

Sudden Infant Death Syndrome: Changing Epidemiologic Patterns in California 1989-2004

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Objective To evaluate the changes of sudden infant death syndrome (SIDS) epidemiology in California.

Study design We used 1989 to 2004 California statewide death registry data. SIDS cases were selected by "age of decedent" <1 year and "cause of death" listed as SIDS.

Results We identified 6303 cases (61% males) of SIDS. SIDS incidence rate decreased by 77%, from 1.38 per 1000 births in 1989 to 0.31 per 1000 births in 2004. No further decrease in SIDS incidence was noted from 2002 to 2004. The incidence rate was highest among blacks (2.02 per 1000 births) and lowest in Asian/Pacific Islanders (0.46 per 1000 births). The overall median age at death was 82 days, with no significant change over time. However, the peak age at death shifted from 2 months of age in 1989 to 2001 to 3 months of age in 2002 to 2004. Seasonal variation in the incidence of SIDS was attenuated. The difference in incidence rates between weekdays and weekends increased over the study period.

Conclusions The incidence rate of SIDS declined in California from 1989 to 2001, with no further decline after 2002. Several epidemiologic changes were noted: The peak age of SIDS death shifted from 2 months to 3 months of age; seasonal variation diminished; and weekday to weekend difference became more pronounced. (*J Pediatr* 2008;153:498-502)

Sudden infant death syndrome (SIDS) is the sudden death of infants under 1 year of age, which remains unexplained after performance of a complete postmortem examination, including an autopsy, examination of the death scene, and review of the case history.¹ It is the most common cause of death for infants between 1 month and 1 year of age. Although SIDS may be a collective term for many pathological processes leading to sudden unexplained infant deaths, the etiologies of this heterogeneous syndrome are mostly unknown. During the 1980s, the SIDS incidence in the United States was at 1.30 to 1.53 per 1000 live births.² Epidemiologic observations and prospective studies found that prone sleep position was a major risk factor for SIDS.³⁻⁷ In 1992, the American Academy of Pediatrics issued official recommendations for the infant sleep position to be either supine or side instead of prone.⁸ In 1994, a massive and coordinated *Back to Sleep* campaign was launched in the United States by the American Academy of Pediatrics, SIDS Alliance, National Institutes of Health, and other collaborative organizations.⁹⁻¹¹ Because this large-scale, population-based intervention, the percentage of infants sleeping in prone position has declined and the number of SIDS deaths has decreased.¹²

SIDS risk-reduction campaigns (such as *Back to Sleep*) were launched in many nations with similar success in reducing the number of infants sleeping in prone position and the incidence of SIDS. With this decline in SIDS incidence, the epidemiologic patterns of SIDS should be re-evaluated. Many investigators from different nations, including the United States, have noted the changes in SIDS epidemiology.¹³⁻¹⁹ For instance, Malloy and Freeman¹⁶ reported decreases in seasonal variation of SIDS incidence in the United States between 1992 and 1999. From the 1990 to 1995 data, Adams et al¹³ reported that the decrease in California's SIDS rate was less for blacks than for whites. Although the impact of the decreasing incidence on SIDS epidemiology in the first few years after the *Back to Sleep* campaign has been reported, it is unclear whether the changes have persisted and if additional changes have occurred.

In this study, we examined the SIDS incidence rates among California infants from 1989 to 2004. Our goal was to evaluate the changes in SIDS epidemiology before and a decade after the launch of the national *Back to Sleep* campaign. The changes in epidemiologic trends of SIDS may shed new light on the potential causes of SIDS and lead to contemporary interventions for further SIDS prevention.

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ICD	International Classification of Disease	SIDS	Sudden infant death syndrome
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METHODS

Database

We used 1989 to 2004 statewide death registry data from the Death Statistics Master File at the California Department of Health Services, Center for Health Statistics. The Death Statistics Master File data include state-mandated reports of all deaths to the California Department of Health Services. Data fields available in the public release of the death registry data include date of death, date of birth, sex, race/ethnicity, operations performed before death, underlying cause of death (in International Classification of Disease [ICD] codes), and 5-digit home zip code.

Case Selection

We selected the SIDS cases by the data fields of “age of decedent” and “cause of death.” We selected the decedent age 0 to 364 days. For “cause of death,” we used ICD-9 CM code of 798.0 for data from the years 1989 to 1998 and ICD-10 code of R95 for the years 1999 to 2004. The California Department of Health Services adheres to the NICHD definition of SIDS as defined previously.¹

To evaluate the changes in infant mortality, we selected all death records of infants (<1 year of age) from the Death Statistics Master File data. California vital statistics data on the number of live births for each year were used to calculate the SIDS incidence rate (per 1000 live births) and infant mortality rate (percent or per 100 live births). To evaluate the possibility of “diagnostic shift” or “coding shift,”^{20,21} we identified the cases classified as “indeterminate cause,” using ICD-9 CM code 799.9 and ICD-10 codes R96, R98, and R99.

Data Analysis

In the Death Statistics Master File, data on date of birth and date of death are provided. The decedent’s age in days was calculated. For each case, the day of the week when death occurred was verified with a calendar. The data on race of the decedent in the registry were coded into 25 categories, and data on Hispanic ethnicity were coded into 9 categories. For the purpose of this study, we grouped the race and ethnicity into non-Hispanic white, non-Hispanic black, Hispanic, Asian/Pacific Islander (including Filipino), American Indian, and other/unknown. In addition to evaluating year-to-year changes, we divided the 16-year study period into 3 eras: 1989 to 1994; 1995 to 2001; and 2002 to 2004 to study time trend. To evaluate the difference in SIDS occurrence during the days of the week, we calculated the weekday-to-weekend ratio. The weekday-to-weekend ratio was calculated by the average number of SIDS occurrences per day on weekdays (total number of SIDS occurrences on weekdays divided by 5 weekdays) divided by the average number of SIDS occurrences per day on weekend days (total number of SIDS occurrences on weekend days divided by 2 weekend days).

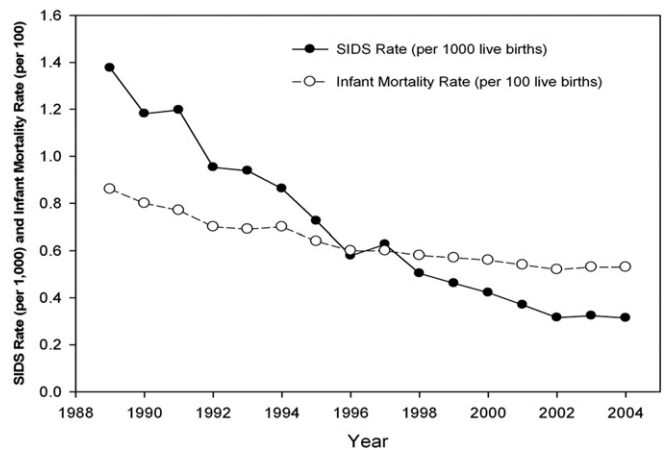


Figure 1. The overall incidence rates of SIDS (in closed circles) and infant mortality (in open circles) in California, 1989–2004. The SIDS incidence rate is calculated as per 1000 live births on the y-axis, infant mortality rate is calculated as per 100 live births on the y-axis.

RESULTS

We identified 6305 cases of SIDS that fulfilled the prespecified case selection criteria in California from 1989 to 2004. Two cases that had no autopsy and were not reported to coroners were removed. The remaining 6303 cases constituted the samples for this study. The study sample included of 3872 males (61%) and 2431 females (39%), with a male-to-female ratio of 1.59 to 1. The overall race and ethnic composition was 2619 white (41.5%), 2007 Hispanic (31.8%), 1222 black (19.4%), 420 Asian/PI (6.7%), 34 American Indian (0.5%), and 1 unknown.

Decreasing Incidence Rate

There were a total 8,850,468 live births in California during the study period 1989 to 2004. The overall SIDS incidence rate for the entire study period was 0.71 per 1000 live births. SIDS incidence rate decreased significantly ($P < .01$) by 77%: from 1.38 per 1000 births in 1989 to 0.31 per 1000 births in 2004 (Figure 1). Of the 77% decrease in SIDS incidence rate, 37% of the decrease occurred in the era 1989 to 1994 before the national *Back to Sleep* campaign and 40% of the decrease occurred in the era 1995 to 2001 after the national *Back to Sleep* campaign. In the era 2002 to 2004, no further decrease of SIDS incidence was noted.

During the study period 1989 to 2004, the infant mortality rate had decreased by 39% (Figure 1). The decline in SIDS incidence is greater than the decline in infant mortality rate (77% vs 39%, $P < .01$). As a result, the proportion of infant deaths due to SIDS had decreased from 16% in the beginning of the study period to 6% in 2004 (Figure 2; available at www.jpeds.com). In the era 2002 to 2004, there was no further decline in the infant mortality rate (Figure 1). Therefore, the proportion of infant deaths from SIDS remained constant in 2002 to 2004 at 6% (Figure 2). The proportion of infant deaths reported as ill-defined or unspecified cause of death for each year is shown on Figure 2. There

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