ARTICLE

Use of a Fan During Sleep and the Risk of Sudden Infant Death Syndrome

Kimberly Coleman-Phox, MPH; Roxana Odouli, MSPH; De-Kun Li, MD, PhD

Objective: To examine the relation between room ventilation during sleep and risk of sudden infant death syndrome (SIDS).

Design: Population-based case-control study.

Setting: Eleven California counties.

Participants: Mothers of 185 infants with a confirmed SIDS diagnosis and 312 randomly selected infants matched on county of residence, maternal race/ethnicity, and age.

Intervention: Fan use and open window during sleep.

Main Outcome Measure: Risk of SIDS.

Results: Fan use during sleep was associated with a 72% reduction in SIDS risk (adjusted odds ratio [AOR], 0.28; 95% confidence interval [CI], 0.10-0.77). The reduction in SIDS risk seemed more pronounced in adverse sleep environments. For example, fan use in warmer room temperatures was associated with a greater reduction in SIDS risk (AOR, 0.06; 95% CI, 0.01-0.52) compared with cooler room temperatures (0.77; 0.22-2.73). Similarly, the reduction associated with fan use was greater in infants placed in the prone or side sleep position (AOR, 0.14; 95% CI, 0.03-0.55) vs supine (0.84; 0.21-3.39). Fan use was associated with a greater reduction in SIDS risk in infants who shared a bed with an individual other than their parents (AOR, 0.15; 95% CI, 0.01-1.85) vs with a parent (0.40; 0.03-4.68). Finally, fan use was associated with reduced SIDS risk in infants not using pacifiers (AOR, 0.22; 95% CI, 0.07-0.69) but not in pacifier users (1.99; 0.16-24.4). Some differences in the effect of fan use on SIDS risk did not reach statistical significance.

Conclusion: Fan use may be an effective intervention for further decreasing SIDS risk in infants in adverse sleep environments.

Arch Pediatr Adolesc Med. 2008;162(10):963-968

Author Affiliations: Division of Research, Kaiser Permanente Northern California, Oakland (Mss Coleman-Phox and Odouli and Dr Li); and University of California, Berkeley, School of Public Health, Berkeley (Ms Coleman-Phox).

DESPITE A 56% DECREASE IN the national incidence of sudden infant death syndrome (SIDS) from 1.2 deaths per 1000 live births in 1992[1] to 0.53 death per 1000 live births in 2003,[2] SIDS continues to be the leading cause of postneonatal mortality in the United States.[3] The decreased rate of SIDS is largely attributed to the increased use of the supine sleep position after the introduction of the "Back to Sleep" campaign in 1994.[4-7] More recently, it has been suggested that the decrease in the SIDS rate has leveled off coincident with a plateau in the uptake of the supine sleep position.[8] Although caretakers should continue to be encouraged to place infants on their backs to sleep, other potentially modifiable risk factors in the sleep environment should be examined to promote further decline in the rate of SIDS. The increased risk of SIDS associated with overheating, a soft sleep surface, and soft bedding has been publicized through the Back to Sleep campaign, but the relation between room ventilation and SIDS risk has received scant attention.

Rebreathing exhaled carbon dioxide trapped near an infant's airway by bedding has been suggested as a possible mechanism for the occurrence of SIDS in at-risk infants and may occur with the use of soft bedding, covering the head during sleep, and use of the prone sleep position.[9-12] Inadequate ventilation might facilitate pooling of carbon dioxide around a sleeping infant's mouth and nose and might increase the likelihood of rebreathing.[13,14] Increased movement of air in the room of a sleeping infant may potentially decrease the accumulation of carbon dioxide around the infant's nose and mouth and reduce the risk of rebreathing.[10] A recent study[15] showing a significantly reduced risk of SIDS associated with pacifier use further supports the importance of rebreathing as a risk factor for SIDS. One explanation for the protective effect of the pacifier is that the external handle may help to maintain air passages in sleep environments with decreased air flow, such as sleeping with the head covered or on soft bedding. To examine whether improved room ventilation by use of a fan or an open window affects the risk of SIDS, we analyzed data from a population-

based case-control study of risk factors for SIDS that included detailed information on sleep environment.

METHODS

We conducted this population-based case-control study in 11 California counties (Alameda, Contra Costa, Sacramento, San Francisco, Marin, San Mateo, Santa Clara, Monterey, San Joaquin, Fresno, and Los Angeles) between May 1, 1997, and April 30, 2000. Detailed information about the identification and selection of cases and controls and data collection procedures is available elsewhere.[16] Briefly, SIDS cases were identified from all infant deaths reported to the California Department of Health Services and to the Los Angeles County coroner's office with a diagnosis of SIDS or presumed SIDS during the study period. California law requires the use of a standard protocol to ensure that all cases with a final diagnosis of SIDS meet the diagnostic criteria of "sudden death of an infant under 1 year of age, which remains unexplained after a thorough case investigation, including performance of a complete autopsy, examination of the death scene, and a review of the clinical history."[17(p681)] Only mothers of infants with a final diagnosis of SIDS who lived in one of the participating counties and spoke English or Spanish were eligible to participate as cases in the study.

As soon as we received information on newly diagnosed SIDS cases, we sent letters to mothers of eligible cases, explaining the purpose of the study and inviting their participation. Before attempting to speak with case mothers directly, we first contacted public health nurses, who are required by law to counsel families who have experienced a SIDS death, to ascertain any other pertinent information about the family. Study interviewers then contacted case mothers by home visit or telephone and scheduled in-person interviews with mothers who agreed to participate.

Of the 396 eligible cases, we could not locate 25.0% of case mothers (n=99), another 12.9% (n=51) refused to participate, and 11.6% (n=46) agreed to participate but did not complete the study interview. Three additional cases were not interviewed owing to administrative error. Of the 197 eligible participating cases, 12 infants who died in foster care were excluded from the analysis because the prenatal history of the biological mother was not available.

Eligible controls were identified from birth certificates issued in the 11 counties where cases resided and were matched to cases on county of residence, maternal race/ethnicity (white, black, Latina, Asian, and other), and infant age (age at death for cases and age at the time of interview for controls, ±2 weeks). Study controls were randomly selected from among eligible controls only for cases with completed study interviews. Of the 756 eligible controls, we could not locate 32.0% of control mothers (n=242), 18.9% (n=143) refused to participate, and 7.8% (n=59) did not complete the study interview despite initially agreeing to participate. A total of 185 SIDS cases and 312 controls were included in the analysis.

Data regarding sleep environment and potential confounding factors, such as sociodemographic characteristics, maternal prenatal history, and infant medical history, were obtained through in-person interviews of mothers of case and control infants. In addition to questions regarding fan use and open windows in the room at the infant's last sleep, mothers were asked about room location, sleep surface, number and type of covers over the infant, bedding under the infant, and room temperature. Interviewers specifically trained in SIDS grief counseling conducted all the study interviews. Date of infant death was the reference date for cases, and questions regarding sleep environment referred to the last period of sleep on that date. The median time between date of death and case interview was 3.8 months (range, <1-20 months). The date of interview was the reference date for controls, and sleep during the previous night was referred to as the last sleep for controls. This study was approved by the institutional review boards of Kaiser Permanente in Northern and Southern California and by the California State Committee for the Protection of Human Subjects.

Using unconditional logistic regression, we estimated adjusted odds ratios (AORs) and 95% confidence intervals (CIs) to examine the relationship between room ventilation at last sleep and risk of SIDS after adjustment for potential confounders. We also examined other characteristics of the sleep environment that might modify the association between room ventilation and SIDS risks in stratified analysis. Matching variables (maternal race/ethnicity, infant age at last sleep, birth year, and region) were included in all the models. All the analyses were conducted using a statistical software program (SAS version 9.1).[18]

RESULTS

Cases and controls were similar in terms of race/ethnicity, infant age at the reference date, and region of residence as a result of matching (**Table 1**). However, cases and controls differed in the distribution of other characteristics known to be associated with increased SIDS risk (Table 1). Case mothers were more likely to be young (<25 years), unmarried, and multiparous and were less likely to have completed high school compared with control mothers. Smoking during pregnancy and initiating prenatal care after the first trimester were also more prevalent in mothers of cases than in mothers of controls. Compared with controls, cases were significantly more likely to have had a low birth weight (<2500 g), be preterm (<37 weeks' gestation), and be ill with a fever during the 48 hours before the last sleep. At the last sleep, more cases than controls were placed on their stomachs or sides, did not use a pacifier, were found with bedding or clothing covering the head, slept on a soft surface, and shared a bed with someone other than a parent. Cases were also more likely than controls to have regular smoking in the home post partum. There were no differences between the groups in the use of soft bedding underneath the infant or room temperature at last sleep.

Table 2 displays the relation between having a fan on or a window open in the room at last sleep and the risk of SIDS. After adjusting for matching variables, known risk factors, and other potential confounders, having a fan on in the room during the last sleep was associated with a 72% reduction in the risk of SIDS (AOR, 0.28; 95% CI, 0.10-0.77) compared with sleeping in a room without a fan. Sleeping in a room with an open window was also associated with reduced SIDS risk, although the association did not reach statistical significance.

To further investigate whether other characteristics of the sleep environment might affect the association between fan use and the risk of SIDS, we examined room temperature, open window status, the infant's last sleep position, with whom the infant shared a bed, and use of a pacifier during the last sleep (**Table 3**). The effect of fan use on the reduction of SIDS risk seemed to be consistently greater when infants were in adverse sleep environments. For example, when the room temperature was warmer (>21°C), fan use was associated with a 94% decreased risk of SIDS (AOR, 0.06; 95% CI, 0.01-0.52)

Table 1. Characteristics of the Study Population

Characteristic	Cases, No. (%)[a] (n=185)	Controls, No. (%)[a] (n=312)	AOR (95% CI)[b]
Maternal Characteristics			
Race/ethnicity			
White	59 (31.9)	119 (38.1)	1 [Reference]
Black	34 (18.4)	59 (18.9)	0.96 (0.52-1.76)
Latina	61 (33.0)	98 (31.4)	1.22 (0.67-2.19)
Other	31 (16.8)	36 (11.5)	2.23 (1.13-4.39)
Age, y			
<20	25 (13.5)	27 (8.7)	1.80 (0.88-3.70)
20-24	55 (29.7)	54 (17.3)	1.86 (1.12-3.09)
≥25	105 (56.8)	231 (74.0)	1 [Reference]
Education, y			
≤12	113 (61.1)	141 (45.2)	1.31 (0.81-2.13)
>12	72 (38.9)	171 (54.8)	1 [Reference]
Marital status			
Married	93 (50.3)	206 (66.0)	1 [Reference]
Cohabiting	61 (33.0)	72 (23.1)	1.49 (0.87-2.52)
Single	31 (16.8)	34 (10.9)	1.79 (0.93-3.47)
Region of California			
Northern	115 (62.2)	211 (67.6)	1 [Reference]
Southern	70 (37.8)	101 (32.4)	1.07 (0.68-1.68)
Parity (before index birth)			
0	57 (30.8)	132 (42.3)	1 [Reference]
1	69 (37.3)	96 (30.8)	1.51 (0.91-2.51)
2	32 (17.3)	52 (16.7)	1.46 (0.77-2.80)
≥3	27 (14.6)	32 (10.3)	2.16 (1.02-4.59)
Smoked during pregnancy			
No	137 (74.5)	265 (85.2)	1 [Reference]
Yes	47 (25.5)	46 (14.8)	1.91 (1.14-3.28)
Weeks of gestation at first prenatal visit			
<12	120 (65.6)	238 (77.8)	1 [Reference]
≥12	63 (34.4)	68 (22.2)	1.59 (1.00-2.53)
Infant Characteristics			
Age, mo			
<2	45 (24.3)	62 (19.9)	1.57 (0.87-2.81)
2-3	90 (48.7)	155 (49.7)	1.08 (0.66-1.76)
≥4	50 (27.0)	95 (30.4)	1 [Reference]
Birth weight, g			
≥2500	148 (81.8)	297 (95.5)	1 [Reference]
<2500	33 (18.2)	14 (4.5)	4.90 (2.34-10.26)
Health during the previous 48 h			
No illness	107 (58.5)	196 (62.8)	1 [Reference]
Sick, no fever	67 (36.6)	109 (34.9)	1.20 (0.78-1.85)
Sick, with fever	9 (4.9)	7 (2.2)	2.6 (0.84-8.03)
Premature (<37-wk gestation)			
No	150 (81.1)	287 (92.0)	1 [Reference]
Yes	35 (18.9)	25 (8.0)	2.96 (1.58-5.54)
Sleep Environment			
Last sleep position			
On back	52 (31.1)	175 (56.1)	1 [Reference]
On stomach or side	115 (68.9)	137 (43.9)	2.74 (1.79-4.21)
Used a pacifier			
No	162 (95.9)	236 (76.4)	1 [Reference]
Yes	7 (4.1)	73 (23.6)	0.10 (0.04-0.23)
Room temperature, °C			
≤21	96 (69.1)	176 (61.5)	1 [Reference]
>21	43 (30.9)	110 (38.5)	0.65 (0.40-1.06)
Soft bedding under infant			
No	125 (76.2)	250 (80.4)	1 [Reference]
Yes	39 (23.8)	61 (19.6)	0.95 (0.57-1.59)
Soft sleep surface			
No	153 (87.9)	289 (93.2)	1 [Reference]
Yes	21 (12.1)	21 (6.8)	1.36 (0.68-2.71)
Covers over head			
No	147 (88.6)	297 (95.5)	1 [Reference]
Yes	19 (11.4)	14 (4.5)	3.13 (1.40-7.02)
Bed-sharing status			
Slept alone	103 (59.9)	195 (67.2)	1 [Reference]
Slept with parent(s) only	45 (26.2)	79 (27.2)	1.01 (0.61-1.68)
Slept with nonparent(s)[c]	24 (14.0)	16 (5.5)	2.86 (1.35-6.07)
Regular smoking in home post partum			
No	164 (89.1)	291 (94.2)	1 [Reference]
Yes	20 (10.9)	18 (5.8)	1.50 (0.68-3.31)

Abbreviations: AOR, adjusted odds ratio; CI, confidence interval.
[a] Adjusted for race/ethnicity, maternal age, education, region, smoking during pregnancy, infant age, birth year, and last sleep position, unless the variable itself was the exposure of interest. Maternal race/ethnicity, infant age at last sleep, and region are matching variables.
[b] Numbers in columns may not sum to total numbers owing to missing data.
[c] Presence of another individual(s) with or without a parent(s).

(continued)

compared with no fan use. In contrast, in a room with a cooler temperature (≤21°C), fan use remained associated with reduced SIDS risk but to a lesser extent, and the reduction was no longer significant (AOR, 0.77; 95% CI, 0.22-2.73). Similarly, having a fan on was associated with a greater reduction in SIDS risk when windows in the room where the infant last slept were closed (AOR, 0.15; 95% CI, 0.03-0.71) compared with the room where there were open windows (0.73; 0.17-3.08). The effect of fan use on reduction in SIDS risk was also greater for infants who slept in the prone or side position (less safe) (AOR, 0.14; 95% CI, 0.03-0.55) than for infants who slept on their backs (0.84; 0.21-3.39) (Table 3). The decrease in SIDS risk associated with fan use was also larger in infants who shared a bed with someone other than their parents (AOR, 0.15; 95% CI, 0.01-1.85) compared with infants who shared a bed with a parent only (0.40; 0.03-4.68). Finally, fan use in infants who did not use a pacifier was associated with an 88% reduction in SIDS risk (AOR, 0.22; 95% CI, 0.07-0.69), whereas fan use was no longer associated with a reduction in SIDS risk in infants who used a pacifier at the last sleep (1.99; 0.16-24.4). The difference in the magnitude of the effect of fan use between warmer and cooler room temperatures was significant ($P=.03$ for the interaction term), whereas the differences in open window status, sleep position, bed sharing, and pacifier use did not reach significance ($P=.13$, $P=.08$, $P=.59$, and $P=.16$, respectively).

COMMENT

Previous studies[10-12,19-21] have suggested that, in sleep environments with limited dispersion of exhaled gases, rebreathing is a possible mechanism for SIDS. In the present

Table 2. Use of a Fan or Having a Window Open in Relation to SIDS Risk[a]

Characteristic	Cases, No. (%) (n=185)	Controls, No. (%) (n=312)	AOR (95% CI)[b]
Fan on in room at last sleep			
No	161 (96.4)	273 (88.3)	1 [Reference]
Yes	6 (3.6)	36 (11.7)	0.28 (0.10-0.77)
Window open in room at last sleep			
No	136 (84.0)	232 (75.1)	1 [Reference]
Yes	26 (16.0)	77 (24.9)	0.64 (0.33-1.21)

Abbreviations: AOR, adjusted odds ratio; CI, confidence interval; SIDS, sudden infant death syndrome.
[a] Numbers in columns may not sum to total numbers owing to missing data.
[b] Adjusted for race/ethnicity, maternal age, education, region, smoking during pregnancy, infant age, birth year, last sleep position, marital status, parity, weeks of gestation at first prenatal care visit, birth weight, gestational age, and room temperature. Further adjustment for seasonality and other variables listed in Table 1 did not change the results.

Table 3. Effect of Fan Use on SIDS Risk by Sleep Environment[a]

Characteristic	Cases, No. (%) (n=185)	Controls, No. (%) (n=312)	AOR (95% CI)[b]
Room temperature			
≤21°C at last sleep			
No fan	91 (94.8)	163 (93.1)	1 [Reference]
Fan on	5 (5.2)	12 (6.9)	0.77 (0.22-2.73)
>21°C at last sleep			
No fan	41 (97.6)	88 (80.0)	1 [Reference]
Fan on	1 (2.4)	22 (20.0)	0.06 (0.01-0.52)
Window closure			
Room with window closed at last sleep			
No fan	132 (98.5)	211 (90.9)	1 [Reference]
Fan on	2 (1.5)	21 (9.1)	0.15 (0.03-0.71)
Room with window open at last sleep			
No fan	22 (84.6)	62 (80.5)	1 [Reference]
Fan on	4 (15.4)	15 (19.5)	0.73 (0.17-3.08)
Sleep position			
Placed on back at last sleep			
No fan	48 (94.1)	156 (90.2)	1 [Reference]
Fan on	3 (5.9)	17 (9.8)	0.84 (0.21-3.39)
Placed prone or on side at last sleep			
No fan	108 (97.3)	117 (86.0)	1 [Reference]
Fan on	3 (2.7)	19 (14.0)	0.14 (0.03-0.55)
Bed sharing			
Slept alone at last sleep			
No fan	93 (96.9)	169 (86.7)	1 [Reference]
Fan on	3 (3.1)	26 (13.3)	0.23 (0.06-0.90)
Slept with a parent(s) only at last sleep			
No fan	44 (97.8)	75 (94.9)	1 [Reference]
Fan on	1 (2.2)	4 (5.1)	0.40 (0.03-4.68)
Slept with a nonparent(s) at last sleep[c]			
No fan	22 (95.7)	11 (68.8)	1 [Reference]
Fan on	1 (4.3)	5 (31.3)	0.15 (0.01-1.85)
Pacifier use			
Used pacifier at last sleep			
No fan	6 (85.7)	65 (89.0)	1 [Reference]
Fan on	1 (14.3)	8 (11.0)	1.99 (0.16-24.4)
No pacifier used at last sleep			
No fan	153 (96.8)	206 (88.0)	1 [Reference]
Fan on	5 (3.2)	28 (12.0)	0.22 (0.07-0.69)

Abbreviations: AOR, adjusted odds ratio; CI, confidence interval; SIDS, sudden infant death syndrome.
[a] Numbers in columns may not sum to total numbers owing to missing data.
[b] Adjusted for race/ethnicity, maternal age, education, region, smoking during pregnancy, infant age, birth year, last sleep position, marital status, parity, weeks of gestation at first prenatal care visit, birth weight, gestational age, and room temperature, unless the variable itself was the modifier examined. Further adjustment for seasonality and other variables listed in Table 1 did not change the results.
[c] Presence of another individual(s) with or without a parent(s).

population-based case-control study, fan use during the last sleep was associated with a statistically significant reduction in SIDS risk. Although the exact underlying mechanism of the observed association is not yet known, this finding is consistent with the hypothesis that reducing rebreathing may reduce the risk of SIDS. It has been reported that increasing the air turbulence with a fan could prevent the accumulation of carbon dioxide in a mechanical model of infant rebreathing.[10] Thus, it is conceivable that increasing room ventilation by using a fan helps to disperse accumulated carbon dioxide in the dead air space around the nose and mouth of infants in sleep environments that heighten the risk of rebreathing. We are not aware of any previous studies of such an association; thus, this finding provides the first epidemiologic evidence of the benefit of fan use in reducing SIDS risk. The findings that the effect of fan use on reduction in SIDS risk was consistently greater in adverse sleep environments (high temperature, prone sleep position, closed windows, bed sharing with a nonparent, and no pacifier use) provide additional support for the argument that the mechanism of the reduction in SIDS risk associated with fan use is likely through mitigation of an adverse sleep environment, most likely by reducing rebreathing.

The limitations of this study include possible selection bias and recall bias. Participation was relatively low, with 50% of eligible cases and 41% of eligible controls completing the study interview. To the extent that the rate of fan use was different between participants and nonparticipants and was related to case or control status, these results may be biased. Although we could not find estimates of fan use in the US population, we examined the potential selection bias by evaluating characteristics associated with SIDS risks in study participants and nonparticipants in a previously published article.[16] Using California birth certificate data, we compared the ORs for maternal age, maternal education, parity, birth weight, infant sex, and late initiation of prenatal care (>5 months' gestation). Except for male sex, which was not a risk factor in study participants, the ORs obtained from participants were similar to those obtained from all eligible cases and controls, providing no evidence of a noticeable selection bias.

Differences between cases and controls in accuracy of recall could be responsible for the decreased SIDS risk associated with fan use. The median length of time between infant death and interview was 3.8 months for cases, and the reference date for controls was the last sleep before the interview. A protective association could be observed if cases were more likely than controls to underreport fan use. To assess this potential bias we examined whether cases with longer recall intervals might report fan use less often than cases interviewed closer to the date of infant death. Fan use was reported by 5.0% of cases with recall intervals less than or equal to the median of 116 days compared with 2.3% of cases with recall intervals greater than 116 days; the difference was not significant. In addition, assuming that cases with longer recall intervals had the same frequency of fan use as cases with shorter intervals (ie, 5.0%), fan use remains strongly associated with a reduction in SIDS risk (OR, 0.38; 95% CI, 0.15-0.86).

The results of this study suggest that using a fan may be an effective intervention for lowering the risk of SIDS in sleeping environments that facilitate rebreathing. It is particularly encouraging that fan use may be protective in infants who sleep in the prone position. Despite the simplicity and effectiveness of the supine sleep position in lowering SIDS risk, 24.4% of care providers do not regularly place infants on their backs to sleep.[22] Use of the prone sleep position remains highest in care providers who are young, black, or of low income or who have low educational attainment. In this study, the frequency of fan use was similar in young and less educated women as in other women; thus, fan use can be easily adopted by these populations. Although improving the methods used to convey the importance of the supine sleep position remains paramount, use of a fan in the room of a sleeping infant may be an easily available means of further reducing SIDS risk that can be readily accepted by care providers from a variety of social and cultural backgrounds.

Accepted for Publication: March 1, 2008.
Correspondence: De-Kun Li, MD, PhD, Division of Research, Kaiser Permanente Northern California, 2000 Broadway, Fifth Floor, Oakland, CA 94612 (dkl@dor.kaiser.org).
Author Contributions: Dr Li had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. *Study concept and design:* Li. *Acquisition of data:* Odouli and Li. *Analysis and interpretation of data:* Coleman-Phox and Li. *Drafting of the manuscript*: Coleman-Phox. *Critical revision of the manuscript for important intellectual content:* Odouli and Li. *Obtained funding:* Li. *Administrative, technical, and material support:* Coleman-Phox and Odouli. *Study supervision:* Li.
Financial Disclosure: None reported.
Funding/Support: This project was supported by contract N01-HD-5-3227 from the National Institute of Child Health and Human Development and the National Institute on Deafness and Other Communication Disorders. Additional support was provided by a Kaiser CHR Fellowship.

REFERENCES

1. Kochanek KD, Hudson BL. Advance report of final mortality statistics, 1992. *Mon Vital Stat Rep.* 1995;43(6)(suppl):1-75. http://www.cdc.gov/nchs/data/mvsr/supp/mv43_06s.pdf. Accessed August 10, 2007.
2. Mathews TJ, MacDorman MF. Infant mortality statistics from the 2003 period linked birth/infant death data set. *Natl Vital Stat Rep.* 2006;54(16):1-29.
3. Heron MP, Smith BL. Deaths: leading causes for 2003. *Natl Vital Stat Rep.* 2007; 55(10):1-92.
4. Centers for Disease Control and Prevention. Progress in reducing risky infant sleeping positions—13 states, 1996-1997. *MMWR Morb Mortal Wkly Rep.* 1999; 48(39):878-882.
5. Pollack HA, Frohna JG. Infant sleep placement after the back to sleep campaign. *Pediatrics.* 2002;109(4):608-614.
6. Willinger M, Hoffman HJ, Wu KT, et al. Factors associated with the transition to nonprone sleep positions of infants in the United States: the National Infant Sleep Position Study. *JAMA.* 1998;280(4):329-335.
7. Willinger M, Ko CW, Hoffman HJ, Kessler RC, Corwin MJ. Factors associated with caregivers' choice of infant sleep position, 1994-1998: the National Infant Sleep Position Study. *JAMA.* 2000;283(16):2135-2142.
8. American Academy of Pediatrics Task Force on Sudden Infant Death Syndrome.

The changing concept of sudden infant death syndrome: diagnostic coding shifts, controversies regarding the sleeping environment, and new variables to consider in reducing risk. *Pediatrics*. 2005;116(5):1245-1255.
9. Kemp JS. Rebreathing of exhaled gases: importance as a mechanism for the causal association between prone sleep and sudden infant death syndrome. *Sleep*. 1996; 19(10)(suppl):S263-S266.
10. Skadberg BT, Oterhals A, Finborud K, Markestad T. CO_2 rebreathing: a possible contributory factor to some cases of sudden infant death? *Acta Paediatr*. 1995; 84(9):988-995.
11. Kemp JS, Nelson VE, Thach BT. Physical properties of bedding that may increase risk of sudden infant death syndrome in prone-sleeping infants. *Pediatr Res*. 1994;36(1, pt 1):7-11.
12. Bolton DP, Taylor BJ, Campbell AJ, Galland BC, Cresswell C. Rebreathing expired gases from bedding: a cause of cot death? *Arch Dis Child*. 1993;69(2):187-190.
13. Corbyn JA. Sudden infant death due to carbon dioxide and other pollutant accumulation at the face of a sleeping baby. *Med Hypotheses*. 1993;41(6):483-494.
14. Corbyn JA. Mechanisms of sudden infant death and the contamination of inspired air with exhaled air. *Med Hypotheses*. 2000;54(3):345-352.
15. Li DK, Willinger M, Petitti DB, Odouli R, Liu L, Hoffman HJ. Use of a dummy (pacifier) during sleep and risk of sudden infant death syndrome (SIDS): population based case-control study. *BMJ*. 2006;332(7532):18-22.
16. Li DK, Petitti DB, Willinger M, et al. Infant sleeping position and the risk of sudden infant death syndrome in California, 1997-2000. *Am J Epidemiol*. 2003; 157(5):446-455.
17. Willinger M, James LS, Catz C. Defining the sudden infant death syndrome (SIDS): deliberations of an expert panel convened by the National Institute of Child Health and Human Development. *Pediatr Pathol*. 1991;11(5):677-684.
18. *SAS Statistical Analysis Software* [computer program]. Version 9.1. Cary, NC: SAS Institute Inc; 2002-2003.
19. Campbell AJ, Bolton DP, Williams SM, Taylor BJ. A potential danger of bedclothes covering the face. *Acta Paediatr*. 1996;85(3):281-284.
20. Chiodini BA, Thach BT. Impaired ventilation in infants sleeping facedown: potential significance for sudden infant death syndrome. *J Pediatr*. 1993;123 (5):686-692.
21. Skadberg BT, Markestad T. Consequences of getting the head covered during sleep in infancy. *Pediatrics*. 1997;100(2):E6.
22. The usual position in which mothers place their babies to sleep: data from the national NISP telephone survey for years 1992-2005. March 29, 2006; National Infant Sleep Position study data. http://dccwww.bumc.bu.edu/ChimeNisp/Tables_in_PDF/NISP%201992-2006%20The%20usual%20sleep%20position.pdf. Accessed July 22, 2007.