SOCIOECONOMIC FACTORS AND FIRE

Fire Analysis and Research Division

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Abstract

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 higher for those between 18 and 64, inclusive. 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. Children account for almost twice the share of black victims as white. In more affluent areas, race played less of a role. The South and Midwest had the highest fire death rates per million population in 2002-2006. The rate in the rural South was the highest by far.

Acknowledgements

The National Fire Protection Association thanks all the fire departments and state fire authorities who participate in the National Fire Incident Reporting System (NFIRS) and the annual NFPA fire experience survey. These firefighters are the original sources of the detailed data that make this analysis possible. Their contributions allow us to estimate the size of the fire problem.

We are also grateful to the U.S. Fire Administration for its work in developing, coordinating, and maintaining NFIRS.

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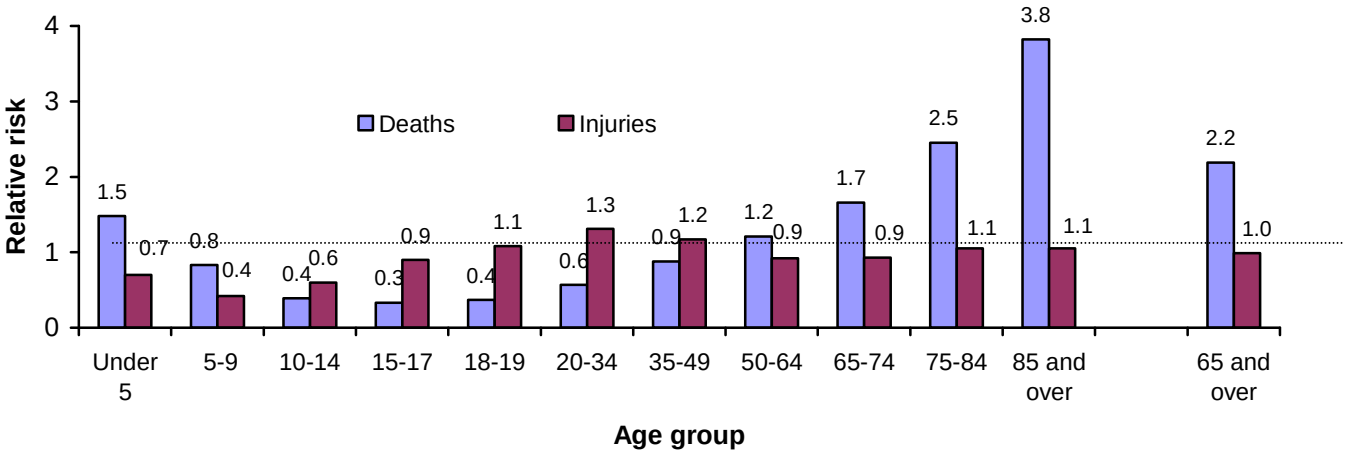
Socioeconomic Factors and Fire

The risk of fire death and injury varies by age group, race, region, and community size. Certain socioeconomic factors are associated with greater or lesser risk of death in certain types of fires. The more we know about which groups are at greatest risk and under what circumstances, the more effective we can be at targeting resources and developing the means to mitigate these risks. Most of the statistics that follow were derived from previously published studies.

Age and Risk of Fire Death and Injury

Very young children and older adults face the highest risk of fire death.
Jennifer Flynn examined age, gender and other victim patters in her study on characteristics of home fire victims.[1] Only 7% of the U.S. population is under five years of age, but in 2002-2005, 10% of the home fire fatalities were under five. Figure 1 shows that these young children were 1.5 times as likely to die in fire as the general population. The three leading causes of home fire deaths in this age group were heating equipment (34%), playing with heat source (27%), and cooking equipment (26%).

Figure 1. Relative Risk of Home Fire Death and Injury by Age: 2002-2005



Source: Jennifer D. Flynn. NFPA, *Characteristics of Home Fire Victims,* p. 2.

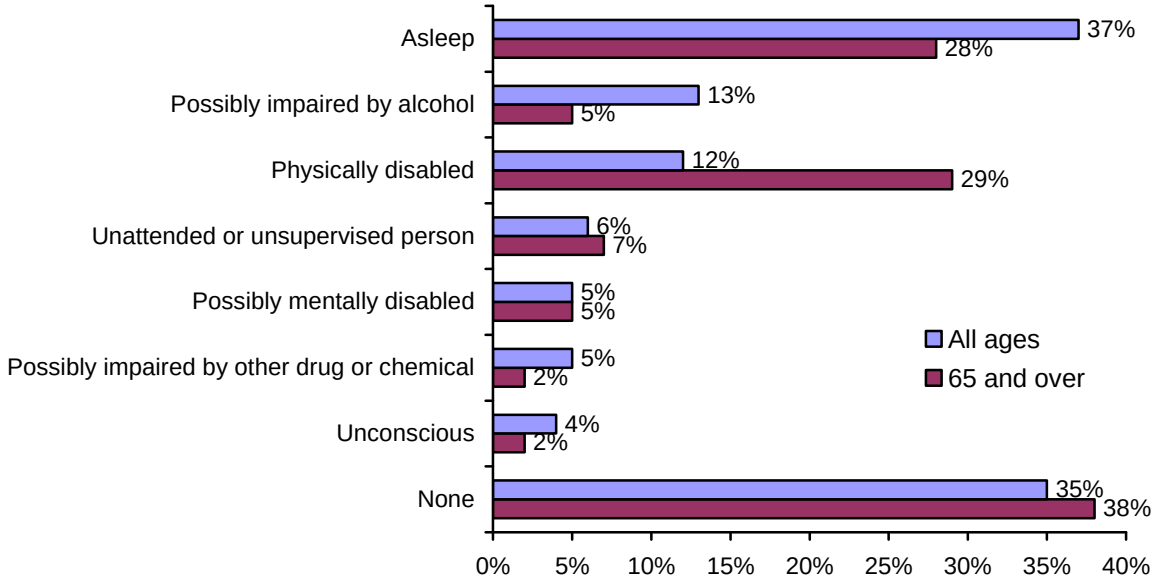
Older adults are the age group with the highest risk of fire death. The risk increases with age. During 2002-2005, 27% of the people fatally injured in home fire were 65 or older, but only 12% of the population was that old. They faced a risk 2.2 times that of the general population. For

[1] Jennifer D. Flynn. *Characteristics of Home Fire Victims*, Quincy, MA: National Fire Protection Association, 2008, pp. 8-9.

those 75 and over, the risk is 2.8 times as high. While only 2% of the population was 85 or older, 6% of the home fire deaths were in this age group, giving these elders a risk 3.8 times the general population. The leading causes of home fire deaths among people 65 and older were smoking materials (30%), heating equipment (22%), cooking equipment (16%), and electrical distribution and lighting equipment (also 16%).

High-risk groups do *not* account for the majority of fire deaths and injuries. Rather, their *share* of deaths and injuries exceeds their share of the general population. Relative risk is calculated by dividing the percentage of deaths or injuries (or other measure) experienced by that group by their percentage of the general population. A relative risk of one means that the percentage of deaths or injuries experienced by a group equals the percentage of the population in that group. Calculations were done on unrounded numbers.

Figure 2. Home Fire Deaths by Human Factor Contributing to Injury, 2002-2005



Source: Jennifer D. Flynn. NFPA, *Characteristics of Home Fire Victims,* p. 52.

Older victims were more likely to have had a physical disability than other age groups. Flynn examined human factors in fire deaths and injuries. Figure 2 shows human factors contributing to injury for all home fatalities and those 65 or older.[2] Possible alcohol impairment was a factor in 13% of all fatalities, but only 5% of the older adult deaths. Alcohol was possibly involved in 20-26% of the fire deaths of adults ages 18-64. Data from special studies suggest that this is an underestimate. A study of Minnesota's 1996-2002 fire deaths found 36% had blood alcohol levels of 0.1 or higher.[3] In his analysis of unintentional fire deaths by state, John Hall

[2] Jennifer D. Flynn. *Characteristics of Home Fire Victims*, Quincy, MA: National Fire Protection Association, 2008, p. 52.

[3] U.S. Fire Administration/National Fire Data Center, *Case Study: Contribution of Alcohol to Fire Fatalities in Minnesota,* Topical Fire Research Series, Volume 3-Issue 4, July 2003.

examined drinking rates, but found that alcohol use was negatively correlated with fire death rates, possibly because the data on alcohol use did not make distinctions about the level of consumption.[4]

Twelve percent of all civilian fire fatalities had a physical disability. Victims with physical disabilities were quite unusual in the younger age groups, but the percentage increased steadily from 3% of the victims in the 20-34 group throughout the later years. Thirty-six percent of victims who were 85 or older had a physical disability.

Risk of non-fatal fire injury is higher for those 18-64.
Flynn also reported that 63% of the population is between 18 and 64, but 72% of the people who suffered non-fatal injuries in reported home fires were in this age group, resulting in a risk 1.2 times that of the general population. Those in the 20-34 age group faced a risk of 1.3 times as high and the 35-49 year-olds faced a risk of 1.2 times the population at large.

Cooking equipment is the leading cause (30-45%) of home fire injuries in all age groups except those under 10. Playing with heat source is the leading cause of home fire injuries for children under five (28%), and those 5-9 (29%).

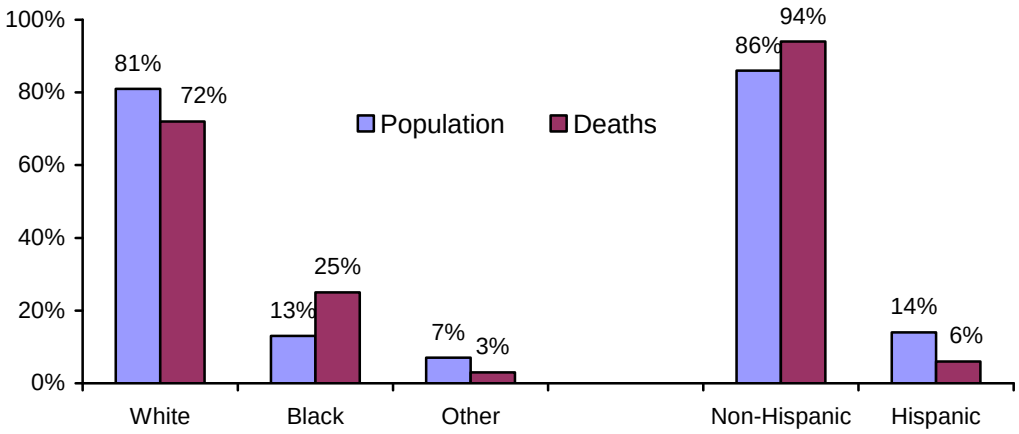
Higher fire death rates are seen in states with larger percentages of people who are black, poor, smokers, have less formal education, and who live in rural areas.
In the same analysis of state fire deaths mentioned above, Hall noted that the Southeastern states (excluding Florida) typically have the highest fire death rates. Many factors associated with higher fire death rates are correlated with each other. They are *not* mutually exclusive. He found that

- 38% of the difference by the percent of people 25 or older who lacked 12 years of education,
- 33% of the difference in state death rates could be explained by the percentage of the population that was black,
- 28% by the percent of population who had smoked at least one cigarette in the previous month,
- 28% by the percentage of population living below the poverty line, and
- 15% of the difference could be explained by the percentage of the population living in rural areas.

The National Safety Council's analysis of unintentional fire, flame and smoke deaths in 2004, found that almost three-quarters (72%) of the victims were white.[5] Figure 3 shows that the 13% of U.S. population that is black accounted for one-quarter (25%) of the fire fatalities. Ethnicity is recorded separately from race. Only 6% of the fire fatalities were Hispanic, although Hispanics account for 15% of the population.

[4] John R. Hall, Jr. *U.S. Unintentional Fire Death Rates by State*, Quincy, MA: National Fire Protection Association, 2008, pp. 2-4.
[5] National Safety Council. (2008) *Injury Facts ®, 2008 Edition.* Itasca, IL: Author, p. 29.

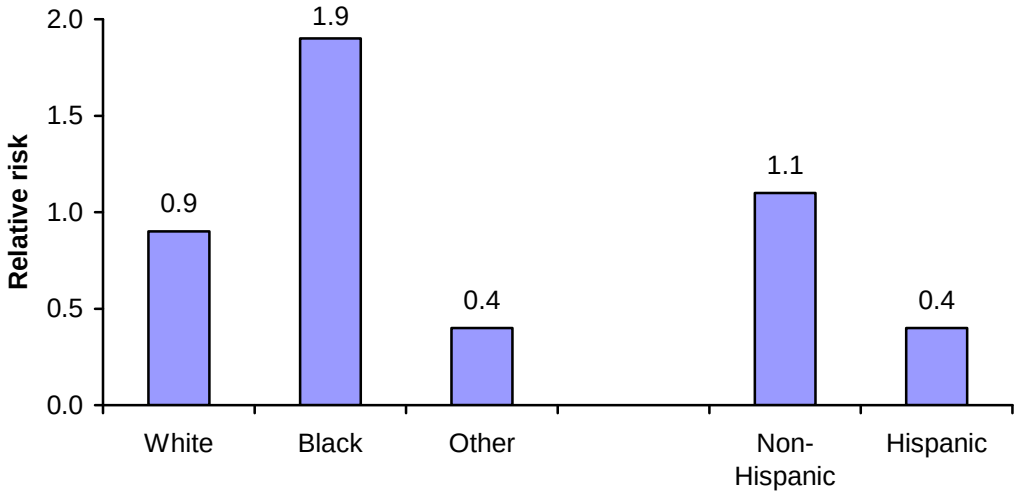
Figure 3. 2004 Unintentional Fire Deaths by Race and Ethnicity



Source: National Safety Council. (2008). *Injury Facts, 2007 Edition.* Itasca, IL, p. 29.

Figure 4 portrays the relative risk of fire death by race. The black population faces a risk of fire death twice as high as that of whites.

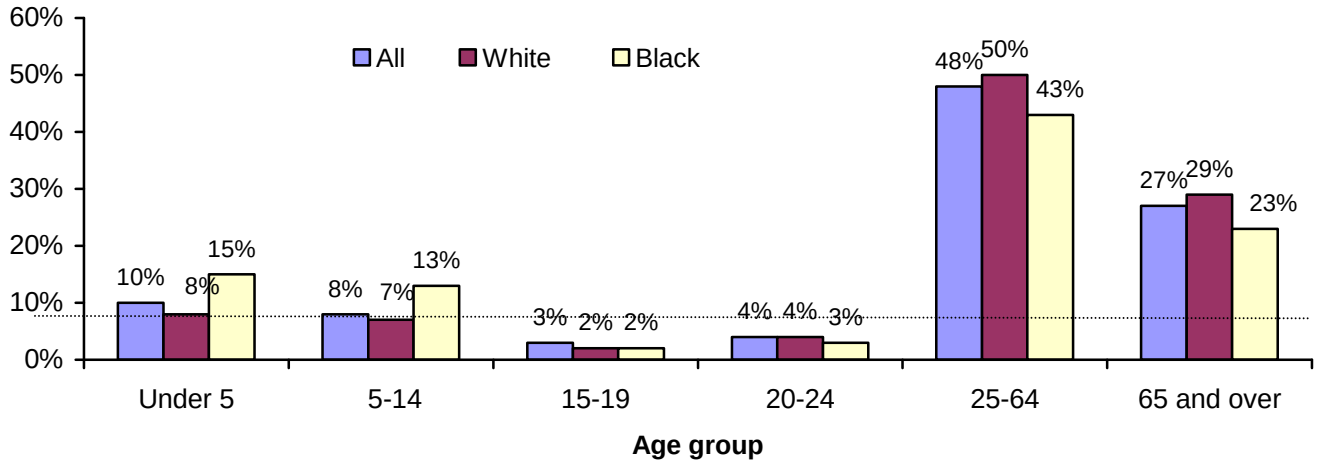
Figure 4. Relative Risk of Unintentional Fire Death by Race and Ethnicity in 2004



Source: National Safety Council. (2008). *Injury Facts, 2007 Edition.* Itasca, IL, p. 29.

Children account for almost twice the share of black victims as white.
Based on an analysis of the details collected in NFIRS 5.0, Figure 5 shows that 15% of black fatal victims were under the age of five compared to 8% for white victims. Children 5-14 accounted for 13% of the black victims but 7% of the white victims.

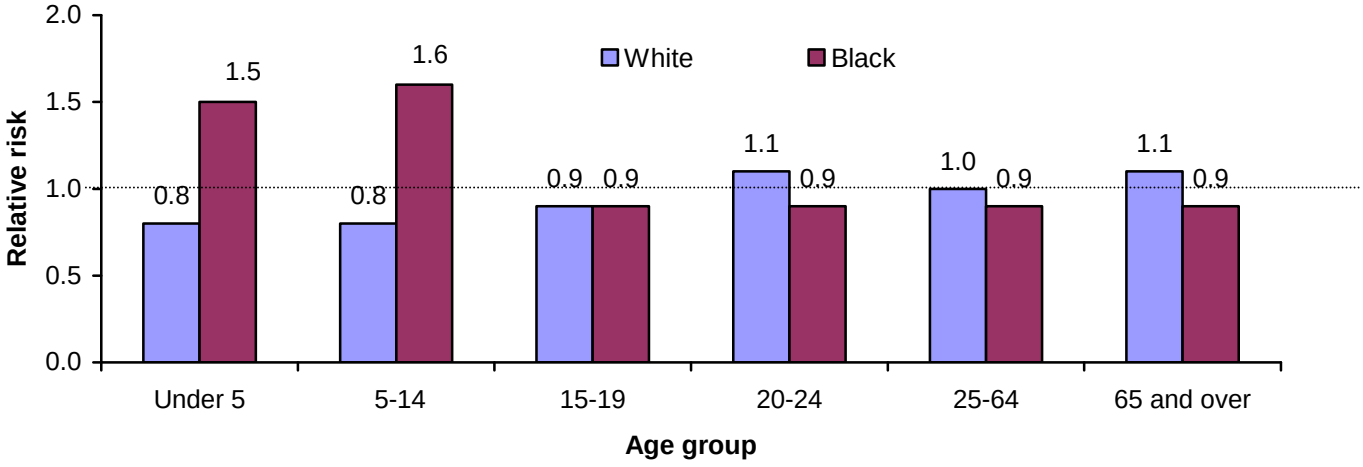
Figure 5. U.S. Home Fire Deaths by Race and Age Group
2002-2005



Source: NFIRS 5.0 and NFPA survey.

Figure 6 shows the same data expressed as relative risk. Black children 14 and under have a risk of fire death (1.5-1.6) that is twice as high as that of white children (0.8). In fact, the risk of fire death for white children is lower than that of the general population.

Figure 6. Relative Risk of Home Fire Death and Injury by Race in Different Age Groups
2002-2005



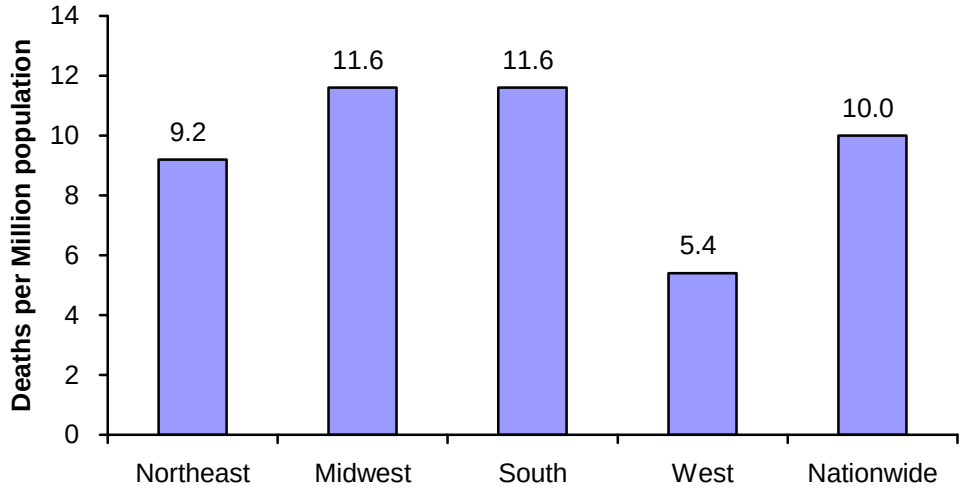
Source: NFIRS 5.0 and NFPA survey.

In more affluent areas, race played less of a role.
Hannon and Shai analyzed 1998-1992 fire death rates and socioeconomic data for U.S. metropolitan counties with populations of at least 250,000.[6] They found that areas in which median family income was low and a large part of the population was African American had extremely high fire death rates. In more affluent areas, the percentage of African Americans in the population had little influence on fire death rates.

Fire Deaths by Region and Community Size

The South and Midwest had the highest fire death rates in 2002-2006.
In his analysis of fire experience by region, Michael Karter found that the South and Midwest had the highest home fire death rates in the 2002-2006 period.[7] (See Figure 7.) His analysis is based on the census regions -- the South extends to Texas. He also found that western states had the lowest home fire death rate. Causes of fire deaths vary somewhat by region. The leading cause of home fire deaths in the South is heating equipment, followed by smoking materials. In the other regions, smoking materials caused the largest percentage of fire deaths.

Figure 7. Home Fire Deaths per Million Population by Region 2002-2006



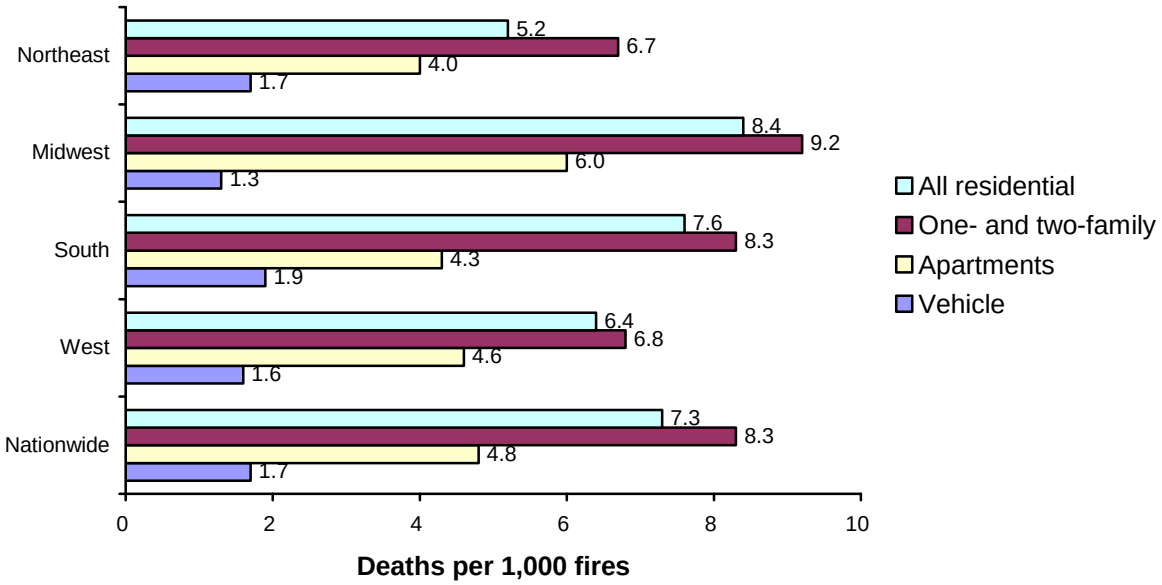
Source: Michael J. Karter, NFPA, *U.S. Fire Experience by Region 2002-2006*, p. 15.

Karter also examined the rate of deaths per 1,000 reported fires in each region. The rate was highest in one- and two-family dwellings in all regions. Figure 8 shows that compared to other regions, the Midwest had the highest death rates per 1,000 fires in all residential fires, one- and

[6] Lance Hannon and Donna Shai. "The Truly Disadvantaged and the Structural Covariates of Fire Death Rates," *The Social Science Journal* 40 (2003) 129-136.
[7] Michael J. Karter, Jr. *U.S. Experience by Region, 2002-2006*, Quincy, MA: National Fire Protection Association, 2008.

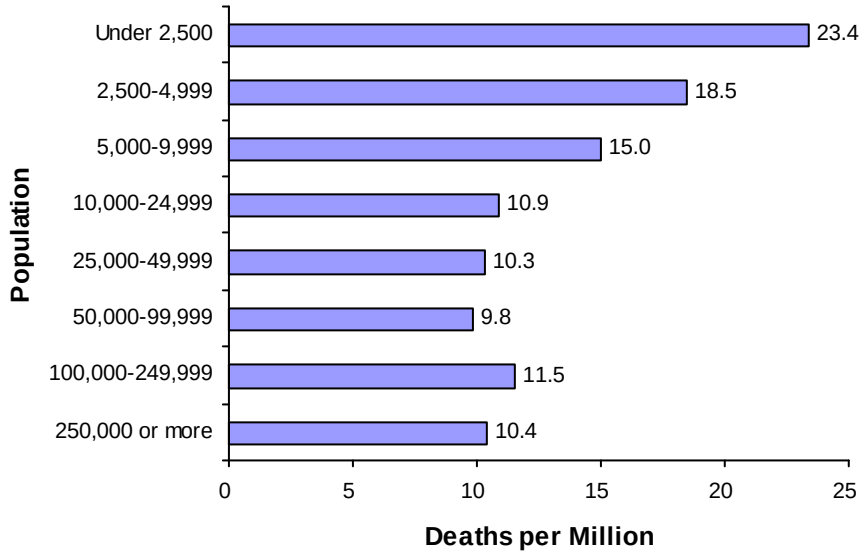
two-family dwelling fires and apartment fires. The South had the highest rate of vehicle fire deaths per 1,000 fires.

Figure 8. Civilian Fire Deaths per 1,000 Fires by Region and Type of Fire 2002-2006



Source: Michael J. Karter, NFPA, *U.S. Fire Experience by Region 2002-2006,* p. 14.

Figure 9. Civilian Fire Deaths per Million Population by Community Size 2002-2006

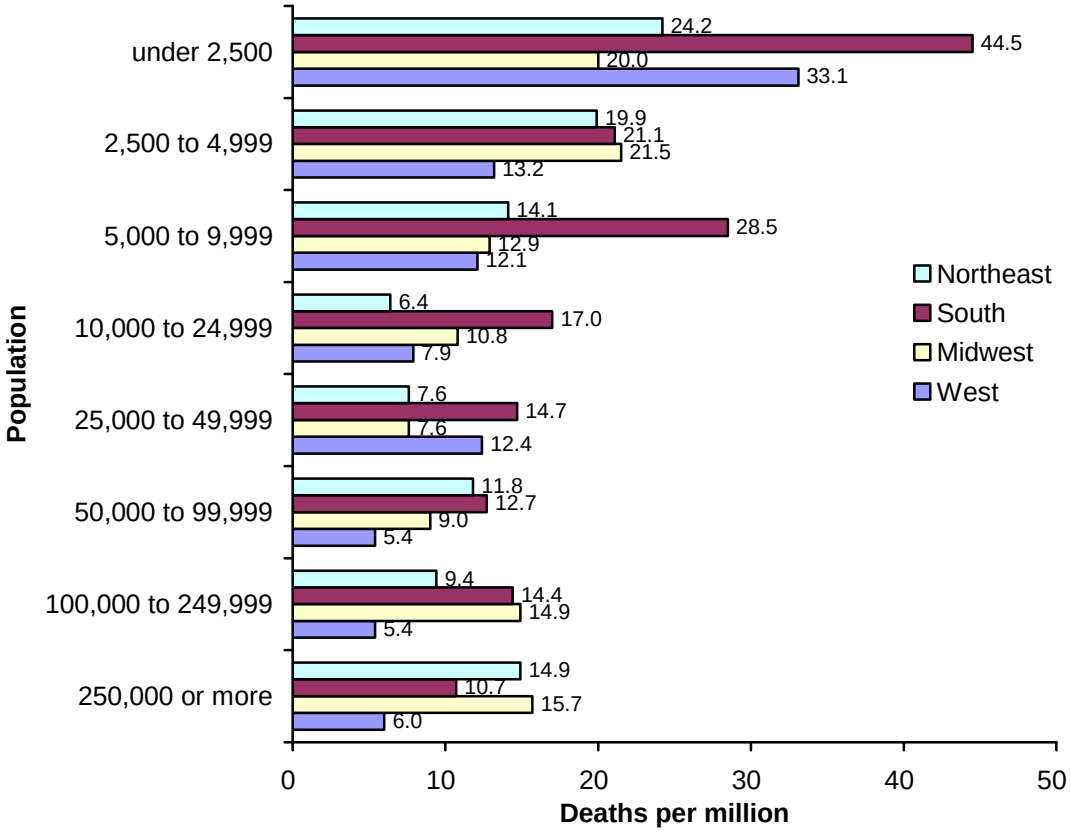


Source: Michael J. Karter, NFPA, *U.S. Fire Experience by Region 2002-2006,* p. 20.

Karter also analyzed fire deaths by community size. Figure 9 shows that the death rate per million population in communities with fewer than 2,500 people is more than twice that of communities with 10,000 or more. This is consistent with Hall's finding of higher death rates in states with larger rural populations.

Figure 10 shows that the fire death rate pattern by community size pattern varies greatly by region. The rural South has by far the highest fire death rate of any community size in any region. Southern communities with populations between 5,000 and 49,999 also have higher death rates than communities of comparable size in other regions. In cities of 100,000 or more, the Midwestern region has the highest fire death rate. The Midwest had the lowest fire death rate in communities with fewer than 2,500 people.

Figure 10. Civilian Fire Deaths per Million Population and Size of Community, 2002-2006



Source: Michael J. Karter, NFPA, *U.S. Fire Experience by Region 2002-2006*, p. 14,

Discussion

Demographic and socioeconomic characteristics of fire victims and areas with high fire death rates vary considerably. While smoke alarm, fire escape planning, and residential sprinklers can reduce the risk of fire death throughout the population, more targeted approaches are needed. Small towns in the rural South and big cities in the Midwest both have higher fire death rates than other communities the same size in other regions. The homes and lifestyles in rural areas

differ from those in big cities. A typical day for an older adult is different from that experienced by families with young children. Prevention strategies will be most effective when the circumstances and lifestyles of the target population are considered.

Appendix A.
How National Estimates Statistics Are Calculated

The statistics in this analysis are estimates derived from the U.S. Fire Administration's (USFA's) National Fire Incident Reporting System (NFIRS) and the National Fire Protection Association's (NFPA's) annual survey of U.S. fire departments. NFIRS is a voluntary system by which participating fire departments report detailed factors about the fires to which they respond. Roughly two-thirds of U.S. fire departments participate, although not all of these departments provide data every year.

NFIRS provides the most detailed incident information of any national database not limited to large fires. NFIRS is the only database capable of addressing national patterns for fires of all sizes by specific property use and specific fire cause. NFIRS also captures information on the extent of flame spread, and automatic detection and suppression equipment. For more information about NFIRS visit http://www.nfirs.fema.gov/. Copies of the paper forms may be downloaded from http://www.nfirs.fema.gov/_download/nfirspaperforms2007.pdf.

Each year, NFPA conducts an annual survey of fire departments which enables us to capture a summary of fire department experience on a larger scale. Surveys are sent to all municipal departments protecting populations of 50,000 or more and a random sample, stratified by community size, of the smaller departments. Typically, a total of roughly 3,000 surveys are returned, representing about one of every ten U.S. municipal fire departments and about one third of the U.S. population.

The survey is stratified by size of population protected to reduce the uncertainty of the final estimate. Small rural communities have fewer people protected per department and are less likely to respond to the survey. A larger number must be surveyed to obtain an adequate sample of those departments. (NFPA also makes follow-up calls to a sample of the smaller fire departments that do not respond, to confirm that those that did respond are truly representative of fire departments their size.) On the other hand, large city departments are so few in number and protect such a large proportion of the total U.S. population that it makes sense to survey all of them. Most respond, resulting in excellent precision for their part of the final estimate.

The survey includes the following information: (1) the total number of fire incidents, civilian deaths, and civilian injuries, and the total estimated property damage (in dollars), for each of the major property use classes defined in NFIRS; (2) the number of on-duty firefighter injuries, by type of duty and nature of illness; and (3) information on the type of community protected (e.g., county versus township versus city) and the size of the population protected, which is used in the statistical formula for projecting national totals from sample results. The results of the survey are published in the annual report *Fire Loss in the United States*. To download a free copy of the report, visit http://www.nfpa.org/assets/files/PDF/OS.fireloss.pdf.

Projecting NFIRS to National Estimates

As noted, NFIRS is a voluntary system. Different states and jurisdictions have different reporting requirements and practices. Participation rates in NFIRS are not necessarily uniform across regions and community sizes, both factors correlated with frequency and severity of fires. This means NFIRS may be susceptible to systematic biases. No one at present can quantify the size of these deviations from the ideal, representative sample, so no one can say with confidence that they are or are not serious problems. But there is enough reason for concern so that a second database - the NFPA survey - is needed to project NFIRS to national estimates and to project different parts of NFIRS separately. This multiple calibration approach makes use of the annual NFPA survey where its statistical design advantages are strongest.

Scaling ratios are obtained by comparing NFPA's projected totals of residential structure fires, non-residential structure fires, vehicle fires, and outside and other fires, and associated civilian deaths, civilian injuries, and direct property damage with comparable totals in NFIRS. Estimates of specific fire problems and circumstances are obtained by multiplying the NFIRS data by the scaling ratios.

Analysts at the NFPA, the USFA and the Consumer Product Safety Commission have developed the specific analytical rules used for this procedure. "The National Estimates Approach to U.S. Fire Statistics," by John R. Hall, Jr. and Beatrice Harwood, provides a more detailed explanation of national estimates. A copy of the article is available online at http://www.nfpa.org/osds or through NFPA's One-Stop Data Shop.

Version 5.0 of NFIRS, first introduced in 1999, used a different coding structure for many data elements, added some property use codes, and dropped others.

Figure 1.

Fires Originally Collected in NFIRS 5.0 by Year

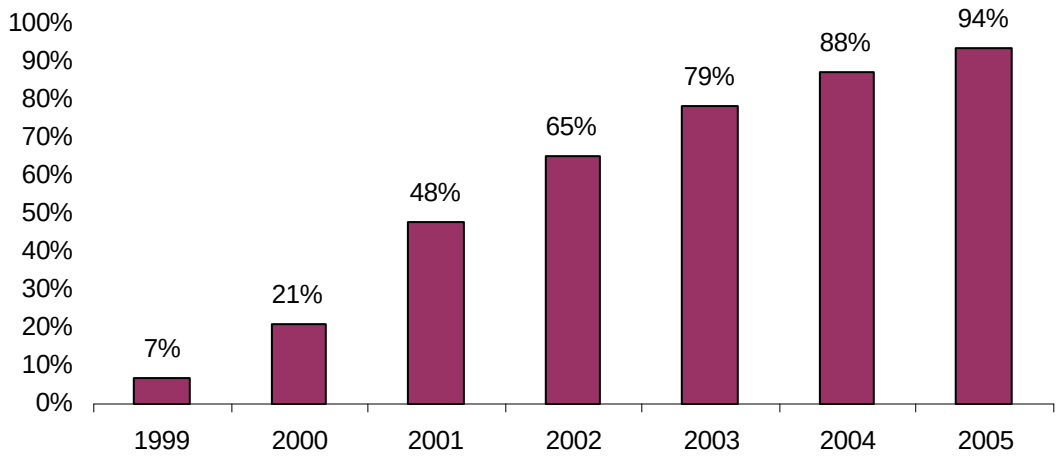


Figure 1 shows the percentage of fires originally collected in the NFIRS 5.0 system. Each year's release version of NFIRS data also includes data collected in older versions of NFIRS that were converted to NFIRS 5.0 codes.

For 2002 data on, analyses are based on scaling ratios using only data originally collected in NFIRS 5.0:

$$\frac{\text{NFPA survey projections}}{\text{NFIRS totals (Version 5.0)}}$$

For 1999 to 2001, the same rules may be applied, but estimates for these years in this form will be less reliable due to the smaller amount of data originally collected in NFIRS 5.0; they should be viewed with extreme caution.

A second option is to omit year estimates for 1999-2001 from year tables.

NFIRS 5.0 has six categories of confined structure fires, including:

- cooking fires confined to the cooking vessel,
- confined chimney or flue fires,
- confined incinerator fire,
- confined fuel burner or boiler fire or delayed ignition,
- confined commercial compactor fire, and
- trash or rubbish fires in a structure with no flame damage to the structure or its contents.

Although causal and other detailed information is typically not required for these incidents, it is provided in some cases. In order for that limited detail to be used to characterize the confined fires, they must be analyzed separately from non-confined fires. Otherwise, the patterns in a factor for the more numerous non-confined fires with factor known will dominate the allocation of the unknown factor fires for both non-confined and confined fires. If the pattern is different for confined fires, which is often the case, that fact will be lost unless analysis is done separately.

For most fields other than Property Use, NFPA allocates unknown data proportionally among known data. This approach assumes that if the missing data were known, it would be distributed in the same manner as the known data. NFPA makes additional adjustments to several fields.

For Factor Contributing to Ignition, the code "none" is treated as an unknown and allocated proportionally. For Human Factor Contributing to Ignition, NFPA enters a code for "not reported" when no factors are recorded. "Not reported" is treated as an unknown, but the code "none" is treated as a known code and not allocated. Multiple entries are allowed in both of these fields. Percentages are calculated on the total number of fires, not entries, resulting in sums greater than 100%. Groupings for this field show all category headings and specific factors if they account for a rounded value of at least 1%.

Type of Material First Ignited (TMI). This field is required only if the Item First Ignited falls within the code range of 00-69. NFPA has created a new code "not required" for this field that is applied when Item First Ignited is in code 70-99 (organic materials, including cooking materials

and vegetation, and general materials, such as electrical wire, cable insulation, transformers, tires, books, newspaper, dust, rubbish, etc..) and TMI is blank. The ratio for allocation of unknown data is:

$$\frac{\text{(All fires – TMI Not required)}}{\text{(All fires – TMI Not Required – Undetermined – Blank))}}$$

Heat Source. In NFIRS 5.0, one grouping of codes encompasses various types of open flames and smoking materials. In the past, these had been two separate groupings. A new code was added to NFIRS 5.0, which is code 60: "Heat from open flame or smoking material, other." NFPA treats this code as a partial unknown and allocates it proportionally across the codes in the 61-69 range, shown below.

61. Cigarette,
62. Pipe or cigar,
63. Heat from undetermined smoking material,
64. Match,
65. Lighter: cigarette lighter, cigar lighter,
66. Candle,
67 Warning or road flare, fusee,
68. Backfire from internal combustion engine. Excludes flames and sparks from an exhaust system, (11)
69. Flame/torch used for lighting. Includes gas light and gas-/liquid-fueled lantern.

In addition to the conventional allocation of missing and undetermined fires, NFPA multiplies fires with codes in the 61-69 range by

$$\frac{\text{All fires in range 60-69}}{\text{All fires in range 61-69}}$$

The downside of this approach is that heat sources that are truly a different type of open flame or smoking material are erroneously assigned to other categories. The grouping "smoking materials" includes codes 61-63 (cigarettes, pipes or cigars, and heat from undetermined smoking material, with a proportional share of the code 60s and true unknown data.

Equipment Involved in Ignition (EII). NFIRS 5.0 originally defined EII as the piece of equipment that provided the principal heat source to cause ignition if the equipment malfunctioned or was used improperly. In 2006, the definition was modified to "the piece of equipment that provided the principal heat source to cause ignition." However, the 2006 data is not yet available and a large portion of the fires coded as no equipment involved (NNN) have heat sources in the operating equipment category. To compensate, NFPA treats fires in which EII = NNN and heat source is not in the range of 40-99 as an additional unknown.

To allocate unknown data for EII, the known data is multiplied by

All fires

(All fires – blank – undetermined –[fires in which EII =NNN and heat source <>40-99])

Additional allocations may be used in specific analyses. For example, NFPA's report about home heating fires treats Equipment Involved in Ignition Code 120, fireplace, chimney, other" as a partial unknown (like Heat Source 60) and allocates it over its related decade of 121-127, which includes codes for fireplaces (121-122) and chimneys (126-127) but also includes codes for fireplace insert or stove, heating stove, and chimney or vent connector. More general analyses of specific occupancies may not perform as many allocations of partial allocations. Notes at the end of each table describe what was allocated.

Rounding and percentages. The data shown are estimates and generally rounded. An entry of zero may be a true zero or it may mean that the value rounds to zero. Percentages are calculated from unrounded values. It is quite possible to have a percentage entry of up to 100%, even if the rounded number entry is zero. Values that appear identical may be associated with different percentages, and identical percentages may be associated with slightly different values.