Prevalence of Residential Smoke Alarms and Fire Escape Plans in the U.S.: Results from the Second Injury Control and Risk Survey (ICARIS-2)

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SYNOPSIS

Objectives. This study was conducted to estimate (*1*) the proportion of U.S. homes with installed smoke alarms and fire escape plans, and (*2*) the frequency of testing home smoke alarms and of practicing the fire escape plans.

Methods. The authors analyzed data on smoke alarms and fire escape plans from a national cross-sectional random-digit dialed telephone survey of 9,684 households.

Results. Ninety-five percent of surveyed households reported at least one installed smoke alarm and 52% had a fire escape plan. The prevalence of alarms varied by educational level, income, and the presence of a child in the home. Only 15% tested their alarms once a month and only 16% of homes with an escape plan reported practicing it every six months.

Conclusion. While smoke alarm prevalence in U.S. homes is high, only half of homes have a fire escape plan. Additional emphasis is needed on testing of installed smoke alarms and on preparedness for fire escape plans.

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In 2004, more than 410,500 residential fires in the United States claimed the lives of 3,190 people and injured another 14,175.[1] Most victims of fires are injured and die from smoke inhalation or toxic gases and not from burns.[2,3] Although the number of fatalities and injuries caused by residential fires has declined gradually over the past several decades, this remains a significant public health problem.

Most residential fires and associated injuries are preventable. The use of smoke alarms has been shown to be an effective, reliable, and inexpensive method of providing early warning in residential fires.[4] Regular testing ensures that alarms remain functional. It is recommended that smoke alarms be tested every month to ensure that they work properly and batteries in conventional smoke alarms be replaced once a year.[5,6] Testing means physically pressing the test button on the smoke alarm, either by hand or with an object such as a broom handle (if hard to reach), and holding it for several seconds until it sounds. If a fire occurs in a home with a smoke alarm, the risk of death is decreased by 40%–50%.[5] Despite availability of this prevention method, 40% of fires reported to U.S. fire departments occur in homes without alarms and 70% of home fire deaths occur in homes with either no smoke alarm or homes in which none of the smoke alarms sounded.[5]

Because fires can grow and spread quickly through a home, it is important that residents be prepared to react as soon as the smoke alarm sounds. Developing and practicing a home fire escape plan are prevention strategies commonly taught in fire safety education programs so that reaction will be well rehearsed.[7–11] Home fire escape plans should be developed and practiced every six months. In the plan, at least two different ways of escape should be identified for each household resident, and a safe place should be designated outside of the home to meet after escaping the fire.[2,6]

This report summarizes data from the fire module of the Second Injury Control and Risk Survey (ICARIS-2).

METHODS

ICARIS-2 sample

The ICARIS-2 survey is a national cross-sectional, list-assisted, random-digit dialed (RDD) telephone survey of English and Spanish speaking adults (aged 18 years and older) conducted in all 50 states and the District of Columbia from July 2001 through February 2003. The survey was conducted by the Centers for Disease Control and Prevention's (CDC) National Center for Injury Prevention and Control (NCIPC) using a computer-assisted telephone interviewing (CATI) system. It took an average of 21.5 minutes to complete the survey, which was designed to obtain national estimates on the occurrence of a wide range of injury risk factors. In addition to the fire module questions listed below, it included helmet use, water safety, automobile related safety practices, and pedestrian injuries; injuries related to physical activity, falls, alcohol use; firearm ownership and use; and interpersonal violence and suicide.

Fire module questions

The fire module of ICARIS-2 is a series of questions about smoke alarm presence, placement, and testing; the occurrence of a home fire and associated injuries; and fire escape planning and practice. Each respondent was asked the following questions, presented here as they appear on the survey form:

1. Are there any smoke alarms or smoke detectors installed in your home?
2. Is there at least one working smoke detector on each floor of your home? This includes a finished basement or attic.
3. Is there a smoke detector in or just outside the area where you sleep?
4. How often do you test your smoke detectors?
5. In the past 12 months, have you had an uncontrolled fire in your home?
6. Were you or anyone else in your household injured as a result of this fire?
7. Have you and your family designed a fire escape plan?
8. How often do you and your family practice your fire escape plan?

Survey data were weighted to adjust for unequal selection probabilities, noncoverage and nonresponse. Data were then post-stratified by household composition to conform to the distribution of the March 2002 Current Population Survey (CPS),[12] after incorporating information from the 2000 Census to produce nationally representative estimates. Telephone exchanges with >10% of households occupied by African Americans or Hispanics were over-sampled in our sampling frame in an attempt to approximate their representation in the population. One adult (aged 18 years or older) was selected for interview from each eligible household such that males were over-sampled in attempt to interview equal numbers of males and females. In households with adults of both genders, a gender category was selected with higher probability of choosing males. The gender distribution was monitored throughout the course of the study and the probability

of selecting a male adjusted as needed to obtain a final sample with approximately equal numbers of males and females. In households with multiple eligible adults of the selected gender, the adult with the most recent birthday was selected.

All analyses were conducted using SUDAAN software to address the complexity of the survey design.[13] The unit of analysis for this study was the household. The weighted data analysis provides national estimates of percentages and total number of households with a given residential fire prevention characteristic of interest in the U.S. population. Chi-square tests were performed on weighted percentages to formally test for the association between variables related to residential fire prevention and demographic characteristics.

RESULTS

Of the 113,476 telephone numbers purchased for screening, 66,949 were deemed ineligible and 31,803 numbers were classified as being of unknown eligibility, leaving 14,724 known households eligible for interview. The primary reasons for a classification of ineligible were business and nonworking numbers (90%). Most numbers were classified as being of unknown ineligibility because of failure to determine if the number dialed reached a household (55%), followed by failure to complete the screening portion of the interview at a known household (40%), making it impossible for a respondent to be selected for interview. Of the 14,724 known households eligible for interview, 2,212 refused to participate, 2,138 were unavailable for interview on subsequent contacts, 370 were either physically or mentally incapable of conducting the interview, 320 began but did not complete the interview, and 9,684 (of 14,724 or 66%) completed the interview with usable data. The weighted response rate for the survey was 47.9%, computed using standard definitions (response rate 3 [RR3] as defined by the American Association for Public Opinion Research, 2004).[14]

Prevalence of smoke alarms

We found that 94.9% (95% confidence interval [CI] 94.4%, 95.4%) of U.S. households reported having at least one smoke alarm installed in their home (Table 1). Households reporting income above the poverty level were more likely to have smoke alarms than those below the poverty level (95.6% vs. 90.3%). Smoke alarm prevalence rates were highest in the North Central region of the country (96.3%), while lower rates were reported in the South (94.0%). Reported smoke alarm prevalence increased with increasing household educational attainment ($p<0.01$, test for linear trend) from 86.8% in homes in which none of the adult occupants had graduated from high school to more than 96% in homes where at least one occupant was a college graduate or had some post-college graduate education. We also found that homes with children younger than 15 years of age were more likely to have a smoke alarm than homes without children or homes with older children (96.5% vs. 94.2%).

Among households that reported having a smoke alarm, 93.1% (95% CI 92.5%, 93.7%) reported one or more working smoke alarms per floor, and 95.2% (95% CI 94.7%, 95.7%) reported a smoke alarm just outside the area where they sleep (data not shown).

Testing smoke alarms

Among all households that reported having a smoke alarm in their home, 15.2% (95% confidence interval [CI] 14.3%, 16.1%) indicated that they test their smoke alarm once a month (the standard recommendation), 38.3% (95% CI 37.1%, 39.5%) every six months, 32.7% (95% CI 31.5%, 33.8%) once a year, and 13.8% (95% CI 13.0%, 14.7%) never test it.

In general, except for homes with children, household characteristics that were associated with lower smoke alarm prevalence were more likely to test their alarms once a month (Table 2). Households more likely to test their alarms monthly were below the poverty level, in rural areas, in mobile homes, in the Southern region of the U.S., in homes with lower household educational attainment, in rented property, and in homes with children younger than 15 years of age.

Having a fire escape plan

Only 51.6% of households reported that they had designed a fire escape plan. Living in a mobile home, having at least a high school education, owning the home, and having children in the home were associated with having designed a fire escape plan (Table 3). There were no differences by household income and region of the U.S.

Practicing fire escape plan

Only 45.3% (95% CI 43.6%, 46.9%) of households that reported having a fire escape plan had actually practiced it. Therefore, only 23% of homes in the U.S. have a fire escape plan and practice it. Only 15.9% (95% CI 14.8%, 17.1%) of those with a fire escape plan report practicing it every six months (i.e., 8.3% of homes in the U.S.), the standard recommendation. Households below the poverty level and that rented were more likely to practice every six months (31.2%, 95% CI 25.6%, 36.9%; 26.9%, 95% CI 23.9%, 29.9%, respectively), while detached single family homes were

Table 1. Presence of smoke alarms by household characteristics, Second Injury Control and Risk Survey

Characteristic	Unweighted number of households	Number reporting installed smoke alarms	Weighted		
			National estimate of households with installed smoke alarms	Percent reporting installed smoke alarms	95% CI
Total	9,667	9,192	103,602,243	94.9	94.4, 95.4
Household income[a]					
Below poverty level	695	631	6,750,344	90.3	87.9, 92.7
Above poverty level	7,611	7,286	83,062,911	95.6	95.1, 96.1
Metropolitan Statistical Area					
Urban	9,522	9,059	101,833,083	95.0	94.5, 95.5
Rural	145	133	179,160	91.6	87.0, 96.3
Type of dwelling[b]					
5 or more apartments	1,219	1,171	11,965,305	96.6	95.5, 97.7
2–4 apartments	656	614	6,953,925	93.5	91.4, 96.6
Mobile home	449	422	5,534,387	94.3	92.1, 96.6
Attached home	816	785	7,313,665	96.0	94.5, 97.5
Detached home	6,381	6,061	70,485,252	94.7	94.1, 95.3
Census region[a]					
Northeast	2,161	2,060	20,234,044	95.4	94.4, 96.4
North Central	1,650	1,585	24,681,553	96.3	95.4, 97.2
South	4,022	3,814	36,666,333	94.0	93.1, 94.8
West	1,834	1,733	22,020,313	94.6	93.5, 95.7
Highest educational level in household[a]					
Less than high school	636	555	6,301,199	86.8	84.0, 89.7
High school graduate	1,969	1,848	21,341,198	93.8	92.6, 94.9
Some college	1,899	1,796	21,283,452	94.2	93.0, 95.3
College graduate	3,104	2,913	32,949,795	96.7	96.0, 97.4
Post-college	2,048	1,988	20,793,885	96.9	96.1, 97.8
Home ownership					
Rented	2,571	2,425	26,456,432	94.3	93.4, 95.3
Owned	6,883	6,571	75,236,758	95.2	94.6, 95.8
Children in the home aged 0–14 years[a]					
Yes	3,087	2,975	32,092,375	96.5	95.9, 97.2
No	6,571	6,208	71,383,153	94.2	93.6, 94.8

[a]Statistically significant, *p*-value <0.01

[b]Statistically significant, *p*-value <0.05

CI = confidence interval

less likely (13.8%, 95% CI 12.5%, 15.1%) to practice every six months compared with other types of homes. In addition, educational attainment was associated with more practice (27.4%, 95% CI 21.4%, 33.3% for less than high school; 10.9%, 95% CI 8.6%, 13.2% for post-college), as was having children in the home (22.5%, 95% CI 20.2%, 24.7%). We did not observe any regional or urban/rural differences.

Occurrence of an uncontrolled fire

Seventy-one (0.6%, 95% CI 0.5%, 0.8%) households reported having an uncontrolled fire in their home in the past 12 months. Among these, 11 (of 71, 15.5%) reported someone being injured.

DISCUSSION

Risk factors for residential fire injury have been well described.[4,15,16] At-risk household characteristics include the presence of children or older adults in the home, low income, rural communities, mobile homes, and the presence of smokers or alcohol users living in the home. Our analysis indicated that some household characteristics were associated with higher smoke

Table 2. Frequency of testing smoke alarms once a month by household characteristics, Second Injury Control and Risk Survey

Characteristic	*Weighted percent*	*95% CI*
Total	15.2	14.3, 16.1
Household income[a]		
Below poverty level	28.2	24.1, 32.4
Above poverty level	14.1	13.2, 15.1
Metropolitan Statistical Area[b]		
Urban	15.0	14.1, 15.9
Rural	24.5	16.1, 32.8
Type of dwelling[a]		
5 or more apartments	15.4	12.8, 18.0
2–4 apartments	18.6	15.0, 22.3
Mobile home	29.2	24.3, 34.1
Attached home	16.4	13.2, 19.6
Detached home	13.5	12.5, 14.6
Census region[a]		
Northeast	13.2	11.4, 15.0
North Central	15.6	13.6, 17.5
South	17.1	15.6, 18.6
West	13.3	11.6, 15.1
Highest educational level in household[a]		
Less than high school	21.6	17.5, 25.7
High school graduate	20.3	18.2, 22.5
Some college	17.5	15.4, 19.6
College graduate	13.8	12.3, 15.3
Post-college	7.9	6.4, 9.3
Home ownership[a]		
Rented	20.3	18.4, 22.2
Owned	13.3	12.3, 14.3
Children in the home aged 0–14 years[a]		
Yes	18.5	16.8, 20.1
No	13.7	12.7, 14.7

[a]Statistically significant, *p*-value <0.01

[b]Statistically significant, *p*-value <0.05

CI = confidence interval

alarm and fire escape plan prevalence. In general, these were consistent with the known risk factors for residential fire-related injury (e.g., household income, type of home, and education level). In addition, we found that homes with children were more likely to use smoke alarms, conduct monthly testing, and have developed and practiced fire escape plans. These findings may be explained by parents wanting to have a safe home environment for their children, by school age children potentially bringing home information from fire safety activities at school that typically includes the importance of smoke alarms and fire escape plans, and by the positive effects of ongoing efforts at the local and national levels to educate parents on fire safety. Individuals in mobile homes were more likely to have and to practice escape plans, which may indicate that escape plans for mobile homes are easier to develop because these structures are not as large as most detached homes and apartment buildings. While there is no direct causal evidence in this study or in the fire safety literature that individuals have better escape planning because they know that they are living in a riskier type of home structure, our results do indicate an association between high risk homes and better escape planning. Strategies for improving escape planning would benefit from a better understanding of this relationship.

Other recent national surveys have examined smoke alarms and fire escape plans. The most recent Behavioral Risk Factor Surveillance System (BRFSS) that captured smoke alarm data for the entire U.S. was in 1999. This survey, which relied on self-report, found that 96.0% of respondents had a smoke alarm in their home; 33.5% tested their smoke alarms in the past month, 35.4% in the past six months, 13.1% within the past year, 8.1% over one year ago, and 9.5% never tested their alarms.[17] In 2002, the Home Safety Council commissioned the State of Home Safety in America (SOHS) report, which included a telephone survey that collected smoke alarm and fire escape plan prevalence. They found that 97% of respondents reported having at least one smoke alarm in the household, and 80% had smoke alarms on each level of their home. Eighty-five percent tested their smoke alarms at least once per year, and 20% tested it at least every three months. Among households with more than one resident, 51% had discussed a fire escape plan.[18] In 2004, the National Fire Protection Association conducted the Fire Prevention Week Survey. They found that 96% of respondents had a smoke alarm installed in their home, 66% had an escape plan in case of a fire, and 66% practiced it.[19]

In general, these national surveys are consistent with the findings of ICARIS-2 that indicated that over 90% of households have a smoke alarm in their home. Differences in results for testing of alarms and prevalence and practicing of fire escape plans seen across surveys may be attributed to different survey methodologies. For example, in the current study the question regarding smoke alarm testing refers to the individual respondent, in contrast to the BRFSS,[17] which asks if the respondent "or someone else" deliberately tested the detectors in the home. It is possible that someone other than the respondent is responsible for testing the smoke alarms; therefore, the values we report here for ICARIS-2 may underestimate the true numbers.

While these other studies report findings regarding smoke alarm and fire escape planning prevalence, they do not report how these prevalences differ by

Table 3. Presence of fire escape plans by household characteristics, Second Injury Control and Risk Survey

			Weighted		
Characteristic	*Unweighted number of households*	*Number reporting fire escape plans*	*Extrapolated U.S. number*	*Percent reporting fire escape plans*	*95% CI*
Total	9,684	4,873	56,202,407	51.6	50.5, 52.7
Household income					
Below poverty level	694	339	3,706,921	49.7	45.6, 53.8
Above poverty level	7,601	3,879	45,037,131	51.9	50.6, 53.2
Metropolitan Statistical Area					
Urban	9,507	4,791	55,094,016	51.5	50.3, 52.6
Rural	144	82	1,108,391	57.8	49.1, 66.4
Type of dwelling[a]					
5 or more apartments	1,212	529	5,342,319	43.3	40.1, 46.5
2–4 apartments	654	282	3,263,583	44.0	39.8, 48.2
Mobile home	450	271	3,531,006	60.2	55.3, 65.1
Attached home	815	375	3,660,019	48.0	44.0, 52.1
Detached home	6,374	3,340	39,633,836	53.3	51.9, 54.7
Census region					
Northeast	2,158	1,048	10,591,201	49.9	47.5, 52.4
North Central	1,642	874	13,521,252	53.0	50.5, 55.5
South	4,016	2,025	20,307,176	52.1	50.3, 54.0
West	1,835	926	11,782,779	50.6	48.2, 53.0
Highest educational level in household[a]					
Less than high school	634	268	3,129,652	43.2	39.0, 47.4
High school graduate	1,968	1,011	11,978,712	52.7	50.2, 55.1
Some college	1,898	1,018	12,200,975	54.0	51.5, 56.5
College graduate	3,009	1,513	17,363,496	51.1	49.0, 53.1
Post-college	2,043	1,019	11,066,927	51.7	49.1, 54.3
Home ownership[a]					
Rented	2,567	1,098	12,022,982	42.9	40.8, 45.0
Owned	6,870	3,672	43,049,723	54.6	53.3, 55.9
Children in the home age 0-14 years[a]					
Yes	3,087	1,719	18,878,125	56.8	54.8, 58.8
No	6,555	3,147	37,225,169	49.2	47.9, 50.6

[a]Statistically significant, p-value <0.001

CI = confidence interval

household characteristics, which is important when targeting prevention programs. Only the first ICARIS study reported a similar analysis.[20] In 1994, this survey was conducted with similar core questions and with a similar fire module. Because this data collection was conducted seven years prior to the ICARIS-2 data collection, it was reasonable to think *a priori* that the newer data may show different results, especially considering that deaths from residential fires have steadily declined over this time period.[1] Results from the 1994 survey[20] and the present study suggest that in the past 10 years, more homes have installed smoke alarms (91.1% in 1994 vs. 94.9% in the current survey; p-value <0.05, chi-square test), but fewer households have fire escape plans (59.8% in 1994 vs. 51.6% in the current survey; $p<0.05$, chi-square test). Associations between household characteristics such as income and education level and smoke alarm presence have not changed in the past 10 years, indicating that those at high risk in 1994 continue to be at high risk today.

The present study has several limitations. First, we relied on self-reported information from telephone surveys to make our estimates. The validity of self-reporting to obtain smoke alarm status information has been examined in previous studies. One telephone survey found that 71% of households in a targeted area reported having a working smoke alarm, but when a home inspection that involved manual testing of smoke alarms was conducted in the same area six months later, only 49% of homes had functioning alarms.[21] Another

study that involved self-reported interview data followed by home observations two to four weeks later found that individuals who reported not having a working smoke alarm and not having a working alarm on each floor of their home were generally accurate (negative predictive values = 100% and 91%); however, among those who reported having a working smoke alarm, only 52% (positive predictive value) actually did, and among those who reported having a working smoke alarm on each floor of their home, only 26% did.[22] These studies suggest that the estimates we observed may be overestimations of the true prevalence of these safety practices.

Second, our response rate of 48%, although lower than we would have liked, is comparable with other RDD studies currently being conducted.[23] Bias in the responses may have occurred if the sample was not representative of the U.S. population. As a means of assessing the representativeness of our data, we compared the demographics of this sample with those of the 2002 population. Our sample was representative with respect to age, race/ethnicity, gender, employment status, and household income. Respondents were slightly more likely (6%–10%) to be more highly educated, married, and own their own homes compared with the general population. Despite this, as previously noted, our overall estimates were consistent with other national surveys, indicating that our response rate did not have a large effect on our estimates.

Third, because less than 1% of respondents indicated that they had an uncontrolled fire in their home in the past 12 months, it was not possible to directly examine risk factors for fire or related injury.

Results from this study indicate the need to emphasize the testing of smoke alarms and the development and practice of fire escape plans. Prevention activities and education should be developed with the understanding that the installation of smoke alarms is a one-time action, whereas monthly testing of alarms and the practicing of escape plans require ongoing intentions for enactment. While we found that better smoke alarm maintenance and fire escape planning education generally is needed in all homes, particular emphasis should be placed on households with lower income and education levels.

As part of the ongoing effort to reduce and minimize injuries and deaths from residential fires, CDC has funded 18 state health departments since 1998 (selection based on competitive applications) to deliver a smoke alarm installation and fire safety education program. By design, this program is conducted in both urban and rural low income communities that are at high risk for residential fires. A key characteristic of this program includes education on smoke alarm maintenance and fire escape planning.[7] This smoke alarm installation and fire safety education program is presently being evaluated to better understand the effect of the program. Additionally, CDC currently is conducting a randomized trial in high risk homes to determine the most effective methods of delivering smoke alarm maintenance education. Results from the ICARIS-2 survey and from these ongoing studies can be used to improve the implementation and effectiveness of residential fire safety programs and to improve the selection of communities at high risk by targeting homes with characteristics associated with lower smoke alarm and escape plan prevalence.

The findings and conclusions in this report are those of the authors and do not necessarily represent the views of the Centers for Disease Control and Prevention.

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