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# Does Breastfeeding Reduce the Risk of Sudden Infant Death Syndrome?

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## What's Known on This Subject

Breastfeeding is beneficial for infants and their mothers. Breastfeeding reduces the risk of gastrointestinal and respiratory infections. In some, but not all, countries SIDS prevention campaigns include breastfeeding.

## What This Study Adds

This study shows that breastfeeding reduced the risk of SIDS by ~50% at all ages throughout infancy. We recommend including the advice to breastfeed through 6 months of age in SIDS-reduction messages.

## ABSTRACT

**BACKGROUND.** In the last 20 years, the prevention campaigns to reduce the risk of sudden infant death syndrome were very successful. In some countries the advice to breastfeed is included in the campaigns' messages, but in other countries it is not.

**OBJECTIVE.** To examine the association between type of infant feeding and sudden infant death syndrome.

**METHODS.** The German Study of Sudden Infant Death is a case-control study of 333 infants who died of sudden infant death syndrome and 998 age-matched controls.

**RESULTS.** A total of 49.6% of cases and 82.9% of controls were breastfed at 2 weeks of age. Exclusive breastfeeding at 1 month of age halved the risk, partial breastfeeding at the age of 1 month also reduced the risk of sudden infant death syndrome, but after adjustment this risk was not significant. Being exclusively breastfed in the last month of life/before the interview reduced the risk, as did being partially breastfed. Breastfeeding survival curves showed that both partial breastfeeding and exclusive breastfeeding were associated with a reduced risk of sudden infant death syndrome.

**CONCLUSIONS.** This study shows that breastfeeding reduced the risk of sudden infant death syndrome by ~50% at all ages throughout infancy. We recommend including the advice to breastfeed through 6 months of age in sudden infant death syndrome risk-reduction messages. *Pediatrics* 2009;123:e406–e410

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### Key Words

case-control, breastfeeding, infant feeding, prevention, sudden infant death syndrome

### Abbreviations

SIDS—sudden infant death syndrome

OR—odds ratio

aOR—adjusted odds ratio

GeSID—German Study of Sudden Infant Death

CI—confidence interval

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**S**UDDEN INFANT DEATH syndrome (SIDS) is still the leading cause of death in the first year of life in the developed world. In Germany in 2006, 298 infants died with that diagnosis (0.44/1000 live births).<sup>1</sup> During the last 2 decades, several case-control studies identified modifiable risk factors for SIDS, mainly the prone sleeping position, smoking by the mother in pregnancy, excess clothing and bedding, and infant bed sharing with an adult.<sup>2–6</sup> In the subsequent prevention campaigns, parents were advised to put their infants supine for sleeping and avoid smoking in pregnancy and in the presence of the infant. In some countries, but not all, the SIDS prevention campaigns included breastfeeding. These recommendations were mainly based on the findings of studies done in the late 1980s and early 1990s.<sup>7–10</sup>

The World Health Organization recommends breastfeeding exclusively for the first 6 months of life. Breastfeeding reduces the risk of hospitalization caused by gastrointestinal and respiratory infections. In a systematic review, van Odiijk and colleagues<sup>11</sup> concluded that breastfeeding also protects infants from atopic diseases like eczema.

A meta-analysis of 23 studies published up to 1997 examining the relationship between SIDS and breastfeeding found the overall risk of SIDS twice as great for formula-fed infants compared with breastfed infants (crude odds ratio [OR]: 2.1).<sup>12</sup> The meta-analysis has been criticized for having poor eligibility criteria and not adjusting for confounders.<sup>13</sup> These authors conducted their own meta-analysis using only studies that provided an objective definition of SIDS, clear reporting of breastfeeding data, and outcomes adjusted for important confounders or risk factors. Four of the original 23 studies<sup>3,5,10,14</sup> plus 2 studies<sup>6,8</sup> published since 1997 met these eligibility criteria. Ever breastfeeding was associated with a reduced risk of SIDS (crude OR: 0.41, adjusted OR [aOR]: 0.64).<sup>13</sup> The results are similar to the

**TABLE 1** Infant Feeding at 2 Weeks of Age, 1 Month, and Last Month and the Risk of SIDS

Breastfeeding	Cases		Controls		Univariate		Multivariate	
	<i>n</i>	%	<i>n</i>	%	OR	95% CI	OR	95% CI
Any at 2 wk of age								
Yes	165	49.6	827	82.9	0.19	0.14–0.25	0.43	0.27–0.69
No	168	50.4	171	17.1	1.00	—	1.00	—
At 1 mo of age								
Exclusive	130	39.0	718	71.9	0.17	0.13–0.23	0.48	0.28–0.82
Partial	35	10.5	109	10.9	0.30	0.19–0.47	0.48	0.21–1.10
None	168	50.5	171	17.1	1.00	—	1.00	—
In the month before death/interview								
Exclusive	31	9.3	334	33.5	0.08	0.05–0.13	0.27	0.13–0.56
Partial	43	12.9	278	27.9	0.18	0.12–0.27	0.29	0.16–0.53
None	259	77.7	386	38.7	1.00	—	1.00	—

earlier meta-analysis. Although there is a relationship between breastfeeding and a reduced risk of SIDS, the association may not be causal. A weakness of the earlier studies is that many only compared never breastfed with any breastfeeding.

The aim of the German Study of Sudden Infant Death (GeSID) was to identify risk factors for SIDS in a population where only few infants sleep prone. We have previously reported a reduced risk of SIDS with breastfeeding at 2 weeks of age.<sup>6</sup> In this study, we examined the relationship between breastfeeding and SIDS in greater detail.

## METHODS

The GeSID was a population-based, case-control study of 333 infants who died from SIDS and 998 age-matched controls, conducted in ~50% of Germany between 1998 and 2001. The response rate of the case families was 82.4% and of the controls 58.7%. The controls were recruited from the same vital registration office with which the case was registered. (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 done, 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 match were chosen. Details about the study methods and recruitment were previously described in detail.<sup>6,15</sup>

All cases were autopsied according to a standardized protocol, a case conference was held for each case with the same group of SIDS experts. The peak age of cases was between 2 and 5 months of age (59%).

A detailed questionnaire was administered to parents by trained interviewers in the infants' homes. Type of feeding was collected retrospectively for each month of life until death (cases) or reference date (controls). For each month it was noted whether the milk the infant was drinking was breast milk only, partly breast milk and partly bottle-fed (milk formula), or bottle-fed (milk formula) only and whether solids were eaten. Exclusive

breastfeeding was defined as breast milk only, with no extra bottle of milk formula or solids given at any time of the day. Partial breastfeeding was defined as any bottle feeding (milk formula) or solids given in addition to breast milk. Not breastfed was defined as no breast milk.

All data were entered into a database and analyzed by using SAS 9.01 (SAS Institute, Inc, Cary, NC). Infant feeding was examined at 2 weeks of age, 1 month of age, and in the last month of life or the last month before the interview for control infants. Univariate and multivariate analyses were performed by using conditional logistic regression. In the multivariate analysis, we controlled for the following variables: maternal smoking in pregnancy, maternal family status, maternal age at delivery, socioeconomic status of the family (socioeconomic status was calculated using school education, present work position, and income), previous live births, birth weight of the infant, bed sharing in the last night, pillow in the infant's bed, additional heating during the last sleep (a hot water bottle in the infant's bed or the bed in front of a heater), position placed to sleep, and pacifier use during the last sleep.<sup>6</sup> As prenatal and postnatal smoking were closely related in our study, we had to exclude 1 variable because of colinearity. We chose to use smoking in pregnancy.

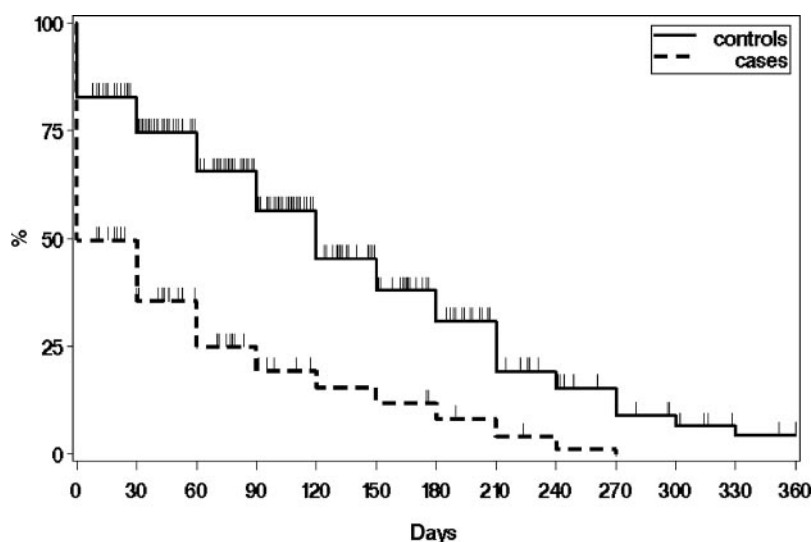
A survival analysis was used to compare SIDS cases with controls, where the length of breastfeeding was taken as the outcome. If infants were breastfeeding in the completed month before their death (or in case of the controls, before the time of death of their matched case), it was assumed breastfeeding had continued to death or reference time, and the data point was censored. The survival analysis used Proc LIFETEST in SAS (Kaplan-Meier). Adjustment for potential confounders was made using Proc PHREG (Cox regression).<sup>16</sup>

## RESULTS

Table 1 shows any breastfeeding at the age of 2 weeks and the risk of SIDS. These results have been reported previously but are repeated here for completeness. Less than 50% of the SIDS cases were breastfed at the age of 2 weeks, and 83% of the controls were breastfed (aOR: 0.43 [95% confidence interval (CI): 0.27–0.69]). Less

FIGURE 1

Proportion of infants who were breastfed (both exclusively and partially) according to month of age for controls and cases. The vertical lines represent where the data were censored.



than 40% of the SIDS cases were exclusively breastfed at the age of 1 month compared with 72% of the controls (aOR: 0.48 [95% CI: 0.28–0.82]). In the univariate analysis, partial breastfeeding was associated with a reduced risk of SIDS, but this was not statistically significant after adjustment for potential confounders (aOR: 0.48 [95% CI: 0.21–1.10]).

In the month before death or interview only, 10.2% of the cases and >40% of the controls were exclusively breastfed (aOR: 0.27 [95% CI: 0.13–0.56]). Partial breastfeeding was associated with a significantly reduced risk of SIDS (aOR: 0.29 [95% CI: 0.16–0.53]).

Figure 1 shows the proportion of infants who were breastfed (both exclusively and partially breastfed) by month of age for cases and controls (Kaplan-Meier curve, OR: 0.42 [95% CI: 0.36–0.48]). After adjustment of confounders, the protective effect of breastfeeding remained significant (Cox regression, aOR: 0.69 [95% CI: 0.57–0.84]). Figure 2 shows the proportions who were exclusively breastfed for cases and controls

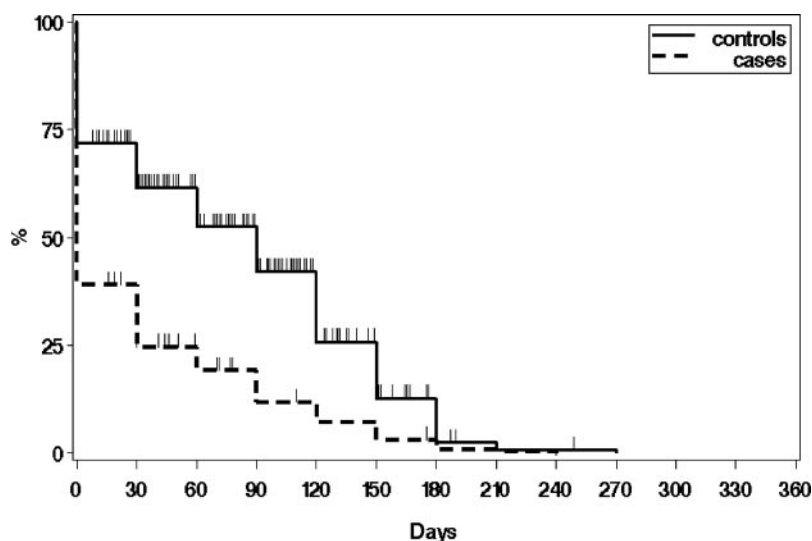
(Kaplan-Meier curve, OR: 0.52 [95% CI: 0.46–0.60]; Cox regression, aOR: 0.82 [95% CI: 0.68–0.98]).

## DISCUSSION

There are several strengths of this study, including being large and one of the most recent case-control studies of SIDS. This study provides risk factor data in a population that has decreased its infant prone sleeping rates as a result of education campaigns. Many of the studies published on risk factors for SIDS were published earlier and form the basis on which the American Academy of Pediatrics and other organizations developed guidelines for reducing the risk of SIDS. In addition, standardized protocols were used for autopsy, and a multidisciplinary panel determined the cause of death. In this study we were able to collect data on feeding patterns from a large number of SIDS victims and controls for each month of their lives. For each month it was noted whether the infant was exclusively breastfed, partially breastfed, or

FIGURE 2

Proportion of infants who were exclusively breastfed according to month of age for controls and cases. The vertical lines represent where the data were censored.



was not breastfed. Furthermore, the study was able to control for a large number of potential confounders.

Limitations of the study should be recognized. Although the response rate of the cases was high, the response rate of the controls was not ideal. Participants, in particular controls, were more likely to be socioeconomically advantaged than those who did not participate. Although multivariate analysis adjusted for socioeconomic status, some residual confounding may persist. Also, any study that is based on retrospectively collected data is subject to recall bias. However, Gibbons et al<sup>17</sup> reported very good agreement between prospective collected data on infant feeding and retrospective collected data in 2 studies of SIDS in Tasmania. In this study, 82.9% of controls were ever breastfed. This is only slightly higher than 76.7% of all children in the German Health Interview and Examination Survey for Children and Adolescents, a nationwide survey of over 17 000 children between 2003 and 2006.<sup>18</sup> In contrast, only 5.8% of controls were exclusively breastfed to 6 months of age compared with 22.4% of infants in the German Health Interview and Examination Survey for Children and Adolescents, which used a similar definition of exclusive breastfeeding. This suggests the results relating to exclusive breastfeeding in our study might be conservative.

Control infants were significantly more often ever breastfed and more likely to be exclusively breastfed than cases at all ages. Exclusive breastfeeding was associated with a slightly greater reduction in SIDS than partial breastfeeding, which itself was associated with reduction in SIDS compared with not breastfed; however, after adjustment for potential confounders, there was no evidence of a dose effect. Breastfeeding reduced the risk of SIDS by ~50% at all ages.

The age distribution of the SIDS infants was similar to that from an earlier German study.<sup>19</sup> Fifty-nine percent of the infants died between 2 and 5 months of age, and 73% died before 6 months of age. The implication of our findings is that these infants would especially benefit from being breastfed at this early age and that breastfeeding should be continued until the infant is 6 months of age and the risk of SIDS is low.

Breastfeeding is recommended by the World Health Organization on other grounds.<sup>20</sup> The morbidity and mortality of infants is reduced when they are exclusively breastfed for the first 6 months of life. Being breastfed also reduces the risk of acute otitis media, atopic eczema, gastrointestinal infections, and lower respiratory infections.

Epidemiologic studies cannot prove causation, but obviously a randomized, controlled trial of breastfeeding could not be done. We would argue that there is a causal relationship between breastfeeding and the reduced risk of SIDS. Breastfeeding fulfills many of the criteria for causation in observational studies.<sup>21</sup> Furthermore, there are plausible biological mechanisms by which breastfeeding reduces SIDS. The most likely mechanism is by its immunologic properties. Minor symptoms of infection, especially respiratory tract symptoms, are present in many SIDS cases in the days preceding death, al-

though the illness is not thought to be sufficient to have caused death.<sup>22-26</sup> Blackwell and colleagues<sup>27,28</sup> postulated that some SIDS deaths are due to uncontrolled inflammatory reaction to infectious agents (especially pyrogenic toxins of *Staphylococcus aureus*) and possibly cigarette smoke. The proinflammatory cytokines induced by infections can cause respiratory and cardiac dysfunction, pyrexia, shock, hypoglycemia, and arousal defects. The age distribution of SIDS is unique with most deaths occurring at 2 to 4 months of age. At this age, maternal-acquired immunoglobulin G is low as is the infant's own production of immunoglobulin G. Human breast milk contains immunoglobulin and cytokines that might help to protect the infant during this vulnerable time.

Infant sleep studies have shown that breastfed infants are more easily aroused than formula-fed infants, which may be an alternative mechanism for the protective effect of breastfeeding against SIDS.<sup>7-10,29,30</sup>

Given the weight of evidence from recent meta-analyses and a plausible biological mechanism, it seems somewhat surprising that breastfeeding has not been included in the American Academy of Pediatrics and United Kingdom Department of Health SIDS prevention recommendations.

In the United Kingdom, breastfeeding rates are low and strongly associated with socioeconomic status. Although breastfeeding is associated with a reduced risk of SIDS in univariate analysis, in some studies the protective effect is no longer statistically significant after adjustment for potential confounding.<sup>3</sup> This has led some authorities, including the American Academy of Pediatrics, to conclude that it is the factors associated with breastfeeding, rather than breastfeeding itself, which are protective.<sup>31</sup>

## CONCLUSIONS

This large study conducted after the major reduction in SIDS mortality adds to the body of evidence showing that breastfeeding reduces the risk of SIDS, and that this protection continues as long as the infant is breastfed. In our study, 73% of the infants died before 6 months of age. The implication of our findings is that breastfeeding should be continued until the infant is 6 months of age and the risk of SIDS is low. Because breastfeeding rates are low in the socially deprived sections of our population,<sup>18</sup> there should be special programs to encourage mothers of low socioeconomic status to breastfeed their infants not only for the established benefits of breastfeeding for the mother and infant but also to reduce the risk of SIDS in their infants.

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