

Sofas and Infant Mortality

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KEY WORDS

SIDS, suffocation, injury, sofa

ABBREVIATIONS

aOR—adjusted odds ratio

ASSB—accidental suffocation and strangulation in bed

CDR-CRS—Child Death Review and Case Reporting System

CI—confidence interval

SIDS—sudden infant death syndrome

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WHAT'S KNOWN ON THIS SUBJECT: Sleeping on a sofa increases the risk of sudden and unexpected infant death.



WHAT THIS STUDY ADDS: Infant deaths on sofas are associated with nonsupine placement, being found in side position, surface sharing, changing sleep location, and experiencing prenatal tobacco exposure. These results may help explain why sofa sleeping is hazardous for infants.

abstract



OBJECTIVE: Sleeping on sofas increases the risk of sudden infant death syndrome and other sleep-related deaths. We sought to describe factors associated with infant deaths on sofas.

METHODS: We analyzed data for infant deaths on sofas from 24 states in 2004 to 2012 in the National Center for the Review and Prevention of Child Deaths Case Reporting System database. Demographic and environmental data for deaths on sofas were compared with data for sleep-related infant deaths in other locations, using bivariate and multivariable, multinomial logistic regression analyses.

RESULTS: 1024 deaths on sofas made up 12.9% of sleep-related infant deaths. They were more likely than deaths in other locations to be classified as accidental suffocation or strangulation (adjusted odds ratio [aOR] 1.9; 95% confidence interval [CI], 1.6–2.3) or ill-defined cause of death (aOR 1.2; 95% CI, 1.0–1.5). Infants who died on sofas were less likely to be Hispanic (aOR 0.7; 95% CI, 0.6–0.9) compared with non-Hispanic white infants or to have objects in the environment (aOR 0.6; 95% CI, 0.5–0.7) and more likely to be sharing the surface with another person (aOR 2.4; 95% CI, 1.9–3.0), to be found on the side (aOR 1.9; 95% CI, 1.4–2.4), to be found in a new sleep location (aOR 6.5; 95% CI, 5.2–8.2), and to have had prenatal smoke exposure (aOR 1.4; 95% CI, 1.2–1.6). Data on recent parental alcohol and drug consumption were not available.

CONCLUSIONS: The sofa is an extremely hazardous sleep surface for infants. Deaths on sofas are associated with surface sharing, being found on the side, changing sleep location, and experiencing prenatal tobacco exposure, which are all risk factors for sudden infant death syndrome and sleep-related deaths. *Pediatrics* 2014;134:e1293–e1300

Sudden infant death syndrome (SIDS) is the leading cause of infant mortality after the first 30 days of life in the United States, with a rate of 53.9 deaths per 100 000 live births.¹ The incidence of SIDS has declined >50% since 1992,^{1,2,3} when the national “Back to Sleep” campaign was launched after research demonstrated the association between SIDS and prone sleep position.⁴ However, during this time the rates of other sleep-related infant deaths (eg, accidental suffocation, strangulation, ill-defined causes) have increased.^{5–7}

The risk of SIDS and other sleep-related infant deaths can be affected by an infant’s sleep environment. Soft bedding,⁸ sleeping somewhere other than in a crib (eg, on a sofa),⁹ surface sharing (when an infant is sleeping on the same surface as another person),¹⁰ and bumper pads¹¹ contribute to an unsafe sleep environment. In 2011, the American Academy of Pediatrics released expanded recommendations for a safe sleep environment to reduce the risk of all sleep-related infant deaths.¹² However, many infants continue to be placed in unsafe sleep environments.^{13,14}

Sleeping on sofas is extremely hazardous. Compared with sleeping on other surfaces (eg, beds, cribs), it increases the risk 49- to 67-fold.^{8,9,15–17} However, less is known about the specific factors associated with infant deaths on sofas. One study has described the dangers associated with sofa sleeping but included only 10 sofa deaths.¹⁸ The purpose of this study is to describe the environmental and situational factors associated with infant deaths on sofas, as compared with other sleep-related infant deaths.

METHODS

Data Source

Data were obtained from the National Center for the Review and Prevention of Child Deaths Child Death Review and

Case Reporting System (CDR-CRS) database. The CDR-CRS, funded by the Maternal and Child Health Bureau, is a web-based system used for the collection, reporting, and analysis of individual child deaths by state child death review teams.^{19,20} The database includes >84 100 child deaths, including >45 300 infant deaths.¹⁹ As of June 2014, 35 states were contributing to the database, which contains >1700 data elements, with each element linked to definitions and a code book to ensure standardization and consistency in reporting.¹⁹ (At the time these data were collected, 24 states were participating.) Data were analyzed from all states that made their data available for the relevant years. Data sources include death scene investigations, autopsies, law enforcement reports, medical records, and death certificates. The reporting system includes information on the child, family, and supervisor at the time of death, as well as data about incident characteristics, investigation actions, risk and protective factors, and services needed or provided.¹⁹

Subjects

The study population included all infants (≤ 365 days of age) whose death was recorded in the CDR-CRS as a sleep-related death (ie, occurring during sleep or in a sleep environment, such as a crib, bassinet, or bed) in 2004 to 2012 for 24 states (see Acknowledgments for list of states). Deaths occurring during sleep but from an explained non-sleep-related medical cause (eg, infection) or weapon-related homicide were excluded. Depending on when they began participating in the CDR-CRS, some states did not have data for all study years; however, even if a state did not provide data for all years, data from that state were still included. To ascertain factors specifically associated with deaths on sofas, we

extracted and compared deidentified data from these deaths with data from other sleep-related infant deaths occurring in other locations. The institutional review board at Children’s National Medical Center approved this study.

Statistical Analysis

The following variables were analyzed: infant characteristics (age, gender, race or ethnicity, complex chronic condition, or technology dependence, eg, ventilator dependence, gastrostomy tube feeds), place of incident, whether an autopsy was performed, cause of death, sleep environment factors (surface sharing, object found in sleep environment, sleep position, and sleep position change), and pregnancy characteristics (maternal medical problems, intimate partner violence, and substance use or abuse). Data elements regarding the manner and cause of death from the death certificate were used to assign cases to 1 of 3 causes of death: SIDS, accidental suffocation and strangulation in bed (ASSB, which included asphyxia), and ill-defined (which included undetermined causes). ASSB encompassed any incidents of accidental suffocation by soft bedding (including pillow or mattress), overlay, or wedging and entrapment, or strangulation in a sleep environment.⁶

We performed all statistical analyses by using SPSS Statistics Data Editor version 21 (IBM Corporation, Armonk, NY), and *P* values $< .05$ were considered statistically significant. We performed multiple imputation by using the Markov Monte Carlo method to impute missing data for variables used in the analyses.^{21,22} (Information on the proportions of missing data is included in Tables 1 and 2.) Multiple imputation has been previously used for analyses of the CDR-CRS database.^{20,23} Multiple imputation predicts values for

TABLE 1 Study Population Characteristics

Characteristic	Total		Deaths on Sofas		Other Sleep-Related Infant Deaths		<i>P</i>
	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%	
Total	7934	100.0	1024	100.0	6910	100.0	
Age (mo)							
<1	875	11.0	137	13.4	738	10.7	<.05
1	1627	20.5	241	23.5	1386	20.1	
2	1705	21.5	224	21.9	1481	21.4	
3	1278	16.1	136	13.3	1142	16.5	
4	882	11.1	104	10.1	778	11.3	
5	568	7.2	61	5.9	507	7.3	
6	368	4.6	37	3.6	331	4.8	
7	255	3.2	34	3.4	221	3.2	
8	147	1.9	20	2.0	127	1.8	
9	92	1.2	13	1.3	79	1.1	
10	77	1.0	9	0.9	68	1.0	
11	60	0.8	7	0.7	53	0.8	
Gender							
Male	4622	58.3	609	59.5	4013	58.1	NS
Female	3295	41.5	412	40.2	2883	41.7	
Unknown	17	0.2	2	0.2	15	0.2	
Missing data	26	0.3					
Race or ethnicity							
Hispanic	1536	19.4	141	13.8	1395	20.2	<.001
Non-Hispanic white	3557	44.8	502	49.0	3056	44.2	
Non-Hispanic black	2401	30.3	335	32.7	2067	29.9	
Other race	439	5.5	46	4.5	393	5.7	
Missing data	302	3.8					
Place of incident							
Child's home	7494	94.5	986	96.3	6508	94.2	<.05
Other	265	3.3	19	1.8	247	3.6	
Unknown	175	2.2	20	1.9	155	2.2	
Missing data	1420	17.9					
Autopsy performed							
Yes	7769	97.9	996	97.3	6773	98.0	NS
No	72	0.9	11	1.1	61	0.9	
Unknown	93	1.2	17	1.7	76	1.1	
Missing data	185	2.4					
Diagnosis							
SIDS or sudden unexpected infant death	2735	34.5	246	24.0	2489	36.0	<.001
ASSB	2139	27.0	410	40.0	1729	25.0	
Ill-defined	3060	38.6	369	36.0	2691	38.9	

NS, not significant.

incomplete variables by using regression equations from complete variables. This minimizes assumptions that the subset of cases with complete data are representative of the entire sample population. Multiple imputation is used so that biases resulting from missing data are reduced; it provides better, nearly unbiased estimates than other methods of handling missing data.^{21,22} All subsequent analyses were conducted with pooled imputed data. The χ^2 test

was performed for bivariate analyses to compare deaths on sofas with other sleep-related infant deaths. Multivariable, multinomial logistic regressions were performed to create adjusted odds ratios (aORs) of deaths on sofas compared with other sleep-related infant deaths. Table 3 shows the aORs using imputation; Supplemental Table 4 shows the aORs for both imputed and original (unimputed) data.

RESULTS

Study Population Characteristics (Table 1)

Of the 9073 sleep-related infant deaths in the database, 7934 (87.4%) met inclusion criteria. Of these, 1024 occurred on sofas, and 6910 occurred elsewhere. Most of the deaths on other surfaces occurred on adult beds (50.5%), cribs (20.1%), and bassinets (8.1%). The majority of deaths on sofas occurred in infants age 0 to 3 months (72.1%) and boys (59.5%). A higher proportion of infants who died on sofas were 0 to 2 months of age (36.9% vs 30.8% of other sleep-related deaths, $P < .05$). Non-Hispanic white was the largest represented ethnicity (44.8%) and made up a statistically significant larger proportion of the deaths on sofas than the other sleep-related deaths (49.0% vs 44.2%, $P < .001$). Most of the study population was cared for primarily by a parent (95.2%) and did not have any complex chronic conditions (98.8%). Most deaths (94.5%) occurred in the infant's home, with deaths on sofas more likely than other deaths to occur in the infant's home (96.3% vs 94.2%, $P < .05$). Additionally, an autopsy was performed in most cases (97.9%). The most common cause of death overall was ill-defined cause (38.6%), followed by SIDS (34.5%). However, the cause of death was classified as ASSB significantly more often for infants who died on sofas compared with other sleep-related deaths (40.0% vs 25.0%, $P < .001$). Overall, deaths on sofas made up 12.1% of all sleep-related deaths, 9.0% of SIDS deaths, 12.1% of ill-defined deaths, and 19.2% of ASSB deaths.

Sleep Environment Factors (Table 2)

Compared with other sleep-related infant deaths, surface sharing occurred in a significantly higher percentage (86.8% vs 66.2%, $P < .001$), and an object was found in the sleep

TABLE 2 Sleep Environment Factors for Deaths on Sofas and Other Sleep-Related Infant Deaths

Risk Factor	Total		Deaths on Sofas		Other Deaths		P
	N	%	N	%	N	%	
Total	7934	100	1024	100.0	6910	100.0	
Surface sharing							
No	2316	29.2	111	10.9	2204	31.9	<.001
Yes	5466	68.9	889	86.9	4576	66.2	
Unknown	152	1.9	23	2.2	129	1.9	
Missing data	1864	23.7					
Object							
Any	2870	36.2	242	23.6	2628	38.0	<.001
Position child placed to sleep							
On back	3232	40.7	307	29.9	2926	42.3	<.001
On stomach	1784	22.5	306	29.9	1478	21.4	
On side	1032	13	134	13.1	898	13.0	
Unknown	1885	23.8	276	27.0	1609	23.3	
Missing data	372	4.7					
Position child found in							
On back	2185	27.5	205	20.1	1980	28.6	<.001
On stomach	3107	39.2	388	37.9	2718	39.3	
On side	973	12.3	174	17.0	799	11.6	
Unknown	1669	21	256	25.0	1413	20.4	
Change in child's sleep position							
Back or side to back or side	2658	33.5	287	28.1	2370	34.3	<.001
Back or side to stomach	1244	15.7	107	10.4	1137	16.5	
Stomach to stomach	1481	18.7	230	22.5	1251	18.1	
Stomach to back or side	156	2.0	41	4.0	115	1.7	
Either placed or found position unknown	2395	30.2	359	35.0	2037	29.5	
Missing data	449	5.7					
Change in sleep location							
New or different sleep location	1253	15.8	304	29.7	950	13.7	<.0001
Same sleep location	3538	44.6	132	12.9	3406	49.3	
Unknown sleep location	3232	39.6	588	57.4	2555	37.0	

environment significantly less frequently (23.6% vs 38.0%, $P < .001$) in the deaths on sofas. Overall, infants were most commonly placed in the supine position to sleep (40.7%), and 13% of infants in both groups were placed on the side. However, infants on sofas were more likely to be placed prone for sleep than infants in other sleep locations (29.9% vs 21.4%, $P < .001$). Infants on sofas were also significantly more likely to be found on their side (17.0% vs 11.6%, $P < .001$), whereas infants in other sleep locations were significantly more likely to be found in the supine (28.6% vs 20.1%, $P < .001$) or prone (39.3% vs 37.9%, $P < .001$) positions. Infants on sofas were less likely than infants in other sleep locations to change from the back or side to prone (10.4% vs

16.5%, $P < .001$) but more likely to move from prone to the back or side (4.0% vs 1.7%, $P < .001$). The sofa was also more likely to be a new or different sleep location for the infant (29.7% vs 13.7%, $P < .0001$).

Pregnancy History

Maternal medical problems during pregnancy and intimate partner violence during pregnancy occurred in 15.8% and 1.0% of the entire study population, respectively, with no significant difference between groups. Maternal tobacco use during pregnancy was present in 25.1% of the study population, with infants on sofas significantly more likely to have prenatal tobacco exposure than infants in other sleep locations (29.9% vs 24.4%,

$P < .001$). Illicit drug use and heavy alcohol use during pregnancy occurred in 7.8% and 1.6% of the study population, respectively; although this proportion was slightly higher among mothers of infants who died on sofas, there were no statistically significant differences between groups. No data were available about environmental tobacco exposure or parental consumption of alcohol or illicit drugs before the last sleep.

Multivariable Analysis (Table 3 and Supplemental Table 4)

After we adjusted for all variables included in the model, deaths on sofas were less likely in Hispanic infants (aOR 0.7; 95% CI, 0.6–0.9) than in non-Hispanic white infants. They were also more likely to be associated with surface sharing (aOR 2.4; 95% CI, 1.9–3.0) but less likely to be associated with objects found in the sleep environment (aOR 0.6; 95% CI, 0.5–0.7), compared with other sleep-related infant deaths. Infants on sofas were more likely to be placed for sleep in the prone (aOR 2.2; 95% CI, 1.3–3.7) or side (aOR 1.4; 95% CI, 1.0–1.8) positions and to be found on the side (aOR 1.9; 95% CI, 1.4–2.4). A new or different sleep location was >6 times more likely if the death occurred on a sofa (aOR 6.5; 95% CI, 5.2–8.2). Infants who died on sofas were more likely to have been exposed to tobacco in utero (aOR 1.4; 95% CI, 1.2–1.6). The cause of death for infants who died on sofas was more likely to be classified as ASSB (OR 1.9; 95% CI, 1.6–2.3) or ill-defined cause of death (aOR 1.2; 95% CI, 1.0–1.5; $P = .05$).

DISCUSSION

It has been well documented that sleeping on a sofa is extremely hazardous for an infant and increases the risk of sudden and unexplained infant death up to 67-fold.^{8,9,15–17} However, this is the first large analysis comparing

TABLE 3 aORs (with 95% CI) of Sleeping on a Sofa at Time of Death (Compared With Not Sleeping on a Sofa)

	aORs ^a	95% CI		P
		Lower Bound	Upper Bound	
Age (mo)				
0–3 mo	0.93	0.80	1.1	.4 (NS)
4–11 mo	Reference			
Gender				
Female	0.9	0.8	1.1	.4 (NS)
Unknown	1.2	0.2	6.1	.8 (NS)
Male	Reference			
Race or ethnicity				
Non-Hispanic black	1.0	0.9	1.2	.9 (NS)
Hispanic	0.7	0.6	0.9	<.01
Other	0.8	0.6	1.1	.2 (NS)
Non-Hispanic white	Reference			
Location				
Other	0.5	0.2	1.1	.07 (NS)
Unknown	0.6	0.1	4.2	.6 (NS)
Child's home	Reference			
Surface sharing				
Yes	2.4	1.9	3.0	<.001
Unknown	2.2	0.9	5.2	.07 (NS)
No	Reference	Reference	Reference	
Any object present in the sleep environment				
Yes	0.6	0.5	0.7	<.001
No	Reference			
Position placed for sleep				
Prone	2.2	1.3	3.7	<.01
Side	1.4	1.0	1.8	<.05
Unknown	1.0	0.7	1.4	.9 (NS)
Supine	Reference			
Position change				
Supine/side to prone	0.9	0.5	1.5	.6 (NS)
Prone to prone	0.8	0.4	1.7	.6 (NS)
Prone to supine or side	0.9	0.4	1.8	.8 (NS)
Unknown	1.0	0.6	1.6	.9 (NS)
Supine or side to supine or side	Reference			
Position found				
Prone	1.4	0.8	2.4	.3 (NS)
Side	1.9	1.4	2.4	<.001
Unknown	1.3	0.8	1.9	.3 (NS)
Supine				
Change in sleep location				
Different location	6.5	5.2	8.1	<.001
Unknown	5.1	4.1	6.2	<.001
Same location	Reference			
Maternal smoking during pregnancy				
Yes	1.4	1.2	1.6	<.001
No	Reference			
Diagnosis of cause of death				
Ill-defined	1.2	1.0	1.5	<.05
ASSB	1.9	1.6	2.3	<.001
SIDS	Reference			

NS, not significant.

^a Adjusted for all variables in the model.

factors associated with infant deaths on sofas with factors associated with other sleep-related infant deaths. This analysis demonstrates that deaths on sofas make up a large proportion of

sleep-related infant deaths. Furthermore, these deaths are significantly more likely, compared with other sleep-related infant deaths, to be associated with surface sharing,

nonsupine placement, being found in the side position, a change in usual sleep location, and in utero tobacco exposure.

The finding of a greater association between sleeping on a sofa and surface sharing may be due in part to the inherent use of this type of furniture. Sofas and similar objects are often shared with others and are meant to be used during waking hours. Sharing a sofa with an infant is becoming increasingly common in some countries²⁴ and may be done to calm or feed the infant, and the parent may inadvertently or intentionally fall asleep with the infant.^{24,25}

It has been assumed that much of the risk associated with sleeping on a sofa results from the soft cushioning and sloping surface of sofas. The American Academy of Pediatrics specifically recommends that infants sleep on a firm, flat surface and that soft cushions and pillows be avoided.¹² The soft surface of most sofas may create rebreathing and a potentially asphyxiating environment for infants, especially if they are placed in a nonsupine position.²⁶ Some sofa surfaces also slope down toward the back cushions, which makes it easier for infants to roll and wedge between the seat and back-supporting surface. In this sample, infants who died on sofas were more likely than those who died on other surfaces to be found in the side position. Sleeping on the side with one's face against the back cushions of the sofa or against another person can result in suffocation.²⁷ Past analyses have found that infant deaths on sofas are usually asphyxia deaths from entrapment between a person and the sofa cushions, overlay by another person, or wedging against the sofa cushions.^{18,28,29} Indeed, the cause of death for infants on sofas in this sample was most frequently classified as ASSB rather than SIDS.

Infants in the sofa group were more likely to be placed in a nonsupine position. The prone and side sleeping positions increase the risk of sudden and unexplained infant death during any sleep, including napping.³⁰ However, caregivers may be less aware or less concerned about the infant's sleeping position if they believe that they will be awake and observing the infant.³¹ Anecdotal data suggest that parents often place their infants on sofas when they will be in the same room and want the infant within sight (R.Y.M., unpublished data). Indeed, a high priority for many parents is to ensure that they can closely monitor their infant, whether the parent is awake or asleep,^{31,32} and this is thought to be best done when the infant is within sight and hearing distance. This may also explain why, when infant deaths occurred on sofas, the sofa was likely to be a new or different sleep location, that is, not the usual location for the infant to sleep. Surveys of sleep location have not found sofas to be a commonly used sleep location for infants.^{32,33} Although we do not have data about time of death, it is possible that many of these infants were placed on a sofa, when this was not a usual sleep location, for naps while the parent was in the same room, or on the parent's chest while the parent was lying down on the sofa. However, it should be noted that a change in sleep environment may be associated with an increased risk of death.³⁴

Maternal tobacco use during pregnancy has been demonstrated to be a major risk factor for SIDS,^{35–38} increasing the risk of SIDS twofold.³⁹ It is unclear why infants who die on sofas are more likely to have mothers who smoke. However, this is consistent with Ball and colleagues'⁴⁰ findings that sleeping with an infant on a sofa was 79% more likely if the mother was a smoker. It may be that those who

place infants in an unsafe sleep environment are also less informed about other SIDS risk factors, such as prenatal maternal tobacco use. Smoking is also more common among low-income women,⁴¹ and lower-income families are, in general, at higher risk of sleep-related infant deaths.³

This study has several limitations. Despite being a large database, the CDR-CRS does not include child deaths from all states or all child deaths within a state, because participation in the case reporting system is voluntary and not all child deaths are reviewed.¹⁹ Thus, the CDR-CRS is not a comprehensive population-based database, nor does it contain comparison data for nonaffected infants. As a result, it is impossible to determine an appropriate denominator for the deaths included in the study.²⁰ Second, despite its definitions of variables and a standardized reporting system, the quality of the data varies between states because of differences in reporters and failure to routinely access the data dictionary. In addition, some variables have large proportions of missing data, which was found to be more likely with novice reporters and decreased with time.¹⁹ Consequently, data were imputed to account for missing values. It should also be noted that these deaths included all sleep-related infant deaths, including those for which the sleep surface was unknown. Other studies that have examined deaths on sofas have been epidemiologic analyses of SIDS deaths.^{8,9,13–15} Because there has recently been a shift in how the cause of death is coded for sudden and unexpected infant deaths in the United States,⁷ we chose to examine all deaths occurring suddenly and unexpectedly. Nonetheless, we acknowledge that this encompasses deaths from causes that are both explained (eg, accidental suffocation) and unexplained (ill-defined and SIDS). This

implies that there may be >1 mechanism of death on sofas. Finally, the information available about the final sleep of these infants is limited compared with observational case-control studies and does not include socioeconomic status or specific circumstances, such as who was on the sofa with the infant, whether they were sleeping, whether they intended to sleep with the infant, and whether any alcohol or sleep-inducing drugs were consumed before the death.

Despite its limitations, the CDR-CRS has numerous strengths. The database captures a wealth of critical information on child deaths and houses it in 1 location.¹⁹ Additionally, the CDR-CRS is continually growing as new states begin to participate in the review process,¹⁹ thereby expanding the data available for analysis. The expanding database and improvement in data quality will enable the CDR-CRS to broaden its ability to identify risk factors and elucidate the circumstances surrounding all types of child deaths.

CONCLUSIONS

Infant deaths occurring on sofas make up a large proportion of sleep-related infant deaths. They are more likely to be associated with nonsupine placement for sleep, being found in the side position, surface sharing, changes in sleep environment, and in utero tobacco exposure, compared with other sleep-related infant deaths in the CDR-CRS database. These results may help explain why sofa sleeping is hazardous for infants. Although it is unclear why deaths on sofas are associated with these factors, these data indicate that many parents and caregivers may consider the sofa to be a safe environment in which the infant can sleep while remaining within sight and hearing range. Given that the risk of death for infants sleeping on sofas is so

high, it is important that parents and caregivers be educated about safe sleep guidelines in general and, more specifically, the dangers of placing infants for sleep on sofas and similar surfaces and sharing these surfaces with an infant.

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