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# Fatal Incident Risk Factors in Recreational Boating in Ohio

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## Synopsis .....

*To identify risk factors predicting the involvement of boat operators in incidents resulting in at least one fatality, the authors obtained data from a mail survey of registered boat owners in the State of Ohio and from the Boating Accident Report*

*(BAR) files for 1983-86 compiled by the Ohio Department of Natural Resources. Additionally, they reviewed Ohio death certificates for those years to identify cases missed by the BAR system. Forty percent of the fatal incidents would have been missed by a search of death certificates alone.*

*During the period studied, 107 boating incidents resulted in 124 deaths. There were 0.9 fatal incidents per million boat-operator hours. Factors found to be associated with an increased risk of a fatal boating incident were the operator being younger than 30 years, having fewer than 20 hours of boat operating experience, and lacking formal boat safety training. Canoes, kayaks, rowboats, and inflatables were associated with a higher rate of fatal incidents per million hours of use than were motorboats. Young age and lack of experience were associated independently with increased risk, explaining some of the effects associated with types of boats and with lack of training.*

*The findings suggest that supervised experience, safety training programs aimed at young operators, and interventions specific to certain types of boats are likely to reduce boating fatalities.*

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**R**ECREATIONAL BOATING INCIDENTS account for more than 1,000 deaths and \$20 million in damage to boats each year in the United States, according to the U.S. Coast Guard (1). Injuries related to water transport, most of which occur during recreational boating, are among the top 10 causes of years of life lost from unintentional injury (2).

Risk factors associated with fatal injuries incurred during recreational boating use have not been well characterized. Estimates of the numbers of boats, numbers of boaters, and hours of use of boats are needed to study the occurrence of recreational boating injury. Ohio is one of seven States (with Arizona, Iowa, Minnesota, New Hampshire, Oklahoma, and Rhode Island) requiring registration of all recreational watercraft, including canoes, kayaks, sailboats, most rubber or vinyl rafts, and motorboats (3), providing a means to obtain data on a random sample of boats and boaters in Ohio. Registration data were obtained, together

with data collected by the State of Ohio, Department of Natural Resources, Division of Watercraft, on incidents leading to fatal boating injuries. The data were combined for the purpose of describing the risks of reported fatal boating incidents in relation to characteristics of the operators and the types of boats involved. The results were used to estimate the possible effects of various injury-prevention interventions on the number of fatal incidents.

## Methods

In Ohio, a new boat must be registered within 30 days of purchase, and registrations must be renewed every 3 years. Each boat is given a unique registration number, and a current registration must be displayed at all times. Failure to register a boat is a misdemeanor, punishable by a fine of up to \$100. Compliance with the registration proce-

dure is high, as evidenced by the fact that no boating incidents investigated by the Division of Watercraft involved unregistered boats.

A questionnaire was mailed to a random sample of 1,200 boat owners registered in Ohio in 1986 (0.3 percent of the total number). The survey was limited to one mailing because the questionnaire, which asked about reported as well as unreported boating incidents, was anonymous. Owners were asked about the number and types of boats they owned; about the age, experience, and training of the person who usually operated the boat (the primary boat operator, not necessarily the owner); and about features of the boats they owned, such as type, length, means of propulsion, and horsepower. Respondents were asked to estimate the amount of time the primary operator had spent boating during the past year. Data from the survey were extrapolated to estimate the size and characteristics of the population of boat operators in Ohio during the study period.

Data on boating incidents were obtained from Boating Accident Reports (BAR) compiled by the Division of Watercraft. By Ohio law, boating incidents are reportable to State officials if there is associated loss of life, personal injury requiring medical treatment beyond first aid, damage to the vessel or other property exceeding \$200, or loss of the vessel. All vessels registered in the State are subject to the reporting requirement.

In the BAR system, incidents are considered to be related to recreational boating if the boat was being used for noncommercial transportation at the time of the incident. Examples of such use include water skiing, fishing (moored and drifting), and river float trips. Incidents are not included if the boat was being used as a fixed platform for other activities, such as swimming. The BAR system contains information about the boat operator at the time of the incident, the boat, and the circumstances surrounding the incident. The investigating officer, usually a Division of Watercraft investigator, records a judgment about factors contributing to the incident; one option is alcohol use. Objective measures of alcohol use, such as blood alcohol levels or breath testing, usually are not obtained. The officer's judgment about alcohol use is based mainly on observation of the boater's behavior, the presence of open alcohol containers, or other, indirect evidence.

Questions in the mail survey about boat operating experience and training were modeled directly on corresponding questions in the BAR form. Experience was categorized on the BAR form as

*'The principal findings of this study are that small boats, such as canoes and rowboats, apparently have a higher fatal incident rate per hour of use than large boats, and that operator age and experience are independent predictors of the risk of a fatal incident.'*

fewer than 20 hours, 20 to 100 hours, 101 to 500 hours, and more than 500 hours. Training was categorized in a check-box format as none, U.S. Coast Guard Auxiliary, U.S. Power Squadron, American Red Cross, State, or other.

We analyzed data on all reported recreational boating incidents resulting in death and occurring in Ohio waters in the 4-year period January 1, 1983, through December 31, 1986. To estimate the completeness of the BAR data, we reviewed Ohio vital statistics records. Death certificates with International Classification of Diseases (ICD-9-CM) (4) external cause of injury codes (E-codes) denoting deaths related to water transport, which includes recreational boating, were matched to BAR incidents for the period 1983-86 to detect deaths reported on death certificates but not to BAR. To find drownings resulting from boating incidents, but not classified as boating-related deaths by E-code, and not included in the BAR system, we reviewed death certificates for drownings (ICD-9-CM code E910) occurring during the study period.

Using the estimated numbers of boats and boat operators during the study period, we calculated the numbers of hours of boat operation by types of boat and by characteristics of operators and calculated the ratios of the number of fatal incidents per million operator hours (MOH). The numerator for each ratio was the number of fatal incidents, with each fatal incident counted but once, regardless of the number of fatalities in an incident. Characteristics of the boat operator, not of the deceased, at the time of the fatal incident, were tabulated. The estimates were stratified by self-reported operator age, operator experience, operator training, and type of boat.

To assess relationships among those variables, data from the BAR and the survey were analyzed as case-control data using a multivariate logistic regression model. Cases were an operator of a boat

Table 1. Recreational boating fatal incidents and fatal incident ratios, by operator age, Ohio, 1983-86

| Age (in years) | Number of fatal incidents | Fatal incidents per million operator hours | Relative risk |
|----------------|---------------------------|--|---------------|
| 10-19          | 13                        | 8.1  | 23.6          |
| 20-29          | 30                        | 2.4  | 7.0           |
| 30-39          | 19                        | 0.7  | 2.1           |
| 40-49          | 19                        | 0.7  | 2.1           |
| 50-59          | 13                        | 0.6  | 1.7           |
| 60-69          | 8                         | 0.5  | 1.4           |
| 70 and older   | 2                         | 0.3  | 1.0           |
| Unknown        | 3                         | ...  | ...           |
| Total          | 107                       | 0.97                                       | ...           |

Table 2. Recreational boating fatal incidents and fatal incident ratios, by operator experience, Ohio, 1983-86

| Experience (in hours) | Number of fatal incidents | Fatal incidents per million operator hours | Relative risk |
|-----------------------|---------------------------|--|---------------|
| Fewer than 20         | 21                        | 39.7                                       | 132.3         |
| 20-100                | 16                        | 1.3  | 4.3           |
| 101-500               | 19                        | 0.6  | 2.0           |
| More than 500         | 23                        | 0.3  | 1.0           |
| Unknown               | 28                        | ...  | ...           |
| Total                 | 107                       | 0.97                                       | ...           |

Table 3. Relative risk<sup>1</sup> and attributable number<sup>2</sup> from multivariate analysis, fatal boating incidents, Ohio, 1983-86

| Factor  | Estimated relative risk | 95 percent CI | Attributable number |
|---|-------------------------|---------------|---------------------|
| Operator age: less than 30 vs. 30 or older            | 4.76                    | 3.46,6.54     | 34                  |
| Experience: less than 100 hours vs. 100 hours or more | 2.65                    | 1.41,4.99     | 23                  |
| Training: none vs. some                               | 1.27                    | 0.63,2.57     | 10                  |
| Boat type: nonpowered <sup>3</sup> vs. motor powered  | 1.41                    | 0.73,2.77     | 10                  |

<sup>1</sup> Estimated by multivariate odds ratio.

<sup>2</sup> Number of fatal incidents potentially attributable to the risk factor over the 4-year period of the study.

<sup>3</sup> Canoes, rafts, and inflatables.

NOTE: CI = confidence interval.

at the time of a fatal incident; controls were a primary operator identified in the survey who had not been involved in an incident during the previous 4 years. We calculated adjusted odds ratios for each variable and used the odds ratios, as well as the prevalence of risk factors, to make calculations of the percent and number of fatal incidents associated with each variable (5).

## Results

**Boating population at risk.** Of the 1,200 questionnaires sent, 922 were returned (76.8 percent). Of the 922 questionnaires returned, 759 were complete and appropriate for analysis. The distribution of the types of boat reported as owned by survey respondents was similar to that for all registered boats. Ownership of a canoe was reported by 11.9 percent of survey respondents and canoes were 12.1 percent of all boats registered. Ownership of a sailboat or motorboat was reported by 74.3 percent of survey respondents and those types were 72.5 percent of all boats registered. Ownership of a rowboat was reported by 10.9 percent of survey respondents and 6.2 percent of registered boats were rowboats. Other types were reported by 2.9 percent of survey respondents and were 4.2 percent of other types registered.

The 759 respondents owned a total of 1,124 boats, a mean of 1.48 boats per responding owner. There was an average of 346,673 boats registered during the study period. Thus, we estimated there were approximately 234,239 boat owners in Ohio at any time during the study period. Boat operators who reported use of their boats averaged 117.7 hours of use per year (a range of 1 to more than 1,000 hours).

**Mortality.** There were 127 nonduplicated recreational boating deaths reported in either the BAR files or on death certificates during the study period. Of these, 124 were reported (98 percent) in 107 fatal incidents recorded in the BAR system, whereas only 76 were reported (60 percent) on death certificates as being associated with water transport.

Of the three deaths detected on death certificates that were not recorded as deaths in the BAR system, one was recorded on a BAR as a nonfatal injury, and two involved falls overboard. There were 51 deaths found on the BARs but not coded on death certificates as related to boating. Thirty-nine were coded as drowning (76 percent), and one each was coded on death certificates as trauma, hypothermia, and "cause unknown." There were no Ohio death certificates for 9 of the 51 BARs; in 6 cases the body was not recovered, 2 bodies drifted into other States and were recorded elsewhere, and 1 boater was a resident of and died in another State. No additional recreational boating fatalities were found in a review of Ohio death certificates for all 571 persons who were recorded as drowning during the study period.

Ninety-nine of the 124 deaths (80 percent) reported on BARs were classified as drownings. The cause of death given for the other 25 deaths included disappearance, burns, smoke inhalation, electrocution, or "other." Fatal incidents occurred most often between noon and 8 p.m. (55 percent of incidents), on weekends (50 percent on a Saturday or Sunday), and during the summer (47 percent in June or July). Thirty-seven of the fatal incidents (36 percent) occurred on Lake Erie, 23 on another large lake or reservoir (22 percent), and 21 on a river (20 percent).

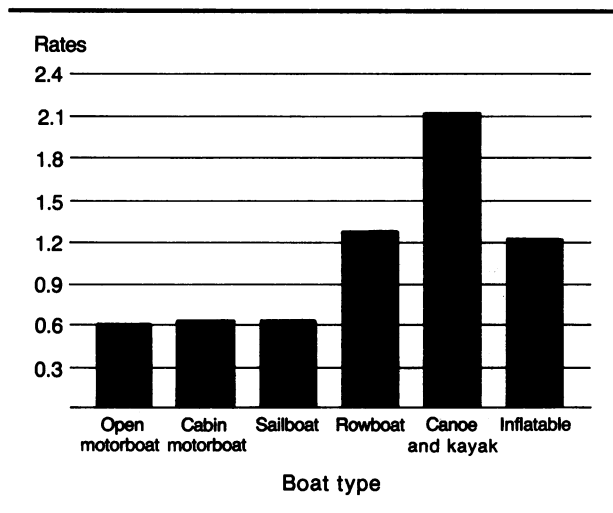
Alcohol use was listed as a contributing cause in eight of the incidents (7 percent). Review of the written BAR reports showed that alcohol was mentioned in a total of 22 of the incidents (21 percent), but most often the box on the form was not checked.

All types of boats, except motorized sailboats and houseboats, were involved in fatal incidents. Open motorboats most frequently were involved in fatal incidents (51 percent), followed by canoes (18 percent), rowboats (13 percent), cabin motorboats (11 percent), and other categories. The distribution of horsepower of motorboats involved in fatal incidents was similar to that for all motorboats registered in Ohio. Fatal incidents occurred primarily while cruising (36 percent), drifting (17 percent), and fishing (15 percent). Capsizing was a factor in 41 percent of the incidents and falling overboard was a factor in 28 percent of the incidents. Speeding, as assessed by the investigating officer, was identified as a cause of only five (5 percent) of the fatal incidents. Water-skiing resulted in only one fatal incident.

**Risk estimates.** The ratio of fatal incidents to operator-hours ranged from 0.34 fatal incidents per million operator-hours (FI per MOH) in the age group 70 years and older to 8.1 FI per MOH in the age group 10 to 19 years (table 1). The ratio for the highest risk age group was 23.6 times as large as that for the lowest risk age group. Similarly, operators with fewer than 20 hours of experience were involved in fatal incidents at a rate 132 times greater than operators with more than 500 hours of experience (table 2).

Differences in ratios by operator training were less striking. Untrained operators were 2.0 times more likely per operator-hour to be the operator in fatal incidents as trained operators. Motorboats were involved in the largest number of fatal incidents, but the ratio of the number of fatal incidents to the number of hours of motorboat opera-

Figure 1. Fatal incident rates per million hours of boat operation, by type of boat, Ohio, 1983-86



tion was only a third to half of the ratio for nonpowered boats (figure 1).

To determine the effect of operator age on fatal incident rates by experience, training, and boat type, we stratified cases by the age group of the operator (figures 2-4). Because of the small number of cases, risk groups were combined. Younger operators had higher ratios within each group, but ratios were higher also for less experienced operators, for operators without safety training, and for operators of small, nonpowered boats, regardless of age. For operators ages 50 years and older, however, training and boat type had little effect on the ratio.

Multivariate analysis from the case-control study gave relative risk estimates similar to those from the analyses of risk per million operator-hours (table 3). Operator age and experience were independently associated with risk of being the operator in a fatal incident. Training (entered as none versus some) and boat type (entered as powered versus nonpowered) were not associated significantly with risk of being the operator in a fatal incident when age and experience were controlled for, although the point estimates of risk were elevated.

### Potential Impact of Preventive Measures

Attributable number estimates are shown in table 3. We found that reducing the risk of operators younger than 30 years to the level of risk of operators aged 30 years or older could potentially have prevented 34 of the 107 fatal incidents. Similarly, reduction of risk among inexperienced

Figure 2. Fatal incident rates per million operator-hours, by operator experience and age, Ohio, 1983-86

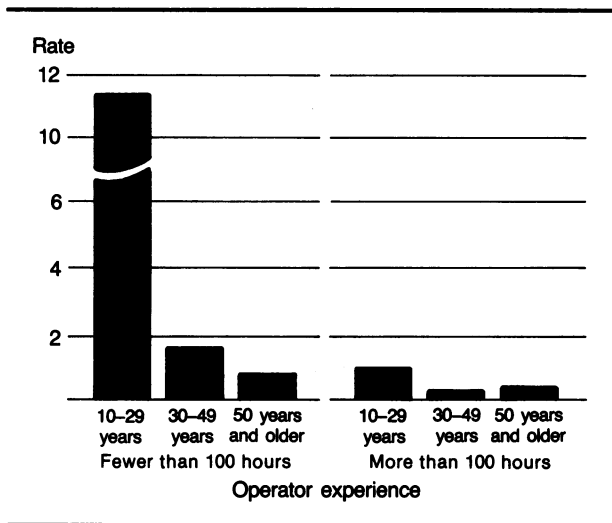
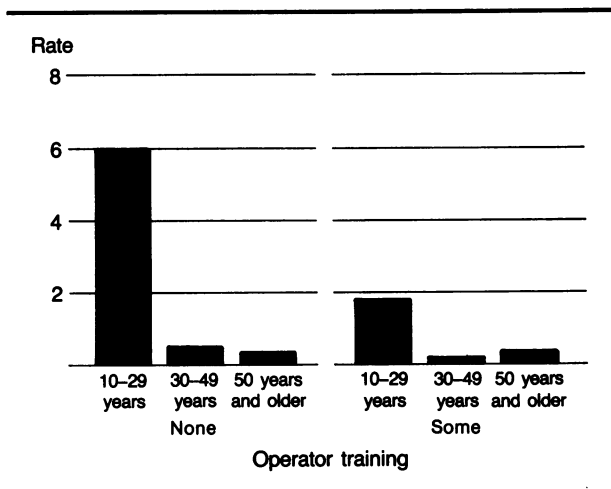


Figure 3. Fatal incident rates per million operator-hours, by operator training and age, Ohio, 1983-86



operators to that of experienced operators potentially could have prevented 23 of the 107 fatal incidents. Risk reduction among untrained operators and operators of a canoe, kayak, or rowboat potentially could have prevented 10 fatal incidents in each of the two categories. Because age, experience, training, and boat type are all correlated, the overall impact of preventive measures aimed at all those variables would be less than the sum of the number of attributable incidents taken separately.

## Discussion

The study findings demonstrate that the occurrence of boating incidents resulting in fatal injuries, like the occurrence of motor vehicle crashes, is

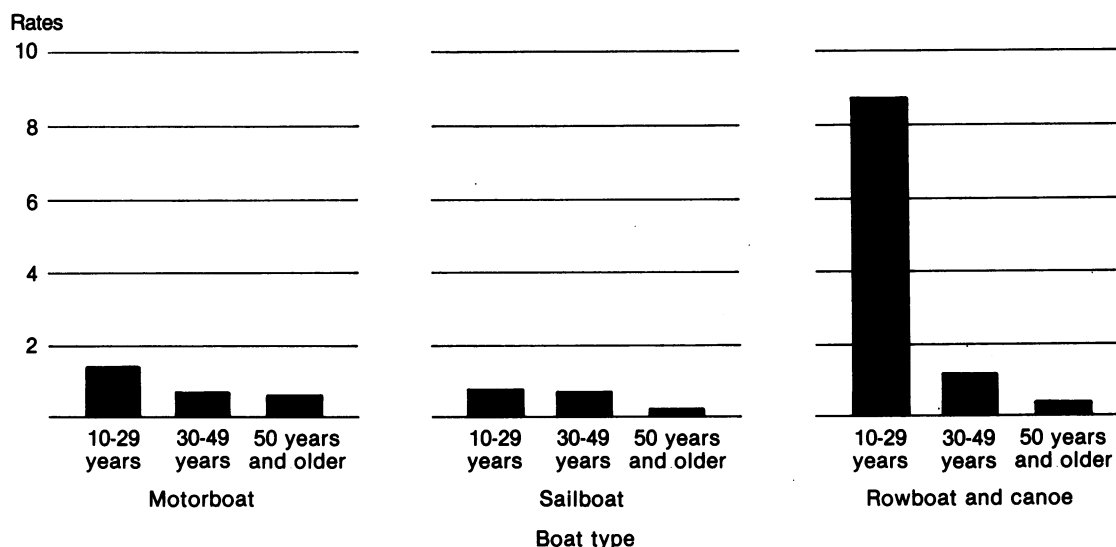
related to the age, training, and experience of the operator and to features of the vehicle. While these general relationships were expected by analogy with other transport-related injuries, the study findings specific to boats have not been reported previously. One of the strengths of this study is that the risk of a fatality is related to hours of exposure, stratified by characteristics of operators and of boats, rather than simply to numbers of boats or operators.

The principal findings of this study are that small boats, such as canoes and rowboats, apparently have a higher fatal incident rate per hour of use than large boats, and that operator age and experience are independent predictors of the risk of a fatal incident. The increased risk with small boats is in part explained by the age of the operators, which is younger than that of operators of large boats; thus, in the multivariate analysis, boat type was associated only weakly with risk of a fatal incident. The increased risk associated with small boats may have to do with how they are used, rather than with intrinsic properties of the boats themselves. Operator training was associated in the stratified analysis with a reduced risk of fatal incident among those ages younger than 50 years, but again the association was weak in the multivariate analysis, suggesting that age and experience account for much of the apparent effect of training.

Our review of the BAR reports suggests that alcohol consumption may have played a role in up to 21 percent of the incidents, while most published reports cite alcohol as a factor in at least 35 percent of incidents (6-8). Our lower estimate may result from the fact that alcohol played a relatively small role in fatal incidents during that time, or because Ohio law enforcement officers were reluctant to record alcohol use unless it could be documented by physical evidence or witness testimony. Alcohol determinations were not consistently performed by Ohio county coroners on decedents eligible for this study, in part because of the unreliability of the tests among persons whose bodies are recovered after several days in water. While it seems plausible that alcohol use by the operator increases the risk of a fatal incident, data on the frequency of alcohol use by operators not involved in fatal incidents are not available for Ohio boaters.

In Ohio, 98 percent of all fatal recreational boating incidents are included in the BAR system, while up to 40 percent of fatalities resulting from such incidents are not coded on Ohio death certificates as such. Studies of boating fatalities should

Figure 4. Fatal incident rates per million boat-hours, by boat type and operator age, Ohio, 1983-86



include information from BARs as well as from death certificates.

Our estimates of exposure are based on a sample survey of boat owners, who were asked about the characteristics of the usual boat operator and the hours of operation of the boat. While the response rate from the questionnaire was not as high as expected, it was high for a single mailing. The survey provided a unique opportunity to make estimates of the risk per hour of operation, stratified by operator age, experience, and training. Respondents showed a distribution of types of boats owned similar to that among all boat owners, suggesting that nonresponding and responding operators may have had similar characteristics. Unfortunately, the design of the study, in which the numerator of the rates is an actual count of number of incidents and the denominator is an estimate of the size of the population at risk, does not allow calculation of confidence limits around our estimates of rate ratios.

We assumed that the primary operators described in the survey responses corresponded to the operators of the boats on BAR reports. To the extent that operators of boats involved in fatal incidents were not the primary operators of these boats, estimates of the ratios may be biased. The direction of that bias most likely would be to increase the ratio estimates for young and inexperienced operators. The size of the bias cannot be estimated directly as the BAR reports do not distinguish between primary and nonprimary operators. A similar bias might be introduced if small, nonpo-

wered boats were less likely to be registered than power boats. While this is possible, observations on Ohio waters by the authors suggest that unregistered boats very rarely are seen in use.

We calculated the potential impact of reducing the risk of young or inexperienced operators to that of older or more experienced boat operators. For the reasons cited, the estimate of impact may be overestimated. While such a reduction would have the greatest impact on the number of fatal incidents, it is not clear how such a risk reduction would be accomplished. Age and experience can be acquired only with the passage of time. Supervised experience or training of younger operators might reduce the risk associated with inexperience and youth, but careful evaluation of such approaches is necessary to assess their effectiveness. Safety training programs already in place should be reviewed to see if they are focused on the groups at highest risk and if they actually change operator behavior and reduce risk of injury. Experience with other classes of injury suggests that reduction of alcohol use by boat operators through education and enforcement would lead to a reduction in boating injuries and deaths.

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## Risk Factors for Drowning and Near-Drowning Among Children in Hillsborough County, Florida

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### Synopsis .....

*The authors obtained data from 700 households in Hillsborough County, FL, in a telephone random survey to determine risk factors for incidents of drowning and near-drowning among children in the county. The survey was conducted from August through December 1991. A combination of forced-choice and open-ended questions was used to assess adults' drowning-related knowledge, attitudes, and prevention behaviors, as well as the incidence of and the circumstances surrounding drowning and*

*near-drowning among children who lived in those households.*

*The results showed that although most respondents had some knowledge of the epidemiology of drowning and near-drowning among children, deficits were noted in their knowledge of the importance of adult supervision and the recommended age at which to begin children's swimming instruction. Results showed a need for isolation fencing, that which separates a swimming pool from a house and yard. Most respondents reported that they did not know how to perform cardiopulmonary resuscitation (CPR) on an infant or child. More than 40 percent reported not knowing how to perform CPR on an adult.*

*Respondents reported no drowning or near-drowning incidents among children of their household within the last 3 years. However, the respondents did describe water-related immersions that involved children who experienced difficulty in the water, but recovered by themselves or with the aid of a nearby person. In some instances the child's breathing pattern was altered. There were three episodes during which difficulty in breathing occurred. The respondents reported a total of nine childhood water-immersion episodes within their families, none of which had been reported to treatment facilities. Recommendations are provided for programs for prevention of childhood drowning.*

**I**NJURIES ARE THE LEADING CAUSE OF DEATH for children ages 1 through 19 years in the United States (1). Leading causes of their injury-related mortality include motor vehicle crashes, homicide, suicide, drowning, and injury from fire or burns

(1). About 1,700 children and youth, predominately male, were victims of drowning in 1988 (2).

The risk for drowning is greatest among toddlers, preschoolers, and male adolescents (2). Children younger than 5 years are more likely to drown