

RISK FACTORS FOR INFANT HOMICIDE IN THE UNITED STATES

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ABSTRACT

Background Homicide is the leading cause of infant deaths due to injury. More than 80 percent of infant homicides are considered to be fatal child abuse. This study assessed the timing of deaths and risk factors for infant homicide.

Methods Using linked birth and death certificates for all births in the U.S. between 1983 and 1991, we identified 2776 homicides occurring during the first year of life. Birth-certificate variables were reviewed in both bivariate and multivariate stratified analyses. Variables potentially predictive of homicide were selected on the basis of increased relative risks among subcategories with adequate numbers for stable estimates.

Results Half the homicides occurred by the fourth month of life. The most important risk factors were a second or subsequent infant born to a mother less than 17 years old (relative risk, 10.9) or 17 to 19 years old (relative risk, 9.3), as compared with a first infant born to a mother 25 years old or older; a maternal age of less than 15 years, as compared with an age of at least 25 years (relative risk, 6.8); no prenatal care as compared with early prenatal care (relative risk, 10.4); and less than 12 years of education among mothers who were at least 17 years old (relative risk, 8.0), as compared with 16 or more years of education.

Conclusions Childbearing at an early age was strongly associated with infant homicide, particularly if the mother had given birth previously. Our findings may have implications for prevention. (N Engl J Med 1998;339:1211-6.)

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HOMICIDE is the leading cause of infant deaths due to injury, accounting for almost one third of such deaths in 1996.¹ Among children and adolescents, homicides are most likely to occur in the first year of life, with similar or higher rates only during later adolescence.¹⁻⁴ More than 80 percent of documented homicides in very young children can be viewed as fatal child abuse, and there is strong evidence that both homicides and fatal cases of child abuse are undercounted.⁵⁻⁷ In addition, almost one fourth of infants discharged from acute care facilities with disabilities

due to injury are considered to have been intentionally injured, almost always as a result of child abuse; in an additional 8 percent of cases, intentionality is undetermined.⁸ Risk factors that can be identified in the prenatal period must be established both to identify infants at high risk for homicide and to develop timely and effective interventions.

Previous studies linking death certificates, social-service records, and police reports have shown that the relationship of the perpetrator changes with the age of the child. Homicides during the first week of life are most likely to be perpetrated by the mother.⁹⁻¹¹ After the first week, the perpetrator is usually male and is often the father or stepfather of the victim.^{5,11,12} The majority of homicides involving children who are three years old or older are committed by a person unrelated to the child.

State studies using linked birth and death certificates have consistently shown that the following maternal characteristics are risk factors for both unintentional and intentional infant deaths: a young age, a low level of education, late initiation of prenatal care, and previous births.¹³⁻¹⁵ Infant characteristics that are risk factors include low birth weight, low gestational age, male sex, and low Apgar scores. The small numbers of homicides in these studies have limited the simultaneous analysis of multiple factors and the generalizability of the findings.

We identified all deaths of U.S. infants born between 1983 and 1991 in order to obtain large enough numbers to establish stable estimates of risk factors for infant homicide. The timing of the deaths and potential risk factors amenable to preventive interventions were assessed in a multivariate analysis.

METHODS**Subjects**

We used data for all 34,895,000 live births in the United States between 1983 and 1991 and for deaths during the first year of life for which birth and death certificates were linked during a

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continuous period.¹⁶ The National Center for Health Statistics linked birth and death certificates between 1983 and 1991 for each yearly birth cohort. A birth-cohort approach is used for the linked files so that the deaths are those of infants born between 1983 and 1991 and do not include deaths occurring in those years among infants born in previous years. Therefore, the number of deaths in the linked files is not the same as the number reported by the National Center for Health Statistics for the study period.

Birth certificates could not be found for reported deaths in approximately 2.0 to 2.8 percent of all deaths during the study period, with the percentage varying according to the state and the year (percentages were not reported for 1983 through 1985). Death certificates without matched birth certificates were more common for infants who were less than 28 days old when they died than for those who were older.¹⁶

Variables

We reviewed univariate frequencies and bivariate associations for most variables that were consistently documented on birth certificates for the nine years of linked data. Associations at the state and county levels were not analyzed, because of small numbers. We performed further analyses of subcategories of variables for which we had sufficient data to make stable estimates, as well as variables that are potential risk factors according to related studies. The age of the father was missing on 41 percent of birth certificates linked to infant homicides and was therefore not included in the analysis. Data on race were based on information that the mother provided for the birth certificate, according to current procedures used for determination of race at the National Center for Health Statistics.¹⁷ Information on Hispanic ethnicity was available for the majority of state birth certificates only after 1988 and was therefore not included in the analysis.

Homicides were identified according to the official designation of the underlying cause of death as specified on death certificates, with the use of *International Classification of Diseases, 9th Revision* codes for external causes of death (e-codes).¹⁸ Deaths classified as "homicide and injury purposely inflicted by other persons" (e-codes 960 through 969) or "injury undetermined whether accidentally or purposely inflicted" (e-codes 980 through 989) were reviewed and subsequently combined because of their similarity and the strength of the associations with risk factors — an approach that is consistent with the methods of other studies of risks for infant homicide.^{6,13,14,19} Analyses of the separate and combined categories showed that the relative risks for the combined categories were almost identical to those for the category of intentional deaths alone. However, the magnitude of the problem would have been underestimated if we had not used the combined categories. Deaths of undetermined intent are considered suspicious by medical examiners and cannot be officially classified as unintentional. Such deaths accounted for 4.2 percent of all infant deaths caused by injuries, and intentional deaths accounted for 22.6 percent.

For the period from 1983 to 1991, the combined rate of intentional and possibly intentional deaths was 8.0 per 100,000 births, or 26.8 percent of all infant deaths due to injury. A total of 2776 infants died from intentional or suspicious causes. We refer to these deaths as homicides. The 52 deaths caused by neglect, abandonment, or exposure but classified as unintentional (e-codes 904.0 through 904.9) were not included in the analysis.

Statistical Analysis

We used the total number of births to determine rates of homicide, proportions of infants at risk, and the public health implications of high risks in categories with small numbers of deaths. Because of the large number of births, regression-model tests produced statistically significant results for most variables. Since births and deaths are complete counts, most modeling assumptions for significance testing based on probability-sampling theory may not be necessary or applicable. Therefore, the final selec-

tion of risk factors was based on adequate numbers to yield stable rates and population-based increased risks of homicide.²⁰

First, bivariate predictors were reviewed for categorical comparisons of relative risk. Then, multivariate effect modifications were assessed by reviewing stratified cross-tabulations of variables for increases in relative risks involving large enough numbers to permit stable estimates. For example, male infants were 1.1 times as likely to be killed as female infants, but the low positive predictive value of an elevated risk of 10 percent for male infants would raise questions about the appropriateness of targeting all male infants for intervention and the costs of such an intervention. Since no effect modification was found for sex in combination with other variables, it was not kept in the analysis as a predictor. Similarly, the bivariate relative risk of homicide was 1.0 for second births, as compared with first births, and 1.2 for third and subsequent births. When the effect modification was assessed for birth order stratified according to each of the other variables, the relative risk was increased severalfold for second births and for third or subsequent births stratified according to maternal age. Therefore, birth order was kept in the analysis as a "main effect" predictor, together with birth order stratified according to maternal age. Gestational age and birth weight were highly correlated, with similar relative risks. Only gestational age was kept in the analysis, because of implications for the timing of interventions during the prenatal period.

RESULTS

Timing and Cause

One quarter of the 2776 homicides occurred by the end of the second month of life, one half by the fourth month, and two thirds by the sixth month (Fig. 1). Five percent of the homicides (139) occurred during the first day of life (data not shown). Ninety-five percent of infants killed on the first day of life were not born in a hospital, whereas 92 percent of all infants killed during the first year of life were born in a hospital. Data on the place of birth for locations other than hospitals were available only after 1988. From 1989 through 1991, 71 percent of all homicides on the first day of life involved infants born at a place of residence.

The classification of the underlying cause of death, as reported on the death certificate, revealed little about the actual circumstances of death (Table 1). Approximately one third of the deaths were classified as caused by battering or other maltreatment. The perpetrator's relationship to the infant was specified in less than 10 percent of these cases. The second leading cause of death was assault by unspecified means (28.1 percent); again, the perpetrator's relationship to the infant was not specified in most cases.

Predictive Factors

The strongest predictive factors, with relative risks of at least 3.0, were a maternal age of 19 years or younger, 12 years of education or less, single marital status, black or American Indian race, a first prenatal visit after the sixth month of pregnancy or no prenatal care, and a gestation of less than 28 weeks (Table 2). The highest risks were associated with maternal education of less than 12 years (relative risk, 8.4

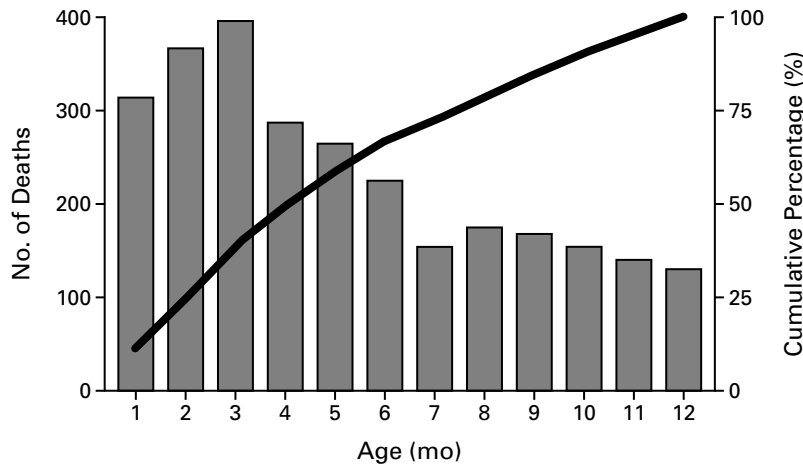


Figure 1. Number and Cumulative Percentage of Infant Homicides According to Age at Death, 1983 through 1991.

The bars indicate the numbers of deaths, and the curve the cumulative percentage.

TABLE 1. CAUSES OF INFANT DEATHS CLASSIFIED AS INTENTIONAL OR OF UNDETERMINED INTENT, 1983 THROUGH 1991.

CAUSE*	ICD-9 e-CODE†	INFANT DEATHS
		no. (%)
Total		2776 (100)
Battering or other maltreatment	967, 987	914 (32.9)
Assault by unspecified means	968.9, 988.9	779 (28.1)
Suffocation or strangulation	963, 983	282 (10.2)
Drowning	964, 984	120 (4.3)
Firearms	965, 985	84 (3.0)
Criminal neglect	968.4	81 (2.9)
Arson	968.0, 988.1	64 (2.3)
Cuts and stabbing	966, 986	58 (2.1)
Other		394 (14.2)

*The categories of battering or other maltreatment and criminal neglect include only deaths classified as intentional. An additional 52 deaths were classified as due to unintentional neglect or abandonment (e-code 904).

†ICD-9 denotes *International Classification of Diseases, 9th Revision*.

as compared with 16 or more years), a maternal age of less than 15 years (relative risk, 6.8 as compared with 25 or more years), and no prenatal care (relative risk, 10.4 as compared with prenatal care starting in the first or second month of pregnancy).

Although higher birth order alone did not appear to be a risk factor (relative risk, 1.2), an effect modification between birth order and maternal age resulted in a relative risk of 10.9 with a second or subsequent birth to a mother less than 17 years old, as compared with a first birth to a mother who was 25 years old or older. A similar effect occurred with a maternal age of 17 to 19 years and a second or sub-

sequent birth (relative risk, 9.3). Childbearing before the age of 17 years accounted for 2.4 percent of births and 6.8 percent of deaths. Almost 17 percent of homicides (459) occurred among the 5.1 percent of infants whose mothers were less than 17 years old or had had two or more children by the age of 19 years. The combined effects of birth order and maternal age were consistent for blacks and whites (data not shown). Numbers were too small to assess the effect of a maternal age of less than 17 years in other racial groups.

The relation between maternal education and infant homicide is confounded by age, since many mothers who were less than 17 years old had not yet had the opportunity to complete 12 years of education. About one fifth of mothers who did not complete 12 years of education were less than 17 years old. When these mothers were excluded from the analysis, the risk of death for infants born to mothers with less than 12 years of education was 8.0 times the risk for infants born to mothers who had 16 or more years of education. A similar comparison was performed with the exclusion of mothers who were 19 years of age or younger, because childbearing may delay the completion of high school. In the group of infants born to older mothers, the relative risk of homicide for infants born to those with less than 12 years of education, as compared with 16 or more years of education, was 6.8.

Although education remained important, the strongest risk factors were a maternal age of less than 17 years, a second or subsequent birth for a mother 17 years old or younger, and no prenatal care. Of the mothers who received no prenatal care, almost 15 percent were the mothers at highest risk (5.8 percent were less than 17 years old, and 8.8 percent were 17

TABLE 2. STRONGEST RISK FACTORS FOR INFANT HOMICIDE.

FACTOR	BIRTHS		HOMICIDES		RELATIVE RISK
	%	no.	no./100,000 births		
Total	100	2776	8.0		—
Mother's education*					
≤11 yr	17.9	1009	16.1		8.4
12 yr	33.3	873	7.5		3.9
13–15 yr	16.6	252	4.3		2.3
≥16 yr†	14.1	94	1.9		1.0
Mother's age					
<15 yr	0.3	27	28.1		6.8
15–16 yr	2.1	162	22.0		5.3
17–19 yr	10.4	684	18.8		4.6
20–24 yr	28.5	1063	10.7		2.6
≥25 yr†	58.6	840	4.1		1.0
First prenatal visit*					
None	1.8	296	46.1		10.4
7–9 mo	4.0	228	16.4		3.7
4–6 mo	17.7	742	12.1		2.7
3 mo	21.2	512	6.9		1.6
1–2 mo†	53.1	821	4.4		1.0
Mother's marital status					
Not married	24.7	1626	18.8		4.3
Married†	75.3	1150	4.4		1.0
Gestational age at birth*					
<28 wk	0.7	59	23.2		3.6
28–36 wk	9.1	458	14.4		2.2
≥37 wk†	87.0	1981	6.5		1.0
Birth order*					
Third or subsequent child	25.8	787	8.74		1.2
Second child	32.5	822	7.24		1.0
First child†	41.1	1067	7.43		1.0
Maternal age and birth order*					
<17 yr					
Second or subsequent child	0.2	25	34.5		10.9
First child	2.2	156	20.6		6.6
17–19 yr					
Second or subsequent child	2.7	278	29.2		9.3
First child	7.7	383	14.3		4.6
20–24 yr					
Second or subsequent child	14.7	693	13.5		4.3
First child	13.7	335	7.0		2.2
≥25 yr					
Second or subsequent child	40.7	613	4.3		1.4
First child†	17.6	193	3.1		1.0
Race					
Black	16.0	1110	19.8		3.5
American Indian	0.9	66	20.3		3.6
Asian	3.1	41	3.8		0.7
White or other†	80.0	1559	5.6		1.0

*For this factor, some data were missing or reported as unknown.

†This was the reference category.

to 19 years old and had two or more children; data not shown). Eleven percent of the mothers at highest risk received no prenatal care.

DISCUSSION

Our study lacks data on the perpetrators. The perpetrator's relationship to the infant was specified on the death certificate in less than 10 percent of homicides due to battering or other maltreatment and in none of those due to other causes. Studies have shown that most infant homicides are carried out by

parents or stepparents, and a slight majority are attributable to males.^{5,11,12} In the case of children killed after the first two years of life, however, the perpetrator tends to be unrelated to the child. Some studies have found that mothers are the perpetrators in the majority of cases only in the case of homicides during the first week of life. A possible explanation is that the mother is trying to hide the pregnancy and birth.⁹⁻¹¹ In our study, 95 percent of infants killed during the first day of life were not born in a hospital, as compared with 8 percent of all infants killed during the first year of life — a finding that is consistent with this explanation.

A number of factors probably lead to underascertainment of infant homicides. Five percent (139) of known homicides in our study occurred during the first day of life, but the actual number of infants killed on the day of birth could be higher, since some births may have been kept secret. In addition, some homicides were probably classified as deaths due to either unintentional injury or other causes, including the sudden infant death syndrome. The classification of homicide was based on the designation of intent in relation to the underlying cause of death, as determined by the medical examiner or coroner. We included deaths with a final designation of suspicious intent. However, at least 5 percent of deaths classified as due to the sudden infant death syndrome may actually be due to child abuse or neglect.^{6,21} Many fatal cases of child abuse are classified as deaths due to other causes and are not consistently documented across information sources such as death certificates, records of medical examiners, crime reports, abuse registries, hospitals, and ambulatory care records.^{11,21-23} Indeed, reviews of records from multiple systems after the cause of death had been determined by a medical examiner showed that substantiated child abuse or neglect may have been involved in 7 to 27 percent of deaths from injuries classified as unintentional.^{3,6,7}

Obtaining accurate information about intent and characteristics of perpetrators is difficult because it requires linkages of records from various state agencies and the collaboration of numerous professionals. Many states now have interdisciplinary teams to review infant deaths and determine the actual cause.²⁴ Schloesser et al. and other investigators have proposed that interdisciplinary review teams conduct surveillance of deaths in order to establish an epidemiologic data base for public policy and prevention programs.²⁵ Concern about confidentiality has limited the merging of sensitive information from various systems, but safeguards can be incorporated.

The results of studies using records from multiple agencies as sources to verify substantiated homicides provide a basis for estimates of underascertainment in our study, which is based only on death certificates. In a review of records from multiple agencies

conducted by Ewigman and colleagues, the rate of deaths attributable to substantiated abuse or neglect of infants and children up to four years old was more than twice as high as the rate reported by medical examiners.²¹ About 50 percent of these deaths were in the first year of life. Although underascertainment certainly affects reported rates, there is no obvious reason to suspect that it has seriously biased the estimates of relative risk in our study.

Our data are limited to deaths during the first year of life, and we excluded nonfatal injuries because no other national linked data are available for such cases. Data on the proportion of homicides among documented cases of physical abuse of infants are not available. In most studies of risk factors for nonfatal physical abuse, the investigators have grouped infants or very young children with older children (up to five years old) but have noted that the youngest children were at the highest risk, possibly because of the behavioral characteristics of infants or their physical vulnerability.^{21,22,26,27}

An incidence study of nonfatal serious injury resulting from child abuse or neglect found that more children were seriously injured in 1996 than in 1986.²⁶ We compared our data for the period from 1988 to 1991 with the data for the period from 1983 to 1987 in order to determine whether the homicide rates and risk factors were the same in the earlier and later periods. The total numbers of homicides and rates were higher in the later period, increasing from 7.2 to 8.8 homicides per 100,000 births. In the period from 1988 to 1991, the average number of homicides per year was 356 — almost one a day — with the true rate probably double that number on the basis of studies of underascertainment.^{6,17} The higher rate for the period from 1988 to 1991 is probably not due to better ascertainment, since the only concerted effort to improve case finding, the child-death review teams, had not been in place long enough to have had an effect by 1991. The relative risks during the period from 1988 to 1991 were in the same range for all variables as the relative risks shown in Table 2 and were consistent for the highest-risk categories (earlier childbearing and later birth order), indicating that the risk factors were stable over time.

Early childbearing with large numbers of closely spaced children has been shown to be a risk factor for nonfatal child abuse.²⁸⁻³⁰ The Third National Incidence Study of Child Abuse and Neglect found that, for children of all ages, serious or moderate injury was strongly associated with birth order.²⁶ Since we found that infants are most likely to be killed during the first few months of life, the identification of risk factors and interventions must take place during pregnancy, at the time of delivery, and in the immediate postpartum period. Abuse of women, and particularly adolescents, may be greater during preg-

nancy and the immediate postpartum period than at other times.³¹⁻³³ The identification of risk factors for infant homicide may also be appropriate in prenatal clinical settings. The recognition that spousal abuse and child abuse overlap has led to the development of interventions to prevent violence during pregnancy and recommendations to cross-train health care professionals in dealing with domestic violence.³⁴⁻³⁶ However, these interventions have not been evaluated for their effect on the abuse of infants after pregnancy.

The National Research Council Panel on Research on Child Abuse and Neglect reviewed prevention studies in very young children²⁸ and found that the most scientifically rigorous program evaluation was that conducted by Olds and associates.³⁷ These investigators reported that home visitation by trained nurses during pregnancy and the first two years of life reduced rates of state-verified cases of child abuse and neglect among first-born children of unmarried adolescents of low socioeconomic status.³⁷ Other risks of injury were reduced as well. The adolescents also had fewer subsequent births, which is relevant to our finding that the risk of homicide is higher among second and subsequent infants than among first infants. The National Committee to Prevent Child Abuse has initiated similar interventions based on an evaluation of the Hawaii Healthy Start Program.³⁸ No interventions have been specifically designed to prevent infant homicides, probably because the annual incidence reported in short-term, community-based studies is relatively low. Our findings suggest that programs designed to prevent nonfatal abuse should be expanded to include interventions among pregnant adolescents, with a specific focus on the prevention of severe — and fatal — abuse.

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