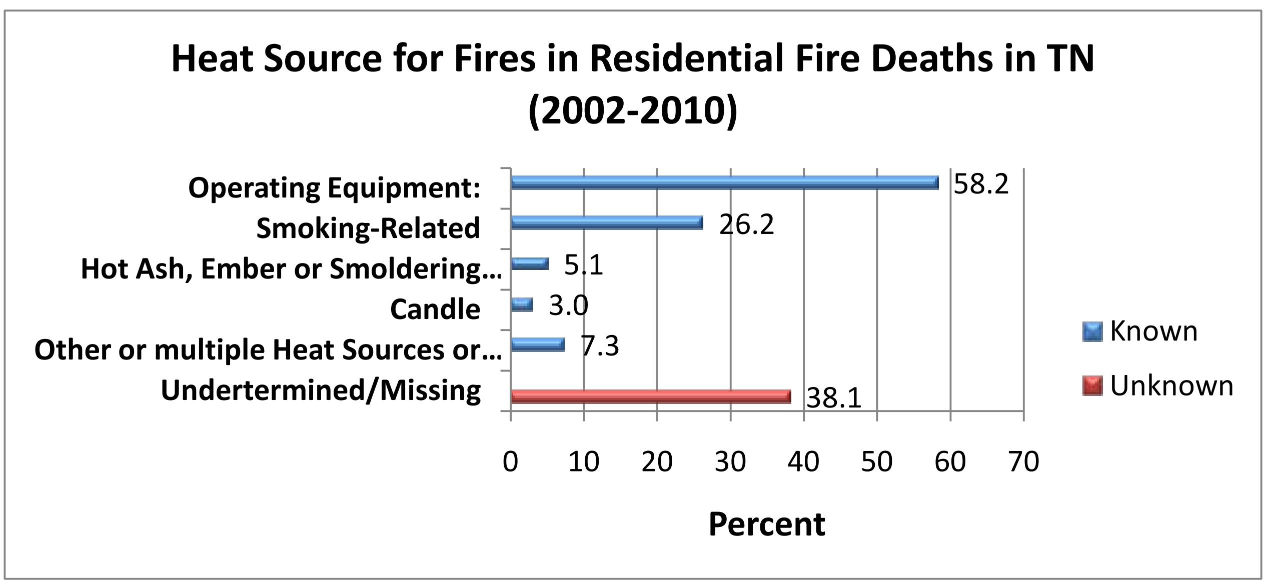


Figure 2-13. Operating Equipment Heat Sources, 2002-2010.

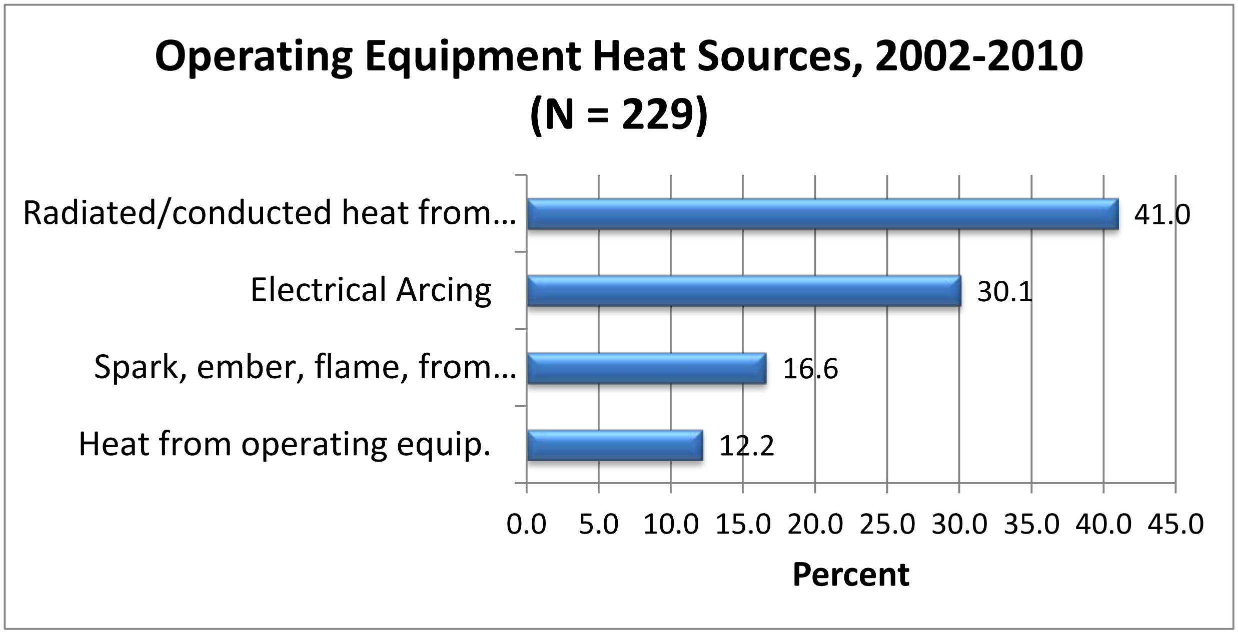


Figure 2-14 indicates that operating equipment was the most important heat source during the study period. While there was a modest decline in this heat source during 2009 and 2010, there was a troubling increase in the number of smoking-related heat sources during 2010. In 2008 the state legislature enacted a fire safe cigarette law that went into effect on January 1, 2010. Unfortunately, no corresponding decline occurred in smoking related heat sources during 2010. In fact, fire deaths due to smoking related heat sources increased by 5 percentage points during that year.

Figure 2-14. The Top Three Leading Heat Sources for Fatal Residential Fires 2002-2010.

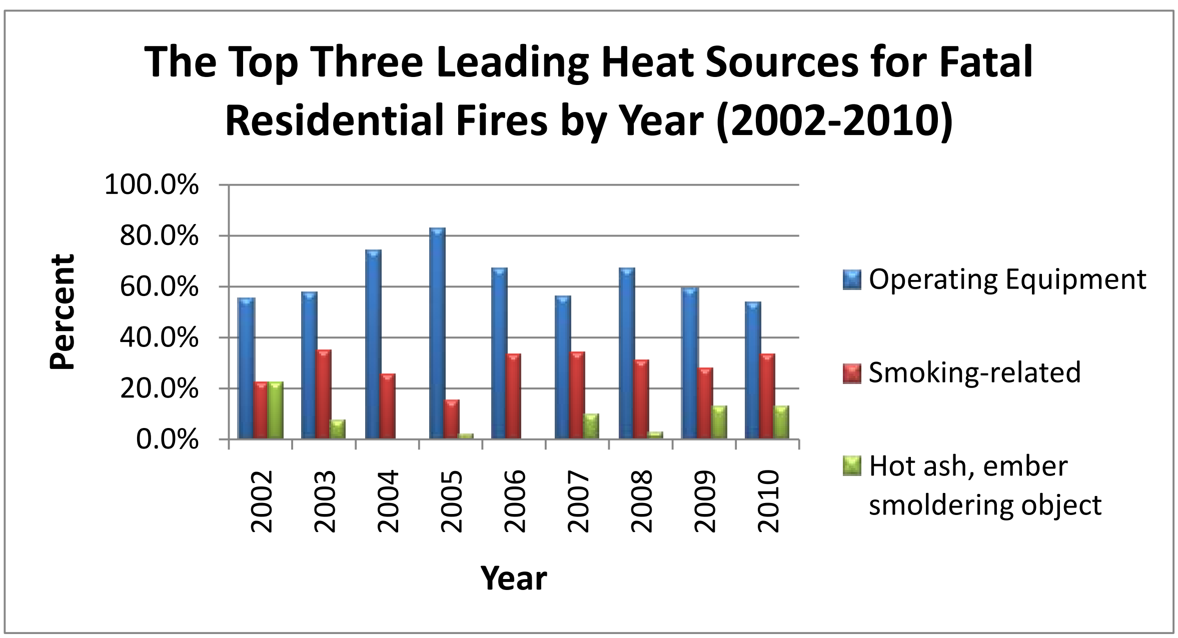


Figure 2-15 illustrates the type of equipment involved in the ignition of residential fire fatalities. The percent of known types of equipment involved in ignition was only about 36 percent. Among these known types of equipment involved in ignition, the single most common cause (38.9 percent) involved heating, ventilation, and AC (HVAC) equipment. Tennessee exceeded the national average (22 percent) for HVAC equipment involved in ignition. The second most common type of equipment involved in ignition was electrical distribution (32.2 percent). This level also was higher than the national average of 12 percent. The third most common type of equipment involved in ignition was kitchen and cooking equipment. These items accounted for 14.6 percent of known causes of ignition. Compared to the national average of 17 percent, Tennessee has a slightly lower level of kitchen and cooking equipment involved in ignition (Ahrens 2010).

Figure 2-15. Type of Equipment Involved in Ignition of Residential Fire Fatalities

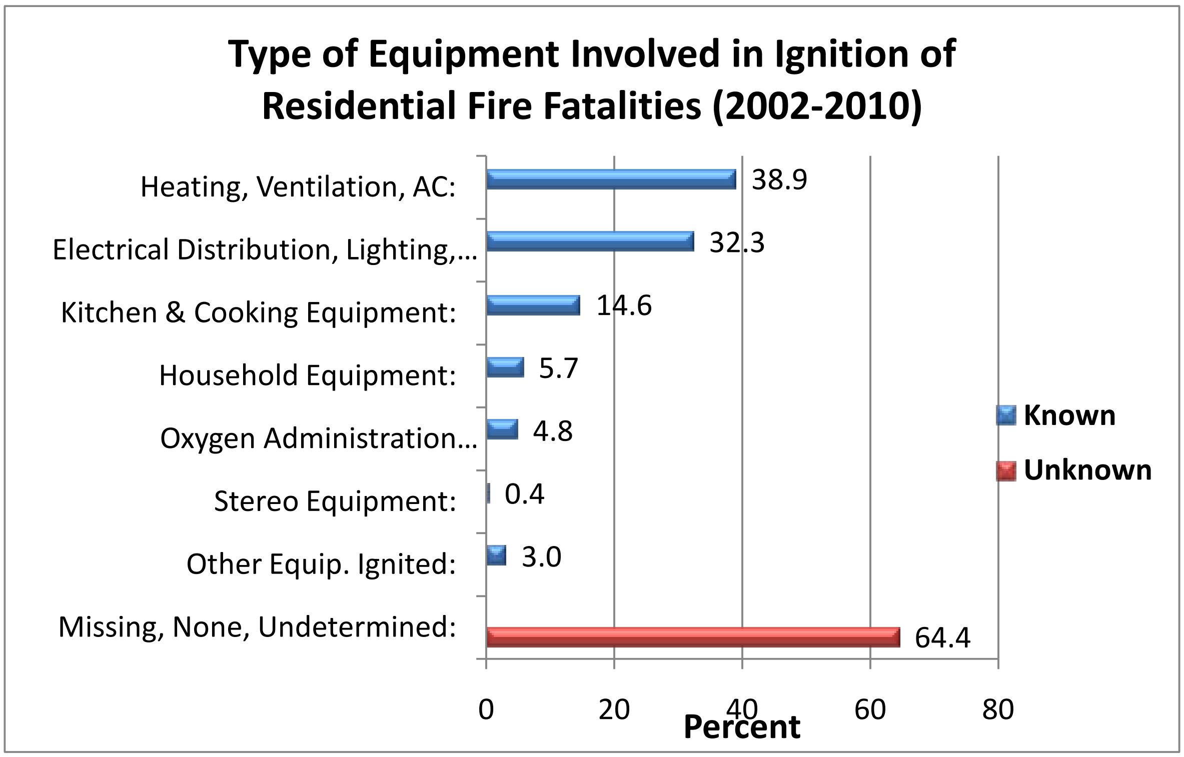


Figure 2-16 illustrates the item first ignited in fatal residential fires. The reported percentage of known items first ignited is about 47 percent. Of the known cases, the two most common items first ignited were upholstered furniture (23.6 percent) and then soft goods & apparel. The latter consists of clothing worn by individuals as opposed to items hanging in a closet. Soft goods included blankets, bedding, and heating pads. Together with clothing these items accounted for 22.6 percent of the items first ignited. The third most common item ignited first involved structural components that consisted primarily of wallpaper, wall covering, paneling, or other materials hanging on walls. These items accounted for 17.3 percent of first-ignited materials.

Figure 2-16. Item First Ignited in Fatal Residential Fires in Tennessee

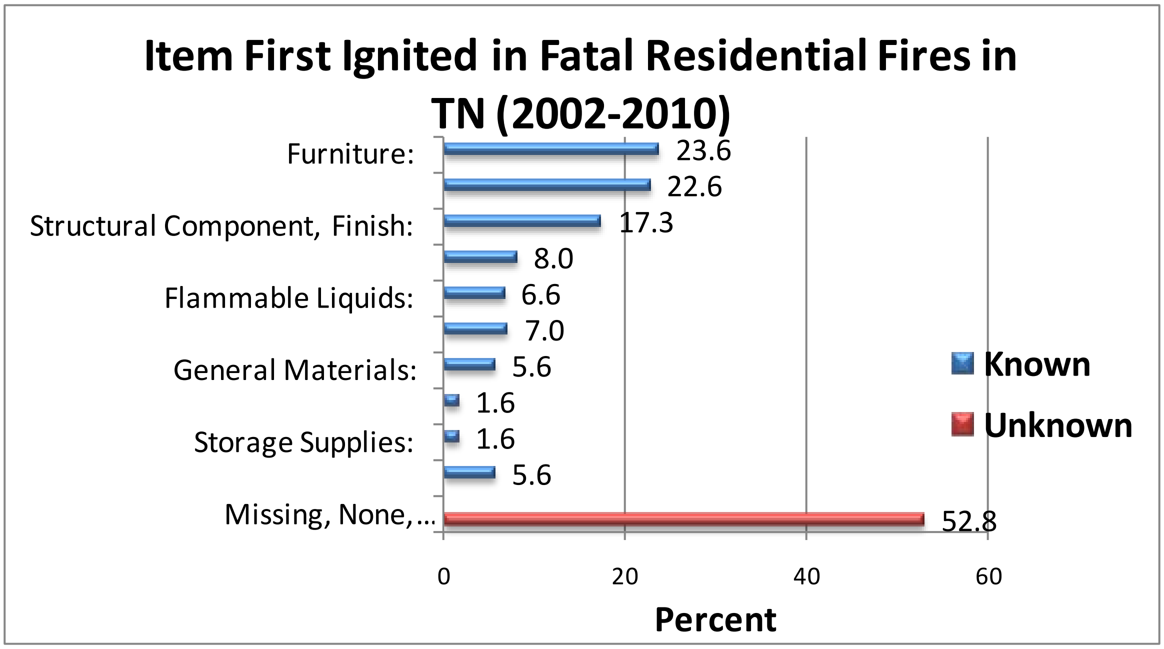
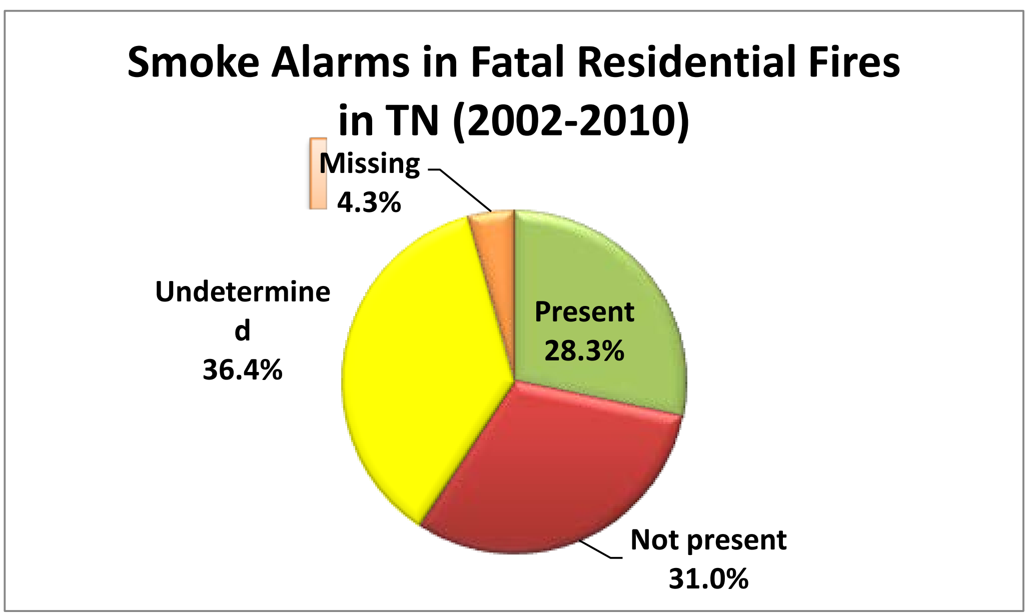


Figure 2-17 indicates that a smoke alarm was determined not to be present in 31 percent of fatal residential fires in the state. The comparable national figure is 22.5 percent. By contrast, smoke alarms were present in only about 28 percent of fatal residential fires in Tennessee while nationally they were present in about 38 percent of fatal residential fires. (U.S. Fire Administration 2010).

Figure 2-17. Smoke Alarms in Fatal Residential Fires in Tennessee

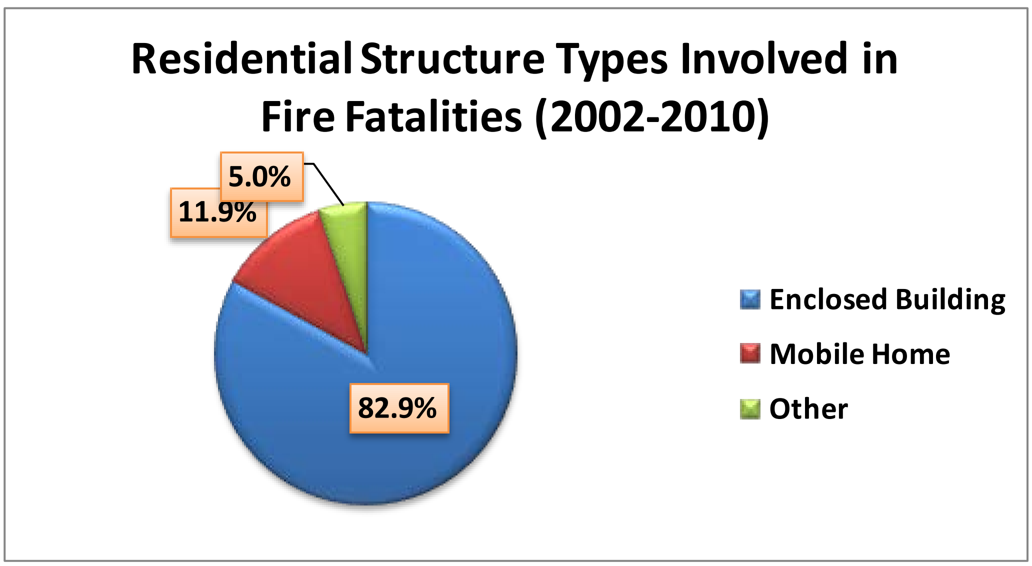


Clearly, there is a problem with the underutilization of smoke alarms in Tennessee. Smoke alarms were present in just over a quarter of fatal fires. A related issue involves whether the smoke alarms that *were* found were operational at the time of the fire. Fire damage to the detector sometimes complicates decisions about prior operational condition unless the discovered device lacks batteries. For those units that may have been operational, there may be a question about whether the victim(s) were physically or mentally unable to respond to the alarm.

More than 75 percent of the fatal home fire incidents in Tennessee had no entry for this variable. Since an operational smoke alarm is perhaps the single best strategy for alerting residents to a fire danger, renewed efforts by state and local officials appear to be needed in order to encourage more people to acquire and maintain home smoke alarms/detectors.

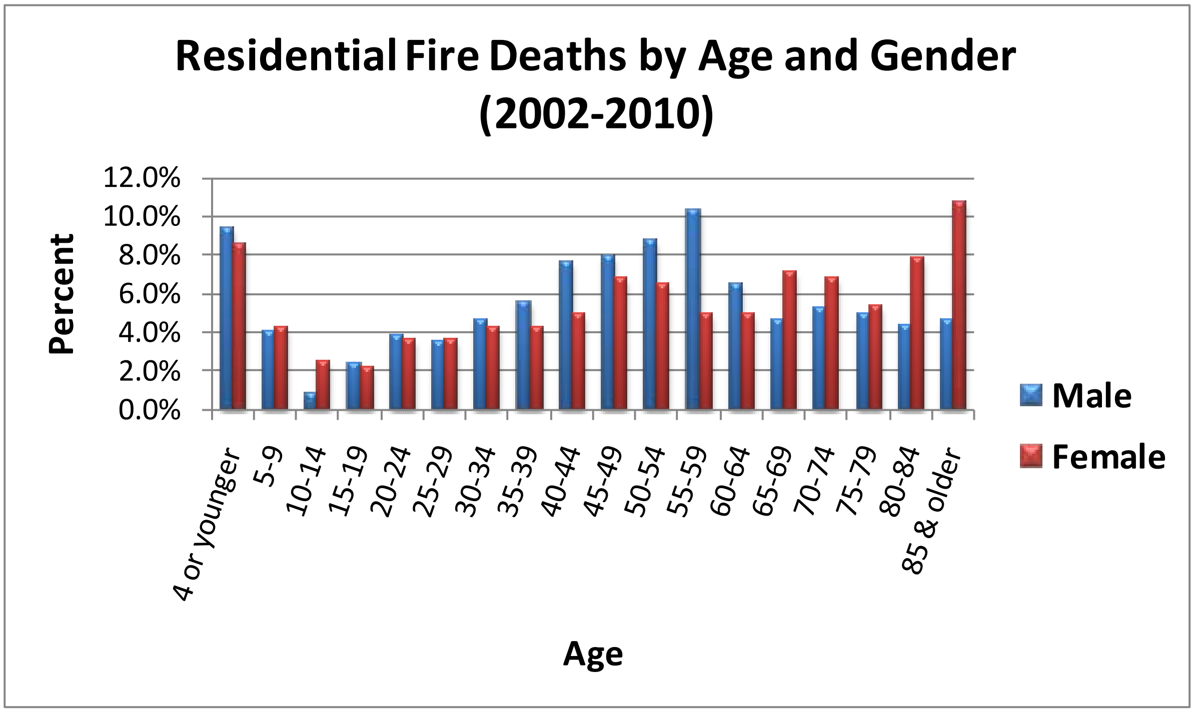
Figure 2-18 illustrates that most residential fatal fires (82.9 percent) involve enclosed buildings. Mobile homes are involved in about 12 percent of fatal residential fires in Tennessee.

Figure 2-18. Residential Structure Types Involved in Fire Fatalities



The profile of the victims in residential fires in the state is similar to that for fire victims nationally. They tend to be the very young or the very old. Tennessee is different from the national profile in one respect in that proportionately more elderly females 65 years old or older perish in residential fires. **Figure 2-19** also shows a spike among males in the 35-64 age range. Males in this age range are more likely than their female counterparts to die in residential fires.

Figure 2-19. Residential Fire Deaths by Age and Gender



Most fire death victims are white (72.8 percent), but just over a fourth (25.2 percent) are African-American. The proportion of the African- American population in Tennessee is 16.5 percent, but as **Figure 2-20** indicates, the proportion of African-Americans who perish in fires is 25.2 percent. This pattern is not unique to Tennessee. Nationally, African-Americans comprise about 13 percent of the total population but account for 22 percent of fire deaths (U.S Fire Administration 2009).

Figure 2-20. Residential Fire Fatalities by Race in Tennessee 2002-2010.

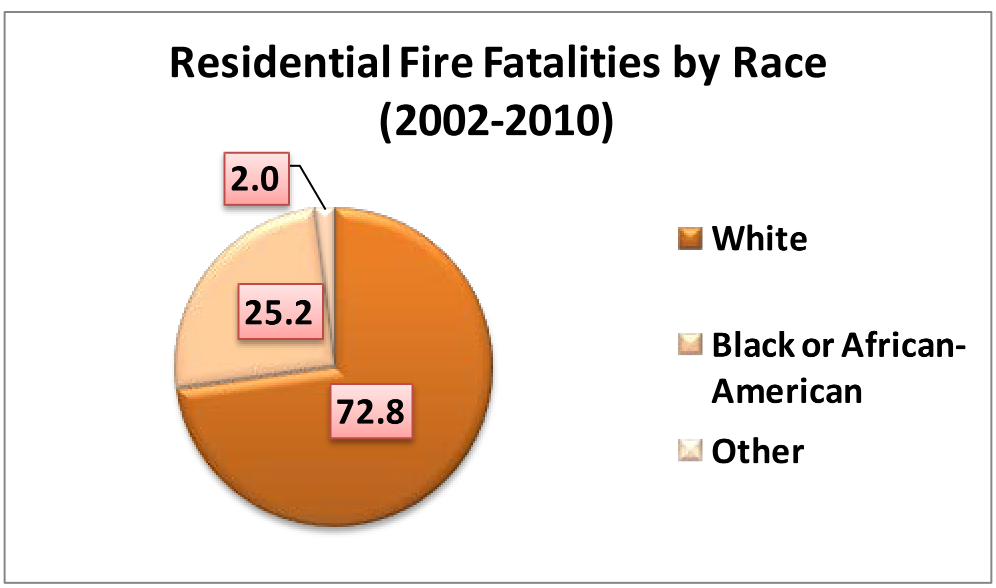


Figure 2-21 shows that females are more likely than males to be fire victims when Operating Equipment is the heat source. Similarly, African-Americans are more likely than whites to be fire victims in cases where heat source involves Operating Equipment. There is no difference between males and females with respect to Smoking-related heat sources. However, whites are twice as likely as African-Americans to be victims in cases where the heat source is smoking related.

Figure 2-21. Victim Gender and Race in Relation to Heat Source Involved in Fatal Fires

	Male	Female	White	Black	Other
Operating Equipment	113	116	130	52	2
	60.8%	**69.5%**	59.1%	**75.4%**	100.0%
Smoking-related	55	49	81	10	0
	29.6%	29.3%	**36.8%**	14.5%	.0%
Hot ash, ember, smoldering object	18	2	9	7	0
	9.7%	1.2%	4.1%	10.1%	.0%
Total	186	167	220	69	2
	100.0%	100.0%	100.0%	100.0%	100.0%

Figure 2-22 illustrates the number of fire deaths that occurred in residential structures that were built in various decades. The research team was able to collect data on the "year built" for those structures in which 379 (60%) of the fatal fire deaths occurred. Among those cases, 24.3 percent of the residential fire deaths occurred in structures built prior to 1950. About 17.9 percent of the residential fire deaths occurred in structures built during the 1950s, about 14 percent involved structures built during the 1960s, and 18.5 percent of the residential fire deaths occurred in structures built during the 1970s.

The largest proportion of fire deaths (50.4%) occurred in structures built between 1950 and 1979. Structures built since 1980 were involved in 25.3 percent of fatalities. As one would expect, fewer fire deaths occurred in structures built since 2000.

Figure 2-22. Number of Residential Fire Deaths in Tennessee by Decade of Construction

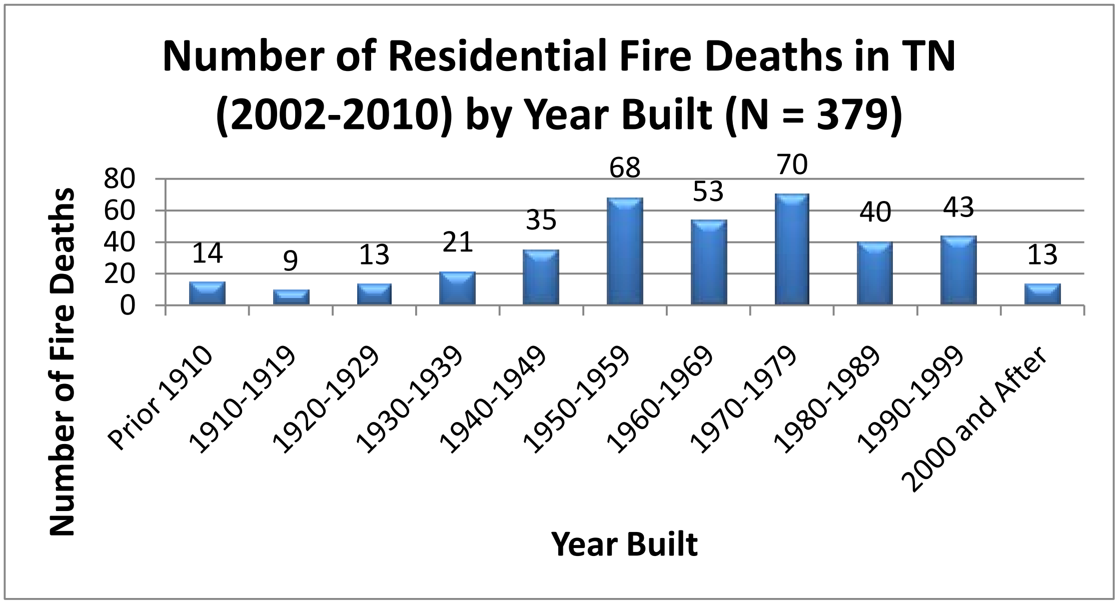


Figure 2-23 indicates the primary heat source for fatal fires in structures constructed during different eras for the cases that have values on both variables. There is not a great deal of difference in the primary heat source in structures that were built in different eras.

Figure 2-23. Heat Source for Fatal Fire by Decade Structure Built

	Decade Built			
	Built 1949 or earlier	1950-1979	1980-present	Total
Operating Equipment	34	69	29	132
	60.7%	65.1%	51.8%	60.6%
Smoking Related	19	29	26	74
	33.9%	27.4%	46.4%	33.9%
Hot ash, ember, smoldering object	3	8	1	12
	5.4%	7.5%	1.8%	5.5%
Totals	56	106	56	218
	100.0%	100.0%	100.0%	100.0%

Likewise, **Figure 2-24** indicates little variation in the equipment involved in the ignition of fatal fires in dwellings constructed during different decades. Together, the findings of little or no variation in the cause of fire by the structure's age suggests that what may matter more than just the age of the dwelling is how well the structure has been maintained. This is a partly a function of the effectiveness of codes enforcement. There is only one characteristic of fatal fire victims that is related to the year the structure was built. Not surprisingly, younger victims tend to perish in more recently constructed buildings and older residents die in more aged structures.

Figure 2-24. Equipment Involved in Ignition and Decade Structure Built

	Decade Built			Total
	Built 1949 or earlier	1950-1979	1980-present	
HVAC	13	24	16	53
	54.2%	38.7%	59.3%	46.9%
Elect Distrib., Wiring	7	23	4	34
	29.2%	37.1%	14.8%	30.1%
Kitchen Equip	2	11	4	17
	8.3%	17.7%	14.8%	15.0%
Household Equip, Dryer	2	4	3	9
	8.3%	6.5%	11.1%	8.0%
Totals	24	62	27	113
	100.0%	100.0%	100.0%	100.0%

Chapter 3. System Reporting, Communication & Coordination Issues

GIS Technology

Tennessee has one of the best GIS platforms in the nation. The Division of Property Assessments in the Office of the Comptroller of the Treasury for example maintains extensive records about each parcel in 88 of the state's 95 counties. The property assessors in the remaining counties are responsible for maintaining their respective databases. These GIS resources have information about the address, structure value, year in which the structure was built, and also include estimates of the effective age of structures. Effective age is a measure that accounts for the maintenance of the structure and any renovations or rehabilitation work that may have been performed since original construction. Consequently, a home built in 1952 might have an effective age of 1992 as a result of rehabilitation, maintenance, and renovation improvements. This is a measure that has diagnostic value as an assessment of the actual condition of the structure in causal analyses of home fires.

The GIS technology isn't new to the fire service in Tennessee. The University of Tennessee Institute for Public Service fire consultants have used GIS technology for a number of years to locate fire stations, complete manpower studies, analyze call volumes among other uses. Because Tennessee continues to build this GIS platform, the technology is now available to create more in-depth and unique studies about the fire mortality problem.

Initial research for this project concluded that most previous fire mortality studies were mainly descriptive. These types of analyses enable officials to react to identified problems but do little to facilitate proactive management of the fire mortality problem. GIS technology can enable analyses that permit fire management officials to be more proactive in terms of identifying where residential fire mortalities may be more likely to occur based on historical data. By identifying these "hot spots" using GIS technology, it is possible to focus efforts on a particular area or problem and address particular needs before crises emerge.

Tennessee State Fire Marshal's Office

The Tennessee State Fire Marshal's Office (TSFMO) is responsible for fire prevention on the state level including managing fire data statewide through the Tennessee Fire Incident Reporting System (TFIRS). All data collected are also reported to the National Fire Incident Reporting System (NFIRS) that is managed by the US Fire Administration.

The Tennessee State Fire Marshal's Office (Fire Prevention Division) is a division under the Tennessee Department of Commerce and Insurance. The Commissioner of Commerce and Insurance is the official State Fire Marshal however the operation of the TSFMO is designated to the Assistant Commissioner for Fire Prevention. Utilizing almost 300 full and part-time employees, the TSFMO is divided into seven sections with a director overseeing each section. Each section has a unique role in preventing fires, reducing injuries, and preventing fire deaths. The Administrative Section delivers public fire education and coordinates TFIRS. This section also issues permits for everything from explosive blasting, fireworks, fire sprinkler and extinguisher licensing, to liquid propane dealers, fire department recognition, code certification licensing, and building permits.

The second section is the Codes Section which includes plans review on certain buildings as well as code enforcement and inspection on existing structures and new construction. The modular housing program is also managed by the codes section. Code inspectors also work large assemblies and events to determine occupancy loads to assure safety for attendees. The third section is the Tennessee Fire and Codes Academy that is charged with training firefighters and code enforcement officials across the state. The fourth section is the Bomb and Arson Section that is responsible for investigating fires and fire causes as well as enforcement of laws related to the crime of arson and explosives including associated crimes like fraud and homicide. The fifth section is the Manufactured Housing Section which inspects and regulates manufactured housing construction, installation, and resale in Tennessee. The Tennessee Commission on firefighting is another section and their responsibility is to test and certify firefighters at different levels. The last and newest section is the Contract Inspection Services Section that oversees and manages the statewide electrical inspection program and statewide residential inspection program including permit issuing agents. This section deals primarily with contractors who provide services that make these inspection programs work.

It is the responsibility of the TSFMO and every section to work collaboratively to reduce fire deaths and injuries in Tennessee. Heretofore, reducing fire mortality rates in Tennessee has not been a primary goal. New leadership at the Commissioner and Assistant Commissioner level and a commitment to reduce fire mortalities have elevated this as a primary goal for the TSFMO. Presently, the TSFMO is conducting a top to bottom review and outlining a strategy to assure that internal performance can achieve this goal. Several job roles are changing and collaboration between all sections will help to improve communications both internal to the organization and externally with others outside the TSFMO.

The TSFMO has the responsibility to coordinate fire prevention efforts statewide and to support local jurisdictions in their fire prevention and public education efforts. This study will be carefully reviewed by the TSFMO and implemented to the extent possible to help reduce Tennessee fire deaths and injuries.

Tennessee Fire Incident Reporting System (TFIRS)

While the TFIRS reports are intended to collect information about the structures involved in fires, many incident reports do not include the necessary data to properly analyze the fire mortality problem. The TSFMO permits download of a free software application or authorizes access to a web-based data entry browser interface that does not require installation. Incident data is keyed and stored in the NFIRS online database and is available on demand as needed. Departments may use commercial incident reporting software but must export and upload their data into the national database using a web-based import utility.

Although Tenn. Code Ann. § 68-102-111 mandates detailed reporting of fires within 10 days of occurrence, not all departments report. All fire grant awards require local jurisdictions to participate in this program.

TFIRS is an incident-based data collection system that provides annual data about fire incidents following a standard format for classifying data. Participating departments fill out incident and casualty reports as fires occur. Property use and fire cause are supposed to be reported for each fire. Additional data such as extent of flame spread and performance of detectors and sprinklers is collected for structure fires. Critical management data such as response time, number of personnel responding, and number and type of equipment responding are also collected. After the incident data are validated and aggregated from across the state, feedback reports are generated with both state and local statistics. This provides the TSFMO with statewide and local profiles of the fire problem in Tennessee. The TSFMO will then analyze when, where and how fires occur, who is most at risk from fire, and the general impact of fire on the citizens of our state. Information from the 2002 through 2010 period is one of the primary data sources for this report.

The data collected from the TFIRS indicates that critical information is often missing in the reports. When completing TFIRS reports, either the local fire department staff do not take time to access these data for purposes of entry into TIFIRS or they do not have the requisite training to do so. To retrieve the correct property record for instance, a precise address must be entered and keyed in a particular order. (The number of TFIRS incident reports that had less than exactly accurate address information for any particular year averaged about 10%-15% for just those incidents that involved fatalities).

Likewise, it would be useful for county property assessors to receive from fire departments any information about the destruction of or damage to structures caused by fires. This exchange of information would help to assure an accurate appraisal and an appropriate adjustment in county property tax bills sent to citizens.

The information about year the structure is built is not presently a data field in the TFIRS system but not only does it need to be there, it needs to be a required field. The assessed value should also be a required field or one on which a state investigator should follow up.

Communication, coordination, and information exchange remain significant challenges between fire departments and other local and state officials. Various entities may have data or expertise that would be very useful to and for other parties, but the mechanisms and procedures for sharing and communicating this information remain undeveloped or underutilized.

Local and State Fire Investigative Challenges

The identification of fire victims is a challenging task in fire investigations. Positive identification of fire death victims often is very difficult and in some fires requires extensive forensic examination by experts. In a few cases it is almost impossible to positively identify a fire victim.

The TFIRS reports are completed usually within a few hours or days after the occurrence of the fire. The typical TFIRS report takes about 15 minutes to complete, but a report on a structure fire that involves victims can take more than an hour to fill in basic information. Some of the individuals who enter data in the TFIRS reports may lack the experience and training to fill them out properly. This may contribute to the large number of variable entries that are missing information.

In addition, some volunteer fire departments do not have computers or internet service at their fire station. Staff may take home the information in order to work on the report. It is unfortunate but most fire departments in Tennessee do not have qualified fire investigators on staff who can determine the cause and origin of a fire. Many fire departments rely on local law enforcement agencies to investigate the fire fatality scene but very few have properly trained fire investigators who can perform even simple fire investigations.

Until recently, the TSFMO Bomb and Arson Investigators would not investigate fires unless an arson or murder had been confirmed, respectively, by local fire officials or local law enforcement. This was mainly due to economics and shortfalls in state budgets that permitted no overtime to be incurred by state agents. In the past, state fire investigators reportedly may have left home to respond to a call but then had to turn around before arrival on the scene in order not to transition to overtime status. New work schedules were implemented to transition special agents to 28 day pay cycles used in law enforcement as well as staggering staff schedules to assure that there would always be a special agent to respond to a call when requested. In the situation where a local fire department needs assistance, there always will be someone within the Bomb and Arson Section that can respond. This section also responds to any call when needed or requested regardless of whether it is a suspected crime or an accidental fire.

Collaboration among sections within the State Fire Marshal's Office is now established division policy. In the past for example, the TFIRS coordinator did not have authority to ask the Bomb and Arson Investigator for additional information about a structure fire that involved a fire death. While there may be certain information that cannot be released in a ongoing investigation, most basic incident information is public record and this information will be coordinated internally by a "Fire Mortality Coordinator" assigned to the Administrative Section.

A comparison of media reported fire deaths, TFIRS reports, and death certificate reviews indicates that there are a large number of fire fatalities that are not reported despite the fact that Tennessee law requires fire chiefs to submit the cause and origin of every structure fire in the state within 10 days. Some of this information gap may be explained by circumstances in which a victim is burned and transported by EMS but which does not involve a responding fire department. In this case, there is no TFIRS report and perhaps no media report but the TSFMO may later receive a death certificate. Death certificates for fatalities typically are not received by the TSFMO until seven to ten months following the end of the calendar year in which the fatalities occurred. A “Fire Mortality Coordinator” working in the TSFMO will manage these cases to assure better incident tracking.

As noted, Tennessee fire chiefs are required by law to report the cause and origin of every structure fire within 10 days. This is a reasonable time frame in most cases. However a fire report sometimes will be listed as “cause under investigation.” While this is an acceptable answer, many times the local fire department will not follow up and revise the fire report unless called by the TFIRS Coordinator. Even though it is state law, there has never been any enforcement of this law.

Since a 2004 amendment, Tenn. Code Ann. § 68-102-111 protects departments from liability for reporting in good faith the probable cause of a fire, there is no potential legal excuse for not reporting this crucial information. The current approach to this problem is to follow up with a phone call when a report is incomplete and to offer assistance in completing the report. This may even involve sending a Bomb and Arson Special Agent to assist in collecting or determining the cause and origin of the structure fire. The fire mortality coordinator will work with state and local officials to clear as many of these cases as possible. The goal is to follow up on all accidental structure fires that involve fire deaths or injuries.

Working with Stakeholders

A key to reducing fire deaths in Tennessee is to provide a comprehensive fire prevention program at the state level that includes effective public education strategies, strict code enforcement, adequate regulation through permitting and licensing, exceptional training and certification of responders, and good fire investigations. However, a factor critical for success is to identify and recruit stakeholders to assist in reducing fire deaths.

One stakeholder group that recently has been identified is the National Fire Protection Association (NFPA) Technical Committee on Deploying Public Fire Educators. This committee recently had their first meeting in Nashville. Their goal is to develop recommendations or standards for deploying public fire educators into local communities. The TSFMO will follow this process closely recognizing that the committee’s work will require about two more years before findings are released.

Associations and organizations are very important stakeholders and several Tennessee organizations are committed to helping in the cause to reduce fire mortalities. The Tennessee Municipal League initially requested this study and it demonstrated support throughout the research process. The Tennessee Fire Chief’s Association and the Tennessee Fire Safety Inspectors Association both have contributed funding for research. The Tennessee Home Builders, Tennessee Housing Association, Tennessee Building Officials Association and several other organizations have volunteered to assist in implementing the recommendations that stem from this report.

The University of Tennessee Institute for Public Service has been a major stakeholder in this project and has committed many hours of research time as well as funding for research. This research project would have been impossible without the University's support. The Fire Mortality Summits held over the past two years have brought together many more stakeholders including the Tennessee Executive Fire Officer graduates from the National Fire Academy.

The 911 Board for the state is an agency within the Tennessee Department of Commerce and Insurance. So far, there have not been coordinated efforts to gather data from the 911 system for use in TFIRS. GIS and 911 are still new technologies for some fire department personnel and barriers to cooperative efforts exist in certain areas across the state.

Implementation of State Level Solutions

The following are suggested solutions and strategies for the issues described:

- The Tennessee State Fire Marshal's Office will assign a staff person internally to coordinate information on the fire death problem. This individual will be responsible for coordination of TSFMO internal efforts between all Sections. This person also will track all media reported fires, conduct death certificate validation, and use other means to assure events are captured. This will include follow-up with local officials on incomplete fire reports to assure compliance with state law and data collection requirements. Monthly reports will be made available to track progress in a timely manner.

- The TFIRS Coordinator should review all structure fires for accuracy and information (especially to fire cause and contributing factors). A plan will be developed to include a data collection item for "age of structure" in the structure module.

- Training of fire department personnel will continue as needed with respect to how to fill out and complete TFIRS reports. This training currently is provided to fire chiefs, but it also should be targeted to those individuals who actually fill out the reports. A training session video will be developed by the fire academy and made available.

- The TSFMO will work with local officials by providing a follow-up by investigators from the Bomb & Arson Section when needed. All incomplete fire reports involving a fire death will include follow up from a state investigator. A challenging scenario concerns those cases that involve transportation of victims to a burn center. Developing a close working relationship with the state's burn facilities is a priority.

- State fire code inspectors will work closely with investigators in order to identify and implement those measures identified by research as having potential to prevent fires and fire deaths.

- The Bomb and Arson section will continue to work with both the Fire Academy and Police Academy in training investigators.

- Possible links between TFIRS and the property assessment data files will be investigated.

Chapter 4. The Fire Protection Infrastructure and the Perspectives of Tennessee Fire Chiefs

Discussions with fire chiefs and fire management experts in the “fire summits” held in April 2010, and in March and April 2011 indicated that when firefighters arrive on the scene in response to a fire call that later turns out to involve a fire death, it is not at all unusual for the person or persons involved to have become mortalities already. In other words, in residential fires in which one or more people die, fire chiefs report that these individuals, with some exceptions, have already perished when the responding fire department arrives on the scene. This reality underscores the importance of examining strategies that may have utility in helping to prevent such fires in the first place.

This circumstance does not imply that the level of fire protection provided by a fire department is unimportant. Indeed, the level of fire protection service provided matters a great deal in terms of response time, the ability to limit the extent of fire damage to property and injuries suffered by individuals, the capacity to provide immediate care for those injured in fires, and a number of other services performed that affect the level of fire risk to which residents are exposed. Communities have invested considerable resources in personnel, continual training and equipment infrastructure to provide the highest level of fire protection that can be afforded and supported by the locality. Investments in fire stations, personnel and equipment can and do result in better response times, professional firefighting capability and greater protection of public safety. However, these aspects of the contemporary fire management are primarily *reactive* in nature. Based on the literature review in Chapter 1, we suggest that future success in reducing residential fire deaths may depend upon the implementation of various types of *proactive* measures to prevent fires. What else, for example, might a fire department do to enhance public safety if it has already attained the highest possible protection rating or at least the highest level of fire protection that the community can afford?

This chapter examines both the existing fire protection infrastructure in Tennessee and the results of a survey of Tennessee fire chiefs. This survey was designed to measure the chiefs opinions about a variety of policies, strategies, and actions for preventing or reducing residential fire deaths in Tennessee.

A Profile of Tennessee Fire Departments

During the study period, there were 715 fire departments in operation in Tennessee. There were 306 municipal fire departments (42.8%), 391 fire departments (54.7%) that served some or all of a county outside an incorporated city, and 18 (2.5%) of fire departments that served both a city and county. This study did not include the array of mutual aid agreements among various fire departments in Tennessee so this profile understates the level of fire protection available to some state residents.

Of the 715 fire departments, 35 or 4.9% are classified as “career” by UT MTAS fire management consultants. Another 113 departments (15.8%) are classified as a combination of career and volunteer. The majority of fire departments in Tennessee are “volunteer.” There are 567 all-volunteer fire departments in the state which represent 79.3% of all fire departments.

Staffing and equipment configurations for each of these types of departments depends upon a number of factors that relate to the department’s mission, service demands and expectations from the community, budget size, the number of people in the service area, the types of structures, and land uses in the service area. For these reasons, the typical measures of central tendency of various fire department attributes such as staff size and population served, for instance, have little utility other than to indicate whether the sample of fire chiefs who responded to the survey (discussed later) are reasonably representative of the larger population of fire chiefs.

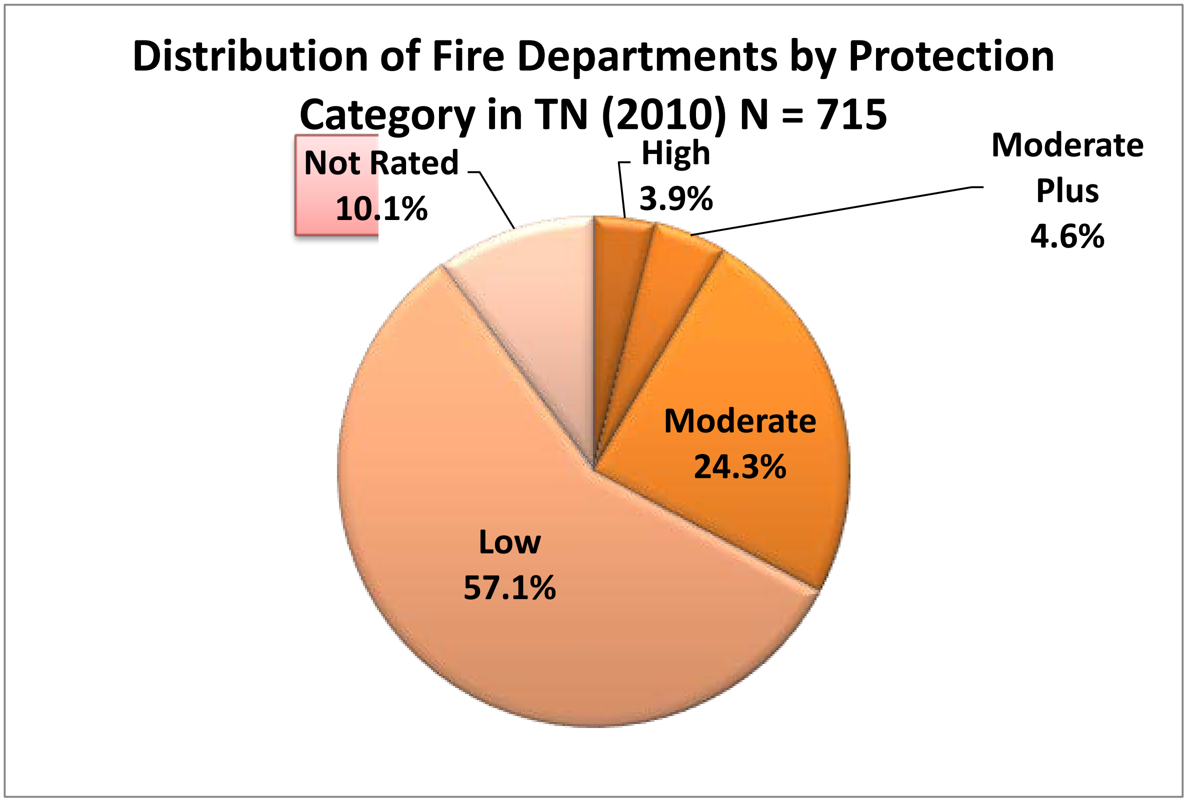
For instance, the average staff size for the 35 “career” fire departments is 153 full-time fire firefighters and 118 part-time fire fighters. Excluding Memphis and Nashville, the state’s two largest fire departments, those figures drop to 82 and 64 respectively. The mean staff size by type of firefighter in the 113 “combination” departments are 13 full-time, 39 volunteers, and 23 part-time personnel. In the 567 “volunteer” departments there are no full-time fire fighters. The average staff size in these departments is 22 volunteers.

Of the 715 fire departments, MTAS consultants identified 306 (42.8%) that serve cities, 391 departments (54.7%) that serve counties or portions of the unincorporated area of a county, and 18 (2.5%) departments that serve both a city and some surrounding territory in the county.

As explained in the methodology section of Chapter 1, the information and data on the fire departments in Tennessee were compiled by the fire management consultants at the UT Municipal Technical Advisory Service. MTAS fire management consultants also assessed each fire department in terms of its level of professionalism, staffing and equipment configurations. **Figure 4-1** indicates the number of fire departments in each category of the five fire protection categories that were devised for this study.

These five categories for fire protection classification are based partly on the Insurances Services Office (ISO) classification system. Generally, fire departments rated as having a “high” level of fire protection had an ISO rating of three or lower. Fire departments classified as having a “moderate plus” level of protection had an ISO rating of five or four and a higher than average rating assigned by an MTAS consultant with respect to the department’s equipment configuration, training, staff professionalism, and departmental leadership. Other fire departments with an ISO rating of four, five, or six were categorized as providing a “moderate” level of protection. A fire department was classified as providing a “low” level of fire protection if its ISO rating was seven, eight, or nine. A fire department that had an ISO rating of 10 was considered to provide no fire protection and was grouped in the “not rated” category.

Figure 4-1. Distribution of Tennessee Fire Departments by Protection Category



These data indicate that most fire departments (57.1%) provide a low level of fire protection. This distribution is not surprising considering the large number of volunteer fire departments that exist to provide at least minimal levels of fire protection to small communities and to various rural areas within counties outside of incorporated municipalities.

This distribution of fire departments by protection classification indicates that about a third (32.8%) of all fire departments offer at least a moderate level of protection to the residents within their service areas. However, this distribution does **not** mean that just a third of all residents benefit from having at least a moderate level of fire protection.

Based on the data compiled by MTAS consultants on the fire departments' service population (as updated by the survey responses and relevant 2010 city census data), **Figure 4-2** indicates the proportion of the state's population that is covered by some form of fire protection. The sum of all of the departments' service area populations exceeds the 2010 state population since some rural fire departments provide overlapping protection for county populations. These data indicate that while only about a third of fire departments provide at least a moderate level of fire protection, these departments serve about 69.1% of the state's population.

These data provide a rough estimate of the extent of public fire protection in Tennessee. Unfortunately, there is no map or inventory of the precise service areas for all of the state's fire departments. In the future, it would be helpful to develop a statewide map of fire departments' service areas that also includes protection of areas through mutual aid agreements. This type of overlay in a GIS would help to identify issues where a gap may occur between protection provided and the incidence of fire mortalities.

Figure 4-2. Fire Departments' Protection Classification and Population Served

Protection Class	Frequency	Valid Percent	Population Served	Percent
High	28	3.9	2,392,575	32.5
Moderate Plus	33	4.6	1,505,072	20.4
Moderate	174	24.3	1,192,617	16.2
Low	408	57.1	1,947,384	26.4
Not Rated	72	10.1	329,769	4.5
Total	715	100.0	7,367,417	100

Fire protection classification makes a difference to public safety in several ways. First, fire departments that provide a higher level of protection have a significantly faster recorded response time to fire calls. Conversely, those departments with lower protection ratings have longer response times. The differences in these mean response times shown in **Figure 4-3** are statistically significant at the .05 level.

Figure 4-3. Mean Fire Department Response Time by Protection Classification

STUDY REVIEW	Mean	N	Std. Deviation
High	5.13	203	2.206
Moderate Plus	6.85	59	4.792
Moderate	7.44	172	4.856
Low	10.65	175	10.031
Unprotected	11.33	3	5.859
Total	7.55	612	6.631

Protection class also makes an important difference in terms of residents' relative risk of fire mortality. Obviously, there are more fire deaths in the protection classes in which more people reside. As noted, the three highest protection classes serve about 69.1% of the population. These three protection classes also recorded 60.4% of all residential fire deaths during the 2002-2010 study period. However, as **Figure 4-4** shows, the risk of dying in a residential fire is generally much ***lower*** in those areas served by a fire department that provides a moderate plus or a high level of fire protection. The rate of fire mortalities is higher among the moderate and low protection classes. The sparse and low density population of those areas that are unprotected partially account for the low rate of fire mortality in that class. However, as the subsequent chapter explains, residents of some of these unprotected census tracts have been fortunate in not yet experiencing the tragedy of a residential fire death.

Figure 4-4. Total Residential Fire Fatalities and Mean Annual Fatality Rate per Million by Protection Classification

Fire Department Protection Category	Number of Residential Fire Deaths	Percent	Mean Fire Fatality Rate/ mill.
High	207	32.6	11.43
Moderate Plus	60	9.5	16.56
Moderate	173	27.3	23.80
Low	178	28.1	18.33
Unprotected	16	2.5	11.46
Total	633	100.0	18.7

Results from the Survey of Tennessee Fire Chiefs

Among the 715 fire departments in the state, email addresses were available for only 535 fire chiefs. Email invitations were sent on behalf of the Assistant Commissioner for Fire Prevention on May 27, 2011 to each of the 535 fire chiefs. Two reminders were mailed during the open survey period and 77 valid responses were obtained before the closing date of June 10, 2011. (Two responses were received from fire chiefs representing private fire departments were excluded from the analysis since these departments were not included in the 715 population). This equates to a low response rate of just 14.4%.

Obtaining a high response rate to a survey is problematic for a group of very busy professionals, especially those engaged in leadership roles in the fire service. The main concern for this study is the extent to which the 77 responses may or may not be representative of the population of fire chiefs. In the first place, it should be noted that the email addresses for 180 fire chiefs were unknown. Virtually all of these unknown email addresses involved fire chiefs of volunteer fire departments. Consequently, we would expect the survey results to under-represent volunteer departments.

Of the 77 responses, 47 or 61.8% were obtained from city fire chiefs. Among the population as a whole, only 42.8% of fire chiefs represented cities. So, the survey tends to over-represent the views of municipal fire chiefs. Only 30.3% of the survey responses were from fire chiefs that represented fire departments in a county compared to 54.7% for the entire population.

A comparison of the ***types*** of fire departments indicated that survey responses were comprised of 7 or 9.2% from career departments, 30 or 39.2% from combination departments and 39 or 51.3% from volunteer departments. The corresponding profile of the entire fire department population indicates that 4.9% are career, 15.8% are combination and 79.3% are volunteer departments. Consequently, the survey responses tend to over-represent fire chiefs from career and combination departments and under-represent volunteer fire chiefs.

Finally, a comparison for the fire protection profiles of the departments represented in the survey and the population of which they are a part indicate that those departments with ratings of High or Moderate Plus are over-represented compared to the figures presented in the pie chart for that variable. Departments in the High category represented 7.9% of survey responses while those in Moderate Plus comprised 9.2%. Responses from the departments rated Moderate, Low and Not Rated comprised 38.2%, 36.8% and 7.9% of the sample population, respectively. The corresponding proportions for the entire population of fire departments are: 3.9%, 4.6%, 24.3%, 57.1% and 10.1%.

While these differences require a great deal of caution in generalizing findings to the larger population of fire chiefs, it is safe to claim that the survey responses obtained most likely represent the views and opinions of those fire chiefs who are more interested in and attentive to the issues and challenges of reducing residential fire mortalities. As a group, the responding fire chiefs served in their positions for an average of 9.73 years and lead a department that provides fire protection services for an average of 17,462 people.

Considering its importance to public safety, the first question in the survey was: “How would you rate the overall level of applicable codes enforcement (building, housing, electrical, plumbing, etc.) in the community served by your fire department during the nine year period of 2002 through 2010?” **Figure 4-5** shows a response distribution that has considerable variation in ratings. While the largest proportion (48.1%) rate the code enforcement effort as good or excellent, a slight majority (52%) rate is as just fair, poor or very poor. There is a strong correlation between the size of the city and the fire chiefs’ ratings such that fire chiefs in smaller cities are much more likely than those in larger cities to rate the code enforcement effort as fair, poor, or very poor.

Figure 4-5. Level of Code Enforcement in the Community

Rating	Frequency	Percent
Very Poor	8	10.4
Poor	14	18.2
Fair	18	23.4
Good	31	40.3
Excellent	6	7.8
Total	77	100.0

The questionnaire also asked fire chiefs what they thought about the receptivity of the citizens in the community they served to the idea of requiring newly constructed homes to be equipped with sprinkler systems. The cost of home sprinkler systems has declined in recent years and the fact that there is no record of anyone perishing in a home equipped with a sprinkler system suggests that this technology has great promise for reducing fire mortalities in the future. However, as **Figure 4-6** suggests, fire chiefs think that most of the citizens in their community (56%) would only be slightly receptive or not at all receptive to this requirement. That sizeable proportion suggests that a significant effort to publicize both the costs and benefits of a sprinkler requirement in new construction would have to overcome a very weak level of support for such a policy.

However, a more positive perspective on this opinion distribution would point out that 65% or almost two-thirds of citizens would be moderately or slightly receptive to a sprinkler requirement. Regardless of how one prefers to view the data, it is clear to the research team (and to the fire chiefs) that local and state officials confront a significant although not insurmountable challenge in persuading citizens to support the idea of requiring newly constructed homes to be equipped with sprinkler systems.

Figure 4-6. Citizens' Receptivity to Requiring Sprinkler Systems in New Construction

	Frequency	Percent
Not at all receptive	9	11.7
Slightly receptive	34	44.2
Moderately receptive	16	20.8
Receptive	6	7.8
Very receptive	1	1.3
Don't know / Not sure	11	14.3
Total	77	100.0

Fire Chiefs also were asked to rank the importance of several factors in terms of how they thought that factor might help to reduce the risk of someone dying in a home fire in Tennessee. The chiefs were asked to place a "1" next to the most important through "5" next to what they considered to be the least important factor. The "mean" ranking of each factor by all respondents is shown in **Figure 4-7.**

Figure 4-7. Mean Ranking of the Importance of Selected Factors in Preventing/Reducing Home Fire Deaths in Tennessee

Mean Rank	Factor
1.97	Smoke Alarm Distribution/Installation
2,47	Home Sprinkler System
2.83	Codes Enforcement
3.19	Fire Safety Demonstrations/Instruction at Local Schools
4.47	Fire Safe Cigarettes

Fire Chiefs were asked to assess, in light of their departmental resource constraints, their department's level of involvement in providing various types of fire safety and prevention education activities in the community during the two year period of 2009 thru 2010. The distribution of their responses is shown in **Figure 4-8**. Once again, the responses show a great deal of variation. While more than 37% of chiefs rate their department's level of involvement as high or very high in fire safety and prevention education activities in the community during 2009 and 2010, more than 58% rate this involvement as moderate or low. Only 4% did not engage in those activities during the two year period.

Figure 4-8. Assessment of Fire Department's Level of Involvement in Fire Safety and Prevention Education Activities in the Community between 2009 thru 2010

Rating	Frequency	Percent
None or virtually non-existent	3	4.0
Low	12	16.0
Moderate	32	42.7
High	21	28.0
Very high	7	9.3
Total	75	100.0

When asked who in the department was responsible for conducting fire safety and prevention education in the community, 25 or 33.3% did not have any personnel in their department with this as an assigned responsibility while 49 or 65.3% indicated that they did have a staff person assigned this responsibility.(One respondent did not know or was not sure). Among the latter group, 28 chiefs (36.4%) indicated that this staff person had fire safety and prevention education as their exclusive or main assignment. Only 9 chiefs (11.7%) indicated that various staff in the fire department had fire safety and prevention education as just one of their shift responsibilities.

Figure 4-9 shows that even in an era of extreme fiscal stress (2009-2010), many fire departments recognize the importance of continuing several types of efforts to promote fire safety education as a strategy to prevent fire mortalities. The types of activities in which the largest proportions of fire departments engaged during the 2009-2010 period were, in order of frequency, (1) fire Safety presentations/demonstrations to school age children (86.7%), (2) fire

Safety week or month events (73.3%), (3) shared fire safety education resources with local teachers and parents (72.0%) and (3) Arranged for class visits to fire stations (72.0%), (4) distribution/installation of smoke alarms (69.3%).

The activities that fire chiefs rated as having more value or utility for promoting fire safety/prevention in the community included (1) distribution/installation of smoke alarms (77.9%), (2) conducting fire safety presentations to school age children (76.1%), (3) conducting smoke alarm battery replacement programs (57.9%), and (4) sharing fire safety education resources with local teachers and parents (52.2%). Among these strategies, the only one that has a statistically important relationship with a lower rate of fire mortalities among the small number of responding communities was "conducting fire safety education presentations/demonstrations to school age children."

Appendix C lists the verbatim responses to the open-ended question included in the survey that asked fire chiefs to identify the one or two policies, strategies, or actions that they thought would have the most impact on preventing or reducing residential fire deaths and that they would like to see implemented or expanded in their community. More than 80% of the responding fire chiefs (62 of 77) provided comments on this question.

Figure 4-9. Fire Department Involvement In and Rating of the Value in Promoting Fire Safety/Prevention in the Community, 2009 & 2010, in Percents (N=75)

Activity	**Performed in 09 or '10**		**Level of Value in Promoting Fire Safety/Prevention in Community**		
	Yes	**No**	**Low**	**Mod.**	**High**
Conducted Fire Safety presentations/demonstrations to school-age children	86.7	13.3	4.2	19.7	76.1
Shared Fire Safety Education Resources with local teachers and parents	72.0	28.0	5.8	42.0	52.2
Conducted Free Home Fire Risk Assessments	28.0	72.0	14.0	47.4	38.6
Distribution/installation of Smoke Alarms	69.3	30.7	0	22.1	77.9
Conducted smoke alarm battery replacement programs	33.3	66.7	5.3	36.8	57.9
Assisted with inspection of distribution of information about residential sprinkler syst.	25.3	74.7	25.9	39.7	34.5

Activity	Performed in 09 or '10		Level of Value in Promoting Fire Safety/Prevention in Community		
	Yes	No	Low	Mod.	High
Distribution/installation of fire extinguishers	12.0	88.0	18.2	50.9	30.9
Arranged for Fire Safety Vans or Mobile Education Units to Schools	29.3	70.7	13.8	46.6	39.7
Arranged for Class visits to Fire Stations	72.0	28.0	13.2	50.0	36.8
Conducted Fire Safety Workshops for Parents of pre-schoolers	25.3	74.7	8.8	50.9	40.4
Provided fire safety training to professional care givers to the elderly or disabled	38.7	61.3	3.3	55.0	41.7
Fire Station Open House & Demonstration Events	62.7	37.3	10.8	63.1	26.2
Fire safety Week or Month Events	73.3	26.7	7.7	47.7	44.6

There are four distinct themes that emerged in the open-ended responses provided by the fire chiefs. These themes clearly indicate what they think will have the most impact on preventing or reducing residential fire deaths while also being actions or policies that they would like to see implemented in their communities. These themes, listed in order of the frequency that they were mentioned by fire chiefs, focused on a variety of actions or policies related to:
(1) smoke detectors (24)
(2) residential sprinklers (19)
(3) education of community residents (17), and
(4) adoption and/or enforcement of codes (10).

The fire chiefs' comments about smoke detectors focused on the need to ensure that all structures, residences included, have working smoke/fire alarms. More widespread and regular smoke detector distribution efforts, battery replacement programs, and annual testing, inspection, and installation programs were all suggested to ensure that every residence has an adequate number of working smoke detectors. The chiefs' remarks about residential sprinklers, the second most frequently mentioned idea to reduce residential fire fatalities, concerned ideas to require that all new buildings, including homes, be required to install sprinklers, adoption of residential sprinkler ordinances, and efforts to educate citizens about the benefits of sprinklers.

The themes of educating community residents about fire prevention, smoke alarms, and sprinklers, and improving local code enforcement were recurrent in many of the fire chiefs' comments. The comments about the need for broader, more extensive, and more consistent fire safety/prevention education efforts covered a number of different target groups including school children, lower income households, high school kids preparing to leave for college, rural residents, and senior citizens.

The comments about the need to adopt and enforce codes reflected the widespread recognition among the state's fire chiefs that public safety begins with the construction of buildings that meet appropriate code standards and continues with the maintenance of structures to assure that smoke and fire alarms operate and that occupants and residents know what to do in the event of a fire emergency. Several comments concerned the need to have effective enforcement of the adopted codes, routine inspections, and to assure that there are no exceptions or special cases that are exempt from the codes.

Chapter 5. Census Tract Analyses of Fire Mortality Risk and Explaining Variation in the Fire Mortality Rate Among Census Tracts

Factors that Distinguish Census Tracts

Based on our review of the literature that examined the social, economic, demographic and housing variables that distinguished counties and other jurisdictions that had higher rates of fire mortalities, we cast a broad net by including in our analysis a large number of factors in each of these categories from the American Community Survey (ACS) (2005-2009) for each of the 1261 populated census tracts in Tennessee. Further, each census tract was identified as being mainly urban or rural depending upon whether at least 2/3's or more of the tract was located within the corporate boundaries of a city (urban) or outside a municipal incorporation (rural). Using that decision rule, there are 581 (46.1%) urban census tracts and 680 (53.9%) rural census tracts in Tennessee. Of the 1261 census tracts, 872 (69.2%) tracts did not have any civilian residential fire deaths between the study period (2002 and 2010) while 389 tracts (30.8%) had at least one such death.

As noted in Chapter 2, there were a total of 635 civilian residential fire deaths during 2002-2010, but the TFIRS data provided sufficient address information only for 624 fire deaths. Insufficiently precise address information for 11 fire deaths made it impossible to link these cases with a census tract. Consequently, the analyses in this chapter are based on 624 fire deaths. This fact explains why the mortality rates reported in this chapter are lower than the mortality figures reported in Chapter 2.

Figure 5-1 shows that a residential fire death was more likely to have occurred in a rural census tract rather than in an urban census tract. This relationship is statistically significant at the .05 level (gamma = .298). This association suggests that the risk of fire mortality would be higher in rural census tracts than in urban census tracts. In fact, the rate of fire deaths in rural census tracts during the study period was 13.05 deaths per million population compared with 11.5 deaths per million for urban census tracts.

Figure 5-1. Urban and Rural Census tracts and Residential Fire Deaths

Fire Deaths	Urban/Rural		
	urban	rural	Total
No	442	430	872
	76.1%	63.2%	69.2%
Yes	139	250	389
	23.9%	36.8%	30.8%
Totals	581	680	1261
	100.0%	100.0%	100.0%

For each of the 107 variables included from the ACS, we examined the mean differences among three groups for census tracts that did and did not have at least one fire death during the study period. The three groups consisted of all census tracts, just urban census tracts, and just rural census tracts. (The variables included from the ACS in this study can be inspected at the links to the reports' data files found in Appendix B).

The purpose of the analysis of mean differences among census tracts is to devise a rational process for helping to identify which tracts, if any among those that did not record a residential fire death during the study period, may have a higher risk for a fire mortality. The difference of means procedure in SPSS (Statistical Package for the Social Sciences) was used to test a large number of hypotheses concerning the expected direction of the difference between the group means. This analysis indicated that there was a statistically significant difference in the means for 31 variables between those census tracts without and with a residential fire death(s) for at least one of the three groups of census tracts (all tracts, urban tracts or rural tracts). These ACS variables included nine social factors, four demographic factors, six economic factors, and twelve housing factors.

Based on the findings from previous research and our analysis of the characteristics of fire victims in Chapter 2, we hypothesized that the census tracts that had one or more residential fire deaths during the study period would have the following characteristics:

- a higher percentage of female householders
- a higher percentage of residents 65 & over
- a larger percentage of children in the tract population enrolled in grades 1-8
- a larger proportion of the population with less than a 9th grade education
- a smaller percentage of the population with high school graduates
- a smaller percentage of the population with a bachelor's degree
- a smaller percentage of the population with a high school education or higher
- a smaller percentage of the population with a bachelor's degree or higher
- a larger proportion of the population under 5 years of age
- a larger proportion of the population between 5 to 9 years of age
- a smaller white and a larger non-white population
- a higher proportion of people who are unemployed
- a lower median household income
- a lower mean household income
- a larger percentage of the population with incomes below the poverty line
- a lower per capita income
- a larger proportion of the housing stock comprised of mobile homes
- a smaller proportion of owner-occupied housing units
- a larger proportion of renter –occupied housing units
- larger proportions of the tract housing stock with values less than $50,000 and between $50,000-$100,000

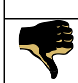
- smaller proportions of the housing stock with values between $150,000 to $199,000, between $200,000 - $299,999, between $300,000-$400,000, and between $500,000-$999,000
- a smaller median home value
- a smaller proportion of units without a mortgage
- a smaller median monthly rent

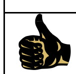
We included a number of variables that measured the proportion of the housing stock that was built in various decades. However, none of the mean differences in these variables proved to be statistically different. Based on these findings, we surmise that the decade in which a structure was built may not matter as much as whether the structure may have been constructed according to appropriate codes, maintained properly, and perhaps inspected periodically for compliance with applicable codes. This points again to the need for fire chiefs to use the "effective" age of the structure variable computed by the state's Division of Property Assessments in the TFIRS incident reports.

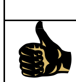
The findings in Figure 5-2 indicate that the hypothesized differences in the means were supported statistically for every variable with the exception of the percent of high school graduates (as an absolute proportion of the population) and the proportion of occupied housing units without a mortgage. The hypotheses supported and not supported are represented respectively by the thumbs-up or thumbs-down symbols.

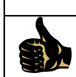
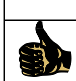
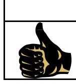
There were ten variables with means that were statistically different for all tracts, urban tracts, and for rural tracts. (These are the variables for which means appear in each of the columns). These consisted of three social variables (percent of population with a bachelor's degree, percent with a graduate or professional degree, and the percent with a bachelor's degree or higher), five economic variables that represent different measures of the income or poverty status of residents, and two housing variables, one that measures the percent of the housing stock that consists of mobile homes and another that measures the median value of the owner-occupied units in the census tract.

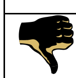
Figure 5-2. Statistically Significant Differences Between Means for the Key Profile Variables in the ACS 05-09 that Distinguish TN Census Tracts Without and With Fire Deaths (sig. <.05)

H_1 supp-orted or not	**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**
	SOC7; Households by type; Total households; Female householder, no husband present, family; Percent			16.856	20.711		
	SOC13; Households by type; Total households; Nonfamily households; Householder living alone; 65 years and over; Percent	10.013	11.043				
	SOC 18; School enrollment; Population 3 years and over enrolled in school; Elementary school (grades 1-8); Percent	42.37	44.52	38.22	40.94		
	SOC 21; Educational attainment; Population 25 years and over; Less than 9th grade; Percent	7.491	8.771	6.579	8.331		
	SOC23; Educational attainment; Population 25 years and over; High school	33.103	36.639	28.662	32.552		

	graduate (includes equivalency); Percent						
H_1 supp-orted or not	**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**
	SOC25; Educational attainment; Population 25 years and over; Bachelor's degree; Percent	14.308	10.941	16.887	12.560	11.669	10.037
	SOC27; Educational attainment; Population 25 years and over; Graduate or professional degree; Percent	7.997	5.747	9.811	6.950	6.101	5.076
	SOC28; Educational attainment; Population 25 years and over; Percent high school graduate or higher; Estimate	80.473	77.961	81.370	77.153		
	SOC29; Educational attainment; Population 25 years and over; Percent bachelor's degree or higher; Estimate	22.283	16.687	26.695	19.512	17.768	15.111
	DEMO5; Sex and age; Total population; Under 5 years; Percent			6.547	7.317		

H_1 supp-orted or not	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
	DEMO7; Sex and age; Total population; 5 to 9 years; Percent	6.147	6.526	5.917	6.623		
	DEMO14; Race; One race; White; Percent			62.469	54.609		
	DEMO15;Race; One race; Black or African American; Percent			31.987	40.252		
	ECON5; Employment status; Population 16 years and over; In labor force; Civilian labor force; Unemployed; Percent	5.326	5.776	6.003	7.426		
	ECON6; Income and benefits (in 2009 inflation-adjusted dollars); Total households; Median household income (dollars); Estimate	44227.91	38907.98	43325.55	34783.45	45140.80	41210.43
	ECON7; Income and benefits (in 2009 inflation-adjusted dollars); Total households; Mean household income (dollars); Estimate	56611.61	50204.23	56665.25	47183.70	56557.61	51890.39
	ECON10; Percentage of families and	24.083	27.116	28.277	36.436	19.870	21.914

	people whose income in the past 12 months is below the poverty level; Under 18 years; Estimate						
H_1 supp-orted or not	**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**
	ECON8;Income and benefits (in 2009 inflation-adjusted dollars); Families; Per capita income (dollars); Estimate	23121.31	20453.78	24026.99	20131.93	22194.53	20633.45
	ECON9;Percentage of families and people whose income in the past 12 months is below the poverty level; All people; Estimate	18.55	19.979	22.126	26.122	14.920	16.550
	HO11; Units in structure; Mobile home; Percent	9.240	12.692	1.955	3.405	16.610* *= sig. =.15	17.876* *= sig. =.15
	HO31; Housing tenure; Occupied housing units; Owner-occupied; Percent					78.19	75.88
	HO33; Housing tenure; Occupied housing units; Renter-occupied; Percent					21.81	24.12
	HO48; Value; Owner-occupied units; Less than $50,000; Percent	12.669	15.382	10.647	14.987		
	HO50; Value;	29.20	32.51	30.18	37.84		

	Owner-occupied units; $50,000 to $99,999; Percent						
H_1 supp-orted or not	**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**
	HO54; Value; Owner-occupied units; $150,000 to $199,999; Percent			13.878	11.253		
	HO56; Value; Owner-occupied units; $200,000 to $299,999; Percent	11.382	9.314	10.962	6.751		
	HO58; Value; Owner-occupied units; $300,000 to $499,999; Percent	6.966	5.085	7.457	4.676	6.479	5.313
	HO60; Value; Owner-occupied units; $500,000 to $999,999; Percent	2.60	1.904			2.374	1.620
	HO63; Value; Owner-occupied units; Median (dollars); Estimate	131902.35	115112.11	141199.29	119002.16	122757.11	112940.56
	HO64; Mortgage status; Owner-occupied units; Housing units without a mortgage; Percent	37.619	40.147	33.889	37.192		
	HO65; Gross rent; Occupied units paying rent; Median (dollars); Estimate	681.12	613.40	724.26	661.40	637.07	586.50

Again, the purpose for examining these mean differences is to employ a rational process for helping to identify which tracts, if any, among those that did not record a residential fire death during the study period, may have a higher risk for a fire mortality. We suggest that the risk of fire mortalities is likely to be higher among those tracts that have means on the ten social, economic, or housing features that are equal to or greater than (in the hypothesized direction) the means of the tracts with home fire deaths.

The level of specificity of these data enables one to generate custom lists of tracts by region, within counties, and by tract type (urban or rural). One might also choose to assign differential weights to particular variables that reflect different views about the relative importance that variables may have for fire mortality risk. For instance, some researchers might consider economic factors to be more important than educational attainment in assessing whether residents of a particular tract are more likely to be fire victims. In this study we make the assumption 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. By learning what distinguishes the census tracts that have had fire deaths, it might be possible to identify tracts with a similar profile that have not had fire deaths so that resources can be used more strategically for fire safety and prevention education efforts.

The method used to “screen” for the tracts that were presumed to have higher levels of “risk exposure” to fire mortalities began by focusing only the ten variables that had statistically different means when ***all*** census tracts were included in the analysis (the first set of columns in Figure 5-2). Then, we chose to introduce particular “screen” variables to identify the relative risk of fire mortality in census tracts based on what prior research suggested as their relative contribution to our understanding of fire mortality variation. Accordingly, we chose to apply the screen variables in the following order: education, economic, and housing. Next, we used the three education variables (percent with a bachelor’s degree: 10.9 or less; percent with a graduate or professional degree: 5.7 or less; percent with a bachelor’s degree or higher: 16.7 or less) to identify the first group of tracts that overall have, in our assessment, an above average risk for home fire mortalities. To identify the next highest tier of fire mortality risk, we chose to employ two economic variables with the largest mean differences (median household income: $38,907 or less; and percentage of families and people with incomes below the poverty level: 19.979 or higher). To identify the group of census tracts with what we presumed to have the highest risk of fire mortalities, we applied screens for the two housing variables (percentage of units in mobile homes: 12.7 or higher; median value of owner-occupied housing units: $115,113 or less).

These screens resulted in three groups of census tracts: 358 tracts labeled as “above average risk,” 199 tracts with “high risk,” and 78 tracts with the “highest risk.” This latter group comprises the census tracts that have a mean variable profile most similar to the tracts that have had fire deaths in the past. These tract groups are listed respectively in **Figures 5-3, 5-4, and 5-5**. These group lists do NOT include any of the 389 census tracts with these profile features that already have had fire fatalities.

Again, the rationale for this process of grouping tracts by fire mortality risk is to provide some reasonable basis for targeting or focusing resources on the most vulnerable populations and areas in the state that, if history is any guide, are at risk of having one or more fire deaths in the future. The 358 tracts in Figure 5-3 represent 41% of those tracts that did not have a fire death during the study period. The 199 census tracts in the "high" risk category represent 22.8% of the 872 tracts without fire deaths during the study period, and the 78 tracts in the "highest risk" group represent 8.9% of that population. Links to the map(s) that show the precise locations of all of the census tracts in these groups are located in Appendix B.

Figure 5-3. Census tracts with "Above Average Risk" of Fire Mortalities (N=358)

Census Tract 1, Hamilton County
Census Tract 1, Putnam County
Census Tract 10, Putnam County
Census Tract 100, Shelby County
Census Tract 1001, Montgomery County
Census Tract 1002, Hamblen County
Census Tract 1004, Montgomery County
Census Tract 1008, Hamblen County
Census Tract 1008, Montgomery County
Census Tract 1009, Montgomery County
Census Tract 101, Maury County
Census Tract 1010, Hamblen County
Census Tract 1010.01, Montgomery County
Census Tract 1012, Montgomery County
Census Tract 1013.02, Montgomery County
Census Tract 102.20, Shelby County
Census Tract 103, Bradley County
Census Tract 103, Shelby County
Census Tract 104.02, Davidson County
Census Tract 104.20, Shelby County
Census Tract 105, Shelby County
Census Tract 106.20, Shelby County
Census Tract 106.30, Shelby County
Census Tract 107.01, Davidson County
Census Tract 107.02, Davidson County
Census Tract 107.20, Shelby County
Census Tract 108, Blount County
Census Tract 108.10, Shelby County
Census Tract 109, Maury County
Census Tract 109, Shelby County
Census Tract 11, Madison County
Census Tract 110, Maury County
Census Tract 110.01, Davidson County

Census Tract 110.10, Shelby County
Census Tract 110.20, Shelby County
Census Tract 1101, Morgan County
Census Tract 1104, Morgan County
Census Tract 1106, Stewart County
Census Tract 113, Bradley County
Census Tract 113, Davidson County
Census Tract 114, Davidson County
Census Tract 115, Hamilton County
Census Tract 116, Bradley County
Census Tract 116, Hamilton County
Census Tract 118, Davidson County
Census Tract 119, Davidson County
Census Tract 12, Knox County
Census Tract 12, Shelby County
Census Tract 1201, Houston County
Census Tract 1202, Houston County
Census Tract 124, Davidson County
Census Tract 126, Davidson County
Census Tract 13, Putnam County
Census Tract 13, Shelby County
Census Tract 130, Davidson County
Census Tract 1301, Humphreys County
Census Tract 1304, Humphreys County
Census Tract 1305, Humphreys County
Census Tract 132, Davidson County
Census Tract 138, Davidson County
Census Tract 14, Knox County
Census Tract 14, Shelby County
Census Tract 143, Davidson County
Census Tract 148, Davidson County
Census Tract 15, Knox County
Census Tract 154.02, Davidson County
Census Tract 16, Hamilton County
Census Tract 160, Davidson County
Census Tract 161, Davidson County
Census Tract 173, Davidson County
Census Tract 18, Madison County
Census Tract 18, Shelby County

Census Tract 19, Hamilton County
Census Tract 19, Shelby County
Census Tract 190.01, Davidson County
Census Tract 2, Hamilton County
Census Tract 20, Knox County
Census Tract 20, Shelby County
Census Tract 201, Sumner County
Census Tract 202.02, Sumner County
Census Tract 202.22, Shelby County
Census Tract 204.01, Sumner County
Census Tract 205, Anderson County
Census Tract 205.21, Shelby County
Census Tract 205.22, Shelby County
Census Tract 207, Anderson County
Census Tract 207, Sumner County
Census Tract 208, Anderson County
Census Tract 208, Sumner County
Census Tract 209.02, Anderson County
Census Tract 21, Knox County
Census Tract 21, Shelby County
Census Tract 210, Anderson County
Census Tract 212, Shelby County
Census Tract 213.01, Anderson County
Census Tract 217.10, Shelby County
Census Tract 217.23, Shelby County
Census Tract 217.31, Shelby County
Census Tract 217.41, Shelby County
Census Tract 219, Shelby County
Census Tract 221.11, Shelby County
Census Tract 222.10, Shelby County
Census Tract 223.21, Shelby County
Census Tract 224.21, Shelby County
Census Tract 224.22, Shelby County
Census Tract 23, Hamilton County
Census Tract 24, Hamilton County
Census Tract 24, Knox County
Census Tract 24, Shelby County
Census Tract 26, Hamilton County
Census Tract 27, Knox County

Census Tract 28, Knox County
Census Tract 3, Hamilton County
Census Tract 3, Shelby County
Census Tract 304, Wilson County
Census Tract 305, Wilson County
Census Tract 307, Roane County
Census Tract 307, Wilson County
Census Tract 308, Wilson County
Census Tract 309, Roane County
Census Tract 36, Knox County
Census Tract 39, Shelby County
Census Tract 40, Shelby County
Census Tract 401, Tipton County
Census Tract 401, Union County
Census Tract 402, Sullivan County
Census Tract 402, Tipton County
Census Tract 402.01, Union County
Census Tract 402.02, Union County
Census Tract 403, Union County
Census Tract 404, Tipton County
Census Tract 405, Sullivan County
Census Tract 406, Sullivan County
Census Tract 406.01, Tipton County
Census Tract 409, Tipton County
Census Tract 41, Shelby County
Census Tract 414, Sullivan County
Census Tract 418, Rutherford County
Census Tract 418, Sullivan County
Census Tract 419, Sullivan County
Census Tract 420, Sullivan County
Census Tract 427.01, Sullivan County
Census Tract 430, Sullivan County
Census Tract 431, Sullivan County
Census Tract 45, Shelby County
Census Tract 48, Shelby County
Census Tract 5, Knox County
Census Tract 5, Shelby County
Census Tract 50, Shelby County
Census Tract 5001, Grainger County

Census Tract 5002, Grainger County
Census Tract 5003, Grainger County
Census Tract 5004, Grainger County
Census Tract 501, Lauderdale County
Census Tract 501, Marion County
Census Tract 502, Hawkins County
Census Tract 502, Lauderdale County
Census Tract 503, Lauderdale County
Census Tract 504, Lauderdale County
Census Tract 505.01, Lauderdale County
Census Tract 507, Hawkins County
Census Tract 508, Hawkins County
Census Tract 509, Hawkins County
Census Tract 51, Shelby County
Census Tract 56, Shelby County
Census Tract 58, Shelby County
Census Tract 59, Shelby County
Census Tract 6, Shelby County
Census Tract 60, Shelby County
Census Tract 601, Dickson County
Census Tract 602, Fayette County
Census Tract 602, Washington County
Census Tract 603, Dickson County
Census Tract 603, Fayette County
Census Tract 606, Fayette County
Census Tract 606, Loudon County
Census Tract 607, Dickson County
Census Tract 607, Loudon County
Census Tract 61, Shelby County
Census Tract 610, Washington County
Census Tract 619, Washington County
Census Tract 62, Shelby County
Census Tract 62.03, Knox County
Census Tract 68, Shelby County
Census Tract 69, Shelby County
Census Tract 7, Putnam County
Census Tract 70, Shelby County
Census Tract 701.02, Cheatham County
Census Tract 702, Jefferson County

Census Tract 704, Carter County
Census Tract 704, Jefferson County
Census Tract 705, Jefferson County
Census Tract 706, Carter County
Census Tract 706, Jefferson County
Census Tract 710, Carter County
Census Tract 711, Carter County
Census Tract 712, Carter County
Census Tract 713, Carter County
Census Tract 715, Carter County
Census Tract 716, Carter County
Census Tract 717, Carter County
Census Tract 78.22, Shelby County
Census Tract 79, Shelby County
Census Tract 8, Madison County
Census Tract 8, Shelby County
Census Tract 801, Sevier County
Census Tract 801, Unicoi County
Census Tract 802, Unicoi County
Census Tract 803, Sevier County
Census Tract 804, Unicoi County
Census Tract 806.01, Robertson County
Census Tract 81.10, Shelby County
Census Tract 82, Shelby County
Census Tract 89, Shelby County
Census Tract 9, Madison County
Census Tract 90, Shelby County
Census Tract 901, Greene County
Census Tract 906, Greene County
Census Tract 907, Greene County
Census Tract 908, Greene County
Census Tract 91, Shelby County
Census Tract 911, Greene County
Census Tract 912, Greene County
Census Tract 913, Greene County
Census Tract 915, Greene County
Census Tract 9501, Campbell County
Census Tract 9501, Hickman County
Census Tract 9501, Overton County

Census Tract 9502, Bedford County
Census Tract 9502, Campbell County
Census Tract 9502, Hickman County
Census Tract 9502, Polk County
Census Tract 9502, Wayne County
Census Tract 9503, Campbell County
Census Tract 9503, Hickman County
Census Tract 9503, Polk County
Census Tract 9504, Bedford County
Census Tract 9504, Campbell County
Census Tract 9504, Hickman County
Census Tract 9504, Polk County
Census Tract 9505, Bedford County
Census Tract 9505, Campbell County
Census Tract 9505, Hickman County
Census Tract 9506, Hardeman County
Census Tract 9506, Overton County
Census Tract 9507, Bedford County
Census Tract 9509, Campbell County
Census Tract 9510, Campbell County
Census Tract 9530, Bledsoe County
Census Tract 9532, Bledsoe County
Census Tract 9553, Marshall County
Census Tract 9561, Johnson County
Census Tract 9563, Johnson County
Census Tract 9564, Johnson County
Census Tract 9601, Franklin County
Census Tract 9601, Lake County
Census Tract 9601, Meigs County
Census Tract 9602, Cannon County
Census Tract 9602, Hancock County
Census Tract 9602, Lake County
Census Tract 9603, Franklin County
Census Tract 9603, Hancock County
Census Tract 9603, Meigs County
Census Tract 9604, Hancock County
Census Tract 9604, Jackson County
Census Tract 9605, Franklin County
Census Tract 9606, Franklin County

Census Tract 9606, Lawrence County
Census Tract 9607, Lawrence County
Census Tract 9609, Lawrence County
Census Tract 9610, Crockett County
Census Tract 9613, Crockett County
Census Tract 9620, Carroll County
Census Tract 9623, Carroll County
Census Tract 9624, Carroll County
Census Tract 9630, Benton County
Census Tract 9631, Benton County
Census Tract 9633, Benton County
Census Tract 9640, Dyer County
Census Tract 9643, Dyer County
Census Tract 9644, Dyer County
Census Tract 9645, Dyer County
Census Tract 9646, Dyer County
Census Tract 9647, Dyer County
Census Tract 9652, Obion County
Census Tract 9656, Obion County
Census Tract 9660, Gibson County
Census Tract 9661, Gibson County
Census Tract 9662, Gibson County
Census Tract 9669, Gibson County
Census Tract 9672, Gibson County
Census Tract 9673, Gibson County
Census Tract 9680, Weakley County
Census Tract 9687, Weakley County
Census Tract 9691, Henry County
Census Tract 9694, Henry County
Census Tract 9695, Henry County
Census Tract 9696, Henry County
Census Tract 9697, Henry County
Census Tract 9701, Chester County
Census Tract 9701, Coffee County
Census Tract 9701, Lewis County
Census Tract 9702, Claiborne County
Census Tract 9702, Macon County
Census Tract 9703, Chester County
Census Tract 9703, Cumberland County

Census Tract 9703, Macon County
Census Tract 9704, Claiborne County
Census Tract 9704, Macon County
Census Tract 9705, Claiborne County
Census Tract 9705, Cumberland County
Census Tract 9705, McMinn County
Census Tract 9707, Coffee County
Census Tract 9708, Claiborne County
Census Tract 9708, Cumberland County
Census Tract 9750, Lincoln County
Census Tract 9750, Rhea County
Census Tract 9750, Scott County
Census Tract 9750, Smith County
Census Tract 9751, Lincoln County
Census Tract 9751, Rhea County
Census Tract 9753, Smith County
Census Tract 9754, Henderson County
Census Tract 9754, Lincoln County
Census Tract 9754, Scott County
Census Tract 9755, Henderson County
Census Tract 98, Shelby County
Census Tract 9801, Cocke County
Census Tract 9801, Hardin County
Census Tract 9801, Haywood County
Census Tract 9802, Cocke County
Census Tract 9802, DeKalb County
Census Tract 9802, Hardin County
Census Tract 9803, Giles County
Census Tract 9804, Hardin County
Census Tract 9805, Giles County
Census Tract 9805, Hardin County
Census Tract 9806, Giles County
Census Tract 9807, Giles County
Census Tract 9808, Haywood County
Census Tract 9850, Van Buren County
Census Tract 9852, Monroe County
Census Tract 9852, Van Buren County
Census Tract 9855, Monroe County
Census Tract 9901, Moore County

Census Tract 9901, Warren County
Census Tract 9902, McNairy County
Census Tract 9902, Perry County
Census Tract 9903, McNairy County
Census Tract 9903, Warren County
Census Tract 9904, McNairy County
Census Tract 9906, McNairy County
Census Tract 9906, Warren County
Census Tract 9907, McNairy County
Census Tract 9909, Warren County
Census Tract 9952, White County
Census Tract 9954, White County
Census Tract 9955, White County
Total 358

Figure 5-4. Census Tracts with "High Risk" of Fire Mortality (N= 199)

Census Tract 1, Hamilton County
Census Tract 1, Putnam County
Census Tract 100, Shelby County
Census Tract 1001, Montgomery County
Census Tract 1004, Montgomery County
Census Tract 1008, Hamblen County
Census Tract 1008, Montgomery County
Census Tract 1009, Montgomery County
Census Tract 1010.01, Montgomery County
Census Tract 102.20, Shelby County
Census Tract 103, Bradley County
Census Tract 103, Shelby County
Census Tract 104.02, Davidson County
Census Tract 104.20, Shelby County
Census Tract 105, Shelby County
Census Tract 106.20, Shelby County
Census Tract 106.30, Shelby County
Census Tract 107.01, Davidson County
Census Tract 107.02, Davidson County
Census Tract 108, Blount County
Census Tract 109, Shelby County
Census Tract 11, Madison County
Census Tract 110.01, Davidson County
Census Tract 110.10, Shelby County

Census Tract 110.20, Shelby County
Census Tract 1101, Morgan County
Census Tract 113, Davidson County
Census Tract 114, Davidson County
Census Tract 115, Hamilton County
Census Tract 118, Davidson County
Census Tract 119, Davidson County
Census Tract 12, Knox County
Census Tract 12, Shelby County
Census Tract 1202, Houston County
Census Tract 124, Davidson County
Census Tract 126, Davidson County
Census Tract 13, Shelby County
Census Tract 138, Davidson County
Census Tract 14, Knox County
Census Tract 14, Shelby County
Census Tract 143, Davidson County
Census Tract 148, Davidson County
Census Tract 16, Hamilton County
Census Tract 161, Davidson County
Census Tract 173, Davidson County
Census Tract 18, Shelby County
Census Tract 19, Hamilton County
Census Tract 19, Shelby County
Census Tract 190.01, Davidson County
Census Tract 2, Hamilton County
Census Tract 20, Knox County
Census Tract 20, Shelby County
Census Tract 205, Anderson County
Census Tract 205.21, Shelby County
Census Tract 205.22, Shelby County
Census Tract 207, Anderson County
Census Tract 208, Anderson County
Census Tract 208, Sumner County
Census Tract 21, Knox County
Census Tract 21, Shelby County
Census Tract 217.10, Shelby County
Census Tract 217.23, Shelby County
Census Tract 217.31, Shelby County
Census Tract 219, Shelby County
Census Tract 221.11, Shelby County
Census Tract 222.10, Shelby County

Census Tract 224.21, Shelby County
Census Tract 23, Hamilton County
Census Tract 24, Hamilton County
Census Tract 24, Knox County
Census Tract 24, Shelby County
Census Tract 26, Hamilton County
Census Tract 28, Knox County
Census Tract 3, Hamilton County
Census Tract 3, Shelby County
Census Tract 307, Wilson County
Census Tract 39, Shelby County
Census Tract 40, Shelby County
Census Tract 402, Sullivan County
Census Tract 402.01, Union County
Census Tract 405, Sullivan County
Census Tract 406, Sullivan County
Census Tract 41, Shelby County
Census Tract 418, Rutherford County
Census Tract 418, Sullivan County
Census Tract 431, Sullivan County
Census Tract 45, Shelby County
Census Tract 48, Shelby County
Census Tract 5, Knox County
Census Tract 5, Shelby County
Census Tract 50, Shelby County
Census Tract 5003, Grainger County
Census Tract 5004, Grainger County
Census Tract 501, Lauderdale County
Census Tract 502, Hawkins County
Census Tract 502, Lauderdale County
Census Tract 509, Hawkins County
Census Tract 51, Shelby County
Census Tract 56, Shelby County
Census Tract 58, Shelby County
Census Tract 59, Shelby County
Census Tract 6, Shelby County
Census Tract 60, Shelby County
Census Tract 603, Fayette County
Census Tract 607, Loudon County
Census Tract 61, Shelby County
Census Tract 610, Washington County
Census Tract 62, Shelby County

Census Tract 68, Shelby County
Census Tract 69, Shelby County
Census Tract 7, Putnam County
Census Tract 70, Shelby County
Census Tract 702, Jefferson County
Census Tract 704, Carter County
Census Tract 710, Carter County
Census Tract 712, Carter County
Census Tract 713, Carter County
Census Tract 715, Carter County
Census Tract 716, Carter County
Census Tract 717, Carter County
Census Tract 78.22, Shelby County
Census Tract 79, Shelby County
Census Tract 8, Madison County
Census Tract 8, Shelby County
Census Tract 801, Unicoi County
Census Tract 81.10, Shelby County
Census Tract 82, Shelby County
Census Tract 89, Shelby County
Census Tract 9, Madison County
Census Tract 90, Shelby County
Census Tract 901, Greene County
Census Tract 907, Greene County
Census Tract 912, Greene County
Census Tract 913, Greene County
Census Tract 915, Greene County
Census Tract 9501, Campbell County
Census Tract 9502, Campbell County
Census Tract 9502, Polk County
Census Tract 9503, Hickman County
Census Tract 9504, Bedford County
Census Tract 9505, Bedford County
Census Tract 9506, Hardeman County
Census Tract 9506, Overton County
Census Tract 9509, Campbell County
Census Tract 9510, Campbell County
Census Tract 9530, Bledsoe County
Census Tract 9532, Bledsoe County
Census Tract 9553, Marshall County
Census Tract 9561, Johnson County
Census Tract 9563, Johnson County

Census Tract 9564, Johnson County
Census Tract 9601, Franklin County
Census Tract 9601, Lake County
Census Tract 9601, Meigs County
Census Tract 9602, Hancock County
Census Tract 9602, Lake County
Census Tract 9603, Hancock County
Census Tract 9603, Meigs County
Census Tract 9604, Hancock County
Census Tract 9606, Franklin County
Census Tract 9606, Lawrence County
Census Tract 9613, Crockett County
Census Tract 9620, Carroll County
Census Tract 9623, Carroll County
Census Tract 9624, Carroll County
Census Tract 9633, Benton County
Census Tract 9643, Dyer County
Census Tract 9644, Dyer County
Census Tract 9656, Obion County
Census Tract 9660, Gibson County
Census Tract 9669, Gibson County
Census Tract 9673, Gibson County
Census Tract 9687, Weakley County
Census Tract 9694, Henry County
Census Tract 9703, Cumberland County
Census Tract 9703, Macon County
Census Tract 9704, Claiborne County
Census Tract 9704, Macon County
Census Tract 9705, Claiborne County
Census Tract 9705, Cumberland County
Census Tract 9705, McMinn County
Census Tract 9708, Claiborne County
Census Tract 9750, Rhea County
Census Tract 9750, Scott County
Census Tract 9754, Henderson County
Census Tract 9754, Scott County
Census Tract 98, Shelby County
Census Tract 9801, Haywood County
Census Tract 9802, Cocke County
Census Tract 9802, DeKalb County
Census Tract 9802, Hardin County
Census Tract 9804, Hardin County

Census Tract 9808, Haywood County
Census Tract 9852, Monroe County
Census Tract 9852, Van Buren County
Census Tract 9902, McNairy County
Census Tract 9903, McNairy County
Census Tract 9909, Warren County
Census Tract 9954, White County
Total = 199

Figure 5-5. Census Tracts with the "Highest Risk" of Fire Mortality (N=78)

Census Tract 1, Putnam County
Census Tract 1008, Hamblen County
Census Tract 1009, Montgomery County
Census Tract 103, Bradley County
Census Tract 110.01, Davidson County
Census Tract 110.10, Shelby County
Census Tract 1101, Morgan County
Census Tract 14, Shelby County
Census Tract 207, Anderson County
Census Tract 208, Anderson County
Census Tract 208, Sumner County
Census Tract 402.01, Union County
Census Tract 431, Sullivan County
Census Tract 5003, Grainger County
Census Tract 5004, Grainger County
Census Tract 501, Lauderdale County
Census Tract 502, Hawkins County
Census Tract 509, Hawkins County
Census Tract 603, Fayette County
Census Tract 607, Loudon County
Census Tract 702, Jefferson County
Census Tract 710, Carter County
Census Tract 712, Carter County
Census Tract 713, Carter County
Census Tract 715, Carter County
Census Tract 716, Carter County
Census Tract 717, Carter County
Census Tract 801, Unicoi County

Census Tract 901, Greene County
Census Tract 907, Greene County
Census Tract 912, Greene County
Census Tract 913, Greene County
Census Tract 9501, Campbell County
Census Tract 9502, Campbell County
Census Tract 9502, Polk County
Census Tract 9503, Hickman County
Census Tract 9504, Bedford County
Census Tract 9505, Bedford County
Census Tract 9506, Hardeman County
Census Tract 9506, Overton County
Census Tract 9509, Campbell County
Census Tract 9510, Campbell County
Census Tract 9532, Bledsoe County
Census Tract 9561, Johnson County
Census Tract 9563, Johnson County
Census Tract 9564, Johnson County
Census Tract 9601, Franklin County
Census Tract 9602, Hancock County
Census Tract 9603, Hancock County
Census Tract 9603, Meigs County
Census Tract 9604, Hancock County
Census Tract 9606, Lawrence County
Census Tract 9620, Carroll County
Census Tract 9623, Carroll County
Census Tract 9624, Carroll County
Census Tract 9660, Gibson County
Census Tract 9669, Gibson County
Census Tract 9673, Gibson County
Census Tract 9687, Weakley County
Census Tract 9703, Cumberland County
Census Tract 9703, Macon County
Census Tract 9704, Claiborne County
Census Tract 9704, Macon County
Census Tract 9705, Claiborne County
Census Tract 9705, McMinn County
Census Tract 9708, Claiborne County
Census Tract 9750, Rhea County

Census Tract 9750, Scott County
Census Tract 9754, Henderson County
Census Tract 9754, Scott County
Census Tract 9801, Haywood County
Census Tract 9802, Cocke County
Census Tract 9802, Hardin County
Census Tract 9808, Haywood County
Census Tract 9852, Van Buren County
Census Tract 9902, McNairy County
Census Tract 9903, McNairy County
Census Tract 9909, Warren County
Total = 78

Figures 5-6, 5-7, and 5-8 show the census tracts in the above average, high and highest risk groups, respectively. Links to more detailed versions of these maps are found in Appendix B.

Figure 5-6. Census Tracts with "Above Average" Risk for Fire Mortalities (N=358)

Figure 5-7. Census Tracts with "High" Risk for Fire Mortalities (N=199)

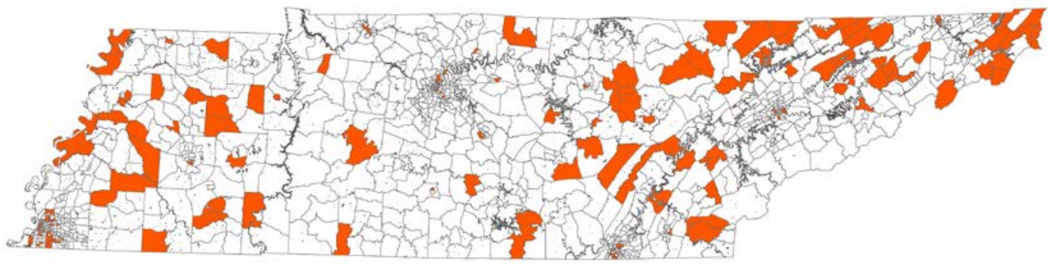
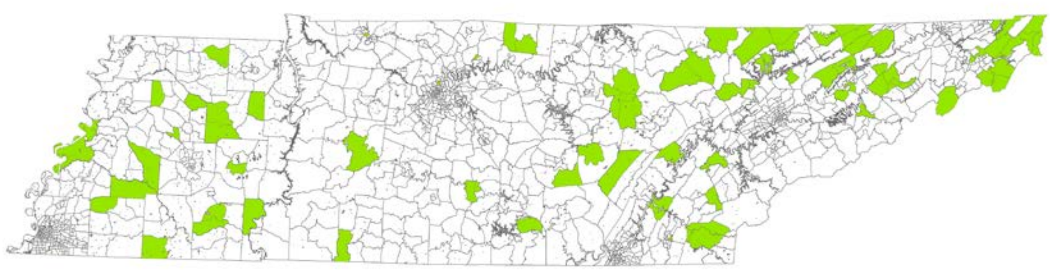


Figure 5-8. Census Tracts with "Highest" Risk for Fire Mortalities (N=78)



The urban/rural status and the fire protection classification of the census tracts in each of the three fire mortality risk groups are summarized in **Figure 5-9**. The total number of census tracts with an above average risk (358) includes those that were identified as having high or highest levels of fire mortality risk. Consequently, the "above average" group represents the largest group of census tracts at-risk of a fire mortality based on the historical pattern of where home fire deaths previously occurred. Among this group, 62.3 percent of the census tracts are rural and 37.7 percent are urban. The vast majority of the urban census tracts with an "above average" mortality risk are located in cities that provide the highest level of fire protection. The vast majority of the rural census tracts in this group are located in areas that provide a low level of fire protection or are unprotected altogether.

Figure 5-9. Key Features of Census Tracts by Fire Mortality Risk Category

Risk Category	**Urban/Rural Status**				**Fire Protection Classification**										Totals
	Urban		**Rural**		**1 High**		**1.5 Moderate Plus**		**2.0 Moderate**		**3.0 Low**		**4.0 Unprotected**		
	N	%	N	&	N	%	N	%	N	%	N	%	N	%	N
Above Average	135	37.7	223	62.3	119	33.3	11	3.1	31	8.7	159	44.5	37	10.4	358
High	106	53.3	93	46.7	101	50.8	7	3.5	14	7.0	65	32.7	12	6.0	199
Highest	8	10.3	70	89.7	7	9.0	2	2.6	9	11.5	52	66.7	8	10.3	78

There are 199 census tracts in the "high" mortality risk category. This group has a more balanced division of urban (53.3%) and rural tracts (46.7%). Almost all of the urban census tracts (101 of 106) are located in cities that provide a "high" level of fire protection. Likewise, more than 80% of the rural census tracts provide a have a low or an unprotected fire protection classification.

Finally, there are 78 census tracts in the highest risk group for fire mortalities. Again, these are the census tracts that did not record any fire mortalities during the 2002-2010 but are most like those that recorded fire mortalities with respect to several key social, economic and housing features. Almost 90% of these tracts are rural. More than three-fourths are located in unincorporated areas that provide low or no fire protection.

The value of this risk assessment for census tracts with respect to fire mortalities is that it provides state and local officials with a systematic means for identifying where resources for public education on fire safety and prevention might be targeted for the greatest effect. It is based on the assumption that using populations with similar profiles on key factors is a reasonable basis to identify those residents that are most vulnerable to or at highest risk for home fire mortalities.

This risk assessment method is not a means for *predicting* the precise location of any particular fatal fire. The 358 tracts classified by risk here comprise the tracts that are most like the 389 census tracts where home fire deaths have already occurred with respect to key social, economic, and housing features. The similarities among the tract groups should be construed to suggest that fatal fires could occur in any tract in any group. Likewise, it is possible that a home fire death *could* occur in any of the remaining 514 census tracts that did not have a fire fatality during the study period. People are mobile; they move, travel and interact socially. Not all victims of fatal fires perish in their own place of residence and not all residents of these tracts have attributes that exceed the means that have been used as cut-points in this study. *Anyone* could be a victim of a residential fire; all it takes is the right combination of carelessness, ignorance, or misfortune to create the circumstances in which virtually any home, in any census tract, could be the locus for a home fire tragedy.

Explaining Variation in Fire Mortality Rates

To what extent can intervention by state and local officials be expected to result in a reduction of residential fire mortalities in Tennessee? If, for instance, variation in the rate of fire mortalities is mainly explained by differences in the social, economic, demographic and housing features among census tracts, then efforts by state and local officials are unlikely to bear much fruit in terms of substantially reducing the incidence of home fire fatalities since there is little government can do to alter the socioeconomic status (SES) features of a census tract. On the other hand, if such environmental factors explain a relatively small proportion of the difference in mortality rates, then there is a much stronger case to be made that government intervention could make a big difference. The challenge for public officials then is to figure out what kinds of intervention are likely to be effective in reducing fire mortalities.

Based on the extensive census data collected for this study, we are able to identify with precision the extent to which several features in the census tract environments account for some of the difference in home fire mortalities among census districts. These analyses show that only a relatively small proportion of the variation in the rate of fire mortalities is explained by these census variables. It is unusual that a small explained variation in a model is reason for optimism, but such is the case in this study. That various social, demographic, economic and housing variables help to explain only a small proportion of the variation in mortality rates means that other factors may help to explain and account for these differences. These other factors may involve various ways that public and private sector actors can intervene to reduce fire deaths.

There are several variables identified in the literature and by the state's fire chiefs that may have a significant impact on reducing or preventing residential fire deaths. We would have preferred to have much more information and data on all of them, for all communities, to include in this analysis. However, while some of these data exist, they are not yet in a form that can be easily accessed and linked to geographic units such as census tracts or fire department service areas. These include factors such as::

- what kind of codes enforcement/inspection regimes exist in each jurisdiction?
- who and how many residents in each jurisdiction have and maintain a sufficient number of smoke detectors/alarms in their homes?
- what is the "effective age" (as well as actual age) of all of the structures in which a residential fire fatality has occurred and how does that that differ from the jurisdiction's (or census tract's) mean for structures' effective age and how do the effective age means vary across jurisdictions?

- what types of strategies, policies, and actions for public education and community outreach with respect to fire prevention and fire safety have local fire departments pursued?

The Insurance Services Office (ISO) produces an assessment of municipal efforts to adopt and enforce building codes. It is called the Building Code Effectiveness Grading Schedule (BCEGS) and it is the only known method capable of comparing communities on this important dimension that has so much potential impact on the incidence of fires and fire deaths. These assessments however do not include county code adoption and enforcement efforts. To date, the ISO data includes relatively few cities in the state.

Surveys can measure the extent to which residents in a state have and maintain smoke detectors in their homes, but these data are not available at the municipal or county level. This information that would be required to analyze mortality rates among these units of analysis. Data on the “effective” age of structures are maintained by the Comptroller of the Treasury for 88 of the state’s 95 counties but seven counties maintain separate data bases. It may be possible for future research to include a mean “effective age” variable for all residential structures in each census tract in at least 88 counties.

Finally, the survey of Tennessee fire chiefs attempted to measure the types of strategies, policies, and actions employed for public education and community outreach efforts with respect to fire prevention and fire safety. The low response rate, however, means that these data are only available for a small proportion of the state’s fire departments.

Limited by these data constraints, the analyses in the following sections present two basic types of models. The first group of models measures the effects primarily of the census variables in helping to explain variation in the dependent variable which is the annual average rate of fire mortalities per million population among all, urban, and rural census tracts, respectively. The second type of model also examines variation in the rate of residential fire mortalities, but the unit of analysis in this model is the fire department. We pursue this strategy to ascertain whether there is any evidence that the presence of certain conditions such as the extent of code enforcement and the use of particular public outreach and education strategies may help to in explain differences in the average annual rate of fire mortalities among the state’s fire departments during the 2002-2010 study period.

Socioeconomic Factors and Fire Mortality Rates Among Census Tracts

Figure 5-10 displays regression models for three groups of census tracts (all, urban, and rural). For each model, we included the fire protection classification of the census tracts and the social, economic, housing, or demographic census variables that previous research suggested were important for explaining differences in mortality rates and which also distinguished those tracts with statistically higher or lower mean levels of fire fatalities based on our analyses of census tracts.

The most salient finding from these models is that each explains a relatively small proportion of the variation in fire fatality rates. This suggests that there are a number of factors that the public and private sectors may pursue that could have a significant impact on reducing the rate of fire mortalities in Tennessee. In other words, only a relatively small proportion of the variation in fire mortality rates is explained by factors that are endemic characteristics of the tracts themselves. In addition, most of the socioeconomic and housing variables have a statistically significant independent effect in explaining variation in fire mortality rates in the expected or hypothesized direction.

The effect of fire protection class on the rate of fire mortalities among census tracts appears counter-intuitive since the negative coefficient indicates that tracts with lower levels of protection (a higher value) have lower fire mortality rates. However, an examination of the mean census tract mortality rates by fire protection class helps to explain why the relationship is the opposite of what one would hypothesize. Tracts with a “high” level of fire protection have a mean mortality rate of 11.85/mill.; tracts with a “moderate plus” protection level have a mean mortality rate of 11.94/mill.; tracts with “moderate” protection have a mean of 21.69/mill. mortality rate; tracts in the “low” fire protection group have a mean of 10.4/mill, and “unprotected” tracts have a fire mortality rate of 6.56/mill. That the mean fire fatality rates are generally lower among the “low” and “unprotected” tracts is what drives the negative sign of the coefficient. There are simply a large number of tracts with a low level of fire protection (N=405) or no fire protection (N=61) that had few, if any, fire mortalities during the study period. These tracts typically have fewer residents and low population densities. They also have been fortunate. This relationship is mainly being produced by the larger number of rural census tracts that have little variation in their level of fire protection. Most have either a low (3) or unprotected (4) fire protection classification.

Among all tracts, fire moralities rates are generally higher among rural tracts (mean = 13.05/mill.) than among urban census tracts (11.5/mill). The SOC29 variable represents the percent of the tract population that have bachelor’s degrees or higher. The negative sign of the coefficient means that as the proportion of residents with a bachelor’s degree or higher increases, the fire mortality rate decreases indicating that residents with higher educational attainment generally are not as likely to perish in home fires.

Two housing variables also have a statistically significant effect in the expected direction on mortality rates. The key effects include the following:

- The larger the proportion of mobile homes as a proportion of the housing stock, the higher the residential fire fatality rate.
- The larger the proportion of the housing stock comprised of structures of less than $50,000 in value, the higher the fire fatality rate.

Figure 5-10. Explaining Variation in the Fire Fatality Rate per mill. in All, Urban, and Rural Census Tracts

	Model #1 All Census Tracts (N=1230) R^2= .071			Model #2 Urban Census Tracts (N=552) R^2= .082			Model #3 Rural Census Tracts (N=667) R^2= .097		
Variable	Unstand. Coeff.	Stand. Coeff.	t	Unstand. Coeff.	Stand. Coeff.	t	Unstand . Coeff.	Stand. Coeff.	t
(Constant)	6.401		1.425	8.140		1.236	38.320		5.592
Fire Protection Class	-6.507	-.235	-4.923	.535	.007	.151	-8.141	-.247	-6.217
Urban/ Rural	6.618	.122	2.558						
SOC29 (% w/ bach. degree or higher)	-.203	-.119	-2.254						
HO11 (% mobile homes)	.260	.111	2.519	.528	.093	2.004	.269	.122	2.780
HO48 (% housing units < $50K)	.224	.107	2.635	.289	.144	2.567			
HO63 (median home value)	.00002997	.081	1.697	.000045	.140	2.022			
HO60 (% units $500K - $1 mill value)							-.308	-.044	-1.084
HO65 (gross rent)							-.016	-.139	-2.769
DEMO5 (% < 5 yrs old)				-.723	-.081	-1.900			
DEMO15 (% Black)				.079	.089	1.511			
ECON5 (% unemploye d				.355	.056	1.003			
ECON6 (Median hh income)				.000	-.148	-2.069			
ECON9 (% below poverty level)	.185	.090	2.261				.181	.061	1.355

Finally, among all census tracts, the economic variable that had a statistically significant impact on fire mortality rates controlling for all of the other effects in the model was the percent of families and people with incomes below the poverty level. The higher this proportion, the higher the rate of fire mortalities.

Among urban census tracts, the variables in the model explained just over eight percent of the variation in fire mortality rates. The statistically significant census variables that helped to explain variation in fire mortality rates included the percentage of the housing stock comprised of mobile homes, the proportion of the housing stock with structures that value less than $50,000, and the median housing value. The economic variable that attained statistical significance in the model was median household income. The higher the median income, the lower the rate of fire mortalities. Conversely, the lower the median income, the higher the fire mortality rate.

Among rural census tracts, the variables in the model explained just under ten percent of the variation in fire mortality rates. Among rural tracts, key variables of import were the proportion of the housing stock comprised of mobile homes and HO65, the median gross rent variable. The higher the proportion of the housing stock comprised of mobile homes, the higher the residential fire mortality rate. The lower the median gross rent, the higher the fire mortality rate in the census tract.

In sum, the census tracts with higher fire mortality rates tended to:

- be rural rather than urban,
- have a smaller proportion of residents who had attained a bachelor's degree or higher,
- have a larger proportion of their housing stock comprised of mobile homes,
- have a larger proportion of the housing stock comprised of units with a value of less than $50,000, and
- have a larger proportion of residents whose income was below the federal poverty level.

Public Policies, Strategies, and Fire Mortality Rates Among Tennessee Fire Departments

Despite the absence of data available on the level of code enforcement among Tennessee communities and the limits inherent in generalizing from survey results that represent a minority of fire chiefs, the study team nonetheless wanted to explore any evidence that might suggest some potential for a particular public policy or public education effort to affect the incidence of residential fire deaths. To advance this effort, we examined the responses of the fire chiefs and noted the nature of the relationship between several of their responses and the mean annual mortality rate as calculated for each of the fire departments in the state.

Even though there were fewer than 100 responses from the fire chiefs, we regressed mortality rates on the chiefs' responses to five survey items. These items asked the chiefs to rate the general level of code enforcement in their community during the study period, to indicate whether their department had a designated staff person assigned the responsibility to conduct fire safety and prevention education in the community, whether the department distributed/installed smoke alarms in the community during 2009-2010, and whether the department engaged in two types of education activities during 2009-2010.

Considering the small number of cases in the model (N=74) in **Figure 5-11**, it is remarkable that any of the variables proved to be statistically significant. It is even more noteworthy that the five variables in this model of fire mortality rates among fire departments explain more than twice the amount of variation in fire mortality rates as any of the models for the census tracts.

Figure 5-11. Potential Policies and Strategies for Reducing the Rate of Fire Fatalities Among Tennessee Fire Departments (N=74, R^2 = .205).

	Unstand. Coeff.	Standardized Coefficients		
	B	Beta	t	Sig.
(Constant)	133.320		3.307	.002
Rating of the Level of Code Enforcement in Community 2002-2010: (1) Very poor (2) Poor (3) Fair (4) Good (5) Excellent	-2.100	-.055	-.454	.651
Staff has assigned responsibility to conduct fire safety, prevention education position: (1) No (2) Yes	-32.980	-.368	-2.797	.007
Distribution/installation of Smoke Alarms-Performed during 2009 or 2010? (1) Yes (2) No	19.019	.197	1.681	.097
FD conducted Fire Safety presentations/demonstrations to school-age children-during 2009 or 2010: (1) Yes (2) No	-51.201	-.397	-3.181	.002
Provided fire safety training to professional care givers to the elderly or disabled-Performed during 2009 or 2010? (1) Yes (2) No	-9.065	-.101	-.892	.375

Three variables have an impact in the expected direction on fire mortality rates. These include whether the department has a designated person on the staff with the assigned responsibility to conduct fire safety and prevention education in the community, the chiefs rating of the code enforcement effort, and whether the fire department engaged in a smoke alarm distribution/installation program. Perhaps the most interesting finding is that the fire mortality rate is significantly lower in those communities served by a fire department that has a designated staff to perform fire safety and prevention education. This finding indicates that there is measurable value in having someone on staff charged with and able to perform community education and outreach activities. Although not statistically significant, the direction of the relationship between the fire chiefs' rating of the level of codes enforcement and the fire mortality rate indicates that rates tend to be lower in those communities where the fire chiefs rates code enforcement more highly.

The relationship between those fire departments that did not distribute or install smoke alarms in the community and fire fatality rates is statistically significant at the .10 level. The communities that did not engage in this activity during 2009-2010 had higher fire mortality rates. Conversely, those that did perform this activity had lower fire morality rates.
That only a handful of fire departments whose chiefs responded to the survey did not conduct fire safety presentations and demonstrations to school-age children during 2009-2010 and that all except one of these departments had no fatalities explains the unexpected negative sign for this variable.

That this model suggests even modest evidence that fire fatality rates can be affected by the level of codes enforcement (perceived) and by having a departmental staff assigned the responsibilities for conducting fire safety education and prevention bodes well for the prospect that future comparisons of these efforts, among a larger sample of fire departments, may yield a more complete picture of the relative effectiveness of strategies for reducing fire fatalities.

Chapter 6. Summary and Implications of Findings

While fire deaths declined nationally during the last 25 years, Tennessee's fire mortality rate has consistently been among the nation's highest since the US Fire Administration began collecting these data. This study examined the nature, extent and causes of civilian residential fire fatalities in Tennessee between 2002 and 2010 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 developing a strategic plan of action to reduce and prevent civilian deaths in residential fires.

The study found that most civilian residential deaths occurred in the state's largest cities but that residents of rural areas and smaller communities actually experienced higher rates of fire mortality. Residential fires in which several individuals perished occurred more frequently in Tennessee compared to the nation. The increase in multiple fire death incidents in urban areas was a principal reason why the state's 2010 mortality rate spiked while the national rate trended downward.

The analyses of fire incident data indicated that the most common heat source for fatal residential fires in Tennessee was operating equipment. This included HVAC and kitchen and cooking equipment that involved heating and electrical malfunctions (short circuits, arcing, and the like). Smoking related causes for fatal fires are more prevalent in Tennessee in the nation. The number of deaths in 2010 attributed to smoking-related causes increased. This outcome indicated that the state's fire safe cigarette legislation appears to have had no impact, at least so far, on reducing the incidence of smoking related fire deaths.

The state's fire incident reports indicated that smoke alarms were present in only 28 percent of cases during the study period. By contrast, smoke alarms were present in about 38 percent of fatal fires nationally suggesting that more lives might be saved if smoke alarms were more widely employed and maintained by Tennessee households. Similar to the national profile of those who have died in home fires, Tennessee fire victims tend to be disproportionately very young, very old, and minorities. Members of each of these groups die in fatal fires in proportions that exceed their size in the population.

There are 715 fire departments in Tennessee, 306 that serve cities, 391 that serve some or all of a county outside of an incorporated city, and 18 that serve both a city and county. Less than five percent of these fire departments are classified as "career." About 16 percent are classified as a combination of "career" and "volunteer" but most fire departments (79.3 percent) are "volunteer." Just over half of Tennessee residents enjoy one of the two highest levels of fire protection but more than 30 percent have low or no fire protection service. The level of fire protection provided matters a great deal. Those departments that provide high or moderate plus service levels respond more quickly to fire calls and the populations they serve have lower rates of fire mortality.

The fire chiefs who responded to the statewide survey thought that the top four strategies to prevent and reduce residential fire deaths were (1) smoke alarm distribution and installation, (2) having home sprinkler systems, (3) enforcing applicable codes and (4) presenting fire safety demonstrations and instruction at local schools. In open-ended comments, most fire chiefs thought that the single best approach to reducing fire deaths was to ensure that all structures, residences included, have working smoke/fire alarms. More widespread and regular smoke detector distribution efforts, battery replacement programs, and annual testing, inspection, and installation programs were all suggested to ensure that every residence has an adequate number of working smoke detectors.

The analysis of mortality rates in the state's 1261 populated census tracts indicated that several social, economic and housing variables distinguished those tracts with residential fire deaths. These included educational variables, median household income and persons living in poverty, and the percentage of mobile homes of the housing stock and the median value of the housing units. These variables were used to identify the census tracts (without fire deaths) that were most like those tracts where fire deaths had occurred during 2002-2010. This analysis yielded 358 census tracts rated as having an "above average" risk for fire fatalities, 199 tracts with "high" risk and 78 tracts with the "highest' risk for fire fatalities.

The value of risk assessment for census tracts is that it provides state and local officials with a systematic means for identifying where resources for public education on fire safety and prevention might be targeted for the greatest effect. It is based on the assumption that comparing population characteristics is a reasonable means for identifying residents who are most vulnerable to or at highest risk for home fire mortalities. In other words, the population characteristics that distinguish those tracts that had fire mortalities during the 2002-2010 period are also likely to be prominent in the tracts that may have a higher risk of fire fatalities but did not have fire deaths during the study period.

This risk assessment of census tracts is not a means for *predicting* the precise location of any particular fatal fire. The 358 tracts classified by risk here comprise the tracts that are most like the 389 census tracts where home fire deaths have already occurred with respect to key social, economic, and housing features. The similarities among the tract groups suggest that fatal fires could occur in any of these 747 census tracts. Likewise, it is possible that a home fire death *could* occur in any of the remaining 514 census tracts that did not have a fire fatality during the study period. People are mobile; they move, travel and interact socially. Carelessness, ignorance, and misfortune are not confined within or by census tract boundaries. Nonetheless, the 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 census variables explained only small proportions of the variation in mortality rates indicating that there may be significant potential for various types of policy interventions to prevent/reduce home fire deaths. A model of fire mortality rates among fire departments based on the fire chiefs survey responses indicated that several policies/practices may have potential for reducing fire mortalities. These included having a staff person in the department assigned the responsibility to provide fire safety and prevention education, enhancing the level of code enforcement in the community, and participating in smoke alarm distribution/installation programs.

In partnership with key stakeholders, the State Fire Marshall's Office has begun the process of developing a strategic action plan to implement the system, policy, procedural, technical, and staffing changes necessary to coordinate and implement a comprehensive approach to preventing and reducing fire mortalities in Tennessee. These include the following actions:

- The Tennessee State Fire Marshal's Office will assign a staff person internally to coordinate information on the fire death problem. This individual will be responsible for coordination of TSFMO internal efforts between all Sections. This person also will track all media reported fires, conduct death certificate validation, and use other means to assure events are captured.

- The TFIRS Coordinator will review all structure fires for accuracy and information (especially to fire cause and contributing factors). A plan will be developed to include a data collection item for "age of structure" in the structure module.

- Training of fire department personnel will continue as needed with respect to how to fill out and complete TFIRS reports. This training currently is provided to fire chiefs, but it also should be targeted to those individuals who actually fill out the reports. A training session video will be developed by the fire academy and made available.

- The TSFMO will work with local officials by providing a follow-up by investigators from the Bomb & Arson Section when needed. All incomplete fire reports involving a fire death will include follow up from a state investigator. A challenging scenario concerns those cases that involve transportation of victims to a burn center. Developing a close working relationship with the state's burn facilities is a priority.

- State fire code inspectors will work closely with investigators in order to identify and implement those measures identified by research as having potential to prevent fires and fire deaths.

- The Bomb and Arson section will continue to work with both the Fire Academy and Police Academy in training investigators.

- Possible links between TFIRS and the property assessment data files will be investigated.

Hall (2011) reported that the total cost of fire in the US in 2008, where total fire costs are defined as the combination of the losses caused by fire and the money spent on fire prevention, protection and mitigation to prevent worse losses, was estimated to be about $362 billion or 2.5% of U.S. gross domestic product. The direct and indirect costs associated with civilian fire deaths and injuries are staggering in several different ways and on several different levels.

The loss or impairment of family members is devastating in itself for the affected families, but the costs of these incidents extend far beyond the family unit. The loss of a main bread-winner 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 appears to be 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 *some* fatalities that occur 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. That so many Tennessee homes involved in a fatal fire incident have no smoke alarm or no operable smoke detector means that occupants may already have succumbed to smoke inhalation, perhaps in their sleep, before any call goes out for emergency assistance. More needs to be done to educate residents about, and to incentivize the use of smoke detectors and the critical, potentially life-saving minutes they provide to members of the most vulnerable groups.

Tennessee is blessed with a very talented and dedicated cadre of professionals in a variety of fields related to fire management, public safety, and building construction. The strategic action plan being developed by the State Fire Marshall's Office in conjunction with key stakeholders represents an important first stage in what must be a continuing, comprehensive, and coordinated effort by fire management professionals to attack the fire mortality problem in Tennessee. This sustained team effort will make it possible to transform the state's notoriety from one distinguished by a high fire death rate to one recognized as being in the vanguard of preventing fire fatalities and saving lives.

Appendix A
Annotated Bibliography

Scope of the Problem:

Ahrens, M. (2007). Trends and patterns of U. S. fire losses*.* National Fire Protection Association. Quincy, MA. Found at: http://www.nfpa.org/assets/files//PDF/OS.firelosstrends.pdf

Projections from the National Fire Protection Associations's annual fire department experience data reported in Michael Karter's annual reports *on U.S. Fire Loss*, *particularly U.S. Fire Loss during 2006*, are summarized in this analysis. Reported fires and fire deaths have fallen since 1977, the first year of available data. The drop in population-based rates is even sharper. In 2006, home structure fires accounted for 24% of the reported fires. However, these incidents caused 80% of all civilian fire deaths. Vehicle fires accounted for 17% of the reported fires and 15% of the civilian fire deaths. Roughly half of the reported fires were outside or other non-structure, non-vehicle fires.

Aherns, M. (2008). Home smoke alarms: The data as context for decision. *Fire Technology, 44,* 313–327.

Considerable attention has been devoted to how home smoke alarms could be more effective at preventing fire deaths. The death rate per 100 reported home fires is half as high in homes with working smoke alarms compared to homes without this protection. This paper summarizes what is known about the performance and effectiveness of home smoke alarms and of victim characteristics in home fires with and without operating smoke alarms based on statistical analysis of actual fire experience data. Special studies on other factors affecting smoke alarm performance, audibility, and nuisance alarms are also discussed. The paper also identifies several questions that cannot, at present, be conclusively addressed.

In 2000–2004, an average of 1,020 people per year (34% of the home structure fire fatalities) died in homes with working smoke alarms. The percentage of fires spreading beyond the room of origin is lower in fires with hardwired smoke alarms than battery-operated devices. Because battery-operated devices are less likely to be interconnected, an activated battery-operated smoke alarm may be further from the area of origin and/or occupants, resulting in delay in automatic detection and/or notification. Victims of fatal fires with working smoke alarms were more likely to have been in the area of fire origin (61%) and possibly severely injured very early in the fire development, to have had a physical or mental disability (10% and 5%, respectively), or to have tried to fight the fire themselves (8%) than are victims of fires without working smoking alarms. 43% of home fire deaths in 2000–2004 occurred in properties with no smoke alarms at all.

In total, 22% of the home fire deaths resulted from fires in which smoke alarms were present but failed to operate. Although nuisance activations, the leading reason for disabled smoke alarms, are produced by both ionization and photoelectric smoke alarms, studies suggest nuisance alarms are more common with ionization devices. In many cases, the smoke alarm was placed too close to cooking equipment or other potential alarm trigger. In total, 43% of home fire deaths in 2000–2004 occurred in properties with no smoke alarms at all.

Bennefield, R., & Bonnette R. (2003). Structural and occupancy characteristics of housing: Census 2000 brief. Found at: http://www.census.gov/prod/2003pubs/c2kbr-32.pdf

This report, part of a series that presents population and housing data collected from Census 2000, examines the number of units in a structure, the year the structure was built, the year the householder moved into the unit, and the number of people per room. The report shows how these measures vary geographically (by regions, states, counties, and large cities), by various household and housing characteristics, and over time.

Bonnette, R. (1994). Statistical brief: Mobile homes. Bureau of the Census.

The United States had 7.3 million mobile homes in 1990, 2.7 million more than in 1980. These homes represented 7 percent of all housing units in 1990, up from 5 percent a decade earlier. This Brief uses data collected in the Census of Population and Housing to examine the characteristics of mobile homes and their occupants in 1990 and how these characteristics had changed since 1980. Where these homes were located, their affordability, size, and age are among the topics covered, as are the age and income level of their occupants.

Division of Unintentional Injury Prevention: National Center for Injury Prevention and Control. (1998). Deaths resulting from residential fires and the prevalence of smoke alarms – United States, 1991-1995. *Morbidity and Mortality Weekly Report, 47*(38), 803-806. Found at: http://www.cdc.gov/mmwr/preview/mmwrhtml/00055009.htm

In 1995, residential fires accounted for an estimated 3600 deaths and approximately 18,600 injuries. In addition, property damage and other direct costs have been estimated to exceed more than $4 billion annually. To determine residential fire-related death rates, the Center for Disease Control (CDC) analyzed death certificate data from 1991 to 1995 from U.S. vital statistics mortality tapes. Data from CDC's Behavioral Risk Factor Surveillance System (BRFSS) was used to determine the prevalence of smoke alarms in U.S. households. This report presents the findings of these analyses, which indicate a seasonal variation in fire-related deaths and a high prevalence of smoke alarms in residences in the United States.

From 1991 to 1995, the U.S. residential fire-related death rate declined from 1.3 per 100,000 population to 1.1. During this time period, residential fire-related death rates were greatest during December-February and lowest during June-August. The averaged annualized death rates for 1991-1995 showed that children aged less than 5 years and adults aged greater than or equal to 65 years had higher rates than those in other age groups. In 1995, 93.6% of households in the United States reported having at least one smoke alarm. The prevalence of smoke alarms ranged from 78.9% in Hawaii to 98.7% in Maryland.

Eisenberg, E. F. (2002). House fire deaths. *The Magazine of Western History, 4*(19.6), 4. Found at: www.dos.state.ny.us/DCEA/pdf/House%20Fire%20Deaths.pdf

House fire deaths in the US have fallen dramatically over the past 25 years. During that time the U.S. has gone from being a county where the chances of dying in a house fire were several times higher than in Europe, to being at worst twice as high and in many cases no higher. While any death is a tragedy, the U.S. has made great progress in reducing fire deaths and they no longer represent a large percentage of total deaths.

It was also shown that fire death rates have been decreasing across all states and decreasing most in states with high death rates. Smoking continues to be the number one cause of fatal residential fires, and bedrooms and living rooms are where nearly half of all fire deaths occur. Lastly, older residential structures were shown to have much higher fire death rates than newer ones.

Hall Jr., J. R. (2011). The total cost of fire in the United States. National Fire Protection Association.

The total cost of fire in the United States, as it is defined, is a combination of the losses caused by fire and the money spent on fire prevention, protection and mitigation to prevent worse losses, by preventing them, containing them, detecting them quickly, and suppressing them effectively.

For 2008, that total cost is estimated at $362 billion, or roughly 2.5% of U.S. gross domestic product. Economic loss (property damage) – reported or unreported, direct or indirect – represents only $20.1 billion of this total. The net costs of insurance coverage ($15.2 billion), the cost of career fire departments ($39.7 billion), new building costs for fire protection ($62.7 billion), other economic costs ($44.0 billion), the monetary value of donated time from volunteer firefighters ($138 billion), and the estimated monetary equivalent for the civilian and firefighter deaths and injuries due to fire ($42.4 billion), all are larger components than property loss.

Hendricks, T. S. (2008). Tennessee deaths 2007. Tennessee Department of Health.

Tennessee's death data provides information on 2007 final mortality data for state residents. Resident data includes events which occurred to residents of the state irrespective of where the events took place. Certificates filed with the Office of Vital Records supplied the data for this report. The 2007 total death rate of 9.3 per 1,000 population was 5.1 percent lower than the rate (9.8) in 2003. The mortality rate for the white population decreased 4.9 percent from 10.2 in 2003 to 9.7 in 2007. The rate for

the black population decreased 5.7 percent from 8.7 per 1,000 population to 8.2 over the 5-year period.

Age-specific death rates for 2007 show the total rates for the age group 65-74 three times that of the age group 45-64. Rates by age group for the black residents were higher than those for the white residents, except for the population group 85 years and older when the white rate was higher than both the total and black rate. The black infant death rate of 16.4 was 2.6 times higher than the white rate of 6.2 per 1,000 births.

International Association for the Study of Insurance Economics. (2010). Information bulletin of the World Fire Statistics Centre, bulletin no. 26. Geneva, Switzerland.
Found at: http://www.genevaassociation.org/PDF/WFSC/GA2010-FIRE26.pdf

This information bulletin of the World Fire Statistics Centre presents statistics on national fire costs from around 20 leading countries in an effort to persuade governments to adopt strategies aimed at reducing the cost of fire. There are eight tables of international fire cost comparisons included in this document.

Karter Jr., M. J. (2008). U.S. fire experience by region, 2002-2006. National Fire Protection Association.

Fire experience varies by region of the country. Regions of the country used in this report are from the U.S. Census Burea. Among the factors that can contribute to differences among regions are: climate, distribution of sizes of communities, percent of population in urban versus rural areas, population age distributions, percent of population below poverty level, percent of population with high school education,and housing characteristics. This report examines some of the similarities and differences in fire experience among regions.

Number of fires per thousand populations for the 2002-2006 period indicate that the South (6.2) and Northcentral (6.0) had the highest overall rates for the five year period. The South with 15.0 and Northcentral with 14.3 had the highest annual average fire death rates per million people for the period. The Northcentral had an average civilian injury rate of 80.0 for the five year period or 31% higher than the national rate. The South had the highest civilian death rates for all community sizes under 100,000. The Northeast with 52% had a higher occurrence of cooking equipment fires than other regions, while the West with 31% had a high occurrence of fires involving heating equipment.

Karter Jr., M.J. (2009). Fire loss in the United States 2008. National Fire Protection Association: Division of Research and Analysis.

U.S. fire departments responded to an estimated 1,451,500 fires. These fires resulted in 3,320 civilian fire fatalities, 16,705 civilian fire injuries and an estimated $15,478,000,000 in direct property loss. (The direct property loss includes the California Wildfires 2008 with an estimated property loss of $1,400,000,000.) There was a civilian fire death every 158 minutes and a civilian fire injury every 31 minutes in 2008. Home fires caused 2,755, or 83%, of the civilian fire deaths. Fires accounted for six percent of the 25,252,500 total calls. Nine percent of the calls were false alarms; sixty-two percent of the calls were for aid such as EMS.

Karter, M.J. (2010). Fire loss in the United States during 2009. National Fire Protection Association. Found at: http://www.nfpa.org/assets/files/PDF/OS.fireloss.pdf

Each year, based on a sample survey of fire departments across the country, the NFPA estimates the national fire problem as measured by the number of fires that public fire departments attend, and the resulting deaths, injuries and property losses that occur. This report summarizes key findings based on the NFPA Survey for 2009 Fire Experience.

U.S. fire departments responded to an estimated 1,348,500 fires. These fires resulted in 3,010 civilian fire fatalities, 17,050 civilian fire injuries and an estimated $12,531,000,000 in direct property loss. There was a civilian fire death every 175 minutes and a civilian fire injury every 31 minutes in 2009. Home fires caused 2,565, or 85%, of the civilian fire deaths. Fires accounted for five percent of the 26,534,000 total calls. Eight percent of the calls were false alarms; sixty-five percent of the calls were for aid such as EMS.

Lauer, K. J. (2006). Tennessee county fire handbook. County Technical Assistance Service Found at: http://www.ctas.tennessee.edu/public/web/ctas.nsf/EntriesWeb/65089461C12D14F5862570F1006DC474/$FILE/TCFH.pdf

County government officials and local citizens across the state face many challenges in regard to fire protection issues. The most serious of the concerns is the fact that the state of Tennessee has the second highest fire death rate in the nation. Many factors contribute to this grim statistic, including some of the deficiencies that are identified in this publication. The scope of this document is to determine the need for fire protection assistance to county governments, assess the current level of fire protection across the state and establish a reference source for improving the multiple versions of fire protection services. In order to accomplish this goal, initially two surveys were developed. One was sent to all County Executives/Mayors, and a more in-depth survey was sent to more than 650 fire departments.

Runyan, S.W., & Casteel, C. (2004). The state of home safety in America: Facts about unintentional injuries in the home (2nd Edition). Washington, D.C.: Home Safety Council.

Found at:
http://www.homesafetycouncil.org/AboutUs/Research/pdfs/sohs_2004_p017.pdf

This is the second edition of The State of Home Safety in America™, a report commissioned by the Home Safety Council. The purpose of the report is to document the (a) occurrence of fatal and nonfatal unintentional home injury in America, (b) societal costs associated with home injury, and (c) safety issues and protective practices associated with injury at home.

U. S. Fire Administration. (2006). Live safely in your manufactured home: A factsheet on manufactured home safety. Found at: www.usfa.fema.gov

The U. S. Fire Administration (USFA) would like consumers to know that there are simple steps you can take to prevent the loss of life and property in home fires. During a typical year, manufactured homes account for 17,700 fires, hundreds of deaths and $155 million in property losses. Manufactured homes have a fire death rate per 100,000 housing units 32-50 percent higher than the rate for other dwellings. Young children account for more than one-fifth of all fire deaths in manufactured homes. A recent study of rural fires showed that smoke alarms were less likely to be present or operating in manufactured homes. Electrical system malfunctions and heating fires are the leading causes of fire in manufactured homes. Together, they account for one-third of manufactured housing fires. Electrical distribution fires occur nearly twice as often in manufactured homes as in one- and two-family dwellings.

U.S. Fire Administration: National Fire Data Center. (2009). Fire in the United States 2003-2007 (15th edition). Emmitsburg, MA.
Found at: http://www.usfa.dhs.gov/applications/publications

This report addresses the overall national fire problem. Topics included are regional and state profiles, residences and other properties, causes of fire and fire loss, and race, age, and gender characteristics of victims. It is designed to equip fire service and others with information that motivates corrective action, sets priorities, targets specific fire programs, serves as a model for State and local analyses of fire data, and provides a baseline for evaluating programs. The 5-year period of 2003 to 2007 is covered with primary focus on 2007.

The report shows that, overall, the fire problem in the United States continues to improve. Five-year fire loss rates are down. It is likely that several factors contribute to the trends such as smoke alarm and sprinkler usage, stronger fire codes, new construction techniques, public education, and improved firefighter equipment and training. Even considering these positive trends, the United States still has a major fire problem compared to other industrialized nations. The study and implementation of international fire prevention programs that have proved effective in reducing the number of fires and deaths should be considered.

U.S. Fire Administration. (2010). One-and two-family residential building fires. *Topical Fire Report Series, 10*(7), 1-14.

An estimated 253,500 one- and two-family residential building fires are reported to U.S. fire departments each year and cause an estimated 2,150 deaths, 8,775 injuries, and $5.3 billion in property loss. One- and two-family residential building fires account for 66 percent of all residential building fires, representing the largest subgroup of residential building fires. Cooking is the leading cause of one- and two-family residential building fires reported to the fire service (30 percent). Nearly all one- and two-family residential building cooking fires are small, confined fires (91 percent). Forty-six percent of nonconfined one- and two-family residential building fires extend beyond the room of origin. The leading causes of these larger fires are electrical malfunctions (17 percent), other unintentional or careless actions (14 percent), and intentional (12 percent). One- and two-family residential building fires peak in January and December (10 percent each). Smoke alarms were not present in 28 percent of the larger, nonconfined fires, a high percentage when compared to the 8 percent of homes lacking smoke alarms nationally.

With cooking, heating, and electrical fires accounting for more than half of one- and two-family fires, residents should focus on equipment maintenance and proper equipment use. Prevention programs should highlight the importance of proper cooking techniques and methods to prevent cooking fires. Special emphasis should be placed on proper heating equipment installation, regular maintenance, and homeowner responsibility. Prevention programs should be tailored towards responsible use of fireplaces, chimneys, and fireplace-related equipment to reduce the number of heating fires in one- and two-family buildings. Proper electrical equipment maintenance is also important for homeowners because it is their individual responsibility as opposed to professional management found in other residential buildings. In addition, many of the small, confined cooking fires occur during fire departments' busier call times. Reducing the number of these minor, confined fires could provide fire departments with more flexibility to respond during busy call times.

U.S. Fire Administration: National Fire Data Center. (2010). Fatal fires in residential buildings. *Topical Fire Report Series, 11*(2).
Found at: http://www.usfa.dhs.gov/downloads/pdf/tfrs/v11i2.pdf

An estimated 1,800 fatal residential building fires are reported to U.S. fire departments each year and cause an estimated 2,635 deaths, 725 injuries, and $196 million in property loss. Fatal residential building fires tend to be larger, cause more damage, and have higher injury rates than nonfatal residential fires. This report addresses the characteristics of fatal residential building fires reported to the National Fire Incident Reporting System (NFIRS) from 2006 to 2008. The information in this report about fatal residential fires can be used not only to assess progress but also to understand the nature of the fatal fire problem and its implications for targeting of prevention programs.

It was found that smoking is the leading cause of fatal residential building fires (19 percent). The leading areas of fire origin in fatal residential building fires are bedrooms (27 percent) and common areas such as living and family rooms (23 percent). Fatal residential building fires are more prevalent in the cooler months, peaking in January (13 percent). Fatal residential building fires occur most frequently in the late evening and early morning hours, peaking from midnight to 5 a.m. One-third (33 percent) of fatal residential fires occur during these 5 hours. About two-thirds (66 percent) of fatal residential building fires are confined to the building of origin or extend beyond the building of origin.

U.S. Fire Administration: National Fire Data Center. (2011). Fire risk in 2007. *Topical Fire Report Series, 11*(8). Found at: http://www.usfa.dhs.gov/downloads/pdf/statistics/v11i8.pdf

The risk from fire is not the same for everyone. Nearly 4,000 deaths and 17,675 injuries in the United States were caused by fires in 2007. These casualties were not equally distributed across the U.S. population, and the resulting risk of death or injury from fire is not uniform—it is more severe for some groups than for others. Much can be learned from understanding why different segments of society are at a heightened risk from the fire problem. This Topical Fire Report explores fire risk as it applies to fire casualties in the U.S. population.

The following are findings from the 2007 analysis of fire death and injury. Adults ages 50 and older have a greater risk of dying in fires than the general population. The elderly ages 85 and over have the highest risk of fire death. The risk of fire injury is greatest in the 20 to 54 age ranges. Adults ages 30 to 34 have the highest risk of fire injury. Men are 1.5 times more likely to die in fires than women. African-Americans and American Indians/Alaska Natives are at much greater risk of death in a fire than the general population. The risk of dying in a fire in the South is higher than other regions of the United States. Populations at the lowest income levels are at a greater risk of dying in fires than those with higher incomes.

U.S. Fire Administration. (2011). One-and two-family residential building fires (2007-2009). *Topical Fire Report Series, 12*(2).
Found at: http://www.usfa.dhs.gov/downloads/pdf/statistics/v12i2.pdf

From 2007 to 2009, fire departments responded to an estimated 248,500 fires in one- and two-family residences each year across the Nation. These fires resulted in an annual average loss of 2,135 deaths, 8,550 injuries, and $5.9 billion in property loss. One- and two-family residential building fires account for the majority of all residential building fires (66 percent) and dominate the overall residential building fire profile. One- and two-family residential buildings include detached dwellings, manufactured homes,

mobile homes not in transit, and duplexes. It was also found that cooking is the leading cause of one- and two-family residential building fires reported to the fire service (31 percent), and nearly all one- and two-family residential building cooking fires are small, confined fires (91 percent). Forty-nine percent of nonconfined one- and two-family residential building fires extend beyond the room of origin. The leading causes of these larger fires are electrical malfunctions (17 percent), other unintentional or careless actions (16 percent), intentional (12 percent), and open flame (11 percent). Moreover, one- and two-family residential building fire incidence is higher in the cooler months, peaking in January at 11 percent. Smoke alarms were not present in 22 percent of the larger, nonconfined fires in occupied one- and two-family residential buildings. This is a high percentage when compared to the 3 percent of households lacking smoke alarms nationally.

Fire Death Victims:

Busuttil, A., Elder, A.T., & Squires, T. (1996). Fire fatalities in elderly people. *Age and Ageing, 25,* 214-216.

Fatal dwelling-house fires account for 10% of all accidental deaths in the United Kingdom with one-quarter of the deaths being of elderly people. No study has described the characteristics of elderly individuals who die in fires. We report results from a retrospective review of all fatal dwelling-house fires in Scotland from 1980 to 1990. Of 1096 people dying in fires, 243 (23%) were aged over 75. When compared with patients under the age of 75, older patients were significantly less likely to have alcohol detected in their blood at the time of the fatal fire and significantly less likely to be smokers. Significantly more fires killing elderly people were caused by faulty or misused electrical items in the house, particularly electric blankets. These differences between elderly and younger individuals dying in dwelling-house fires may suggest that preventative strategies for the elderly population require a different emphasis from those for younger population.

Byard, R.W., Lipsett, J., & Gilbert, J. (2000). Fire deaths in children in South Australia from 1989 to 1998. *Journal of Pediatric Child Health, 36*, 176-178.

A study was undertaken of childhood deaths caused by fires in South Australia over a 10-year period from 1989 to 1998. A total of 23 deaths of children occurred with an age range of 2 months to 16 years. Fourteen deaths were associated with house fires, four with fires in cars and four were miscellaneous or unspecified. While house fire deaths remained the major cause of childhood fire deaths (65%), deaths in car fires accounted for a significant proportion of cases (17%). Although the numbers are small, cars represented a specific danger because of their confined space with highly flammable interiors, lockable doors, and built in non-childproof lighters. Cars should not be regarded as suitable places to leave young children, or for children to play in unsupervised.

Conway, G.A., Smialek, J., Langhorst, T., Ortiz, T., & Hull, H.F. (1985). Current trends deaths associated
with fires, burns, and explosions—New Mexico, 1978-1983.
Found at: http://www.cdc.gov/mmwr/preview/mmwrhtml/00000622.htm

The New Mexico Health and Environment Department (NMHED) examined fire-, burn-, and explosion-associated deaths occurring in the state during 1978-1983. Included were all deaths caused unintentionally by fire and flames, explosive material, and hot substance or object, caustic or corrosive material, and steam. Also included were fire-associated deaths by suicide and assault and of undetermined intent.

The sex- and age-adjusted death rate for American Indians was twice that for white, non-Hispanics; the rate for persons of Hispanic origin was slightly higher than that for white, non-Hispanics. The average annual age-adjusted death rate for males was about three times that for females. Age-specific mortality rates were similar for males and females up to 14 years of age. Among persons older than 14 years, rates were higher for males than for females, with the highest rates for persons over age 75 years.

Thirty (15%) of the New Mexico deaths occurred in the workplace, compared with 5%-6% nationally. Of the 30, 14 (47%) were caused by gas explosions. Fires or explosions involving homes, mobile homes or other structures accounted for 119 deaths. 32 (27%) of these deaths in homes or other structures occurred in mobile and trailer homes, which account for only 12% of year-round housing in New Mexico. Additionally, cigarette smoking, use of natural or propane gas, and alcohol consumption all contributed to fire-related deaths in New Mexico.

Flynn, J.D. (2010). Characteristics of home fire victims. National Fire Protection Association.

Children under age 5 are almost one and a half times as likely to die in a home fire as the average person, but their relative risk has been declining over time. Adults over the age of 65 are more than twice as likely to die in home fires as the average person. Alcohol or other drugs, disabilities and age-related limitations are all factors in the risk of home fire death.

Hall, J.R., (2005). Characteristics of Home Fire Victims. National Fire Protection Association.

Children under age 5 are nearly twice as likely to die in home fires as the average person, but their relative risk has been declining, and by 2002 was down to only 56% over the average. Older adults age 65 and older are more than twice as likely to die in home fires as the average person. Alcohol or other drugs, disabilities and age-related limitations are all factors in home fire risk.

Marshall, S.W., Runyan, C.W., Bangdiwala, S.I., Linzer, M.A., Sacks, J.J., & Butts, J.D. (1998). Fatal residential fires: Who dies and who survives?. *Journal of the American Medical Association, 279*, 1633-1637.

The United States has one of the highest fire fatality rates in the developed world, and three quarters of these deaths are in residential fires. The objective of this study is to compare characteristics of those who die and those who survive in the same residential fire. Data on fatal residential fires were collected from the medical examiner and interviews with local fire officials. Of the 190 decedents, 124 (65%) were male, 78 (41%) were home alone, and 69 (53%) of 130 adults who had blood alcohol measured were intoxicated. Of the 254 persons present during fires in which more than 1 person was at home, 112 died. Individuals more likely to die (high-vulnerability group) were younger than 5 years or 64 years or older, had a physical or cognitive disability, or were impaired by alcohol or other drugs. The presence of an adult with no physical or cognitive disabilities who was unimpaired by alcohol or other drugs (a potential rescuer) reduced the risk of death in the high-vulnerability but not the low vulnerability group. Overall, a functioning smoke detector lowered the risk of death.

This study found that smoke detectors were equally effective in both low and high vulnerability populations. The high-vulnerability group was more likely to survive if, in addition to a smoke detector, a potential rescuer was present. Further research should seek to identify prompts that facilitate speedy egress from a burning structure and that can be incorporated into residential fire alarm systems.

National Fire Protection Association: Fire Analysis Research Division. (2010). Demographics and other characteristics related to fire deaths or injuries. Quincy, MA.
Found at: http://www.nfpa.org/assets/files/PDF/OS.SocFactors.pdf

The risk of fire death and injury varies by age group, race, region, and community size. Children under five and adults 65 or older face the highest risk of fire death, although they do not account for the majority of fire fatalities. The risk of non-fatal fire injury is highest for those between 20 and 49. Higher fire death rates are seen in states with larger percentages of people who possess one or more of the following characteristics: are black, poor, smoke, have less formal education, or who live in rural areas. In more affluent areas, race played less of a role. The South and Midwest had the highest fire death rates per million population in 2004-2008. The rate in the rural South was the highest by far.

Patetta, M.J., & Cole, T.B. (1990). A population-based descriptive study of housefire deaths in North Carolina. *Public Health Briefs, 80*(9), 1116-1117.

This report is a population-based study of housefire deaths in North Carolina in 1985 using data obtained from fire investigators and the North Carolina medical examiner system. The crude death rate was 3.2 per 100,000 population; age-specific death rates were highest for ages 75-84 years. Death rates for Whites were one-third as high as death rates for other races. Of those decedents tested for alcohol, 56 percent had blood alcohol levels - 22 mmol/L. Most fatal fires were caused by heating units or cigarettes.

Roberts, I. (1995). Deaths of children in house fires. *British Medical Journal, 311*, 1381.

Few pediatricians are surprised by the steep social class gradient in childhood mortality and morbidity resulting from residential fires. The link with poverty can be made intuitively on the basis of repeated exposure to scenarios like this. Between 1979 and 1987 the number of people living in relative poverty (with less than half the national mean household income) increased from five million to ten million. Between 1983 and 1992 an average of 69 childhood deaths from residential fires occurred each year. The risk of death from a residential fire is related to two sets of determinants: risk factors for the occurrence of a fire and risk factors for death once a fire has occurred. Data from the 1994 survey show that the risk of fire is strongly related to the type of housing. The risk is greatest for those living in the poorest council housing and in temporary accommodation. Single parent families also have a significantly increased risk.

Scholer, S.J., Hickson, G.B., Mitchel, E.F., & Ray, W.A. (1998). Predictors of mortality from fires in young children. *Pediatrics, 101*, 1-5.
Found at: http://pediatrics.aappublications.org/content/101/5/e12.full.html

In the United States in 1994, fires claimed 3.75 lives per 100 000 child years and accounted for 17.3% of all injury deaths in children <5 years of age. The objective of this paper is to conduct a historical cohort study that uses maternal demographic characteristics to identify young children at high risk of fire-related deaths, thus defining appropriate targets for prevention programs.

The cohort consisted of children born to mothers who resided in the state of Tennessee between 1980 and 1995. Compared with children whose mothers had a college education, children whose mothers had less than a high school education had 19.4 times an increased risk of a fatal fire event. Children whose mothers had more than two other children had 6.1 times an increased risk of a fatal fire event compared with children whose mothers had no other children. Children of mothers <20 years of age had 3.9 times increased risk of a fatal fire event compared with children whose mothers were >30 years old. Although both maternal neighborhood income and race were associated strongly with increased rates of fatal fire events in the univariate analysis, this association did not persist in the multivariate analysis. Other factors that were associated with increased risk of fatal fire events in the multivariate analysis were male gender and having a mother who was unmarried or who had delayed prenatal care.

Maternal education, age, and number of other children had strong and independent associations with fire-related deaths among young children. Taken together, these factors defined a steep risk gradient, where children in the highest-risk group had a fire-related mortality rate that was 150 times that of the lowest risk group. From a public

health perspective, maternal factors clearly define children who would be good candidates for prevention programs. There is an urgent need to develop prevention programs that can be shown to reduce fire-related injury in high-risk children.

Squires, T., & Busuttil, A. (1996). Can child fatalities in house fires be prevented? *Injury Prevention, 2,* 109-113.

The objective of this study is to analyze all child deaths in house fires in Scotland between 1980 and 1990. This is a retrospective study based on the 'sudden death' investigation instigated by the procurator fiscal in whose jurisdiction the death occurred. The necropsy, toxicology, police, and fire brigade reports were examined in each case. There were 168 child deaths occurring in 118 house fires. In the 0-5 years age group 40% of deaths occurred in fires started as a direct result of the actions of children. The careless disposal of smoking materials was the most frequent cause of fatal fires killing older children. Upholstery and bedding were common materials of first ignition, accounting for over half the incidents. The majority of children were dead before the arrival of the emergency services and most died as a result of the inhalation of smoke.

This survey emphasizes the importance of 'self escape' which, particularly in the case of young children, requires the assistance of adult carers. The number of fires started as a result of children playing with sources of ignition raises important questions of supervision and the provision of a safe environment. There is, we contend, a need to highlight the importance of individual behavior and responsibility while recognizing the need to develop measures that are relevant to, and effective in, a particular socioeconomic context.

Sternberg, S. (2011, February 14). Report: Half of children killed in fires are under age 5. *USA Today.* Found at: http://www.usatoday.com/news/nation/2011-02-14-kidsinfire14_ST_N.htm?loc=interstitialskip#

Children younger than 5 made up 52% of the deaths of children younger than 16 in fires in 2007, researchers for the Federal Emergency Management Agency (FEMA) found in analyzing the most current data. They were 46% of the injuries that year. Researchers found that deaths among the youngest of children increased 2% from 2004 to 2007. Fire and burns were the third-leading cause of accidental deaths, after transportation accidents and drowning, for children younger than 15 in 2007. Nearly 510 children died in fires that year.

Although children are less likely to die in fires than the population as a whole — with 8.3 per million deaths among children younger than 15 vs. 13.2 per million in the general population — the youngest children face the highest risk of all children of dying or being injured, federal statistics show. Children 9 and younger accounted for 93% of deaths and 38% of injuries where the cause of a residential fire was reported to be "playing with a heat source," researchers say.

The lack of a working smoke detector has been linked with nearly 25% of fatal residential fires, though just 3% of homes do not have smoke alarms installed, the report says. Studies carried out in Australia and Canada have shown that sleeping children often do not react quickly enough when a smoke alarm goes off and must be roused by an adult.

Stiles, N.J., Bratcher, D., Ramsbottom-Lucier, M., & Hunter, G. (2001). Evaluating fire safety in older persons through home visits. *Journal of Kentucky Medical Association*, *99*(3), 105-110. Found at: www.ncbi.nlm.nih.gov

To evaluate elders' risk factors for fire injury, this study performed in-home assessments on Geriatric Clinic clients. Nearly two-thirds of the subjects had physical impairments that could compromise escaping a fire. Fire safety equipment often was suboptimal. Nearly three-fourths of subjects were not worried about fire injury, yet all had at least one fire injury risk factor. Fire safety knowledge was poor. Apathy was common, with fewer than one-third of our subjects complying with our recommendations.

Causes and Circumstances of Civilian Fire Deaths:

Ahrens, M. (2009). Possible impairment by alcohol or drugs as a contributing factor in home fire deaths. National Fire Protection Association: Fire Analysis Research Division. Quincy, MA.

Based on data reported by the fire service, NFPA estimates that possible impairment by alcohol or drugs was a factor contributing to an average of 430, or 15%, of home fire deaths annually in 2003-2006. Although this percentage is lower than that typically found in studies based autopsy reports, data from the fire service about the fire deaths with alcohol involvement provides for a more detailed understanding of the circumstances of the fires and victim demographics. Seventy-one percent of the victims were male. Eighty-eight percent were over 14 and under 65 years of age. Forty-five percent of these deaths resulted from fires started by smoking materials. At the time of the incident, 46% of the victims were in the area of origin and involved in the ignition.

Ahrens, M. (2010). US home structure fires. National Fire Protection Association: Fire Analysis Research Division. Quincy, MA. 1-104.

The National Fire Protection Association (NFPA) estimates that U.S. fire departments responded to an average of 380,000 reported home structure fires per year during the five-year-period of 2003-2007. These fires caused an estimated average of 2,840 civilian deaths, 13,160 civilian injuries, and $6.4 billion in direct property damage per year. More than two-thirds (70%) of the reported home structure fires and 84% of the fatal home fire injuries occurred in one- or two-family homes, including manufactured homes. The remainder occurred in apartments or similar properties.

Cooking equipment is the leading cause of home structure fires and home fire injuries, while smoking materials are the leading causes of home fire deaths. Roughly half of all home fire deaths result from incidents reported between 11:00 p.m. and 7:00 a.m. Twenty-four percent of all home fire deaths were caused by fires that started in the bedroom; 23% resulted from fires originating in the living room, family room, or den. Roughly two-thirds of home fire deaths resulted from fires in which no smoke alarms were present or in which smoke alarms were present but failed to operate.

Allareddy, V., Peek-Asa, C., Yang, J., & Zwerling, C. (2007). Risk factors for rural residential fires. National Rural Health Association, 264-269.

Rural households report high fire-related mortality and injury rates, but few studies have examined the risk factors for fires. This study aims to identify occupant and household characteristics that are associated with residential fires in a rural cohort. This study also examines the association between the occurrence of previous fires and the adoption of safety measures.

A total of 78 (11.3%) households reported a residential fire. Occupant characteristics that were associated with significantly higher odds of reported fires included the presence of an occupant with alcohol problems and being married. Rural farm households were associated with significantly higher odds of reporting a fire when compared to residences in towns, after controlling for all other occupant and household characteristics. The presence of a fire extinguisher was the only fire safety measure that had a statistically significant association with reported fire. Experiencing a fire was not associated with an increased likelihood of adopting safety measures to prevent injuries once a fire has started.

Ballesteros, M.F., Berger, L.R., Caraballo, R.S., Diekman, S.T., & Kegler, S.R. (2008). Ecological level analysis of the relationship between smoking and residential-fire mortality. *Injury Prevention*, *14,* 228-231.
Found at: http://injuryprevention.bmj.com/content/14/4/228.full.pdf

The objective of this study was to examine the association between tobacco smoking and residential-fire mortality and to investigate whether this association is explained by the confounding effects of selected socioeconomic factors (ie, educational attainment and median household income).

An ecological analysis relating state-level residential-fire mortality to state-level percentages of adults who smoke was conducted. After educational attainment and median household income had been controlled for, smoking percentages among adults correlated significantly with state-level, population-based residential-fire mortality. Mortality from residential fires is high in states with high smoking rates; however, this relationship cannot be explained solely by the socioeconomic factors examined in this study.

Bangdiwala, S.I., Butts, J., Linzer, M.A., Runyan, C.W, & Sacks, J.J. (1992). Risk factors for fatal residential fires. *The New England Journal of Medicine*, *327*(12), 859-863.

Residential fixes are the most important cause of fire-related mortality in the United States. Previous research has concentrated on fatal fires in urban areas; considerably less is known about fatal fires in rural areas. We studied fatal and nonfatal residential fires in predominantly rural areas. Using a case-control design, we compared all 151 fatal fires (cases) in single-family dwellings in North Carolina during a 13-month period with a sample of nonfatal fixes (controls). Case fires were identified through the medical-examiner system, and control fires that occurred within a few weeks of the case fires were chosen from the records of randomly selected fire departments statewide. For each fixe, fire officials were interviewed about the dwelling, the fire, the people involved, and the fixe-response system.

Although heating incidents were the leading cause of fires, fatal fires were more likely to have been caused by smoking (31% of fatal fires vs. 6% of nonfatal fires). Mobile homes posed a higher risk of death if a fire occurred, as did the absence of a smoke detector. Smoke detectors were more protective against death in fires involving young children and when no one present was impaired by alcohol or drugs or had a physical or mental disability. The presence of an alcohol-impaired person was the strongest independent risk factor for death in the case of a fire. In conclusion, residential fires are most likely to be caused by heating equipment or smoking materials. The risk of death is greatest in fires in mobile homes, in those involving alcohol impaired persons, and in those in houses without smoke detectors.

Barillo, D.J., & Goode, R. (1996). Fire fatality study: Demographics of fire victims. *Burns, 22*(2), 85-88.

Injury or death caused by fire is frequent and largely preventable. This study was undertaken to define the populations, locations, times, and behaviours associated with fatal fires. Seven hundred and twenty-seven fatalities occurring within the State of New Jersey, between the years 1985 and 1991, were examined retrospectively. Most deaths were attributed to a combination of smoke inhalation and burn injury. Five hundred and seventy-four fatalities occurred in residential fires. Smoking materials were the most common source of ignition for residential fires. More than half of the fatal residential fires started between the hours of 11 p.m. and 7 a.m. Children and the elderly represented a disproportionate percentage of fire victims. Victims under the age of 11 years or over the age of 70 years constituted 22.1 percent of the state population but 39.5 percent of all fire fatalities. Fire prevention efforts should target home fire safety, and should concentrate on children and the elderly. The development of fire-safe smoking materials should be encouraged.

Carlin, D.K., Istre, G.R., McClain, J., & McCoy, M. (2002). Residential fire related deaths and injuries among children: Fireplay, smoke alarms, and prevention. *Injury Prevention, 8,*

128-132.

The aim of this study was to describe the epidemiology of residential fire related deaths and injuries among children, and identify risk factors for these injuries through a linked dataset for the city of Dallas, Texas. From 1991–98, 76 children were injured in residential fires (39 deaths, 37 non-fatal). The highest rates occurred in the youngest children (<5 years) and in census tracts with lowest income. Fireplay accounted for 42% (32/76) of all injuries, 62% (15/24) of deaths in children 0–4 years, and 94% (13/14) of deaths from apartment and mobile home fires. Most of the fireplay related injuries (27/32, 84%) were from children playing with matches or lighters. Most started in a bedroom. Smoke alarms showed no protective efficacy in preventing deaths or injuries in fires started by fireplay or arson, but there was significant protective efficacy for a functional smoke alarm in fires started from all other causes (p<0.01).

Residential fire related injuries among children in Dallas occurred predominantly in the youngest ages (<5 years) and in poor neighborhoods. Most of the deaths, especially those in apartments and mobile homes, resulted from fireplay. Smoke alarms appeared to offer no protection against death or injury in fireplay associated fires, possibly from the nature of the child's behavior in these fires, or from the placement of the smoke alarm. Prevention of childhood residential fire related deaths may require interventions to prevent fireplay in order to be successful.

Chapman, V., Fine, P., McGwin, G., Robinson, J., & Rousculp, M. (2000). The epidemiology of fire-related deaths in Alabama, 1992-1997. *Journal of Burn Care & Rehabilitation, 21,* 75-83.

The state of Alabama has one of the highest fire-related fatality rates in the nation. The goal of this study was to present the epidemiology of fire-related deaths in the state of Alabama. Fatality reports for all fire-related deaths in the state of Alabama from 1992 to 1997 were obtained from the State Fire Marshal's Office. Fatality rates were calculated and compared according to age, sex, and race. Descriptive statistics were generated for population and fire characteristics.

Fatality rates were higher among black people, men, children, and older people. Approximately half (48.8%) of the deaths occurred between the months of November and March; July had the lowest proportion of deaths (5.0%). Residential fires accounted for the largest proportion of deaths. Fatality rates were higher for mobile home residents. Overall, smoke detectors were present in only 32.5% of the residential fires. The presence of smoke detectors was more common with deaths in urban locations (41.8%) than with deaths in rural locations (20.8%). The most frequently reported cause of fatal fires was misuse of cigarettes. More than half of the victims aged 18 years and older tested positive for alcohol. Fire prevention efforts should focus on smoke detectors, fire-safe cigarettes, and alcohol. Mobile home residents should also be targeted for fire prevention initiatives.

Charlton, M., & Fotheringham, A. S. Geographically weighted regression: A tutorial on using GWR in ArcGIS 9.3. National Centre for Geocomputation, National University of Ireland Maynooth. Found at: http://ncg.nuim.ie/ncg/GWR/GWR_Tutorial.pdf

This short tutorial is designed to introduce you to the operation of the Geographically Weighed Regression Tool in ArcGIS 9.3. It assumes that you understand both regression and Geographically Weighted Regression (GWR) techniques. GWR is a powerful tool for exploring spatial heterogeneity. Spatial heterogeneity exists when the structure of the process being modeled varies across the study area.

Federal Emergency Management Agency & United States Fire Administration. (1997). Socioeconomic factors and the incidence of fire. Found at: http://www.usfa.dhs.gov/downloads/pdf/statistics/socio.pdf

Each year in the U.S. there are over 400,000 fires in residential structures, and these fires kill and injure many people. Between 1983 and 1990, an average of percent of all fire deaths occurred in residential fires, as did an average of 66 percent of all fire injuries. However, research indicates that the risk of a fire in the home is not the same for everyone. This working paper concentrates on building stock characteristics and human factors. The intent is to identify socioeconomic factors that influence the complex and varied relationships between buildings, humans, and the occurrence of residential fires.

While structural factors of buildings have an effect on the incidence of fire, of equal or greater importance today is how humans use and maintain those buildings. Year after year, the primary causes of residential structure fires include cooking, heating, incendiary or suspicious causes, smoking, and other causes directly related to human activities. Together these causes accounted for over 66 percent of all residential fires in 1994.

To explore how socioeconomic factors are related to fire rates, this paper is divided into five sections. The first section presents findings from research aimed at identifying the socioeconomic characteristics most closely related to increased fire rates. In the second section, the nature of the relationships between socioeconomic factors and differential fire rates is explored. The third section briefly addresses fire risks in rural locations, while the fourth and fifth sections review the importance of studying socioeconomic factors and suggest topics for future research, respectively.

Hall, J.R. (2008). Home structure fires involving electrical distribution or lighting equipment. National Fire Protection Association. Found at: http://www.dos.state.ny.us/code/pdf/Home Structure Fires.pdf

In 2005, an estimated 20,900 reported U.S. non-confined home structure fires involving electrical distribution or lighting equipment resulted in 500 civilian deaths, 1,100 civilian injuries, and $862 million in direct property damage. Lamps, light fixtures, and light bulbs accounted for the largest share of 2002-2005 non-confined home structure fires involving electrical distribution or lighting equipment, while cords and plugs accounted for the largest share of home structure fire civilian deaths. Halogen lights have a higher risk of fire than incandescent lights.

Or, to put it another way electrical failure accounted for roughly three-fourths of home electrical distribution or lighting equipment fires and half of associated deaths, but electrical distribution or lighting equipment accounted for only one-third of total home electrical failure fires and one third of associated deaths.

Hall, J.R. (2010). The smoking-material fire problem. National Fire Protection Association.

In 2008, U.S. fire departments responded to an estimated 114,800 smoking-material fires in the U.S., down from 140,700 in 2007. These fires resulted in an estimated 680 civilian deaths, 1,520 civilian injuries and $737 million in direct property damage. Upholstered furniture and mattresses and bedding are the first items ignited for most home structure fatal fires started by smoking materials. One out of four fatal victims of smoking-material fires is not the smoker whose cigarette started the fire. Most deaths from smoking-material fires result from fires that started in living rooms, family rooms, and dens or in bedrooms. In recent years, Canada and all U.S. states have passed legislation requiring that all cigarettes sold be “fire safe,” that is, have sharply reduced ignition strength (ability to start fires), as determined by ASTM Standard E2187-04. When these laws are fully implemented, it is currently projected that smoking-material structure fire deaths will be down by 56-77% from 2003, the last year before any state implemented the law.

Hannon, L., & Shai, D. (2003). The truly disadvantaged and the structural covariates of fire death rates. *The Social Science Journal, 40*(1), 129-136.

This study investigates the social and demographic correlates of fire death rates for large metropolitan counties (N = 199). Data were derived from the 1990 census and the Centers for Disease Control (CDC). Multiple regression analyses revealed that age of housing, prevalence of mobile homes, and the proportion of the population renting had significant independent effects on fire death rates. Furthermore, the results indicated a significant interaction between the proportion of the population that is African American and median family income. The combination of low income and a high proportion of African Americans was related to fire death rates in a multiplicative rather than additive way. That is, the combination of low income and high proportion of African Americans appears to be associated with *extremely* high fire death rates, much more so than would be predicted by simply summing the two risk factors together. The results are discussed in relation to cumulative disadvantage theory. It is argued that the relationship between race and fire death is the product of both racial disparities in income and the geographic concentration of multiple disadvantages.

Holborn, P.G., Nolan, P.F., & Golt, J. (2003). An analysis of fatal unintentional dwelling fires investigated by London Fire Brigade between 1996 and 2000*. Fire Safety Journal*, 38, 1-42.

Data from the London Fire Brigade Real Fire Library has been used to obtain a range of statistics about fatal fires and fire death victims for the 5-year period from 1996 to 2000. Most deaths occurred in unintentional dwelling fires. The statistical information has therefore been analyzed to identify the main factors involved as to why people die in unintentional dwelling fires and see what lessons can be learnt from these deaths. Common risk factors identified in the unintentional dwelling fire deaths investigated include smoking, alcohol, old age, disability, illness, living alone, social deprivation and not having a working smoke alarm fitted.

The results found for the fatal fires investigated in London are broadly consistent with the findings of a number of other international studies. Of course many of these factors will have acted in combination to increase the risk of death due to an unintentional dwelling fire. The results would suggest that it is the weakest members of society—the old, the sick and disabled and those suffering from mental illness or an alcohol problem—that are most at risk of unintentional death due to fires in dwellings.

The analysis has also highlighted some important lifestyle trends, such as the use of candles as a 'lifestyle' product, the usage of drugs and medicines (particularly sleeping tablets and anti-depressants) and the incidence of alcohol intoxication in young adult male victims, which have played a role in a significant number of fatal unintentional dwelling fires.

Istre, G.R., McCoy, M.A., Osborn, L., Barnard, J.J., & Bolton, A. (2001). Deaths and injuries from house fires. *New England Journal of Medicine, 344,* 1911-1916.

This study sought to define the factors associated with house fires and related injuries by analyzing the data from population-based surveillance. There were 223 injuries (91 fatal and 132 nonfatal) from 7190 house fires, for a rate of 5.2 injured persons per 100,000 population per year. Rates of injury related to house fires were highest among blacks and in people 65 years of age or older. Census tracts with low median incomes had the highest rates of injury related to house fires. The rate of injuries was higher for fires that began in bedrooms or living areas; that were started by heating equipment, smoking, or children playing with fire; or that occurred in houses built before 1980. Injuries occurred more often in houses without functioning smoke detectors. The prevalence of functioning smoke detectors was lowest in houses in the census tracts with the lowest median incomes. Rates of injuries related to house fires are highest in elderly, minority, and low-income populations and in houses without functioning smoke

detectors. Efforts to prevent injuries and deaths from house fires should target these populations.

Lewis, C. (2008). Are House Fires Changing? *The Australian Journal of Emergency Management, 23*(1).

NSWFB Fire Investigation and Research Unit continually undertake case study analyses of significant house fires. This analysis and recent statistical analysis of fire services response data indicate that the effectiveness of containing a fire to the object or room of origin has deteriorated slightly over the last five years. This domestic research resonates with fire research from other countries showing a possible increase in speed and ferocity of experimental domestic fires. Furthermore, this is supported by a survey of the perceptions of operational firefighters within the NSW Fire Brigades. If confirmed, this emergent trend in domestic fires will present an ever increasing risk to the life safety of both building occupants and firefighters.

To test this hypothesis NSW Fire Brigades has entered into a collaborative project with CSIRO to research changes in the residential environment in Class 1a dwellings (houses), looking in particular at changes over the last three decades that may affect life safety outcomes for residents and firefighters exposed to residential fires. This article will outline the findings and outcomes of stage one of this research and briefly discuss the implications of applied research in gathering evidence for the design, implementation and evaluation of strategic fire prevention policy.

National Fire Data Center. (2010). Smoking-related fires in residential buildings. *Topical Fire Report Series, 11*(4).

The term “smoking-related fires” applies to those fires that are caused by cigarettes, cigars, pipes, and heat from undetermined smoking materials. Between 2006 and 2008, an estimated annual average of 9,000 smoking-related fires occurred in residential buildings in the United States. These smoking-related fires accounted for 2 percent of residential building fires responded to by fire departments across the Nation and resulted in an average of approximately 450 deaths, 1,025 injuries, and $303 million in property loss each year. They are the leading cause of fire deaths, accounting for 17 percent of fire deaths in residential buildings. Nonconfined smoking-related fires account for 94 percent of residential building smoking-related fires. Sixty-seven percent of the nonconfined residential building smoking-related fires occur because of abandoned or discarded smoking materials or products, primarily cigarettes. The bedroom is the leading area of fire origin for nonconfined residential building smoking-related fires—26 percent of smoking-related residential building fires originate in bedrooms. Residential building smoking-related fires peak in the afternoon and early evening between 2 and 7 p.m. with the highest peak between 2 and 3 p.m. This 5-hour period accounts for 27 percent of all residential building smoking-related fires.

Shai, D., & Lupinacci, P. (2003). Fire fatalities among children: An analysis across Philadelphia's census tracts. *Public Health Reports, 118,* 115-126.

This study investigates the possible causes of high levels of residential fire deaths to children younger than 15 years of age in Philadelphia from 1989 to 2000. The statistically significant variables that resulted from the logistic regression were census tracts in the highest quartile for low income households, census tracts in the highest quartile for single-parent households with children younger than age 18, census tracts in the highest quartile for houses built before 1939, and the number of children younger than 15 years of age in a census tract. Population characteristics by census tract are useful in identifying risk factors for residential fire deaths of children. Census tracts identified as at highest risk can provide fire prevention units with opportunities to take preventative measures such as the distribution of smoke detectors, and the education of residents about the dangers of careless smoking and planning for the rescue of children in the event of a fire.

Shai, D. (2006). Income, housing, and fire injuries: A census tract analysis. *Public Health Reports (1974-), 121*(2), 149-154. Found at: http://www.jstor.org/stable/20056933

This study investigates the social and demographic correlates of nonfatal structural fire injury rates for the civilian population for Philadelphia census tracts during 1993-2001. The author analyzed 1,563 fire injuries by census tract using the 1990 census and unpublished data from the Office of the Fire Marshal of the Philadelphia Fire Department. Injury rates were calculated per 1,000 residents of a given census tract. Multiple regression was used to determine significant variables in predicting fire injuries in a given census tract over a nine-year period and interaction effects between two of these variables—age of housing and income.

Multiple regression analysis indicates that older housing (prior to 1940), low income, the prevalence of vacant houses, and the ability to speak English have significant independent effects on fire injury rates in Philadelphia. In addition, the results show a significant interaction between older housing and low income. Given the finding of very high rates of fire injuries in census tracts that are both low income and have older housing, fire prevention units can take preventative measures. Fire protection devices, especially smoke alarms, should be distributed in the neighborhoods most at risk. Multiple occupancy dwellings should have sprinkler systems and fire extinguishers. Laws concerning the maintenance of older rental housing need to be strictly enforced. Vacant houses should be effectively boarded up or renovated for residential use. Fire prevention material should be distributed in a number of languages to meet local needs.

Tridata Corporation. (1998). An NFRIS analysis: Investigating city characteristics and residential fire rates. United States Fire Administration.

The objective of this study was to identify relationships between city characteristics and residential fire rates. The study analyzed data from 27 cities reporting to the United States Fire Administration's National Fire Incident Reporting System (NFIRS). The causes included fires due to arson, children playing, careless smoking, cooking, heating, electrical distribution, appliances, and open flames. In seeking to explain city-to-city variation in fire rates, the study examined climate, age structure of the population, and differences in the socioeconomic status of city residents.

Particular city characteristics were found to be strongly related to fire rates. The most common factors related to higher fire rates were climate and the age of the housing stock. Cities with worse climates and older housing stocks had a greater likelihood of fire. Five of the eight causes of fire were found to be strongly related to at least one city characteristic. These included fires due to arson, children playing, careless smoking, heating, and electrical distribution. Much of the variation between cities in the rates of these fires could be explained by factors not controllable by the fire service. Cooking fires were not found to be strongly related to city characteristics. This was unexpected because other studies have found strong links between poverty and the incidence of cooking fires. The use of cities as the unit of analysis may explain why no significant correlates of cooking fires were identified in this study.

The intent of research such as this is to help identify and clarify relationships between characteristics of people and places and fire risk. This information can be used for a variety of purposes, including the design, targeting, and evaluation of fire prevention programs. For example, cities with high proportions of children under age five need to recognize that their risk of children playing fires is higher than in other cities. They should compare their progress in reducing the rate of these fires against cities with similar proportions of children. Similarly comparisons could be made for other causes of fires.

U.S. Fire Administration: National Fire Data Center. (2009). Multiple-fatality fires in residential buildings. *Topical Fire Report Series, 9*(3).
Found at: www.usfa.dhs.gov/downloads/pdf/statistics/v9i3.pdf

Between 2004 and 2006, an average of 250 fires in residential buildings each year resulted in two or more civilian fire deaths. These multiple-fatality fires were responsible for an estimated 825 deaths, 200 injuries, and $33 million in fire loss on an annual basis. Multiple-fatality fires in residential buildings are rare, but tragic, occurrences. Less than one-tenth of a percent (0.1 percent) of all fires in residential buildings result in multiple fatalities. Nonetheless, they account for 29 percent of all fatalities in residential buildings and 70 percent of all multiple-fatality fires in the United States. This topical report focuses on multiple-fatality fires in residential buildings that are reported to the National Fire Incident Reporting System (NFIRS) using the standard fire reporting modules, and examines the causes and basic characteristics of these multiple-fatality fires.

This research found that electrical fires and unintentional or careless fires were the leading causes of multiple-fatality fires in residential buildings. Eighty-one percent of multiple-fatality fires in residential buildings occurred in one- and two-family dwellings. Thirty-six percent of multiple-fatality fires in residential buildings occurred in December, January, and February. The incidence of multiple-fatality fires in residential buildings peaks between 3 a.m. and 5 a.m. This period accounts for 21 percent of these fires.

Warda, L., Tenenbein, M., & Moffatt, M.E.K. (1999). House fire injury prevention update, part I: A review of risk factors for fatal and non-fatal house fire injury. *Injury Prevention, 5,* 145-150.

The objective of this paper is to summarize house fire injury risk factor data, using relative risk estimation as a uniform method of comparison. Fifteen relevant articles were retrieved, including two case-control studies. Non-modifiable risk factors included young age, old age, male gender, nonwhite race, low income, disability, and late night/early morning occurrence. Modifiable risk factors included place of residence, type of residence, smoking, and alcohol use. Mobile homes and homes with fewer safety features, such as a smoke or a telephone, presented a higher risk of fatal injury. Risk factor data should be used to assist in the development, targeting, and evaluation of preventive strategies.

Policies and Strategies for Reducing, Preventing Fire Deaths

Committee on Injury and Poison Prevention. (2000). Reducing the number of deaths and injuries from residential fires. *Pediatrics, 105*, 1355-1357.
Found at: http://pediatrics.aappublications.org/content/105/6/1355.full.html

Smoke inhalation, severe burns, and death from residential fires are devastating events, most of which are preventable. In 1998, approximately 381,500 residential structure fires resulted in 3,250 nonfirefighter deaths, 17,175 injuries, and approximately $4.4 billion in property loss. This report reviews important prevention messages and intervention strategies related to residential fires. It also includes recommendations for pediatricians regarding office anticipatory guidance, work in the community, and support of regulation and legislation that could result in a decrease in the number of fire-related injuries and deaths to children.

Corman H., Ignall E.J., Rider K.L., Stevenson A. (1975). Fire casualties and their relation to fire company response distance and demographic factors. *The New York City-Rand Institute*, 193-203.

Fatalities and injuries per structural fire in New York City have been compared by time of day, season, year, construction, region of the city, floor of origin, and occupancy. The relationship between response distance and fire casualties has also been studied. In

1972, there were 279 deaths and 1,986 civilian injuries resulting from fires in New York City. A basic responsibility of the fire department is to keep the number of fire casualties at a minimum. In fulfilling this responsibility, the department deploys its equipment, so that it can make a speedy response when it is informed of a fire. To do this effectively, however, two questions need to be answered. (1) What is the relationship between fire company response distance and the risk of a casualty? (2) How is the risk of a casualty affected by demographic and temporal factors? This report addresses these questions.

Eisenberg, Elliot F. (2005). Fire deaths in the United States: How best to keep reducing them. *Fire Protection Engineering*, *25*, 6-15.
Found at: http://www.fpemag.com/archives/article.asp?issue_id=26&i=110

While noting that declines in fire deaths have occurred nationwide (despite wide and persistent variations from state to state), the rate of future improvements in the U.S. may slow.
This article evaluates which demographic and housing unit characteristics best explain residential fire death rates. Inter-county-fire death rate differences are strongly correlated with the percentage of new housing stock, differences in household wealth, the percentage of minorities, and the percentage of mobile homes. These findings suggest that a particularly effective way to reduce future fire deaths may be to focus prevention efforts in proportion to the level of these four variables in a community, as opposed to using traditional policies that are largely location invariant.

Age and race of the occupants are meaningfully related to fire deaths rates. For example, were one to regress annual income on the age of a person, the result will be that age appears to increase income. However, the relationship between age and income is more complex; older people are more likely to have more education and more savings. And since education and age, and savings and age, are positively correlated, excluding education and savings will cause the coefficient on age to be larger than it really is. To prevent this, as many variables as possible that affect income should be included in the equation. In fire death research, the housing market variables are analogous to the education and savings variables in this paragraph.
The implications of the research suggest that to save lives: increase fire prevention efforts where the housing stock is old and households are poor with the magnitude of the intervention increasing the older the housing stock and the poorer the area. Doing otherwise wastes resources and withholds help from those who stand to benefit from it most.

Finkelstein, E.A., Corso, P.S., Miller T.R. (2006). Incidence and economic burden of injuries in the United States. New York, Oxford University Press.

Injuries are one of the most serious public health problems facing the United States today. Through premature death, disability, medical cost and lost productivity, injuries impact the health and welfare of all Americans. Deaths only begin to tell the story.

Although many injuries are minor, a large proportion result in fractures, amputations, burns, or significant injuries that have far-reaching consequences. Now, for the first time in over 15 years, we have comprehensive estimates of the impact of these injuries in economic terms. This book updates a landmark Report to Congress from 1989. Since that report, no undertaking has addressed the incidence and economic burden of injuries with more timely data, despite major changes in the fields of prevention, reporting and surveillance. Since the mid-eighties, new safety technologies have been developed to prevent injuries or to decrease the severity of injuries, and new policies and laws have been enacted to promote injury prevention. Chapter topics include incidence by detailed categorizations, lifetime medical costs and productivity losses as a result of injuries, and a discussion of recent trends.

Hemenway, D. (1985). The smoldering issue of fire fatalities. *Journal of Policy Analysis and Management, 4*(4), 593-597. Found at: http://www.jstor.org/stable/3323758

More than half of all Americans who die between the ages of one and 35 die from injuries rather than disease. Yet, compared with the research lavished on disease, the scientific attention directed to the problems of injuries is miniscule. Indeed: "That injuries are not often considered a public health problem is one of the reasons that they are a public health problem." Fire is the fourth leading cause of death from unintentional injury-behind only motor vehicles, falls, and drownings. Some 6,000 people died by fire in the United States in 1983. Fatalities give a sense of the overall public health effects of fires; reliable data do not exist for non-fatal injuries, nor for the public health problems caused by loss of home, wealth, family, or community.

In recent years, public health officials have tried to replace the term "accident" with "injury." They mean, of course, to emphasize that such damages are neither natural nor random events and can be decreased through appropriate policy. Is this true of deaths from fires? Surely 6,000 deaths per year add up to a serious problem, but is it one that public health policy can address? The principal causes of fire deaths are not lightning or natural disaster, but rather conditions that public policy often seeks to change-smoking, heavy drinking, and poverty. In part, looking at deaths from fire simply reinforces the general message that cutbacks in cigarettes, alcohol, and poverty would promote public health. This paper explores whether anything more specific can be done about the fire problem that would have a more immediate impact.

Institution of Fire Engineers US Branch (2008). National strategies for fire loss prevention: Forum results and report. Washington, DC.
Found at: http://www.firehouse.com/mz/images/2008/10/vision2020_finalreport.pdf

The goal of Vision 20/20 is a simple one – to marshal forces for the development and support of a national strategic agenda for fire loss prevention. The report of National Strategies for Fire Loss Prevention presented here is the end-result of the Vision 20/20

National Forum. It is derived from the collective knowledge of experts from across the nation of the fire problem and from experience in the field. These strategies were determined to have a direct impact on the loss of life and property from fire in both the short- and long-term. This report is also an active, growing and evolving document that will serve as a blueprint for continued refinement by task groups working to earn commitment for the recommended actions.

This report represents the refined forum results from the meeting where more than 170 fire and other agencies with a stake in the nation's fire problem met to outline the next steps that would lead toward a more fire safe nation. It represents the first steps in filling perceived gaps in the nation's fire prevention efforts. Ultimately the strategies and actions steps listed here must be moved forward collaboratively, and in conjunction with existing efforts.

Jarret, J. G. (2005). Fire alarm: Managing the risk challenges of fire services. *Public Risk Magazine* (Nov/Dec), 10-12.

According to a 2005 study measuring the economic impact of firefighter injuries generated by the National Institute of Standards and Technology, about 80,000 U.S. firefighters a year are injured. The total economic burden to the nation for addressing and preventing firefighter injuries is $2.7 billion to $7.8 billion per year, the report estimates. While the majority of injuries are minor, a significant number are debilitating and career-ending. Such injuries exact both a great human toll and financial toll upon public entities. Further, less subtle, but nevertheless substantial costs associated with the profession come in the form of monies expended to provide insurance coverage, and for safety training, physical fitness program, and protective gear and equipment. All of the aforementioned provide unique challenges for the public risk manager. This article addresses ways to approach these particular risks associated with firefighting.

Kobes, M., Helsloot, I., de Vries, B. & Post, J. G. (2010). Building safety and human behaviour in fire: A literature review. *Fire Safety Journal, 45*(1), 1-11.

The most crucial aspect of a building's safety in the face of fire is the possibility of safe escape. An important precondition is that its fire safety facilities enable independent and adequate fire response performances by the building's occupants. In practice, it appears that the measures currently required by law do not always provide the support that people in burning buildings need. Consequently, understanding how individuals behave in the case of fire and fire evacuation is essential if we are to bring fire safety measures into line with occupants' needs during an incident.

This paper contains a review of the available literature on human behaviour in a fire so far as building safety is concerned. The findings are presented as an overview of the critical factors which determine occupants' fire response performances, namely the characteristics of fire, human beings and buildings. The study highlights that some of the assumptions about the existing paradigm of fire safety in buildings are not consistent with the knowledge set out in the literature. The key observation is that psychonomics appear to have significant influence on occupants' fire response performances. Accordingly, the traditional approach to fire safety will have to be supplemented by scientific knowledge from this field. Hence, there is a need for a new approach to fire safety design in buildings, which is set out herein.

Kulenkamp A., Lundquist B., Schaenman P. (1994). Reaching the hard-to-reach: Techniques from fire prevention programs and other disciplines. TriData. Arlington, VA.

To assist fire service professionals with the tough task of reaching the hard-to-reach, TriData developed a research project to identify fire service programs that are reaching hard-to-reach high-fire-risk groups effectively and to identify the techniques being used. They originally assumed that many of these efforts would be community-based prevention programs in low-income neighborhoods using local service organizations and neighborhood leaders to assist the fire department. Indeed, the early programs identified were of the community-based prevention type. However, they began to identify many other techniques and innovative approaches, and documented these as well. In all, 40 fire prevention programs from across the country were documented.

Another premise of the research is that the hard-to-reach groups of concern to fire officials are in large part the same groups targeted by other public programs, such as crime prevention, drug use prevention, public health, and social services. Police departments have been working for decades on community-based policing and other crime prevention programs in hard-core areas. Twenty-five case studies of programs from non-fire areas are included in this report, illustrating approaches and techniques from these other disciplines. Well over 100 specific program development and implementation ideas are identified and described.

Rhodes, A., & Reinholtd, S. (1998). Beyond technology: A holistic approach to reducing residential fire fatalities. *Australian Journal of Emergency Management*, 39-44.

Reducing the rate of death from residential fires is a key challenge facing fire services around Australia. However, the results of this study suggest that the traditional focus on fire service response, suppression, and technological solutions is unlikely to contribute significantly to further reductions in fatalities.

The study has highlighted the role of social and behavioral factors in residential fire fatalities. It suggests that attention needs to shift from technological solutions to activities that address the human dimension of the problem and from dealing with hazard agents to addressing the vulnerability of high risk groups. In conclusion, the results suggest that future efforts to reduce loss of life from residential fires will only be effective if the fire and emergency services explore opportunities to employ a more diverse range of strategies to address the problem.

Schaenman, P. (2007). Global concepts in residential fire safety part 1 – Best practices from England, Scotland, Sweden, and Norway. TriData, Arlington, VA.
Found at:
http://www.sysplan.com/documents/tridata/international/global_concepts_1.2.pdf

This report provides many examples of successful community fire safety programs in European nations, specifically England and Scotland in the United Kingdom, and Sweden and Norway in Scandinavia. Both of these European areas were known to have innovative community fire safety programs associated with reductions in their residential fire death rates. Prevention programs were sought at both the national and local levels in each nation.

Of all the best practices identified in this study, one stands out. To reduce fire casualties in the home, the British fire service is visiting large numbers of high-risk households to do fire safety inspections and risk reductions, especially to ensure they have a working smoke detector. This approach has required a major change in the culture and mission of the British fire service. The approach is thought by the British to be a major factor in the 40 percent drop in fire deaths in the United Kingdom over the last 15 years, and it probably could have a large impact in the United States and other nations as well.

Schaenman, P. (2008) Global concepts in residential fire safety part 2 – Best practices from Australia, New Zealand and Japan. TriData, Arlington, VA.
Found at: http://maine.gov/dps/fmo/research/documents/Global_Concepts_Part2.pdf

This report summarizes best practices in community fire safety programs from Australia, New Zealand and Japan. These nations have significantly lower accidental fire death rates in residences compared to the United States. Visits to their fire services found many best practices that we might use for reducing residential fire deaths and injuries.

Some of the more important factors of success in achieving a low fire death included the following: data from research used to target programs and design messages, legislation requiring working smoke alarms in every home, and public housing having hard-wired smoke alarms. Partnerships with non-fire agencies, especially social service and health agencies that work with high-risk groups to whom they deliver fire safety messages and undertake inspections while delivering services in the home, also proved to be helpful. There was also a social safety net that provides safer housing for low income people (e.g., electricity and heat are never disconnected for lack of payment, which reduces fires from misuse of candles, stoves, ovens, and portable heaters).

Schaenman, P. (2009). Global concepts in residential fire safety part 3 – Best practices from Canada, Puerto Rico, Mexico, and Dominican Republic. TriData, Arlington, VA.

Found at: http://www.sysplan.com/documents/tridata/international/Global_Concepts_Part_III_FINAL_8-11-2009.pdf

Canada now has a significantly lower fire death rate per capita than the United States, after having had slightly higher rates 30 years ago. Visits with Canadian fire services found many best practices that the United States and other nations might use to reduce residential fire deaths and injuries. Site visits to three countries where Spanish is the dominant language revealed programs that may have special relevance to the large and growing United States Hispanic population.

National, state, and local fire agencies should consider the rich array of ideas found in this global research on best practices. There are many innovative, proven prevention programs that will likely increase residential fire safety. There also are many ways to increase outreach and impact of conventional programs and there is little doubt that major savings are possible in life and property loss if fire departments use the established ideas.

The following are some of the more important ideas: home visits made to most households by firefighters, primarily to increase the percent of households with working smoke alarms; soliciting sponsorships of fire safety education from industry and wealthy individuals; wide-scale programs to reach school children; mandated use of residential sprinklers (British Columbia); mandated working smoke alarms on every story of a home (Ontario); and tailoring fire safety programs to be culturally sensitive to their targeted audience.

TriData. (1997). Fire death rate trends: An international perspective. Arlington, VA. Found at: http://www.usfa.dhs.gov/downloads/pdf/statistics/internat.pdf

The data and analyses presented in this report depict an unfortunate but correctable situation. The United States has one of the premier firefighting forces in the world, but we need to focus more on prevention and less on putting out fires once they have started. Time line data show that while the situation in the U.S. has improved, we still lag behind other countries in the relative loss of life due to fires. Other countries have demonstrated that it is possible to save lives by expending more energy and funding on fire prevention and fire education. While current institutional arrangements and cultural attitudes make wholesale adoption of foreign fire prevention methods unlikely, the experiences of other countries provide the U.S. fire service with a wealth of information and ideas that can be integrated into current firefighting practices and services.

Among the strategies that appear to offer the best means of “reinventing” fire protection in the United States are: better funding and fire department staffing of fire prevention activities; improving public awareness of the fire problem; changing attitudes about the acceptability of fires; teaching people how to protect themselves from fire; and teaching people what to do in the event of a fire to minimize the losses to both persons and property.

Warda, L., Tenenbein, M., Moffatt, M.E.K. (1999). House fire injury prevention update Part II. A review of the effectiveness of preventive interventions. *Injury Prevention, 5*, 217–225.

The objective of the paper is to evaluate and summarize the house fire injury prevention literature. This review of house fire prevention interventions underscores the importance of program evaluation. There is a need for more rigorous evaluation of educational programs, particularly those targeted at schools. An evidence based, coordinated approach to house fire injury prevention is critical, given current financial constraints and the potential for program overload for communities and schools.

Policies and Strategies for Reducing, Preventing Fire Deaths: Sprinklers

Brown, H. (2005). Economic analysis of residential fire sprinkler systems. Gaithersburg: U.S. Department of Commerce Technology Administration, National Institute of Standards and Technology.
Found at: http://www.bfrl.nist.gov/oae/publications/nistirs/NISTIR_7277.pdf

This report designs and applies a comparative life-cycle cost analysis to multipurpose network and stand-alone fire sprinkler systems designed in compliance with NFPA 13D. The life-cycle costs of the systems are studied in each of three National Institute of Standards and Technology (NIST)-designed prototypical house floor plans: a two-story colonial with basement, a three-story townhouse, and a single-story ranch. The economic analysis includes those elements of life-cycle cost that are unique to each system, such as design, material, installation and inspection costs. Estimated cost results for all systems are within a close range, and are most sensitive to the decision to incorporate a backflow preventer. Both the cost data in this report and the cost-effectiveness analysis are intended to support a follow-on benefit-cost study by NIST on residential sprinkler systems.

Stand-alone sprinkler designs are least-cost in the Colonial and Townhouse, when backflow preventers are not included. When backflow preventers are included in the Colonial and Townhouse, a stand-alone system can be least-cost when annual backflow inspection costs are low, homeowner tenure is short, and discount rates are high. When annual inspection costs are higher, homeowner tenure is longer, or discount rates are low, then the multipurpose network system is least-cost. The multipurpose network system is least-cost in the Ranch whether backflow preventers are included or not.

Butry, D. T., Brown, M. H., & Fuller, S. K. (2007). Benefit-cost analysis of residential fire sprinklers. Gaithersburg: U.S. Department of Commerce Technology Administration, National Institute of Standards and Technology.
Found at: http://www.bfrl.nist.gov/oae/publications/nistirs/NISTIR_7451_Oct07.pdf

This report documents a benefit-cost analysis performed to measure the expected present value of net benefits resulting from the installation of a multipurpose network fire sprinkler system in a newly-constructed, single-family house. The benefits and costs associated with the installation and use of a fire sprinkler system are compared across three prototypical single-family housing types: colonial, townhouse, and ranch. The installation costs differ by housing types, with the colonial being the most expensive and the ranch the least.

The benefits experienced by residents of single-family dwellings with sprinkler systems, as measured in this report, include reductions in the following: the risk of civilian fatalities and injuries, homeowner insurance premiums, uninsured direct property losses, and uninsured indirect costs. The primary costs examined are for initial purchase and installation of the sprinkler system. Maintenance and repair costs are not examined because they are negligible.

Results of the benefit-cost analysis show that multipurpose network sprinkler systems are economical. The expected present value of net benefits (PVNB) in 2005 dollars is estimated as $2919 for the colonial-style house, $3099 for the townhouse, and $4166 for the ranch-style house. A sensitivity analysis is performed to measure the variability of the results to changes in the modeling assumptions. The sensitivity analysis confirms the robustness of the baseline analysis. The PVNB range from $704 to $4801 for the colonial-style house, from $884 to $4981 for the townhouse, and from $1950 to $6048 for the ranch-style house. Multipurpose network systems are the lowest life-cycle cost systems because homeowners can perform their own regular inspections and maintenance, and thereby save on costs they would incur with other systems. Given that they provide a similar level of performance, in terms of fire-risk mitigation, multipurpose network systems then achieve greater cost-effectiveness over alternate systems.

Dewar, B. (2001). Residential fire sprinklers for life safety: An economic and insurance perspective. Prepared for the Orange County Fire Authority, California. Found at: http://www.nfsa.org/info/residential/econsprinklers.pdf

The United States has one of the highest fire loss rates of the industrialized world – in terms of both fire deaths and fire losses. This unenviable status has mystified world fire service experts because the solution to significantly reduce the fire death rate is available and affordable. The simple solution to minimize our nation's fire death rate is residential fire sprinklers. But there exists opposition to installing these new technologically advanced residential fire sprinklers because of economic reasons. This paper will focus on the economic concerns of installing residential fire sprinklers with specific focus on *affordable housing* and *insurance rate reductions.* This study will discuss the U.S. fire problem as well as the cost of installing residential fire sprinklers. The impact of an increase in the asset price for new housing by discussing the many underlying forces that affect supply and demand of housing is analyzed. The paper also

discusses actions that may be taken by local government to make the installation of residential fire sprinklers economically palatable for the homebuilder and the public.

Fleming, R. P. (2002). What drives the cost of residential sprinklers? *National Fire Protection Association Journal.*
Found at: http://findarticles.com/p/articles/mi_qa3737/is_200211/ai_n9114936

During the development of the 2002 edition of NFPA 13D, Sprinkler Systems for One- and Two-Family Dwellings and Manufactured Homes, there was a great deal of debate as to whether certain changes in the standard would increase system costs. The real culprits in the story of unnecessary system costs aren't these code requirements, but community requirements such as excessive meter charges, tap-in fees, water standby charges, and others that exceed the minimum standards. Recent reports from progressive communities such as Scottsdale, Arizona, indicate that residential sprinklers can be installed economically and that they perform exceptionally well in the field. Communities that want to emulate Scottsdale's success should focus on eliminating their excessive installation requirements, all of which create obstacles to low-cost residential- sprinkler protection.

Ford, J. (1997). Saving lives, saving money, automatic sprinklers, a 10 year study: A detailed history of the effects of the automatic sprinkler code in Scottsdale, Arizona. Home Fire Sprinkler Coalition.
Found at: http://www.nfsa.org/info/sprinklers.PDF

In the early 1980's, a unique opportunity presented itself to the rapidly growing City of Scottsdale, Arizona and the Rural/Metro Fire Department. This report will look specifically at one community's history and efforts to address the fire problem. It will outline the steps used in Scottsdale to research, adopt, implement, and now evaluate the benefits that this community received as a result of embracing and using sprinkler technology to help address the current and future fire problem.

The research suggests that cost and economics associated with built-in protection can be addressed through design freedoms without negatively impacting fire suppression effectiveness. The impact and installation costs have been reduced dramatically, from $1.14 sq. ft to $0.59 sq. ft. The average fire loss per sprinklered incident was only $1,945, compared to a non-sprinklered loss of $17,067. Automatic protection had a direct role in saving eight lives. One or two heads controlled or extinguished the fire 92% of the time, with the majority of the exceptions a result of flammable liquid incidents. Estimated water flows were substantially reduced for this community. The potential structural fire loss has been dramatically reduced for sprinklered incidents. When the city finally reaches its full growth potential, it is estimated that it will be a community with over 300,000 residents and more than 65% of the residential homes and 85% of commercial property protected with automatic sprinkler systems. There are many more examples of the experiences and benefits in the report that follows.

Hall Jr., J. R., (2007). U. S. experience with sprinklers and other automatic fire extinguishing equipment. National Fire Protection Association. Quincy, MA.
Found at: http://www.nfpa.org/assets/files//PDF/OSsprinklers.pdf

Automatic sprinklers are highly effective elements of total system designs for fire protection in buildings. They save lives and property, producing large reductions in the number of deaths per thousand fires, in average direct property damage per fire, and especially in the likelihood of a fire with large loss of life or large property loss. When sprinklers are present in the fire area, they operate in 93% of all reported structure fires large enough to activate sprinklers, excluding buildings under construction. When they operate, they are effective 97% of the time, resulting in a combined performance of operating effectively in 91% of reported fires where sprinklers were present in the fire area and fire was large enough to activate sprinklers. In homes (including apartments), wet-pipe sprinklers operated effectively 96% of the time. When wet-pipe sprinklers are present in structures that are not under construction and excluding cases of failure or ineffectiveness because of a lack of sprinklers in the fire area, the fire death rate per 1,000 reported structure fires is lower by 83% for home fires, where most structure fire deaths occur, and the rate of property damage per reported structure fire is lower by 40-70% for most property uses. In homes (including apartments), wet-pipe sprinklers were associated with a 74% lower average loss per fire. Also, when sprinklers are present in structures that are not under construction and excluding cases of failure or ineffectiveness because of a lack of sprinklers in the fire area, 95% of reported structure fires have flame damage confined to the room of origin compared to 74% when no automatic extinguishing equipment is present. When sprinklers fail to operate, the reason most often given (53% of failures) is shutoff of the system before fire began. (All statistics are based on 2003-2007 fires reported to U.S. fire departments, excluding buildings under construction.)

Hart, F. L., Nardini, C., Till R., & Bisson, D. (1993). Backflow Protection and Residential Fire Sprinklers. Journal of American Water Works Association.
Found at: http://www.usfa.dhs.gov/downloads/pdf/publications/fa-12054.pdf

This report addresses risk versus benefit issues associated with the installation of residential fire sprinkler systems. A primary objective of this assessment is to rate the risk of potable water contamination from a residential sprinkler system, and consequently to evaluate the need for installing backflow prevention devices. Statistics and assumptions outlined in this report show that the present risk from fire (death and/or injury) is 11.1 times higher than the present risk of waterborne disease (illness). This finding alone demonstrates a significant benefit from installing residential sprinkler systems.

Home Fire Sprinkler Coalition. Building for life. Frankfort, IL.
Found at: http://www.dos.state.ny.us/code/pdf/Building for Life.pdf

Fires kill more people in the United States every year than all natural disasters combined. 80% of all fire deaths occur in the home. The single most effective way to prevent fire related deaths is the installation of residential fire sprinklers. Combined with smoke alarms, they cut the risk of dying in a home fire by 82% compared to having neither.

Fire sprinklers can save money for developers, builders, home owners, and communities. Through the use of trade-ups, developers and builders can achieve reduced construction costs while providing higher value homes for their customers. In the event of a home fire, homeowners can expect financial losses
90% lower than those that occur from fires in unsprinklered homes. Communities can deploy emergency services resources more effectively by reducing the burden caused by home fires.

Home Fire Sprinkler Coalition. (2006). New national survey shows a majority of homeowners believe that fire sprinklers increase a home's value. Frankfort, IL.
Found at: http://www.homefiresprinkler.org/releases/HarrisPoll.html

In a new national poll commissioned by the nonprofit Home Fire Sprinkler Coalition (HFSC) and conducted by Harris Interactive®, 45 percent of U.S. homeowners said a sprinklered home is more desirable than an unsprinklered home, most often because of the added safety provided by the sprinklers (51%). The survey also found that 69 percent of homeowners believe having a fire sprinkler system increases the value of a home, and 38 percent say they would be more likely to purchase a new home with sprinklers than one without.

Yet widespread misconceptions about sprinklers apparently undermine interest in the technology among both homeowners and home builders. For 48 percent of homeowners, a fear of water damage would prevent them from installing a home sprinkler system. The HFSC survey showed that 63 percent of homeowners were aware fire sprinklers are available for home use. Builders who offer fire sprinklers as a standard feature of new homes fared well in the study. These builders are seen by homeowners as being "safety concerned" (70%), "innovative" (52%), and "caring" (51%). Thirty-nine percent of homeowners said they would be more likely to hire such a builder to build their house over a builder that does not offer fire sprinklers as a standard feature.

The increased safety provided by sprinkler systems is also well understood. When thinking about building a new home, many homeowners say they would prefer to install a fire sprinkler system over other amenities, such as cabinet upgrades (35%) and hardwood floors (36%). And if the cost of sprinklers could be included in the mortgage, 43 percent of homeowners said they would be more likely to have home fire sprinklers installed. While most (85%) homeowners say they completely trust the fire department

as a source for information about fire sprinklers, about two in five homeowners (40%) say they completely trust home builders for these details.

Milke, J. A. (2003). Summary of Meeting—United States Fire Administration. National Residential Fire Sprinkler Initiative.
Found at: http://www.usfa.dhs.gov/downloads/pdf/nrfsi-03report.pdf

The following policy statement was developed at this meeting to reflect the motivation for a renewed National Residential Fire Sprinkler Initiative:

> "The United States Fire Administration advocates the use of automatic fire sprinklers to save lives, reduce injuries, and protect property. Based on an identified history of success, this technology should be employed in all residential occupancies."

As described in this report, several strategies were proposed at this meeting for the National Residential Fire Sprinkler Initiative. Some of these strategies were significant in their difference from previous thrusts, including the concept of localized sprinkler protection in the kitchen area of existing homes. Other strategies consisted of an expansion of existing ideas, such as developing broader-based coalitions composed of a wide range of organizations and Federal agencies to develop educational and policy-related plans to promote residential sprinkler systems. Other topics discussed in the summary are the identification of the impediments to greater acceptance of residential sprinkler systems, identification of solutions to overcome the impediments, and development of national strategies to implement the solutions.

National Fire Protection Association. (2011). News release: Home fire sprinklers offer environmental benefits and reduce water infrastructure demand.
Found at: http://www.nfpa.org/newsReleaseDetails.asp?categoryid=488&itemId=50509
The Fire Protection Research Foundation's (FPRF) new report, Residential Fire Sprinklers – Water Usage and Water Meter Performance Study, finds that the amount of water used in fighting fires in homes without fire sprinkler systems can be many times higher than the amount discharged by a fire sprinkler system with a 10 minute operation. In addition to saving lives and property, sprinklers have added environmental benefits, including water conservation and the potential to reduce water infrastructure demands in communities, according to this study.

National Fire Sprinkler Association. (2006). Water purveyor's guide to fire sprinklers in single family dwellings. Found at:
http://www.nfsa.org/info_items/Water_Purveyors_Guide.pdf

This guide will provide a water purveyor with information on the topics that need to be addressed in preparing a jurisdiction for fire sprinklers in single-family dwellings. Although there is general information provided on all sprinkler systems this guide will concentrate on fire sprinkler system for one- and two-family dwellings, manufactured homes and townhouses. In order to save space, this guide will refer to "single family dwellings" or "homes" to make a distinction between this kind of building and a larger multi-family building like an apartment building or multi-unit condominium. In all cases, the rules that apply to single family dwellings or homes also apply to two-family dwellings, manufactured homes and townhouses that are built with sufficient separation to be considered individual homes or two-family buildings.

New York State Builders Association Research and Education Foundation, Inc. (2007). Reducing fatal fires in New York State's new one- and two-family homes: Is mandating the installation of fire sprinkler systems the best course of action?
Found at: http://www.dos.state.ny.us/code/pdf/Reducing Fatal Fires in New York.pdf

The New York State Builders Association Research and Education Foundation is recommending the continued use of smoke detecting alarms, and education of the public on their maintenance, along with vigilant existing code compliance, as the best courses of action to reduce fatal fires in New York State's new one- and two-family homes. Data included in this study show that the average home in which a fire fatality occurred was built in 1940. These homes probably did not have operational smoke detecting alarms and were not built to today's standards. Mandating residential fire sprinklers in homes in New York State is not an economically sound idea. Fire sprinklers have operational shortcomings, and they have not been proven to save more lives. Additionally, the costs will create barriers to entry level homebuyers.

Newport Partners for the Fire Protection Research Council. (2008). Home fire sprinkler cost assessment.

Residential fire sprinkler ordinances have been adopted by several hundred United States communities for use in single-family dwellings. Such systems have been shown to provide significant life safety benefits, however the installed cost of these systems remains as a point of uncertainty and a potential barrier to broader adoption. Informal estimates of typical installation costs can vary widely and influence decision makers' views on the viability of sprinkler systems in new homes. Accordingly, the purpose of this study is to provide a national perspective on the cost of home fire sprinklers by developing data on installation costs and cost savings for ten communities distributed throughout the United States. The study also explores the range of insurance premium discounts which are available to homeowners with sprinkler systems in their houses.

Ray, S. (2004). Motivating fire chiefs to promote fire sprinklers: Leading community risk reduction. Pleasant View, TN.

The problem this research project addressed was the fact that a marketing kit for fire chiefs regarding the importance of fire sprinklers and the need for legislation that requires them does not exist. The purpose of this research was to assess the current opinion of a target group of fire chiefs and utilize their feedback to create a marketing kit that was appropriate to share with fire chiefs across the nation. A literature review and targeted fire chief survey were the primary procedures utilized in the study. The results of the information gathered and analyzed created a marketing kit and educational program action plan. The marketing kit was designed to provide the information needed, and the educational program was designed to motivate the fire chief.

Scottsdale report: A 15-year study. (2002). North Carolina Firemen's Association.
Found at: http://www.dos.state.ny.us/code/pdf/Scottsdale Report 15-Year Study.pdf

The Scottsdale Sprinkler Ordinance was implemented 1/1/86 and evaluated through 1/1/01. More than 50% of the 41,408 homes had sprinklers. Of the 598 home fires, only 49 occurred in sprinklered homes. There were no deaths in sprinklered homes; however, there were 13 deaths in homes without sprinklers. Less water damage occurred in sprinklered homes. (Sprinkler systems discharged an average of 341 gallons of water per fire compared to an average of 2,935 gallons that would have been released by firefighter hoses.) Additionally, there was less fire damage in sprinklered homes with an average fire loss per single family sprinklered fire incident totaling $2,166. This is compared to an average fire loss per unsprinklered home incident totaling $45,019.

Siarnicki, R. J., (2001). Residential sprinklers: One community's experience twelve years after mandatory implementation. Prince George's County, MD.

The purpose of this research paper is to take a look at one community's experience with the introduction of residential sprinklers into the housing market and, more importantly, what results have been acquired twelve years after a mandatory ordinance was enacted. The community is Prince George's County, Maryland, who has an ordinance requiring that residential sprinkler systems be installed in all new construction. This research includes a literature review, subject matter expert interviews, and eight years of documentation by the PGFD concerning all residential sprinkler activations that had occurred in that time period. Results of the research revealed that the department was able to document reduced fire damage and significant lives saved.

US Fire Administration and Federal Emergency Management Association. (2008). USFA position paper: Residential fire sprinklers. Emmitsburg, MD.
Found at: https://www.usfa.dhs.gov/downloads/pdf/sprinkler_position_paper.pdf

Much has been written about the reduction of residential fire deaths due to improvements in building codes and the installation of smoke alarms. Without a doubt, these have had a substantial impact on the home fire problem. The annual number of fire deaths in residential occupancies continues to decline. The trend in fire death data, however, shows that the number of residential fire deaths is declining at a slower rate over the past 10 years than it did in the period 1977 through 1995.

Full-scale fire tests in residential settings suggest an explanation for this slowing in the rate of decline in residential fire deaths. The available time to escape a flaming fire in a home has decreased significantly (i.e., from 17± 6 minutes in 1975 to 3± ½ minute in 2003). This decrease in time to escape has been attributed to the difference in fire growth rates of the representative samples of home furnishings used in the two studies6. In short, it appears that a fire involving modern furnishings grows faster than a fire involving older furnishings. The practical impact of this finding is clear – smoke alarms alone may not provide a warning in time for occupants to escape a home fire.

Xu, L. (2007). Fire sprinklers and homeowner insurance. Prepared for: National Association of Home Builders.
Found at:
http://www.dos.state.ny.us/code/pdf/Fire Sprinklers and Homeowner Insurance.pdf

Fire sprinkler proponents sometimes allege that such savings already exist in the form of reduced rates on home owner insurance. This article studies that particular issue. From the insurer's point of view, sprinklers may generate savings, but also additional costs. Savings to insurance companies occur if sprinklers extinguish fires in their early stage or contain fires until the fire fighters get to the scene —resulting in reduced injuries, deaths, and property damage. Additional costs may occur if sprinklers discharge accidentally and cause unnecessary water damage. Insurance companies thus have both the means and incentive to track savings and costs associated with sprinklers. If the expected savings are greater than the expected costs, it should show up as discounts on insurance for owners of homes with fire sprinklers. Information compiled from various sources for this article indicates that most insurers do offer meaningful discounts for residential sprinkler systems. The discounts vary somewhat from state to state, but are not high enough in any state to offset the added upfront cost buyers pay for sprinklers.

Policies and Strategies for Reducing, Preventing Fire Deaths: Smoke Alarms

Ahrens, M., (2009). Smoke alarms in U.S. home fires. NFPA Division of Fire Analysis and Research.

Almost all households in the U.S. have at least one smoke alarm, yet in 2003-2006, smoke alarms were present in only two-thirds (69%) of all reported home fires and operated in just under half (47%) of the reported home fires. ("Homes" includes one- and two-family homes, apartments, and manufactured housing.) Forty percent of all home fire deaths resulted from fires in homes with no smoke alarms, while 23% resulted from homes in which smoke alarms were present but did not operate. The death rate per 100 reported fires was twice as high in homes without a working smoke alarm as it was in home fires with this protection. Hardwired smoke alarms are more reliable than those powered solely by batteries.

Arai, L., Roen, K., Roberts, H., Popay, J. (2005). It might work in Oklahoma but will it work in Oakhampton?: Context and implementation in the effectiveness literature on domestic smoke detectors. *Injury Prevention, 11,* 148–151
Found at:http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1730217/pdf/v011p00148.pdf

The objective of this study is to explore data on factors affecting implementation processes in papers contributing to a Cochrane systematic review (SR) of smoke alarm interventions, supplemented by further papers not included in the review. Relatively few data were found to help people seeking to implement smoke alarm promotion interventions. For practitioners and policymakers to be able to build on research evidence, researchers and journal editors need to ensure that sufficient data are published, or are otherwise available to interested parties to move from understanding the evidence to using it.

DiGuiseppi, G., Roberts, I., Wade, A., Sculpher, M., Edwards, P., Godward, C., Pan, H., & Slater, S. (2002). Incidence of fires and related injuries after giving out free smoke alarms: cluster randomised controlled trial. *BMJ, 325(*2).

Residential fires caused 466 deaths and 14 600 non-fatal injuries in the United Kingdom in 1999. The risk of death from fire is associated with socioeconomic class, partly because of social differences in the risk factors for fires and in ownership of smoke alarms. The risk of death in a house fire is three times higher in homes without smoke alarms.

The objective of this paper is to measure the effect of giving out free smoke alarms on rates of fires and rates of fire related injury in a deprived multiethnic urban population. According to the study, giving out free smoke alarms did not reduce injuries related to fire, admissions to hospital and deaths, or fires attended by the fire brigade. Similar proportions of intervention and control households had installed alarms and working alarms. Widespread implementation of programs giving away smoke alarms may waste resources and be of little benefit unless alarm installation and maintenance is assured. The results suggest that simply giving alarms to poor, urban households is unlikely to reduce injuries related to fire.

Istre, G.R., & Mallonee S. (2000). Smoke alarms and prevention of house-fire–related deaths and injuries. *Western Journal of Medicine, 173*, 92-93.

The opportunity exists to mobilize our collective efforts with the goal of eliminating deaths related to house fires in the United States. A multifaceted approach to elimination should include the distribution of smoke alarms, education about fire prevention, legislation to require smoke alarms in all existing residences and fire sprinkler installation where possible, enforcement of existing codes, and development of new and better long-lived smoke alarms. Such an approach can take us well along the road to eliminating deaths related to house fires.

Primary care physicians can play an important role in this preventive effort in at least 2 ways. First, physicians can educate patients about the importance of fire prevention, escape plans, and smoke alarms, including issues about nuisance alarms and how to deal with them. Second, physicians can advocate for a community-based approach to try to reach those persons at greatest risk through programs such as smoke alarm distributions. Through a collaborative approach among physicians, public health agencies, fire departments, private industry, and volunteer groups such as the Red Cross, house-fire–related deaths may one day become as rare as some vaccine-preventable diseases.

Mallonee, S., Istre, G.R., Rosenberg, M., Douglas, M.R., Jordan, F., Silverstein, P., & Tunell, W. (1996). Surveillance and prevention of residential-fire injuries. *The New England Journal of Medicine, 335(*1*)*, 27-31.

The majority of severe and fatal burn injuries result from residential fires. We studied the effectiveness of a smoke-alarm–giveaway program in the prevention of burn injuries in an area with a high rate of such injuries. Before the intervention the rate of burn injuries per 100,000 population was 4.2 times higher in the target area than in the rest of Oklahoma City. An initial survey indicated that 11,881 of the 34,945 homes in the target area (34 percent) did not have smoke alarms. A total of 10,100 smoke alarms were distributed to 9291 homes; 45 percent were functioning four years later. The annualized fire-injury rates declined by 80 percent in the target area during the four years after the intervention (from 15.3 to 3.1 per 100,000 population), as compared with a small increase in the rest of the city (from 3.6 to 3.9 per 100,000 population). There was also a 74 percent decline in the target area in the injury rate per 100 fires (from 5.0 to 1.3; rate ratio, 0.3; 95 percent confidence interval, 0.1 to 0.6), as compared with a small increase in the rest of the city. A targeted intervention involving a smoke-alarm–giveaway program can reduce the incidence of injuries from residential fires.

Roberts, I., & Diguiseppi, C. (1999). Smoke alarms, fire deaths, and randomised controlled trials. *Injury Prevention, 5*, 244-246.

Neither giving away free smoke alarms nor enacting legislation requiring alarm installation in materially deprived areas will necessarily increase the prevalence of *functioning* alarms. A survey of inner London public housing found that only half of installed smoke alarms were functioning. In most cases of non-function, the installed alarms had no batteries. However, failure to maintain a functioning smoke alarm does not signal a feckless disregard for safety. Although residential fires are a leading cause of death in childhood, for families living in the inner city slums there are many competing concerns. Without reliable evidence of effectiveness and cost effectiveness, smoke alarm giveaway programs or legislation run the risk of diverting scarce resources from other important concerns that may have greater benefit to the population.

Randomized controlled trials are the gold standard for the evaluation of healthcare interventions. There is no good reason why interventions to prevent fire injury should not be evaluated in the same way. Smoke alarms are only one approach to the prevention of fire deaths and injuries, but a particularly promising one. Some countries and states mandate the use of smoke alarms, others do not. On the basis of the existing evidence it is easy to make an argument for smoke alarm legislation, but it is also an easy argument to refute. Reliable evidence from large scale randomized controlled trials of smoke alarm interventions could change this.

Rowland, D., DiGuiseppi, C., Roberts, I., Curtis, K., Roberts, H., Ginnelly, L., Sculpher, M., & Wade, A. (2002). Prevalence of working smoke alarms in local authority inner city housing: randomised controlled trial. *BMJ, 325*, 998–1001.
Found at: http://www.bmj.com.proxy.lib.utk.edu:90/content/325/7371/998.full.pdf

The objective of this study is to identify which type of smoke alarm is most likely to remain working in local authority inner city housing, and to identify an alarm tolerated in households with smokers. One of five types of smoke alarm (ionisation sensor with a zinc battery; ionization sensor with a zinc battery and pause button; ionization sensor with a lithium battery and pause button; optical sensor with a lithium battery; or optical sensor with a zinc battery) were installed in 2145 local authority housing estates in inner London. Nearly half of the alarms installed were not working when tested 15 months later. Type of alarm and power source are important determinants of whether a household had a working alarm.

Shults, R.A., Sacks, J.J., Briske, L.A., Dickey, P.H., Kinde, M.R., Mallonee, S., & Douglas, M.R. (1998). Evaluation of three smoke detector promotion programs. *American Journal of Preventive Medicine, 15,* 165-171.

Seventy percent of U.S. residential fire deaths occur in homes without a working smoke detector. To help prevent residential fire deaths, many programs have distributed or installed detectors in unprotected homes. Because persons receiving a detector may not install it and because detector batteries require annual replacement, the enduring effectiveness of these programs may be questioned. This study evaluated the long-term functional status of smoke detectors distributed to high risk households in eight areas of Minnesota, Cherokee County (North Carolina), and Oklahoma City (Oklahoma).

Participation rates ranged from 72% to 82%. The percentage of evaluation households with at least one working detector ranged from 58% in Oklahoma to 73% in North Carolina. In 76% of households with nonworking detectors, the batteries were either missing or disconnected. When batteries in nonworking detectors were replaced, 83% of the detectors regained function.

Future programs should consider distributing detectors that do not require annual battery changes or find effective ways to ensure that batteries are routinely replaced.

Programs should also provide each household with the number of detectors needed to meet the most current recommended standard of the National Fire Protection Agency. The evaluation's participation rates support the practicality of unannounced home visits to evaluate home injury prevention programs in high-risk groups.

Policies and Strategies for Reducing, Preventing Fire Deaths: Public Education & Outreach

Philip Schaenman, P., Lundquist, B., Stambaugh, H., Camozzo, E., & Granito A. (1987). Overcoming barriers to public fire education in the United States. TriData. Found at: http://www.sysplan.com/documents/tridata/prevention/Overcoming_Barriers.pdf

Virtually every fire department in the United States carries out at least some public fire education. Many departments have good programs that reach part of their community's population, but only few can say that they *regularly* reach *most* of their population with *effective* programs. None of our large departments reach the level of fire prevention education practiced in the best European or Japanese cities. While surveys of our fire officials show that they believe fire prevention is highly important, it is in fact one of the least supported functions in our fire departments. The subject of this study was to identify the barriers to public education. Information on barriers to doing a better job in public fire education was gathered from over one hundred in-depth interviews with practitioners in city management, schools, fire service, and insurance. The authors have provided examples of how to overcome these barriers. Recommendations include: form a citizen's committee for fire prevention, link prevention to cost reduction or productivity improvement, show the school administrator evidence that the children in the community do not have adequate fire safety knowledge, and select and train recruits with an eye toward their future public fire education responsibilities as well as their suppression duties.

Schaenman, P., Stambaugh, H., Rossomando, C., Jennings, C., & Perroni, C. (1990). Proving public fire education works. Tri Data. Found at: http://tridatacorp.com/documents/tridata/prevention/PublicFireEdu.pdf

Despite a long-term downward trend, the United States continues to have one of the highest fire death rates per capita in the world. Part of the reason for this is the lack of adequate public fire education. That stems partly from a lack of confidence that public fire education really works. Unfortunately, local government budgeteers and many fire chiefs are among the skeptics who question public fire education's effectiveness. This report provides data that indicate that good public fire education does, indeed, work. It also describes a methodology for evaluating public education, with the hope that as more people know how to evaluate their own programs, they will be able to marshal better evidence for budgets and public support.

As our research progressed, we found more than 70 good examples spread across the United States and Canada, from large cities to small rural communities. This collection of case studies not only shows that public education works, but demonstrates that it is probably more productive in terms of casualties and dollar loss saved per staff-year than any other aspect of fire protection. Evidence in this report suggests that tripling the size of public education efforts, which can be accomplished by a minor shift in staff assignments in most departments, would produce enormously beneficial results. The assembled case studies also provide a wealth of examples of different types of public education programs. Names, addresses, and telephone numbers of contacts for the programs are provided for those who want additional information.

Appendix B
Links to Maps and Data Files

Maps for Incidents and Census Tract Risk Groups:
http://ctasgis02.psur.utk.edu/TNFireMortality/

Appendix C
TN Fire Chiefs Survey and Responses

Your responses to these questions are an important part of the University of Tennessee study of civilian fire fatalities in Tennessee residences. This survey should take about 10 minutes to complete. Neither your name, community, fire department ID, nor any other identifying information will ever be linked to your responses in any document. Only aggregate responses will be tabulated.

1. What is your fire department ID# ? * Required

____

2. Please provide your contact information here.

===

First Name

____

Last Name

____

Email Address

____

3. What was the total number of firefighters in your department in 2010?

____

Of that total, how many were:

Full-time _________________

Part-time _________________

Volunteer _________________

4. About how long (in years) have you served in your current position as fire chief?

____

5. About how many people lived in the area served by your fire department in 2010?

____

6. How would you rate the overall level of applicable codes enforcement (building, housing, electrical, plumbing, etc.) in the community served by your fire department during the nine year period of 2002 through 2010?

(1) Very poor
(2) Poor
(3) Fair
(4) Good
(5) Excellent

7. How receptive, if at all, do you think the citizens in the community you serve would be to the idea of requiring newly constructed homes to be equipped with sprinkler systems?

(1) Not at all receptive
(2) Slightly receptive
(3) Moderately receptive
(4) Receptive
(5) Very receptive
(6) Don't know / Not sure

8. Please rank each of the following in order of importance with respect to how you think each may help to prevent or reduce the risk of someone dying in a home fire in TN.
Use the following to rank the programs:

1 = most important
2 = second in importance
3 = third in importance
4 = fourth in importance
5 = least important

Please do not use the same ranking for more than one program. For example, only one program can be ranked "most important."

Home Sprinkler System ________________
Codes Enforcement ________________
Fire Safe Cigarettes ________________
Fire Safety Demonstrations/Instruction at Local Schools ________________
Smoke Alarm Distribution/Installation ________________

9. Considering your fire department's resource constraints, how would you assess your department's level of involvement in providing various types of fire safety and prevention education activities in the community during the two year period of 2009 thru 2010?

(1) None or virtually non-existent
(2) Low
(3) Moderate
(4) High
(5) Very high

10. Do any personnel in your fire department have an assigned responsibility for conducting fire safety and prevention education in the community?

(1)No
(2) Yes
(3) Don't know / Not sure

10a. Which of the following best describes who is responsible for implementing this program:

(1) Staff whose exclusive or main assignment is fire safety and prevention education
(2) Staff in the fire department who have fire safety and prevention education as just one of their shift responsibilities
(Text answers) Other (please explain briefly)

11. Please indicate whether your fire department engaged in any of the following activities during 2009 or 2010.
Then, for each activity, whether or not performed by your department, please indicate how valuable or useful you think that the activity was or would be in promoting fire prevention/safety in the community.

	Yes	No	Low	Moderate	High
	1	2	1	2	3
Conducted Fire Safety presentations/ demonstrations to school-age children					
Shared Fire Safety Education Resources with local teachers and parents					
Conducted Free Home Fire Risk Assessments					
Distribution/installation of Smoke Alarms					
Conducted smoke alarm battery replacement program(s)					
Assisted with inspection of distribution of information about residential sprinkler system					
Distribution/installation of fire extinguishers					
Arranged for Fire Safety Vans or Mobile Education Units to Schools					
Arranged for Class visits to Fire Stations					
Conducted Fire Safety Workshops for Parents of Pre-schoolers					

Provided fire safety training to professional care-
givers to the elderly or disabled

Fire Station Open House & Demonstration Events

Fire safety Week or Month Events

<u>Fire Chiefs' Responses to Open-Ended Question #12</u>: "What are the one or two policies, strategies, or actions that you think would have the most impact on preventing or reducing residential fire deaths and that you would like to see implemented or expanded in your community?"

Try to have all homes with at least one smoke detector
Sprinkler systems in all new buildings, home and business. adopt new building and fire codes 2009 or newer. we are still in the 1992 southern building code ?????
More PSA's for Home Fire Sprinklers
Better roads and water supply
Enforcing the current TCA codes and laws that are in force now. We do not have a fire Marshall in our County, therefore we cannot enforce the laws. We have new construction-two story-four family apartments un-sprinkled residences and no enforcement. I know another County in Tennessee with the same problem.
Door to door smoke detector program
The continued push to ensure all residence have a working smoke/fire alarm. The push to ensure that is imperative this is the only alarm available to most residence. Even if Home sprinklers were initiated the residence most impacted by fire would not be covered due to the cost. The second thing would be to continue to improve fire prevention education and attempt to ensure we are able to reach the most vulnerable demographic of residence in our community. Home fire sprinklers would prove a great impact but the effect would not be seen for a while though i think that is important the most pressing should be addressed 1st. . Early and prompt notification will save lives if working properly.
We must educate our firefighters on the importance of promoting fire prevention.
Distribution of Smoke Alarms and Educating our youngest on Fire prevention...and how to get out and call fire department....
Working smoke detectors in every home by distribution and installation.
Smoke detector programs
We already have the latest code adopted and all new construction must install fire sprinklers regardless of size or occupancy. However, we need a rental inspection and licensing program for rental properties and we don't do enough for high school kids preparing for college.
Awareness and education to parents and citizens of the community. Smoke detector and battery replacement programs.
Better Codes on building construction.
Finding a way to emphasize the importance of smoke alarm installation and maintenance in residential homes. Insurance companies could offer discount incentives to insured who properly install, maintenance, and certify annual inspection.

more funding to be able to educate community more
Code Enforcement
Home sprinkler systems in all homes and at the very least rural areas.
more education for both the kids and adults
Burn Permits are required in the city year round. Fire codes on new and existing buildings enforced.
require all occupancies have smoke alarms require sprinklers
Being able to talk with parents and the community on fire safety! We are not able to do this very much with our tight budget!
residential sprinkler ordinance and require all residential occupancies to have hardwired smoke detectors
Inspection of all homes in a regular bases, at least once a year for smoke detectors in home and require training for grade school children.
residential sprinkler, more grants for smoke alarms and make time to install them, set up a battery replacement program and continue all areas of education in the public sector
Improved fire code enforcement and more pro active approach from building inspector regarding fire and life safety. Increased public awarness of residential sprinklers and their effectiveness.
Public education, especially among our senior citizens. This has had a "trickel down" effect with some in our communities. Schools need to be required to include a fire prevention program within their curriculum.
better smoke alarm distribution and testing
I think sprinkler systems in all new construction would eventually save lives. However, it is the older homes inhabited by low income and often less educated individuals that seem to be the most dangerous. Strict codes enforcement of existing structures and mandatory smoke alarms in all residences would be a step in the right direction.
MANDATORY POWER WITH BATTERY BACK-UP SMOKE ALARMS IN ALL RENTAL PROPERTY THAT ARE TAMPER RESISTANT.
Neighborhood delivery of escape and prevention education in low income housing areas.
Residential Sprinklers
citizens fire academy for business and professional citizens; and residential home safety inspection program.
I would like to see more fire hydrants installed.
Distribution and installation of smoke alarms.
Public announcements about fire safety and smoke detectors. It would be good to give away smoke detectors and inform the public about proper installation, how many they need per square ft. and when to change the batteries.
Required residential sprinkler codes for everyone.
Getting into the community a lot more but one problem we have is the restrictions put onto volunteer departments in having to have someone to be certified to be able to go into the homes and help with the prevention and the monies to do community programs for this, its just volunteer Fire Departments AND WE CANNOT afford to do a lot of these things in the community. These things need to be done its very important. JUST WISH EVERYONE WOULD REALIZE WE ARE A VOLUNTEER DEPARTMENT NOT FULL TIME BUT SEEMS THAT EVERYTHING IS EXPECTED OF US TO OPERATE AS A FULL TIME DEPARTMENT!

1. Smoke, heat, fire detection and suppression system installation with maintenance reminder PSAs (example:battery change for smoke detectors) 2. Comprehensive fire safety inspection program available for residential occupancies(voluntary) and public facilities (mandatory).
Smoke Alarms and maintaining them. Building inspectors
The continued push to ensure all residence have a working smoke/fire alarm. The push to ensure that is imperative this is the only alarm available to most residence. Even if Home sprinklers were initiated the residence most impacted by fire would not be covered due to the cost. The second thing would be to continue to improve fire prevention education and attempt to ensure we are able to reach the most vulnerable demographic of residence in our community. Home fire sprinklers would prove a great impact but the effect would not be seen for a while though i think that is important the most pressing should be addressed 1st. . Early and prompt notification will save lives if working properly.
More Smoke Detectors and Community taking more Interest in Fire Service
Provided fire safety training to professional care givers to the elderly or disabled and Distribution/installation of fire extinguishers.
Sprinkler education for all ages and construction types.
Laws enacted to enforce the installation of sprinklers in all residential homes and commercial facilities regardless of square footage.
1. Required residential sprinklers for new construction 2. 1-2 family residential structures built for the purpose of commercial use (rental cabin) be classified as commercial rather than residential and also have required sprinklers.
1. Home Sprinkler System 2.Smoke Alarm Distribution/Installation
Programs for parents of preschoolers and more public education in the schools.
While residential sprinklers would be obvious, wide spread use is still in the distant future. I tell everyone that I would not lay my head on my pillow without having a working smoke detector in my home. In 37 years of service in the Fire Department I have not experienced a death or injury in a structure fire with a working smoke detector. It is by far the most economical, best deterrent we have.
Continuation of Fire Education to the public. Implementing residential sprinklers code requirements.
Fire sprinklers; Additional smoke detectors for distribution
I would like to have more information given to the Homebuilders on residential sprinklers. Thier focus is cost and I am not sure they know how little the cost could be.
1. Wired in smoke detectors on all new residential construction. 2. Residential sprinklers.
Mandatory hydrant installation by all water departments, public and private. Mandatory funding of volunteer fire depts by the local AND state govt. Mandatory County Fire Marshall to enforce fire codes.
Require residential sprinklers
It would be wonderful to have the resources available to teach more pre-school thru high school children and adolescents about fire safety. I believe there is a need for the elderly or disabled to have someone available to actually meet and greet the people and then physically inspect their smoke detectors and residences for any dangers
Smoke detector program enhancement.
FULL TIME DEPT
Statewide effort in promoting and implementing residential sprinkler mandates within a certain minimum of square footage on new construction throughout the state.
The opportunity to distribute free smoke detectors to all households in our area of responsibility.

residential sprinklers
1. require new homes to have residential fire sprinklers 2. expand smoke alarm installations to more households 3. routine inspections for multi-family housing, especially w/o sprinklers.