Sleep Environment Risks for Younger and Older Infants
Jeffrey D. Colvin, Vicki Collie-Akers, Christy Schunn and Rachel Y. Moon

Pediatrics; originally published online July 14, 2014;
DOI: 10.1542/peds.2014-0401

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://pediatrics.aappublications.org/content/early/2014/07/09/peds.2014-0401
Sleep Environment Risks for Younger and Older Infants

WHAT’S KNOWN ON THIS SUBJECT: Sudden infant death syndrome and other sleep-related causes of infant mortality have several known risk factors. Less is known about the association of those risk factors at different times during infancy.

WHAT THIS STUDY ADDS: Risk factors for sleep-related infant deaths may be different for different age groups. The predominant risk factor for younger infants is bed-sharing, whereas rolling to prone, with objects in the sleep area, is the predominant risk factor for older infants.

abstract

OBJECTIVE: Sudden infant death syndrome and other sleep-related causes of infant mortality have several known risk factors. Less is known about the association of those risk factors at different times during infancy. Our objective was to determine any associations between risk factors for sleep-related deaths at different ages.

METHODS: A cross-sectional study of sleep-related infant deaths from 24 states during 2004–2012 contained in the National Center for the Review and Prevention of Child Deaths Case Reporting System, a database of death reports from state child death review teams. The main exposure was age, divided into younger (0–3 months) and older (4 months to 364 days) infants. The primary outcomes were bed-sharing, objects in the sleep environment, location (eg, adult bed), and position (eg, prone).

RESULTS: A total of 8207 deaths were analyzed. Younger victims were more likely bed-sharing (73.8% vs 58.9%, P < .001) and sleeping in an adult bed/on a person (51.6% vs 43.8%, P < .001). A higher percentage of older victims had an object in the sleep environment (39.4% vs 33.5%, P < .001) and changed position from side/back to prone (18.4% vs 13.8%, P < .001). Multivariable regression confirmed these associations.

CONCLUSIONS: Risk factors for sleep-related infant deaths may be different for different age groups. The predominant risk factor for younger infants is bed-sharing, whereas rolling into objects in the sleep area is the predominant risk factor for older infants. Parents should be warned about the dangers of these specific risk factors appropriate to their infant’s age. Pediatrics 2014;134:e406–e412

AUTHORS: Jeffrey D. Colvin, MD, JD, Vicki Collie-Akers, PhD, MPH; Christy Schunn, MSW; and Rachel Y. Moon, MD

Department of Pediatrics, Children’s Mercy Hospitals and Clinics, Kansas City, Missouri; Department of Pediatrics, University of Missouri-Kansas City School of Medicine, Kansas City, Missouri; Work Group for Community Health and Development, University of Kansas, Lawrence, Kansas; Kansas Infant Death and SIDS Network, Wichita, Kansas; Goldberg Center for Community Pediatric Health, Children’s National Health System, Washington, District of Columbia; and Department of Pediatrics, George Washington University School of Medicine and Health Sciences, Washington, District of Columbia

KEY WORDS
SIDS, suffocation, injury

ABBREVIATIONS
CCC—complex chronic condition
CI—confidence interval
NCRPCD—National Center for the Review and Prevention of Child Deaths
OR—odds ratio
SIDS—sudden infant death syndrome

Dr Colvin participated in the study design and analysis and interpretation of the data, was the primary author of the manuscript, and provided critical intellectual content in the revision of the manuscript; Drs Collie-Akers and Moon participated in the study design and analysis and interpretation of the data, were authors of the manuscript, and provided critical intellectual content in the revision of the manuscript; Ms Schunn participated in the interpretation of the data and provided critical intellectual content in the revision of the manuscript; and all authors approved the final version of the manuscript as submitted.

doi:10.1542/peds.2014-0401
Accepted for publication Apr 30, 2014
Address correspondence to Jeffrey Colvin, MD, JD, Department of Pediatrics, Children’s Mercy Hospitals and Clinics, 2401 Gillham Rd, Kansas City, MO 64108. E-mail: jdcollin@cmh.edu

PEDIATRICS (ISSN Numbers: Print, 0031-4005; Online, 1098-4275).
Copyright © 2014 by the American Academy of Pediatrics

FINANCIAL DISCLOSURE: The authors have indicated they have no financial relationships relevant to this article to disclose.

(Continued on last page)
Sudden infant death syndrome (SIDS; 53.9 deaths per 100,000 live births) and unintentional injury (including suffocation; 27.5 deaths per 100,000 live births) represent the third and fifth leading causes, respectively, of infant mortality in the United States. Although the incidence of SIDS has decreased since 2000, rates of other sleep-related infant deaths (eg, accidental suffocation, asphyxiation) have increased. It has been suggested that these observed changes may be attributable, in part, to changes in diagnostic categorization. The sleep environment can impact the risk of both SIDS and other sleep-related infant deaths. Several elements contribute to an unsafe sleep environment, including the following: sleeping in something other than a crib (eg, sofa); bed-sharing; soft bedding; bumper pads or other items; and sleeping in the prone position. Indeed, the American Academy of Pediatrics recently released statements that include comprehensive recommendations for a safe sleep environment. However, the adoption of safe sleep practices has been inconsistent in home, child care, and health care settings.

Studies have examined differences in rates of sleep-related deaths among infants by age, but most have studied 1 risk factor or sought to separate the effects of different risk factors. Less is known about how multiple elements of a safe sleep environment are associated with different rates of sleep-related infant death for younger and older infants. Understanding how different factors reflect risk at different developmental stages is critical for appropriately advising parents and caregivers on safe sleep practices across infancy. The purpose of this study is to compare differences in the sleep environments for younger (birth through 3 months) and older (ages 3 months to 364 days) infants who experienced sleep-related deaths. A secondary aim of the study was to examine differences in diagnoses for younger and older infants who experienced sleep-related deaths.

**METHODS**

**Data Source**

Data for this cross-sectional study were obtained from the National Center for the Review and Prevention of Child Deaths (NCRPCD) Case Reporting System, a database comprising reports of individual child death reviewed by state child death review teams. As of late 2013, 43 states were participating in the database, which contains >1700 data elements. States use a standardized reporting tool and record all data online. A data dictionary and data code book are provided to ensure accuracy and consistency in reporting. The reporting tool includes demographic, social, and medical characteristics of the child, family, supervisor, and perpetrator, as well as data regarding the investigation (including whether an autopsy was performed) and risk factors. Participating states sign data-sharing agreements with the NCRPCD. Additional details about the NCRPCD have been described previously.

**Study Participants**

Inclusion criteria were all deaths recorded in the NCRPCD database that occurred during sleep or in the sleep environment for children <1 year old during the calendar years 2004–2012 from 24 states. Some states, because of when they began participating in the NCRPCD, did not provide data for all study years. Exclusion criteria were deaths occurring during sleep but from a non–sleep-related medical condition (eg, meningitis) or weapon-related homicide. On the basis of data regarding cause of death determination, cases were assigned to 1 of 3 causes of death: SIDS/sudden unexpected infant death, accidental suffocation or strangulation in bed, and unknown/undetermined. This study was approved by the Institutional Review Board at Children’s National Medical Center.

**Study Definitions**

**Infant and Caregiver Characteristics**

Patient demographic characteristics included age in months, gender, and race/ethnicity. Age was further dichotomized into “younger” infants (<4 months) and “older” infants (4 months to 364 days). The presence of a complex chronic condition (CCC) was defined as “any medical condition that can be reasonably expected to last at least 12 months (unless death intervenes) and involving either several different organ systems or one system severely enough to require specialty pediatric care and probably some period of hospitalization in a tertiary care center,” and was determined by review of data elements describing physical disability and/or chronic condition. CCCs, such as cerebral palsy, chromosomal abnormalities, and cardiac conduction disorders, carry a higher risk of early death. Medical conditions meeting the definition of CCC have been previously published. The primary caregiver categories included parent, foster parent, parent’s partner, relative or friend, other, and unknown. “Parent” included biological, adoptive, and stepparent.

**Objects in the Sleep Environment**

Bed-sharing was defined as the infant sleeping on the same surface with a person or animal. Categories of objects found in the sleep environment included “blanket,” “pillow,” “bumper pads,” “hard furniture,” “stuffed toy,” “nonstuffed toys,” “clothing,” “small, soft fabric items,” “cord,” “bag,” “other,” and “unknown.” “Blanket” referred to blanket, afghan, quilt, comforter, sleeping bag, bedding, and swaddling. “Pillow” included cushion, pillow, breastfeeding pillow, and
positional support (eg, wedge). “Clothing” referred to adult and child clothing items. “Small, soft fabric items” included bib, burp cloth, washcloth, and handkerchief. “Bag” included plastic bag, duffel bag, and diaper bag. “Nonstuffed toys” included hard toys and hard objects, such as phones, books, hairbrushes, batteries, and teething rings. The object categories “blanket,” “pillow,” “bumper pads,” “stuffed toys,” “clothing,” “cords,” and “bag” were further defined as “dangerous objects.”

**Sleep Place and Position**

Sleep place was categorized as “crib,” “playpen,” “car seat/stroller,” “adult bed,” “person,” “other,” and “unknown.” “Crib” referred to crib, cradle, or bassinet. “Car seat/stroller” included car seat, stroller, and other sitting device (eg, other infant seat, swing). “Adult bed” included adult bed, waterbed, adult mattress, bunk bed, child’s bed, sofa bed, and air mattress. “Person” indicated sleeping in the arms or on the chest of another person. These locations were further collapsed to 5 categories: (1) crib, bassinet, playpen; (2) car seat/stroller; (3) adult bed or person; (4) other; and (5) unknown. Sleep position, both placed to sleep and position found, were categorized as “back,” “side,” “stomach,” and “unknown.”

**Analytical Sequence**

All statistical analyses were performed by using SPSS version 21 (IBM Corporation, Armonk, NY), and P values <.05 were considered to be significant. Multiple imputation using the Markov Monte Carlo method was performed to impute missing data of variables used in the analyses. Multiple imputation has been previously used for analyses of the NCRPCD database. All subsequent analyses were conducted by using pooled imputed data. Frequencies were calculated for infant and caregiver characteristics as well as for diagnosis, objects in the sleep environment, sleep position, and sleep location. Blankets and comforters were counted separately when determining the number of objects in the sleep environment, but were collapsed to 1 category for analyses of types of objects found in the sleep environment. The \( \chi^2 \) test was performed for bivariate analyses to compare deaths in younger and older infants. Multivariable, multinomial logistic regressions were performed to create adjusted odds ratios (ORs) of any object in the sleep environment, sleep position, and sleep location on the basis of age category (younger versus older), adjusting for race/ethnicity, gender, and CCC.

**RESULTS**

**Population Characteristics**

Of the 9073 infant deaths, 8207 (90.5%) met the inclusion criteria (Table 1). The median age at the time of death was 2 months (interquartile range: 1–4 months). Most infants were male (58.2%) and did not have a CCC (98.8%). Most of the deaths occurred in non-Hispanic whites (44.9%), with a larger percentage of non-Hispanic black deaths occurring in the younger age group (31.0% vs 28.0%). Although <2% of the study population had a CCC, there were significantly more deaths of infants with CCCs in the older age group (39.4% vs 33.5%, \( P < .001 \)). The vast majority of the study population was primarily cared for by a parent (95%). An autopsy was performed in 97.6% of infants. The diagnosis “unknown” was the most frequent diagnosis (58.2%). This diagnosis was found significantly more often in the younger age group (39.2% vs 36%, \( P = .02 \)), whereas accidental suffocation and strangulation in bed was responsible for more deaths in the older age group (28.2% vs 26.1%, \( P = .92 \)).

**Sleep-Related Death Risk Factors**

The majority (69.2%) of the study population was bed-sharing at the time of death (Table 2). Deaths occurring in the younger infants were significantly more likely to be associated with bed-sharing (73.8% vs 58.9%, \( P < .001 \)). An object was found in the sleep environment of approximately one-third of the deaths. A higher percentage of deaths occurring in the older age group had at least 1 object in the sleep environment (39.4% vs 33.5%, \( P < .001 \)). The only objects found in >10% of deaths were blankets (24.5%) and pillows (17.8%). Deaths in the older age group were significantly more likely to be associated with the presence of blankets (26.8% vs 23.5%, \( P = .01 \)), stuffed toys (2.4% vs 1.2%, \( P < .001 \)), bags (1.2% vs 0.3%, \( P < .001 \)), hard furniture (0.5% vs 0.1%, \( P < .01 \)), and cords (0.2% vs 0.0%, \( P < .01 \)). There were no differences between age groups for the presence of pillows, bumper pads, nonstuffed toys, clothing, or other objects. The most common sleep position that infants of all age categories were placed for sleep was the supine position (39.7%). A significantly higher percentage of infants in the younger age group were placed on their side or stomach (37.3% vs 28.7%, \( P < .001 \)). In contrast, the most common position in which all infants were found was prone (38.3%). The younger age group had a significantly higher percentage of infants found on their back and side (40.1% vs 35.9%, \( P < .001 \)), whereas the older age group had a significantly higher percentage of infants found prone (42.2% vs 36.8%, \( P < .001 \)). A significantly higher percentage of deaths in the older age group were associated with a change in sleep position from back/side to stomach or stomach to back/side, although the former change occurred 8 times more frequently. Older infants changed their sleep position from side/back to prone more frequently than younger infants (18.4% vs 13.8%, \( P < .001 \)). When stratified further, 12.8% of 0- to 2-month-olds changed position from side/back to
prone, compared with 17.3% of 3-month-olds and 18.4% of those infants aged ≥4 months. Nearly half (49.2%) of all deaths occurred in an adult bed or on a person, with a higher percentage occurring in the younger age group (51.6% vs 43.8%, P < .001). Approximately one-quarter of the deaths occurred in a crib, bassinet, or playpen, with this sleep location being more common in older infants (34.0% vs 24.6%, P < .001).

**Multivariable Results**

After adjusting for gender, race/ethnicity, and CCC, deaths occurring in the younger age group continued to be associated with bed-sharing (OR: 2.0; 95% confidence interval [CI]: 1.8–2.2); a sleep place other than a crib, bassinet, or playpen (eg, adult bed or on a person; OR: 1.6; 95% CI: 1.5–1.8); and prone (OR: 1.3; 95% CI: 1.1–1.5) or side (OR: 1.9; 95% CI: 1.6–2.2) placement (Table 3). However, deaths in the younger age group were less likely to have an object in the sleep environment (OR: 0.8; 95% CI: 0.7–0.9). Deaths in the younger age group were also less likely to be associated with changes in the sleep position from back/side to stomach (OR: 0.6; 95% CI: 0.6–0.7). Deaths in non-Hispanic blacks were more likely than those in non-Hispanic whites to be associated with risk factors such as sleeping in a location other than a crib, bassinet, or playpen (eg, adult bed; OR: 1.9; 95% CI: 1.7–2.1), bed-sharing (OR: 1.7; 95% CI: 1.5–1.9), and being placed to sleep in the prone (OR: 1.4; 95% CI: 1.2–1.6) or side (OR: 1.2; 95% CI: 1.0–1.3) position. Compared with deaths in non-Hispanic white infants, deaths in Hispanic infants were more likely to be in an adult bed (OR: 1.6; 95% CI: 1.4–1.9) and in infants placed to sleep in the side position (OR: 1.3; 95% CI: 1.1–1.6), but were less likely in infants placed in the prone position (OR: 0.7; 95% CI: 0.6–0.9). Differences in the likelihood of a sleep-related death risk factor also existed by gender. Deaths in girls were more likely than those in boys to be associated with sleeping in an adult bed (OR: 1.2; 95% CI: 1.0–1.3), but less likely to be associated with being placed in the prone position (OR: 0.8; 95% CI: 0.7–0.9).

**DISCUSSION**

In this analysis of infant sleep-related deaths, we found that sleep environment risks for 0- to 3-month-old infants were different than those for infants aged 4 months to 364 days. The younger infants were more likely to die while sleeping on the same surface (usually a bed) with adults, whereas the older infants were more likely to have been found prone with objects, such as blankets and stuffed animals, in the sleep area.

These findings may in part reflect risk at different developmental stages. Older infants were more likely to have been placed on their back or side and then found in the prone position. Infants typically begin rolling from the supine position to the prone position at ~4 months of age. Indeed, when we stratified the age groups even further, we found that 17.3% of 3-month-olds rolled into a prone position, compared with 12.8% of 0- to 2-month-olds. It has been well documented that the risk of sudden unexpected infant death when an infant is placed or rolls into the prone position is much higher than in any other sleep position combination (as much as 19.3 times higher) when prone is not a usual position (unaccustomed prone).22 It is possible that many of these infants rolled into the prone position and into objects, such as blankets,
TABLE 2  Risk Factors for Sleep-Related Death by Age Category

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Total*</th>
<th>Age Category†</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0–3 Months</td>
<td>4 Months to 364 Days</td>
<td></td>
</tr>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>n</td>
</tr>
</tbody>
</table>

Bed-sharing

Yes

5681 69.2 4191 73.8 1489 58.9

No

2335 28.4 1375 24.2 856 37.9

Unknown

193 2.4 111 1.9 85 3.3

Number of objects in the sleep environment

<.001

0

5398 64.7 3775 66.5 1533 60.6

1

2014 24.5 1295 22.8 719 28.4

2

672 8.2 461 8.1 211 8.3

3

182 2.2 127 2.2 55 2.2

4

25 0.3 15 0.3 10 0.4

5

5 0.1 3 0.1 2 0.1

6

1 0.0 1 0.0 0 0.0

One or more dangerous objectsb

2879 33.3 1883 33.4 986 39.0 <.001

Position placed to sleep

<.001

On back

3258 38.7 2160 38.0 1098 43.4

On side

1041 12.7 820 14.4 221 8.7

On stomach

1806 22.0 1298 22.9 507 20.0

Unknown

2102 25.6 1398 24.6 704 27.8

Position infant found

<.001

On back

2204 26.9 1567 27.6 637 25.2

On side

981 11.9 710 12.5 271 10.7

On stomach

3144 38.3 2075 36.6 1068 42.2

Unknown

1878 22.9 1325 23.3 554 21.9

Change in position from position placed to position found

<.001

Back/side to back/side

2676 32.6 1934 34.1 742 29.3

Back/side to stomach

1251 15.2 786 13.8 465 18.4

Stomach to stomach

1501 18.3 1083 19.1 418 16.5

Stomach to back/side

157 1.9 101 1.8 56 2.2

Either placed or found position unknown

2622 32.0 1774 31.3 848 33.5

Sleep place at time of death

<.001

Crib, bassinet, or playpen

2259 27.5 1398 24.6 860 34.0

Car seat, stroller; or infant chair

245 3.0 174 3.1 72 2.8

Adult bed or person

4037 49.2 2929 51.6 1108 43.8

Other

1385 17.0 984 17.3 409 16.2

Unknown

275 3.3 192 3.4 83 3.2

* Frequencies are nonintegers due to averaging over 5 independent imputations during the multiple imputation process; frequencies shown are rounded to the nearest integer.

† Dangerous objects includes pillows, blankets, bumper pads, stuffed toys, clothing, cords, and bags.

b This is a reversion mistake. The table originally presented a different set of data.

determination by autopsy and death scene investigation what exactly transpired in deaths such as these. It is therefore not surprising that deaths of younger infants were more likely to be coded as unknown or undetermined cause of death. Many coroners and medical examiners are more likely to determine the cause of death as unknown or undetermined when the death occurs in a bed-sharing scenario, because it is often unclear if the infant died of SIDS or accidental suffocation, and we found that bed-sharing deaths in this cohort were more likely to be categorized as unknown or undetermined, regardless of the infant’s age.

It is interesting that the younger infants were less likely to be found with objects in the sleep environment. It is unclear whether this is a reflection of inaccurate coding (eg, if pillows and blankets in adult beds were not coded). Another possibility, given the high proportion of infants in this age group who were found in bed-sharing situations, is that bed-sharing even without extraneous objects (eg, pillows and blankets) is hazardous for these youngest infants. It has been assumed by some that bed-sharing can be made safe if measures such as eliminating soft bedding from the adult bed are followed, but our findings raise questions about the validity of this assumption. In addition, although there were no differences between younger and older infants with regard to the presence of pillows in the sleep environment, pillows were the second most common object found in the sleep area. This finding may indicate that pillows are dangerous objects to have in the infant’s sleep environment, regardless of the infant’s age.

There were also some notable differences in sleep environment risks between minority groups. African-American infants who died were more likely to be bed-sharing and to be found with an object in the sleep environment. Latino and African-American infants were more likely to be placed in a nonsupine position and to be sleeping in a location other than a crib, bassinet, or playpen. These findings mirror data about sleep behaviors in different racial/ethnic groups in cross-sectional studies. There are limitations inherent to this type of study. First, there were multiple individuals in multiple sites who were responsible for data entry, and the quality of the data varied. In addition,
some of the variables had sizable proportions of missing data. Although we used imputation to account for the missing data, missing data may still have skewed the results. Furthermore, although this is a large population-based database, it is not comprehensive, because participation in the NCHCD database is voluntary, and not all sudden and unexpected infant deaths are reviewed by state child death review teams and are therefore not included in this database. Because the database is not comprehensive, it is impossible to determine the denominator for these deaths. Furthermore, because there is no comparison group, risk cannot be determined. In addition, coroners and medical examiners have different protocols and criteria for classifying sudden and unexpected infant death, so any differences with regard to diagnosis and cause of death determination may have been affected. Nonetheless, this database provides a cross-sectional view of potential risks for infants in different age groups.

### CONCLUSIONS

Sleep environment risks factors for infants may be different for different age groups. The predominant risk factor for younger infants (0–3 months of age) is bed-sharing, whereas rolling to prone, with objects in the sleep area, is the predominant risk factor for older infants (4 months to 364 days). Parents should be warned about the dangers of bed-sharing, particularly in 0- to 3-month-old infants. Although the American Academy of Pediatrics advises that infants do not need to be repositioned onto their backs if they roll into the prone position, parents should be reminded that cribs should be clear of any objects, so that if the infant rolls, there is no risk of rolling into something that may create an asphyxial environment.

### TABLE 3

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Sleep Place</th>
<th>Car Seat/Stroller</th>
<th>Adult Bed</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0–3 months</td>
<td>1.5 (1.1–2.0)*</td>
<td>1.6 (1.5–1.8)</td>
<td>1.5 (1.3–1.7)*</td>
<td>2.0 (1.8–2.2)*</td>
</tr>
<tr>
<td>4 months to 364 days</td>
<td>1.3 (1.1–1.5)*</td>
<td>1.9 (1.6–2.2)*</td>
<td>0.8 (0.7–0.9)*</td>
<td>Reference</td>
</tr>
<tr>
<td>Gender</td>
<td>Female</td>
<td>1.1 (0.8–1.4)</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td></td>
<td>Male</td>
<td>1.2 (1.0–1.3)*</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Race/ethnicity</td>
<td>Non-Hispanic black</td>
<td>1.3 (0.9–1.9)</td>
<td>1.9 (1.7–2.1)*</td>
<td>1.4 (1.2–1.7)*</td>
</tr>
<tr>
<td>Other</td>
<td>1.2 (0.9–2.0)</td>
<td>1.5 (1.2–1.9)*</td>
<td>1.3 (0.9–1.7)</td>
<td>1.0 (0.8–1.3)</td>
</tr>
</tbody>
</table>

Data adjusted for race/ethnicity, gender, and CCC ORs for CCCs were not statistically significant and are not displayed.

* Reference: crib, bassinet, or playpen.
* Reference: no bed-sharing.
* Reference: no objects.
* Reference: on back.
* Reference: back/side to back/side.
* Reference: back to stomach.

** P < .01.
*** P < .001.
**** P = .02.
† P = .04.
‡ P = .01.
§ P = .03.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Bed-Sharing</th>
<th>Any Object in the Sleep Environment</th>
<th>Position Placed to Sleep</th>
<th>Position Found</th>
<th>Position Change</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>On Stomach</td>
<td>On Back</td>
<td>On Stomach</td>
<td>On Back</td>
<td>On Stomach</td>
</tr>
<tr>
<td>Age</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>0–3 months</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>4 months to 364 days</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Gender</td>
<td>Female</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td></td>
<td>Male</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Race/ethnicity</td>
<td>Non-Hispanic black</td>
<td>1.3 (0.9–1.9)</td>
<td>1.9 (1.7–2.1)*</td>
<td>1.4 (1.2–1.7)*</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>1.2 (0.9–2.0)</td>
<td>1.5 (1.2–1.9)*</td>
<td>1.3 (0.9–1.7)</td>
<td>1.0 (0.8–1.3)</td>
<td></td>
</tr>
</tbody>
</table>

Some of the variables had sizable proportions of missing data. Although we used imputation to account for the missing data, missing data may still have skewed the results. Furthermore, although this is a large population-based database, it is not comprehensive, because participation in the NCHCD database is voluntary, and not all sudden and unexpected infant deaths are reviewed by state child death review teams and are therefore not included in this database. Because the database is not comprehensive, it is impossible to determine the denominator for these deaths. Furthermore, because there is no comparison group, risk cannot be determined. In addition, coroners and medical examiners have different protocols and criteria for classifying sudden and unexpected infant death, so any differences with regard to diagnosis and cause of death determination may have been affected. Nonetheless, this database provides a cross-sectional view of potential risks for infants in different age groups.
ACKNOWLEDGMENTS
The data set used was provided by the NCPRCD, which is funded in part by
grant U49MC00225 from the US Department of Health and Human Services
(HHS), Health Resources and Services Administration, and in part by the US
Centers for Disease Control and Prevention Division of Reproductive Health. The
contents are solely the responsibility of the authors and do not necessarily rep-
resent the official views of NCPRCD, HHS, or the participating states. Twenty-four
states contributed data from their child
death review. They include the following
21 states: Alabama, Arizona, California,
Colorado, Connecticut, Delaware, Georgia,
Hawaii, Iowa, Michigan, Minnesota, Nebraska,
Nevada, New Jersey, Ohio, Oklahoma, Rhode
Island, Tennessee, Texas, West Virginia, and
Wisconsin.

REFERENCES
1. MacDorman MF, Hoyert DL, Mathews TJ. Recent declines in infant mortality in the
Center for Health Statistics; 2013
2. Malloy MH, MacDorman M. Changes in the classification of sudden unexpected infant
3. Tappin D, Ecor B, Brooke H. Bedsharing, room-sharing, and sudden infant death
infant death syndrome in an urban pop-
6. Thach BT, Rutherford GW, Harris K. Deaths and injuries attributed to infant crib bumper
infants dying suddenly and unexpectedly:
results of a four-year, population-based, death-
scene investigation study of sudden infant
cgi/content/full/106/3/e41
pediatrics.org/cgi/content/full/111/2/e12
9. Moon RY. Task Force on Sudden Infant Death Syndrome. SIDS and other sleep-related in-
fant deaths: expansion of recommendations for a safe infant sleeping environment. Pediat-
rics. 2011;128(5). Available at: www.pedi-
atrics.org/cgi/content/full/128/5/e1341
bed sharing, 1993-2010: the National Infant
Sleep Position Study. JAMA Pediatr. 2013;
167(11):1032–1037
with infant sleeping position: the national in-
fant sleep position study, 1993-2007. Arch
factors influencing the risk of the sudden
infant death syndrome. BMJ. 1999;319(7223):
1457–1461
13. Ryus JH, de Jonge GA, Brand R, Engelberts AC,
Semmekrot BA. Bed-sharing in the first four
months of life: a risk factor for sudden infant
14. Covington TM. The US National Child Death
2011;17(suppl 1):s44–s57
15. National MCH Center for Child Death Re-
view Web site. Available at: www.child-
16. Schnitzer PG, Covington TM, Dykstra HK. Sudden unexpected infant deaths: sleep
environment and circumstances. Am J
17. National MCH Center for Child Death Re-
view. Child Death Review Case Reporting
Available at: www.childdeathreview.org/
Reports/PrintCaseVersion3.pdf. Accessed
January 7, 2014
18. Feudtner C, Feinstein JA, Satchell M, Zhao
H, Kang TI. Shifting place of death among
children with complex chronic conditions in
297(24):2725–2732
19. Feudtner C, Christakis DA, Connell FA. Pedi-
atric deaths attributable to complex chronic
conditions: a population-based study of Wash-
20. Baraldi AN, Enders CK. An introduction to
modern missing data analyses. J Sch Psychol.
2010;48(1):5–37
Handbook of Social Science Methodology
London, United Kingdom: Sage; 2008:1–44
22. Mitchell EA, Thach BT, Thompson JM, Williams
S. Changing infants’ sleep position increases
risk of sudden infant death syndrome. New Zealand Cot Death Study. Arch Pediatr Adolesc
23. Pollack HA, Frohna JG. Infant sleep place-
ment after the back to sleep campaign.
24. Beck LF, Morrow B, Lipscomb LE, et al. Prevalence of selected maternal behaviors and
experiences, Pregnancy Risk Assess-
ment Monitoring System (PRAMS), 1999.
MMWR Surveill Summ. 2002;51(2):1–27
25. Camperengo LT, Shapiro-Mendoza CK, Kim
SY. Sudden infant death syndrome: di-
agnostic practices and investigative poli-
33(3):197–201

(Continued from first page)

FUNDING: Primary funding for this project was provided by the CJ Foundation for SIDS. The authors also received support from the National Institutes of Health (P20MD000198) and the Maternal and Child Health Branch, Health Resources and Services Administration (R40MC21511). The funding was used for the design and conduct of the study, collection, management, analysis, and interpretation of the data, and manuscript preparation. The study sponsor had no role in study design, collection, analysis and interpretation of data, writing of the manuscript, or the decision to submit the manuscript for publication. Drs Colvin, Collie-Akers, and Moon wrote the first draft of the manuscript; no honorarium, grant, or other form of payment was given to anyone to produce the manuscript. Funded by the National Institutes of Health (NIH).

POTENTIAL CONFLICT OF INTEREST: The authors have indicated they have no potential conflicts of interest to disclose.
Sleep Environment Risks for Younger and Older Infants
Jeffrey D. Colvin, Vicki Collie-Akers, Christy Schunn and Rachel Y. Moon

_Pediatrics_; originally published online July 14, 2014;
DOI: 10.1542/peds.2014-0401

<table>
<thead>
<tr>
<th>Updated Information &amp; Services</th>
<th>including high resolution figures, can be found at: <a href="http://pediatrics.aappublications.org/content/early/2014/07/09/peds.2014-0401">http://pediatrics.aappublications.org/content/early/2014/07/09/peds.2014-0401</a></th>
</tr>
</thead>
<tbody>
<tr>
<td>Post-Publication Peer Reviews (P³Rs)</td>
<td>2 P³Rs have been posted to this article <a href="http://pediatrics.aappublications.org/cgi/eletters/peds.2014-04-01v1">http://pediatrics.aappublications.org/cgi/eletters/peds.2014-04-01v1</a></td>
</tr>
<tr>
<td>Permissions &amp; Licensing</td>
<td>Information about reproducing this article in parts (figures, tables) or in its entirety can be found online at: <a href="http://pediatrics.aappublications.org/site/misc/Permissions.xhtml">http://pediatrics.aappublications.org/site/misc/Permissions.xhtml</a></td>
</tr>
<tr>
<td>Reprints</td>
<td>Information about ordering reprints can be found online: <a href="http://pediatrics.aappublications.org/site/misc/reprints.xhtml">http://pediatrics.aappublications.org/site/misc/reprints.xhtml</a></td>
</tr>
</tbody>
</table>

PEDIATRICS is the official journal of the American Academy of Pediatrics. A monthly publication, it has been published continuously since 1948. PEDIATRICS is owned, published, and trademarked by the American Academy of Pediatrics, 141 Northwest Point Boulevard, Elk Grove Village, Illinois, 60007. Copyright © 2014 by the American Academy of Pediatrics. All rights reserved. Print ISSN: 0031-4005. Online ISSN: 1098-4275.