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Residential Smoke Alarms and Fire Escape Plans

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SYNOPSIS

Objective. To estimate the proportion of U.S. homes with installed smoke alarms, smoke alarms on the same floor as occupants' bedrooms, and fire escape plans.

Methods. The authors analyzed data on smoke alarm use and fire escape planning from a 1994 stratified random telephone survey of 5238 U.S. households.

Results. Respondents from 91% of surveyed households reported the presence of at least one installed smoke alarm, and 94% of respondents reported having an alarm on the same level of the home as their sleeping area. The prevalence of installed smoke alarms varied by highest education level in the household and income level. Sixty percent of all households had designed or discussed a fire escape plan at least once; only 17% of these households had actually practiced one.

Conclusions. Although overall use of smoke alarms was high, certain population subgroups were less likely to have smoke alarms or to have them installed on the same floor as bedrooms. Fire escape planning, another important safety measure, was somewhat less common, and very few respondents reported having practiced a fire escape plan with the members of their household.

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Each year in the United States, more than 400,000 residential fires claim the lives of approximately 3600 people and injure approximately an additional 18,600.[1] Although these figures reflect a gradual decline over the past 10 years in the number of fatalities and injuries caused by residential fires, fire-related deaths and injuries remain a significant public health problem. The United States has the highest overall fire-related death rate of all industrialized countries outside the former Soviet Union, with a 1995 crude death rate of 1.4 per 100,000 population.[1] A national health objective is to reduce residential fire-related deaths to no more than 1.2 per 100,000 by the year 2000.[2]

An installed and maintained smoke alarm reduces the likelihood of death or injury due to a residential fire.[3-5] Although some studies have assessed the prevalence of residential smoke alarms at the state and local levels,[3,4,6] few have examined this issue from a national perspective.[7] Our report summarizes data from the fire module of the Injury Control and Risk Survey (ICARIS), a national telephone survey conducted in 1994 by the Centers for Disease Control and Prevention, which assessed a wide variety of injury risk factors.[8-13]

METHODS

ICARIS survey staff drew a stratified random sample from a proprietary list of telephone exchanges that links Census data with phone exchanges in all 50 states and the District of Columbia. The survey oversampled telephone exchanges with more than 10% of households occupied by members of minority ethnic groups (high minority stratum) to improve the precision of minority group estimates. Calls were made by trained interviewers between April 28, 1994, and September 18, 1994. A minimum of six attempts were made to contact each telephone number.

The interviewer asked the number of adult men and women in the household ages 18 and older. Because injury rates vary by sex,[14] we sought to sample an equal number of adult men and women. Using a specified random selection procedure, we selected one gender for each household; if there were more than one eligible person of the selected gender, the person with the most recent birthday was selected for the interview. Additional telephone calls were made if necessary to reach that person. After the selected adult respondent consented to be interviewed, interviews were conducted in either English or Spanish.

The fire injury risk module of ICARIS is a series of questions about smoke alarm prevalence, testing, and placement and fire escape planning and practice. Each respondent was asked the following questions:

1. Do you have any smoke detectors installed in your home?
2. During the past 12 months, what did you or anyone in the household do to check if any of the smoke detectors were working?
3. Are any of the smoke detectors on the same floor as the room where you sleep?
4. Have any of the members of your household ever discussed an escape plan in case of fire?
5. In the past 12 months, have any of the members of your household practiced an escape according to the plan?

For the present study, we recoded all responses of "don't know" to "no"; we recoded "refused" responses as missing. Households were classified as being in an urban area (a Metropolitan Statistical Area [MSA] with more than 20,000 households) or a rural area (an MSA with 20,000 households or fewer).

To derive national estimates, we weighted the data to reflect the ethnic and sex distribution of the U.S. population based on the March 1994 Current Population Survey.[15] Weighting factors included selection probability weights and post-stratification weights. Selection probability weights adjusted for the probability of selecting a particular household and respondent. Post-stratification weights increased the weights of individual records to fully represent the known distribution of households in the same MSA containing people of similar age, sex, and ethnicity. Full details are provided elsewhere.[8-13]

For the present study, we used SUDAAN software, which is designed for analyses of complex surveys, to estimate prevalence and 95% confidence intervals (CIs).[16] The log-likelihood chi-square test was used to assess independence, and the adjusted Wald F-test was used to assess linear trends.

RESULTS

For the present study, we analyzed responses to the questions comprising the fire injury risk module of ICARIS from the 5238 respondents providing usable

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data. A total of 9342 households were eligible for inclusion in the ICARIS survey. Of these, 5238 (56.1%) completed interviews with usable data, 3630 refused to participate, 462 did not complete the interviews, and 12 completed interviews that were unusable because of technical problems. Response rates were similar for the high minority sample stratum (55.4%) and low minority sample stratum (57.5%)

Prevalence of smoke alarms. Of the 5238 respondents, 4757 (91%) reported having at least one smoke alarm installed in their home. Households reporting income below the poverty level were less likely to be equipped with smoke alarms than those at or above the poverty level (82% vs. 93%, $P < 0.001$) (see Table). (The definition of poverty level was adapted from the household size and income criteria published by the U.S. Department of Health and Human Services in 1994.[17]) Households in rural areas were less likely to have installed smoke alarms than urban households (86% vs. 93%, $P < 0.001$). Multi-unit apartment buildings (five or more units) had a 5% greater likelihood of being equipped with smoke alarms than detached homes. Ninety-seven percent of respondents who reported living in homes built in 1980 or later said their homes were equipped with smoke alarms, compared with 90% in homes built before 1950 ($P < 0.001$). Regionally, the Northeast and North Central states had significantly higher smoke alarm prevalence rates than did southern and western states.

Of the demographic characteristics analyzed (that is, household income, highest education level in the household, type of dwelling, year home built), the prevalence of installed smoke alarms varied most by educational level. Of homes in which none of the adult occupants had reportedly graduated from high school, 78% had smoke alarms, compared with 94% of homes with at least one occupant who reportedly had a graduate degree ($P < 0.001$). We also found a positive linear association between the presence of an installed smoke alarm and total household income ($P < 0.001$).

Smoke alarm on same floor as respondent's bedroom. In households reporting at least one installed smoke alarm, 94% of respondents reported having a unit on the same level of the home as their bedroom. People in the 25–54 age group were most likely to report having a smoke alarm installed on the same level as their bedroom (96%), as were households in which at least one adult had some college education (95%). We also found a positive linear relationship between respondents' income level and having smoke alarms installed on the bedroom level. Of those living below the poverty level, 86% said they had a smoke alarm on the same floor as their bedroom, compared with 95% of people living above the poverty level ($P < 0.001$).

Checking or testing smoke alarms. Because of the variety and complexity of the answers to the question about checking whether alarms were working, an appropriate analysis could not be conducted.

Fire escape plan. Having a fire escape plan was not nearly as common as having a smoke alarm in the home. However, a few important household characteristics were significantly associated with having designed a fire escape plan—home ownership, homes built in 1980 or later, the presence of at least one high school graduate

Table. Presence of smoke alarm and plans for fire escape, by household characteristics, Injury Control and Risk Survey, 1994

Characteristic	Smoke alarm: Unweighted number of households	Smoke alarm: Number reporting installed smoke alarms	Smoke alarm: Weighted: Extrapolated U.S. number	Smoke alarm: Weighted: Percent reporting installed smoke alarms	Smoke alarm: Weighted: 95% CI	Fire escape plan: Unweighted number of households	Fire escape plan: Number reporting fire escape plans	Fire escape plan: Weighted: Extrapolated U.S. number	Fire escape plan: Weighted: Percent reporting fire escape plans	Fire escape plan: Weighted: 95% CI
Total	5238	4757	88,459,231	91.1	90.3, 92.0	5238	3048	57,975,877	59.8	58.3, 61.2
Household income[a]										
Below poverty level	586	481	8,059,311	82.3	78.8, 85.8	586	294	5,038,189	91.0	87.9, 94.1
Above poverty level	3987	3697	69,606,887	92.8	91.8, 93.7	3985	2357	45,374,353	90.2	89.0, 91.3
Metropolitan Statistical Area[b]										
Urban	4260	3927	67,438,273	92.9	92.1, 93.7	4528	2457	43,037,432	59.3	57.7, 61.0
Rural	978	830	21,020,959	85.8	83.5, 88.1	978	591	14,938,445	61.0	57.7, 64.3
Type of dwelling[a]										
Five or more apartments	719	686	11,403,525	95.6	93.9, 97.2	719	357	5,974, 287	50.1	46.0, 54.2
2–4 apartments	459	424	7,567,882	93.0	90.5, 95.6	459	240	4,405,629	54.2	49.0, 59.3
Mobile home	348	312	6,406,638	90.3	87.0, 93.7	348	230	4,723,614	66.6	61.1, 72.1
Attached home	428	391	6,538,420	91.0	87.9, 94.1	428	230	3,922,355	54.6	49.3, 60.0
Detached home	3239	2907	55,810,730	90.2	89.0, 91.3	3237	1966	38.484,730	62.2	60.3, 64.1
Year home built[c]										
Before 1950	1143	1019	19,604,202	89.5	87.5, 91.5	1141	699	13,603,563	62.2	59.1, 65.4
1950–1959	708	634	11,231,537	90.5	88.2, 92.9	708	396	6,996,792	56.4	52.3, 60.6
1960–1979	1586	1431	26,959,143	90.0	88.3, 91.7	1586	936	18,000,430	60.1	57.4, 62.8
1980 or later	1342	1293	24,484,732	96.7	95.7, 97.7	1342	815	16,017,163	63.3	60.4, 66.2
Census region[b]										
Northeast	839	778	18,119,672	93.1	91.2, 95.0	838	475	11,564,376	59.5	55.9, 63.2
North Central	1069	1007	21,913,317	93.8	92.1, 95.4	1068	630	13,944,118	59.7	56.5, 62.9
South	2181	1938	30,119,091	88.8	87.4, 90.3	2181	1251	19,938,242	58.8	56.5, 61.1
West	1149	1034	18,307,151	90.0	88.0, 92.0	1149	692	12,529,141	61.6	58.4, 64.8
Highest educational level in household[a]										
Less than high school	379	296	4,957,178	78.3	73.7, 83.0	378	174	3,014,497	47.9	42.3, 53.6
High school graduate	1239	1096	21,309,956	88.9	86.9, 90.8	1239	699	14,033,643	58.5	55.5, 61.6
Some college	1456	1337	24,927,555	92.6	91.1, 94.0	1455	889	17,005,197	63.2	60.4, 66.0
College graduate	1057	993	18,840,112	93.6	91.9, 95.4	1057	617	12,000,980	59.6	59.3, 63.0
Home ownership[d]										
Rented	1745	1555	27,056,220	89.6	88.0, 91.2	1745	866	15,481,116	51.3	48.6, 54.0
Owned	3434	3154	60,556,512	91.9	90.9, 92.9	3432	2148	41,863,508	63.6	61.8, 65.4

[a]Statistically significant at $P < 0.001$ for smoke alarms and fire escape plans.
[b]Statistically significant at $P < 0.001$ for smoke alarms only.
[c]Statistically significant at $P < 0.001$ for smoke alarms and $P < 0.05$ for fire escape plans.
[d]Statistically significant at $P < 0.05$ for smoke alarms and $P < 0.001$ for fire escape plans.

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in the household, and a household income greater than $20,000 per year (see Table). Only 17% of households that reported having a fire escape plan had actually practiced it, according to respondents. Weighting these figures to estimate national prevalence, we find that only 10 million of the 97 million U.S. households have a fire escape plan and practice it.

DISCUSSION

Although the overall use of smoke alarms appears to be high, the results of this survey support other published findings that certain subgroups, such as poor or low-income people, are less likely than others to live in homes with smoke alarms and are also most vulnerable to fire injury and death.[3,5,14] Another finding was that southern states had the lowest prevalence of residential smoke alarms; southern states have been shown to have the highest incidence of fire-related mortality.[18]

We also found that certain groups, such as people without a high school education, unemployed or retired people, and low-income people, were less likely to have an alarm on the same floor as their bedroom. Home fires in which a death occurs usually happen between 10 p.m. and 6 a.m.[19] It is therefore critical that functioning smoke alarms be located outside bedrooms to alert sleeping occupants and allow them time to exit the burning home safely.

The results of this study should be considered in light of certain limitations of the ICARIS study. The response rate was 56%, which is low for a telephone survey. In addition, data were self-reported and unvalidated. The participants may not have been fully representative of the U.S. population; a comparison of the study population with the U.S. population suggests that the sample was generally representative, except for underrepresentation of low-income people, as is typical of phone surveys.[11] Given our finding that low-income households were less likely to have installed smoke alarms, we may have overestimated smoke alarm prevalence.

Finally, it is important to appreciate that many installed smoke alarms do not work. A study by the Consumer Product Safety Commission showed that in 1992, although 88% of homes in the United States had at least one installed smoke alarm, only 74% of homes were equipped with a functional smoke alarm.[7] Nonfunctional smoke alarms were primarily due to missing or dead batteries, the alarm being disconnected from the power source, or the alarm being clogged with dirt or dust.[7]

Because smoke alarms are effective early warning devices, efforts should be made to encourage people to install and periodically check them. Public education campaigns can help raise the awareness of all age groups about the importance of smoke alarms and can be effective in increasing their use and lowering fire death rates.[4] Continued support should be given to programs that target people at highest risk for injury or death due to fire (that is, low-income people, children younger than age five, and adults older than age 65).

Although equipping homes with operable smoke alarms is an important component of fire safety, another critical element is fire escape planning and practicing. The escape plan should include two exits from each room (where possible), crawling low to avoid smoke, and meeting at a predesignated place in front of the home.[20] According to our data, fire escape planning is done by only 60% of U.S. households, and only 17% of these households actually practice their plan. Future studies should identify why so few households have such plans

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and why even fewer practice them. Maintaining operable smoke alarms and designing and practicing fire escape plans are critical to preventing injury or death from residential fires.

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