

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,^{a,b} Vicki Collie-Akers, PhD, MPH,^c Christy Schunn, MSW,^d and Rachel Y. Moon, MD^{e,f}

^aDepartment of Pediatrics, Children's Mercy Hospitals and Clinics, Kansas City, Missouri; ^bDepartment of Pediatrics, University of Missouri-Kansas City School of Medicine, Kansas City, Missouri; ^cWork Group for Community Health and Development, University of Kansas, Lawrence, Kansas; ^dKansas Infant Death and SIDS Network, Wichita, Kansas; ^eGoldberg Center for Community Pediatric Health, Children's National Health System, Washington, District of Columbia; and ^fDepartment 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.

www.pediatrics.org/cgi/doi/10.1542/peds.2014-0401

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: jdcolvin@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.¹ Although the incidence of SIDS has decreased since 2000, rates of other sleep-related infant deaths (eg, accidental suffocation, asphyxiation) have increased.² It has been suggested that these observed changes may be attributable, in part, to changes in diagnostic categorization.²

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),³ bed-sharing,⁴ soft bedding,⁵ bumper pads or other items,⁶ and sleeping in the prone position.^{7,8} Indeed, the American Academy of Pediatrics recently released statements that include comprehensive recommendations for a safe sleep environment.⁹ However, the adoption of safe sleep practices has been inconsistent in home, child care, and health care settings.^{10,11}

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.^{3,4,12,13} 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.¹⁴ As of late 2013, 43 states were participating in the database, which contains >1700 data elements.^{15,16} States use a standardized reporting tool and record all data online.¹⁴ A data dictionary and data code book are provided to ensure accuracy and consistency in reporting.¹⁴ 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.¹⁷ Participating states sign data-sharing agreements with the NCRPCD. Additional details about the NCRPCD have been described previously.^{14,16}

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,”^{18,19} 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.^{18,19} 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. “Non-stuffed 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.^{20,21} Multiple imputation has been previously used for analyses of the NCRPCD database.¹⁶ 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 χ^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 (*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 (38.2%). 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* = .02).

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 (17.6%). Deaths in the older age group were significantly more likely to be associated with the presence of blankets (26.8% vs 23.5%, *P* = .001), stuffed toys (2.4% vs 1.2%, *P* < .001), bags (1.2% vs 0.3%, *P* < .001), hard furniture (0.3% 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 36.6%, *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

TABLE 1 Study Population Characteristics by Age Category

Characteristic	Total ^a		Age Category ^a				P
			0–3 Months (n = 5677)		4 Months to 364 Days (n = 2530)		
	n	%	n	%	n	%	
Gender							.24
Male	4780	58.2	3273	57.7	1507	59.6	
Female	3408	41.5	2390	42.1	1018	40.2	
Unknown	19	0.2	13	0.2	5	0.2	
Race/ethnicity							.02
Hispanic	1595	19.4	1078	19.0	517	20.5	
Non-Hispanic white	3688	44.9	2537	44.7	1151	45.5	
Non-Hispanic black	2471	30.1	1762	31.0	708	28.0	
Other race	453	5.5	300	5.3	154	6.1	
Any CCC	102	1.2	46	0.8	56	2.2	<.001
Primary caregiver							.17
Parent	7795	95.0	5404	95.2	2391	94.5	
Foster parent	87	1.1	61	1.1	27	1.1	
Parent's partner	70	0.9	46	0.8	24	0.9	
Relative or friend	135	1.6	80	1.4	55	2.2	
Other	40	0.5	26	0.5	14	0.6	
Unknown	80	1.0	60	1.1	20	0.8	
Autopsy performed							.29
Yes	8008	97.6	5544	97.7	2464	97.4	
No	89	1.1	54	1.0	35	1.4	
Unknown	109	1.3	79	1.4	31	1.2	
Diagnosis							.02
SIDS/SUID	2873	35.0	1969	34.7	904	35.7	
Accidental suffocation and strangulation in bed	2196	26.8	1482	26.1	714	28.2	
Unknown/undetermined	3138	38.2	2226	39.2	912	36.0	

SUID, sudden unexpected infant death.

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

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: 1.0–1.5) 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

Characteristic	Total ^a		Age Category ^a				P
			0–3 Months		4 Months to 364 Days		
	n	%	n	%	n	%	
Bed-sharing							<.001
Yes	5681	69.2	4191	73.8	1489	58.9	
No	2333	28.4	1375	24.2	958	37.9	
Unknown	193	2.4	111	1.9	83	3.3	
Number of objects in the sleep environment							<.001
0	5308	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 objects ^b	2879	33.3	1893	33.4	986	39.0	<.001
Position placed to sleep							<.001
On back	3258	39.7	2160	38.0	1098	43.4	
On side	1041	12.7	820	14.4	221	8.7	
On stomach	1806	22.0	1299	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	1393	17.0	984	17.3	409	16.2	
Unknown	273	3.3	192	3.4	81	3.2	

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

^b "Dangerous objects" includes pillows, blankets, bumper pads, stuffed toys, clothing, cords, and bags.

bags, and stuffed animals, in the sleep environment and could not escape the asphyxiating situation.

In contrast, infants aged 0 to 3 months were more likely to die while sharing a sleep surface. Infants at this age do not yet have the motor ability or strength to move their head or reposition their body when in an asphyxiating environment, such as when another person rolls over or moves such that part of the adult's body obstructs the infant's airway. In retrospect, it is often difficult to de-

termine 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,¹⁶ 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.^{10,23,24} 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,

TABLE 3 ORs (95% CIs) for Presence of an Infant Sleep-Related Death Risk Factor

Characteristic	Sleep Place ^a		Bed-Sharing ^b	Any Object in the Sleep Environment ^c	Position Placed to Sleep ^d		Position Found ^d		Position Change ^e
	Car Seat/Stroller	Adult Bed			Other	On Stomach	On Side	On Stomach	
Age									
0–3 months	1.5 (1.1–2.0)*	1.6 (1.5–1.8) [§]	1.5 (1.3–1.7)*	0.8 (0.7–0.9) [§]	1.3 (1.1–1.5) [§]	1.9 (1.6–2.2) [§]	0.8 (0.7–0.9) [§]	1.1 (0.9–1.3)	0.6 (0.6–0.7) [§]
4 months to 364 days	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Gender									
Female	1.1 (0.8–1.4)	1.2 (1.0–1.3)*	1.0 (0.9–1.1)	1.0 (0.9–1.0)	0.8 (0.7–0.9)*	0.9 (0.8–1.1)	0.7 (0.6–0.8) [§]	1.0 (0.8–1.1)	Reference
Male	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Race/ethnicity									
Non-Hispanic black	1.3 (0.9–1.9)	1.9 (1.7–2.1) [§]	1.4 (1.2–1.7) [§]	1.1 (1.0–1.3) [¶]	1.40 (1.2–1.6) [§]	1.2 (1.0–1.5) [¶]	1.2 (1.0–1.3)**	1.0 (0.8–1.2)	1.0 (0.8–1.1)
Hispanic	1.2 (0.8–1.9)	1.6 (1.4–1.9) [§]	1.0 (0.8–1.2)	1.0 (0.9–1.1)	0.7 (0.6–0.9) [§]	1.3 (1.1–1.6) ^{§§}	0.8 (0.7–0.9) [§]	1.0 (0.8–1.2)	0.8 (0.7–1.0) ^{¶¶}
Other	1.2 (0.6–2.6)	1.5 (1.2–1.9)*	1.3 (0.9–1.7)	1.1 (0.9–1.4)	0.9 (0.7–1.2)	1.1 (0.8–1.5)	1.0 (0.8–1.3)	1.1 (0.8–1.6)	1.1 (0.8–1.6)
Non-Hispanic white	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference

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

^a Reference: crib, bassinet, or playpen.

^b Reference: no bed-sharing.

^c Reference: no objects.

^d Reference: on back.

^e Reference: back/side to back/side.

* $P < .01$.

[§] $P < .001$.

[¶] $P = .02$.

** $P = .04$.

^{§§} $P = .01$.

^{¶¶} $P = .03$.

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 NCRPCD 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,²⁵ 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.

ACKNOWLEDGMENTS

The data set used was provided by the NCRPCD, 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 represent the official views of NCRPCD, 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 United States, 2005-2011. In: NCHS Data Brief. No. 120. Hyattsville, MD: National Center for Health Statistics; 2013
2. Malloy MH, MacDorman M. Changes in the classification of sudden unexpected infant deaths: United States, 1992-2001. *Pediatrics*. 2005;115(5):1247-1253
3. Tappin D, Ecob R, Brooke H. Bedsharing, roomsharing, and sudden infant death syndrome in Scotland: a case-control study. *J Pediatr*. 2005;147(1):32-37
4. Vennemann MM, Hense H-W, Bajanowski T, et al. Bed sharing and the risk of sudden infant death syndrome: can we resolve the debate? *J Pediatr*. 2012;160(1):44-e2
5. Hauck FR, Herman SM, Donovan M, et al. Sleep environment and the risk of sudden infant death syndrome in an urban population: the Chicago Infant Mortality Study. *Pediatrics*. 2003;111(5 pt 2):1207-1214
6. Thach BT, Rutherford GW, Harris K. Deaths and injuries attributed to infant crib bumper pads. *J Pediatr*. 2007;151(3):271-274
7. Kemp JS, Unger B, Wilkins D, et al. Unsafe sleep practices and an analysis of bedsharing among infants dying suddenly and unexpectedly: results of a four-year, population-based, death-scene investigation study of sudden infant death syndrome and related deaths. *Pediatrics*. 2000;106(3). Available at: www.pediatrics.org/cgi/content/full/106/3/e41
8. Unger B, Kemp JS, Wilkins D, et al. Racial disparity and modifiable risk factors among infants dying suddenly and unexpectedly. *Pediatrics*. 2003;111(2). Available at: www.pediatrics.org/cgi/content/full/111/2/e127
9. Moon RY; Task Force on Sudden Infant Death Syndrome. SIDS and other sleep-related infant deaths: expansion of recommendations for a safe infant sleeping environment. *Pediatrics*. 2011;128(5). Available at: www.pediatrics.org/cgi/content/full/128/5/e1341
10. Colson ER, Willinger M, Rybin D, et al. Trends and factors associated with infant bed sharing, 1993-2010: the National Infant Sleep Position Study. *JAMA Pediatr*. 2013;167(11):1032-1037
11. Colson ER, Rybin D, Smith LA, Colton T, Lister G, Corwin MJ. Trends and factors associated with infant sleeping position: the national infant sleep position study, 1993-2007. *Arch Pediatr Adolesc Med*. 2009;163(12):1122-1128
12. Blair PS, Fleming PJ, Smith IJ, et al. Babies sleeping with parents: case-control study of factors influencing the risk of the sudden infant death syndrome. *BMJ*. 1999;319(7223):1457-1461
13. Ruys 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 death. *Acta Paediatr*. 2007;96(10):1399-1403
14. Covington TM. The US National Child Death Review Case Reporting System. *Inj Prev*. 2011;17(suppl 1):i34-i37
15. National MCH Center for Child Death Review Web site. Available at: www.child-deathreview.org. Accessed January 7, 2014
16. Schnitzer PG, Covington TM, Dykstra HK. Sudden unexpected infant deaths: sleep environment and circumstances. *Am J Public Health*. 2012;102(6):1204-1212
17. National MCH Center for Child Death Review. Child Death Review Case Reporting System Case Report, version 3.0. 2013. 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 the United States, 1989-2003. *JAMA*. 2007;297(24):2725-2732
19. Feudtner C, Christakis DA, Connell FA. Pediatric deaths attributable to complex chronic conditions: a population-based study of Washington State, 1980-1997. *Pediatrics*. 2000;106(1 pt 2):205-209
20. Baraldi AN, Enders CK. An introduction to modern missing data analyses. *J Sch Psychol*. 2010;48(1):5-37
21. Howell DC. The treatment of missing data. In: Outhwaite W, Turner S, eds. *SAGE 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 Med*. 1999;153(11):1136-1141
23. Pollack HA, Frohna JG. Infant sleep placement after the back to sleep campaign. *Pediatrics*. 2002;109(4):608-614
24. Beck LF, Morrow B, Lipscomb LE, et al. Prevalence of selected maternal behaviors and experiences, Pregnancy Risk Assessment Monitoring System (PRAMS), 1999. *MMWR Surveill Summ*. 2002;51(2):1-27
25. Camperlengo LT, Shapiro-Mendoza CK, Kim SY. Sudden infant death syndrome: diagnostic practices and investigative policies, 2004. *Am J Forensic Med Pathol*. 2012;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;

Updated Information & Services

including high resolution figures, can be found at:
<http://pediatrics.aappublications.org/content/early/2014/07/09/peds.2014-0401>

Permissions & Licensing

Information about reproducing this article in parts (figures, tables) or in its entirety can be found online at:
<http://www.aappublications.org/site/misc/Permissions.xhtml>

Reprints

Information about ordering reprints can be found online:
<http://www.aappublications.org/site/misc/reprints.xhtml>

American Academy of Pediatrics

DEDICATED TO THE HEALTH OF ALL CHILDREN™



PEDIATRICS®

OFFICIAL JOURNAL OF THE AMERICAN ACADEMY OF PEDIATRICS

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;

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>

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: 1073-0397.

American Academy of Pediatrics

DEDICATED TO THE HEALTH OF ALL CHILDREN™

