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Comparing factors associated with infant sleep related deaths in singleton births less than 12 months old by Medicaid and private insurance patients

By

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Epidemiology

_____

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Comparing factors associated with infant sleep related deaths in singleton births less than 12 months old by Medicaid and private insurance patients

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2014

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An abstract of
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Abstract

Comparing factors associated with infant sleep related deaths in singleton births less than 12 months old by Medicaid and private insurance patients

By Sara Jo Johnson

Objectives: Evaluate factors associated with Sleep-Related Infant Deaths and how these factors differ by insurance type.

Methods: The data for this case control study come from the Georgia Department of Public Health and includes a cohort of births from 2010 – 2014 where all infant deaths due to Sudden Unexpected Infant Death (SUID) causes were included as cases and a 1% systematic random sample of live births were included as controls. Covariates included in the analysis were: insurance type, maternal tobacco use during pregnancy, maternal race and ethnicity, maternal age at birth, maternal education, number of previous live births still living, number of prenatal visits, birthweight. A stratified analysis was conducted of SUID by insurance type. Collinearity and interaction assessments were performed prior to logistic regression analysis. Interaction was assessed using Hierarchal Backwards Elimination.

Results: The stratified analysis showed ORs and 95% CI for each covariate were primarily in the same direction between Medicaid and privately insured births, but estimates for privately insured births tended to be further from the null. The overall OR was 4.10 (95% CI: 3.22, 5.23). Effect modification was observed in many of the strata in the stratified analysis. The collinearity assessment did not indicate any variables needed to be removed from the final model and the stepwise logistic regression did not indicate that interaction terms should be included, though it did indicate that maternal education should be dropped. An adjusted OR of 2.06 (95% CI: 1.50, 2.83) was obtained when controlling for maternal tobacco use during pregnancy, maternal race and ethnicity, maternal age at birth, number of previous live births still living, number of prenatal visits, and birthweight.

Conclusions: Each of the aforementioned factors were associated with SUID and the associations were consistent across insurance type. Those most at risk for SUID include pregnancies with tobacco use, low birthweight infants, and those of Black non-Hispanic race/ethnicity. More studies should be done to further examine factors that determine insurance type which would lead to a better understanding of risk factors for SUID.

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Background/Literature Review

The CDC defines Sudden Unexpected Infant Death (SUID) as "the death of an infant less than 1 year of age that occurs suddenly and unexpectedly, and whose cause of death is not immediately obvious before investigation," [1]. The (tentative) case definition for SUID includes 3 causes using the International Classification of Diseases (ICD) codes, version 10, published by the World Health Organization (WHO): Sudden Infant Death Syndrome (SIDS) (ICD code R95), accidental suffocation and strangulation in bed (ICD code W75), and unknown cause (ICD code R99) [2]. Applying each of these codes can be challenging. For example, the cause of SIDS is not well understood so a R95 code could be assigned when an R99 code should be assigned and vice versa. Furthermore, a W75 code is often assigned based on the presence of risk factors, but it may not be the actual code that should be assigned.

In 2015, there were about 3,700 of these deaths, and most of these deaths (43%) were due to SIDS, 32% were due to unknown causes, and 25% were due to accidental suffocation and strangulation in bed [3]. Trends in SUID rate have shown a decline since 1990. Most of this decline is due to a decrease in deaths attributed to SIDS [3]. "The SUID rate declined considerably following the release of the American Academy of Pediatrics safe sleep recommendations in 1992, the initiation of the Back to Sleep campaign in 1994, and the release of the Sudden Unexplained Infant Death Investigation Reporting Form in 1996," [3]. Since 1998, deaths due to an unknown cause have increased, and in 2015 deaths due to accidental suffocation and strangulation in bed reached an all-time high, [3].

Categorization of a SUID can be difficult to determine, especially since death can occur during sleep while the child is not being directly supervised. However, risk factors for each of these categories overlap and the Recommendations for a Safe Infant Sleeping Environment published by the American Academy of Pediatrics (AAP), can be used to reduce the occurrence of SUID [4]. These recommendations include: put the infant to sleep on his/her back, use a firm sleep surface, breastfeed exclusively, room share with parents but do not bed share, no soft objects in the infant sleep area, pacifier use when starting sleep, avoid smoking and smoke exposure, avoid alcohol and illicit drug use before and

after birth, avoid overheating, obtain regular prenatal care during pregnancy, stay up to date on immunizations [4]. Several devices are marketed to decrease the risk of SIDS, but have no evidence to support these claims including: positioners, special crib mattresses, bed sharing dividers, cardiorespiratory monitors. There is also no data to suggest that swaddling decreases the risk of SIDS, and it can put a child at danger of SIDS if the child rolls over while its arms are pinned [4].

Smoking

Smoking compromises the health of the mother, and it also affects the health of an infant before and after it is born. SUIDs are no exception. Smoking as a risk factor for SIDS has been well established. Numerous cohort and case-control studies have been performed to observe this effect. Golding et. al. reviewed these studies and even with the inadequacies that were noted in each study, the strong association of smoking and SIDS cannot be denied and there appears to be a dose-response relationship [5]. One of the inadequacies of studies examining the effect of smoking on SIDS, is that the cases are normally compared to a cohort of children who survived infancy. The Friedmann et al. study, however, compared SIDS cases to a surviving cohort of infants as well as a cohort of infants that experienced premature mortality due to other causes. When comparing SIDS cases to both control groups, it was found that "women whose babies developed SIDS were, on average, … more frequently smokers," [6].

Maternal Race/Ethnicity, Age, Education

Race/ethnicity is one of the most frequently observed risk factors in SUID, even though understanding why race impacts SUIDs can be multifaceted and complex. The CDC has found that when compared to non-Hispanic Whites in the United States, Hispanics and Asian/Pacific Islander infants have lower SUID rates, while American Indian/Alaskan Natives and non-Hispanic Blacks have rates more than two times as high [3]. SIDS accounts for the greatest proportion of these deaths and accidental suffocation and strangulation in bed accounts for the smallest proportion of these deaths in all racial/ethnic groups [3].

A study comparing African American sleep practices to Hispanic sleep practices in the Washington DC area found that African Americans were more aware of SIDS than Hispanics, but Hispanics more closely adhered to the AAP recommendations for safe sleep. African American infants were more likely to be exposed to smoke, not have partial or exclusive breastfeeding, bedshare, and be placed in a non-supine position. Both African American mothers and Hispanic mothers cited the same reasons for their behaviors, including infant comfort and safety [7]. There seems to be cultural differences between these two groups that contribute to risk of SIDS and other SUID.

Sleeping practices as well as many other SUID risk factors differ by race/ethnic group. Parks et. al performed extensive stratified analyses of racial/ethnic groups for a number of risk factors including: age at death, infant sex, infant season of birth, preterm birth [8]. This study noted that SUID rates declined for all races and ethnicities following the Back-to-Sleep campaign, but the magnitude varied. The reasons for these differences are not well understood and cannot be pinpointed because it is likely a multitude of factors.

One case control study by Kraus et. al. saw the association between race and SIDS and further examined it. Young maternal age, low income, and low maternal education all showed strong associations initially, and black race had a lesser association [9]. Since sociodemographic variables can complicate the relationship of the association to SIDS, Kraus et al. examined each of these variables again after adjusting for the other variables. They found that the associations of young maternal age, low income, and low maternal education with SIDS did not change even after adjustment, but the association of SIDS with race no longer existed when adjusting for low income and low maternal education [9]. Even though there is a strong association of race with SIDS it is important to consider other demographic factors that contribute and confound the relationship of race with SIDS.

A study by Hakeem et al [10] found that one of the factors most associated with SIDS was maternal age <20 years. Maternal age < 20 years may make the mother more likely to have other risk factors of SIDS, such as delivering a low birth weight baby, low income, and/or less education. Mothers

that already have multiple children are more likely to bed share, which could explain why this is a risk factor for SIDS [11].

Maternal education is a common risk factor found in studies on SIDS and other SUIDs. As mentioned above, a young mother is more likely to possess other risk factors, such as low educational attainment. A study in Colorado attempted to understand the attitudes of teen mothers on recommendations for preventing SUIDs. Many of the mothers knew what SIDS was and were even able to describe some of the risk factors for SIDS. Most mothers knew that babies should be placed on their backs for sleep and followed this practice. Most of the mothers also knew not to place soft objects in an infant's sleep space, however, some did not know why this was a recommendation and many did this anyway. Almost all mothers in the study practiced bed sharing some of the time, and many did it exclusively. Reasons for bed sharing included better sleeping for the infant and better monitoring for the mother. Many of the mothers admitted to being informed of the risks of bed sharing, but felt they knew what was best for their child [12]. This study makes it clear why maternal education can impact SUIDs.

Maternal race, age, and education are not surprising risk factors for SUID. These demographics often put populations at risk for more adverse health outcomes and that could be due to the fact that poverty is associated with the same demographic variables. Poverty is known to put people at greater risk for adverse health outcomes and SUID are not an exception. It can be hard to separate one risk factor from the other since race and age of a mother may affect things like access to education and healthcare and poverty might affect all of these variables. However, learning more about these groups will help paint a picture of those most at risk of SUID and potentially better inform public health efforts to plan successful interventions within these groups.

Number of Prenatal /Visits

The number of prenatal visits a woman receives naturally affects pregnancy outcomes since physicians and medical technology can catch problems earlier and address them, but only if the prenatal care is regular. Kitsantas et.al found that across all racial groups, inadequate prenatal care increases the

risk of SIDS. The Kraus et. al. study also found that number of prenatal visits was a risk factor even when the data was stratified by maternal age and birthweight category, which demonstrates the risk imposed by inadequate prenatal care. However, "gestational age and maternal education accounted for much of [this] association," [9]. Changing the pregnancy outcome by receiving adequate prenatal care may also change an outcome of SUID. Infants that receive regular prenatal care are more likely to have positive pregnancy outcomes (such as normal birthweight) and this will also decrease the risk of SUID.

Number Previous Pregnancies

The AAP recommendations for safe sleep identify several behaviors that can be potentially be modified through education. Many of these recommendations relate to an infant's sleep environment. An infant's sleep environment should consist of a firm flat surface and nothing else. No soft objects, such as blankets or comfort objects, should be near the infant since these items can lead to suffocation. Sharing a sleep surface with a parent poses a risk to the infant because of the likelihood of soft objects entering the sleep environment or adults altering the firmness of a shared sleep surface. A study by Colson et al., found that bed sharing has increased from 6.5% in 1993 to 13.5% in 2010 [13]. It can be hard to examine the effect of bed sharing on SUID because case investigations are done on infant deaths where bed sharing practices are examined, but comparable data is not collected for surviving infants on a routine basis. This is especially true for studies whose primary data source are vital records, such as birth certificates. Several studies have found that number of previous pregnancies increases risk for SIDS [10, 14]. Ostfeld et. al discovered that several factors, including number of pregnancies, are related to bed sharing [15]. Number of pregnancies may be associated with bed sharing because more pregnancies may also mean more children at home. More children at home may increase the likelihood that parents bed share with an infant to save space. Therefore, studies using vital record data, where a variable that captures bed sharing is not available, may be able to use number of pregnancies as an indicator variable for bed sharing. Number of pregnancies would not be a perfect indicator of bed sharing, but it may help find a better estimate of association than a study that has no way to control for bed sharing at all.

Birthweight

Premature births are one cause of low birthweight in infants. A common method used to measure premature birth is gestational age of the child at birth. Gestational age may be a good measure of premature birth if a mother received prenatal care early enough in the pregnancy to have an ultrasound that could accurately date the pregnancy. However, when this is not the case gestational age can be subject to recall bias because it is calculated based on when a mother reports the date of her last menstrual period. Because of this, low birthweight can be a better variable to use than gestational age. The Kraus et. al. study supports this. In this study birthweight was examined as a risk factor for SIDS. The study controlled for gestational age in the analysis of several gestational factors, and found that birth weight remained a risk factor for SIDS even when controlling for gestational age [9].

Low birthweight puts infants at risk for several health complications, including SUIDs. In a study of deaths from SIDS three birthweight groups were compared: normal birthweight, defined as more than 2,499 grams; low birth weight (LBW), defined as 1,500 to 2,499 grams; and very low birth weight (VLBW), defined as 500 to 1,499 grams. The study found that the rate of deaths from SIDS was higher in LBW (1.98 per 1,000 live births) and VLBW (2.52 per 1,000 live births) infants than in normal birth weight (0.59 per 1,000 live births) infants. However, there was no significant difference in rate of deaths from SIDS between LBW and VLBW infants [16].

Methods

Data Source

Data for this thesis comes from the Georgia Department of Public Health. Data was obtained from Georgia state birth certificates and includes birth cohorts for each single year from 2010 to 2014. These cohorts included 655,306 births. All births linked to an infant death and a one percent systematic random sample of remaining births were retained resulting in 10,975 observations to be used for data analysis. Of these observations 6,510 were births not linked to an infant death (i.e., still living) and could potentially be used for controls. Of the 4,465 linked infant deaths, only 718 were infant deaths due to Sudden Unexpected Infant Death (SUID) which includes: Sudden Infant Death Syndrome (SIDS), accidental suffocation and strangulation in bed, and unknown cause.

Study Design

This is a case control study. The initial dataset included 10,975 observations. Observations were excluded for the following reasons: plural birth (or missing information that could identify the birth as a singleton or plural birth), not a resident of Georgia, has an insurance payer other than Medicaid or Private insurance (i.e., Medicare, PeachCare, Tricare, self-pay, worker's compensation, other government assistance, other, missing), infant cause of death is missing or is not due to SUID. After exclusions, 5,401 observations remained. This included 537 cases (infant deaths due to SUID) and 4,864 controls (live births without a linked cause of death).

Hypothesis

The purpose of this thesis is to determine which factors are associated with SUID and how these associations differ between Medicaid and Privately insured patients.

Variables

The exposure variable in this analysis is insurance type (Medicaid vs. Private). The outcome is infant death due to SUID. Covariates includes: maternal tobacco use during pregnancy, maternal race/ethnicity, maternal age, maternal education, number of previous births still living, number of prenatal visits, birthweight. A literature review revealed that smoking, mothers with Black race, mothers with low educational attainment, fewer prenatal visits, and a birthweight below normal (2500g) increases risk for SUID. Mothers of Hispanic ethnicity are at decreased risk for having a child die of SUID. The literature review also revealed that bed sharing greatly increases the risk of SUID, and families with an increasing number of children are more likely to bed share.

Each of the variables were categorized based on risk categories identified in the literature. The observed data distribution was also used to guide the choice of categories for continuous variables. The variables were coded as follows.

Variable	Categories
Insurance type	Medicaid Private
Infant death due to SUID	SUID Death Living
Maternal Tobacco Use During Pregnancy	Yes No
Maternal race/ethnicity	White non-Hispanic White Hispanic Black non-Hispanic Black Hispanic Other race non-Hispanic Other race Hispanic
Maternal age at birth	Younger than 20 years old 20 to 29 years old Older than 29 years old
Maternal education	Less than 9^{th} grade 9^{th} to 11^{th} grade High school diploma/GED Some college and above

Number of previous live births, living	0 to 1 2 to 4 More than 4
Number of prenatal visits	0 to 9 10 to 15 More than 15
Birthweight	Extremely low birthweight (less than 500 grams) Very low birthweight (500 to 1,499 grams) Low birthweight (1,500 to 2,499 grams) Normal birthweight (2,500 grams and above)

Data Analysis

Descriptive statistics are given for the 5,401 selected observations. ORs were calculated for each covariate among Medicaid insured patients as well as privately insured patients. A stratified analysis by insurance type was conducted to examine differences in the distribution of SUID infant deaths as well as the unadjusted ORs and 95% confidence intervals (CI) for each covariate category. Stratified analyses were also conducted to examine each of the covariates as an exposure and its association with SUID. ORs were calculated for the effect of each covariate on insurance type as an outcome. Chi-squared test statistics were calculated to test for associations between the exposure and outcome, covariates and exposure, and covariates and outcome. Stepwise logistic regression was performed to determine which variables to include in the model. A final model was determined and logistic regression was performed. All statistical analysis was performed using SAS version 9.4 (Cary, NC).

Results

Descriptive Statistics

This dataset included 5,401 eligible births. Descriptive statistics by infant cause of death and insurance type can be seen in Table 1 and Table 2. Medicaid insured births totaled 3,251 (60.2%), and Privately insured births totaled 2,150 (39.8%). Live births with no linked cause of death were used as controls in this study and totaled 4,864 births (90.1%), while deaths due to SUID made up the cases and totaled 537 births (9.9%). Medicaid insured births made up the majority of the cases (455 births, 84.7%).

Mothers that used tobacco during pregnancy made up 8% of all births, but 23% of SUID deaths reported maternal tobacco use. Mothers of White non-Hispanic ethnicity made up 45% of all births and mothers of Black non-Hispanic ethnicity made up 37% of all births. However, 48% of SUID deaths reported Black non-Hispanic race and 47% of Medicaid births reported Black non-Hispanic race. Mothers aged 20 to 29 accounted for 55% of all births, but roughly 64% of SUID deaths and births insured by Medicaid. Meanwhile, mothers aged greater than 29 accounted for 34% of all births, but only 18% and 20% of all SUID deaths and those insured by Medicaid, respectively. Mothers reporting some college education and above made up 50% of all births, but only 31% of SUID deaths and Medicaid insured births. Women with 0 to 1 previous live births still living accounted for 70% of all births, but only 66% of Medicaid births and 59% of SUID deaths. Meanwhile, women with 2 to 4 previous live births still living accounted for 27% of all births, but 36% of SUID deaths and 30% of Medicaid insured births. Women with 10 to 15 prenatal visits accounted for 53% of the study but 41% of SUID deaths. Women with less than 10 prenatal visits accounted for 22% of the study and 34% of SUID deaths. 90% of all births were normal birthweight, but normal birthweight infants only made up 78% of SUID deaths.

Among cases in the entire study population, the OR for Medicaid was 4.10 (95% CI: 3.22, 5.23) (Table3). The likelihood of a mother smoking was more than 4 times higher among SUID cases. In SUID deaths, the mother was 50% more likely to be Black non-Hispanic. Cases were also more likely to have more previous live births still living, fewer prenatal visits, and lower birthweights. Cases were less likely to have mothers older than 29 and maternal education of some college and above. lower maternal education, more previous live births still living.

Among Medicaid insured births, cases were 3 times more likely to report tobacco use during pregnancy, and more likely to have a larger number of previous live births still living, fewer prenatal visits, and lower birthweights. Cases were less likely to have mothers more than 29 years old.

Among privately insured births, cases were more than 7 times more likely to report tobacco use during pregnancy, more than twice as likely to report maternal race/ethnicity as Black non-Hispanic race/ethnicity, and more than 3 times more likely to have a mother aged less than 20 years old. Cases were less likely to have mothers aged over 29 and have mothers with education level greater than high school diploma/GED.

The relationship between Medicaid insured births was examined with respect to each of the largest categorizations of the covariates (Table 8). Medicaid insured births were 5 times more likely to use tobacco during pregnancy, 4 times more likely to be Black Non-Hispanic, less likely to be aged over 29, less likely to have some college education and above, more than 50% more likely to have 2 to 4 previous live births still living, 3 times more likely to have fewer (0 to 9) prenatal visits, and more than 50% more likely to have a low birthweight.

Stratified Analysis

As mentioned above, the OR for Medicaid insurance type among SUID deaths was 4.10 (95% CI: 3.22, 5.23). Effect modification (on the Medicaid-SUID association) was observed for each of the covariates (Table 6). Maternal race/ethnicity was the strongest observed effect modifier with an OR of 6.9 for White non-Hispanics and 2.3 for Black non-Hispanics. Both ORs were significant and the 95% CI did not overlap. All other covariates also showed effect modification, but data was sparse in some cells resulting in non-significant ORs, and overlapping or very imprecise 95% CI.

Stratified analyses were conducted treating each of the following covariates as the exposure: maternal race/ethnicity, maternal age, maternal education, number of previous live births still living, number of prenatal visits, birthweight. Effect modification (for each covariate-SUID association) was observed for nearly all of the covariates. Prior to doing these analyses, Chi-squared tests of association were performed for each covariate. All Chi-squared tests were significant (p-value < 0.05) indicating that each covariate is associated with the others, except for number of previous live births still alive and birthweight.

Logistic Regression

All Chi-squared tests of association were significant (p-value < 0.05) indicating that insurance type is associated with SUID infant death and each of the covariates is associated with insurance type as well as SUID infant death. A collinearity assessment did not indicate that any variables needed to be removed from the model. Stepwise logistic regression indicated that the following should be included in the model: insurance type, maternal tobacco use during pregnancy, maternal age, number of previous live births still living, number of prenatal visits, birthweight. Therefore, no interaction terms were included in the model, neither was maternal education, but maternal race/ethnicity was still included in the model to control for confounding based on the literature review. Since effect

modification was apparent in the stratified analysis a confounding assessment was not performed. Using these variables, logistic regression analysis was conducted and the OR for a Medicaid insured birth was 2.06 (95% CI: 1.50, 2.83).

Logistic regression analyses using all variables and no interaction terms (insurance type, tobacco use during pregnancy, maternal race/ethnicity, maternal age, maternal education, number of previous live births still alive, number of prenatal visits, birthweight) were also performed for select strata with the largest number of observations (Table 7). Among births where the maternal race/ethnicity was White non-Hispanic, Medicaid insurance was 3 times more likely among the cases. Among births where the maternal race/ethnicity was Black non-Hispanic, Medicaid insurance was only 30% more likely, though not significant. Among births to women aged 20-29 at delivery, Medicaid was 2 times more likely in the event of SUID. The same was true among mothers with 0 – 9 prenatal visits. However, among mothers with 10 – 15 prenatal visits, a Medicaid insured birth was about 75% more likely among cases. Among low birthweight infants, a Medicaid insured birth was more than 3 times more likely in the event of a SUID compared to 78% more likely among normal birthweight infants.

Discussion

One additional variable included in this study, but is less common in other studies on SUID, is number of previous live births still living. This variable was included as a proxy for bed sharing, which greatly increases risk for SUID and is more common among families with more children, but is not captured on vital records and can be hard to control for.

It is a challenge to examine the association between insurance type and SUID. The exposure, outcome, and the covariates (only a limited number included) all exhibit associations with each other. Furthermore, given the Medicaid-SUID association, all covariates were effect modifiers. Medicaid is a socio-economic variable because low income is a criterion for Medicaid enrollment. Therefore, the associations between Medicaid and other socio-economic variables used in this study, such as maternal race and education, are expected. However, this study also observed associations between Medicaid and parameters not primarily classified as socio-economic, such as: demographic (maternal age, number of previous live births), behavioral (tobacco use), prenatal exposure (number of prenatal visits), birth outcome (birthweight). Including parameters from a spectrum of public health realms accounted for some of the variance of the Medicaid-SUID relationship, but other sets of parameters still need to be examined to truly understand the association between Medicaid and SUID.

Medicaid may not have been the best exposure to consider when looking at SUID because Medicaid is clearly complex and multifaceted as evidenced by the effect modification seen in every covariate of this study. It may be more beneficial to further examine the covariates as outcomes, or as exposures with SUID. When these associations are clearer, a list of factors contributing to SUID may be able to be compiled and that list may better describe why those insured by Medicaid are at such great risk.

Of the factors examined in this study maternal race/ethnicity is perhaps the most important effect modifier. The greatest difference between the observed effect in strata and the adjusted effect in logistic regression is among maternal race/ethnicity groups. Mothers of Black non-Hispanic race/ethnicity should be targeted specifically for interventions. While factors such as decreased education and maternal age increase risk for SUID, these populations seem to be somewhat small. A greater decline in SUID incidence may observed if resources are used to target a much larger group that is at considerable elevated risk for SUID.

Strengths and Weaknesses

The overall sample size of this study is a strength. There are a fair amount of cases, but small cell sizes under stratification yielded non-significant results. More data on these categories would allow better OR estimates for these particularly high risk groups. Selection bias is not an anticipated issue because data was pulled from all births in the state of Georgia and controls were selected through systematic random sampling.

Data comes from birth certificates which are subject to error. Errors can stem from employee errors during data collection as well as reporting errors on demographics that mothers may not want to be transparent about such as tobacco use and education level.

Data is available from death scene investigations and child fatality reviews that is not available for births still living. These case reports contain valuable information on potential confounders and predictors of deaths due to SUID causes such as whether bed sharing occurred or whether the child was breastfed. Both variables are important risk factors for SUID. Since this information is not collected for live births still living, however, there is no way to compare and control for these variables between the two groups.

Stratified logistic regression analysis was used in this study, but other methodologies may be better suited to examine the complex relationship between Medicaid and socio-economic, demographic, biologic, medical, behavioral, and environmental risk factors.

Future Directions

Studies could be done on high risk groups for which there were very few observations in this study, such as babies with very low or extremely low birthweight or mothers with less than 9th grade education. Bias analyses could be done to adjust for errors on birth certificates due to healthcare staff which would allow adjusted OR to be obtained that may be more accurate than unadjusted estimates.

SUID associations between prenatal visits, maternal age, birthweight, and number of previous live births still living could be examined as continuous variables to see if a dose-response relationship exists.

It would be valuable to do cohort studies on a cohort of births and gather information on variables and confounders that normally are only collected on SUID. This may be difficult because deaths due to SUID make up such a small amount of overall births, but would greatly contribute to understanding the risk factors and predictors of SUID. The National Children's Study would have been a great source of information collected prospectively, but the study was closed prematurely. Some data from the Pregnancy Risk Assessment Monitoring System (PRAMS) could be used to accomplish this, however subjects in this study may not be followed long enough to observe SUID outcomes or ask about post-pregnancy behaviors, such as breast feeding.

The variables used in this study could be used as exposures in studies examining SUID as an outcome, as well as Medicaid as an outcome. Identifying what specific factors determine a person's insurance type, will in turn lead to identifying exposures that lead to SUID. When Medicaid insurance type can be more readily classified, predictors of SUID may be able to be better controlled for in studies leading to more targeted intervention efforts in the highest risk groups.

While Medicaid is a socio-economic variable, factors affecting it are not limited to just those of a socio-economic nature. Once factors affecting Medicaid are better understood, the Medicaid-SUID association could be examined using solely socio-economic parameters or solely behavioral parameters as covariates. Or the strongest parameter from each health discipline could be used to build a model that might further explain the variance seen in the Medicaid-SUID association.

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Tables

Table 1. Characteristics of a Cohort of Georgia Singleton Live Births Using 2010 - 2014 Birth Certificate Data by Cause of Death

	Eligible Births (n=5,401)		SUID[a] (n=537)		Live (n=4,864)	
	No.	%	No.	%	No.	%
Insurance Type						
Medicaid	3,251	60.2	455	84.7	2,796	57.5
Private	2,150	39.8	82	15.3	2,068	42.5
Mother Used Tobacco During Pregnancy						
Yes	437	8.1	125	23.3	312	6.4
No	4,935	91.4	411	76.5	4,524	93.0
Missing	29	0.5	1	0.2	28	0.6
Maternal Race/Ethnicity						
White Non-Hispanic	2,442	45.2	219	40.8	2,223	45.7
White Hispanic	371	6.9	17	3.2	354	7.3
Black Non-Hispanic	1,993	36.9	257	47.9	1,736	35.7
Black Hispanic	42	0.8	7	1.3	35	0.7
Other Race Non-Hispanic	308	5.7	19	3.5	289	5.9
Other Race Hispanic	61	1.1	5	0.9	56	1.2
Missing	184	3.4	13	2.4	171	3.5
Maternal Age, Years						
< 20	584	10.8	91	17.0	493	10.1
20 - 29	2,960	54.8	347	64.6	2,613	53.7
> 29	1,857	34.4	99	18.4	1,758	36.1
Maternal Education						
< 9th Grade	134	2.5	22	4.1	112	2.3
9th - 11th Grade	758	14.0	128	23.8	630	13.0
High School Diploma/ GED	1,625	30.1	200	37.2	1,425	29.3
Some College and Above	2,704	50.1	171	31.8	2,533	52.1
Missing	180	3.3	16	3.0	164	3.4
Number Previous Live Births, Living						
0 - 1	3,774	69.9	317	59.0	3,457	71.1
2 - 4	1,435	26.6	195	36.3	1,240	25.5
> 4	102	1.9	21	3.9	81	1.7
Missing	90	1.7	4	0.7	86	1.8
Number Prenatal Visits						
0 - 9	1,177	21.8	183	34.1	994	20.4
10 - 15	2,870	53.1	221	41.2	2,649	54.5
> 15	438	8.1	25	4.7	413	8.5
Missing	916	17.0	108	20.1	808	16.6
Birthweight[b]						
Extremely Low Birth Weight	7	0.1	4	0.7	3	0.1
Very Low Birthweight	86	1.6	25	4.7	61	1.3
Low Birthweight	438	8.1	91	17.0	347	7.1
Normal Birthweight	4,870	90.2	417	77.7	4,453	91.6

[a]Sudden Unexpected Infant Deaths include deaths due to: Sudden Infant Death Syndrome (SIDS), accidental suffocation and strangulation in bed, and unknown cause

[b]Birthweight categorizations are as follows: extremely low < 500 grams, very low 500 - 1,499 grams, low 1,500 to 2,499 grams, normal 2,500 grams and above

Table 2. Characteristics of a Cohort of Georgia Singleton Live Births Using 2010 - 2014 Birth Certificate Data by Insurance Type

	Eligible Births (n=5,401)		Medicaid (n=3,251)		Private (n=2,150)	
	No.	%	No.	%	No.	%
Infant Cause of Death						
SUID[a]	537	9.9	455	14.0	82	3.8
Live	4,864	90.1	2,796	86.0	2,068	96.2
Mother Used Tobacco During Pregnancy						
Yes	437	8.1	383	11.8	54	2.5
No	4,935	91.4	2,849	87.6	2,086	97.0
Missing	29	0.5	19	0.6	10	0.5
Maternal Race/Ethnicity						
White Non-Hispanic	2,442	45.2	1,127	34.7	1,315	61.2
White Hispanic	371	6.9	258	7.9	113	5.3
Black Non-Hispanic	1,993	36.9	1,540	47.4	453	21.1
Black Hispanic	42	0.8	34	1.1	8	0.4
Other Race Non-Hispanic	308	5.7	134	4.1	174	8.1
Other Race Hispanic	61	1.1	44	1.4	17	0.8
Missing	184	3.4	114	3.5	70	3.3
Maternal Age, Years						
< 20	584	10.8	534	16.4	50	2.3
20 - 29	2,960	54.8	2,074	63.8	886	41.2
> 29	1,857	34.4	643	19.8	1,214	56.5
Maternal Education						
< 9th Grade	134	2.5	121	3.7	13	0.6
9th - 11th Grade	758	14.0	704	21.7	54	2.5
High School Diploma/ GED	1,625	30.1	1,308	40.2	317	14.7
Some College and Above	2,704	50.1	1,019	31.3	1,685	78.4
Missing	180	3.3	99	3.1	81	3.8
Number Previous Live Births, Living						
0 - 1	3,774	69.9	2,136	65.7	1,638	76.2
2 - 4	1,435	26.6	988	30.4	447	20.8
> 4	102	1.9	78	2.4	24	1.1
Missing	90	1.7	49	1.5	41	1.9
Number Prenatal Visits						
0 - 9	1,177	21.8	923	28.4	254	11.8
10 - 15	2,870	53.1	1,582	48.7	1,288	59.9
> 15	438	8.1	222	6.8	216	10.1
Missing	916	17.0	524	16.1	392	18.2
Birthweight[b]						
Extremely Low Birth Weight	7	0.1	6	0.2	1	0.1
Very Low Birthweight	86	1.6	66	2.0	20	0.9
Low Birthweight	438	8.1	310	9.5	128	6.0
Normal Birthweight	4,870	90.2	2,869	88.3	2,001	93.1

[a]Sudden Unexpected Infant Deaths include deaths due to: Sudden Infant Death Syndrome (SIDS), accidental suffocation and strangulation in bed, and unknown cause

[b]Birthweight categorizations are as follows: extremely low < 500 grams, very low 500 - 1,499 grams, low 1,500 to 2,499 grams, normal 2,500 grams and above

Table 3. Unadjusted Estimated Incidence Odds Ratios (OR), and 95% Confidence Intervals (CI) for the Risk of Infant Death Due to SUID[a] in a Cohort of U.S. Singleton Live Births Using 2010 - 2014 Georgia Birth Certificate Data

	SUID 537	Total 5,401	OR	95% CI	
Insurance Type					
Medicaid	455	3,251	4.10	3.22	5.23
Private[c]	82	2,150	1.00		
Mother Used Tobacco During Pregnancy					
Yes	125	437	4.41	3.50	5.55
No[c]	411	4,935	1.00		
Maternal Race/Ethnicity					
White Non-Hispanic[c]	219	2,442	1.00		
White Hispanic	17	371	0.49	0.29	0.81
Black Non-Hispanic	257	1,993	1.50	1.24	1.82
Black Hispanic	7	42	2.03	0.89	4.62
Other Race Non-Hispanic	19	308	0.67	0.41	1.08
Other Race Hispanic	5	61	0.91	0.36	2.29
Maternal Age, Years					
< 20	91	584	1.39	1.08	1.78
20 - 29[c]	347	2,960	1.00		
> 29	99	1,857	0.42	0.34	0.53
Maternal Education					
< 9th Grade	22	134	1.40	0.87	2.26
9th - 11th Grade	128	758	1.45	1.14	1.84
High School Diploma/ GED[c]	200	1,625	1.00		
Some College and Above	171	2,704	0.48	0.39	0.60
Number Previous Live Births, Living					
0 - 1[c]	317	3,774	1.00		
2 - 4	195	1,435	1.72	1.42	2.07
> 4	21	102	2.83	1.73	4.63
Number Prenatal Visits					
0 - 9	183	1,177	2.21	1.79	2.72
10 - 15[c]	221	2,870	1.00		
> 15	25	438	0.73	0.47	1.11
Birthweight[b]					
Extremely Low Birthweight	4	7	14.24	3.18	63.83
Very Low Birthweight	25	86	4.38	2.72	7.05
Low Birthweight	91	438	2.80	2.18	3.60
Normal Birthweight[c]	417	4,870	1.00		

[a]Sudden Unexpected Infant Deaths include deaths due to: Sudden Infant Death Syndrome (SIDS), accidental suffocation and strangulation in bed, and unknown cause

[b]Birthweight categorizations are as follows: extremely low < 500 grams, very low 500 - 1,499 grams, low 1,500 to 2,499 grams, normal 2,500 grams and above

[c]Reference group

Table 4. Unadjusted Estimated Incidence Odds Ratios (OR), and 95% Confidence Intervals (CI) for the Risk of Infant Death Due to SUID[a] Among Medicaid Insured Births in a Cohort of U.S. Singleton Live Births Using 2010 - 2014 Georgia Birth Certificate Data

	SUID 455	Total 3,251	OR	95% CI	
Mother Used Tobacco During Pregnancy					
Yes	114	383	3.12	2.44	3.99
No[c]	341	2,849	1.00		
Maternal Race/Ethnicity					
White Non-Hispanic[c]	183	1,127	1.00		
White Hispanic	12	258	0.25	0.14	0.46
Black Non-Hispanic	225	1,540	0.88	0.71	1.09
Black Hispanic	6	34	1.11	0.45	2.71
Other Race Non-Hispanic	15	134	0.65	0.37	1.14
Other Race Hispanic	3	44	0.38	0.12	1.23
Maternal Age, Years					
< 20	83	534	1.06	0.82	1.38
20 - 29[c]	306	2,074	1.00		
> 29	66	643	0.66	0.50	0.88
Maternal Education					
< 9th Grade	22	121	1.40	0.86	2.28
9th - 11th Grade	121	704	1.31	1.02	1.68
High School Diploma/ GED[c]	179	1,308	1.00		
Some College and Above	119	1,019	0.83	0.65	1.07
Number Previous Live Births, Living					
0 - 1[c]	255	2,136	1.00		
2 - 4	177	988	1.61	1.31	1.98
> 4	20	78	2.54	1.51	4.30
Number Prenatal Visits					
0 - 9	167	923	1.73	1.38	2.18
10 - 15[c]	179	1,582	1.00		
> 15	20	222	0.78	0.48	1.26
Birthweight[b]					
Extremely Low Birthweight	4	6	14.54	2.65	79.66
Very Low Birthweight	24	66	4.15	2.48	6.94
Low Birthweight	80	310	2.53	1.91	3.34
Normal Birthweight[c]	347	2,869	1.00		

[a]Sudden Unexpected Infant Deaths include deaths due to: Sudden Infant Death Syndrome (SIDS), accidental suffocation and strangulation in bed, and unknown cause

[b]Birthweight categorizations are as follows: extremely low < 500 grams, very low 500 - 1,499 grams, low 1,500 to 2,499 grams, normal 2,500 grams and above

[c]Reference group

Table 5. Unadjusted Estimated Incidence Odds Ratios (OR), and 95% Confidence Intervals (CI) for the Risk of Infant Death Due to SUID[a] Among Privately Insured Births in a Cohort of U.S. Singleton Live Births Using 2010 - 2014 Georgia Birth Certificate Data

	SUID 82	Total 2,150	OR	95% CI	
Mother Used Tobacco During Pregnancy					
Yes	11	54	7.37	3.64	14.89
No[c]	70	2,086	1.00		
Maternal Race/Ethnicity					
White Non-Hispanic[c]	36	1,315	1.00		
White Hispanic	5	113	1.64	0.63	4.28
Black Non-Hispanic	32	453	2.70	1.66	4.40
Black Hispanic	1	8	5.08	0.61	42.34
Other Race Non-Hispanic	4	174	0.84	0.29	2.38
Other Race Hispanic	2	17	4.74	1.04	21.49
Maternal Age, Years					
< 20	8	50	3.93	1.73	8.90
20 - 29[c]	41	886	1.00		
> 29	33	1,214	0.58	0.36	0.92
Maternal Education					
< 9th Grade	0	13	0.00		
9th - 11th Grade	7	54	2.10	0.85	5.21
High School Diploma/ GED[c]	21	317	1.00		
Some College and Above	52	1,685	0.45	0.27	0.76
Number Previous Live Births, Living					
0 - 1[c]	62	1,638	1.00		
2 - 4	18	447	1.07	0.62	1.82
> 4	1	24	1.11	0.15	8.32
Number Prenatal Visits					
0 - 9	16	254	1.99	1.10	3.61
10 - 15[c]	42	1,288	1.00		
> 15	5	216	0.70	0.28	1.80
Birthweight[b]					
Extremely Low Birthweight	0	1	0.00		
Very Low Birthweight	1	20	1.45	0.19	11.00
Low Birthweight	11	128	2.59	1.34	5.03
Normal Birthweight[c]	70	2,001	1.00		

[a]Sudden Unexpected Infant Deaths include deaths due to: Sudden Infant Death Syndrome (SIDS), accidental suffocation and strangulation in bed, and unknown cause

[b]Birthweight categorizations are as follows: extremely low < 500 grams, very low 500 - 1,499 grams, low 1,500 to 2,499 grams, normal 2,500 grams and above

[c]Reference group

Table 6. Unadjusted Estimated Incidence Odds Ratios (OR), and 95% Confidence Intervals (CI) for the Risk of Infant Death Due to SUID[a] by Insurance Type Among Strata in a Cohort of U.S. Singleton Live Births Using 2010 - 2014 Georgia Birth Certificate Data

	Medicaid[b] 3,251	SUID 537	Total 5,401	OR	95% CI	
Mother Used Tobacco During Pregnancy						
Yes	383	125	437	1.66	0.82	3.33
No	2,849	411	4,935	3.92	3.01	5.10
Maternal Race/Ethnicity						
White Non-Hispanic	1,127	219	2,442	6.89	4.77	9.94
White Hispanic	258	17	371	1.05	0.36	3.06
Black Non-Hispanic	1,540	257	1,993	2.25	1.53	3.31
Black Hispanic	34	7	42	1.50	0.15	14.57
Other Race Non-Hispanic	134	19	308	5.36	1.73	16.54
Other Race Hispanic	44	5	61	0.55	0.08	3.61
Maternal Age, Years						
< 20	534	91	584	0.97	0.44	2.13
20 - 29	2,074	347	2,960	3.57	2.55	4.99
> 29	643	99	1,857	4.09	2.66	6.29
Maternal Education						
< 9th Grade	121	22	134	0.00[d]		
9th - 11th Grade	704	128	758	1.39	0.62	3.16
High School Diploma/ GED	1,308	200	1,625	2.23	1.40	3.58
Some College and Above	1,019	171	2,704	4.15	2.97	5.81
Number Previous Live Births, Living						
0 - 1	2,136	317	3,774	3.45	2.59	4.58
2 - 4	988	195	1,435	5.20	3.16	8.57
> 4	78	21	102	7.93	1.01	62.58
Number Prenatal Visits						
0 - 9	923	183	1,177	3.29	1.93	5.60
10 - 15	1,582	221	2,870	3.79	2.68	5.34
> 15	222	25	438	4.18	1.54	11.34
Birthweight[c]						
Extremely Low Birthweight	6	4	7	0.00[d]		
Very Low Birthweight	66	25	86	10.86	1.37	86.25
Low Birthweight	310	91	438	3.70	1.90	7.22
Normal Birthweight	2,869	417	4,870	3.80	2.92	4.94

[a]Sudden Unexpected Infant Deaths include deaths due to: Sudden Infant Death Syndrome (SIDS), accidental suffocation and strangulation in bed, and unknown cause

[b]Exposed = Medicaid; Referent Group = Private

[c]Birthweight categorizations are as follows: extremely low < 500 grams, very low 500 - 1,499 grams, low 1,500 to 2,499 grams, normal 2,500 grams and above

[d]OR could not be calculated due to a value of 0 in one of the cells

Table 7. Adjusted Estimated Incidence Odds Ratios (OR), and 95% Confidence Intervals (CI) for the Risk of Infant Death Due to SUID[a] Among Strata in a Cohort of U.S. Singleton Live Births Using 2010 - 2014 Georgia Birth Certificate Data

	OR	95% CI	
Maternal Race/Ethnicity			
White Non-Hispanic[c]	2.96	1.81	4.82
Black Non-Hispanic	1.33	0.81	2.19
Maternal Age, Years			
20 - 29	2.11	1.37	3.24
Maternal Education			
High School Diploma/ GED	1.27	0.75	2.16
Some College and Above	2.19	1.41	3.41
Number Previous Live Births, Living			
0 - 1	1.63	1.09	2.44
2 - 4	2.58	1.41	4.72
Number Prenatal Visits			
0 - 9	2.23	1.20	4.14
10 - 15	1.74	1.15	2.62
Birthweight[b]			
Low Birthweight	3.89	1.42	10.67
Normal Birthweight	1.78	1.25	2.53

[a]Sudden Unexpected Infant Deaths include deaths due to: Sudden Infant Death Syndrome (SIDS), accidental suffocation and strangulation in bed, and unknown cause

[b]Birthweight categorizations are as follows: extremely low < 500 grams, very low 500 - 1,499 grams, low 1,500 to 2,499 grams, normal 2,500 grams and above

Table 8. Unadjusted Estimated Incidence Odds Ratios (OR), and 95% Confidence Intervals (CI) for the Risk of Medicaid in a Cohort of U.S. Singleton Live Births Using 2010 - 2014 Georgia Birth Certificate Data

	Medicaid 3,251	Total 5,401	OR	95% CI	
Mother Used Tobacco During Pregnancy					
Yes	383	437	5.19	3.88	6.94
No[c]	2,849	4,935	1.00		
Maternal Race/Ethnicity					
White Non-Hispanic[b]	1,127	2,442	1.00		
Black Non-Hispanic	1,540	1,993	3.97	3.48	4.52
Maternal Age, Years					
20 - 29[b]	2,074	2,960	1.00		
> 29	643	1,857	0.23	0.20	0.26
Maternal Education					
High School Diploma/ GED[b]	1,308	1,625	1.00		
Some College and Above	1,019	2,704	0.15	0.13	0.17
Number Previous Live Births, Living					
0 - 1[b]	2,136	3,774	1.00		
2 - 4	988	1,435	1.70	1.49	1.93
Number Prenatal Visits					
0 - 9	923	1,177	2.96	2.53	3.46
10 - 15[b]	1,582	2,870	1.00		
Birthweight[a]					
Low Birthweight	310	438	1.69	1.36	2.09
Normal Birthweight[b]	2,869	4,870	1.00		

[a]Birthweight categorizations are as follows: extremely low < 500 grams, very low 500 - 1,499 grams, low 1,500 to 2,499 grams, normal 2,500 grams and above

[b]Reference group