Widening Social Inequalities in Sudden Infant Death Syndrome

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ABSTRACT

Objectives - Studies in the US have generally found socioeconomic and race disparities for SIDS. Our aim was to see whether the "Back to Sleep" campaign, which involves an effective, easy and free intervention, has reduced social class inequalities in SIDS.

Methods – We conducted a population-based case-cohort study during two periods, 1989-1991 and 1996-1998, using the U.S. Linked Birth/Infant Death Data Sets. Cases were infants who died of SIDS in infancy (N=21,126), controls were a 10% random sample of infants who lived through the first year and all infants who died of other causes (N=2,241,218). Social class was measured by mother's education.

Results –There was no evidence that inequalities in SIDS were reduced after the "Back to Sleep" campaign. In fact, odds ratios for SIDS associated with lower social class increased between 1996-1998 and 1989-1991. The race disparity in SIDS increased following the "Back to Sleep" campaign.

Conclusions – The introduction of an inexpensive, easy, public health intervention has not reduced social inequalities in SIDS, in fact the gap has widened.

Introduction

Sudden Infant Death Syndrome (SIDS) is the leading cause of postneonatal infant mortality in the United States. (1) During the 1990's the US experienced a dramatic decline in these deaths subsequent to the recognition of a causal role for infant sleep position and the implementation of public health policy initiatives to promote supine sleep position. The American Academy of Pediatrics agreed and adopted recommendations on sleep position in 1992 (2), followed in 1994 by the launch of the "Back to Sleep Campaign" by the United States Public Health Service. (3) Consequently, the SIDS rate dropped from 1.3 per 1000 live births in 1990 to 0.7 per 1000 live births in 1998. (4)

Social inequalities have been a noted feature of the epidemiology of SIDS for several decades. Non-white ethnicity, single parenthood, teenage pregnancy and low educational attainment and poverty have been consistently noted as risk factors. (5-8) Racial and ethnic disparities in SIDS have been pronounced in the US, reflecting these socio-economic inequalities. During the 1980's, black infants were twice as likely to die as white infants, and Native American infants had a mortality risk 3.5 times greater. (9)

In this study, we examined social inequalities in risk of SIDS before and after the introduction of the "Back to Sleep" campaign. If effective new preventive and treatment regimens are taken up inequitably, then they could actually increase any disparities that previously existed in health conditions. Disparities have been observed in receipt of recent advances in primary and secondary prevention. For example, there is evidence that patients with less education and/or lower income are less likely to receive intensive cardiac procedures. (10-13) Among diabetics, low socioeconomic status is associated with lack of compliance with regimens to achieve close glucose control (14-16) and among HIV positive individuals, highly active antiretroviral therapy (HAART) is less likely to be prescribed to the less educated. (17) However, these examples are all complicated and/or expensive treatments.

In contrast, a public health preventive intervention that is easily adopted, easily disseminated and free, such as the "Back to Sleep" campaign could reduce inequalities in this largely preventable condition. We hypothesized that the "Back to Sleep" campaign would not increase social inequalities and examined social disparities in risk of SIDS before and after the introduction of the campaign.

Methods

The U.S. Linked Birth/Infant Death data set

The U.S. National Center for Health Statistics has established a research data set of linked birth and death certificates for all infants born in the U.S. and those who die in their first year. We used the data sets for years 1989-1991, and for years 1996-1998 to represent, respectively, the periods before and after the introduction of the U.S. Department of Public Health "Back to Sleep" campaign in June 1994.

Cases and controls

We restricted our study to singleton infants without congenital abnormalities or abnormal conditions. Cases (N=21,126) were defined as all infant deaths where the cause of death was Sudden Infant Death Syndrome, coded according to the International Classification of Diseases, 9th Revision. (18, 19) Controls were all non-SIDS deaths (N=79,638) and a 10% random sample of infants who survived the first year (N=2,161,580). We compared SIDS cases to each control series in order to examine the specificity for SIDS of any cohort effects or effects of maternal social class.

Social class

Mother's highest level of educational attainment was used as a measure of social class. Mothers were categorized as having either: (1) no education or only elementary education, (2) some high school, (3) graduated high school, (4) some college education, or (5) graduated from college or beyond. College graduation is the reference category for all analyses of education effects.

Statistical Methods

We compared risk of SIDS before and after the "Back to Sleep" campaign for all mothers and infants and compared rates of SIDS by mother's education between infants born to non-Hispanic white, non-Hispanic black and Hispanic women. We used logistic regression to examine the independent and joint effects of education and pre- and post-campaign cohort status on risk of SIDS. We also examined three-way interactions between education, cohort status and race/ethnicity. We then adjusted these models for the following potential confounding variables: region of usual residence of the mother at time of birth, infant sex, mother's age, nativity (U.S. vs. foreign-born) and marital status, mother's race/ethnicity, parity, gestational age and birth weight at delivery, 5-minute APGAR score, and mother's tobacco use during pregnancy. All analyses were weighted to reflect the fact that the comparison group of infants who survived the first year were a 10% sample of this cohort.

Missing data

Linkage of infant deaths to birth certificates is close to complete, for example in 1996, 98% of infant deaths were linked to their corresponding birth records. Some records had missing information on maternal education (4.1%), maternal nativity (0.3%), parity (0.6%),

infant gestation (1.3%) and birth weight (0.2%), 5-minute APGAR score (23.9%), maternal tobacco use during pregnancy (25.8%), information about congenital abnormalities (8.7%) and abnormal conditions (20.8%). None of these records were eliminated from the analyses; rather we created categorical variables to indicate missing information. There was a statistically significant higher risk of SIDS ($p < 0.05$) among infants with missing information about mother's education (OR=1.34), parity (OR=1.63), gestational age (OR=1.31), birth weight (OR=1.67), abnormal conditions (OR=1.06) and mother's tobacco use (OR=1.07).

Results

Characteristics of the sample

Descriptive characteristics of mothers and infants for both time periods together are shown in Table 1. The pre-campaign cohort born in 1989-1991 consisted of 13,830 SIDS deaths, 46,829 non-SIDS deaths and 1,119,121 live infants. Mothers of SIDS cases in this cohort had a mean education of 11.5 years, compared to 11.8 years for mothers of non-SIDS deaths and 12.4 years for mothers of live infants. The post-campaign cohort born in 1996-1998 consisted of 7,296 SIDS deaths, 32,809 non-SIDS deaths and 1,042,459 live infants. Mothers of SIDS cases in this later cohort had a mean education of 11.7 years, compared to 12.0 years for mothers of non-SIDS deaths and 12.7 years for mothers of live infants.

The effect of the "Back to Sleep" campaign on SIDS

In unadjusted analyses, infants born in the post-campaign 1996-1998 cohort were significantly less likely to die of SIDS ($p<0.001$) than infants born in 1989-1991, OR=0.57, 95% CI, 0.55-0.58. For white mothers, the OR was 0.58 (95% CI, 0.56-0.60). This decline was more pronounced ($p<0.05$) for infants born to Hispanic women (OR=0.51, 95% CI, 0.47-

0.56) and less pronounced ($p<0.01$) for infants born to black mothers (OR=0.63, 95% CI, 0.60-0.66). Thus the race disparity increased following the "Back to Sleep" campaign.

Figure 1 shows rates of SIDS per 1000 live births by mother's race/ethnicity and highest educational achievement in the 1989-1991 and the 1996-1998 birth cohorts. Rates declined within each education and race/ethnicity category. Across all educational groups, and in both time periods, infants born to black mothers were at higher risk of death than infants born to white mothers and infants born to Hispanic mothers were at lower risk of death than infants born to white mothers.

Maternal education impact on SIDS risk, pre- and post-campaign

Table 2 shows the odds ratios for the effects of different categories of maternal education on SIDS risk in the pre- and post- "Back to Sleep" campaign cohorts. Risk of SIDS is estimated in relation to two comparison groups: infants who survived the first year and infants who died of causes other than SIDS. Odds ratios are estimated in both unadjusted models **(model 1)** and models adjusted for maternal and infant characteristics **(model 2)**. Because preliminary analyses did not identify significant three-way interactions between maternal education, cohort and race/ethnicity, which would have suggested that cohort changes in the effect of maternal education on SIDS risk varied by race/ethnicity, we report results for all race/ethnic groups combined.

Three trends are notable in this table. First, the risk of SIDS among women with no education or only elementary education does not fit expectations of increased risk among women of lower social class. Since education is compulsory in the US to age 16, women with no or only elementary education are a small and heterogeneous group that includes foreign-born women, as well as some women with severe health or cognition problems; it is not surprising that relationships between education and health are anomalous in this category.

It is also possible that this finding is partly explained by the well-known paradox of some ethnic minority groups in the US having much better reproductive health than expected given their socio-economic status. (20)

Second, with the exception of the anomalous group of women with only elementary or no education, within each time period lower levels of maternal education are associated with higher risk of SIDS vs. an infant surviving the first year. This is also true for the risk of SIDS vs. death from a non-SIDS cause in the unadjusted model. However, after adjusting for maternal and infant risk characteristics, such as low birth weight and parity, there is little evidence of a social gradient in risk of SIDS compared to any other cause of death in 1989-1991. In 1996-1998, there is evidence of an education effect on risk of SIDS vs. death from any other cause: women with less than a college education have a higher risk of having an infant die of SIDS than from any other cause.

Third, education differentials for risk of SIDS increase rather than decline in the later time period. In fact, for all educational categories in both unadjusted and adjusted models, odds ratios for educational attainment relative to college graduates are higher in 1996-1998 than in 1989-1991. The increases in odds ratios are statistically significant in all of the comparisons to surviving infants (except for the anomalous lowest category of education). For example, a high school graduate had a 14% higher risk of having an infant die of SIDS than a college graduate in 1989-1991, but a 43% higher risk in 1996-1998. The increase in risk was statistically significant ($p < 0.001$).

Discussion

In this case-cohort study, we found that social class inequalities in SIDS (measured by maternal education) did not narrow in the post-"Back to Sleep" campaign era, compared to the pre-campaign era. Although absolute risk of SIDS was reduced for all social class

groups, a widening social class inequality was evident; more educated women have experienced a greater decline than less educated women.

Strengths of our study include the fact that it is population-based, including all SIDS deaths in the US for the two study periods, and a random sample of non-SIDS deaths and live infants, allowing direct estimation of population rates of SIDS over time and in each social class group. Our study is also large enough to allow precise estimation of interaction effects between social class and birth cohort. The high degree of linkage in the US Linked Birth-Death Data Sets is also a strength.

Nevertheless, our study has some limitations. First, around 4% of records had missing information on mother's education and these infants had an increased risk of SIDS. It seems likely that mothers with low social class will be missing education information more often than mothers with high social class, therefore our estimates of the effects of lesser educational attainment, as well as our estimates of social class inequalities, are conservative. Second, although we were able to adjust for a wide range of potential confounders, we were lacking information on some strong risk factors for SIDS, such as breast-feeding, and had incomplete information on others, such as mother's tobacco use during pregnancy. Although our intention was to describe changes in social inequality in SIDS risk, information on breast-feeding and exposure to environmental tobacco smoke, among other factors, would be useful in explaining the continuing and widening social class inequalities that we present. It is also possible that changes in society other than the Back to Sleep campaign, such as welfare reform and economic changes might have had an impact. However, the fact that we report widening social inequalities in SIDS deaths but not in infant deaths due to other causes strengthens our interpretation that the campaign, rather than any broader social processes, has led to the increased gap. Third, we used mother's education as a proxy for social class, which may not accurately reflect the socioeconomic context of the households in which women live.

(21-24) However, in a Belgian study low maternal education, but not paternal occupational status, was associated with parents reporting a higher number of SIDS-related risk behaviours. (25)

Before the epidemiological studies establishing an association between infant sleep position and SIDS were published in the early 1990s, (see, for example:(26-28)) little was known about risk factors for SIDS that could help parents or clinicians effectively reduce risk. (29) The long-standing social gradient in SIDS risk was likely due, in part, to increased exposure to breast-feeding and decreased exposure to tobacco smoke among infants in higher social class groups. Home monitoring systems, used to detect periods of apnea and bradycardia in infants believed to be at high risk of SIDS, were more frequently used for white infants than for infants in minority racial/ethnic groups (30), perhaps due to disparities in ability to pay or discriminatory attitudes about parents' ability to comply with monitoring, but were, in any case, ineffective at preventing SIDS. (31) The epidemiological evidence that reducing the population prevalence of prone infant sleep position could dramatically lower SIDS rates offered a seemingly ideal intervention for a public health campaign: simple and free. In theory, public health interventions with these qualities ought to lead to a reduction in health inequalities, as there would appear to be few barriers to universal uptake of the intervention. Mothers can be advised at delivery about infant sleep position, whether or not they receive antenatal care or postnatal medical care for their infant. Clinicians can provide written and verbal information about infant sleep position in a myriad of different clinical settings. Mass media outlets can be used to publicize the public health message. But despite these features of the "Back to Sleep" campaign, social class inequalities in SIDS have grown since its introduction.

There are two possible, and not mutually exclusive, explanations for this phenomenon; either the information about infant sleep position is not being disseminated as

fully to women in low social class groups, or women in low social class groups are receiving appropriate advice but not heeding it.

There is some evidence that information about the protective effects of supine infant sleep position is not equally disseminated to all social class groups. In a study based in Louisville, Kentucky, researchers compared advice given to mothers who received pediatric care for their children in a private practice clinic serving mostly white middle- and upper-income families to that given to families who received care at a clinic serving mostly inner-city low-income African-Americans. (32) While 72% of the private practice families reported receiving advice about sleep positions, only 48% of the families served by the inner-city clinic reported receiving such advice. In the National Infant Sleep Position Study, conducted between 1994-1998, 21% of night-time caregivers of infants reported not receiving advice from any source to place their infants in a supine position to sleep. (33) In the 1997-1998 period, 3-4 years after the initiation of the "Back to Sleep" campaign, 40.7% of caregivers still reported receiving no advice on sleep position from a physician. In the Chicago Infant Mortality Study, prone sleep position was recommended to a higher proportion of black mothers than to mothers of other race/ethnicity. (34)

Despite receiving recommendations about infant sleep position, some parents and night-time caregivers continue to place infants in a prone or side-lying position, rather than supine. In the Louisville study cited above, nearly three-quarters of families attending the private clinic followed the advice they were given on infant sleep position, whereas only 54% of the inner-city families reported following the advice they were given. (32) In the National Infant Sleep Position Study, most caregivers (86%) who reported placing their infants in a prone sleep position had actually received advice from some source to place the infant supine. (33) Caregivers most likely to place their infants prone were mothers of low social class and mothers with parity greater than one. Black mothers, younger mothers, mothers

with parity greater than one, and those who lived in a southern or mid-Atlantic state were most likely to place their infants prone. Similar findings were reported in a Belgian study. (25) There is little empirical evidence that helps to illuminate the cultural barriers to acceptance of supine sleep position among families of low social class, although there is much speculation about the role of the advice of family and friends. We were unable to identify any qualitative studies of choices around infant sleeping environment in low social class or ethnic minority groups in the U.S., although such studies have been conducted in middle class and ethnic minority groups in Australia and New Zealand. (35, 36) More research is needed to understand how night-time caregivers in high-risk groups come to make decisions about infant sleep position, particularly in situations where they have been advised to the contrary.

It is also possible that the widened social class gap in SIDS after the introduction of the "Back to Sleep" campaign reflects social inequalities in known and unknown risk factors for SIDS that were previously somewhat masked by the widespread prevalence of prone sleep. In the U.K., Macfarlane et al. have drawn attention to the fact that interactions between socioeconomic status and risk factors for SIDS have not been fully explored. (37) Enhanced efforts to promote supine sleep, as well as breastfeeding, the avoidance of soft bedding and exposure to tobacco among families of low social class are clearly a necessity.

The US public health goals for the nation, "Healthy People 2010" place special emphasis on the reduction of health inequalities. (38) Our study illustrates the persistence and even growth in inequalities, suggesting the importance of institutional and cultural barriers, despite the availability of a free, easy and effective behavioural intervention.

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Table 1. Maternal and Infant characteristics of SIDS cases, non-SIDS dead controls and live controls

Characteristic	SIDS cases (N=21,126)	Live controls (N=2,161,580)	Non-SIDS dead controls (N=79,638)
Education			
Elementary school	7	6	7
Some high school	32	16	23
High school	35	34	35
Some college	14	20	16
College graduate	7	19	11
Age	23.8 (5.6)	26.7 (5.9)	25.7 (6.3)
Region			
North-east	11	18	19
Midwest	27	22	20
South	36	35	39
West	25	25	22
Nativity			
Born in USA	92	82	81
Born outside USA	8	18	16
Race/ethnicity			
White	58	63	45
Black	28	15	35
Hispanic	10	17	16
Other	5	5	4
Married	48	70	50
Parity			
1	30	41	40
2	34	32	28
3+	36	26	30
Tobacco use during pregnancy	30	12	14
Sex (female)	40	49	44
Gestation (weeks)	38.6 (3.1)	39.2 (2.3)	31.6 (7.9)
Preterm delivery (> 37 weeks gestation)	18	8	56
Birthweight (grams)	3115 (632)	3382 (535)	1893 (1291)
Very low birth weight (< 1500 grams)	2	0	45
Low birth weight (< 2500 grams)	12	4	12
5 minute APGAR score	8.9 (0.7)	9.0 (0.6)	5.7 (3.5)

Values in table are mean and standard deviation for continuous variables, percentage for categorical variables

Table 2. Effect of mother's education on risk of SIDS in the pre- and post- "Back to Sleep" birth cohorts

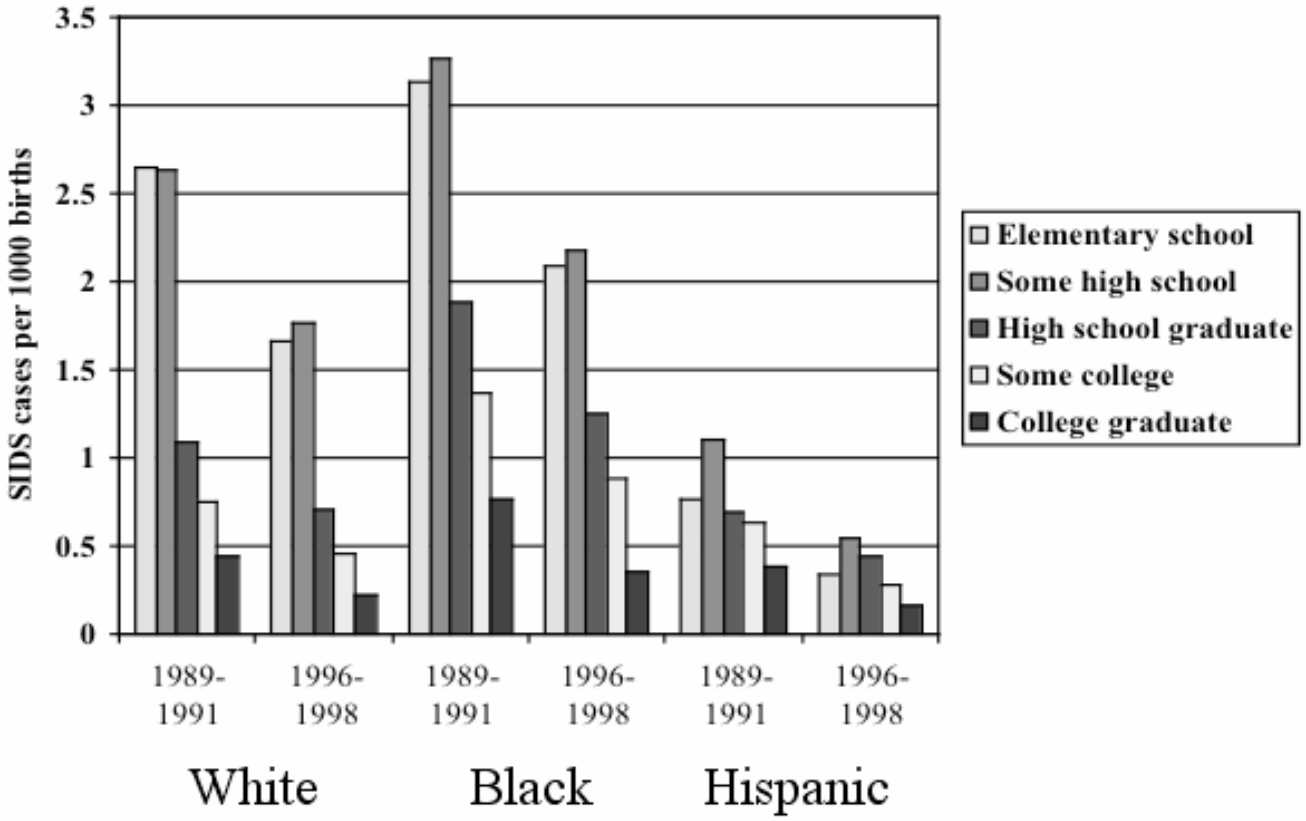
	Risk of SIDS death vs. infant surviving first year			Risk of SIDS death vs. infant death from other cause		
	OR and 95% confidence intervals		p-value	OR and 95% confidence intervals		p-value
	1989-1991	1996-1998		1989-1991	1996-1998	
Model 1 (unadjusted)						
College graduate or beyond (reference category)	1.00 (--)	1.00 (--)	--	1.00 (--)	1.00 (--)	--
Some college	1.77 (1.64, 1.92)	2.16 (1.95, 2.40)	0.003	1.31 (1.20, 1.43)	1.45 (1.30, 1.62)	0.161
Completed high school	2.56 (2.38, 2.75)	3.29 (3.00, 3.61)	<0.001	1.44 (1.33, 1.56)	1.66 (1.51, 1.84)	0.029
Some high school	5.15 (4.79, 5.53)	6.30 (5.74, 6.91)	<0.001	2.03 (1.87, 2.20)	2.43 (2.20, 2.69)	0.006
No education or elementary school only	2.99 (2.73, 3.27)	3.16 (2.79, 3.58)	0.474	1.35 (1.22, 1.49)	1.48 (1.30, 1.70)	0.259

Model 2 (adjusted)*						
College graduate or beyond (reference category)	1.00 (--)	1.00 (--)	--	1.00 (--)	1.00 (--)	--
Some college	1.08 (0.99, 1.17)	1.27 (1.14, 1.41)	0.015	1.06 (0.96, 1.17)	1.15 (1.02, 1.33)	0.282
Completed high school	1.14 (1.06, 1.23)	1.43 (1.30, 1.57)	<0.001	1.00 (0.91, 1.10)	1.13 (1.01, 1.26)	0.098
Some high school	1.45 (1.34, 1.58)	1.86 (1.68, 2.05)	<0.001	1.07 (0.97, 1.18)	1.19 (1.06, 1.34)	0.139
No education or elementary school only	1.52 (1.37, 1.68)	1.74 (1.53, 1.99)	0.078	0.98 (0.87, 1.11)	0.99 (0.85, 1.16)	0.914

P-value is the significance level of the test of differences in the odds ratios

*OR adjusted for: region of residence, infant sex, mother's age, nativity, marital status, race/ethnicity and tobacco use during pregnancy, parity, gestational age and birth weight, 5-minute APGAR score

Figure 1. Rates of SIDS per 1000 live births by mother's race/ethnicity and social class in the pre- and post-"Back to Sleep" birth cohorts


SIDS cases per 1000 births
3.5
3
2.5
2
1.5
1
0.5
0
1989-1991
1996-1998
1989-1991
1996-1998
1989-1991
1996-1998
White
Black
Hispanic
Elementary school
Some high school
High school graduate
Some college
College graduate