

# Sleep Environment Risk Factors for Sudden Infant Death Syndrome: The German Sudden Infant Death Syndrome Study

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## What's Known on This Subject

A number of case-control studies in the late 1980s and early 1990s identified prone sleeping as a major risk factor for SIDS. Following advice to put infants only on their back for sleeping, the rates in all developed countries for SIDS have decreased dramatically.

## What This Study Adds

This study has identified several novel risk factors for SIDS: an increased risk occurred if the infants slept outside the parental home or in the living room, and a high risk occurred if the infants were placed prone on a sheepskin.

## ABSTRACT

**OBJECTIVE.** Our goal was to investigate the risk factors for sudden infant death syndrome in the infants' sleep environment for a population in which few infants sleep prone as a result of education campaigns.

**METHODS.** This was a population-based sudden infant death syndrome case-control study over 3 years (1998–2001) in Germany.

**RESULTS.** There were 333 sudden infant death syndrome cases and 998 matched controls. Although only 4.1% of the infants were placed prone to sleep, those infants were at a high risk of sudden infant death syndrome. Those who were unaccustomed to sleeping prone were at very high risk, as were those who turned to prone. Bed sharing (especially for infants younger than 13 weeks); duvets; sleeping prone on a sheepskin; sleeping in the house of a friend or a relative (compared with sleeping in the parental home); and sleeping in the living room (compared with sleeping in the parental bedroom) increased the risk for sudden infant death syndrome; pacifier use during the last sleep was associated with a significantly reduced risk of sudden infant death syndrome.

**CONCLUSIONS.** This study has clarified the risk factors for sudden infant death syndrome in a population where few infants sleep prone. This study supports the current recommendations of the American Academy of Pediatrics. This study has identified several novel risk factors for sudden infant death syndrome: an increased risk if the infants sleeps outside the parental home, death in the living room, and the high risk when sleeping prone on a sheepskin; however, because the numbers of cases in these groups are small, additional studies are needed to confirm these findings. *Pediatrics* 2009;123:1162–1170

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### Key Words

bed sharing, environmental factors, SIDS, sleep position

### Abbreviations

SIDS—sudden infant death syndrome  
GeSID—German SIDS Study  
SES—socioeconomic status  
OR—odds ratio  
CI—confidence interval  
aOR—adjusted odds ratio  
df—degree(s) of freedom

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**T**HE SUDDEN AND unexplained death of a seemingly healthy child is still the leading cause of death in most developed countries after the first month of life and to the end of the first year of life. The majority of these infant deaths are certified as sudden infant death syndrome (SIDS). In 2005 in Germany 298 infants died of SIDS (0.4/1000 live births), emphasizing the continued importance of this disorder. The number of SIDS deaths in the United States in 2005 was 2230 (0.54 of 1000 live births).<sup>1</sup>

A number of case-control studies in the late 1980s and early 1990s identified prone sleeping position as a major risk factor for SIDS.<sup>2–4</sup> This led to the recommendation to avoid the prone sleeping position (“Back to Sleep” campaign), which was followed by a substantial fall in SIDS mortality in many countries.<sup>5–7</sup> In Germany the rate in 1990 was 1.5 per 1000 live birth and dropped after a local campaign in North Rhein-Westfalia. After this success additional advice about other infant care practices has been given, although the specific recommendations vary from country to country.<sup>8–12</sup> Current SIDS prevention recommendations in Germany are supine sleeping position, in the parental bedroom, in a crib, and in a sleeping sack.<sup>13</sup> The evidence supporting some of the recommendations is

limited.<sup>14</sup> Furthermore many of the recommendations were derived from studies conducted when many infants were sleeping prone.

The German SIDS Study (GeSID) was implemented to identify risk factors for SIDS with a special emphasis on the sleep environment. It was conducted after the major reduction in SIDS mortality when few infants were sleeping prone. We have previously reported on the major risk factors for SIDS in Germany.<sup>15</sup> From this study we report the sleep environment in more detail.

## METHODS

The GeSID study was a population-based case-control study conducted between 1998 and 2001 in an area of Germany in which ~50% of births occur. There were 2.3 million live births in the study region over the 3 years of the study. In the 3 years 333 SIDS cases were recruited and matched with 998 control infants for age, gender, region, and sleep time. The controls were recruited from the same vital registration office the case was registered with. (In Germany every town and county has 1 or several vital registration offices, where every citizen has to be registered). Control infants were born 4 to 6 weeks after the case infant, so that by the time the interviews were performed, they had the same age as the index case ( $\pm 2$  weeks). If 1 control family refused to participate another family was recruited. If more than 3 control families agreed to participate, the 3 controls with the best age matching were chosen.

A detailed questionnaire was filled in with the parents by a trained interviewer in the parents' homes. During the first contact with the parents the likely time of death was established, morning sleep, afternoon sleep, evening sleep, or night sleep. This information was then used to determine the time of the reference sleep for the control infants. The sleep environmental questions were the same for cases and controls. For cases the last sleep determined as the sleep period during the infant died and the control parents were asked about the reference sleep. Questions included previous illnesses of the child, feeding of the infant, previous sleep arrangements, and sleep environment of the child during the last sleep for cases or reference sleep for controls.

All cases were autopsied by forensic pathologists using a standardized protocol including histology, microbiology, virology, toxicology, and neuropathology examination. A multidisciplinary panel decided whether this case was a SIDS or an explained sudden unexpected death in infancy. Details on case and control recruitment were reported previously.<sup>15,16</sup> Response rate of the cases was 82.4%, whereas the response rate of the controls was 58.7%.

All data were entered onto a database and analyzed with SAS 9.1 (SAS Institute, Inc, Cary, NC). Univariate and multivariate analyses were conducted using conditional logistic regression. In the multivariate analysis, we controlled for the following variables: (1) for the analysis of the reference sleep, maternal smoking in pregnancy, maternal family status, maternal age at delivery, socioeconomic status of the family (socioeconomic status [SES] was calculated by using school education, present work position, and income), previous live births, birth

weight of the infant, not breastfeeding for at least the first 2 weeks of life, bed sharing in the last night, pillow in the infants bed, additional heating during the last sleep (a hot water bottle in the infants bed or the bed in front of a heater), position place to sleep, pacifier use during the last sleep; and (2) for the usual sleep environment (previous 4 weeks), the same variables but replacing bed sharing and pacifier use during the last sleep with the usual practice in the last 4 weeks.

The study had the ethical approval of each ethics committee of each university and state institute for legal medicine. The data protection officer for each participating federal state approved the study.

## RESULTS

### Last Sleep

The univariate and multivariate odds ratios (ORs) and 95% confidence intervals (CIs) for factors of the sleep environment during the last sleep is shown in Table 1. The risk of SIDS was significantly higher when the infant slept in a friend's or relative's accommodation compared with sleeping in the parental home (adjusted OR [aOR]: 4.39 [95% CI: 1.11–17.38]). Compared with sleeping in the parental bedroom, there was an increased risk of SIDS when sleeping in the living room (aOR: 2.41 [95% CI: 1.06–5.51]), but not when sleeping alone in own bedroom or in a bedroom with siblings (aOR: 1.72 [95% CI: 0.97–3.04]). There was no change in the aOR whether the infant was in his or her own bedroom, or bedroom with siblings, or combined. Among the controls infants sleeping in the living room was not associated with SES (low, 10.0%; middle, 8.9%; high, 7.4%;  $\chi^2 = 0.75$ , degrees of freedom [*df*] = 2,  $P = .69$ ).

In the univariate analysis sleeping in the parental bed, on a sofa or in a bed with siblings were all associated with an increased risk of SIDS compared with sleeping in their own bed (this included crib or bed, bassinette, and portable bed). However, after adjustment which includes bed sharing none of the types of bed were statistically associated with SIDS. In particular infants placed to sleep on a sofa alone were not associated with an increased risk of SIDS (3 cases [0.9%] vs 11 controls [1.1%],  $P =$  not significant).

The increased risk of prone sleeping position (aOR: 7.08 [95% CI: 3.69–13.60]), bed sharing (aOR: 2.73 [95% CI: 1.34–5.55]), and protective effect of pacifier use (aOR: 0.39 [95% CI: 0.25–0.59]) have been reported previously but are presented here for completeness. The ORs and CIs are slightly different from that reported previously as the multivariable model differs slightly. There were 6 controls and 7 cases who bed shared with siblings only and this was associated with an increased risk of SIDS in the univariate analysis (OR: 3.81 [95% CI: 1.27–11.40]). In the multivariate analysis this was not significant although the point estimate was increased (aOR: 1.95 [95% CI: 0.23–14.02]). In the control population placing the infant prone to sleep was more prevalent in the low socioeconomic group (11.8%) compared with middle (4.5%) and upper (2.1%) groups

**TABLE 1 Univariate and Multivariate ORs for Variables Relating to the Sleep Environment During the Last Sleep or Reference Sleep**

	Sleep Environment, n (%)		Univariate		Multivariate <sup>a</sup>	
	Case	Control	OR	95% CI	OR	95% CI
<b>Home</b>						
Parental home	302 (90.7)	921 (92.3)	1.00	—	1.00	—
Home of relatives/friends	20 (6.0)	8 (0.8)	7.87	3.31–18.71	4.39	1.11–17.38
Outside	3 (0.9)	50 (5.0)	0.16	0.05–0.53	0.39	0.05–2.95
Anything else <sup>b</sup>	8 (2.4)	19 (1.9)	1.28	0.53–3.05	1.79	0.49–6.52
<b>Room the infant slept in</b>						
Own room or with siblings	129 (42.9)	386 (39.0)	1.07	0.80–1.44	1.72	0.97–3.04
Parental bedroom	136 (40.8)	435 (43.6)	1.00	—	1.00	—
Living room	40 (12.0)	83 (8.3)	1.64	1.04–2.59	2.41	1.06–5.51
Outside	3 (0.9)	50 (5.0)	0.17	0.05–0.57	0.45	0.06–3.34
Bedroom at friends place	14 (4.2)	4 (0.4)	13.93	3.93–49.44	38.67	3.89–384.05
Everything else <sup>c</sup>	11 (3.3)	38 (3.8)	0.92	0.45–1.86	3.47	1.23–9.77
<b>Bed</b>						
Own bed	221 (66.4)	735 (73.7)	1.00	—	1.00	—
Bed with siblings	4 (1.2)	2 (0.2)	6.68	1.21–36.69	1.12	0.03–37.26
Parental bed	42 (12.6)	74 (7.4)	2.02	1.31–3.13	2.81	0.81–9.75
Sofa	14 (4.2)	13 (1.3)	3.61	1.65–7.87	3.69	0.86–15.84
Everything else	28 (8.4)	90 (9.0)	1.08	0.69–1.71	1.85	0.78–4.37
<b>Bed sharing last sleep</b>						
No	285 (85.6)	909 (91.1)	1.00	—	1.00	—
Yes	48 (14.4)	89 (8.9)	1.80	1.21–2.66	2.73	1.34–5.55
<b>Position placed to sleep</b>						
Prone	136 (41.3)	41 (4.1)	16.62	10.38–26.61	7.08	3.69–13.60
Side	97 (29.5)	462 (46.4)	1.12	0.79–1.58	0.79	0.47–1.34
Back	91 (27.7)	490 (49.2)	1.00	1.00	1.00	—
<b>Position found</b>						
Prone	204 (62.4)	68 (6.9)	23.47	15.13–36.40	21.29	8.93–50.73
Side	40 (12.2)	162 (16.5)	1.99	1.23–3.20	1.37	0.59–3.19
Back	81 (24.8)	700 (71.1)	1.00	—	1.00	—
Others	2 (0.6)	55 (5.6)	0.33	0.08–1.46	0.15	0.02–1.13
<b>Pacifier used last sleep</b>						
Yes	135 (41.0)	543 (54.7)	0.57	0.44–0.74	0.39	0.25–0.59
No	194 (59.0)	450 (45.3)	1.00	—	1.00	—
<b>Bedding during last sleep</b>						
Thick duvet	115 (35.0)	328 (33.2)	1.57	1.11–2.23	2.20	1.21–4.00
Light duvet	149 (45.3)	377 (38.2)	1.78	1.27–2.50	1.92	1.07–3.45
Sleeping bag or light cotton	65 (19.8)	283 (28.6)	1.00	—	1.00	—
<b>Pillow used in last sleep</b>						
Yes	118 (35.9)	200 (20.1)	2.41	1.80–3.23	1.03	0.66–1.59
No	211 (64.1)	793 (79.9)	1.00	—	1.00	—
<b>Sheepskin underneath infant</b>						
Yes	39 (11.7)	205 (20.6)	0.51	0.35–0.74	0.88	0.47–1.68
No	289 (88.1)	787 (79.3)	1.00	—	1.00	—
<b>Waterproof layer underneath infant</b>						
Yes	29 (8.8)	138 (13.8)	0.60	0.39–0.91	0.62	0.30–1.29
No	299 (91.2)	854 (86.1)	1.00	—	1.00	—

For some variables there is missing information in a small number of cases and controls.

<sup>a</sup> Adjusted for sleep position, breastfeeding, maternal smoking in pregnancy, family status, SES, maternal age at delivery, bed sharing, previous live birth, birth weight, and extra heating of the infant.

<sup>b</sup> Included a day care center, in the car, or a paid caregiver.

<sup>c</sup> Included rooms such as the kitchen or hallway or in the car.

( $\chi^2 = 15.1$ ,  $df = 2$ ,  $P < .001$ ). In contrast, bed sharing did not vary according to SES ( $\chi^2 = 0.47$ ,  $df = 2$ ,  $P = .79$ ).

Duvets doubled the risk of SIDS (aOR: 2.20 [95% CI: 1.21–4.00] [thick] and 1.92 [95% CI: 1.07–3.45] [thin]) in comparison with infant using a sleeping bag only or very light cotton blankets only.

A sheepskin placed under the infant was associated with a reduced risk of SIDS in the univariate analysis but not after adjustment (aOR: 0.88 [95% CI: 0.47–1.68]). Sheepskin use was strongly associated with economic status (low, 10.5%; middle, 18.9%; high, 25.0%;  $\chi^2 =$

10.3,  $df = 2$ ,  $P = .006$ ). Similarly, a waterproof layer under the infant was associated with SIDS in the unadjusted analysis but not after adjustment (aOR: 0.62 [95% CI: 0.30–1.29]).

A pillow used in the last sleep was associated with an increased risk of SIDS in the univariate analysis, but not after adjustment.

#### Last 4 Weeks

Information about the usual accommodation in the last 4 weeks was not collected (Table 2). The usual room and

**TABLE 2 Univariate and Multivariate ORs for Variables Relating to the Sleep Environment During the Last 4 Weeks**

	Sleep Environment, N (%)		Univariate		Multivariate <sup>a</sup>	
	Case	Control	OR	95% CI	OR	95% CI
Usual room in the last 4 wk						
Own room or with siblings	119 (39.9)	373 (37.7)	0.86	0.64–1.14	1.47	0.85–2.52
Parental bedroom	159 (47.9)	434 (43.6)	1.00	—	1.00	—
Living room	27 (8.1)	83 (8.3)	0.88	0.54–1.42	1.91	0.82–4.42
Outside	1 (0.3)	36 (3.6)	0.06	0.01–0.46	1.01	0.11–9.43
Anything else <sup>b</sup>	26 (7.8)	69 (6.9)	0.96	0.59–1.58	1.81	0.82–4.02
Bed usually used in the last 4 wk						
Own bed	234 (73.2)	733 (73.5)	1.00	—	1.00	—
Bed with siblings	6 (1.8)	3 (0.3)	5.96	1.48–23.98	0.76	0.09–6.40
Carriage	16 (4.8)	67 (6.7)	0.67	0.36–1.25	1.10	0.36–3.37
Parental bed	26 (7.8)	67 (6.7)	1.21	0.74–1.99	0.76	0.26–2.17
Sofa	5 (1.5)	15 (1.5)	1.02	0.36–2.87	1.87	0.28–12.15
Everything else <sup>c</sup>	36 (10.8)	112 (11.2)	0.96	0.64–1.47	1.35	0.69–2.68
How often infant taken into parental bed						
Never	184 (55.8)	630 (63.2)	1.00	—	1.00	—
Sometimes every night	146 (44.2)	367 (36.8)	1.41	1.08–1.82	1.08	0.61–1.66
Usual sleep position in the last 4 wk						
Prone	93 (28.1)	40 (4.01)	11.65	7.15–18.99	4.12	2.19–8.52
Side	90 (27.2)	446 (44.7)	1.05	0.73–1.50	0.66	0.38–1.16
Back	88 (26.6)	441 (44.2)	1.00	—	—	—
Varied never prone	18 (5.4)	56 (5.6)	1.56	0.86–2.83	1.66	0.68–4.07
Varied including prone	42 (12.7)	14 (1.4)	14.25	7.08–28.69	6.19	1.95–19.68
Infant changed sleep position						
Yes	214 (64.5)	653 (65.4)	0.94	0.71–1.25	1.26	0.80–2.00
No	118 (35.5)	345 (34.6)	1.00	—	1.00	—
Usual position found after sleep the last 4 wk						
Prone	113 (34.3)	54 (5.4)	12.18	7.99–18.55	5.88	3.16–10.92
Side	43 (13.1)	137 (13.8)	1.73	1.12–2.67	1.18	0.58–2.40
Varied, never prone	16 (4.8)	87 (8.7)	1.04	0.56–1.92	1.36	0.56–3.32
Varied, also prone	36 (10.9)	39 (3.9)	5.23	3.07–8.90	2.49	1.12–5.53
Back	93 (28.3)	626 (62.8)	1.00	—	1.00	—
Pacifier usually used in last 4 wk						
Yes	168 (50.8)	579 (58.1)	0.73	0.57–0.95	0.49	0.32–0.76
No	163 (49.2)	418 (41.9)	1.00	—	1.00	—
Sheepskin usually underneath infant in last 4 wk						
Yes	37 (11.3)	214 (21.6)	0.45	0.31–0.66	0.67	0.35–1.28
No	291 (88.7)	776 (78.4)	1.00	—	1.00	—
Waterproof layer usually underneath infant in last 4 wk						
Yes	37 (11.3)	131 (13.2)	0.84	0.57–1.25	0.89	0.45–1.75
No	291 (88.7)	859 (86.8)	1.00	—	1.00	—

For some variables there is missing information in a small number of cases and controls.

<sup>a</sup> Adjusted for sleep position, breastfeeding, maternal smoking in pregnancy, family status, SES, maternal age at delivery, bed sharing, previous live birth, birth weight, and extra heating of the infant.

<sup>b</sup> Included a day care center, in the car, in a hotel room, or with a paid caregiver.

<sup>c</sup> Included rooms such as the kitchen or hallway or in the car.

bed in the last 4 weeks were not associated with SIDS after adjusting for potential confounders. Similarly bed sharing in the last 4 weeks increased the risk of SIDS in the univariate analysis but not in the multivariate analysis.

Usually placed prone to sleep and placed in various positions including prone were associated with an increased risk of SIDS after adjustment. Similarly, usually found prone and found in various positions including prone were associated with an increased risk of SIDS.

Pacifier used in the last 4 weeks was associated with a reduced risk of SIDS (aOR: 0.49 [95% CI: 0.32–0.76]). Sleeping on a sheepskin in the last 4 weeks under the infant was associated with a reduced risk of SIDS in the

univariate analysis, but these were not significant after adjustment.

Type of bedding in the last 4 weeks was not examined.

#### Combination of Sleep Environment Variables

The reduced risk of SIDS with pacifier use was in the group that usually used a pacifier and also used it in the last sleep (aOR: 0.40 [95% CI: 0.24–0.68]; Table 3). There was an increased risk of SIDS in infants who usually used a pacifier, but did not use it in the last sleep in the univariate analysis. However this was not statistically significant after adjustment for all the other factors.

Infants who are not usually placed prone to sleep, but

**TABLE 3** Combination of Variables: Pacifier Use, Secondary Prone Sleeper, Unaccustomed Prone Sleeper, and Bed Sharing

	Sleep Environment, N (%)		Univariate		Multivariate <sup>a</sup>	
	Cases	Controls	OR	95% CI	OR	95% CI
Pacifier use (usual and last sleep)						
Usual use and used during last sleep	130 (39.0)	531 (53.2)	0.62	0.47–0.82	0.40	0.24–0.68
Usual use but not used during last sleep	36 (10.8)	44 (4.4)	2.20	1.33–3.64	1.63	0.71–3.78
Use not usual but used during last sleep	5 (1.5)	12 (1.2)	1.51	0.50–4.56	3.84	0.45–32.59
Use not usual and not used during last sleep	157 (47.1)	405 (40.6)	1.00	—	1.00	—
Placed to sleep and position found						
Placed to sleep non prone and found non prone after last sleep	116 (34.8)	899 (90.1)	1.00	—	1.00	—
Placed to sleep non prone and found prone after last sleep <sup>b</sup>	71 (21.3)	39 (3.9)	15.70	8.76–28.13	18.54	7.84–43.87
Placed to sleep prone and found non prone after last sleep	4 (1.2)	12 (1.2)	4.35	1.18–16.02	1.92	0.36–10.15
Placed to sleep prone and found prone after last sleep	132 (39.6)	29 (2.9)	29.70	17.36–50.90	22.11	10.05–48.62
Sleep position (usual and last sleep)						
Non prone usual sleep position and non prone position during last sleep	179 (53.8)	941 (94.3)	1.00	—	1.00	—
Non prone usual sleep position but prone position during last sleep <sup>c</sup>	17 (5.1)	2 (0.2)	40.42	8.71–187.71	37.73	5.37–265.27
Prone usual sleep position but non prone position during last sleep	16 (4.8)	15 (1.5)	5.61	2.58–12.21	3.58	1.09–11.80
Prone usual sleep position and prone position during last sleep	119 (35.7)	39 (3.9)	15.79	10.04–24.83	7.79	4.19–14.49
Sheepskin underneath infant and sleep position						
Sheepskin used and prone sleep position	21 (6.3)	4 (0.4)	18.09	5.88–55.66	27.92	6.45–120.91
Sheepskin used and non prone sleep position	18 (5.4)	201 (20.1)	0.38	0.22–0.65	0.49	0.23–1.05
Sheepskin not used and prone sleep position	114 (34.2)	37 (3.7)	12.83	8.08–20.38	6.00	3.08–11.68
Sheepskin not used and non prone sleep position	172 (51.7)	750 (75.2)	1.00	—	1.00	—
Bed sharing (usual and last sleep)						
Bed sharing usual and bed shared during last sleep	40 (12.1)	82 (8.2)	1.81	1.17–279	2.63	1.23–5.62
Bed sharing usual but bed not shared during last sleep	106 (32.1)	285 (28.6)	1.35	0.98–1.74	1.04	0.62–1.74
Bed sharing not usual but bed shared during last sleep	8 (2.4)	7 (0.7)	3.92	1.41–10.89	3.74	0.67–20.82
Bed sharing not usual and bed not shared during last sleep	176 (23.0)	623 (62.5)	1.00	—	1.00	—
Position placed to sleep and use of pillow						
Placed prone and used a pillow	51 (15.9)	8 (0.8)	32.10	14.11–73.02	5.21	1.83–14.85
Placed prone and did not use a pillow	85 (25.5)	33 (3.3)	14.26	8.64–23.54	8.62	4.18–17.75
Placed non prone and used a pillow	65 (20.2)	192 (19.4)	1.92	1.33–2.78	0.84	0.49–1.42
Placed non prone and did not use a pillow	120 (37.4)	757 (76.5)	1.00	—	1.00	—
Bed sharing and age of infant						
Bed shared and <13 wk	27 (8.1)	28 (2.8)	8.79	3.04–25.41	19.86	2.33–169.54
Bed shared and >13 wk	21 (6.3)	61 (6.1)	1.10	0.63–1.91	1.02	0.44–2.36
Bed not shared and <13 wk	87 (26.1)	289 (29.0)	2.57	1.03–6.42	2.65	0.42–16.84
Bed not shared and >13 wk	198 (59.5)	620 (62.1)	1.00	—	1.00	—

For some variables there is missing information in a small number of cases and controls.

<sup>a</sup> Adjusted for sleep position, breastfeeding, maternal smoking in pregnancy, family status, SES, maternal age at delivery, bed sharing, previous live birth, birth weight, and extra heating of the infant.

<sup>b</sup> Secondary prone sleeper.

<sup>c</sup> Unaccustomed prone sleeper.

are placed prone for the reference sleep (unaccustomed to prone) are at increased risk of SIDS (aOR: 37.73 [95% CI: 5.37–265.27]). Also, infants who are not placed prone but are found prone (secondary prone) are at increased risk of SIDS (aOR: 18.54 [95% CI: 7.84–43.87]).

Sleeping prone on a sheepskin was associated with an increased risk of SIDS (aOR: 27.92 [95% CI: 6.45–120.91]). However, sleeping nonprone on a sheepskin was associated with a reduced risk of SIDS (aOR: 0.49 [95% CI: 0.23–1.05]) compared with sleeping nonprone and not on a sheepskin, but it did not reach statistical significance.

Infants who were unaccustomed to bed sharing (that is they did not bed share in the last 4 weeks but bed shared in the last sleep) were at increased risk of SIDS in

the univariate analysis only. After adjustment only those who usually bed shared and bed shared in the last night were at a greater risk (aOR: 2.63 [95% CI: 1.23–5.62]). In the control population the proportion placed prone did not differ between those who bed shared or not (bed sharing: 4.5% prone vs not bed sharing: 4.1% prone,  $P =$  not significant). Bed sharing was a particular risk for infants <13 weeks (aOR: 19.86 [95% CI: 2.33–169.50]), but not for those 13 weeks and more (aOR: 1.02 [95% CI: 0.44–2.36]). There was no evidence of an interaction between sleep position and pillow use ( $P = .82$ ).

## DISCUSSION

Many of the informative epidemiologic SIDS studies were conducted in the 1980s and 1990s.<sup>5,17–22</sup> The substantial decline in SIDS with the Back to Sleep campaign



**TABLE 4 Major Risk Factors for SIDS in Germany, Previously Reported**

Major Risk Factors for SIDS	Cases, n (%)	Controls, n (%)	Univariate, OR (95% CI)	Multivariate, OR (95% CI) <sup>a</sup>
Maternal age at delivery, <20 y	60 (18.0)	10.0 (1.0)	50.0 (21.95–113.92)	18.71 (6.00–58.32)
Family status, living alone	68 (20.4)	32 (3.2)	7.45 (4.73–11.73)	2.38 (1.10–5.12)
Lower SES	164 (49.6)	77 (7.7)	31.58 (18.52–53.89)	3.00 (1.35–6.69)
Maternal smoking during pregnancy, >20/d	47 (14.1)	19 (1.9)	16.64 (8.93–30.99)	3.43 (1.39–8.46)
Birth weight < 1500 g	18 (5.4)	6 (0.6)	15.12 (5.83–39.22)	10.67 (2.10–54.17)
Gestational age < 30 wk	11 (3.3)	6 (0.6)	6.74 (2.46–18.49)	—
Sleep position				
Side	97 (29.9)	462 (46.5)	1.12 (0.79–1.58)	0.82 (0.52–1.28)
Prone	136 (42.0)	41 (4.1)	16.62 (10.38–26.61)	6.08 (3.33–11.08)
Bed sharing, yes	48 (14.4)	89 (8.9)	1.80 (1.21–2.66)	2.71 (1.44–5.10)
Pillow in the infants bed, yes	118 (35.9)	200 (20.1)	2.41 (1.80–3.23)	1.03 (0.66–1.59)
Breast feeding for at least 2 wk, no	168 (50.5)	171 (17.1)	5.36 (3.97–7.23)	1.71 (1.06–2.77)
Extra heating during the last sleep, yes	53 (16.1)	90 (9.2)	2.01 (1.37–2.96)	1.70 (0.91–3.16)

<sup>a</sup> Adjusted for sleep position, maternal smoking during pregnancy, breastfeeding, family status, SES, maternal age at delivery, ethnicity, bed sharing, previous live births, birth weight, and extra heating of the infant.

has resulted in changes to some of the epidemiologic features.<sup>23,24</sup> This large case-control study was conducted after the substantial fall in SIDS mortality rates, thus the findings from this study are relevant to the situation now in most developed countries. Furthermore, the large number of cases in the study has enabled more detailed subgroup analyses. However, the limitations of the study should be recognized. Although the response rate of the cases was very high, the response rate of the controls was not ideal. Participants in the control group were more likely to be socioeconomically advantaged. Although multivariate analysis adjusted for SES, some residual confounding may persist. The study collected detailed information on the sleep environment. However, information on the clothes the infants were wearing during the last sleep or the reference sleep was not collected. Therefore the amount of thermal insulation (clothing and bedding) and whether the infant was over or under wrapped for the environmental temperature could not be calculated.

Infants sleeping at a friend's or relative's accommodation were at higher risk of SIDS than those sleeping at the parental home. This might be because of changes of their normal sleep routine or exposure to a more hazardous environment if, say, the infants had to sleep on a surface not made for infants. Not only is the home of relatives and friends a risk factor but sleeping in the bedroom at a friend's place had a very high OR, although it concerned only 14 (4.2%) cases.

The American Academy of Pediatrics, the United Kingdom Department of Health, and the German Pediatric Association recommend that infants in the first year should not sleep separate from the parents but in the parental bedroom in their own crib.<sup>9,11,13</sup> This study tends to support this recommendation, although the increased risk of SIDS in the infants who slept in their own bedroom was borderline statistically significant ( $P = .06$ ). An increased risk of SIDS was seen in infants sleeping in the living room compared with those sleeping in the parents' bedroom, even after controlling for various factors including SES. Sleeping on a sofa has been reported

to be a risk factor for SIDS<sup>25</sup>; in our study the risk was only increased in the univariate analysis, but after adjustment it was not significant. This might be because of the fact that placing an infant to sleep on a sofa is not a common practice in Germany. In our study only 1% of controls slept on a sofa. There was no evidence to suggest that infants sleeping on a sofa alone were at increased risk of SIDS.

It is also recommended that infants sleep without a pillow in their bed. There was no increased risk of SIDS with a pillow in the adjusted analysis. It has been postulated that if the infant is placed prone on a pillow the head of the infant will sink into the pillow and the infant will rebreath expired air. There was no interaction between pillow and sleep position. In Germany infant pillows are mostly very thin and the potential of rebreathing might be very low.

The prone sleeping position is now one of the best established risk factors for SIDS and is causally associated with SIDS (Table 4). In this study prone sleeping position was more commonly associated with the low socioeconomic group. However, more than half of the infants placed prone to sleep are in the middle socioeconomic group. This emphasizes that SIDS prevention messages need to reach all sections of society, although different educational methods might be necessary for the "hard to reach" population.

In contrast to other studies, the side sleeping position was not associated with an increased risk of SIDS.<sup>21,25–29</sup> Most studies have examined the position the infant is placed to sleep, as this is readily modifiable. Some infants are placed on their side or back and turn to the prone position (secondary prone). We have previously reported that this is associated with an increased risk of SIDS,<sup>15</sup> confirming the results from other studies.<sup>30,31</sup> This study also reports on the risk of SIDS for unaccustomed prone sleepers. These are the infants who are normally placed to sleep nonprone but in this last sleep were placed prone. The risk of SIDS is 37 times higher than for the infant that is usually placed nonprone to sleep and in the last sleep was also placed in the non-

prone sleeping position confirming the findings of previous studies.<sup>21,31</sup> The reasons for the change in sleeping position were not examined systematically in this study. However, some parents volunteered to the study coordinator (Dr Vennemann) that there was a different care taker from the usual (eg, the infant was staying with the grandparents) or sometimes the mother had placed the infant prone for the first time because they had been told infants sleep better on their tummy. This emphasizes the need to teach the safe sleeping position not only to the parents but also to anyone who might care for the infant (eg, baby-sitter, grandparents).

The risk of SIDS with bed sharing in this study has been reported previously.<sup>15</sup> As has been reported by others,<sup>26,27,29,32,33</sup> we have shown that the risk is larger in infants of mothers who smoke.<sup>15</sup> In this study taking the infant into the bed sometimes or every night during the previous 4 weeks was not a risk factor but taking the infant into the bed the last night was associated with a high risk. It has been suggested that infants who bed share on the last night might be ill and that it is this, rather than the bed sharing itself, that increases the risk of SIDS. Previous studies found that infection is only a risk factor for SIDS in infants sleeping prone.<sup>34</sup> We have previously reported that infection is no longer a risk factor for SIDS in these populations.<sup>35</sup> Infants unaccustomed to bed sharing (that is infants who usually do not bed share, but did on the night of death or reference sleep) were not at a higher risk of SIDS than those who usually bed shared and also bed shared on the last night. This suggests it is bed sharing that is the risk factor for SIDS, and not the other factors that lead to bed sharing. The proportion of control infants sleeping prone did not differ whether they were bed sharing. This is in contrast with a previous report which suggested bed sharing infants were less likely to be placed prone to sleep.<sup>36</sup> Bed sharing was a greater risk for infants <13 weeks of age than older infants, which has been reported previously.<sup>26</sup> A limitation of the study was that we did not collect data on parental alcohol consumption, as this might impair the parent's ability to respond to the infant. Many bed sharing infants are breastfed. It was reassuring that toxicology screening for alcohol and central acting drugs in the cases were negative in all cases (unpublished data), which suggest the infants were not influenced or impaired by these drugs, and that parental alcohol consumption was unlikely to be an important factor, at least among breastfeed infants.

We previously reported that pacifier use during the last sleep reduced the risk of SIDS.<sup>15</sup> This is in line with other studies.<sup>37-39</sup> The arguments for and against recommending pacifiers have recently been discussed, so will not be reiterated here.<sup>37,38</sup> One study has suggested that not using a pacifier in the last sleep when the pacifier is normally used is associated with an increased risk of SIDS.<sup>40</sup> In this study the risk was increased in the univariate analysis, but was not statistically increased after adjusting for various other risk factors. This is reassuring as this was 1 reason given for not recommending pacifier use for the prevention of SIDS. Even if the increased risk had reached statistical significance the small magnitude

of the effect would not undermine the recommendation to use pacifiers which results in a halving of the risk of SIDS.

The New Zealand Cot Death Study showed that sheep skins under infants are only a risk for SIDS if the infant is placed prone on them.<sup>41</sup> In the German study the results are similar; the risk of SIDS is almost 28 times higher if the infant is placed prone on a sheep skin in comparison to an infant placed nonprone and not on a sheep skin. Animal studies suggest that rebreathing of expired gases occurs when face down on a sheepskin, and this is a postulated mechanism of death.<sup>42,43</sup> Being placed nonprone on a sheepskin was associated with a significantly reduced risk of SIDS in the univariate analysis, but this was not significant after adjustment. Sheepskin use was associated with a reduced risk of SIDS in the univariate analysis, but not after adjustment. The cost of sheepskins varies between 40 and 50 US\$ and there is a strong socioeconomic association with their use. Thus these results largely reflect the higher SES of those who use sheepskins.

Proponents of the toxic-gas theory for SIDS have recommended covering the crib mattress with polythene.<sup>44,45</sup> Although the type of crib mattress wrapping was not assessed in this study, covering of the crib mattress with a waterproof cover was not associated with a reduced risk of SIDS in this study.

In Germany, thick duvets are made of eiderdown, whereas light duvets are made of wool or synthetic material. Both types of duvets doubled the risk of SIDS in comparison with infants using a sleeping bag only or very light cotton blankets only. Although the German Pediatric Association is now recommending a sleeping sack for SIDS prevention, at the time of this study few infants were using one; thus, we cannot confirm or refute this recommendation. This study supports the recommendation to avoid duvets.<sup>9,26,46</sup> Other studies have not always identified duvets as a risk for SIDS,<sup>47</sup> but this may be because of differences in the thickness or size of the duvet.

## CONCLUSIONS

This study clarified the risk factors for SIDS in the sleeping environment in a population where few infants sleep prone. Despite this, prone sleeping position is strongly associated with SIDS. This study in general supports the current recommendations of the American Academy of Pediatrics. This study identified several novel risk factors for SIDS: an increased risk if the infants sleeps outside the parental home, death in the living room, and the high risk when sleeping prone on a sheepskin; however, as the numbers of cases in these groups are small, additional studies are needed to confirm these findings.

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#### THE MYTH OF RAMPANT TEENAGE PROMISCUITY

“Have American teenagers gone wild? Parents have worried for generations about changing moral values and risky behavior among young people, and the latest news seems particularly worrisome. It came from the National Center for Health Statistics, which reported this month that births to 15- to 19-year-olds had risen for the first time in more than a decade. And that is not the only alarm being sounded. The talk show host Tyra Banks declared a teen sex crisis last fall after her show surveyed girls about sexual behavior. A few years ago, Oprah Winfrey warned parents of a teenage oral-sex epidemic. The news is troubling, but it's also misleading. While some young people are clearly engaging in risky sexual behavior, a vast majority are not. The reality is that in many ways, today's teenagers are more conservative about sex than previous generations. Today, fewer than half of all high school students have had sex: 47.8% as of 2007, according to the National Risk Behavior Survey, down from 54.1% in 1991. 'There's no doubt that the public perception is that things are getting worse, and that kids are having sex younger and are much wilder than they ever were,' said Kathleen A. Bogle, an assistant professor of sociology and criminal justice at La Salle University. 'But when you look at the data, that's not the case.'”

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