The Determinants of Prone Infant Sleep Position:

Analysis of the 1998-1999 Oregon Pregnancy Risk Assessment Monitoring System Dataset

by

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List of Abbreviations

.95 CI	95th Percentile Confidence Interval
AA	African-American
AN	Alaskan Native
AAP	American Academy of Pediatrics
BC	Birth Certificate
CATI	Computer-Assisted Telephone Interview
CDC	Centers for Disease Control and Prevention
DHS	Department of Human Services (State of Oregon)
HMO	Health Maintenance Organization
L & D	Labor & Delivery
LBW	Low birthweight
NHW	Non-Hispanic White
OR	Odds Ratio
PAR	Population Attributable Risk
PRAMS	Pregnancy Risk Assessment Monitoring System
SD	Standard Deviation
SES	Socioeconomic Status
SIDS	Sudden Infant Death Syndrome
WIC	Women, Infants and Children's Supplemental Nutrition Program

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Abstract

BACKGROUND: The Sudden Infant Death Syndrome (SIDS) is the third leading cause of infant mortality in the United States (0.62 deaths per 1000 live born infants per year), accounting for 9.0% of all infant deaths in the U.S. Prone infant sleep position is the predominant modifiable risk factor for SIDS. In 1992, the American Academy of Pediatrics recommended healthy infants be placed non-prone. In 1994, a nationwide "Back to Sleep" campaign was launched. The prevalence of prone sleeping position has fallen dramatically, from 70% in 1992 to 17% in 1998, with a concomitant 38% drop in the SIDS death rate. The reduction in prone infant sleeping position among African-American infants has lagged behind that of non-Hispanic white infants, and the racial disparities in sleep position and in SIDS deaths rates have widened.

METHODS: The Pregnancy Risk Assessment Monitoring System (PRAMS), a mixed mode surveillance system, uses a stratified, weighted sample of women having recently given birth, collecting information on a wide variety of maternal characteristics and behaviors. Utilizing the 1998-1999 Oregon PRAMS dataset, race/ethnicity, parity and initiation of prenatal care, all previously identified as important determinants, were analyzed to compare Oregon's experience to that of others.

RESULTS: *African-American race* was the single most significant predictor of prone positioning, with crude odds ratio 2.11 (.95 CI 1.35 – 3.30) and adjusted odds ratio 4.35 (.95 CI 2.55 – 7.42). *Parity* was a significant predictor, as well, with an crude odds ratio (OR) for a fourth or higher child of 3.83, .95 confidence interval (CI) 1.69 – 8.65, and adjusted OR of 7.56 (.95 CI 3.13 – 18.27) compared to a firstborn child. The results

for a second or third child were intermediate. *Initiation of prenatal care* was not found to be significant, but the power to detect an odds ratio of at least 2.0 was only .61.

Prenatal care site was found to be a very significant determinant of prone infant sleep position, with a crude odds ratio of 4.62 (.95 CI 2.07 – 10.31) for care from private physicians and HMOs compared to health department clinics, and adjusted odds ratio of 8.80 (.95 CI 2.23 – 34.73). This association has not been previously reported. The analysis of well baby care site was inconclusive and, at best, far weaker, and the analysis suffered from survey and power difficulties.

DISCUSSION: The high prevalence of prone infant sleep position among African-American infants may account for much of the racial disparity in SIDS. The reasons why African-American or multiparous mothers choose prone sleep position as frequently as they do are unclear and are worthy of further study. Both of these groups should be targeted for more, and perhaps different, health education regarding infant sleep position. Private physicians and HMOs providing prenatal care should increase or initiate "Back to Sleep" efforts with their patients. Further research is needed on the impact of well baby care site on choice of infant sleep position, and on understanding the motivation of higher-risk subgroups in their choices of position, in order to design more effective supine infant sleep position promotion measures.

Background and significance

Prone infant sleep position is a significant and modifiable risk factor for Sudden Infant Death Syndrome (SIDS) and the promotion of supine infant sleep position has been the foremost public health intervention aimed at reducing the incidence of SIDS.

SIDS

Sudden Infant Death Syndrome (SIDS) is defined as the sudden death of an infant (a child under one year of age) that remains unexplained after a thorough case investigation, including performance of a complete autopsy, examination of the death scene, and review of the clinical history.(1) SIDS is uncommon before one month of age or after six months, and its peak incidence is between two and three months of age.(2)

Nationally, in 2000, the last year for which complete data is available, SIDS was the leading cause of postneonatal infant deaths, and the third leading cause of all infant deaths, with 0.62 per 1000 live born per year, and accounting for 9.0% of all infant deaths.(3, 4) The mortality rate for white infants was 0.50 per 1000 and for African-American infants was 1.3 per 1000.(3)

SIDS also ranks third as a cause of infant mortality in Oregon but Oregon's SIDS mortality rate is nearly twice that of the nation as a whole. In Oregon, for the year 2000, the infant mortality rate for SIDS was 1.1 per 1000 live births per year, accounting for 20% of all infant deaths, 3% of all neonatal deaths and 54% of all post-neonatal deaths, being the leading cause of post-neonatal infants deaths, with the mortality rate for males (1.44) nearly twice that for females (0.76).(5) During 2000, 51 Oregon infants died of SIDS, 5 between 7-27 days of age (neonatal) and the remainder between 28-364 days of age (post-neonatal). While the absolute numbers may be relatively small, 2523 infants dying of SIDS nationwide[3] and 51 in Oregon[5] in the year 2000, SIDS deaths remain a significant cause of infant mortality. SIDS is devastating to the families involved and may often be preventable.

A number of maternal and infant characteristics have been reported as risk factors for SIDS.[6-15] These include multiparity and short inter-pregnancy intervals, mother's education less than 12 years, mother not married, mother's age less than 20 years at first pregnancy, chronic unemployment and public assistance, late onset or no prenatal care, race/ethnicity, low birth weight, small for gestational age and multiple births, male sex and recent respiratory illness. The interactions between race/ethnicity, socioeconomic status (SES) and SIDS are not straightforward.[2] The racial disparity in SIDS deaths may be independent of SES,[16] but related to cultural factors.

An increased incidence of SIDS during the winter months has been widely reported,[6] but this may be due to increased exposure to respiratory illness or risk of over-bundling; multiparity and passive smoking may act by increasing the exposure to illness, as well. Studies exploring the relationship between breastfeeding and SIDS are inconclusive.[17] Some[18-22] have found that breastfeeding lowers the risk of SIDS; others have not.[23-25] One recent study found that the relationship persisted after adjustment for socioeconomic status (SES) but disappeared when adjusted for other environmental factors.[26] Use of a pacifier has been reported to be protective.[24, 26] Prenatal and postnatal maternal cigarette smoking are risk factors for SIDS,[26, 27] but the relative contributions of each are unclear as women who smoke during pregnancy tend to smoke after as well. In addition, soft sleep surfaces and pillow use, loose bedding, and overheating have been implicated as risk factors for SIDS.[24, 26, 28-33]

Co-sleeping (the sharing of a adult bed by the infant and an adult or older child) as a risk factor is controversial;[34-37] co-sleeping with smoking mothers has been more consistently associated with SIDS.[24, 38-41] Parental alcohol consumption, parental fatigue, lack of an alternative sleeping place and use of thick bed coverings and other established risk factors may account for some or all of the association of SIDS with co-sleeping;[39] even if co-sleeping is not a risk factor, per se, it may be associated with more well established risk factors, such as non-standard sleep surfaces and loose bedding.[39, 42, 43] In reviews of death investigations of sudden deaths among infants,[37, 42] co-sleeping was frequently associated with non-standard sleep surfaces and other unsafe sleep practices. One recent study found an increased risk for SIDS due to co-sleeping (OR 3.6) primarily if the co-sleeper was someone other than the mother and for co-sleeping when the sleep surface was a sofa, but not when cases involving a sofa were excluded.[26] Co-sleeping may promote breastfeeding,[44] and may improve infant arousability,[45] but no study has found that co-sleeping reduces the risk of SIDS. The single most important risk factor identified to date has been prone infant sleep position.

Infant Sleep Position

In the 1970's, reports began implicating prone infant sleep position, the predominant position in the United States, as a significant risk factor for SIDS. The evidence in support of a role for infant sleep position in the causality of SIDS includes both case-control and ecologic studies. Epidemiological studies have found odds ratios ranging from 1.7 – 12.9, with most falling in the range of 3.5 – 9, for prone sleep position.[14, 18, 24, 26, 29, 46-50] The incidence of SIDS is low in countries where infants are rarely put to sleep prone, such as in Asia,[51] although these reports suffer from the limitations of ecological studies. More compelling was been the observation that the incidence of SIDS has fallen following changes from predominately prone to predominately supine sleeping position in Scandinavia,[52, 53] New Zealand,[54] Australia,[55] and the United Kingdom.[56] In April 1992, the American Academy of Pediatrics issued a statement recommending a non-prone sleeping position for all healthy infants[57]. At that time, the mortality rate for SIDS was 1.01 per 1000 live-born white infants and 2.18 per 1000 for live born black infants.[58]

The AAP recommendation for non-prone sleep position was recently reaffirmed;[59] supine sleep is preferred but lateral sleep position, while not as safe as supine, has a significantly lower risk than prone and is acceptable, with an added recommendation to place the infant's lower arm forward to prevent rolling. The risks associated with lateral sleep position,[38] with a reported OR of 2-4, may be due to the instability of the position with a greater potential to roll into prone than if placed supine.

The mechanism(s) by which prone sleep position lead to SIDS remains controversial. It appears likely that apnea is the final common pathway to SIDS,[2] rather than a cardiovascular mechanism, as proposed by some.[60] Some believe that prone sleep – as well as soft bed surfaces and overlying bedding, other known risk factors – increases re-breathing of expired air, elevates ambient CO_2 and reduces ambient O_2.[61-64] Others dispute the clinical significance of re-breathing expired air and suggest that the prone sleep position acts through impairment of infant arousal – or auto-resuscitation – from commonly occurring, brief apneic episodes.[2, 46, 65-67] Prenatal exposure to maternal smoking may act through impairment of arousal, as well.[68] Genetic and environmental factors (e.g. infections, hyperthermia) may act as facilitators of these proposed mechanism(s) of prone sleep position. The combined risks of prone sleeping and soft bedding (OR 21.0) or pillow use (11.8) may be greater than would by expected by a simple multiplicative effect.[26] SIDS is likely the result of multifactorial causation, due to risk factors with variable risk (odds ratios) and variable prevalence,[69] some intrinsic and some extrinsic to the infant, probably of both prenatal and postnatal occurrence, one of which is prone sleep position.

The nationwide “Back to Sleep” campaign, a joint effort of the American Academy of Pediatrics, U.S. Public Health Service, SIDS Alliance and Association of SIDS and Infant Mortality Programs began June 1994. At that time the SIDS mortality rate was 0.85 per 1000 live births for white infants and 1.94 for black infants.[58] The prevalence of prone infant sleep position and the incidence of SIDS have both reportedly declined since the start of the campaign. Willinger and colleagues reported that choice of prone sleep declined from 70% in 1992 to 43% in 1994, 24% by 1996 and 17% by 1998, with a corresponding increase in supine sleep from 13% to 56% and lateral sleep from 15% to 27%;[70, 71] SIDS rates declined approximately 38% during this same period, although the SIDS rates among black infants have not declined as rapidly as those among non-blacks.[70, 72] The total infant mortality declined, as well – roughly 23% – over this period.[73] There was no concomitant rise in the rates of aspiration or acute lifethreatening events among infants,[74] as some feared would follow a switch from prone to supine sleep position.

Many of the older epidemiological investigations of SIDS risk factors did not adjust for prone infant sleep position. Investigators have indentified the following factors as still significant, following “back-to-sleep” campaigns: maternal smoking, bottle feeding, side infant positioning, young maternal age, low maternal education and SES, unwed marital status, late prenatal care, multiparity, multiple births, prematurity, low birthweight, lack of pacifier use and male gender.[21, 26, 38, 75, 76] The age distribution is unchanged, but the winter prediliction has been blunted.[21, 75]

Previous studies, subsequent to the 1992 AAP recommendations, have identified a number of determinants of prone infant sleep position. Race and ethnicity, specifically African-American race, has been the strongest and most consistently reported risk factor for prone sleep[70, 77-80], with OR 1.5 – 2.4. African-American mothers are also more likely to switch from use of non-prone to prone positions by age three months (OR 1.7), as are younger mothers (OR < 18 year old 2.2, 18 – 24 years old 1.6) and multiparous women (OR two children 1.5, three or more children 1.7), when the SIDS risk is still high; overall, 11- 40% of mothers, often citing infant comfort and improved sleep, switch from the use of non-prone to prone positions between three and seven months after delivery, depending on the populations studied.[79, 80] Infants under eight weeks of age were 0.63 times as likely to be placed prone as infants 16 or more weeks old.[70]

Parity,[70, 77-79] with OR 1.3 – 2.6, and initiation of prenatal care after the first trimester,[78] with OR 1.4 – 3.6, have also been reported as risk factors. Other factors less consistently or strongly associated include normal birthweight[77], older infant age[70, 79] and male infant gender,[79] single marital status,[80] younger maternal age[70, 79, 80] and use of public clinics for pediatric care;[81] some investigators[77-80] but not others[70] have identified maternal education level as a risk factor, although associations with both less than and more than high school have been reported. Two studies[80, 82] of inner-city, low-income, predominantly African-American women, but not a third,[83] found presence of the baby's grandmother in the home to be a significant predictor for use of prone position (OR 1.8 – 2.9). Some of these differences may be attributable to timing of the study in relation to the initiation of the Back-to-Sleep campaign, the population studied, the size of the study population and/or the age of the infant at the time of the study.

Study Goals and Hypotheses

This study was designed to identify significant risk factors for prone infant sleep position in Oregon for the purposes of program evaluation using population-based cross-sectional surveillance data from Oregon's Pregnancy Risk Assessment Monitoring System. The sample data are analyzed in a way that allows findings to be applied to all Oregon women who have recently had a baby. The results of this analysis are intended to be used for the Department of Human Services (DHS) Health Services program evaluation by identifying sub-populations in Oregon at greater risk for SIDS due to lesser adoption of infant supine sleep position despite ongoing efforts to encourage supine sleep.

The primary goal of this study was to determine if race, parity and delayed prenatal care were risk factors in Oregon as they were elsewhere. The three hypotheses were that each of these three factors was a significant determinant of prone infant sleeping position in Oregon. The null hypotheses were that none of these three factors were significant predictors of prone infant sleep position.

The secondary goal was to identify other significant Oregon risk factors to generate hypotheses for further evaluation. The information generated might then be used to modify or re-direct public health efforts to further reduce prone infant sleep position.

Methods

PRAMS

Oregon PRAMS, the Pregnancy Risk Assessment Monitoring System, is an ongoing public health surveillance project of the Office of Family Health of the Department of Human Services' Health Services. It combines mailed questionnaires with computer-assisted telephone interviews (CATI) of non-respondents. Oregon PRAMS relies upon a stratified random sample of women who have recently given birth, utilizing birth certificates for the selection of the sample. To ensure adequate sample size for analysis, five of the six strata (African-Americans, Hispanics, Asians and Pacific Islanders, American Indians and Native Alaskans, and babies with birthweights less than 2500 grams) are over-sampled; the sixth strata consists of Non-Hispanic white women with normal birthweight babies. Modeled after the PRAMS survey developed by the Centers for Disease Control and Prevention, Oregon PRAMS began in November 1998. The questionnaire asks a number of questions about the woman's prenatal, perinatal and post-natal experiences, attitudes and practices. The PRAMS information is also linked to the Birth Registry information, to obtain additional demographic information from birth certificates.

Beginning two to six months after delivery, women are mailed a questionnaire and an explanation of PRAMS. About three weeks later, a second mailing is sent to non-respondents. About two weeks after this, those still not responding are referred to the CATI contractor for phoning, using a script modeled after the written questionnaire. Women are generally called beginning six weeks after the initial mailing. During Oregon

PRAMS' first year (November 1998 through October 1999), of 2,919 total women sampled, 1,867 responded, for a response proportion of 64.0%.[84] Of the 1867 total respondents, 1308 women (70.1%) responded to the first mailing 230 (12.3%) to the second mailing and 329 (17.6%) to the CATI.

Staff at the Department of Human Services (DHS) Health Services entered the information from the questionnaires and from the CATI interviews into a database, which was then converted to an SPSS dataset. A DHS Health Services Office of Family Health research analyst, working with the CDC, devised a three-tiered weighting scheme, in order to make the sample representative of Oregon women as a whole. First, each respondent was assigned a weight, ranging from 1.95 for American Indian/Alaskan Native women to 61.75 for Non-Hispanic White women with babies weighing ≥ 2500 grams at birth, to account for the sampling design and restore the proper demographic proportions to the dataset.

Next, each respondent was assigned a weight, ranging from 1.19 to 2.74, to account for non-responders, based on the following characteristics: race/ethnicity, marital status, parity, initiation of prenatal care, maternal age and maternal education (e.g., young women were less likely to respond than older women). Finally, each respondent was assigned the weight of 0.9998 to account for the very few birth certificates (about 0.03%) that were lost from the sampling frame. The dataset was linked with the birth certificate and a number of data elements imported. The dataset was then de-identified by staff at the DHS Health Services and a subset of the full dataset was then made available for this analysis. Only authorized DHS Health Services staff would be able to re-identify respondents. DHS is a HIPPA-compliant covered entity. (For additional details on PRAMS Methodology, see Appendix A)

As an ongoing public health surveillance project, the DHS Health Services determined that PRAMS is not research and therefore does not require IRB approval. The mailings and CATI script explain the methods and risks. Voluntary response to the mailed survey implied consent. Verbal consent is given for the CATI. The dataset used for this analysis was de-identified and responses cannot be traced back to specific individuals.

Population Studied

All Oregon women who had given birth within the previous 60-180 days, as identified by birth certificate records submitted to the DHS Health Services within the previous month, beginning in November 1998, were eligible for sampling. Random sampling was by strata. The overall response proportion was 64.0%, totaling 1,867 respondents, with 277 non-Hispanic white women with low birthweight babies (strata 1), 416 non-Hispanic white women with normal birthweight babies (strata 2), 443 Hispanic women (strata 3), 211 African-American women (strata 4), 306 Asian or Pacific Islander women (strata 5) and 214 American Indian or Alaskan Native women (strata 6). Of these women, 1824 were eligible to respond to the infant sleep position question, based on the PRAMS skip pattern requiring the infant to be alive and living with them at the time of the survey (see below under Variable Selection and Coding). Of the women eligible to respond, 1763 (96.7%) had valid responses for the infant sleep position question. See Appendix F, Tables 18 and 19, for population characteristics.

Variable Selection and Coding

Potential risk factors were selected for analysis if other investigators had evaluated these variables or if DHS Health Services' Office of Family Health deemed them of interest. See Appendix B for the list of variables.

Some variables were taken exclusively from the birth certificate, including mother's race, age, education, marital status, parity, and infant's gender, birthweight, and date of birth. Others were taken exclusively from PRAMS, including infant sleep position, prenatal care site, well baby care site, duration of breastfeeding, co-sleeping, current insurance status and family income and current smoking and alcohol status. A third group of variables was taken from both the birth certificate and PRAMS, including insurance status at delivery, smoking status and alcohol use during pregnancy, timing of prenatal care and WIC enrollment, as the responses from the two sources might differ.

PRAMS includes three choices for **usual** infant sleep position: stomach, back and side. For the purposes of this analysis, back and side were combined. The risk of SIDS with lateral (side) sleep position (OR 1.84 – 2.57) is intermediate between but closer to supine (back) than prone (stomach) sleep position.[14, 24, 50]

PRAMS includes a number of "skip patterns"; i.e. respondents are asked to skip questions. For example, question 49 asks "*is your baby alive now?*" and, if yes, "*is your baby living with you now?*" Those who respond that their baby is not alive or not living with them are asked to skip questions 50 – 65. These questions include infant sleep position, type of well baby care site and co-sleeping status. If such a respondent inadvertently answered these questions instead of skipping them, their responses were entered into the original dataset. For the purposes of this analysis, all responses that failed to comply with the skip pattern were coded as "missing".

In addition, in general, for those subjects who responded to any question "*I don't know*", the responses were coded as missing. One rare exception was for questions of the form "*When did you....*" If the question included the choice "*I never*", or a comparable choice, as did PRAMS *WIC enrollment* question 27, and the respondent opted instead for "*I don't know*", it was assumed that the uncertainty regarded the timing only. If the variable was to be recoded into a binary yes/no format, these responses were coded as "*yes*", rather than invalidate the responses entirely and lose the information. Of the respondents to question 27 *WIC enrollment*, 690 indicated that they never enrolled in WIC, 118 responded that they did not remember [when they enrolled] and 789 provided the timing of enrollment.

PRAMS question 63 asks "*how many times has your baby been to a doctor or nurse for <u>routine</u> well baby care?* " If the respondent answered "*My baby hasn't been for routine well baby care"* but ignored the skip pattern and went on to answer question 64 *"When your baby goes for routine well baby care, where do you take him or her?*", their response was coded as missing. If question 63 was left blank and question 64 answered, the response was retained. Question 64 allowed the respondent to choose more than one type of site. The primary coding of this variable included only those respondents choosing one type of site. In contrast, question 25 "*Where did you go <u>most of the time</u> for your prenatal visits?*" allowed only one response, simplifying the analysis.

Infant age: Time from infant birth to completion of the PRAMS survey was coded as "*infant age*" in weeks, as a control (confounding) variable. Unfortunately, the

PRAMS dataset did not include the date of the a computer-assisted phone interview (CATI), while those women responding to either the first or second mailing almost always included a date (> 90%). Given the timing of the mailings and the delay between mailing and referral to the CATI contractor, and the fact that 90% of all women responded after 10 weeks post-partum, it is assumed that all CATI respondents were surveyed after 13 weeks post-partum. Infant age was therefore coded as before or after 13 weeks, as this corresponds to the time frame in which mothers typically switch from supine to prone positioning and was also the categorization used by a number of earlier investigators.

Duration of breastfeeding: Of the women eligible to respond, 156 never initiated breast-feeding, 64 breast-fed for less than one week and 582 reported breastfeeding from one to 36 weeks. Nine-hundred-and-sixteen women reported that they were still breastfeeding. These women were assigned their "infant age", as determined above, as the breastfeeding duration. As the breastfeeding variables looked at started/never started, at least 4/less than 4 weeks and at least 10/less than 10 weeks, and as no woman would have responded by four weeks and > 90% of all the women responded after 10 weeks, and as those women who responded by CATI and had missing date data – and would have the longest interval between their child's birth and completion of the survey – this was considered very unlikely to introduce any significant bias.

Birth order was coded from birth certificate data, combining the birth certificate data elements "*live birth living*" and "*live birth dead*" into a single numerical parity variable. This variable was then recoded as a binary variable (firstborn vs. not firstborn) and by adopting the coding used by Pollack and Frohna[77], a categorical variable with four levels. All were considered as candidate variables and tested in the logistic regression models. The most significant version was retained.

Initiation of prenatal care was coded from both the birth certificate data elements and PRAMS question 21: "about how many weeks or months were you whey you had your first visit for prenatal care?" Data from both the birth certificate and from PRAMS were utilized and there were differences in the data and the results. The Cox and Snell R^2 for the univariable regression model using a binary *initiation of prenatal care* variable from both the birth certificate (outcome) and from PRAMS (determinant) was 0.154, indicating only a moderate correlation.(85) Only sixty-eight percent of the subjects indicated care within the first trimester on both the birth certificate and PRAMS, and only 12% indicated care not within the first trimester on both; 20% of the respondents had discordant information, 13% indicating later initiation on PRAMS and 7% indicating earlier initiation than on the birth certificate. No attempt was made to validate one source against the other. There were similar problems with the *WIC enrollment during pregnancy variable*, with 116 respondents reporting enrollment to PRAMS but not on the birth certificate and 31 respondents reporting enrollment on the birth certificate but not to PRAMS; an additional 166 responses were coded on the birth certificate but missing from PRAMS.

SPSS and SUDAAN

Data management and recoding were done using SPSS v. 10. Cross-tabulation and logistic regression analysis were done using SUDAAN 8.01. SUDAAN software was used to account for the complex sample design involving a stratified weighted sample. Variable significance was estimated using the Wald-F test statistic,(85) with level of significance $p < .05$. Odds ratios are shown with 0.95 confidence intervals. All estimations of the odds ratios and the significance testing were based on the weighted data.

Analytical Method

Univariable logistic regression

Each risk factor mentioned previously was entered into a univariable logistic regression model, using the SUDAAN logistic regression procedure, with infant sleep position as the dependent variable (and prone position as the outcome). Following univariable analysis, maternal race/ethnicity, birth order and initiation of prenatal care – as the primary hypotheses – and those variables with Wald-F p-value < 0.25,[85] and those variables "clinically or intuitively relevant"[85] or requested by the DHS Health Services Office of Family Health epidemiologist, despite Wald-F p-value ≥ 0.25, were selected as candidates for inclusion in the multivariable logistic regression models.

Multivariable logistic regression

The change-in-point estimate method of multivariable regression was selected for the identification of confounding variables.[86] (see Appendix D for a graphic description of the method) The target variable (e.g. *Race/ethnicity*) was analyzed in a simple logistic regression model. A crude odds ratio (e.g. African-American race compared to Non-Hispanic Whites) was obtained. This constituted the target odds ratio. Next, each variable from the panel of candidate variables selected for analysis was added singly to the model, producing a series of models that included the target variable and one candidate variable. That variable which changed the target odds ratio the most, either up or down, <u>and</u> produced at least a 10% change,[86] was added to the model. Again, the remaining variables were added singly to the model, now consisting of the target variable and one confounder, producing a series of models that included the target variable, one confounder and one of the remaining candidate variables; the same criteria – using the value of the target odds ratio from the preceding step – were used to add additional variables to the model. In addition, after the third variable (second confounder) was added to the model, each previously added variable, other than the target variable, was removed singly if the target odds ratio did not change by at least 10% when that previously added variable was removed from the model. This removal step followed each addition step. The analysis continued until no remaining variable produced at least a 10% change in the target odds ratio and no variable met removal criterion. Those variables added to the model were considered to be confounders.

Following the identification of all confounders in a given analysis, a forward stepwise logistic regression procedure was utilized, to identify non-confounding but statistically significant variables from the remaining candidate variable, with entry criterion of a Wald-F p-value $< .05$ and removal criterion of a Wald-F p-value $> .10$; this did not apply to the previously identified confounders, which were retained regardless of p-value. (see Appendix E for a graphic description of the method) In this way, a crude OR, an OR adjusted for confounders only and an OR adjusted for confounders and independent (non-confounding) but statistically significant variables were obtained. All target variables were analyzed in the same way.

When multiple codings of a single variable (e.g. mother's age), or multiple similar variables (e.g. insurance at delivery from PRAMS and insurance at delivery from the birth certificate) were tested as confounding (control) variables and one of the variations of that variable met entry criteria, the other variations were dropped from further steps in that model-building procedure. If a variable previously entered met removal criterion, all variations of that variable were again eligible for testing in further steps of that model-building procedure.

Following completion of the multivariable analysis of the selected target variables, a forward-stepwise model-building procedure was performed, using the entire pool of candidate variables. This was done to compare the results of the "change-in-point-estimate" model-building procedure, which focused on identifying the confounders of a single target variable, with a commonly-used procedure relying solely on statistical significance for variable selection. Entry criterion at each step was the most statistically significant variable with a Wald-F p-value < .05; removal criterion at each step was any variable with a Wald-F p-value > .10. This procedure was continued until no further variables met entry or removal criteria.

Pollack and Frohna[77] recently reported the results of the combined PRAMS data of 15 states using the 1996-1998 infant birth cohorts and including data on 55,263 live infants. Potential confounders/control variables were selected *a priori*. The Oregon data was fit to a similar model; modified comparison variables, with combined categorical levels, were used for *initiation of prenatal care* and *infant birthweight*, to avoid small cell sizes in the Oregon dataset.

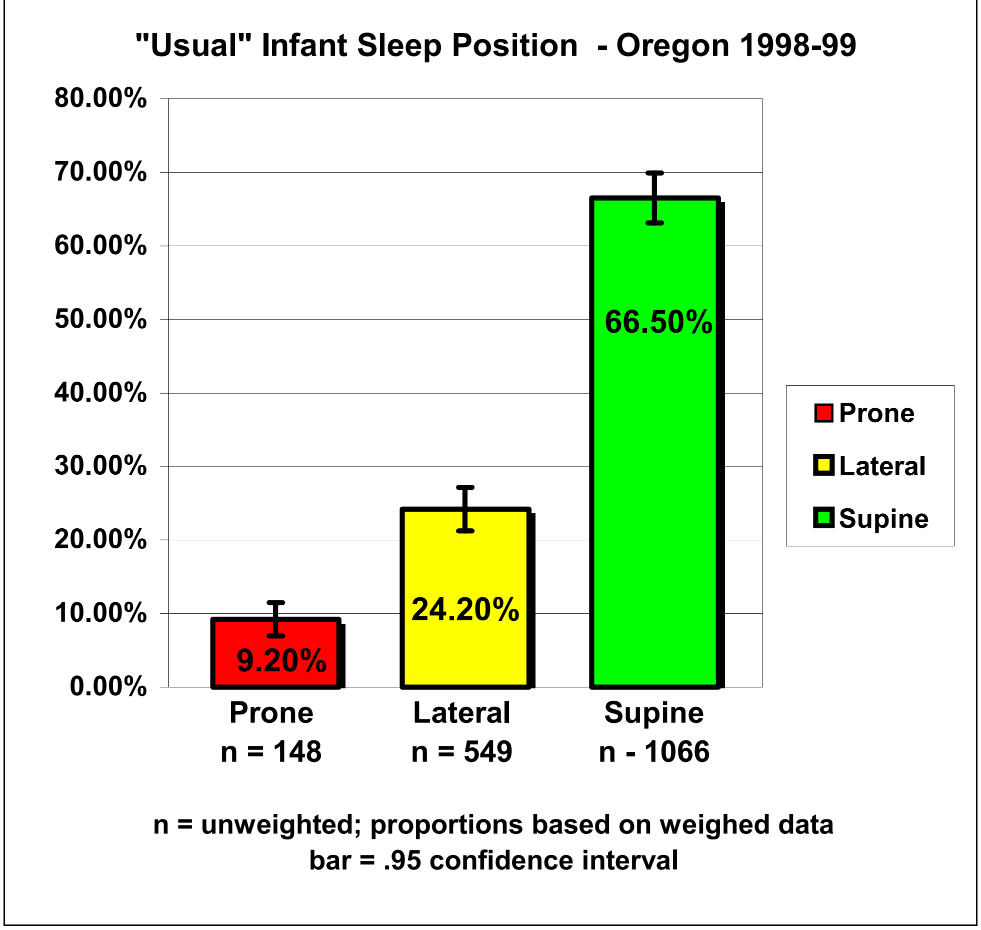
Post hoc Power analysis and the Design Effect

PRAMS utilizes a complex survey design, involving stratified random sampling without replacement and unequal probabilities per strata (over-sampling), followed by weighting of the strata. Power calculations must take this into account. The design effect (DEFF) is used to adjust for the complex study design.[87-89] The DEFF estimations, using SUDAAN 8.01's $DEFF_1$ option to measure variance inflation due to stratification, clustering, unequal weighting and over-sampling and assuming a fixed total sample size[89], were obtained using the logistic regression model consisting of the target variables and confounders. The sample sizes were readjusted by dividing the actual unweighted sample sizes by the calculated DEFF to obtain the effective sample sizes.[87] Estimates of power were based on the effective sample sizes. Power calculations were performed, assuming a simple random sample, using Epi Info 2002, Statcalc utility, power or sample size calculator, cohort or cross-sectional study. For all target variables, *race/ethnicity*, *parity*, *initiation of prenatal care*, *prenatal care site* and *well baby care site*, the smallest odds ratio that could be detected to achieve a power of .80, given the effective sample size, was determined. In addition, for those target variables that did not achieve statistical significance, *timing of initiation of prenatal care* and *well baby care site*, the power to detect a true odds ratio of at least 2.0, given the effective sample size, was also determined.

Results

Prone sleep position as the ***usual*** infant sleep position was reported by 9.2% of all respondents with valid responses (see Figure 1 below). Most women (66.5%) usually put their babies to sleep supine.

Figure 1: Distribution of infant sleep positions among Oregon women. The percentages represent the proportions of women responding to the PRAMS infant sleep position question and are based on the weighted data. The absolute numbers given are unweighted. These 1763 respondents represent 96.7% of the entire sample; there were 3.3% missing responses.



Demographics

The mean age of the women was 26.75 years (± 2SD 0.45 years), with 13.49 (± 0.57) years of education. The mean parity was 1.95 (± 0.08) children; nine percent had four or more. Slightly more than 29% were single or divorced and 26.4% had an annual family income under $15,000 (weighted proportions are reported unless otherwise stated). Slightly over 75% initiated prenatal care in the first trimester. At the time of delivery, 38.1% of the women had public insurance (the Oregon Health Plan or the Indian Health Care Program), 60.1% had private insurance (one's own or one's spouse's employer, CHAMPUS, other), and 1.8% were uninsured. Ninety-two percent had initiated breastfeeding and 63.4% breastfed at least ten weeks. Twenty percent of the women always co-slept with their baby and 23.6% never did. The proportion of women reporting their race/ethnicity as African-American was 2.0%, Hispanic 14.3%, Asian or Pacific Islander 4.6%, American Indian or Alaskan Native 1.4% and non-Hispanic white 77.6%. Detailed demographic information can be found in Appendix F, Tables 18 - 19.

Univariable Logistic Regression Results

The results of univariable logistic regression, with prone infant sleep position as the outcome, can be found in Tables 1-3. Candidate variables that were eliminated due to small cell sizes (unweighted < 5 respondents) were: birthweight, when categorized as < 1500 grams; insurance at labor and delivery, when categorized as "no insurance"; mother's education, when categorized as < 8 years; alcohol use, from the birth certificate;

and last trimester alcohol use, from PRAMS, when categorized as at least one drink per week.

Table 1: Univariable Logistic Regression, Prone Sleep Position, Independent Variables (p < .05) *

Variable	Unweighted n	OR (.95 CI)	p-value
BC † Race/ethnicity			< .0001
African-American	205	2.11 (1.35 - 3.30)	
Hispanic	412	0.44 (0.26 - 0.77)	
Asian/Pacific Islander	296	0.79 (0.48 - 1.31)	
American Indian/Alaskan Native	197	0.41 (0.22 - 0.79)	
N0n-Hispanic White (referent)	653	1.00	
BC Parity (per birth)	1761	1.32 (1.08 – 1.62)	.0061
BC Parity			.0147
1st (referent)	785	1.00	
2nd	537	1.62 (0.83 – 3.15)	
3rd	271	1.41 (0.63 – 3.17)	
4th and higher	168	3.83 (1.69 – 8.65)	
BC Parity			.0314
Not firstborn	976	1.88 (1.06 – 3.33)	
Firstborn (referent)	785	1.00	
PRAMS Co-sleeping			.0367
Never	330	1.88 (1.04 – 3.39)	
Sometimes/Almost Always/Always (referent)	1428	1.00	
BC Maternal education			.0002
≥ 10 years	1535	4.42 (2.02 – 9.69)	
< 10 years (referent)	214	1.00	
PRAMS Prenatal care site			.0021
Hospital	305	2.55 (0.88 – 7.32)	
Health Department (referent)	226	1.00	
Private	1056	4.62 (2.07–10.31)	
Other	119	3.55 (1.02–12.36)	
PRAMS Prenatal care site			.0406
Private	1056	2.42 (1.22 – 4.79)	
Hospital & Health Department (referent)	531	1.00	
Other	119	1.86 (0.57 – 6.01)	
PRAMS Prenatal care site			.0228
Private	1056	2.03 (1.10 – 3.75)	
Not Private (referent)	650	1.00	
PRAMS alcohol last trimester			< .0001
No alcohol use	1635	5.95 (2.65 – 13.36)	
Any alcohol use (referent)	82	1.00	

*** odds ratio and p-value based on weighted data** **† BC = Birth Certificate**

While maternal alcohol use in the third trimester was highly statistically significant when coded as none vs. any alcohol use, the reporting of alcohol use was significantly associated with the mode of administration of PRAMS, mail vs. CATI, and was believed to be biased. It will not be considered further in this analysis. See Appendix G. Smoking during pregnancy was not associated with mode of administration (data not shown) and was placed in the pool of candidate variables.

Table 2: Univariable Logistic Regression, Prone Sleep Position, Independent Variables (.05 ≤ p < .25) *

Variable	Unweighted n	OR (.95 CI)	p-value
PRAMS Breastfeeding			.2461
> 4 Weeks	1252	1.55 (0.74 – 3.28)	
≤4 Weeks (referent)	434	1.00	
BC † Maternal education			.1189
< 12 years	428	0.96 (0.39 – 2.35)	
12-15 years	942	1.77 (0.89 – 3.53)	
≥ 15 years (referent)	379	1.00	
BC Maternal education			.1948
< 16 years	1370	1.56 (0.80 – 3.06)	
≥ 16 years (referent)	379	1.00	
BC Maternal education			.2015
≥ 12	1321	1.62 (0.77 – 3.35)	
< 12 years (referent)	428	1.00	
PRAMS source			.1233
First mailing (referent)	1234	1.00	
Second mailing	212	0.35 (0.13 - 0.99)	
Computer Assisted Telephone Interview	317	1.08 (0.53 – 2.20)	

*** odds ratio and p-value based on weighted data** **† BC = Birth Certificate**

Table 3: Univariable Logistic Regression, Prone Sleep Position, Clinically and Intuitively Important Independent Variables (p ≥ .25) *

Variable	Unweighted n	OR (.95 CI)	p-value
BC † Infant gender			.8945
Female	869	1.04 (0.60 - 1.78)	
Male (referent)	894	1.00	
BC Birthweight			.4324
≥ 2500 grams	1449	1.21 (0.75 – 1.96)	
< 2500 grams (referent)	314	1.00	
PRAMS Infant age			.8329
< 13 weeks	572	1.07 (0.58 – 1.97)	
≥ 13 weeks (referent)	813	1.00	
PRAMS Breastfeeding			.8277
No	155	1.12 (0.41 – 3.03)	
Yes (referent)	1531	1.00	
PRAMS Breastfeeding			.8986
< 10 weeks	606	1.09 (0.58 – 2.05)	
≥ 10 weeks (referent)	1046	1.00	
PRAMS well baby care site (single response)			.7622
Hospital only	314	1.36 (0.43 – 4.31)	
Health Department only (referent)	239	1.00	
Private physician/HMO only	1010	1.56 (0.59 – 4.09)	
Other only	83	0.99 (0.19 – 5.10)	
BC Initiation of Prenatal care			.9603
Within the first trimester	1385	1.02 (0.51 – 2.02)	
Later than the first trimester or none (ref.)	372	1.00	
PRAMS Initiation of Prenatal care			.5781
Within the first trimester	1220	1.20 (0.63 – 2.28)	
Later than the first trimester or none (ref.)	503	1.00	
BC Maternal education per year	1749	1.01 (0.99 – 1.04)	.3162
BC Maternal age per year	1763	1.01 (0.96 – 1.06)	.7400
BC Maternal age			.3056
< 18 years	90	1.82 (0.58 – 5.72)	
≥ 18 years (referent)	1673	1.00	
BC Maternal age			.7440
< 20 years	270	1.14 (0.52 – 2.50)	
≥ 20 years (referent)	1493	1.00	
BC Maternal age (Pollack/Frohna coding)			.8411
13 – 19 years of age	270	1.36 (0.56 – 3.28)	
20 – 25 years of age (referent)	564	1.00	
26 – 30 years of age	462	1.30 (0.65 – 2.60)	
31 – 48 years of age	467	1.31 (0.64 – 2.71)	
BC Marital status			.4600
Married/Separated	1152	1.25 (0.69 – 2.27)	
Unmarried/Divorced (referent)	611	1.00	
PRAMS family income			.9526
< $15,000 (referent)	576	1.00	
$15,000 - $29,999	485	1.23 (0.59 – 2.55)	
$30,000 - $49,999	307	1.14 (0.52 – 2.53)	
≥ $50,000	302	1.20 (0.52 – 2.77)	
PRAMS family income			.5887
≥ $15,000	1094	1.20 (0.63 – 2.26)	
< $15,000 (referent)	576	1.00	

*** odds ratio and p-value based on weighted data** **† BC = Birth Certificate**

Table 3: Univariable, Prone Sleep, Important Variables, p ≥ .25 (continued) *

Variable	Unweighted n	OR (.95 CI)	p-value
BC † WIC enrollment			.2667
No	920	1.37 (0.79 – 2.38)	
Yes (referent)	843	1.00	
PRAMS WIC enrollment			.4328
No	690	1.26 (0.71 – 2.25)	
Yes (referent)	907	1.00	
BC Insurance at L&D			.6635
Yes	1012	1.14 (0.65 – 1.99)	
No (referent)	751	1.00	
BC Insurance at Labor & Delivery (L&D)			.6235
Private	1003	1.15 (0.66 – 2.02)	
Not Private (referent)	760	1.00	
BC Insurance at L&D			.8928
Not public insurance	1146	1.04 (0.58 – 1.86)	
Public insurance (referent)	617	1.00	
PRAMS Insurance at L&D			.4434
OHP/IHCP/None	812	1.24 (0.72 – 2.14)	
Other than OHP/IHCP/None (referent)	926	1.00	
PRAMS Insurance at L&D			.6551
OHP	763	1.13 (0.65 – 1.97)	
Not OHP (referent)	975	1.00	
PRAMS Insurance at L&D			.6957
OHP/IHCP	779	1.12 (0.64 – 1.94)	
Private Insurance (referent)	959	1.00	
PRAMS Current health insurance			.2811
Insured	1511	1.58 (0.69 – 3.65)	
Not insured (referent)	227	1.00	
PRAMS Current health insurance			.7173
OHP	572	1.12 (0.61 – 2.04)	
Not OHP (referent)	1166	1.00	
PRAMS Current health insurance			.6855
Other than OHP/IHCP/None	923	1.12 (0.64 – 1.95)	
OHP/IHCP/None (referent)	815	1.00	
BC Smoker			.9530
Yes	209	1.03 (0.45 – 2.35)	
No (referent)	1544	1.00	
PRAMS Smoker before pregnancy			.4160
Yes	427	1.28 (0.70 – 2.33)	
No (referent)	1305	1.00	
PRAMS Smoker last trimester			.3396
No	1529	1.61 (0.61 – 4.28)	
Yes (referent)	214	1.00	
PRAMS Current smoker			.9857
Yes	300	1.01 (0.50 – 2.02)	
No (referent)	1444	1.00	
PRAMS Other smoker in the house			.3304
Yes	490	1.34 (0.74 – 2.42)	
No (referent)	1267	1.00	
PRAMS Any smoker in the house			.6226
Yes	580	1.16 (0.65 – 2.05)	
No (referent)	1162	1.00	
PRAMS Mode of administration			.6418
Mail survey (referent)	1446	1.00	
CATI	317	1.18 (0.59 – 2.39)	

*** odds ratio and p-value based on weighted data** **† BC = Birth Certificate**

Multivariable Logistic Regression Results: Race/Ethnicity

The weighted frequencies of infant sleep position by race/ethnicity are shown in Figure 2 (and Appendix H). Throughout the analyses, race/ethnicity remained the single most statistically significant predictor of prone infant sleep position ($p < .0001$). The strength of this association was due almost entirely to the greater use of prone infant sleep position by African-American women compared to non-Hispanic white women, with an OR 4.35 (.95 CI 2.55 – 7.42), adjusted for confounding. The low ORs for the use of prone positioning among Hispanic and American Indian/Alaskan Native (AN) women seen in univariable analysis rose and statistical significance was lost when adjusted for confounding. See Table 4 for the crude and adjusted odds ratios and Table 5 for the Full Model. In addition, race/ethnicity was statistically significant in every other analysis performed, demonstrating the strength of the association despite the presence of a wide range of other variables in the multivariable logistic regression models (data not shown).

Figure 2: Frequencies of the infant sleep positions (weighted data), by race/ethnicity.

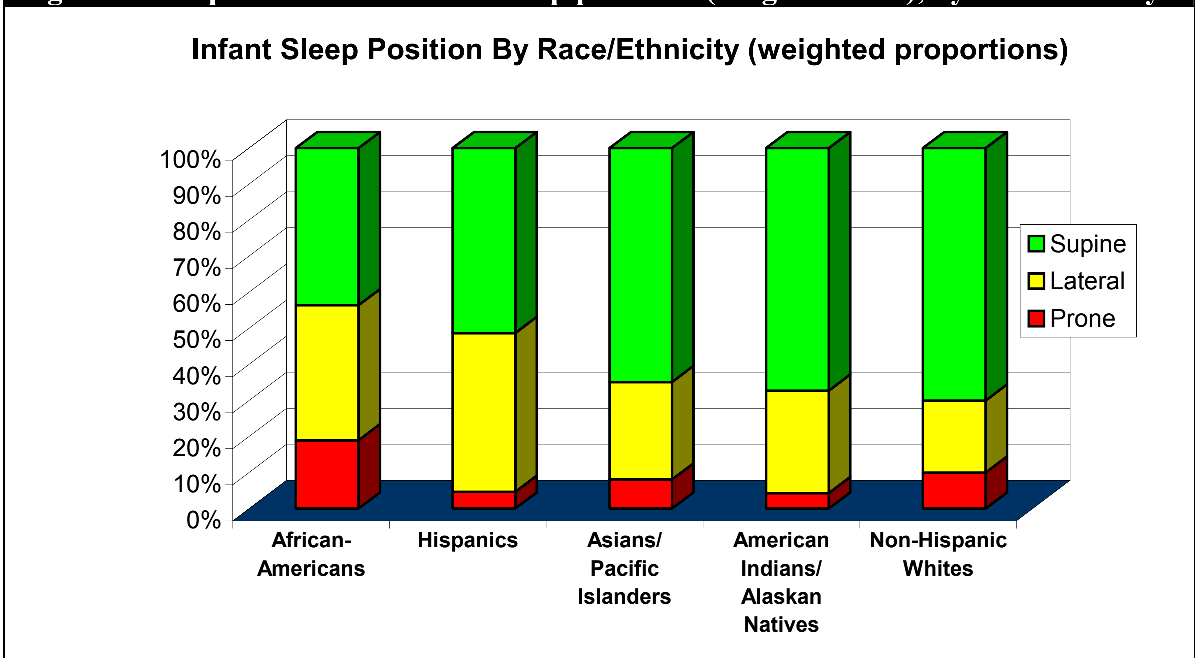


Table 4: Race/ethnicity and Prone Sleep Position, Crude and Adjusted OR

	Variable	OR	95% CI (OR)	p-value
Crude Odds Ratio	**Race/Ethnicity**			**< .0001**
	African-American	**2.11**	**1.35 - 3.30**	
	Hispanic	**0.44**	**0.26 - 0.77**	
	Asian/Pacific Islander	**0.79**	**0.48 - 1.31**	
	American Indian/AN	**0.41**	**0.22 - 0.79**	
	Non-Hispanic White (referent)	**1.00**		
Adjusted for confounding *	**Race/Ethnicity**			**< .0001**
	African-American	**4.35**	**2.55 – 7.42**	
	Hispanic	**0.95**	**0.53 – 1.71**	
	Asian/Pacific Islander	**0.99**	**0.57 – 1.72**	
	American Indian/AN	**0.56**	**0.27 – 1.16**	
	Non-Hispanic White (referent)	**1.00**		
Full model, with confounders * & other significant variables †	**Race/Ethnicity**			**< .0001**
	African-American	**5.41**	**3.06 – 9.58**	
	Hispanic	**0.82**	**0.44 – 1.52**	
	Asian/Pacific Islander	**1.22**	**0.68 – 2.21**	
	American Indian/AN	**0.52**	**0.25 – 1.10**	
	Non-Hispanic White (referent)	**1.00**		

* Confounders: *breastfeeding status at 4 weeks, co-sleeping, prenatal care site* and *family income*.
† Non-confounding but statistically significant variables, *mother's education* and *parity*.

Table 5: Race/ethnicity and Prone Sleep Position, Full Model *

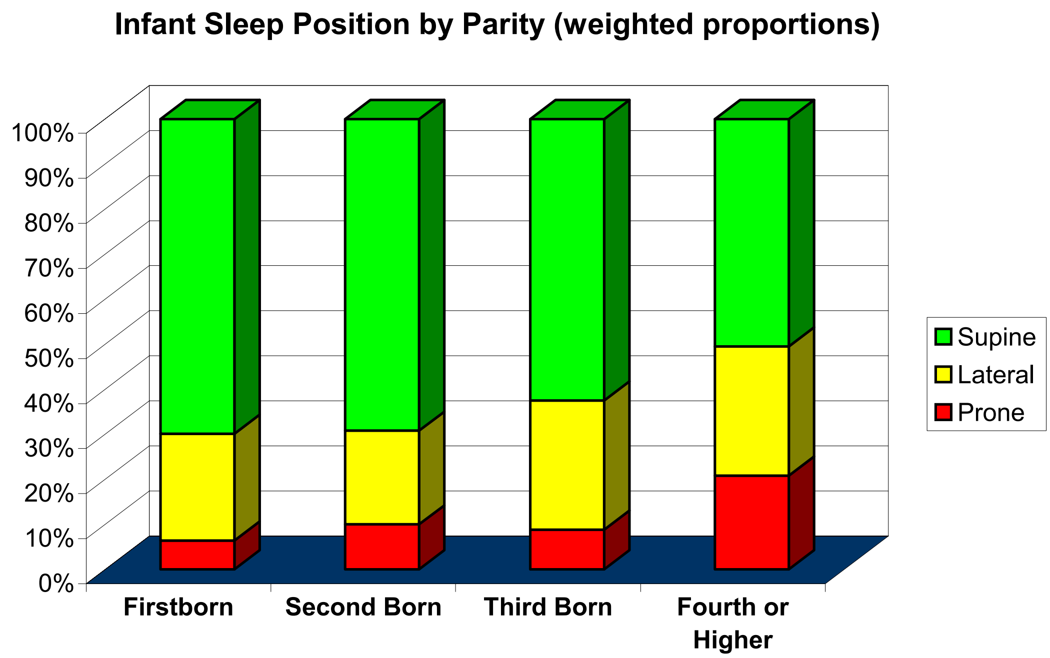
Variable	OR	.95 CI OR	p-value
Race			**< .0001**
African-American	**5.41**	**3.06 – 9.58**	
Hispanic	**0.82**	**0.44 – 1.52**	
Asian/Pacific Islander	**1.22**	**0.68 – 2.21**	
American Indian/Alaskan Native	**0.52**	**0.25 – 1.10**	
Non-Hispanic White (referent)	**1.00**		
Prenatal Care Site			**.0208**
Hospital Clinic	**1.77**	**0.55 – 5.75**	
Health Dept. Clinic (referent)	**1.00**		
Private MD/HMO	**3.82**	**1.53 – 9.53**	
Other	**2.33**	**0.56 – 9.63**	
Breastfeeding by Annual Family Income †			**< .0001**
Income ≥ \$15,000 and breastfeeding > 4 weeks	**7.99**	**3.54 – 18.03**	
and breastfeeding ≤ 4 weeks	**5.63**	**2.04 – 15.55**	
Income < \$15,000 and breastfeeding > 4 weeks	**7.94**	**3.03 – 20.83**	
and breastfeeding ≤ 4 weeks (referent)	**1.00**		
Co-sleeping			**.0143**
Never	**2.36**	**1.19 – 4.69**	
Sometimes/Almost Always/Always (referent)	**1.00**		
Parity			**.0081**
Firstborn (referent)	**1.00**		
Second-born	**1.79**	**0.86 – 3.70**	
Third-born	**0.99**	**0.38 – 2.55**	
Fourth or higher	**4.14**	**1.70 – 10.05**	
Mother's education			**.0383**
< 16 years of education	**2.41**	**1.05 – 5.56**	
≥ 16 years (referent)	**1.00**		

* Adjusted for confounding and including non-confounding but statistically significant variables.
† There was a significant interaction between *breastfeeding* and *family income*, with significant differences in choice of prone sleep by breastfeeding duration seen only among women with annual family income less than \$15,000.

Multivariable Logistic Regression Results: Birth Order

The distribution of the weighted frequencies of infant sleep position by birth order is shown in Figure 3. Birth order was a statistically significant predictor of prone infant sleep position, in both the crude and adjusted logistic regression models.

Figure 3: Frequencies of infant sleep positions (weighted data), by birth order.



The crude OR for prone sleep position for a fourth or higher child compared to a firstborn child was 3.83 (.95 CI 1.69 – 8.65), with OR for a second and third child intermediate and not statistically significant (see Table 6). After adjustment for confounding (using timing of the start of prenatal care, maternal age and education, infant age and family income), the OR for a fourth or higher order child rose to 7.56 (.95 CI 3.13 – 18.27), with the OR for a second and third child intermediate and achieving or nearing statistical significance; the overall p-value = .0001 (see Table 6). The addition of the non-confounding but statistically significant variables, *Race/ethnicity* and *type of prenatal care site*, reduced the OR for a fourth or higher child slightly, to 7.20 (.95 CI 2.96 – 17.52), while raising those for a second child, which remained significant, and for a third child, which was not significant (see Table 7). In addition, parity remained a significant variable in the *race/ethnicity* and the *prenatal care site* models. Finally, parity (as an continuous variable) was selected in the third step of the forward-stepwise procedure, after *race/ethnicity* and *prenatal care site*, and remained in the final model (p = .0049). (See Table 13)

Table 6: Parity and Prone Sleep Position, Crude and Adjusted Odds Ratio

	Variable	OR	95% CI (OR)	p-value
Crude Odds Ratio	**Parity**			**.0147**
	Firstborn (referent)	**1.00**		
	Second	**1.62**	**0.83 – 3.15**	
	Third	**1.41**	**0.63 – 3.17**	
	Fourth or higher	**3.83**	**1.69 – 8.65**	
Adjusted for confounding *	**Parity**			**.0001**
	Firstborn (referent)	**1.00**		
	Second	**2.79**	**1.43 – 5.44**	
	Third	**2.26**	**0.99 – 5.14**	
	Fourth or higher	**7.56**	**3.13 – 18.27**	
Full model, with confounders * & other significant variables †	**Parity**			**.0001**
	Firstborn (referent)	**1.00**		
	Second	**2.55**	**1.30 – 5.01**	
	Third	**2.07**	**0.89 – 4.80**	
	Fourth or higher	**7.20**	**2.96 – 17.52**	

* Confounders: *initiation of prenatal care, mother's age, mother's education, infant age,* and *annual family income*.
† Non-confounding but statistically significant variables, *race/ethnicity* and *prenatal care site*.

Table 7: Parity and Prone Sleep Position, Full Model *

Variable	OR	.95 CI OR	Wald p-value
Parity			**.0001**
Firstborn (referent)	**1.00**		
Second	**2.55**	**1.30 – 5.01**	
Third	**2.07**	**0.89 – 4.80**	
Fourth or higher	**7.20**	**2.96 – 17.52**	
Timing of prenatal care			**.9260**
First trimester	**1.03**	**0.51 – 2.11**	
Later or none (referent)	**1.00**		
Mother's age			**.0888**
13 – 19 years old	**2.96**	**1.05 – 8.37**	
20 – 25 years old	**0.92**	**0.44 – 1.94**	
26 – 30 years old (referent)	**1.00**		
31 – 48 years old	**0.68**	**0.29 – 1.60**	
Maternal Education			**.0178**
Education ≥ 10 years	**3.03**	**1.21 – 7.58**	
Education < 10 years (referent)	**1.00**		
Infant age at time of survey			**.7601**
> 13 weeks	**1.11**	**0.58 – 2.12**	
≤ 13 weeks (referent)	**1.00**		
Family Income			**.6959**
< $15,000	**0.79**	**0.27 – 2.34**	
$15,000 – 29,999	**0.59**	**0.24 – 1.47**	
$30,000 _ 49,999	**0.68**	**0.26 – 1.83**	
≥ $50,000 (referent)	**1.00**		
Race			**< .0001**
African-American	**2.79**	**1.50 – 5.19**	
Hispanic	**0.77**	**0.40 – 1.46**	
Asian/Pacific Islander	**0.91**	**0.50 – 1.65**	
American Indian/Alaskan Native	**0.37**	**0.17 – 0.82**	
Non-Hispanic White (referent)	**1.00**		
Prenatal Care Site			**.0252**
Hospital Clinic	**2.95**	**0.88 – 9.91**	
Health Dept. Clinic (referent)	**1.00**		
Private MD/HMO	**4.43**	**1.68 – 11.68**	
Other	**2.96**	**0.67 – 13.08**	

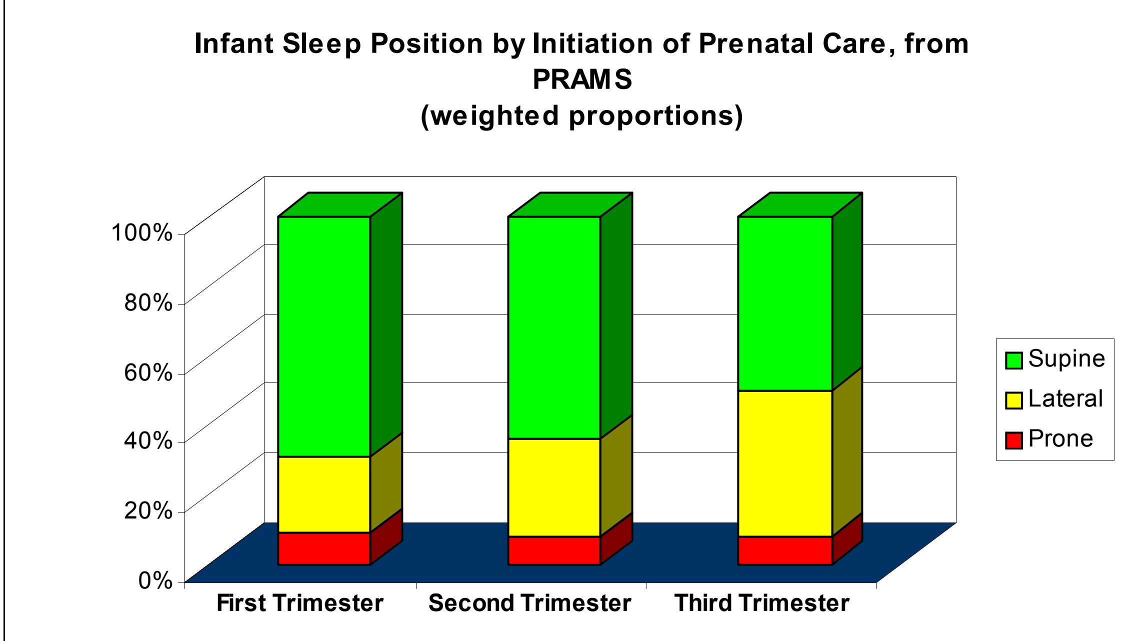
* Adjusted for confounding and including non-confounding but statistically significant variables.

Multivariable Logistic Regression Results:

Initiation of Prenatal Care

The distribution of the weighted frequencies of infant sleep position by the timing of initiation of prenatal care is shown in Figure 4. The results of univariable logistic regression of each candidate variable for the initiation of prenatal care suggested that earlier care was a risk factor for prone infant sleep position, rather than late or no care as described in the literature, although no univariable model was statistically significant. Multivariable logistic regression was carried out using the PRAMS-coded binary variable (first trimester vs. later than the first trimester or none).

Figure 4: Frequencies of infant sleep positions (weighted data), by the initiation of prenatal care.



Only the type of prenatal care site was identified as a confounding variable and the addition of this confounder only reduced the statistical significance of the target variable, initiation of prenatal care. (see Table 8) The addition of additional (non-confounding) statistically significant variables to the model did not improve the statistical significance of the target variable (data not shown).

Table 8: **Initiation of Prenatal Care and Prone Sleep Position, Crude and Adjusted Odds Ratios**

	Variable	OR	95% CI (OR)	p-value
Crude Odds Ratio	**BC Prenatal Care Initiation by Month** odds ratio per month of initiation	**1.04**	**0.88 – 1.22**	**.6512**
	BC Prenatal Care Within the First Trimester **Yes** **No (referent)**	 **1.02** **1.00**	 **0.51 – 2.02**	**.9603**
	PRAMS Prenatal Care Within the First Trimester Yes No (referent)	 **1.20** **1.00**	 **0.63 – 2.28**	**.5781**
Adjusted for Confounding*	**PRAMS Prenatal Care Within the First Trimester** First Trimester Later than first trimester (referent)	 **1.06** **1.00**	 **0.55 – 2.03**	**.8604**

* Confounder: *prenatal care site*.

Multivariable Logistic Regression Results:

Type of Medical Care Sites

The distribution of the weighed frequencies of infant sleep positions for prenatal care site is found in Figure 5 and for well baby care site in Figure 6. Prenatal care site was clearly and strongly associated with prone infant sleep position (p = .0021, in univariable analysis), while the relationship between well baby care site and sleep position was inconclusive and showed a far weaker association.

Figure 5: Frequencies of infant sleep positions (weighted data), by prenatal care site

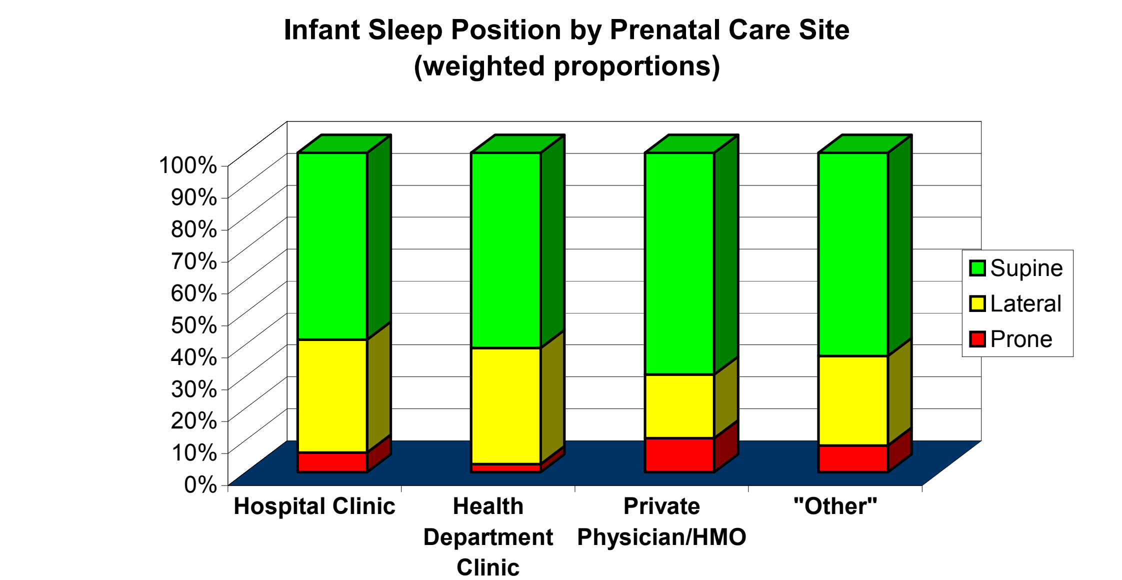
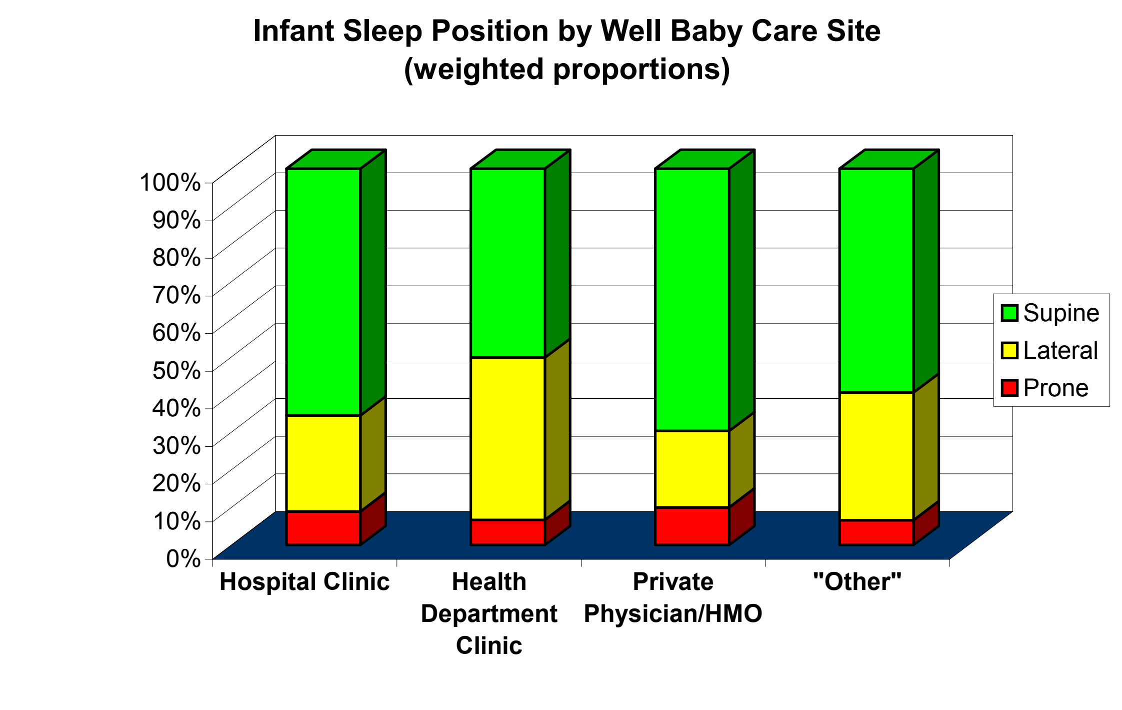


Figure 6: Frequencies of infant sleep positions (weighted data), by well baby care site.



The strength of the association between prone infant sleep position and prenatal care site was due primarily to the impact of care from a private physician or HMO compared to a health department clinic (referent), with a crude OR of 4.62 (.95 CI 2.07 – 10.31) and an adjusted OR of 8.80 (.95 CI 2.23 – 34.73). The association was stronger but there was a loss of precision in the estimate after adjustment. Care at a hospital clinic and care at "other," unspecified, sites were also risk factors relative to care at a health department clinic, but only the latter was statistically significant. (see Tables 9 - 10). Prenatal care site was also selected from the entire pool of candidate variables by multivariable logistic regression utilizing a forward stepwise procedure, relying solely on statistical significance for model building (see Table 13). Finally, when added to a logistic regression model utilizing the same 11 independent variables selected by Pollack

Pollack and Frohna for their analysis of a multistate PRAMS dataset,[77] *race/ethnicity*, *maternal education*, *infant gender*, *marital status*, *smoking during pregnancy*, *initiation of prenatal care*, *birthweight*, *maternal age* and *parity*, *prenatal care site* remained statistically significant (see Table 9).

Table 9: Prenatal Care Site and Prone Sleep Position, Crude and Adjusted OR

	Variable	OR	95% CI	p-value
Crude Odds Ratio	**Prenatal Care Site**			**.0021**
	Hospital Clinic	**2.55**	**0.88 – 7.32**	
	Health Department Clinic (referent)	**1.00**		
	Private Physician/HMO	**4.62**	**2.07–10.31**	
	Other	**3.55**	**1.02–12.36**	
Adjusted for confounding *	**Prenatal Care Site**			**.0063**
	Hospital Clinic	**2.56**	**0.53 – 12.47**	
	Health Department Clinic (referent)	**1.00**		
	Private Physician /HMO	**8.80**	**2.23 – 34.73**	
	Other	**5.51**	**1.10 – 27.71**	
Full model, with confounders * & other significant variables †	**Prenatal Care Site**			**.0072**
	Hospital Clinic	**2.40**	**0.49 – 11.69**	
	Health Department Clinic (referent)	**1.00**		
	Private MD/HMO	**8.58**	**2.17 – 33.85**	
	Other	**5.57**	**1.07 – 28.97**	
Prenatal Care Site added to the Pollack & Frohna Model[77] ‡	**Prenatal Care Site**			**.0132**
	Hospital Clinic	**2.09**	**0.67 – 6.53**	
	Health Department Clinic (referent)	**1.00**		
	Private MD/HMO	**3.63**	**1.59 – 8.32**	
	Other	**2.18**	**0.55 – 8.63**	

* Confounders: *mother's education, infant age, WIC enrollment, well baby care site, breastfeeding status at 4 weeks, PRAMS source, parity, mother's age* and *smoking status before pregnancy*.
† Non-confounding but statistically significant variable, *race/ethnicity*.
‡ Including *race/ethnicity, mother's education, infant gender, marital status, smoking status during pregnancy, initiation of prenatal care, birthweight, mother's age* and *parity*.

Table 10: Prenatal Care Site and Prone Sleep Position, Full Model *

Variable	OR	.95 CI OR	p-value
Prenatal Care Site			**.0072**
Hospital Clinic	**2.40**	**0.49 – 11.69**	
Health Department Clinic (referent)	**1.00**		
Private Physician /HMO	**8.58**	**2.17 – 33.85**	
Other	**5.57**	**1.07 – 28.97**	
Mother's education			**.0821**
≥ 10 years of education	**2.63**	**0.88 – 7.82**	
< 10 years (referent)	**1.00**		
Infant age at times of PRAMS			**.7293**
> 13 weeks post partum	**1.15**	**0.52 – 2.52**	
≤ 13 weeks (referent)	**1.00**		
WIC Enrollment			**.7909**
No	**1.12**	**0.49 – 2.58**	
Yes (referent)	**1.00**		
Well Baby Care Site			**.1430**
Hospital Clinic	**0.67**	**0.15 – 3.08**	
Health Department Clinic (referent)	**1.00**		
Private physician/HMO	**0.26**	**0.06 – 1.07**	
Other	**0.51**	**0.08 – 3.36**	
Breastfeeding			**.2082**
> 4 weeks	**1.78**	**0.73 – 4.36**	
≤ 4 weeks (referent)	**1.00**		
PRAMS source			**.2994**
Mail 1 (referent)	**1.00**		
Mail 2	**0.47**	**0.14 – 1.61**	
CATI	**1.32**	**0.54 – 3.21**	
Birth order			**.0261**
Not firstborn	**2.13**	**1.09 – 4.15**	
Firstborn (referent)	**1.00**		
Mother's age			**.1171**
< 20 years old	**2.19**	**0.82 – 5.85**	
≥ 20 years old (referent)	**1.00**		
Smoking Before Pregnancy			**.5218**
Yes	**1.30**	**0.59 – 2.87**	
No	**1.00**		
Race			**.0002**
African-American	**2.54**	**1.27 – 5.08**	
Hispanic	**0.73**	**0.35 – 1.49**	
Asian/Pacific Islander	**0.65**	**0.32 – 1.35**	
American Indian/Alaskan Native	**0.43**	**0.19 – 0.96**	
Non-Hispanic White (referent)	**1.00**		

* Adjusted for confounding and including non-confounding but statistically significant variables.

In the univariable analysis of well baby care site (see Table 11), *well baby care site* was not significant (p = .7622). Women receiving well baby care from private physicians had more than 1.5 times the likelihood of choosing prone infant positioning that women attending health department clinics, although it was not statistically significant. After adjustment for confounding, however, use of private physicians was associated with one-quarter the risk for prone sleep position, and was statistically significant, although barely so, when compared to health department clinics (p = .0403 for that specific comparison), although well baby care site, overall, was not significantly associated with sleep position (p = .0949). Further model building did not significantly alter the results (see Table 11 - 12).

Table 11: Well Baby Care Site and Prone Sleep Position, Crude and Adjusted OR Restricted to respondents reporting only a single type of site

	Variable	OR	95% CI	p-value
Crude Odds Ratio	**Well Baby Care Site**			**.7622**
	Only Hospital Clinic	**1.36**	**0.43 – 4.31**	
	Only Health Department Clinic (referent)	**1.00**		
	Only Private Physician	**1.56**	**0.59 – 4.09**	
	Only Other	**0.99**	**0.19 – 5.10**	
Adjusted for confounding *	**Well Baby Care Site**			**.0949**
	Only Hospital Clinic	**0.55**	**0.13 – 2.30**	**(.4127)**
	Only Health Department Clinic (referent)	**1.00**		
	Only Private Physician	**0.25**	**0.07 – 0.94**	**(.0403)**
	Only Other	**0.31**	**0.04 – 2.28**	**(.2501)**
Full model, with confounders * & other significant variables †	**Well Baby Care Site**			**.0789**
	Only Hospital Clinic	**0.59**	**0.14 – 2.51**	**(.4735)**
	Only Health Department Clinic (referent)	**1.00**		
	Only Private Physician	**0.23**	**0.06 – 0.93**	**(.0399)**
	Only Other	**0.34**	**0.04 – 2.59**	**(.2964)**

* Confounders: *prenatal care site, breastfeeding status at 4 weeks, annual family income, parity, PRAMS source, mother's age, mother's education* and *smoking status in the third trimester*.
† Non-confounding but statistically significant variables, *race/ethnicity* and *co-sleeping*.

Table 12: Well Baby Care Site and Prone Sleep Position, Full Model *
Restricted to respondents reporting only a single type of site

Variable	OR	.95 CI OR	p-value
Well Baby Care Site			**.0789**
Only Hospital Clinic	**0.59**	**0.14 – 2.51**	**(.4735)**
Only Health Department Clinic (referent)	**1.00**		
Only Private Physician	**0.23**	**0.06 – 0.93**	**(.0399)**
Only Other	**0.34**	**0.04 – 2.59**	**(.2964)**
Prenatal Care Site			**.0041**
Hospital Clinic	**2.18**	**0.52 – 9.09**	
Health Department Clinic (referent)	**1.00**		
Private Physician/HMO	**8.40**	**2.20 – 32.11**	
Other	**4.81**	**0.83 – 28.04**	
Breastfeeding at 4 weeks			**.1163**
> 4 weeks	**2.05**	**0.84 – 4.99**	
≤ 4 weeks (referent)	**1.00**		
Maternal Family Income			**.8227**
< 15K	**1.11**	**0.46 – 2.67**	
≥ 15K(referent)	**1.00**		
Parity			**.0001**
Firstborn (referent)	**1.00**		
Second Born	**1.85**	**0.88 – 3.89**	
Third Born	**1.33**	**0.53 – 3.34**	
Fourth or higher	**7.00**	**2.91 – 16.87**	
PRAMS Source			**.1523**
Mail 1 (referent)	**1.00**		
Mail 2	**0.35**	**0.11 – 1.08**	
CATI	**1.20**	**0.56 – 2.60**	
Mother's Age			**.0201**
< 20 years old	**3.13**	**1.20 – 8.17**	
≥ 20 years old (referent)	**1.00**		
Mother's Education			**.0656**
≥ 10 years	**3.06**	**0.93 – 10.03**	
< 10 years (referent)	**1.00**		
Smoking Third Trimester			**.1620**
No	**2.08**	**0.75 – 5.79**	
Yes (referent)	**1.00**		
Race			**< .0001**
African-American	**3.57**	**1.83 – 6.99**	
Hispanic	**0.76**	**0.38 – 1.52**	
Asian/Pacific Islander	**0.89**	**0.47 – 1.69**	
American Indian/Alaskan Native	**0.36**	**0.157 –0.85**	
Non-Hispanic White (referent)	**1.00**		
Co-sleeping			**.0085**
Never	**2.61**	**1.28 – 5.33**	
At least sometimes (referent)	**1.00**		

*** restricted to respondents reporting only a single type of site and adjusting for confounding and statistically significant, but non-confounding, variables.**

Multivariable Logistic Regression Results:

Forward Stepwise Regression

The "change-in-point-estimate" model-building procedure focuses on a single target variable and other variables are added to the model based solely on their role as confounders. Alternatively, some other procedures rely solely on the statistical significance of each of the added variables. Table 13 displays the results of the non-canned forward stepwise logistic regression procedure, considering all the candidate variables. As can be seen, this method identifies *race/ethnicity*, *parity* and *prenatal care site*, et. al., as significant determinants of prone infant sleep position, and fails to identify *initiation of prenatal care* and *well baby care site*, paralleling the results of the change-in-point-estimate method.

Table 13: Prone Sleep Position Forward Stepwise Procedure *

Variable	OR	.95 CI OR	p-value
Race/ethnicity			**< .0001**
African-American	**2.97**	**1.74 – 5.07**	
Hispanic	**0.82**	**0.45 – 1.47**	
Asian/Pacific Islander	**0.96**	**0.56 – 1.67**	
American Indian/Alaskan Native	**0.40**	**0.19 – 0.84**	
Non-Hispanic White (referent)	**1.00**		
Parity (continuous)	**1.43 (per birth)**	**1.13 – 1.80 (per birth)**	**.0027**
Mother's education			**.0065**
≥ 10 years of education	**4.04**	**1.48 – 11.06**	
< 10 years (referent)	**1.00**		
Prenatal Care Site			**.0072**
Hospital Clinic	**1.84**	**0.68 – 4.95**	
Health Department Clinic (referent)	**1.00**		
Private MD/HMO	**3.29**	**1.54 – 7.05**	
Other	**3.16**	**0.87 – 11.56**	
Mother's age			**.0073**
< 18 years old	**5.49**	**1.58 – 19.04**	
≥ 18 years old (referent)	**1.00**		
Co-sleeping			**.0269**
Never	**2.02**	**1.08 – 3.75**	
Sometimes/Almost Always/Always (referent)	**1.00**		

* Based on Wald-F test statistic, with entry criterion $p < .05$ and removal criterion $p > .10$.

Multivariable Logistic Regression Results:

Comparison with Pollack & Frohna Model

Table 14 displays a comparison with the results of the combined 15-states PRAMS model reported by Pollack and Frohna. In both models, African-American race was a significant predictor of prone sleep position, with similar OR, although the Oregon OR was slightly higher. In both, Hispanic ethnicity was associated with a lower odds ratio for prone sleep, when compared with Non-Hispanic White women. The “other” racial/ethnic category displayed a similarly lower odds ratio in both models, although only in the 15-state model was it statistically significant, probably due to the larger sample size.

Maternal education, infant birthweight and smoking during pregnancy were not significant in either model, although the point estimates (odds ratios) were similar. Pollack and Frohna found female infant gender to have lower odds than male gender, with an OR = 0.88 (.95 CI 0.82 – 0.95), while in Oregon there was no difference between male and female infants. Marital status and initiation of prenatal care were not statistically significant in either model, although the point estimates were on opposite sides of unity. Both studies found the youngest maternal age group (under age 20) to be a significant risk factor but Pollack and Frohna found the age group 20-25 years to be significant, as well. Finally, both models found parity to be a significant risk factor, with the risk rising with the number of births, achieving statistical significance at fourth or higher parity; Oregon’s OR for this level was greater than that found in the 15-state model (6.67 compared to 1.72), although the precision of the estimate was lower.

Table 14: Prone Sleep Position, Comparison with the Pollack & Frohna Model[77]

Variable	Oregon PRAMS	15-state PRAMS
Race		
African-American	**2.54 (1.42 – 4.55)**	**1.45 (1.33 – 4.59)**
Hispanic	**0.43 (0.20 – 0.93)**	**0.81 (0.69 – 0.95)**
Other	0.77 (0.46 – 1.29)	**0.74 (0.58 – 0.93)**
Non-Hispanic White (referent)	1.00	1.00
Maternal Education		
> 15 years	0.78 (0.25 – 2.49)	0.92 (0.83 – 1.02)
12 -15 years	1.31 (0.54 – 3.19)	1.26 (1.12 – 1.40)
< 12 years (referent)	1.00	1.00
Infant gender		
Female	1.00 (0.55 – 1.80)	**0.88 (0.82 – 0.95)**
Male (referent)	1.00	1.00
Marital Status		
Single/Divorced	0.70 (0.33 – 1.48)	1.10 (0.99 – 1.21)
Married/Separated (referent)	1.00	1.00
Smoking in Pregnancy (PRAMS)		
Yes	0.55 (0.20 – 1.55)	0.96 (0.85 – 1.09)
No (referent)	1.00	1.00
Initiation of Prenatal Care	Small cell sizes preclude analysis using the same coding as Pollack and Frohna; the variable below was substituted	
First trimester		0.93 (0.80 – 1.09)
Third trimester or never		1.18 (0.39 – 3.51)
Second trimester (referent)		1.00
Initiation of Prenatal Care (PRAMS)		
First trimester	1.12 (0.58 – 2.17)	
Not first trimester (referent)	1.00	
Birthweight	Small cell sizes preclude analysis using the same coding as Pollack and Frohna; the variable below was substituted	
500-1000 grams		0.96 (0.79 – 1.16)
1001-1500 grams		1.02 (0.87 – 1.20)
1501 – 2500 grams		**0.91 (0.85 – 0.98)**
> 2500 grams (referent)		1.00
Birthweight		
< 2500 grams	0.94 (0.55 – 1.62)	
≥ 2500 grams (referent)	1.00	
Maternal Age		
13-19 years	**2.72 (1.01 – 7.28)**	**1.25 (1.09 – 1.43) for 12-19y**
20-25 years	0.81 (0.38 – 1.70)	**1.17 (1.05 – 1.30)**
26-30 years (referent)	1.00	1.00
31-48 years	0.74 (0.34 – 1.62)	0.94 (0.85 – 1.05) for 31-60y
Parity		
Fourth or higher	**6.67 (2.71 – 16.38)**	**1.72 (1.08 – 2.74)**
Third	**2.53 (1.29 – 4.99)**	1.41 (0.88 – 2.24)
Second	1.97 (0.83 – 4.69)	1.12 (0.70 – 1.78)
First	1.00	1.00

Post Hoc Power Analysis

The estimations of the design effects for each of the target variables are shown in Table 15. The actual unweighted sample size were divided by the DEFF (Design Effects) estimate to produce an effective sample size; as can be seen, for two of the variables, *race/ethnicity* and *prenatal care site*, the design effect correction generated an effective sample size greater than the actual sample size. For the remainder, the effective sample size was roughly one-half of the actual size. This is considered within the range of a well-designed study.[88]

Table 15: $DEFF_1$ Estimations and Effective Sample Size (n_e), Target Variables

Variables Wald-F p < .05	Deff	n_e	Variables Wald-F p ≥ .05	Deff	n_e
Race			**Well Baby Care Site**		
African-American	0.33	621	Hospital Clinic	2.15	146
Hispanic	0.86	479	Health Department Clinic (referent)	-----	112
Asian/Pacific Island	0.39	758	Private Physician	2.15	469
American Indian/Alaskan Native	0.13	1515	Other	2.12	39
Non-Hispanic White (referent)	-----	653	(restricted to respondents reporting only a		
Parity			single site)		
First (referent)	-----	353			
Second	2.43	220			
Third	2.22	104			
Fourth or higher	2.59	64			
Prenatal Care Site			**Timing of Prenatal Care (PRAMS)**		
Hospital Clinic	0.86	354	First trimester	2.57	474
Health Department Clinic (referent)	-----	251	Not first trimester (referent)	-----	195
Private Physician/HMO	0.82	1287			
Other	0.90	132			

For a confidence level of 0.95, following odds ratios can be detected at a power of .80:

Table 16: Detectable Odds Ratio, for a Given Power and Effective Sample Size

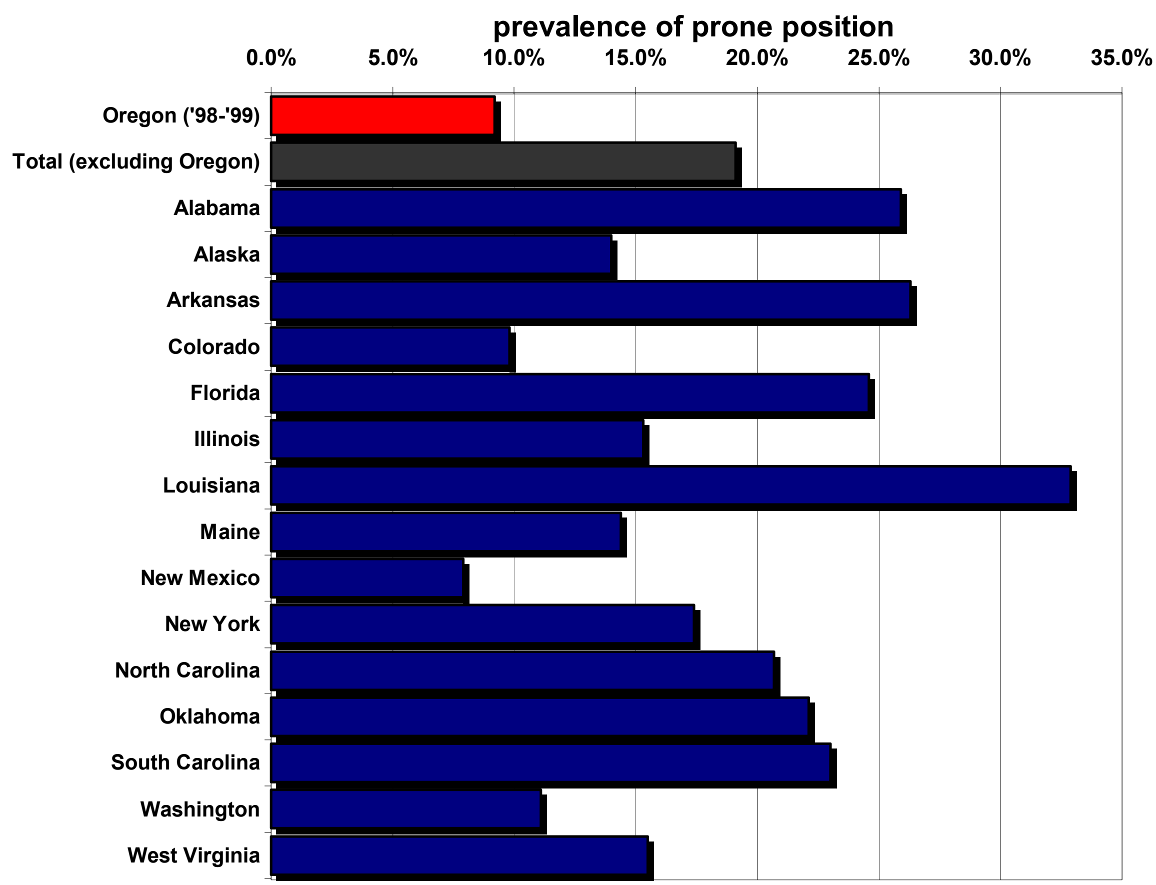
Variables Wald-F $p < .05$	**OR, given $\alpha = .05$ $\beta = .20$**	**Variables Wald-F $p \geq .05$**	**OR, given $\alpha = .05$ $\beta = .20$**
Race		**Well Baby Care Site**	
African-American	≥ 1.7	Hospital Clinic	≤ 0.06
Hispanic	≤ 0.47	Health Department Clinic (referent)	-------
Asian/Pacific Island	≤ 0.53	Private Physician	≤ 0.15
American Indian/Alaskan Native	≤ 0.58	Other	$< .01$
Non-Hispanic White (referent)	-------	(restricted to respondents reporting only a single site)	
Parity			
First (referent)	-------		
Second	≥ 2.4		
Third	≥ 2.9		
Fourth or higher	≥ 3.5		
Prenatal Care Site		**Timing of Prenatal Care (PRAMS)**	
Hospital Clinic	≥ 2.7	First trimester	≥ 2.3
Health Department Clinic (referent)	-------	Not first trimester (referent)	-------
Private Physician/HMO	≥ 2.4		
Other	≥ 3.3		

Put another way, this study has a power of only 0.57 to detect an odds ratio of at least 2.0 in the risk of prone infant sleep position between women seeking well baby care from a health department clinic compared to a private physician or HMO (and less power to detect differences between health department clinics and hospital clinics or “other” sites), and a power of only 0.61 to detect an odds ratio of at least 2.0 in the risk of prone sleep among women initiating care in the first trimester compared to those initiating care later or not at all.

Discussion

Oregon's 9.2% prevalence of prone infant sleep position, as the *usual* position, falls within that reported by 15 other states in 1998, the last year for which PRAMS prone sleep data is available, with an overall prevalence of 19.1%[77] and a range from 7.9%, in New Mexico, to 32.9%, in Louisiana.[90]

Figure 7: Comparison of the prevalence of prone infant sleep position in Oregon and fifteen other states, from 1998 PRAMS data reported by the CDC.[90]



Further reductions will likely require identification of subgroups of women at higher risk for use of prone infant sleep position and understanding of the reasons why they choose this position. Investigators have reported that among women who choose the supine position, media exposure, medical advice and SIDS prevention are most of ten cited as the reasons, while among women choosing the prone position, infant comfort and previous experience are most often cited.[71, 82, 91] There is experimental support for the sleep-promoting effects of prone sleep,[92, 93] but this begs the question: why do some women choose apparent infant comfort over medical advice and SIDS prevention?

This study confirms that in Oregon, race/ethnicity and parity have similar associations to infant sleep position as that seen in other states and other studies. The initiation of prenatal care was not associated with choice of sleep position, but the study lacked sufficient power to rule this out (see below). Not previously reported, prenatal care site was strongly associated with choice of sleep position (see below).

Race/ethnicity

Race/ethnicity was the most statistically significant predictor of infant sleep position among Oregon women giving birth between November 1998 and October 1999. This was due entirely to the influence of African-American (AA) women. African-American women put their babies to bed on their stomachs 18.4% of the time, compared to 9.6% for non-Hispanic white (NHW) women, for a crude OR of 2.11 (.95 CI 1.35 – 3.30), and an adjusted OR of 4.35 (.95 CI 2.55 – 7.42). There was no statistically significant difference in the likelihood of prone infant sleeping position between any other racial/ethnic group and the referent group, NHW women. The study may have lacked power to detect the small differences found for Hispanics and Asians/Pacific

Islanders but was sufficient to detect an odds ratio of 0.56 for American Indians/Alaskan Natives.

These findings are similar to those of other studies. The CDC reporting 1996 PRAMS results from selected states,[94] found that, overall, the percentage of prone infant sleeping position ranged from 16.0% (Maine) to 30.8% (Alabama). The percentage of African-American mothers reporting prone infant sleeping position ranged from 22.5% (Washington) to 42.1% (Florida), and was 11%-54% higher than that reported by NHW mothers.

PRAMS investigators in 13 states[95] found that in 1997 prone infant sleep position ranged from 10.5% (Washington) to 28.8% (Arkansas). Excluding South Carolina (where no racial differences were observed), AA mothers in the other eight states reporting racial data were twice as likely as NHW mothers to put their babies to bed on their stomachs.

The 1998 PRAMS Surveillance Report,[90] which included data from 15 states, found prone infant sleep position ranging from 7.9% to 32.9%. Prone position among black infants was 6.9% to 36.9%, ranging from 20% higher to more than double that seen among white infants. This report falls within this range, with 18.4% of black infants put to sleep prone, nearly twice that of white infants. Willinger and co-workers,[71] in their 1998 nationwide phone survey, found that 32% of black infants were put to bed prone, compared to 17% of white infants.

Pollack and Frohna,[77] combining 1996-1998 PRAMS data from 15 states, found AA mothers 1.45 (.95 CI 1.33 – 4.59) times as likely to choose the prone infant sleeping position as NHW mothers. In Oregon, AA mothers were more than four times as likely to put their babies to bed on their stomachs than NHW mothers, but published PRAMS data shows wide variations between states and the odds ratio reported here falls within Pollack and Frohna's confidence intervals.

The Michigan Department of Community Health, using PRAMS data, documents a progressive increase in supine sleep position, the recommended position, from 1996 through 1999; the curve for black women was parallel to but persistently below that for white women.[96]

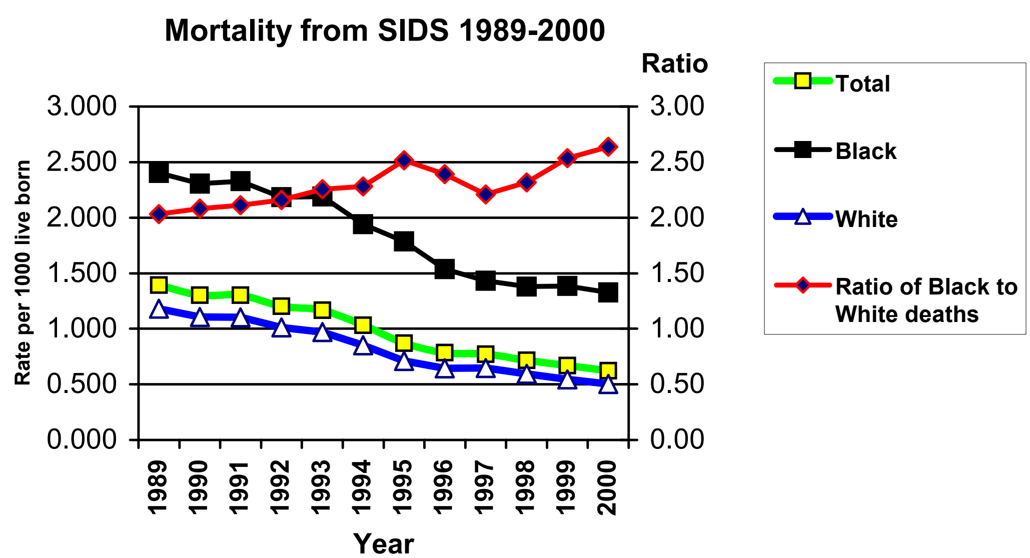
The reasons for the persistent racial disparity in abandoning prone infant sleeping position have not been resolved. These disparities persisted after adjustment for maternal income level and education, parity, type of prenatal care site, duration of breast-feeding, co-sleeping and infant birth weight. While adjustment for the type of prenatal care site (hospital clinic, health department clinic, private physician/HMO or other) actually increased the odds ratio for African-American race, a difference in the care offered to white and African-American mothers within the same type of site cannot be excluded, and issues of cultural competency might play a role.

Living with a grandmother has been reported to be a risk factor for prone sleep among African-Americans.[80, 82] However, Flick and co-workers[83] failed to reduce choice of prone position in low-income AA households through focused teaching of grandmothers (or other senior caregivers, such as an aunt or sister), compared to teaching only the mothers (13.3% vs. 17.3%, $p = .44$). Neither the senior caregiver's prenatal preference nor her living with the mother predicted usual infant sleep position, undermining the previous studies that attributing risk to the presence of a grandmother.

Others have found significant differences in the proportions of white women and black women reporting having received sleep position recommendations from health care providers (see the Prenatal and Well Baby Care Sites discussion below); this may account for some, but not all, of the differences.

The differences in infant sleep position by race/ethnicity assume greater importance in the context of the increasing racial disparities in SIDS rates, with death rates more than twice as high among black infants as compared to white infants. (see Figure 7) Much of the racial disparities in SIDS death rates can likely be explained by sleep positioning, although not all agree.

Figure 8: SIDS mortality rates by race, 1989-2000.
Taken from the CDC's National Center for Health Statistics' mortality data from the National Vital Statistics System, which can be found at



Kemp and colleagues' case series,[37] retrospectively reviewing death-scene information and medical examiners' reports in St. Louis County, disputed the contribution of prone sleep position to the racial disparity in SIDS rates. They attributed the difference in mortality rates (2.08 per 1000 live births of black infants vs. 0.65 per 1000 live births of white infants), at least in part, to more frequent co-sleeping and use of non-standard sleep surfaces among AA infants than NHW infants dying of SIDS and discounted the role of sleep position. Their data do not necessarily support their conclusions. Kemp considered the finding that the proportion of AA infants found prone (59.5%) was no greater than that of non-AA infants (62.5%) as an argument against the role of sleep position in the contributing to the racial disparity in SIDS rate. But this finding is not inconsistent with the hypothesis that racial disparities are due, at least in part, to prone sleep position. One might expect to find similar proportions of AA and non-AA SIDS cases found prone if prone position is a major cause of SIDS. Investigators consistently find that AA infants are put to sleep prone much more often than non-AA infants; the population attributable risk (PAR) for AA infants is much greater than for non-AA infants. Kemp found the SIDS mortality rate three times higher in black infants; the literature indicates that they are put down prone approximately twice as often. In fact, this study supports the hypothesis that differences in sleep position are an important source of the racial disparities in SIDS rates.

Kemp did find that co-sleeping (67.1% vs. 35.1%, p = .005) and use of non-standard sleep surfaces (79.0% vs. 46.0%, p = .001) were more frequent among AA than white SIDS victims. However, co-sleeping is more common among AA families than NHW families, in general. They themselves reported, in 1998,[97] that 61% of infants of consecutive pregnant AA women enrolled in a Medicaid managed care obstetrics clinic, from June 1996 through March 1998, had shared a sleep surface for one or more nights in the previous two weeks, a proportion quite similar to their earlier reported proportion of infants dying of SIDS found to have been co-sleeping. In Oregon, 62.9% of AA mothers co-slept always or almost always, compared to 55.9% of Hispanics, 44.9% of Asians/Pacific Islanders, 41.8% of American Indians/Alaskan Natives and 29.5% of non-Hispanic whites; the OR for co-sleeping at least sometimes among AA mothers compared to NHW mothers is 3.71 (.95 CI 2.29 – 6.01), and other studies have reported similar findings. Kemp and colleagues[97] also reported that co-sleeping infants were more likely to be usually placed prone (18% vs. 9%, p = .04). Very soft items of bedding were more likely to be found beneath co-sleeping AA infants than solitary sleeping AA infants (p = .002), as well, and soft or multi-layered bedding are better accepted as risk factors than co-sleeping. As mentioned earlier, the role of co-sleeping in SIDS remains controversial.

Two recent reports of a Chicago-based ongoing case-control study, from the same group of investigators, support the importance of prone sleep position as a risk factor for SIDS among African American infants and a major contributing factor to the racial disparities in SIDS. Examining SIDS deaths occurring between 1993-1996, Hauck and colleagues[15] found an adjusted OR of 4.0 (1.8 – 8.8) for prone sleep position in a predominantly AA population. The PAR for SIDS due to prone positioning was greater for AA infants than non-AA infants. Only 46% of case mothers reported receiving infant sleep recommendations before discharge, compared to 64% of controls (p < .001. Of those advised, a similar proportion of case and control mothers reported being told to use the side position (62% and 70%, respectively) and prone position (22, and 23% respectively); only 12% reported supine recommendations; approximately 94% of both groups reported following the recommendations received. When stratified by race, 25% of combined AA case and control mothers recalled recommendations for prone positioning compared to only 7% of non-AA mothers (p = .01), supporting the hypothesis that differences in medical provider recommendations contribute to the racial disparities in sleep position. Again, parental reports of past sleep recommendations were unconfirmed and must be viewed with caution.

Hauck and colleagues, reporting additional details from this study,[(26)] identified "extremely hazardous", albeit imprecisely estimatee, interactions between prone sleep and soft bedding (OR 21.0, .95 CI 7.8 – 56.2) or pillow use (OR 11.8, .95 CI 4.0 – 34.4) that were more than multiplicative and all three are found with greater prevalence among AA than non-AA families. Fifteen SIDS cases and no controls co-slept on a sofa and the authors concluded that this practice might be "extremely hazardous", as well. Again, this has been found to be more common in AA families.

Birth order

This study, as have others before,[(70, 77-79, 91)] found multiparity to be a significant predictor of prone infant sleep position. This effect was most pronounced among women with four or more children, but was also significant when comparing second born to firstborn children. There was a tendency for increased risk at three children, as well, but the odds ratio found for the third born was lower than the study's ability to detect, at a power of .80. Additionally, parity as a binary (firstborn vs. not firstborn) and as a continuous variable was also statistically significant. The odds ratios found in this study are similar to, though somewhat higher than those found in the Pollack and Frohna's 15-state PRAMS report.[77] This might be due to the smaller sample size here, as the estimates were less precise than in their model.

Willinger and co-workers[71] found no more than 10% of their subjects reported choosing prone infant sleep position because "I sleep that way, my other children slept that way," even though 48.9% of their subjects had more than one child, similar to the 56.6% found here. Brenner and associates,[80] studying a 1995 – 1996 cohort of low income, predominately black new mothers, found only 5% reported previous experience or habit as the reason for choice of prone position; they did not report the parity of their study population.

Gibson and colleagues[98] reported a higher proportion of subjects giving tradition as a reason (42 – 47%), but their study was conducted in 1993-1994, prior to the "Back to Sleep Campaign" and may not be comparable. In any case, none of these studies examined why multiparous women are more likely to choose the prone sleep position; none compared the rationales for choice of sleep position between primiparous and multiparous women.

Although the underlying cause(s) of this association is not known, the identification of multiparous women as at greater risk of using the prone infant sleep position should encourage medical providers to explore their individual patients' choices of sleep position and their reasons for those choices, and can assist medical providers in targeting enhanced health education at this subgroup of parents.

The Initiation of Prenatal Care

This study was unable to detect an association between the initiation of prenatal care and choice of prone infant sleep position, although this has been previously reported.[77, 78] This may have been due to small sample size and insufficient power, as noted above. As mentioned previously, there was only moderate correlation between the birth certificate and PRAMS initiation of prenatal care variables. Either variable might have been subject to bias, with the birth certificate information collected and entered by many different people with no standardized approach to its collection. Conversely, the birth certificate data would be more contemporaneous than the PRAMS survey data, collected months after the birth. Interestingly, however, Pollack and Frohna,[77] combining three years of data from 15 states' PRAMS, were unable to demonstrate a statistically significant association, and their odds ratio for those obtaining prenatal care within the first trimester were quite similar to Oregon's.

Prenatal and Well Baby Care Sites

Although an association between pediatric care from public clinics and prone infant sleep position has been previously reported,[81] this association could not be confirmed nor ruled out by the current study. The analysis was complicated by the PRAMS question language that allowed multiple responses (see Appendix C), and the need to eliminate the 56 respondents reporting two or more sites. Further, the crude odds ratios favored health department clinics, while the adjusted odds ratios suggested an association between these clinics and prone sleep; even the direction of the association between health department clinics and prone sleep, beyond the strength of any association, was dependent on the model-building method and control variables selected. Conversely, the association with prone sleep seen for health departments compared to private physicians was weakly significant and the study did lack power to detect significant differences at the other two types of sites. In addition, when supine sleep was chosen as the outcome and side and prone sleep were combined (data not shown), *well baby care site* was significant following univariable logistic regression (p = .0029) and when adjusted for confounding (p = .0147). Well baby care from private physicians, in this alternate analysis, was significantly associated with choice of supine position (adjusted OR 2.89, .95 CI 1.45 – 5.75) when compared to health department clinics. The role of well baby care sites remains unresolved.

There are no previous reports of an association between the type of site for prenatal care and sleep position. In this study, prenatal care from a private physician or HMO (compared to a health department clinic) was strongly associated with prone position (hospital clinics were associated with prone sleep, as well, and the study lacked power to detect an association with "other" sites), and this association persisted after controlling for confounders and after entering *prenatal care site* into the change-in-point-estimate models for *race/ethnicity*, *parity* and *initiation of prenatal care*, into the forward stepwise model, and when adding it to the Pollack and Frohna model, attesting to the strength of the association. There is no indication that Pollack and Frohna looked for this association.

This study is unable to distinguish between inadequate or indifferent care at private physicians and HMOs, exceptional care at health department clinics or some combination of the two, nor can the effect of some as yet unidentified confounder be ruled out. Nor can the current study determine if the influence is felt in the prenatal period, the immediate post-natal period, or both. It is possible that the association is due to different patterns of hospital affiliation by type of site linked to differences in hospital practices. It is also possible that this association is specific to Oregon and Oregon's health care systems. Even if the results are specific to Oregon, this helps identify a high-risk population to target for additional efforts to promote supine sleep. However, there is reason to think that the results may be generalizable. There is strong, but not uncontradicted, evidence that medical care providers play a significant role in women's choice of infant sleep position and, additionally, some investigators point to the importance of early and continued medical recommendations and behavior-modeling. Differences in the frequency or quality of medical advice might contribute to the racial disparities in choice of infant sleep position but the importance of these factors is unresolved.

Speiker and Brannen,[(99)] in a 1995 survey of uniformed family practitioners, found only 62% encouraging supine sleep, 17.6% giving no recommendation, and 20.5% actually discouraging supine sleep position. Their sample was not representative of the membership of the American Academy of Family Practitioners as a whole, being younger and more male. However, the authors indicated that only 77% of a sample of pediatricians, given the same questionnaire, reported encouraging supine sleep.

Johnson and colleagues[(100)] suggested that awareness of the risk of SIDS from prone positioning and the receipt of medical advice were frequently not associated with avoidance of prone sleep. They found that among AA, Hispanic and Asian inner-city women contacted in a 1994-1997 nationwide random telephone survey, 80% percent had heard of the AAP recommendations and 72% had received sleep recommendations from a physician or nurse, the most common source; 64% cited the media, while only 11.5% cited family and friends. Fifty-eight percent agreed with the AAP, while 24% disagreed, and, not unexpectedly, this correlated with choice of sleep position ($p = .001$). Forty percent of respondents used the prone sleep position at least some of the time, when their infant was two months old, and this rose to 47% by age four months, increasing during the period of greatest risk of SIDS. Many mothers cited "they keep changing the recommendations," better infant sleeping and fear of choking as reasons for choice of the prone position.

Gibson and colleagues(98) compared AA parents attending Philadelphia pediatric clinics with mainly (60%) NHW parents attending private practices and found that the groups similarly cited advice from health care professionals (43.2% and 48.7%, respectively), or family advice and tradition (47.2% and 42.3%, respectively), as the reason for infant sleep position practices. The similarity of findings would argue against significant differences in racial experience or perceptions and the impact of medical advice was only moderate. These interviews followed the 1992 AAP recommendations but preceded the "Back to Sleep" campaign begun in April 1994.

Gibson and colleagues(81) carried out a similar, second study from December 1995 through February 1997. Attendance at the public pediatric clinics for well baby care compared to the private pediatric practices was strongly associated with a usual choice of prone infant sleep position (34% compared to 16%, $p < .001$); no attempt was made to control for confounding. The authors indicated that all hospitals associated with the pediatric groups involved in the study dispensed information on sleep position before discharge, that all the pediatric groups were aware of the AAP recommendations and all reportedly discussed these recommendations with their patients during the initial well-child visits, although none had a specific educational protocol for reinforcing the recommendation. These results would argue against differential medical advice as an important factor in either the choice of sleep position or the racial differences in those choices. More ambiguously, the authors reported that women choosing the prone position (31.2% of the sample) cited infant comfort (65%) and/or family recommendation (17%) as the reason, although 73% reported discussing sleep position with a medical provider and 21% had heard of the "Back to Sleep" campaign; however, only 4% reported receiving medical advice. Of the women choosing non-prone positions, 56% reported receiving medical advice and 82% had discussed sleep position with a medical provider (no statistical comparison of these two groups was provided). The low proportion of women choosing prone positions who recalled receiving medical advice, despite general clinic practices, might indicate differential application or quality of the clinic practices regarding sleep position recommendations or may represent recall bias or deliberate misreporting due to perceived social pressure.

Willinger and co-workers[(71)], conducting an annual national telephone survey of households containing infants less than seven months old, reported results from the period 1994-1998. During the study period, prone sleep position fell from 43% to 17%; while prone sleep fell in black families as well as white, the reduction was less dramatic, and black infants by study's end were put to bed prone twice as often as white infants. Even as late as 1997-1998, 40.7% of respondents reported receiving no recommendation from a physician. “Reading about it” was the most common reason given for a choice of supine or lateral sleep, although “doctor or nurse” was nearly as common. The most common reason given for choice of prone was that “the baby likes it or sleeps better that way.” Tradition – “I sleep that way, my other children slept that way” – was reported by very few caregivers. Eighty-six percent of those placing their infants prone had received only non-prone sleep position recommendations. The authors concluded that the racial disparities in infant sleep position are independent of whether or not the caregiver had received recommendations for supine sleep position from a medical source. They further concluded that within a subgroup of caregivers, factors as yet unknown override the sleep position recommendations the caregivers had received. Their results were limited by an under-representation of AA and Hispanic women, women under 20 years of age and those with less than 12 years of education. If any of these groups were more likely to choose prone positioning and less likely to receive medical advice, both plausible hypotheses, the results might have been different.

Ottolini and associates(91) conducted a telephone survey of new parents identified through a community hospital nursery and participating urban and suburban pediatric offices in Washington, D.C., from November 1995 through September 1996. Most women chose non-prone positioning (87.8%) initially. Of those women choosing prone sleep, infant comfort was the most often cited reason (≈ 40%), followed by previous experience (≈ 30%); of those choosing non-prone positions, over 55% cited media exposure, followed by medical provider advice (≈ 35%). Advice from a relative or friend was cited very rarely as was observation of hospital positioning. This study confirms that women choosing different infant sleep positions cite different reasons for their choice but cannot explain why each group of women responds more strongly to some influences than others. Another possible explanation is that the reasons given are post-hoc rationalizations or based on what the respondent believes are the surveyor's expectations. Additionally, the investigators found that 67% of infants initially placed non-prone at one week of age were switched to a prone position by six months of age, reportedly because of infant comfort, while only 20% of those positioned prone initially were switched to a non-prone position. The authors recommended medical providers begin counseling prenatally or the nursery at the latest – as once begun, prone positioning is to hard discourage – and to provide ongoing counseling during the second to fourth months of life to discourage switching to prone positions – when infants are most likely to be switched and when the risk of SIDS is highest. Interestingly, pediatricians underestimated the prevalence of prone sleep among their patients. The study may have been significantly limited by differences in subject recruitment. Those receiving care at the suburban clinics were recruited during the hospital stay, and consistently received sleep position advice from the research assistant, while those receiving care at the urban or military clinics were recruited during the first well-baby visit and did not consistently receive such advice.

As mentioned above, Hauck and co-workers[(15)] reported that AA mothers in Chicago, at least from 1993-1996, were more likely to receive recommendations for *prone* positioning than non-AA mothers (25% vs. 7%, respectively; $p = .01$), while over 94% of all study mothers reported following the recommendations received.

Ray and colleagues[(101)] compared 50 mid-to-upper income non-Hispanic white women who attended private pediatric clinics to 50 low-income African-American women who attended a university-affiliated inner city clinic in Louisville, KY. Only 48% of the African-American women reported receiving instructions for non-prone sleep position compared to 72% of the white women (p = .01); the African-American women who did receive instructions were not statistically less likely to follow those instructions (54% vs. 72%, respectively, p = .15). Investigators found that the one inner city hospital, which accounted for 73% of the African-American births, had not adopted the American Academy of Pediatrics recommendations and that 79% of the study infants born there were put to sleep prone. Two other hospitals, accounting for 80% of the NHW births and 22% of the AA births, had adopted the recommendations and 67% of the white infants and 60% of the African-American infants born there were put to sleep non-prone. This studies suggests that a significant factor in the high prevalence of prone sleep among African-Americans is the failure of the medical providers to recommend non-prone infant sleeping positions, and that once informed, African-American mothers are as likely to adopt the recommendations as white mothers. However, subject awareness of having received sleep position recommendations may not accurately reflect the actual provision of those recommendations by health care providers and may reflect either recall bias or an unwillingness to admit to failure to follow medical advice. Further, the study was limited by the ecologic nature of the hospital surveys – attributing individual experience (i.e. receipt or lack of receipt of sleep position advice from a medical provider) to hospital-level data.

Rainey and coworkers[102] found a similar acceptance of non-prone sleep recommendations among mother attending a community health center pediatric clinic -- 63.9% of those who had heard the recommendation complied; however, only 51%

reported that they had heard the recommendation and only 36% reported hearing the recommendation from a medical source. After hearing the recommendation again or for the first time during the study, 60.8% of women who had been using the prone position indicated that they would change to a non-prone position, 28.9% stated they would not change and 11.3% stated that they needed more information. There was no follow-up to confirm changes in sleep position following recommendations.

Brenner and colleagues[80], studying an inner-city, predominantly AA population from 1995-1996, found that only 69% of the mothers reported receiving advice on sleep position while in the hospital and only 64% reported receiving advice during well baby visits. Reported/recalled discussion of sleep position with a medical provider was not associated with the choice of sleep position. However, of the mothers who observed the use of prone positioning by hospital staff, 56% used the prone infant sleep position the previous night compared to only 34% of those who observed only non-prone positioning by hospital staff (OR 2.45, 1.25 – 4.79), suggesting that observation of hospital practice, more than medical provider advice, may influence maternal behavior. Incidentally, in this study, a grandmother in the home had a modest (OR 1.83, 1.11 – 3.00) association with prone sleep choice.

Moon and Omron[82], replicating Brenner's study three years later, found that only 70.6% of their subjects reported receiving sleep position recommendations, with 23% reporting supine only recommendations, 24.6% lateral only and 21.4% supine or lateral. Two of the 126 subjects reported receiving recommendations for <u>prone</u> sleep as late as 1999! Eight subjects reported observing prone sleep position use by hospital staff. Only 45% recalled receiving a "Back to Sleep" brochure when shown a copy. Of these, only

75.4% had read it and, of these, only 48.8% (16.7% of all subjects) remembered the recommendations. Receipt of this brochure was not correlated with later choice of sleep position. Clearly, distribution of this brochure in this population was an ineffective means of communication. Receipt of a recommendation for supine sleep from a health care provider was strongly associated with choice of supine sleep (OR 5.7, $p < .001$), while receipt of recommendations for either supine or lateral sleep was negatively correlated with supine sleep (OR 2.9, $p = .001$). These two studies support the hypothesis that medical care providers play an significant role in influencing women's choice of infant sleep position and that observations of actual practice and cultural competency are important factors in the acceptance of medical advice.

If maternal observation of hospital positioning practices is important, as suggested by the above studies, a July 1999 survey of Iowa maternity hospitals by Hein and associates(103) is disconcerting. The investigators found that 89.5% of the hospitals used either back or side positioning and 90.5% told parents that lateral position was acceptable. The most common reason given for choice of lateral position in the nursery was fear of aspiration (51.4%), followed by adherence to a recently published federal brochure (34.2%); 3.6% reported force of habit and 2.7% indicated it was because the babies sleep better. Parental observations of lateral sleep position in the nursery might weaken recommendations for use of supine sleep position.

Colson and co-workers(104) surveying inner city, primarily minority families attending their first well baby visit at an urban hospital-based clinic between December 1999 and March 2000, found that only 47% percent reported receiving sleep position recommendations from a nurse and 46% from a doctor, for a combined 63%. Of these families, only 65% received recommendations for supine sleep position (only 41% of the entire sample). Unfortunately, only 37% of parents reported observing exclusive supine use by the hospital staff; 50% reported lateral use and 10% reported supine and lateral use. Only 42% of the parents reported use of the supine position alone and an additional 10% reported use of supine in combination with lateral sleep position. Forty-three percent used lateral position alone. Twenty-six percent used the prone position sometimes, although only 3% reported usually using this position. The likelihood of parental choice of supine position was strongly associated with medical recommendations (OR 7.00, p = .003); similarly, those parents who reported observing only supine sleep position use in the nursery were more likely to chose the supine position (OR 3.8, p = .003) and the association was stronger if parents both observed exclusive supine use in the hospital and received medical provider recommendations (OR 8.0, p = .0006) compared to those who neither observed exclusive supine use nor received recommendations for supine sleep position. Half of the families were African-American and 25% Hispanic. Again, this study supports the importance of medical provider advice and medical provider practice prior to hospital discharge in influencing maternal choice of sleep position.

On the other hand, Morgan and Johnson[105] reported a disconnect between medical recommendations and parental practices. Ninety-percent of the medical residents at two urban Midwest university-affiliated family practice centers reported recommending supine sleep position for infants two and four months of age, 75% for infants eight months of age and 70% at 12 months. However, only 38%, 51%, 36% and 53% of parents reported use of supine sleep position, respectively. Parents of lower socioeconomic status (SES), estimated from type of insurance and uncontrolled for race/ethnicity, liked prone sleep more (55% vs. 26%), disliked prone sleep less (18% vs. 43%) and had heard of the AAP recommendations less often (59% vs. 83%) than those of higher SES. Of the women who had heard of the recommendations, low SES women were less likely to agree (27% vs. 43%) and more likely to disagree (25% vs. 13%) with the AAP recommendations than higher SES women. There was no statistical difference between lower and higher SES families regarding sources of information about infant sleep position, with 70% citing medical providers and 40-45% citing family. The study was limited by the exclusion of clinical faculty, who also saw patients, from completing the provider questionnaire, and no attempt was made to limit the patients to those seen only by residents.

Rasinski and colleagues[106] reported that neither observation of supine sleep position in the nursery (OR 1.02, 0.65 – 1.63) nor instructions from a medical provider (OR 1.34, 0.77 – 2.34) were significantly associated with choice of prone sleep position but that a “comprehensive, ethnically-sensitive” multimedia SIDS community-wide public health risk reduction education program targeting both health professionals, pregnant mothers and their family members, and community and religious leaders could influence medical provider and maternal behavior positively. The investigators conducted a two-sample CATI survey in primarily AA communities in Chicago before and after this campaign. After the campaign, which was begun in November 1999, significantly more AA mothers reported observing the infant put supine in the nursery (64% vs. 53% before the campaign, $p < .05$) and significantly more reported receiving sleep position recommendations before discharge (70% vs. 22%, $p < .05$). When temporality was considered (before or after the campaign), significantly more mothers surveyed after the campaign were responsive to provider recommendations than mothers surveyed before the campaign, suggesting to the authors that community-wide dissemination of information about sleep position did influence maternal behavior. Prone sleep choice among AA mothers fell from 24.5% before to 21% after the campaign. The authors concluded that cultural explanations for specific infant sleep practices must be better understood to reduce the discordance between knowledge of unsafe sleep practices and choice of safe sleep practices.

The above-noted studies exploring the impact of medical care providers on the subsequent choice of infant sleep position, particularly among AA women, have come to differing conclusions. Medical care providers may have provided inadequate or culturally inappropriate sleep recommendations or no recommendations at all, and this may account for the apparent disparities in parental recollection of advice. Alternately, women who have stronger motivations to choose the prone infant sleep position may not remember or may not wish to report receiving medical care provider recommendations. These are not mutually exclusive possibilities. There may also be subgroups of women, particularly among AA women, who are less open to provider recommendations for as yet unrecognized reasons. The Oregon PRAMS data supports the hypothesis that the actions of medical care providers do make a difference, as prenatal care site was strongly associated with choice of infant sleep position, even after adjusting for a number of demographic and socioeconomic factors.

All reported studies have relied on cross-sectional design and/or ecological analysis. Nine of the seventeen cited studies that explored the determinants of choice of infant sleep positioning were clinic-based rather than hospital- or population-based, excluding women who fail to seek well baby care, a potentially high-risk group. No studies have confirmed the accuracy of maternal reporting of medical care provider recommendations. There have been no prospective studies of the pre- or post-natal experiences of individual patients, with validation of reported medical provider interactions with those individual patients, and the women's subsequent choice of infant sleep position. As Colson and colleagues point out,[(104)] parental recall is subject to possible recall bias as those parents who chose supine sleep position may be more likely to remember and report recommendations for supine sleep, while those parents who chose prone sleep positions may be less likely to remember or less willing to report receiving recommendations for supine sleep. Both possible sources of error would tend to overestimate the impact of medical personnel recommendations. Medical providers may be as, or even more likely, to mis-report provision of supine sleep recommendations, for similar reasons of social and medical acceptability.

Distinguishing between these alternate explanations of the data – inadequate provider intervention or resistance to provider recommendations on the part of caregivers – or determining the relative contributions of each, is very important if we are to further reduce the prevalence of prone infant sleep position, as well as lessen the racial disparities in choice of supine position and thus SIDS itself, through more effective public health interventions.

Limitations

One limitation is common to most research on this subject – what to do with the lateral sleep responses. The most common approaches have been to combine lateral sleep responses with either prone or supine responses, depending on the focus of the study, for the performance of binary logistic regression. There are two problems with this. First, the addition of lateral sleep position to either of the other two positions might strengthen or diminish an association with any given variable, depending on the direction of the relationship of lateral sleep with that variable; a moderate association may disappear or a weak one appear stronger than it is, leading to both alpha and beta type errors. This would be more likely to occur when lateral sleep is paired with prone sleep, given the relatively low prevalence of prone sleep; this supports the choice of coding selected here. On the other hand, lateral sleep position does not appear to be without risk. The initial AAP recommendations treated supine and lateral positions equivalently; this has changed somewhat since that 1992 article. At least two groups of authors(24, 38, 41) argue that side-sleeping now has a greater PAR than prone-sleeping because of its much greater prevalence. Given the current AAP recommendations, this study chose to focus on prone sleep position as the outcome of interest. However, given the low prevalence of the choice of prone infant positioning and limited sample size, some variables could not be explored because of small cell sizes, and the study's power was diminished.

The proportion of women not responding to this survey was 36%, slightly higher than the CDC goal of at most 30% non-responses. The responders were weighted for non-response using several of the variables, but this cannot completely eliminate possible bias due to non-response. However, the associations between prone sleep and race/ethnicity, parity and prenatal care site are so strong that it is unlikely that this would have altered the results.

PRAMS is not completely representative of the Oregon population as it excludes by design adoptive mothers or women whose birth certificate was submitted more than 180 days after birth. These numbers are small and would have been unlikely to have altered the results. PRAMS also excludes women whose babies were not living with them at the time of the survey; they comprised only 2.3% of the sample.

One theoretical source of bias would be the exclusion of women whose babies died of SIDS prior to mother's completion of the survey, in compliance with the PRAMS *skip pattern*. As SIDS is associated with sleep position, and with other factors examined here, this might bias the results. However, given the sample size, the likely number of respondents excluded would be extremely small, two or three women at the most.

Another CDC recommendation is the rejection of any variable with more than 10% missing responses. No variable used in this study failed this test, at least when considering the unweighted data, although PRAMS enrollment in WIC came close. No target variable (*race/ethnicity, parity, initiation of prenatal care, prenatal* and *well baby care sites*) had more than 3.5% missing responses.

"Social acceptability" bias occurs when respondents provide what they believe to be desired responses or avoid providing socially less acceptable responses, resulting in misclassification. The self-reporting of choice of infant sleep position may be subject to this type of bias if sleep position is a sensitive subject and the respondent feels compelled to give a socially acceptable answer (e.g. other than prone). In this study, sleep position is the outcome, and if this misreporting were true equally of all categories of respondents (e.g. all racial subgroups), the results would be subject to non-differential misclassification, with a tendency to dilute the odds ratios toward unity. However, if the tendency to give socially acceptable answers differs by category, this might lead to differential misclassification. Non-differential misclassification of infant sleep position due to “social acceptability” bias cannot be ruled out, but the findings here are consistent with those in the literature; any such bias would likely be small or universal to all such studies. Arguing against such a bias is the lack of a significant association between prone sleep position and mode of administration. If bias were present, one would expect it to be more apparent with CATI respondents than mail respondents, resulting in an association between mail mode and prone sleep. In fact, just the opposite was found – there was a non-significant, weak tendency for the CATI mode to be associated with prone sleep.

One instance of probable “social acceptability” bias – that of alcohol use during pregnancy – was apparently identified, as a “mode of administration” bias. Alcohol use in the third trimester was significantly associated with the mode of administration, even after adjusting for confounding; apparently, women who were contacted by phone were less willing to report alcohol use than those who responded to the mailed questionnaire. This type of bias affecting PRAMS has been previously reported.[(107)] No similar association was found between the mode of administration and sleep position or smoking. Because of this, alcohol-related variables were not used in the analyses.

Residual confounding might play a role, particularly in the case of *prenatal care site*; hospital affiliation patterns/hospital nursery practices or urban-rural differences might play a role. Residual confounding due to socioeconomic factors or other demographic factors is unlikely given the range of variables tested. Given the strength of the associations – and the consistency with previously reported findings in the cases of *race/ethnicity* and *parity* – it is unlikely that residual confounding would have significantly altered the results.

The PRAMS questionnaire allows multiple responses to the well baby care site question. This greatly complicated the analysis of this variable. Of the 1728 valid respondents, 52 (3.0%) reported two types of sites and 4 (0.2%) reported 3 types of sites. In the end, the analysis was restricted to women with only single responses. The addition of those with multiple responses led to a cell size < 5. Further, the power to analyze this variable was low. This study reached no definitive conclusion as to the importance of this factor. Resolution will require a larger sample, either from combining multiple states, as some have done,[(77)] or combining multiple years of Oregon PRAMS, which would be preferable, as there is no *a priori* reason to believe that all states share similar experiences. Similarly, the finding that private physician/HMO prenatal care sites were risk factors for prone sleep, as strong as it was found to be, will need to be replicated.

Several of the variables were taken from both the birth certificate and the PRAMS dataset. As seen with *initiation of prenatal care*, the correlation was less than ideal. No follow-up verification or validation was possible. It is possible that faulty memory was operative in the PRAMS responses to the *initiation of prenatal care* question, as the PRAMS responses were obtained months after the event, whereas the birth certificate information was obtained more contemporaneously. However, the BC-derived variable was no more associated with prone sleep than the PRAMS-derived variable, suggesting that such misclassification, if present, had little effect on the results. It is also possible that "social acceptability" bias was at play, with reporting in face-to-face encounters with hospital staff completing the birth certificates was less accurate than solitary completion of questionnaire.

Other dual-source variables, *WIC enrollment* and *smoking during pregnancy*, were entered into the models as confounders. Their use did not greatly change the findings. In addition, any errors of collection, at the hospitals, or data entry, either at the multiple hospitals and multiple personnel involved, or at the Department of Human Services Health Services, with only a single individual involved in PRAMS data entry, would likely lead to non-differential misclassification and dilute any true associations.

PRAMS includes no questions regarding the reasons behind the choice of sleep position and none can be inferred from the data. This information may be critical to designing effective public health interventions targeted at the identified high-risk subgroups of new mothers, but it is beyond the scope of this paper to address.

Because the CATI data did not include a date of the telephone interview, no precise infant age could be assigned and they were all assumed to be older than 13 weeks, a reasonable assumption. However, this prevented the analysis of infant age and breastfeeding duration as continuous rather than binary variables. As both variables did enter into one or more of the models, this might have led to small differences but given the strength of the target variables, it is unlikely the results would be much different.

There is a limitation inherent to the "change-in-point-estimate" model-building procedure. The procedure requires assessing the impact of multiple variables on the odds ratio of a target variable. Assessing the impact of multiple variables added individually to multiple levels of a multi-level target variable would not be possible. For any variable with more than two levels, the procedure would identify only confounders of that level compared to the referent level. The target levels used in this study were African-American race (relative to NHW) in the race variable, with five levels, and the fourth or higher child (relative to firstborn) in the parity variable and private physician\HMO (relative to health department) in the two care site variables, all with four levels. How much would the results have been altered if one or another of these other levels had been used to gauge confounding? Parity, as a binary variable comparing firstborn with later born infants, was still a significant variable, in crude and adjusted analysis, and the Pollack/Frohna parity results were similar, so it is unlikely that basing the procedure on changes in the second or third born child would have made a significant difference. The odds ratios for the other racial/ethnic groups were consistent with the literature, and did not show an increased risk of prone sleep; the precise estimates would likely have varied if a different racial/ethnic group had been chosen but the general results would not. There are no comparable studies reporting the risk associated with hospital clinics or "other" sites for prenatal or well baby care and those odds ratios of the other levels should be viewed with caution.

Importance of the Findings

SIDS remains the leading cause of post-neonatal infant mortality and prone infant sleep position, as a significant and modifiable risk factor, has been targeted for public health intervention. Oregon's rate of SIDS death is one of the highest in the nation. There have been significant declines in the use of prone infant sleep positioning but there persist subgroups with a disturbingly high prevalence of this position. African-American infants die of SIDS at more than twice the rate of white infants, and some – perhaps most

– of this can be attributed to the high prevalence of prone infant sleep position among AA infants. This study confirms the high and disproportionate frequency of prone sleep position among AA infants in Oregon. Oregon infants, like those of other states, are at greater risk if they have siblings, and the more siblings, the greater the risk. The identification of these two high-risk groups here can help target additional public health efforts to reducing the use of prone sleep position.

Not previously reported, prenatal care site, at least in Oregon, appears to be strongly associated with prone infant sleep position, with those infants of mothers receiving care from private physicians or HMOs at greatest risk. Although the literature is somewhat divided on this subject, it appears that information from – and observations of – health care providers is important in parental choice of sleep position, and that the earlier that the information is received – and reinforced – the more likely will be the compliance of the mother.

It is possible that it is not the providers, per se, that are associated with the choice of prone sleep position; perhaps it is the hospitals at which they practice. Further study will be needed to replicate and confirm this finding and to identify any associated factors, such as hospital of delivery or nursery sleep practices. In the meantime, private physicians providing prenatal care and HMOs might be informed of the results and encouraged to look at their policies and practices regarding recommendations for infant sleep position.

An association between well baby care site – specifically health department clinics – and prone sleep position could not be conclusively shown – or ruled out. It has been reported previously. If true, it would also pinpoint a potential target for intervention.

Directions for Further Research

First and foremost, additional research should be directed at determining the reasons for choice of infant sleep position, so as to more effectively intervene to promote supine and discourage prone – and possibly lateral – sleep position, particularly among subgroups most resistant to the “Back to Sleep” campaign. A number of studies suggest that lack of or differential efforts by medical providers, particularly in regard to African-American mothers, is important, while others suggest that certain populations are resistant to such recommendations and are motivated by other factors. The decline in the use of prone sleep position has apparently reached a plateau and further advances may require more specific knowledge of the motivations of those persisting in the use of this position. This will be especially important in addressing the racial disparities in both choice of sleep position and in SIDS.

Other factors may play a role in this racial disparity. Research that disentangles the separate and/or combined risks, if any, of co-sleeping, unsafe sleep practices and non-standard sleep surfaces, would help to resolve this thorny issue. Given the higher prevalence of co-sleeping among African-American families, it is important to know if this is truly a risk factor, increases the likelihood of more directly causal risk factors (such as soft bedding or thick covers) or is merely an innocent confounder.

With the decline in prone infant sleep position, it is possible that lateral sleep position may pose a greater risk factor – population-wide – than prone sleep. Further analysis of this issue is warranted.

Exploring the reasons behind the association between private prenatal care and prone sleep position – e.g. survey of area obstetricians and family practitioners regarding their knowledge of or practices of sleep position recommendations, a survey of hospital nursery policies and practices, focus groups of patients – might identify opportunities to promote supine infant sleep position. Similarly, additional attention to clarifying the role of well baby care sites would be helpful.

Summary and Conclusions

This paper analyzed the first year of Oregon PRAMS (1998 – 1999), a statewide, mixed mode surveillance system, that surveys a stratified random sample of women who have recently given birth, collecting information on a respondent's prenatal, perinatal and post-natal experiences, attitudes and practices, including infant sleep position, the major modifiable risk factor for SIDS.

Among Oregon women, African-American race was the most significant predictor of prone infant sleep position, with a greater than fourfold likelihood of utilizing the prone position, compared to non-Hispanic white women. This may account for some or most of the racial disparity in SIDS rates. Oregon's findings were similar to those of other states.

Among Oregon women, parity is a significant predictor of prone infant sleep position, particularly if the index infant is the fourth or higher in birth order, with a more than seven-fold increase in risk. Second and third children are at increased but intermediate risk. This has also been reported by others, although this study found a higher risk than that reported from a similar combined 15-state 3-year PRAMS report.

Delayed initiation of prenatal care has been reported to be a risk factor for prone sleep position, but no association was found here. This may be due to small sample size and insufficient power, but the previously noted 15-state PRAMS study reported similar results to Oregon's.

Not previously reported, the site of prenatal care was found to be a significant risk factor for prone infant sleep position. Specifically, receipt of care from a private physician or HMO conferred a greater than eightfold risk of use of prone sleep position, when compared to patients at health department clinics; the risk of "other" sites was less but still significant. An increased risk was found for hospital clinics, but this was not statistically significant. Whether these results are due to special attention at the health department clinics or insufficient attention at other sites is unknown, and there may be other, more causal but unidentified factors at work, such as nursery practices in hospitals serving those private physicians.

Well baby care site as a determinant of infant sleep position was explored. The results were inconclusive and not statistically significant, and if an association was present, it is much weaker than that found for prenatal care sites. The univariable analysis seemed to favor health department well baby clinics but the multivariable analysis found that patients at these health department clinics to be at higher risk for prone sleep position. This dataset lacked sufficient power to rule out a true association.

A "change-in-point-estimate" multivariable logistic regression procedure was used to identify confounders and create multivariable models for each of the target variables discussed above. By way of comparison, a forward-stepwise procedure was performed. This procedure identified race/ethnicity, parity and prenatal care site as significant predictors, among others, supporting the validity of the above noted findings. Finally, Oregon's results were compared with those of the 15-state PRAMS study. The results were generally similar, again supporting the validity of the current findings.

References

1. M Willinger, LS James, C Catz. 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;11:677-684.

2. WG Guntheroth. Crib Death: The Sudden Infant Death Syndrome. Third Edition ed. Armonk, NY: Futura Publishing Co., Inc.; 1995.

3. AM Miniño, E Arias, KD Kochanek, et. al., Division of Vital Statistics. Deaths: Final Data for 2000. Hyattsville, MD: National Center for Health Statistics; 2002 09/16/02. http://www.cdc.gov/nchs/data/nvsr/nvsr50/nvsr50_15.pdf Accessed 03/22/03.

4. RN Anderson, Division of Vital Statistics. Deaths: leading causes for 2000. Hyattsville, MD: National Center for Health Statistics; 2002 9/16/02. http://www.cdc.gov/nchs/data/nvsr/nvsr50/nvsr50_16.pdf Accessed 05/03/03.

5. Oregon Department of Human Services Health Services, Office of Disease Prevention and Epidemiology, Center for Health Statistics. Oregon Vital Statistics Report 2000.Volume 2:Table 6-4. http://www.ohd.hr.state.or.us/chs/arpt/00v2/00v2.pdf Accessed 03/22/03.

6. HJ Hoffman, LS Hillman. Epidemiology of the sudden infant death syndrome: maternal, neonatal, and postneonatal risk factors. Clin Perinatol 1992;19:717-737.

7. HJ Hoffman, K Damus, L Hillman, E Kongrad. Risk factors for SIDS: results on the National Institute of Child Health and Human Development SIDS Cooperative Epidemiological Study. Ann N Y Acad Sci 1988;533:13-30.

8. MH Malloy, HJ Hoffman. Prematurity, sudden infant death syndrome and age of death. Pediatrics 1995;96:464-471.

9. MF MacDorman, S Cnattingius, HJ Hoffman, et. al. Sudden infant death syndrome and smoking in the United States and Sweden. Am J Epidemiol 1997;146:249-257.

10. KC Schoendorf, JL Keily. Relationship of sudden infant death syndrome to maternal smoking during and after pregnancy. Pediatrics 1992;90:905-908.

11. MH Malloy, JC Kleinman, GH Land, WF Schramm. The association of maternal smoking with age and cause of infant death. Am J Epidemiol 1988;128:45-55.

12. B Haglund, S Cnattingius. Cigarette smoking as a risk factor for sudden infant death syndrome: a population-based study. Am J Public Health 1990;80:29-32.

13. EA Mitchell, RPK Ford, AW Stewart, et. al. Smoking and the sudden infant death syndrome. Pediatrics 1993;91:893-896.

14. N Øyen, T Markestad, R Skjærven, et. al. Combined effects of sleeping position and prenatal risk factors in sudden infant death syndrome: the Nordic Epidemiological SIDS Study. Pediatrics 1997;100:613-621.

15. FR Hauck, CM Moore, SM Herman, et. al. The contribution of prone sleeping position to the racial disparity in Sudden Infant Death Syndrome: the Chicago Infant Mortality Study. Pediatrics 2002;110:772-780.

16. EM Papacek, JW Collins, NF Schulte, et. al. Differing postneonatal mortality rates of African-American and White infants in Chicago: an ecologic study. Mat Child Health J 2002;6:99-105.

17. FR Hauck, JS Kemp. Bedsharing promotes breastfeeding and AAP Task Force On Infant Positioning and SIDS. Pediatrics 1998;102:662-664.

18. EA Mitchell, R Scragg, AW Stewart, et. al. Results from the first year of the New Zealand cot death study. N Z Med J 1991;104:71-76.

19. RP Ford, BJ Taylor, EA Mitchell, et. al. Breastfeeding and the risk of sudden infant death syndrome. Int J Epidemiol 1993;22:366-375.

20. DD Fredrickson, JR Sorenson, AK Biddle, M Kotelchack. Relationship of sudden infand death syndrome of breast-feeding duration and intensity. Am J Dis Child 1993;147:460 (Abstract 191).

21. MP l'Hoir, AC Engelberts, GThJ van Well, et. al. Case-control study of current validity of previously described risk factors for SIDS in the Netherlands. Arch Dis Child 1998;79:386-393.

22. B Alm, G Wennergren, SG Norvenius, et. al., on behalf of the Nordic Epidemiological SIDS Study. Breast feeding and the sudden infant death syndrome in Scandinavia, 1992-1995. Arch Dis Child 2002;86:400-402.

23. RE Gilbert, RE Wigfield, PJ Fleming, et. al. Bottle feeding and the sudden infant death syndrome. Br Med J 1995;310:88-90.

24. PJ Fleming, PS Blair, C Bacon, et. al. Environment of infants during sleep and risk of the sudden infant death syndrome: results of 1993-5 case-control study for confidential inquiry into stillbirths and deaths in infancy. Br Med J 1996;313:191-195.

25. H Brooke, A Gibson, D Tappin, et. al. Case control study of sudden infant death syndrome in Scotland, 1992-1995. Br Med J 1997;314:1516-1520.

26. FR Hauck, SM Herman, M Donovan, et. al. Sleep environment and the risk of Sudden Infant Death Syndrome in an urban population: the Chicago Infant Mortality Study. Pediatrics 2003;111:1207-1214.

27. T Dwyer, AL Ponsonby, D Couper. Tobacco smoke exposure at one month of age and subsequent risk of SIDS - a prospective study. Am J Epidemiol 1999;149:593-602.

28. JS Kemp, BT Thach. Sudden death in infants sleeping on polystyrene-filled cushions. N Engl J Med 1991;324:1858-1864.

29. AL Ponsonby, T Dwyer, LE Gibbons, et. al. Factors potentiating the risk of sudden infant death syndrome associated with prone position. N Engl J Med 1993;329:377-382.

30. EA Mitchell, JMD Thompson, RPK Ford, et. al. Sheepskin bedding and the sudden infant death syndrome. J Pediatr 1997;133:701-704.

31. EA Mitchell, R Scragg, M Clements. Soft cot mattresses and the sudden infant death syndrome. N Z Med J 1996;109:206-207.

32. AL Ponsonby, T Dwyer, D Couper, J Cochrane. Association between use of a quilt and sudden infant death syndrome: case-control study. Br Med J 1998;316:195-196.

33. SM Williams, BJ Taylor, EA Mitchell. Sudden infant death syndrome: insulation from bedding and clothing and its effect modifiers. Int J Epidemiol 1996;25:366-375.

34. S Nakamura, M Wind, MA Danello. Review of hazards associated with children placed in adult beds. Arch Pediatr Adolesc Med 1999;53:1019-1023.

35. KD Rosenberg. Sudden infant death syndrome and co-sleeping. Arch Pediatr Adolesc Med 2000;154:529-531.

36. H Klonoff-Cohen, SL Edelstein. Bed sharing and the sudden infant death syndrome. Br Med J 1995;311:1269-1272.

37. B Unger, JS Kemp, D Wilkins, et. al. Racial disparity and modifiable risk factors among infants dying suddenly and unexpectedly. Pediatrics 2003;111(e127):e127-131. http://www.pediatrics.org/cgi/content/full/111/2/e127 Accessed 03/29/03.

38. EA Mitchell, PG Tuohy, JM Brunt, et. al. Risk factors for sudden infant death syndrome following the prevention campaign in New Zealand: a prospective study. Pediatrics 1997;100:835-840.

39. PS Blair, PJ Fleming, IJ Smith, et. al. Babies sleeping with parents: case-control study of factors influencing the risk of sudden infant death syndrome. Br Med J 1999;319:1457-1462.

40. RK Scragg, EA Mitchell, BJ Taylor, et. al. Bed sharing, smoking, and alcohol in the sudden infant death syndrome. Br Med J 1993;307:1312-1318.

41. RKR Scragg, EA Mitchell. Side sleeping position and bed sharing in the sudden infant death syndrome. Ann Med 1998;30:345-349.

42. JS Kemp, B Unger, D Wilkins, et. al. Unsafe sleep practices and an analysis of bedsharing among infants dying suddenly and unexpectedly: results of a four-year, population-based, death-scene investigation study of sudden infant death syndrome and related deaths. Pediatrics 2000;106:e41. http://www.pediatrics.org/cgi/content/full/106/3/e41 Accessed 03/27/03.

43. J Kattwinkel, J Brooks, ME Keenan, M Malloy, M Willinger, AAP Task Force on Infant Positioning and SIDS. Does bed sharing affect the risk of SIDS? Pediatrics 1997;100:272.

44. JJ Mosko, SS Mosko, CA Richard. Bedsharing promotes breastfeeding. Pediatrics 1997;100:214-219.

45. S Mosko, C Richard, J McKenna. Infant arousals during mother-infant bed sharing: implications for infant sleep and sudden infant death syndrome research. Pediatrics 1997;100:841-849.

46. WG Guntheroth, PS Spiers. Sleeping prone and the risk of Sudden Infant Death Syndrome. JAMA 1992;267:2359-2362.

47. T Dwyer, AL Ponsonby, NM Newman, LE Gibbons. Prospective cohort study of prone sleeping position and sudden infant death syndrome. Lancet 1991;837:1244-1247.

48. LM Irgens, T Markestad, V Baste, et. al. Sleeping position and sudden infant death syndrome in Norway 1967-91. Arch Dis Child 1995;72:478-482.

49. JA Taylor, JW Krieger, DT Reay, et. al. Prone sleep position and the sudden infant death syndrome in King County, Washington: a case-control study. J Pediatr 1996;128:626-630.

50. EA Mitchell, R Scragg. Observations on ethnic differences in SIDS mortality in New Zealand. Early Hum Dev 1994;38:151-157.

51. NNY Lee, YF Chan, DP Davies, et. al. Sudden infant death syndrome in Hong Kong: confirmation of low incidence. Br Med J 1989;298:721.

52. G Wennergren, B Alm, N Øyen, et. al. on behalf of the Nordic Epidemilogical SIDS Study. The decline in the incidence of SIDS in Scandinavia and its relation to risk-intervention campaigns. Acta Paediatr 1997;86:963-968.

53. BT Skadberg, I Morild, T Markestad. Abandoning prone sleeping: effect on the risk of sudden infant death syndrome. J Pediatr 1998;132:340-343.

54. EA Mitchell, JM Brunt, C Everard. Reduction in mortality from sudden infant death syndrome in New Zealand: 1986-1992. Arch Dis Child 1994;70:291-294.

55. T Dwyer, AL Ponsonby, L Blizzard, et. al. The contribution of changes in the prevalence of prone sleeping position to the decline in sudden infant death syndrome in Tasmania. JAMA 1995;273:783-789.

56. RE Wigfield, PJ Fleming, PJ Berry, et. al. Can the fall in Avon's sudden infant death rate be explained by changes in sleeping position? Br Med J 1992;304:282-283.

57. J Kattwinkel, J Brooks, D Myerberg, AAP Task Force on Infant Positioning and SIDS. Positioning and SIDS. Pediatrics 1992;89:1120-1126.

58. Centers for Disease Control and Prevention. Sudden Infant Death Syndrome - United States, 1983-1994. MMWR 1996;45(40):859-863. ftp://ftp.cdc.gov/pub/Publications/mmwr/wk/mm4540.pdf Accessed 04/30/03.

59. J Kattwinkel, JG Brooks, ME Keenan, M Malloy, M Willinger, NJ Scheers, AAP Task Force on Infant Sleep Position and Sudden Infant Death Syndrome. Changing concepts of sudden infant death syndrome: implications for infant sleeping environment and sleep position. Pediatrics 2000;105:650-656.

60. PJ Schwartz, M Stramba-Badiale, A Segantini, et. al. Prolongation of the QT interval and the sudden infant death syndrome. N Engl J Med 1998;338:1709-1714.

61. JS Kemp. Rebreathing of exhaled gases: importance as a mechanism for the causal association between prone sleep and Sudden Infant Death Syndrome. Sleep 1996;19:S263-S266.

62. BT Skadberg, T Markestad. Consequences of getting the head covered during sleep in infancy. Pediatrics 1997;100:e6. http://www.pediatrics.org/cgi/content/full/100/2/e6 Accessed 03/27/03.

63. JS Kemp, M Livne, DK White, CL Arfken. Softness and potential to cause rebreathing: Differences in bedding used by infants at high and low risk for sudden infant death syndrome. J Pediatr 1998;132:234-239.

64. AL Patel, D Paluszynska, KA Harris, BT Thach. Occurrence and mechanisms of sudden oxygen desaturation in infants who sleep face down. Pediatrics 2003;111:e328-e332. http://www.pediatrics.org/cgi/reprint/111/4/e328 Accessed 04/11/03.

65. WG Guntheroth, PS Spiers. Sleeping prone and the risk of SIDS. JAMA 1992;267:2359-2362.

66. BC Galland, G Reeves, BJ Taylor, DP Bolton. Sleep position, autonomic function and arousal. Arch Dis Child Fetal Neonatal Ed 1998;78:F189-F194.

67. RS Home, D Ferens, AM Watts, et. al. The prone sleeping position impairs arousability in term infants. J Pediatr 2001;138:811-816.

68. KW Lewis, EM Bosque. Deficient hypoxia awakening response in infants of smoking mothers: a possible relationship to sudden infant death syndrome. J Pediatr 1995;127:691-699.

69. WG Guntheroth, PS Spiers. The Triple Risk Hypotheses in Sudden Infant Death Syndrome. Pediatrics 2002;110:1-6. http://www.pediatrics.org/cgi/content/full/110/5/e64 Accessed 05/02/03.

70. M Willinger, HJ Hoffman, KT Wu, 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;280:329-335.

71. M Willinger, CW Ko, HJ Hoffman, et. al. Factors associated with caregiver's choice of infant sleep position, 1994-1998: The National Infant Sleep Position Study. JAMA 2000;283:2135-2142.

72. EJ Adams, GF Chavez, D Steen, et. al. Changes in the epidemiologic profile of sudden infant death syndrome as rates decline among California infants: 1990-1995. Pediatrics 1998;102:1445-1451.

73. B Guyer, DL Hoyert, JA Martin, et. al. Annual summary of vital statistics – 1998. Pediatrics 1999;104:1229-1246.

74. J Kattwinkel, J Brooks, ME Keenan, M Malloy, M Willinger, AAP Task Force on Infant Positioning and SIDS. Positioning and sudden infant death syndrome (SIDS): Update. Pediatrics 1996;98:1216-1218.

75. CEA Leach, PS Blair, PJ Fleming, et. al. Epidemiology of SIDS and explained sudden infant deaths. Pediatrics 1999;104:e43. http://www.pediatrics.org/cgi/content/full/104/4/e43 Accessed 03/27/03.

76. B Sowter, LW Doyle, CJ Morley, et. al. Is sudden infant death syndrome still more common in very low birthweight infants. Med J Aust 1999;171:411-413.

77. HA Pollack, JG Frohna. Infant sleep placement after the Back to Sleep Campaign. Pediatrics 2002;109:608-614.

78. M Saraiya, F Serbanescu, R Rochat, et. al. Trends and predictors of infant sleep position in Georgia, 1990-1995. Pediatrics 1998;102:1-6.

79. SM Lesko, MJ Corwin, RM Vezina, et. al. Changes in sleep position during infancy; a prospective longitudinal assessment. JAMA 1998;280:336-340.

80. RA Brenner, BG Simons-Morton, B Bhaskar, et. al. Prevalence and predictors of the prone sleep position among inner-city infants. JAMA 1998;280:341-346.

81. E Gibson, CA Dembofsky, S Rubin, JS Greenspan. Infant sleep position practices 2 years into the “back to sleep” campaign”. Clin Pediatr 2000;39:285-289.

82. RY Moon, R Omron. Determinants of infant sleep position in an urban population. Clin Pediatr 2002;41:569-573.

83. L Flick, C Vemulapalli, BB Stulac, JS Kemp. The influence of grandmothers and other senior caregivers on sleep position used by African American infants. Arch Pediatr Adolesc Med 2001;155:1231-1237.

84. KD Rosenberg, PR Westling, AS Sandoval, K Stebbins, T Kent T, M Lahr. Oregon PRAMS First Year Report, 1998-99. Department of Human Services, Health Services, Portland, Oregon: Office of Family Health 2000:Appendix D: Weighting Scheme. http://www.dhs.state.or.us/publichealth/pch/prams/9899/9899appd.cfm Accessed 03/22/03.

85. DW Hosmer, S Lemeshow. Applied Logistic Regression. Second Edition ed. New York: John Wiley & Sons, Inc.; 2000.

86. S Greenland. Modeling and variable selection in epidemiologic analysis. Am J Public Health 1989;79:340-349.

87. SL Lohr. Sampling: design and analysis. In: Doxbury Press; 1999. p. 239-242.

88. G Shackman. Sample size and design effect. presented at the Albany Chapter of the American Statistical Association. Albany, NY: New York State Department of Health; 2001 March 24, 2001.

89. Research Triangle Insitute. SUDAAN User Manual Release 8.0. Research Triangle Park, NC: Research Triangle Institute; 2001.

90. LE Lipscomb, CH Johnson, B Morrow, et. al. PRAMS 1998 Surveillance Report. Division of Reproductive Health, National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control and Prevention 2000. http://www.cdc.gov/nccdphp/drh/prams/pdf/98prams/prams_98.pdf Accessed 03/29/03.

91. MC Ottolini, BE Davis, K Patel, et. al. Prone infant sleeping despite the "Back to Sleep" campaign. Arch Pediatr Adolesc Med 1999;153:512-517.

92. T Hashimoto, K Hiura, S Endo, et. al. Postural effects on behavioral states of newborn infants - a sleep polygraphic study. Brain Dev 1983;5:286-291.

93. A Kahn, J Groswasser, M Sottiaux, et. al. Prone or supine body position and sleep characteristics in infants. Pediatrics 1993;91:1112-1115.

94. Pregnancy Risk Assessment Monitoring System Working Group, Centers for Disease Control and Prevention. Assessment of infant sleeping position – selected states, 1996. MMWR 1998;47:873-877.
http://www.cdc.gov/mmwr/PDF/wk/mm4741.pdf Accessed 03/27/03.

95. Pregnancy Risk Assessment Monitoring System Working Group, Centers for Disease Control and Prevention. Progress in reducing risky infant sleeping positions – 13 States, 1996-1997. MMWR 1999;48:878-882.
http://www.cdc.gov/mmwr/PDF/wk/mm4839.pdf Accessed 03/27/03.

96. Division of Family and Community Health, Michigan Department of Community Health. Infant sleeping position in Michigan, 1996-1999. MI PRAMS Delivery 2002;1(3):1-2.

97. L Flick, DK White, C Vemulapalli, et. al. Sleep position and the use of soft bedding during bed sharing among African American infants at increased risk for sudden infant death syndrome. J Pediatr 2001;138:338-343.

98. E Gibson, JA Cullen, S Spinner, et. al. Infant sleep position following new AAP guidelines. American Academy of Pediatrics. Pediatrics 1995;96:69-72.

99. MR Spieker, SJ Brannen. Supine infant sleep: what do family physicians recommend? J Am Board Fam Pract 1996;9:319-323.

100. CM Johnson, MS Borkowski, KE Hunter, et. al. Infant sleep position: a telephone survey of inner-city parents of color. Pediatrics 1999;104:1208-1211.

101. BJ Ray, SC Metcalf, SM Franco, CK Mitchell. Infant sleep position instruction and parental practice: comparison of a private pediatric office and an

inner-city clinic. Pediatrics 1997;99:e12. http://www.pediatrics.org/cgi/content/full/99/5/e12 Accessed 03/27/03.

102. DY Rainey, MR Lawless. Infant positioning and SIDS. Acceptance of the nonprone position among clinic mothers. Clin Pediatr 1994;33:322-324.

103. HA Hein, SF Pettit. Back to Sleep: good advice for parents but not for hospitals? Pediatrics 2001;107:537-539.

104. ER Colson, DM Bergman, E Shapiro, JH Leventhal. Position for newborn sleep: associations with parents' perceptions of their nursery experience. Birth 2001;28:249-253.

105. SK Morgan, CM Johnson. Infant sleep: resident recommendations and socioeconomic status differences in patient practices. Fam Med 2001;33:614-620.

106. KA Rasinski, A Kuby, SA Bzdusek, et. al. Effect of a Sudden Infant Death Syndrome risk reduction education program on risk factor compliance and information sources in primarily black urban communities. Pediatrics 2003;111:e347-e354. http://www.pediatrics.org/cgi/reprint/111/4/e347 Accessed 04/11/03.

107. N Whitehead, H Shulman, Centers for Disease Control and Prevention, and the PRAMS Working Group. Mode of administration bias in a mixed mode health survey. (unpublished manuscript).

108. Oregon Department of Human Services Health Services, Portland Oregon: Office of Family Health. PRAMS Home Page. http://www.dhs.state.or.us/publichealth/pch/prams/index.cfm. Accessed 03/22/03.

Appendices

Appendix A: PRAMS Methodology (taken from the DHS website)

"Oregon PRAMS, the Pregnancy Risk Assessment Monitoring System, is a project of the Office of Family Health with support from the national Centers for Disease Control and Prevention (CDC). PRAMS collects data on maternal attitudes and experiences prior to, during, and immediately after pregnancy for a sample of Oregon women. The sample data are analyzed in a way that allows findings to be applied to all Oregon women who have recently had a baby. Oregon PRAMS began in November 1998 with partial CDC funding beginning in 2001."[108]

PRAMS 1998-99 Methodology[84]

"PRAMS is a mixed-mode, standardized data collection surveillance system, allowing for observation of Oregon trends over time and comparisons between Oregon and other states. PRAMS combines two modes of data collection. The primary data collection method is a mailed questionnaire. Women who are indicated as being Hispanic on the birth certificate receive the survey and all materials in both English and Spanish. Multiple attempts are made by mail and then by telephone to follow up with non-respondents. Phone surveys are also available in both English and Spanish.

"The following is the sequence of contacts for PRAMS surveillance:

1. Preletter. This letter introduces PRAMS to the mother and informs her that a questionnaire will arrive soon.
2. Initial mail questionnaire packet. This packet is sent to all sampled mothers about 7 days after the preletter. Its contents are described subsequently. Mothers are instructed to call the Oregon SafeNet toll-free number if they want to be interviewed by phone rather than complete the written survey.

3. Tickler. The tickler serves as thank you or reminder note. It is sent about 7 days after the initial mail packet.
4. Second mail questionnaire packet. This packet is sent to all sampled mothers who have not yet responded 14 days after the tickler was sent.
5. Telephone follow-up. Telephone follow-up is initiated for all non-respondents 14 days after mailing the second questionnaire. It is done, in both English and Spanish, by Clearwater Research, Inc., Boise, Idaho.

“The series of mailings commences two to six months after delivery. The questionnaire contains items asking about the early postpartum period; thus, the mailings are timed to ensure that all women can respond for this period. The data collection cycle from mailing the preletter to the close of telephone follow-up lasts approximately 60-70 days. Each month a stratified random sample is drawn from the current birth certificate file. This sequence of contacts is attempted for each of these monthly samples, or "batches." The median time from birth to completion of the survey is four months.

“The mail packets contain the following items:

”A multipurpose cover letter that describes PRAMS, explains how and why the mother was chosen, elicits the mother's cooperation, describes procedures for filling out and returning the questionnaire, explains the incentive and provides a toll-free telephone number for additional information. This letter is modified slightly in the second mailing, primarily by adding an additional appeal for response.

1. The questionnaire booklet. The questionnaire booklet is 20 pages long, has a colorful cover, is [7"x8.5"] and contains two blank pages for comments from the mother. A self-addressed return envelope with postage is provided.
2. An information sheet that contains answers to the questions most frequently asked about PRAMS. It can be an important tool to convince the mother to participate.
3. A three-year calendar to be used as a memory aid for answering the questions.

4. Incentive: each woman who returns the first survey within 8 weeks is entered into a drawing; one woman each month wins $200 in gift certificates from Fred Meyer stores.

"In addition to the questionnaire created for the mail packet, a Computer-Assisted Telephone Interview (CATI) version of the questionnaire has also been developed for use during the telephone phase. Telephone follow-up begins six weeks after the first questionnaire is mailed. Various sources of telephone numbers are used to obtain valid phone numbers. Calls to a particular number are staggered over different times of the day and different days of the week. Up to 15 attempts, on each phone number, are made to contact a mother.

"The interviewer-administered questionnaire includes the same content as the self-administered version, however some questions have been reformatted to facilitate reading them aloud to the mother. Alternate interview arrangements have been made for women who speak neither English nor Spanish.

"Every month, a stratified random sample of 200-300 new mothers was selected from a frame of eligible birth certificates. The sampling frame included all Oregon resident women whose babies had been born in Oregon 60-180 days before the selection date and who had not previously been in the sampling frame. The PRAMS survey over-sampled American Indian, Hispanic, African-American and Asian women and women whose babies had a birth weight less than 2500 grams (5 pounds and 8 ounces). This over-sampling provided a sufficient number of responses to permit meaningful analysis of health risks related to race/ethnicity and low birth weight. Most women were contacted about 3 months after their baby was born. Each sampled mother was mailed an explanatory letter that introduced the survey, followed by a package containing the 20-

page questionnaire one week later. A second package, containing the same questionnaire was mailed about 3 weeks later to those who did not respond. CATI interviews were conducted by staff from Clearwater Research, Inc. of Boise, Idaho. Clearwater staff then telephoned those mothers who did not respond to the mailed survey and attempted to complete an interview.

“Before analysis, the interview responses were weighted to make them representative of Oregon women with live births. Responses were first weighted to account for the sampling design (over-sampling by race/ethnicity and birth weight): "over-sampling adjustment." The second layer of weighting ("unit non-response") accounted for non-response (e.g., young women were less likely to respond than older women). The third layer of weighting ("non-coverage adjustment") accounted for the very few birth certificates (about 0.03%) that were never in the sampling frame, most of whom are adopted or whose birth certificates were processed more than 180 days after birth (who were intentionally excluded).”

Appendix B: The Coding of the Independent Variables

Table 17: Variable Coding for Variables used in the Multivariable Analyses

Variable	Source	Coding of variable
Sleep position	PRAMS	Binary prone v. lateral/supine
Mother's race/ethnicity	BC*	African-American, Hispanic, Asian/Pacific Islander, American Indian/Alaskan Native, Non-Hispanic White
Mother's Marital Status	BC	married/separated, unmarried/divorced
Mother's age	BC	1. Continuous 2. < 18, 18-19, 20-34, ≥ 35 3. 13-19, 20-25, 26-30, 31-48 as coded in[77] 4. < 20, ≥ 20 5. < 18, ≥ 18
Mother's education	BC	1. Continuous 2. < 12, 12-15, ≥ 16 3. < 16, ≥ 16 4. < 12, ≥ 12 5. < 10, ≥ 10 6. < 8, ≥ 8
Mother's smoking status	BC	yes, no
Mother's smoking status before pregnancy	PRAMS	any, none
Mother's smoking status last trimester	PRAMS	any, none
Mother's smoking status current	PRAMS	any, none
Other smoker in the house now	PRAMS	yes, no
Any smoker in the house now (combining mother current smoker and other smoker questions)	PRAMS	yes, no
Mother's alcohol use	BC	no, yes
Mother's alcohol use before pregnancy	PRAMS	1. none, some 2. < 1 drink per week, ≥ 1 drink per week 3. < 4 drinks per week, ≥ 4 drinks per week 4. ≤ 3 per week, 4-6 per week, > 6 per week
Mother's alcohol use last trimester		1. none, some 2. < 1 drink per week, ≥ 1 drink per week 3. < 4 drinks per week, ≥ 4 drinks per week 4. ≤ 3 per week, 4-6 per week, > 6 per week
Timing of the start of prenatal care	PRAMS	1. first trimester, not within first trimester 2. first trimester, second, third or none
Timing of the start of prenatal care	BC	first trimester, not within first trimester
Type of prenatal care site	PRAMS	1. hospital clinic, health department clinic, private physician/HMO, other 2. private physician/HMO, hospital or health department, other 3. private physician/HMO, not private
Infant's gender	BC	Male, female
Infant's birth weight	BC	1. continuous 2. < 2500 grams, ≥ 2500 grams 3. < 1500 grams, ≥ 1500 grams 4. 500-1000 grams, 1001-1500 grams, 1501-2500 grams, > 2500 grams, as in [77]

* BC = Birth Certificate

Table 17: Coding of the Independent Variables Used in the Multivariable Analyses (continued)

Variable	Source	Coding of variable
Infant's birth order	BC	1. Continuous (1-9) 2. Firstborn, not firstborn 3. First, second, third, fourth or higher
Breast-feeding duration	PRAMS	1. yes, no 2. ≤ 4 weeks, > 4 weeks 3. < 10 weeks, ≥ 10 weeks
Co-sleeping	PRAMS	never, sometimes/almost always/always
Type of well baby care site	PRAMS	1. hospital clinic, health department clinic, private physician/HMO, other 2. hospital clinic, health department clinic, private physician/HMO, other, multiple types of sites
Family income	PRAMS	1. < $15,000, $15,000-29,999, $30,000-49,999, ≥ $50,000 2. < $15,000, ≥ $15,000
Insurance at delivery	BC	1. private, none, public, other 2. private, not private 3. public or private, none or other 4. insured, not insured 5. public insurance, not public insurance
Insurance at delivery	PRAMS	1. public (OHP, Indian Health Care Plan) or none, private(employer, spouse's employer, CHAMPUS, other) 2. not insured, insured 3. OHP, not OHP 4. OHP/IHCP, none, private 5. public, private
Current insurance	PRAMS	1. public (OHP, Indian Health Care Plan) or none, private(employer, spouse's employer, CHAMPUS, other) 2. not insured, insured 3. OHP, not OHP
WIC enrollment	BC	yes, no
WIC enrollment	PRAMS	yes, no
Smokers in the house	PRAMS	yes, no
PRAMS mode	PRAMS	1. First Mailing, Second Mailing, CATI 2. Mail, CATI
Infant age at time of response	PRAMS	< 13 weeks, ≥ 13 weeks

* BC = Birth Certificate

Appendix C: Selected PRAMS Questions

25.	Where did you go **most of the time** for your prenatal visits? **Don't include visits for WIC.** **Check one answer.**	❑ Hospital clinic ❑ Health department clinic ❑ Private doctor's office or HMO clinic ❑ Other ⇨ Please tell us: ____________
48.	What type of insurance paid for your delivery?	❑ Insurance through my employer ❑ Insurance through someone else's employer ❑ Oregon Health Plan ❑ CHAMPUS (Military) ❑ Indian Health Care Program ❑ Other ⇨ please tell us: ____________ ❑ I didn't have insurance for my delivery ❑ I don't know

49. Is your baby alive now?

__ Yes ⇨ Is your baby living with you now? ❑ No ❑ Yes

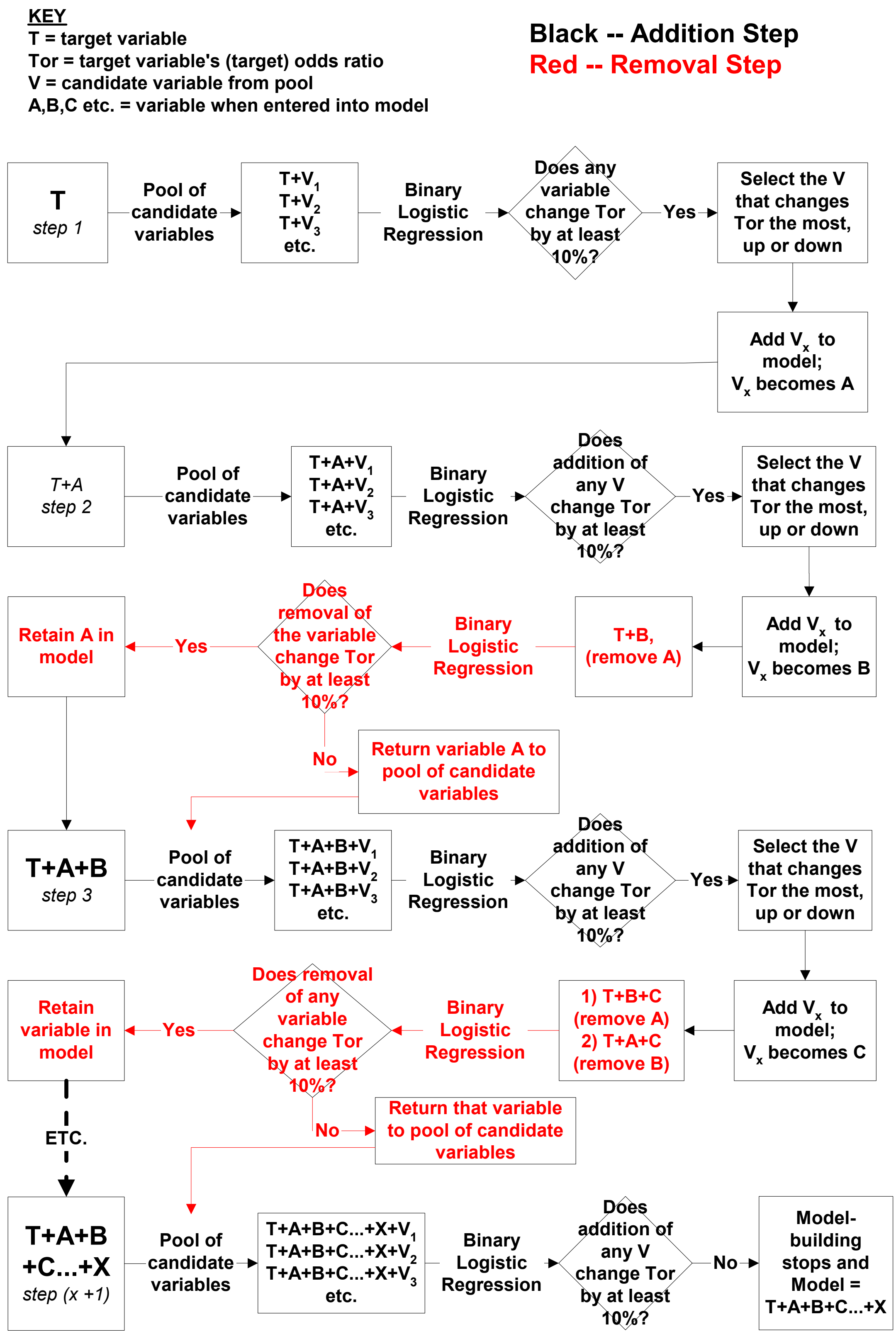
__ No ⇨ **We are truly sorry about your loss and extend our sympathy to you and your family. Your answers are especially important and could help us learn about ways to improve the health of babies in the future.**

When did your baby die? ______/_____/_____ (month day year)

If your baby is not alive or is not living with you now, go to Question 66 on Page 14.

61.	How do you put your new baby down to sleep **most** of the time? **Check one answer.**	❑ On his or her side ❑ On his or her back ❑ On his or her stomach
62.	How often does your new baby sleep in the same bed with you? **Check only one.**	❑ Always ❑ Almost always ❑ Sometimes ❑ Never
63.	How many times has your baby been to a doctor or nurse for **routine** well baby care? Don't count the times you took your baby for care when he or she was sick. **It may help to use the calendar.**	_______ Times ❑ My baby hasn't been for routine well baby care. ⇨ **Go to Question 65**
64.	When your baby goes for routine well baby care, where do you take him or her? **Check all the places that you use.**	❑ Hospital clinic ❑ Health department clinic ❑ Private doctor's office ❑ Other ⇨ Please tell us: ____________

Appendix D: "Change-in-Point-Estimate" Logistic Regression Procedure[86]



Text Description of Change-in-Point-Estimate Flow

1 **Identify target variable and target odds ratio to be used to assess confounding**

  1.1 Addition Step

    1.1.1 Select candidate variable from pool, add to target variable, carry out binary logistic regression

    1.1.2 Repeat for each candidate variable from pool

    1.1.3 Look at series of bivariable models: does the addition of any candidate variable change the target odds ratio by at least 10%?

    1.1.4 If yes, select the candidate variable that produces the greatest change, up or down, in the target variable's target odds ratio and add to model (and remove it from pool)

    1.1.5 If no, stop.

2 **Beginning with two-variable model built at previous step,**

  2.1 Addition Step

    2.1.1 Select candidate variable from pool, add to 2-variable model, carry out binary logistic regression

    2.1.2 Repeat for each candidate variable remaining in pool

    2.1.3 Look at series of trivariable models: does the addition of any candidate variable change the target odds ratio by at least 10%?

    2.1.4 If yes, select the candidate variable that produces the greatest change, up or down, in the target variable's target odds ratio and add to model (and remove it from pool)

    2.1.5 If no, stop

  2.2 Removal Step

    2.2.1 Remove variable added at step 1.1.4 and carry out binary logistic regression using target variable and candidate variable added at step 2.1.4

    2.2.1 Does the removal of the previously added variable change the target odds ratio by at least 10%, up or down?

    2.2.2 If yes, return it to model

    2.2.3 If no, return it to pool and resume model-building

3 **Beginning with model built at previous step,**

  3.1 Addition Step

    3.1.1. Select candidate variable from pool, add to the model, carry out binary logistic regression

    3.1.2 Repeat for each candidate variable remaining in pool

    3.1.2. Look at series of models: does the addition of any candidate variable change the target odds ratio by at least 10%?

    3.1.3. If yes, select the candidate variable that produces the greatest change, up or down, in the target variable's target odds ratio and add to model (and remove it from pool)

3.2 Removal Step

3.1.1 Remove variable added at step 1.1.4 and carry out binary logistic regression using target variable and variables added at steps 2.1.4 and 3.1.4

3.1.2 Does the removal of the previously added variable change the target odds ratio by at least 10%, up or down?

3.1.3 If yes, return it to model

3.1.4 If no, return it to pool of candidate variables

3.1.5 Remove variable added at step 2.1.4 and carry out binary logistic regression using target variable and variables added at steps 1.1.4 and 3.1.4

3.1.6 Does the removal of the previously added variable change the target odds ratio by at least 10%, up or down?

3.1.7 If yes, return it to model

3.1.8 If no, return it to pool of candidate variables

4 **Beginning with model built at previous step, continue as above**

4.1 Addition Step:

4.1.1 Take multivariable model, add one new variable from pool, perform binary logistic regression

4.1.2 Create series of new models, differing only by the addition of a single new variable from pool

4.1.3 Evaluate models using criteria described above

4.2 Removal Step

4.2.1 Take new model built at step 4.1.3, and remove one of the variables added, other than the target variable or the last added, perform binary logistic regression

4.2.2 Create a series of new models, differing only by the removal of a single variable added at steps 1-3

4.2.3 Evaluate models using criteria described above…

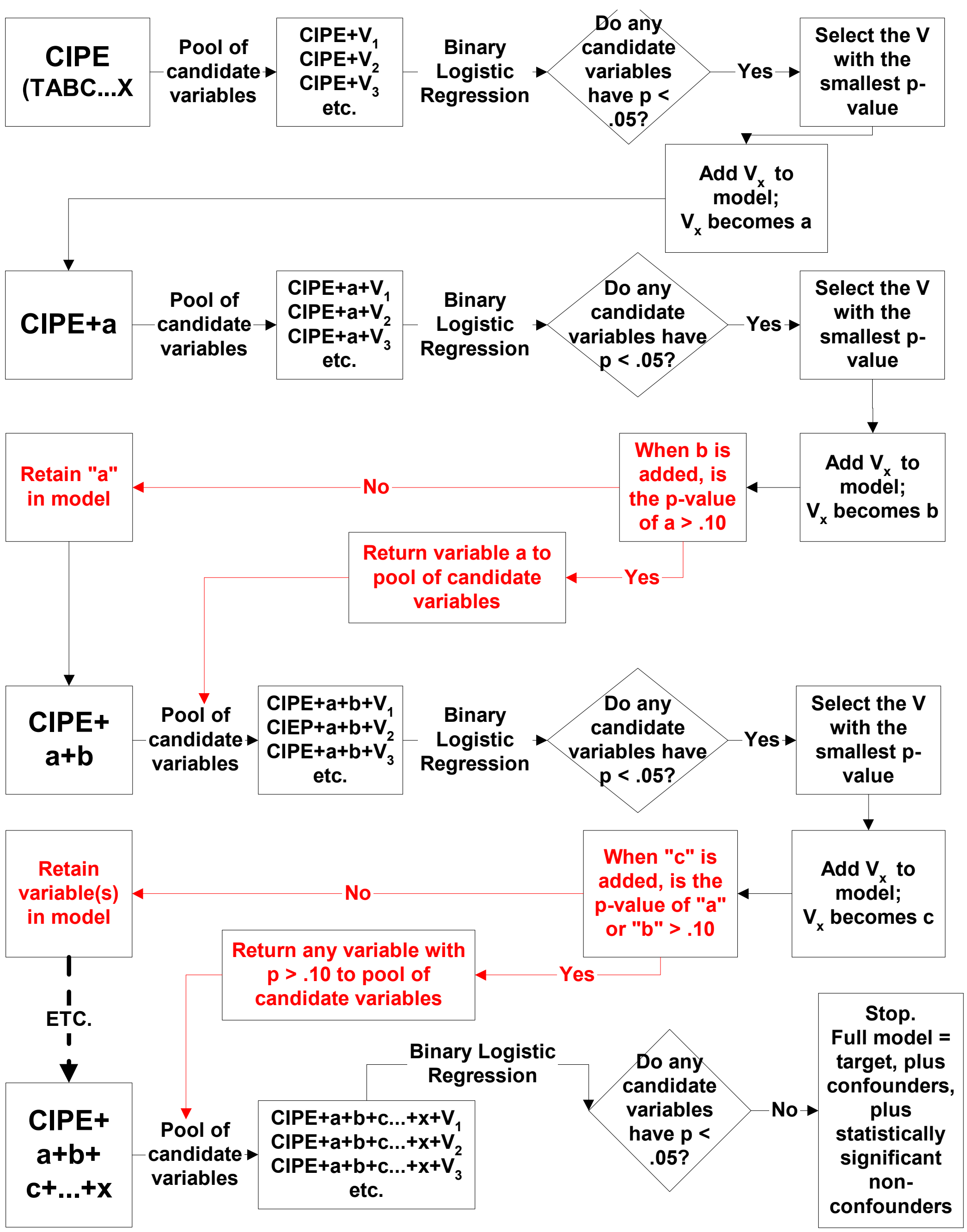
.
.
.

X. **Continue the above process until the addition of no candidate variable from the pool changes the target odds ratio by at least 10%. All confounders of importance from the pool of candidate variables have now been identified. Model = target variable, with adjusted odds ratio, and identified confounders.**

Appendix E: Forward Stepwise Logistic Regression Procedure,
Using SUDAAN Logistic Regression Procedure, entry $p < .05$, removal $p > .10$

KEY
CIPE = "Change-in-point-estimate" Model (see Appendix D)
T = target variable
A,B,C...X = confounders from CIPE method (see Appendix D)
V = candidate variable from pool
a,b,c....x = statistically significant but non-confounding variables once entered into the model

Black -- Addition Step   Red -- Removal Step



Appendix F: Demographic Characteristics of the Sample
(Restricted to women with valid responses to infant sleep position question)

Table 18: Characteristics of the Respondents, Selected Continuous Variables, Stratified by Race/Ethnicity

Weighted (n = 43315)	Maternal age mean years ± 2 SD (range)	Maternal education mean years ± 2 SD (range)	Parity mean ± 2 SD (range)	Infant Birthweight mean grams ± 2 SD (range)
Total	**26.75 ± 0.45 (13 – 48)**	**13.49 ± 0.57 (0 – 17)**	**1.95 ± 0.08 (1 – 9)**	**3434.92 ± 35.40 (538 – 5414)**
African-Americans	24.61 ± 0.76* (15 – 42)	12.59 ± 0.27† (6 – 17)	1.92 ± 0.14** (1 – 7)	3246.83 ± 71.95* (680 – 5414)
Hispanics	24.73 ± 0.53* (13 – 46)	11.20 ± 0.98* (0 – 17)	2.10 ± 0.14§ (1 – 9)	3384.19 ± 51.78Δ (1060 – 4870)
Asians/ Pacific Islanders	28.58 ± 0.67‡ (14 – 41)	15.20 ± 1.33** (0 – 17)	1.82 ± 0.10** (1 – 6)	3269.95 ± 52.00* (850 – 4450)
American Indians/AN	24.45 ± 0.74* (14 – 43)	13.15 ± 1.20** (7 – 17)	2.13 ± 0.18** (1 – 9)	3444.21 ± 66.42** (1757 – 5244)
Non-Hispanic Whites	27.11 ± 0.57 (15 – 48)	13.84 ± 0.71 (5 – 17)	1.93 ± 0.10 (1 – 8)	3458.95 ± 44.33 (538 – 4876)

* Significantly different from Non-Hispanic Whites at $p < .0001$

† Significantly different from Non-Hispanic Whites at $p = .0014$

§ Significantly different from Non-Hispanic Whites at $p = .0391$

Δ Significantly different from Non-Hispanic Whites at $p = .0319$

‡ Significantly different from Non-Hispanic Whites at $p = .0009$

** Not significantly different from Non-Hispanic Whites

Table 19: Characteristics of the Respondents, Selected Categorical Variables

	Unweighted (n = 1763) No. (% of responses*)	**Weighted (n = 43315)** No. (% of responses*)
Race		
African-American (AA)	205 (11.6%)	884 (2.0%)
Hispanic	412 (23.4%)	6215 (14.3%)
Asian/Pacific Islander	296 (16.8%)	2008 (4.6%)
American Indian/Alaskan Native	197 (11.2%)	604 (1.4%)
Non-Hispanic White (NHW)	653 (37.0%)	33603 (77.6%)
Mother's age		
13-19 years old	270 (15.3%)	5124 (11.8%)
20-25 years old	564 (32.0%)	14341 (33.1%)
26-30 years old	462 (26.2%)	12013 (27.7%)
31-48 years old	467 (26.5%)	11836 (27.3%)
Mother's education		
< 12 years education	428 (24.5% of responses)*	8176 (19.0% of responses)
12-15 years education	942 (53.9%)	24734 (57.5%)
> 15 years education	379 (21.7%)	10087 (23.5%)
missing	*14 (0.8% of respondents)†*	*317 (0.7% of respondents)*
Marital status		
Unmarried/divorced	611 (34.7%)	12688 (29.3%)
Married/separated	1152 (65.3%)	30627 (70.7%)
Mother's family income		
< $15,000	576 (34.5%)	11071 (26.4%)
$15,000 – 29,999	485 (29.0%)	12325 (29.3%)
$30,000 - 49,999	307 (18.4%)	10319 (24.6%)
≥ $50,000	302 (18.1%)	8281 (19.7%)
missing	*93 (5.3% of respondents)*	*1318 (3.0% of respondents)*
Start of Prenatal Care (B.C.)		
First trimester	1385 (78.8%)	34986 (81.1%)
Second trimester	308 (17.5%)	6917 (16.0%)
Third trimester or none	64 (3.6%)	1216 (2.8%)
missing	*6 (0.3% of respondents)*	*196 (0.5% of respondents)*
Start of Prenatal Care (PRAMS)		
First trimester	1220 (70.8%)	31741 (75.2%)
Second trimester	435 (25.2%)	9205 (21.8%)
Third trimester or none	68 (3.9%)	1289 (3.1%)
missing	*40 (2.3% of respondents)*	*1080 (2.5% of respondents)*
Parity		
Index child = first	785 (44.6%)	18763 (43.4%)
Index child = second	537 (30.5%)	13443 (31.1%)
Index child = third	271 (15.4%)	7028 (16.3%)
Index child = fourth or higher	168 (9.5%)	3991 (9.2%)
missing	*2 (0.1% of respondents)*	*90 (0.2% of respondents)*
WIC Enrollment (B.C.)		
yes	843 (47.8%)	18406 (42.5%)
no	920 (52.2%)	24908 (57.5%)
WIC Enrollment (PRAMS)		
yes	907 (56.8%)	19032 (49.9%)
no	690 (43.2%)	19116 (50.1%)
missing	*166 (9.4% of respondents)*	*5166 (11.9% of respondents)*
Breastfeeding		
yes	1531 (90.8%)	37975 (92.2%)
no	155 (9,2%)	3213 (7.8%)
missing	*77 (4.4% of respondents)*	*2126 (4.9% of respondents)*

Table 19: Respondent Characteristics, Selected Categorical Variables (Continued)

	No. (% of responses*)	No. (% of responses*)
Breastfeeding		
Breastfeeding > four weeks	1252 (74.3%)	31009 (75.3%)
Breastfeeding ≤ four weeks	434 (25.7%)	10180 (24.7%)
missing	*77 (4.4% of respondents)*	*2126 (4.9% of respondents)*
Breastfeeding		
Breastfeeding ≥ ten weeks	1046 (63.3%)	25551 (63.4%)
Breastfeeding < ten weeks	606 (36.7%)	14736 (36.6%)
missing	*111 (6.3% of respondents)*	*3027 (7.0% of respondents)*
Insurance at delivery (B.C.)		
Private insurance	1003 (56.9%)	27156 (62.7%)
No insurance	130 (7.4%)	2396 (5.5%)
OHP	610 (34.6%)	13416 (31.0%)
Other	20 (1.1%)	346 (0.8%)
Insurance at delivery (PRAMS)		
OHP /IHCP	763 (43.9%)	16288 (38.1%)
No insurance	33 (1.9%)	788 (1.8%)
Private insurance or other	942 (54.2%)	25719 (60.1%)
missing	*25 (1.4% of respondents*)	*519 (1.2% of respondents)*
Prenatal Care Site		
Hospital Clinic	305 (17.9%)	5457 (12.8%)
Health Department Clinic	226 (13.2%)	3650 (8.6%)
Private Physician/HMO	1056 (61.9%)	30672 (72.3%)
Other	119 (7.0%)	2659 (6.3%)
missing	*57 (3.2% of respondents)*	*876 (2.0% of respondents)*
Well Baby Care Site		
Hospital Clinic	314 (18.4%)	5885 (14.0%)
Health Department Clinic	239 (14.0%)	3830 (9.1%)
Private Physician/HMO	1010 (59.3%)	29184 (69.2%)
Other	83 (4.9%)	1712 (4.1%)
More than one type	56 (3.3%)	1532 (3.6%)
missing	*61 (3.5% of respondents*)	*1171 (2.7% of respondents)*
Birthweight in grams (B.C.)		
500 – 1000 grams	18 (1.0%)	102 (0.2%)
1001 – 1500 grams	28 (1.6%)	207 (0.5%)
1501 – 2500 grams	268 (15.2%)	1607 (3.7%)
> 2500 grams	1449 (82.2%)	41399 (95.6%)
Smoked last trimester (PRAMS)		
yes	214 (12.3%)	5551 (12.9%)
no	1529 (87.7%)	37315 (87.1%)
missing	*20 (1.1% of respondents)*	*448 (1.0% of respondents)*
Current smoker		
yes	300 (17.7%)	8712 (20.3%)
no	1444 (82.8%)	34133 (79.7%)
missing	*19 (1.1% of respondents)*	*469 (1.1% of respondents)*
Co-sleeping		
Always	465 (26.5%)	8736 (20.3%)
Almost always	283 (16.1%)	6302 (14.6%)
Sometimes	680 (38.7%)	17909 (41.5%)
Never	330 (18.8%)	10158 (23.6%)
missing	*5 (0.3% of respondents)*	*210 (0.5% of respondents)*
PRAMS Mode of Administration		
Mail 1	1234 (70.0%)	32673 (75.4%)
Mail 2	212 (12.0%)	4481 (10.3%)
CATI	317 (18.0%)	6161 (14.2%)

* percent of responses = percent of respondents with valid response

† percent of all respondents = percent of combined valid responses and missing responses

Appendix G: **Mode of Administration Bias and PRAMS Alcohol Use During Pregnancy**

Maternal alcohol consumption in the third trimester, when coded as a binary variable (none vs. even less than once per week) was a highly significant determinant of prone infant sleep position, with the risk factor being abstention from alcohol use (Wald-F p-value < .0001). While this variable remained highly statistically significant in a number of multivariable models, it was only very rarely found to be a weak confounder of other variables. Further, neither other codings of this variable (e.g. less than one drink per week vs. at least one drink per week) nor alcohol use before pregnancy and current alcohol use were statistically significant. Differential misclassification of variables, including alcohol use, based on the mode of administration of PRAMS has been reported.[(107)]

Reporting of alcohol use during pregnancy in the birth certificate was compared to PRAMS reporting. (See Tables 20 - 22). Among all PRAMS respondents, 4.8% reported some (including less than one drink per week) third trimester alcohol use; the birth certificate indicated only 1.5% reported some alcohol use during pregnancy. Among mail respondents to PRAMS, 5.4% reported some third trimester alcohol use, while only 2.2% of CATI respondents did and the difference was significant, for either the unweighted or weighted numbers. There was no significant difference in the proportion of women reporting alcohol use on the birth certificate among PRAMS mail and PRAMS CATI respondents. In the absence of bias, one would expect the birth certificate proportions to follow the PRAMS proportions.

As can also be seen, women reporting alcohol use in the birth certificate were more likely to deny use in PRAMS than vice versa, and this pattern was more pronounced among those women responding to PRAMS by CATI

Table 20: Comparison of Birth Certificate & PRAMS "Alcohol Use" Questions

		BIRTH CERTIFICATE	
		Alcohol use	No alcohol use
PRAMS*	Third trimester use	10	73
	No third trimester use	19	1699

* OR 15.04 (4.59 – 49.26), p = .0360

Table 21: Comparison of Birth Certificate & PRAMS "Alcohol Use" (Mail Only)

		BIRTH CERTIFICATE	
		Alcohol use	No alcohol use
PRAMS*	Third trimester use	9	68
	No third trimester use	13	1384

* OR 19.32 (5.38 – 69.39), p = .0357

Table 22: Comparison of Birth Certificate & PRAMS "Alcohol Use" (CATI Only)

		BIRTH CERTIFICATE	
		Alcohol use	No alcohol use
PRAMS*	Third trimester use	1	5
	No third trimester use	6	315

* OR 4.88 (0.44 – 54.34), p = .3900

To further evaluate this possibility, a change-in-point-estimate binary logistic regression procedure was performed, using alcohol use as the outcome variable and mode of administration as the target variable. Mail mode of administration was significantly associated ($p < .0001$) with the reporting of some alcohol use during the last trimester (OR 7.03, .95 CI 2.90 – 17.05). After adjusting for mother's age, family income, prenatal care site, birthweight, duration of breast-feeding and well baby care site, the OR for mail mode had risen to 14.89 (.95 CI 3.41 – 64.99, p-value = .0003). Using the same control variables as Whitehead and colleagues,[(107)] the mail mode OR = 7.37 (3.04 – 17.86). Because of apparent mode of administration bias and the generally minimal impact on the ORs of other variables when added to multivariable analysis, maternal alcohol use was not considered further.

Appendix H: Distribution of Sleep Positions for Target Variables

Table 23: Distribution of Sleep Positions, Target Variables *

	Prone	Lateral	Supine
Total Sample	**9.24%**	**24.25%**	**66.51%**
Race/ethnicity			
African-American	**18.96%**	**37.45%**	**43.58%**
Hispanic	**4.69%**	**43.99%**	**51.32%**
Asian/Pacific Islander	**8.05%**	**27.04%**	**64.91%**
American Indian/Alaskan Native	**4.37%**	**38.39%**	**67.24%**
Non-Hispanic White	**9.99%**	**20.01%**	**70.01%**
Parity			
Firstborn	**6.42%**	**23.73%**	**69.85%**
Second –born	**9.99%**	**20.86%**	**69.15%**
Third -born	**8.83%**	**28.725**	**62.45%**
Fourth born or higher	**20.79%**	**28.70%**	**50.51%**
Initiation of Prenatal Care (PRAMS)			
First trimester	**9.01%**	**22.18%**	**68.80%**
Second trimester	**7.64%**	**28.66%**	**63.70%**
Third trimester	**7.56%**	**42.33%**	**50.21%**
Prenatal Care Site			
Hospital Clinic	**6.11%**	**35.40%**	**58.50%**
Health Department Clinic	**2.49%**	**36.42%**	**61.09%**
Private MD/HMO	**10.55%**	**20.00%**	**69.45%**
Other	**8.31%**	**28.08%**	**63.61%**
Well Baby Care Site †			
Only Hospital Clinic	**8.90%**	**25.48%**	**65.63%**
Only Health Department Clinic	**6.69%**	**43.07%**	**50.24%**
Only Private Physician	**10.04%**	**20.24%**	**69.72%**
Only Other	**6.60%**	**33.93%**	**59.57%**

*** Based on weighted proportions.**
† Restricted to respondents reporting only a single type of site.