

# Using US Data to Estimate the Incidence of Serious Physical Abuse in Children

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## KEY WORDS

abuse, epidemiology-injury, injury severity

## ABBREVIATIONS

CI—confidence interval

CPS—Child Protective Services

E-codes—external cause of injury codes

HCUP—Healthcare Costs and Utilization Project

ICD-9-CM—International Classification of Diseases, Ninth Revision, Clinical Modification

KID—Kids' Inpatient Database

NCANDS—National Child Abuse and Neglect Data System

NIS—National Incidence Study

TBI—traumatic brain injury

Dr Leventhal conceived of the project, reviewed the data, drafted the manuscript and prepared revisions of the manuscript, and had access to all of the data; Ms Gaither conducted the analyses and provided feedback on drafts of the manuscript, approved the submissions of the manuscript, and had access to all of the data; and Dr Martin assisted with the analyses, provided feedback on the drafts of the manuscript, and approved the submissions of the manuscript.

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**WHAT'S KNOWN ON THIS SUBJECT:** Limited data exist about the frequency and incidence of serious injuries due to physical abuse of children. Data from Child Protective Services, which are published yearly, do not have information about severity.



**WHAT THIS STUDY ADDS:** This is the first study to provide US estimates on the occurrence of serious injuries due to physical abuse. The incidence was highest in infants on Medicaid. Such data can be used to track changes due to prevention.

## abstract

**BACKGROUND:** There are limited data on the epidemiology of serious injuries due to physical abuse of children.

**METHODS:** We used the 2006 Kids' Inpatient Database to estimate the incidence of hospitalizations due to serious physical abuse among children <18 years of age. Abuse was defined by using International Classification of Diseases, Ninth Revision, Clinical Modification codes for injuries (800–959) and for physical abuse (995.50, 995.54, 995.55, or 995.59), selected assault codes (E960-966, 968), or child battering (E967). We examined demographic characteristics, mean costs, and length of stay in 3 groups of hospitalized children: abusive injuries, nonabusive injuries, and all other reasons for hospitalization. Incidence was calculated using the weighted number of cases of physical abuse and the number of children at risk based on 2006 intercensal data.

**RESULTS:** The weighted number of cases due to abuse was 4569; the incidence was 6.2 (95% confidence interval [CI]: 5.5–6.9) per 100 000 children <18 years of age. The incidence was highest in children <1 year of age (58.2 per 100 000; 95% CI: 51.0–65.3) and even higher in infants covered by Medicaid (133.1 per 100 000; 95% CI: 115.2–151.0 [or 1 in 752 infants]). Overall, there were 300 children who died in the hospital due to physical abuse.

**CONCLUSIONS:** This is the first study to provide national US data on the occurrence of serious injuries due to physical abuse in hospitalized children. Data from the 2006 Kids' Inpatient Database on hospitalizations due to serious physical abuse can be used to track trends over time and the effects of prevention programs on serious physical abuse. *Pediatrics* 2012;129:1–7

In the United States, 2 approaches have been used to ascertain the national occurrence of child maltreatment. The first has counted cases of suspected maltreatment reported to state or local Child Protective Services (CPS). Since 1990, state-level and national data have been prepared by the National Child Abuse and Neglect Data System (NCANDS).<sup>1</sup> Data include the number of reported and substantiated cases, the types of maltreatment (eg, physical abuse, sexual abuse, or neglect), and the number of deaths due to maltreatment.

The second approach has used the National Incidence Studies (NISs), which are congressionally mandated studies aimed at providing national estimates of the incidence of child maltreatment. Four studies have been conducted (1979–1980, 1986–1987, 1993–1994, and 2005–2006).<sup>2</sup> In each, professionals in selected counties throughout the country were trained to provide case surveillance over two 3-month periods during the year. Counted cases included those reported to CPS and those identified by professionals but not reported. In each NIS, the number of cases of maltreatment was greater than the number from the comparable year of NCANDS.

Although cases of physical abuse are counted in both approaches to collecting national data, neither approach can specifically identify cases of serious physical abuse, such as children who are hospitalized with head injuries, fractures, or burns due to abuse. Knowing the number of children with serious injuries from physical abuse would provide an important estimate of the burden of the problem, and the number of such injuries could be tracked over time to determine whether prevention programs are able to reduce these serious injuries.

Therefore, to estimate the number of children in the United States with serious injuries due to physical abuse, we

used a national dataset of hospitalized children. We used diagnostic codes to identify children with injuries and child abuse or assault codes to identify those injuries due to physical abuse. Demographic characteristics of the abused children were compared with those of children hospitalized with injuries not due to abuse and with all other causes of hospitalization. In addition, we sought to determine the estimated costs of hospitalizations and length of stay due to physical abuse and the estimated number of in-hospital deaths due to physical abuse.

## METHODS

We used the 2006 Kids' Inpatient Database (KID), which was prepared by the Healthcare Cost and Utilization Project (HCUP).<sup>3</sup> The KID is a weighted US sample of discharged patients from all nonrehabilitation hospitals in HCUP's State Inpatient Databases. Systematic random sampling is used to select 10% of uncomplicated in-hospital births and 80% of complicated in-hospital births and other pediatric cases. To obtain national estimates, weighting takes into account 6 hospital characteristics (ownership/control, bed size, teaching status, rural/urban location, US region, and freestanding children's hospitals). The sampling frame for the 2006 KID includes 3739 hospitals from 38 states, which represent 88.8% of the US population in 2006.

For each hospital discharge in the KID, there is information about demographics, payment, hospital type, diagnoses, and external cause of injury (E-codes) based on the *International Classification of Diseases, Ninth Revision, Clinical Modification*<sup>4</sup> (ICD-9-CM) and disposition (eg, discharged or died). Because most CPS agencies in the country accept reports on children up to the age of 18, we defined a child as a patient who was <18 years of age at the time of discharge from the hospital.

We excluded cases where age was missing and all in-hospital births. Physical abuse was defined in 1 of the following 4 ways:

1. An ICD-9-CM code for an injury (800–959) and either an ICD-9-CM code for child abuse (995.50, 0.54, 0.55, or 0.59) or an E-code for the identified perpetrator of child abuse (E967). We excluded injuries coded as late effects (905–909) so as not to include children who were being hospitalized for the nonacute consequences of an acute injury (eg, late effect of a burn).
2. An ICD-9-CM code for an injury and an E-code for assault (E960–E966, 968). Because these E-codes for assault are not specific for child abuse and can be used when a child is hurt in a fight with peers or older persons or the child is shot with a gun on the street, for example, we used the following stepwise approach to derive the eligible cases identified in this category: (1) we excluded injuries that were coded as occurring in the following places: farms, recreation or sports sites, industrial places, public buildings, streets, or residential facilities (E849.1–0.6); (2) we excluded injuries caused by air guns (E968.6) or firearms (E965); (3) we included injuries that were coded as occurring in the home (E849.0); and (4) for children >8 years of age, we excluded cases that did not provide an E-code for the location. This last restriction was used to avoid including children where no information was coded about where the injury had occurred and thus the injury may have been due to an assault, as opposed to abuse from a caretaker.
3. An ICD-9-CM code for child abuse or the E-code 967 (identified perpetrator of abuse) and at least 1 ICD-9-CM code that was consistent with

abuse (eg, retinal hemorrhages or anoxic brain damage). These children had no specific diagnostic code of an injury (800–959) but were included because of the specific child abuse code.

4. The ICD-9-CM code 995.55, which is the code for “shaken infant syndrome,” and no specific injury code.

We grouped the children with specific injury codes into the following types of injuries (Table 1): fractures, traumatic brain injuries (TBIs) (excluding isolated skull fractures), abdominal injuries, burns, skin injuries/open wounds, and other types of injuries.

Data on length of stay, charges for the hospitalization, and whether the child died during the hospitalization are provided in the KID. Demographic data available included the child’s age, gender, race, and source of payment for the hospitalization (grouped as Medicaid, private, self, and other). To calculate costs, we followed the HCUP recommendations<sup>5</sup> and used the hospital-specific cost-to-charge ratio, which was available in 78% of the hospitals, and the weighted group average when the hospital specific cost-to-charge ratio was not available.

We used the weightings provided in the KID to calculate the number of physically abused children in the United States. To calculate the incidence of physically abused children in 2006, we used this number as the numerator. The denominator was based on the number of children nationally in the age group in 2006; this number was

obtained from the 2006 intercensal estimates.<sup>6</sup> Confidence intervals (CIs) were calculated by using the Taylor Series in SAS Version 9.2 (SAS Institute, Inc, Cary, NC). We used an identical approach to determine the number of children who died during the hospitalization in the abused group and the in-hospital mortality due to abuse.

We compared the cases in the abused group with 2 groups: (1) cases with injury codes but not classified as abuse (called “nonabusive injures”) and (2) all other acute care hospitalizations in the dataset. We used  $\chi^2$  or analysis of variance to compare the demographic characteristics, the percent of deaths, costs, and length of stay.

Because of the association of physical abuse and poverty, the incidence of serious injuries due to abuse was calculated in children who were on Medicaid and compared with the incidence in children with other types of health insurance. To obtain estimates of children on Medicaid in 2006, we used the Health Insurance Historical Tables prepared by the US Census Bureau.<sup>7</sup>

The study was considered exempt from approval by the Yale Medical School institutional review board.

## RESULTS

In 2006, the weighted number of children hospitalized with serious injuries due to physical abuse was 4569. Table 2 shows the demographic characteristics in the abuse group compared with children with nonabusive injuries and other causes of hospitalization. There

were statistically significant differences ( $P < .0001$ ) among the 3 groups for gender, race/ethnicity, and medical insurance. The most striking difference between the cases of abuse and the other 2 groups concerned the type of medical insurance: 71.6% of abuse cases were on Medicaid compared with 36.6% of cases with nonabusive injuries and 48.5% of cases with other hospitalization causes.

The mean length of stay for the children in the abuse group (7.4 days; 95% CI: 6.9–8.0) was significantly longer ( $P < .0001$ ) than for children with nonabusive injuries (3.9 days; 95% CI: 3.8–4.1) or with other hospitalizations (4.5 days; 95% CI: 4.4–4.6). Also, mean hospital costs were statistically significantly higher ( $P < .0001$ ) in the abuse group (\$16 058; 95% CI: \$14 644–\$17 473) versus the 2 other groups (\$9550 [95% CI: \$9084–\$10 017] for the nonabusive injury group and \$7964 [95% CI: \$7516–\$8411] for the other hospitalization group). The national costs for hospitalization of abused children were ~\$73.8 million.

The yearly incidence of hospitalization of children with serious physical abuse was 6.2 (95% CI: 5.5–6.9) per 100 000 children <18 years of age. Figure 1 shows the incidence of cases for each year of life, and Table 3 shows the results for 3 age groups. The incidence was highest in the first year of life: 58.2 (95% CI: 51.0–65.3).

When the incidence was calculated for the estimated number of children on Medicaid in 2006, the rate was 16.3 per 100 000 children <18 years of age (95% CI: 14.2–18.4) compared with 2.4 (95% CI: 2.1–2.7) for all other children not covered by Medicaid (Table 3). In each age group, the incidence in children covered by Medicaid was about 6 times greater compared with all other children not covered by Medicaid.

The weighted number of children who died during the hospitalization from

**TABLE 1** Types of Injuries Based on ICD-9-CM Codes

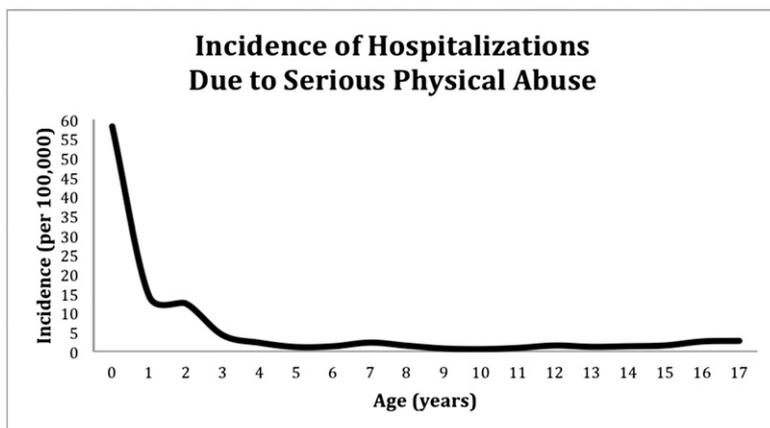
Injury	ICD-9-CM Codes
Fracture	800–829
TBI	800.1–800.4; 800.6–800.9; 801.1–801.4; 801.6–801.9; 803.1–803.4; 803.6–803.9; 804.1–804.4; 804.6–804.9; 850–854
Abdominal	863–869; 902
Burn	940–949
Skin/open wound	870–897; 910–924
Other <sup>a</sup>	830–839; 840–848; 860–862; 900–901; 903–904; 925–929; 930–939; 950–957; 959

<sup>a</sup> For example, 861.21 = contusion of lung without mention of open wound into thorax.

**TABLE 2** Demographic Characteristics by Percentage in Each of the 3 Hospitalized Groups: Abuse, Nonabusive Injuries, and Other Causes of Hospitalization

	Abuse ( <i>n</i> = 4569)	Nonabusive Injuries ( <i>n</i> = 189 414)	Other Causes of Hospitalization ( <i>n</i> = 2 291 632)	<i>P</i>
Gender				<.0001
Male	58.8	65.0	49.8	
Race/ethnicity				<.0001
White	45.3	56.3	49.8	
African American	25.5	15.6	17.1	
Hispanic	19.6	19.8	24.3	
Other	9.5	8.3	8.8	
Medical insurance				<.0001
Medicaid	71.6	36.6	48.5	
Private/HMO	18.5	51.8	43.1	
Self-pay	4.5	6.3	3.9	
Other	5.4	5.3	4.5	

*n* = weighted number in group. Data were missing for gender, 16 353; race/ethnicity, 404 178; and medical insurance, 2259. HMO, health maintenance organization.



**FIGURE 1** Incidence of hospitalizations due to serious physical abuse.

injuries due to physical abuse was 300. This number represents 6.6% of the abused group compared with 0.9% of the group with nonabusive injuries and 0.5% of the group with other causes of hospitalization ( $P < .0001$ ). The overall in-hospital mortality rate due to abuse was 0.41 (95% CI: 0.32–0.49) per 100 000 children <18 years of age. As shown in Fig 2, the in-hospital mortality rate due to abuse for each year of life shows a similar pattern to the incidence of hospitalizations due to physical abuse. The incidence was 4.09 (95% CI: 3.11–5.07) deaths per 100 000 children <1 year old, was about 1.0 per 100 000 children for each of the second and third years of life, and was lowest in school-age children and adolescents.

## DISCUSSION

In this study, the first to use the KID to estimate the number of children with serious abusive injuries resulting in hospitalizations, we found 4569 children nationally in 2006; 300 of these children (6.6%) died because of their abuse. Not surprisingly, the incidence was highest for children during the first year of life (58.2 per 100 000 children) and was substantially higher for children covered by Medicaid compared with all other children. The estimated national cost for the hospitalizations due to serious abusive injuries was \$73.8 million.

We included in our definition of “serious abuse” any child who was admitted

to the hospital with an injury that was coded as abuse (or assault in younger children). Such children included a 3-month-old with multiple bruises due to abuse (who was admitted for safety and further evaluation) and a 3-month-old with life-threatening abusive head trauma. Our definition did not include children who were admitted with injuries suspicious for abuse but eventually were diagnosed as having nonabusive injuries. These children, regardless of the severity of the injuries, would not receive an ICD-9-CM code for abuse or assault and, therefore, would not be counted as having an injury caused by abuse.

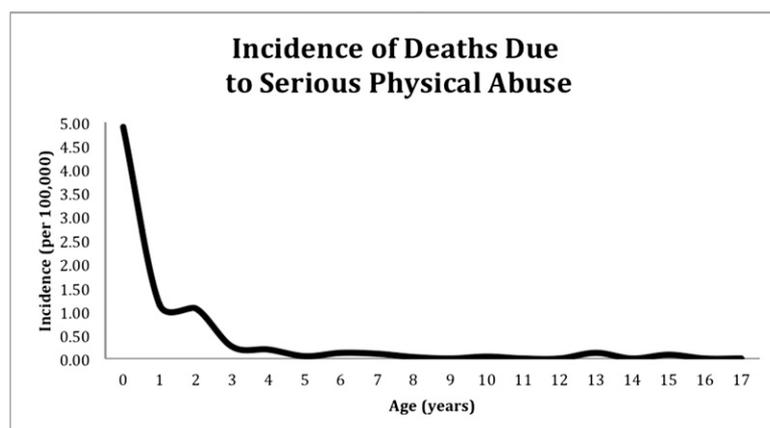
Previous estimates of the number of physically abused children in the United States have been based on data from the yearly NCANDS reports or the periodic NISs, but no information is provided about the seriousness of the injuries or the number of hospitalizations due to abusive injuries. In 2006, based on the NCANDS data, there were 142 000 cases of substantiated physical abuse.<sup>1</sup> In the latest NIS, which collected data in 2005–2006 from GPS and mandated reporters in selected regions of the country, there were 323 000 cases of physical abuse with at least a moderate injury.<sup>2</sup> Moderate injuries were defined as physical injuries, such as bruises, that lasted  $\geq 48$  hours.

These 2 approaches capture many more children who have been physically abused compared with those children hospitalized because of abuse and identified in the 2006 KID. By using the higher estimate of physically abused cases from NIS-4 ( $N = 323\ 000$ ), the results from the KID show that about 1.4% of physically abused children were hospitalized in 2006.

One other national US study of maltreated children used the HCUP 2005 Nationwide Inpatient Sample, which includes a 20% sample of hospitalizations

**TABLE 3** Incidence of Hospitalization of Children With Serious Injuries Due to Abuse Incidence per 100 000 Children and 95% CIs

Age Group, y	Overall	Children Covered by Medicaid	Children Not Covered by Medicaid
0–18	6.2 (5.5–6.9)	16.3 (14.2–18.4)	2.4 (2.1–2.7)
0–3	28.4 (24.9–32.0)	64.2 (55.3–73.2)	10.7 (9.2–12.2)
0–1	58.2 (51.0–65.3)	133.1 (115.2–151.0)	21.8 (18.2–25.5)

**FIGURE 2** Incidence of deaths due to serious physical abuse.

from acute care community hospitals. In this study reported by the Agency for Healthcare Research and Quality, there were 6700 hospitalized cases associated with maltreatment.<sup>8</sup> When cases of neglect and sexual abuse are removed from the total, there were 5290 hospitalizations due to physical abuse. Not surprisingly, this number is similar to our result using the 2006 KID, because the sample for the KID is drawn from the same population of community hospitals as the Nationwide Inpatient Sample. The KID provides more precise incidence estimates since it includes an 80% sample of pediatric discharges, while the Nationwide Inpatient Sample includes a 20% sample. The estimated costs of about \$74 million due to the hospitalizations for abuse are similar to the results using the 2005 Nationwide Inpatient Sample, Statistical Brief,<sup>8</sup> but markedly different from the often quoted figure from Prevent Child Abuse America of \$6.6 billion (in 2007 dollars).<sup>9</sup> The latter figure was based on the NIS-3 estimate of 565 000 maltreated children and the

assumption that 50% of these children were hospitalized. As shown in our study, the percentage of physically abused children who are hospitalized in 1 year is much closer to 1.5% than to 50%.

We found the incidence of hospitalization due to serious abuse in the first year of life to be 58.2 per 100 000 children in this age group. This rate is almost twice the rate for abusive head trauma of about 30 per 100 000 infants.<sup>10</sup> Interventions aimed at the prevention of abusive head trauma might consider broadening the message to include other types of abusive injuries in children. This broadening of the message would mean that the emphasis of the message changes from “not shaking” to “not hurting” an infant.

Two other studies have examined the incidence of serious abusive injuries. Gessner et al<sup>11</sup> linked birth certificate, CPS, and hospital data over a 7-year period (1994–2000) in Alaska and found that the incidence of physical abuse in infants leading to hospitalization and/or death was 100 per 100 000

births. These authors note that the rates of physical abuse in Alaska were higher than those in other states. In a study using a different methodology, Sibert et al<sup>12</sup> determined the incidence of severe physical abuse in Wales by using a prospective case-surveillance system to collect data from April 1996 to March 1998 about serious physical abuse in children from birth to age 14. In this study, the incidence in the first year of life was 54 per 100 000, which is remarkably similar to our rate of 58 per 100 000.

In our study, children covered by Medicaid had rates of serious abuse about 6 times higher than those not on Medicaid. In the first year of life, the incidence for Medicaid-covered children was 133 per 100 000 compared with 22 for all other children. Thus, 1 in 752 children who are covered by Medicaid were hospitalized due to serious physical abuse in the first year of life. This very high rate speaks to the importance of poverty as a major risk factor for serious abuse and for the need to prevent these serious injuries.<sup>13</sup> We also found less dramatic differences by gender and race, although the number of missing data for race was substantial.

It is important to note that the incidence of serious abuse in the first year of life is higher than the rate of sudden infant death syndrome, which is about 50 per 100 000 births.<sup>14</sup> The national “Back to Sleep” campaign has successfully reduced the incidence of sudden infant death syndrome from about 100 per 100 000 to its current rate. Perhaps a national campaign to reduce serious abusive injuries would have similar success at decreasing abusive injuries in infants.

Our study has at least 4 limitations. First, the KID only includes hospitalized children, so children with serious abusive injuries who die before hospitalization or who are never hospitalized are not counted. Thus, our estimate of

abused children with serious injuries is clearly an underestimate of the problem. In Keenan et al's prospective study of traumatic brain injuries in children <2 years of age,<sup>15</sup> 8.8% of children diagnosed with abusive head injuries died prior to hospitalization and the diagnosis was made by the medical examiner (H.T. Kennan, MDCM, MPH personal communication, 2010). A larger component of the underestimation of serious injuries due to abuse would occur when abused children with serious injuries are not hospitalized. While it is unlikely that children identified with abusive head or abdominal injuries would not be hospitalized, some children with abusive fractures are managed without hospitalization. For example, in a study by Leventhal and colleagues of fractures in 672 children <3 years of age who were evaluated at Yale-New Haven Hospital, 15% of children <12 months of age and 29% of those aged 12–23 months with fractures due to abuse were not hospitalized.<sup>16</sup>

Second, the KID counts hospitalizations during a specific year, not children. A few children may have been hospitalized twice in the same year for acute injuries due to serious physical abuse.

To help ensure that we did not count the same child twice, we excluded hospitalizations that included codes for the late effects or complications of an injury. Third, since we relied on ICD-9-CM codes to diagnose abuse, we have no information on the accuracy of the diagnosis of abuse made by the physicians who cared for the child. A previous study has shown variability in the likelihood of abuse when child abuse physicians review the same case.<sup>17</sup> There also are data to suggest that physicians overdiagnose abuse in minority children and underdiagnose in white children.<sup>18</sup>

Fourth, there have been concerns that child abuse codes may not be used accurately when physicians make the diagnosis of abuse. Unfortunately, there is limited research to address this question. For example, Winn et al<sup>19</sup> showed that the use of the child abuse and assault codes may underestimate injuries due to abuse. To the extent that this concern is true, our results may underestimate the number of hospitalizations due to physical abuse. On the other hand, Ellingson et al<sup>10</sup> showed that the use of these codes in the 1997, 2000, and 2003 KID

provided estimates of the incidence of abusive head injuries during the first year of life that were comparable to those from prospective studies. Thus, the estimates of hospitalized children due to abuse are likely not substantially underestimated due to the failure to use appropriate coding.

Data from the KID can be used in future studies to track changes in the incidence of serious injuries due to physical abuse over time. Such studies might examine the effects of a large child abuse prevention program or the effects of an economic downturn.<sup>20</sup>

## CONCLUSIONS

In 2006, there were ~4600 children hospitalized with serious injuries due to physical abuse. The incidence was highest in children <1 year of age (58.2 per 100 000 infants) and about 6 times higher in children on Medicaid compared with all other children not on Medicaid. The overall cost of hospitalization was \$73.8 million. Data from the KID on hospitalizations due to serious abuse should be useful in examining trends over time and in studying the effects of large-scale prevention programs.

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