

Drowning in Childhood and Adolescence: A Population-Based Study

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Abstract: We present the results of a residence-based study of drownings among Sacramento County, California children and adolescents ages 0–19 years for the years 1974–84. Children ages 1–3 had the highest drowning rates. The majority of drownings in this group, and one-third of all drownings in the study, occurred in

residential swimming pools. Males ages 15–19 had a high drowning rate as well; at least 38 per cent of drownings in that age group were alcohol-associated. The implications for preventive efforts are discussed. (*Am J Public Health* 1987; 77:830–832.)

Introduction

In 1983, 2,470 children and adolescents ages 0–19 years drowned in the United States.* Drowning is the third leading cause of unintentional injury death in children under age 5, and ranks second for ages 5–19.¹ Yet relatively little is known of the epidemiology of childhood drowning in this country. This article presents the results of a residence-based study of all fatal immersions involving Sacramento County (California) children ages 0–19 during the years 1974–84.

Sacramento County is located in the Central Valley of California, approximately 80 miles from the Pacific coast. It is a mixed urban-rural county, with a 1980 population of 783,381 (239,647 ages 0–19). Summer temperatures are frequently above 38°C. Two major rivers flow through the county and are heavily used for recreation. Many roads lie immediately adjacent to these rivers or smaller waterways. The number of in-ground residential pools in the county grew from approximately 7,000 in 1974 to 22,000 in 1984.**

Methods

As defined in this study, the term "drowning" applies both to immediate and delayed immersion deaths. Autopsy diagnoses were used as the basis for final case certification, for two reasons. Substantial variation between the cause of death determined at autopsy and that appearing on the death certificate, particularly among injury deaths, has repeatedly been demonstrated.² Second, the International Classification of Diseases (ICD), the basis for cause of death coding on death certificates, has classified drownings resulting from motor vehicle immersions as motor vehicle deaths since the 1920s. We included these deaths in this report.

A computerized review of death certificates in the California Master Mortality File produced a list of Sacramento County residents ages 0–19 who died in the United States between 1974 and 1984 and were assigned an ICD "E" (External Cause) code for drowning or submersion. Coroner's records were reviewed in each case, and the case was included if autopsy results confirmed drowning as the immediate, or near-drowning as the underlying, cause of death.

Additional cases were identified by a register of autopsy results maintained by the Sacramento County Coroner's Office.

Intercensal population estimates were generated by linear interpolation and extrapolation. Years of potential life lost (YPLL) were calculated by the method employed at the Centers for Disease Control.³

In conformity with earlier studies, blood alcohol determinations were accepted as valid if death occurred within six hours of immersion and sampling occurred within 24 hours of immersion.^{4,5} As putrefaction will not produce a blood alcohol concentration (BAC) greater than 100 mg/dl within 48 hours of death,^{6,7} cases with a BAC > 100 mg/dl obtained 24–48 hours after immersion were also considered alcohol-associated.

Injury severity was scored using the Abbreviated Injury Scale (AIS), which assigns to individual injuries a numerical score between 1 (mild) and 6 (unsurvivable).⁸ When multiple injuries were involved an Injury Severity Score (ISS) was calculated.⁹

Results

There were 137 drownings of Sacramento County children ages 0–19 during the years 1974–84. Thirty-six of these deaths (26 per cent) occurred in 13 other California counties; 14 of 101 Sacramento County drownings were identified only by a review of county coroner records. No out-of-state drownings were recorded. All drownings occurred in fresh water. Deaths were considered unintentional in 95 per cent of cases, homicidal in 1 per cent, and of undetermined intent in 4 per cent.

Average annual drowning rates per 100,000 person years were five for the study population as a whole, eight for males, two for females, five for Whites, and nine for Blacks. No trends over time were observed. The deaths resulted in 7,456 years of potential life lost.

As shown in Figure 1, drowning rates for both males and females were age-related. Children under age 5 accounted for 35 per cent of all drownings, but only 23 per cent of the study population.

Fifty-one per cent of immersions occurred in June, July or August; less than 20 per cent occurred in the six months October–March; 40 per cent of immersions occurred on a Saturday or Sunday.

One-third of all drownings, and 58 per cent of those among children ages 0–4, occurred in swimming pools. Half of pool drownings occurred at the child's own house or apartment complex. In an additional 36 per cent, the pool was at the residence of a friend, neighbor, or family member. Other residential pools and public pools each accounted for 7 per cent of pool drownings. Information on residential pool

*Unpublished data. Division of Vital Statistics, National Center for Health Statistics (NCHS), Hyattsville, MD.

**Unpublished data. Sacramento Municipal Utilities District.

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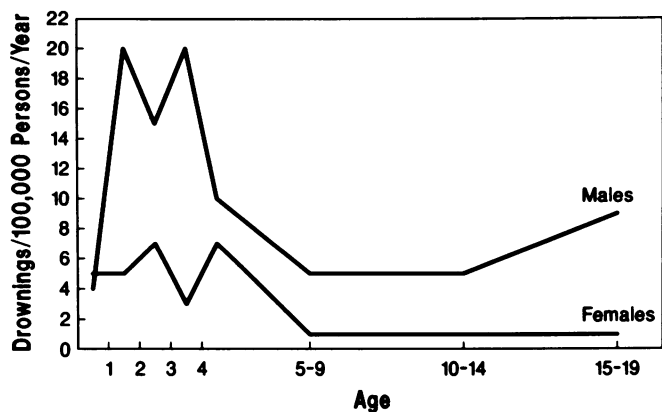


FIGURE 1—Drowning Rates by Age and Gender, Sacramento County Children Ages 0-19, 1974-84

fencing was not routinely available; 80 per cent of children appeared to have gained access to the pool directly from the house or yard.

The swimming pool drowning rate increased from 2/100,000 person years in 1974 to 3/100,000 in 1984. Ninety-five per cent of pool drownings involved pools in Sacramento County; Figure 2 illustrates that the rate increase was correlated with the increasing number of pools.

Seventy-four per cent of residential drownings occurred in swimming pools (Table 1). Most nonresidential drownings were divided between the two major rivers and 29 other bodies of water; 52 per cent of these latter cases occurred outside Sacramento County. Children ages 0-4 were involved in 74 per cent of all pool drownings, while children ages 10 and above accounted for 70 per cent of drownings in rivers, lakes, and canals (Figure 3). Infants ages 0-1 accounted for 67 per cent of bathtub drownings.

The children's activities at the time of drowning are given in Table 2. "Playing" embodies a wide range of both supervised and unsupervised activities, which were not necessarily water-oriented. None of the swimmers or boaters was recorded as wearing a personal flotation device.

Acute injury was noted at autopsy in 21 cases. Two of these were homicides; in both cases the drowning was deliberately induced and did not result from the other injuries noted. Of the remaining 19, an Injury Severity Score (ISS) greater than 1 was obtained in 7 (37 per cent); all these cases involved a head injury of AIS 2 or above. External head

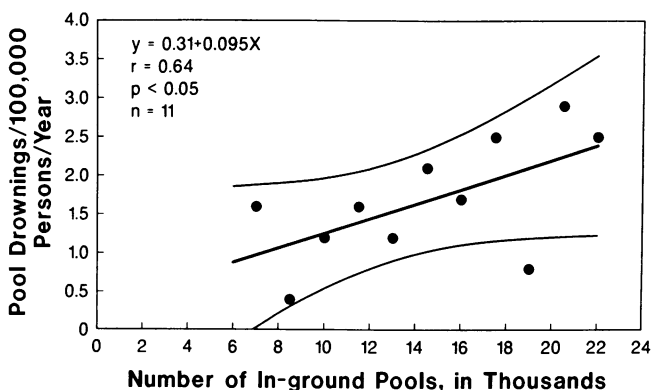


FIGURE 2—Pool Drowning Rates as a Function of Pool Ownership in Sacramento County, 1974-84 (Curves represent 95% confidence limits)

TABLE 1—Location of 137 Drownings among Sacramento County Children Ages 0-19, 1974-84

Location	Number	(%)
Residential	57	(42)
Swimming Pool	42	(31)
Bathtub/Shower	9	(7)
Other	6	(4)
Nonresidential	80	(58)
Two Major Rivers	38	(28)
Other River, Lake, Canal, Slough	39	(28)
Public Pool	3	(2)

injury (abrasion, contusion, and/or laceration) was noted in nine of the 12 cases with an ISS of 1. Four of the six motor vehicle-associated deaths had an ISS of 1; all six had head injuries.

Antecedent medical problems other than substance abuse were noted in seven cases. Six children had central neurologic disorders; a history of prior seizures was recorded in three of these. One had congenital heart disease and chronic renal failure.

A blood alcohol analysis was performed on 115 cases—79 per cent of those ages 0-9, and 88 per cent of those ages 10-19; the specified criteria were met in 75. Of these, 12 blood alcohol measures were positive; in six the concentration was ≥ 100 mg/dl. In one additional case, a blood alcohol of 110 mg/dl was obtained some 36 hours postmortem. All 13 positive determinations were in males ages 15-19. In that group, a minimum of 38 per cent of drownings were alcohol associated. Activity just prior to drowning was specified in 11 of these cases; six were swimming, three were boating or rafting, and two were operating motor vehicles.

Drug screens were performed on 99 of 101 Sacramento County cases. From 1974-82 acid neutral drugs (barbiturates and other tranquilizers) were assayed; screening for opiates, cocaine and its metabolites, and others was added in 1983. Only anticonvulsants were detected, and in all seven cases the child either had a known seizure disorder or had been hospitalized prior to death.

The estimated duration of immersion was 30 minutes or less for 71 children, 52 per cent of the total. For 67 (94 per cent) of these children resuscitation was attempted at the immersion site. However, in 20 (34 per cent) of 58 cases in which the child was retrieved from the water by a lay person,

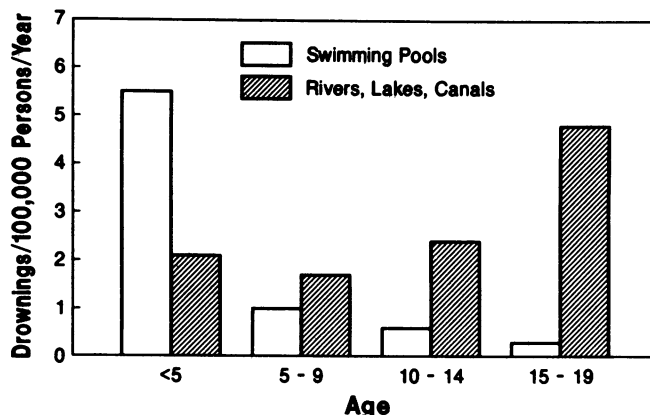


FIGURE 3—Drowning Rates by Age at Selected Sites, Sacramento County Children Ages 0-19, 1974-84

TABLE 2—Activity at the Time of Drowning among Sacramento County Children Ages 0–19, 1974–84

Activity	Number	(%)
Playing	45	(33)
Swimming/Wading	35	(25)
Boating/Rafting	8	(6)
Motor Vehicle Occupant	6	(4)
Other	18	(13)
Unspecified	25	(19)

resuscitation was delayed until the arrival of emergency medical services (EMS) personnel or never begun at all. In 42 per cent of drownings resulting from a child's immersion in his own home pool for 30 minutes or less, the child was retrieved from the water by a lay person—often a family member—but resuscitation was delayed until the arrival of EMS personnel.

Sixty-three (89 per cent) of the 71 children immersed for 30 minutes or less reached an emergency room; 38 (60 per cent) of these 63 were pronounced dead there. Twenty-five, 35 per cent of the original 71 cases, were hospitalized. The average length of hospitalization prior to death was 11.4 days for the 23 cases in which duration was recorded.

Discussion

Drowning is a serious public health problem for Sacramento County children. The overall drowning rate of 5/100,000 persons reported here equals those reported recently for children in Queensland (5/100,000 persons, ages 0–15)¹⁰ and New Mexico (5/100,000 persons, age 0–19),¹¹ and exceeds that for Honolulu (3/100,000 persons, ages 0–15)¹² and for the United States as a whole (3/100,000 persons, ages 0–19; authors' calculation based on 1983 NCHS data).

The residential swimming pool was the site of one-third of the drownings in this study, and 30–50 per cent of cases in several previous reports.^{10,12–16} Increased exposure, resulting from a growing prevalence of pool ownership, probably accounts for much of the increase in the childhood pool drowning rate seen over time. Childhood pool drowning and near-drowning rates are lower where fencing is required^{12,17,18} than in comparable communities where it is not required.¹⁰ In one Australian community with a high rate of pool ownership and a strictly enforced pool fencing ordinance, the only pool drowning in a 10-year period occurred in a pool which had been exempted from the requirements of the ordinance.¹⁸

Pool fencing is now required in Sacramento County. However, such fences may be placed at the perimeter of the premises on which the pool is located and incorporate the wall of a house or other building. In 80 per cent of residential pool drownings the victim apparently gained access to the pool directly from the house or yard. The importance of such direct access as a cause of pool drownings has been emphasized previously.^{13,19}

No state now requires that residential pools be isolated by a barrier designed to bar access by children already on the premises. The results of this study suggest that such a requirement should be enacted where pool drownings are common.

Survival following an immersion incident is critically dependent on the rapidity with which effective resuscitative care is delivered. Too often in this study the child received no

resuscitative care until EMS personnel arrived. Community-wide training in cardiopulmonary resuscitation (CPR) targeting families with small children, supplemented by mandated CPR training for residential pool owners, might substantially improve post-immersion survival rates.

Alcohol use is a major risk factor for drowning among males ages 15–19, although California's minimum legal drinking age was 21 throughout the study period. Alcohol education should emphasize the danger of mixing alcohol with aquatic activities. Alcohol availability has increased at California locations which are heavily used for water-oriented recreation.²⁰ Server liability should apply to drownings as to motor vehicle fatalities.

Motor vehicle immersions with driver or passenger head injuries may result in drownings in areas with waterside roadways. Use of seat belts and airbags would prevent head injuries and the resulting loss of consciousness, and might then prevent the drowning. Barrier placement at high-risk locations would also be beneficial.

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