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Prevalence of Pregnancy-related Complications among Pregnant Women with Congenital Heart Defects Enrolled in Medicaid during 1999-2013

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By

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Abstract

PREVALENCE OF PREGNANCY-RELATED COMPLICATIONS AMONG PREGNANT WOMEN WITH CONGENITAL HEART DEFECTS ENROLLED IN MEDICAID DURING 1999-2013

By Dahanah Josias Sejour

Purpose: Those with congenital heart defects (CHD) require on-going care and lifelong cardiac surveillance. However, individuals with CHD are often lost to follow up as they transition from childhood to adulthood. While reasons for lapses in medical care vary, studies have found that a change in or a loss of medical insurance are two major causes of lapses in care for individuals with CHD. Due to the increased risk of pregnancy related complications, it is imperative that women with CHD receive adequate medical care prior to and during pregnancy. The current study determined whether prevalence of pregnancy-related complications differed by history of Medicaid enrollment among pregnant women with CHD.

Methods: Medicaid claims were limited to female patients who were coded as having at least one CHD diagnosis in the years 1999-2007 with at least one pregnancy-related diagnosis in 2008-2013. Using multivariable logistic regression, odds ratios were calculated between Medicaid enrollment history and pregnancy-related complications.

Results: The analytic sample retained was 1,799 women. Of those, 557 (31%) were continuously enrolled in Medicaid from 1999-2007, while 1,242 (69.0%) were occasionally enrolled in Medicaid from 1999-2007. With respect to pregnancy-related complications, 206 (11.5%) had cardiovascular complications, 476 (26.5%) experienced neonatal/fetal loss, 1,426 (79.3%) had maternal complications and 419 (23.3%) experienced complications in pregnancy. While history of Medicaid enrollment was not a significant predictor of cardiovascular complications, complications during pregnancy or neonatal/fetal loss, it was a significant predictor of complications during delivery for women aged 19 or older. Pregnant women $\geq$ 19 with CHD who were only occasionally enrolled in Medicaid were more likely to have complications during delivery than those who were continuously enrolled in Medicaid.

Conclusion: Results suggest an association between history of enrollment in Medicaid and certain pregnancy-related complications among pregnant women with CHD. More research is needed to further examine this relationship, especially with the inclusion of previously uninsured women with CHD who only become eligible for Medicaid because of their pregnancy. Subsequently, to assess this relationship, there is a need for additional data sources that provide more accurate reporting of medical histories for Medicaid patients with CHD. Given that the majority of this CHD sample were occasionally enrolled in Medicaid, and given that there is an ever-growing number of individuals with CHD surviving into adulthood, these findings indicate the need for a re-assessment of Medicaid's eligibility requirement for adult disability status.

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TABLE OF CONTENTS

List of Abbreviations

ACHD	Adult Congenital Heart Disease
ACA	Affordable Care Act
AHRQ	Agency for Healthcare Research and Quality
CCS	Clinical Classification Software
CDC	Centers for Disease Control and Prevention
CHD	Congenital Heart Defects
CHIP	Children's Health Insurance Plan
CI	Confidence Interval
CMS	Centers for Medicare and Medicaid Services
DAG	Directed Acyclic Graph
FBR	Federal Benefit Rate
FIPS	Federal Information Processing Standard
FISMA	Federal Information Security Management Act
FPL	Federal Poverty Level
HCUP	Healthcare Cost and Utilization Project
IOM	Institutes of Medicine
MAX	Medicaid Analytic Extracted file
PIH	Pregnancy Induced Hypertension
PHI	Protected Health Information
PRAMS	Pregnancy Risk Assessment Monitoring System
ResDAC	Research Data Assistance Center
S-CHIP	State Children's Health Insurance Plan

SEM	Social Ecological Model
SSA	Social Security Administration
SSI	Supplemental Security Income Program

CHAPTER I: BACKGROUND

Congenital Heart Defects (CHD)

Congenital heart defects (CHD) are a type of birth defect that affect the structure and function of the heart (1). In the U.S., CHD are the most common birth defect, affecting nearly 1% of births per year, and are the leading cause of birth defect-related illness and death among infants (2). Common signs of CHD are a hole in the heart, obstructed blood flow, abnormal blood vessels or heart valve abnormalities. Symptoms of CHD include discoloring of nails or lips, fast or troubled breathing, feelings of tiredness, and sleepiness (1,3). CHDs can range from simple to complex defects. Simple defects are those that have little to no symptoms and are managed with medicine, while symptoms of complex defects are severe and life threatening. Infants born with a complex defect usually require surgery right after birth (1,4). Due to improvements in diagnostic tests and treatments, there have been an increase in life expectancy such that approximately 95% of those born with a non-severe CHD, and 69% of those born with a severe CHD are expected to survive into adulthood (2). In the U.S, there are an estimated 1.4 million adults 18 years old and older living with CHD (1).

As the number of individuals living with CHD grows, concerns arise regarding the medical management of this population (1,5,6). Those with CHD require on-going care and lifelong cardiac surveillance (7,8). A cardiac follow-up with a physician every 3 to 5 years is recommended for adults with simple CHD, every 12 to 24 months for those with moderate to complex CHD conditions, and every 6 to 12 months for those with more complex CHD conditions (9). However, those with CHD are often lost to follow-up as they transition from childhood to adulthood (10,11,12). A study by Gurvitz et al. (2013) reported that of the 922 patients seen at CHD centers, 42% of patients experienced at least a three-year gap in cardiology

care, and of those, 8% of the gaps were longer than 10 years (10). Lapses in care often began as patients transitioned from childhood into adulthood, at 19 years old (10). Another study examining retention of young adult CHD patients in cardiac care (N=153) found that 18% of patients were lost to follow-up; lost to follow-up was defined as not being seen by a cardiologist within two years of the study interview (13). Among those who were lost to follow-up, 2% did not have a cardiology visit since age 18, while among those who were retained in care, 6% had at least one lapse in care since age 18 (13).

There are many negative implications for lapses in care for adults with CHD. First, lapses in care have been associated with greater need for urgent care. Rates of outpatient care, emergency department encounters, hospitalization rates, and admittance into care units have seen increases (14). One study examining 400 patients seen at an Adult Congenital Heart Disease (ACHD) regional clinic from 2002 to 2003 found that those who had experienced a lapse in medical care were three times as likely to require urgent cardiac intervention compared to those who did not experience a lapse in care (14). Furthermore, from 1998 and 2005, the annual number of hospitalizations among adults with CHD doubled from 35,992 in 1998 compared to 72,656 in 2005 (15). One study of CHD patients, ages 12 to 44, who were discharged from a California hospital between 2000 and 2005, found that CHD patients who were over 17 years old were more likely to be admitted to the hospital via emergency departments compared to any other department (11). Between clinic visits and hospitalization expenses, it is estimated that an individual with CHD will spend an average of $2,851 per year between birth and 21 years of age and $1,120 per year between the ages of 22 and 40 years (15).

Second, lapses in care have been associated with increased risk of co-morbidities. Approximately 20% to 30% of individuals living with CHD have other physical problems or developmental/cognitive disorders (2). Adults diagnosed with a complex CHD are at greater risk of experiencing co-morbidities such as heart failure, arrhythmia, hypertension or diabetes (15,16). In a study evaluating trends in the care of adult CHD patients in the U.S between 2003-2012, researchers found that not only was there a significant increase (82%) in admissions of adult patients with CHD, but there was also a significant increase in the prevalence of accompanying co-morbidities such as hypertension, diabetes, obesity, peripheral arterial disease, and chronic kidney disease among this population (17).

Social Ecological Model and CHD

A complex set of factors may contribute to poor retention in medical care among CHD patients. The Social Ecological Model (SEM), which describes how multiple factors at the individual and environmental levels interact to influence health behaviors, and consequently, affect health outcomes, can be applied as a guiding theory to describe factors that contribute to lapse in care among those with CHD (18). There are five hierarchal levels within SEM: individual (individual characteristics), interpersonal (our relationships with others or social networks), community (relationships among organizations, institutions, informational networks and including built environment), organizational (organizational and social institutions), and policy (local, state, national and global laws and policies) (18). Given the hierarchical and interrelated nature of SEM, herein, the highest level is the primary level where lapses in care can be seen, namely policy level factors including access to health care coverage. Previous studies have shown that changes in medical insurance or loss of medical insurance are the two main causes of lapses in care for individuals with CHD (11,14).

Medicaid and the Children's Health Insurance Program (CHIP)

Medicaid was passed into law in 1965 under Title XIX of the Social Security Act (SSA) with the purpose of providing healthcare coverage to individuals with low incomes (19). While Medicaid eligibility requirements are determined by states and can vary from state to state, federal laws require healthcare coverage for certain at-need groups. Mandatory eligibility groups include low-income families, qualified pregnant women and children, and aged, blind and disabled individuals receiving Supplemental Security Income (SSI) (20). In addition to Medicaid, healthcare coverage to children is also offered through the Children's Health Insurance Program (CHIP), introduced in 1997. CHIP provides low cost healthcare coverage for children whose family's income is too high to qualify them for Medicaid coverage, but who, at the same time, cannot afford private insurance. Together, Medicaid and CHIP provide healthcare coverage to millions of Americans. In 2010, the Affordable Care Act (ACA) was signed into law with the goal of increasing the number of Americans covered by providing states with the opportunity to expand Medicaid (21). With Medicaid expansion, Medicaid eligibility levels for adults who are under 65 years old without children and who are at or above 138% of the Federal Poverty Level (FPL) can be eligible for coverage. As of 2016, while 31 states have expanded Medicaid programs, 19 states, including Georgia, have not (21).

Medicaid and the State Children's Health Insurance Program (S-CHIP) in Georgia

In Georgia, the eligibility criteria for Medicaid include being low income (defined differently under different demographic criteria) and pregnant, or a child or teenager, or age 65 or older, or legally blind, or disabled or need nursing home care (22). Georgia's State Children's Health Insurance Program (S-CHIP) is referred to as PeachCare For Kids (22) and provides medical benefits to children whose family's income is more than the Medicaid income eligibility

criteria (income cannot exceed 247% of the Federal Poverty Level (FPL)). Unlike Medicaid, PeachCare for Kids requires a monthly premium for children six years and older (22). In 2012, only 20% of individuals living in Georgia were enrolled in Medicaid or PeachCare for Kids, with children making up the majority of enrollees (23). Georgia is among the top three states with the highest uninsured rate (23). In 2015, 13% of Georgia's population was uninsured; about 31% of those who are currently uninsured would be insured if Georgia expanded Medicaid (23, 24).

Medicaid, Supplemental Security Income (SSI) and CHD

A person with CHD can be eligible for Medicaid under the disability category based on their Supplemental Security Income (SSI) status. SSI is a federal income supplement program funded by general tax revenues, and it provides benefits to the elderly, blind and disabled with low incomes (25). The SSA defines disability SSI eligibility differently for children and adults. In order to receive SSI benefits as a child under the age of 18 years old, one must have a physical or mental impairment that causes marked and severe functional limitations which either can result in death or is expected to last 12 months or more. Persons with CHD can be automatically approved for SSI benefits if their conditions meet the criteria listed in the SSA's "Listings of Impairments"; however, criteria differ for children and adults (25)**.** To meet SSA's income and asset requirements, one's federal benefit rate (FBR) must be less than $733 per month for individuals, and $1,100 per month for couples. When adolescents turn 18 years old, their personal income and assets are considered for eligibility rather than the income of their parents and their eligibility is reconfigured based on adult criteria. Due to changes in eligibility criteria for adults, it is often for individuals to remain eligible for SSI into adulthood. It is estimated that 43% of children transitioning into adulthood have their benefits terminated (25).

Pregnancy and Medicaid

Approximately, two-thirds of women enrolled in Medicaid are in their reproductive years between ages 19 to 44, and nearly half of all births per year in the United States are covered by Medicaid (26). Data from CDC's 2009 Pregnancy Risk Assessment Monitoring System (PRAMS) of 29 participating states reported that only 16% of women had Medicaid coverage before pregnancy compared to 50% during pregnancy through delivery (27,28,29). Only 18% had continuous Medicaid coverage prior to pregnancy, during pregnancy, and at delivery (27,28,29). In addition, while 23% of women were uninsured before pregnancy, only 3% were uninsured during pregnancy and 2% were uninsured at delivery (27,28,29). Overall, 30% of women had changes in healthcare insurance coverage status from pre-pregnancy to delivery. Specifically, in 2011 in Georgia, 37% of women reported that they were uninsured in the month before pregnancy, and 2% remained uninsured at the time of delivery (30). While 61% of women reported having had Medicaid any time (before pregnancy, during pregnancy for prenatal care and at delivery), only 15% of women indicated having Medicaid before pregnancy (30). While the ACA hoped to close the gap for uninsured mothers with low income, in states where Medicaid was not expanded, it is estimated that 1.7 million women remain ineligible for Medicaid during pregnancy (8).

Consequence of Lack of Insurance or Delayed Coverage during Pregnancy

Health insurance coverage status has important implications for pregnant women. It is recommended that a pregnant woman have at least one prenatal visit per month during weeks 4 through 28, twice per month during weeks 28 through 36, and weekly visits from 36 weeks to delivery (31). However, women who are uninsured or received coverage after their first trimester are less likely to receive prenatal care and have fewer prenatal care visits during their pregnancy

compared with women who are insured (32,33). Lack of prenatal care is associated with increased risk of premature delivery (<37 completed weeks of gestation) and low birth weight (<2500 grams) which can lead to prolonged hospital stays for both the mother and child (32,34). One study surveying 9,394 women who had live births in 1988 found that those who received adequate prenatal care throughout their pregnancy were at lower risk of having an infant born with a low birth weight compared to those who did not receive adequate prenatal care (35).

In addition, lack of prenatal care also increases the risk of neonatal, infant and maternal mortality (32,34). According to the Institute of Medicine (IOM), women who are uninsured during pregnancy are at greater risk of having poor health outcomes such as pregnancy-related hypertension during or after pregnancy or placental abruption compared to pregnant women who are insured. They are also more likely to have early deliveries, and are more likely to experience complications (32).

Comorbidities Associated with Pregnancy

There are a number of comorbidities associated with pregnancy which can occur among otherwise healthy women. For example, a pregnant woman who has no prior history of diabetes may develop gestational diabetes during pregnancy (36). The prevalence of gestational diabetes is 9%, and poor management of gestational diabetes causes the weight of the baby to increase (fetal macrosomia), and increases the likelihood of delivery by cesarean section (C-section) (37). In addition, women with gestational diabetes are more likely to have high blood pressure (preeclampsia) and low blood sugar (hypoglycemia) (36,38). High blood pressure in women without a history of chronic hypertension may develop during pregnancy, referred to as gestational hypertension or pregnancy induced hypertension (PIH) (38). During pregnancy, 7% of pregnant women experience gestational hypertension, and it has been reported that gestational

hypertension can lead to early delivery, low birth weight, seizures or a stroke (due to blot clots) during labor and delivery (38).

Pregnancy-related Complications among CHD Patients

While many women with CHD are able to have successful pregnancies, CHD does increase the risk of pregnancy-related co-morbidities and complications (39). Pregnancy outcomes in women with CHD can include birth defects, miscarriage, premature birth, low birth weight, and stillbirth. One study by Khairy (2016) examined pregnancy outcomes of 53 women with CHD who were pregnant between 1998 and 2004. Of the 72 pregnancies that were carried to full term during this time period, cardiac events complicated 19% of pregnancies and adverse neonatal outcomes occurred in 28% of those pregnancies. Of those who experienced adverse neonatal outcomes, 21% had preterm-deliveries, 8% infants were small for their gestational age, 8% were born with respiratory distress syndrome, 1% had intraventricular hemorrhage, and there were 3% stillbirths and 1% neonatal deaths (40). Similarly, a study examining pregnancy outcomes of women with heart disease during 1986-1994 found that of the 276 pregnancies during this time period, 24 ended in miscarriages (41). Of the 252 completed pregnancies, cardiac complications occurred in 18%, and neonatal complications occurred in 17% of the pregnancies (41). Due to the increased risk of pregnancy related complications, it is imperative that women with CHD receive adequate medical care prior to and during pregnancy (42,43,44).

While previous studies have examined pregnancy outcomes among women with CHD, studies on this population have been limited. Furthermore, there is no existing study that has assessed the relationship between factors at the policy level as they relate to pregnancy outcomes among this population. The purpose of the current study was to determine whether prevalence of

pregnancy-related complications differed by history of Medicaid enrollment among pregnant women with CHD.

Hypothesis

It was hypothesized that women who were occasionally enrolled in Medicaid or who were only enrolled in Medicaid during pregnancy, would have a greater prevalence of pregnancy-related complications compared to women who were continuously enrolled in Medicaid.

CHAPTER II: METHODS

Study Design and Population

This retrospective cohort study is part of a larger collaborative pilot surveillance project between Emory University and the Centers for Disease Control and Prevention whose aim was to design and develop a population-based CHD surveillance system in the state of Georgia. The objectives of the parent pilot project included acquiring a better estimate of the prevalence of adolescents and adults living with CHD and a better understanding of their healthcare utilization and long-term health outcomes. This thesis contributes to the larger project by examining the relationship between Medicaid coverage and pregnancy-related complications among pregnant women with CHD.

The secondary data analyzed for this study were acquired through the Centers for Medicare and Medicaid Services (CMS) and extracted by Research Data Assistance Center (ResDAC), a consortium of subcontractors from University of Minnesota, Boston University, Dartmouth Medical School, and the Morehouse School of Medicine. ResDAC serves to assist academic, government as well as non-profit and for-profit entities acquire Medicaid and/or Medicare datasets for research and surveillance purposes. The Medicaid data obtained via ResDAC were Medicaid Analytic Extract (MAX) files are compiled annually and include information on enrollment, demographic, and claims for Medicaid beneficiaries. Information on Medicaid eligible individuals who are not enrolled and therefore do not have claims are not included in MAX files (45). Medicaid data from the Personal Summary, Inpatient and Other Services MAX files for years 1999 through 2013 were used to build the current analytic sample (Appendix A). The data were limited to female patients who were coded as having at least one CHD diagnosis in the years 1999-2007 with at least one pregnancy-related diagnosis in 2008-

2013. Pregnancy-related claims for Medicaid beneficiaries who were at least 12 years old and less than 50 years of age at the time of diagnosis resulted in a dataset comprised of 2,185 individuals.

Inclusion and Exclusion Criteria

Included in the final analytic sample were 1,799 pregnant female Medicaid beneficiaries between the ages of 12 and 50 years old who had a CHD diagnosis. These beneficiaries had at least one of 55 ICD-9-CM defining CHD-related diagnostic codes on a minimum of at least one Medicaid claim paid between January 1, 1999 and December 31, 2007. The 55 ICD-9-CM defining CHD-related diagnostic codes were used not only to identify CHD cases, but also to classify CHD patients into one of five levels of CHD severity based on a modified version of Marelli's hierarchical scheme (17) (Appendix B). Patients who had evidence of having died during the 15 years of Medicaid claims or who were younger than 12 years of age or older than 50 years old as of 01/01/2013 or whose gender was inconsistent across claims were excluded.

Data Management and IRB

The larger surveillance pilot study was approved by Emory University's Institutional Review Board (IRB) (#IRB0000064051). Data were securely stored on a FISMA-compliant (Federal Information Security Management Act) network computer housed within the Rollins School of Public Health at Emory University's Information Technology Department. Data were only accessible to IRB authorized study researchers. The final analytic dataset was previously cleaned, de-duplicated, and linked across years by unique Medicaid beneficiary number. All Protected Health Information (PHI) was removed and replaced by non-identifiable unique encrypted identifiers to protect patient confidentiality.

Outcome Variable

The outcome variable in this study is pregnancy-related complications. To account for variance in pregnancy-related complications, four categories of complications were identified: (1) cardiovascular complications, (2) complications at delivery, (3) complications in pregnancy, and (4) neonatal/fetal loss. The four categories of pregnancy-related complications used in the current study were constructed from the Clinical Classification Software (CCS) tool which was developed by the Agency for Healthcare Research and Quality (AHRQ) as part of the Healthcare Cost and Utilization Project (HCUP). The CCS tool crosswalks the over 15,000 ICD-9-CM codes into a much smaller number of comorbidity and complication groupings (46). For the current study, four pregnancy-related groupings developed from the larger CCS crosswalk used, and the ICD-9-CM codes which are included within the parent CCS groups are listed in Appendix C.

Cardiovascular complications were defined as having had any cardiovascular disorders and/or maternal heart complications

Complications at delivery were defined as having any complications of pregnancy at delivery and puerperium, and/or preterm labor

Complications in pregnancy were defined as having gestational diabetes and/or gestational hypertension.

Neonatal/Fetal loss were defined as having any complications leading to pregnancy lost and/or fetal death/stillborn.

These four groups of pregnancy-related complications were coded as dichotomous variables, with '1' indicating presence of the complication and '0' indicating absence of the complication. Cases were defined as women whose Medicaid history provided evidence of any of the specified

pregnancy-related complications. Controls were defined as women whose Medicaid history provided no evidence of any specified pregnancy-related complications.

Predictor Variable

The main predictor variable in this study is history of Medicaid enrollment. This variable was considered because lapse in healthcare coverage is a well-established risk factor for pregnancy-related complications for pregnant women with CHD (11,14,47). Women were categorized into three distinct groups based on Medicaid enrollment history —continuous enrollment, occasional enrollment and pregnancy eligible enrollment.

Continuous enrollment group: women who were continuously enrolled in Medicaid for at least one month each year from 1999 to 2007 or who were continuously enrolled in Medicaid before age 19 and enrolled for at least one year after age 19 (not due to pregnancy-related eligibility).

Occasional enrollment group: women who had sporadic records of enrollment in Medicaid prior to the index pregnancy.

Pregnancy eligible enrollment group: women who only had a record of a Medicaid claim during the years of their pregnancy. It is important to note that given the small sample of women who fell in this group, this group was excluded from the final analysis.

Directed Acyclic Graph (DAG)

A Directed Acyclic Graph (DAG) was created to assess the association between the predictor variable (history of Medicaid enrollment), and the four outcome variables (pregnancy-related complications) accounting for the effects of confounding including age at pregnancy, race, CHD severity, urban-rural residence, and maternal behavioral factors (Figure 1).

Covariates

Age at Pregnancy was calculated using the date which a pregnancy-related ICD-9-CM code first showed up in the Medicaid claims data and mother's date of birth; in cases with multiple dates of birth, the most recent observation was used. Age at pregnancy was then transformed into a dichotomous variable: 18.999 years old or younger was code as '1' and 19 years old or older was coded as '2', to account for the change in Medicaid eligibility criteria at that age.

Race was a categorical variable including White, Black, Asian, American Indian/Alaskan native, native Hawaiian/Pacific Islander. White was coded as '1', Black was coded as '2', American Indian/Alaskan native was coded as '3', Asian was coded as '4', and native Hawaiian/Pacific Islander was coded as '5'. However, given the small sample of individuals who identified as Asian, American Indian/Alaskan Native, Native Hawaiian/Pacific Islander, only those who identified as black or white were included in the final analysis.

Severity of CHD was initially coded into five categories based on a modified version of Marelli's CHD hierarchy: Severe = '1', Shunt = '2', Shunt and Valve = '3', Valve = '4', and Other = '5'. This variable was then recoded, collapsing the Marelli-based five hierarchical categories into three groups: '1'= Severe, '2' =mild/moderate, and '3' = those CHD patients with an isolated 745.5 ICD-9-CM code (a code that is often used for non-CHD diagnoses).

Urban-Rural Residence was computed using the Federal Information Processing Standard (FIPS) county codes to create a dichotomous variable with counties categorized as either urban coded as '1' or rural coded as '2'. FIPS county codes were based on the 2010 Census of Population and Housing (48).

Maternal Behavioral Risk Factors included three independent dichotomous variables constructed from the CCS crosswalk: Smoking during Pregnancy, Obesity during Pregnancy and Maternal Drug-use during Pregnancy (Appendix D). For each variable, '1' indicated presence of the behavioral risk factor and '0' indicated absence of the risk factor.

Statistical Analysis

IBM SPSS Statistics, version 23, was used for all analyses, and the alpha level of 0.05 was used to determine statistical significance. Simple descriptive analyses were performed to provide demographic characteristics of the sample. After excluding women who were classified in the pregnancy only group and those who did not identify their race as Black or White, the final analytic sample consisted of 1,799 pregnant women.

Bivariate analyses were conducted between the predictor variable (continuous Medicaid enrollment and occasional Medicaid enrollment), the four outcome variables (cardiovascular complications, complications at delivery, complications in pregnancy, and neonatal/fetal loss) and the following covariates - age at pregnancy, race, urban-rural residence and the three maternal behavioral risk factors. Variables significant in the bivariate analysis at a $p<0.05$ level were included in the multivariate logistic regression models. A step-wise model was used in order to adjust first for characteristic variables and additionally for behavioral variables. Initially, three multivariate logistic regression models were created. The first model examined whether the crude association between Medicaid enrollment history and maternal complications were confounded by race, severity of CHD or urban/rural residence. The second model examined whether the association between Medicaid enrollment history and maternal complications might be mediated by smoking, obesity and drug use during pregnancy. The final model examined whether the remaining variance might be explained by age at pregnancy. However, to assess if

age at pregnancy also served as an effect modifier of history of Medicaid enrollment (exposure), separate multivariable logistic regression models stratified by the different age groups were conducted. Two sets of models were developed and assessed. For each age group separately (18.999 years old or younger and 19 years old or older), the first model examined whether the crude association between Medicaid enrollment history and pregnancy-related complications were confounded by race, severity of CHD or urban/rural residence. Likewise, for each age group separately, the second model examined whether the association between Medicaid enrollment history and maternal complications might be mediated by smoking, obesity and drug use during pregnancy.

Descriptive Statistics

Of 1,799 women included in the sample, 557 (31%) were continuously enrolled in Medicaid from 1999-2007, while 1,242 (69.0%) were occasionally enrolled in Medicaid from 1999-2007. The majority of women were 19 years old or older at pregnancy (n=1,411; 78.4%), black (n=978; 54.4%), had a mild/moderate CHD (n=1,384; 76.9%), and resided in an urban Georgia county (n=1,323; 73.5%). During pregnancy, 140 (7.8%) of these women smoked, 38 (2.1%) indicated using drugs, and 125 (6.9%) were classified as obese. In respect to pregnancy-related complications, 206 (11.5%) had cardiovascular complications, 476 (26.5%) experienced neonatal/fetal loss, 1,426 (79.3%) had maternal complications and 419 (23.3%) experienced complications in pregnancy (Table 1).

Bivariate Level Analysis

Chi-square tests were conducted to examine the association between the predictor variable, covariates and outcomes. Only results were significantly associated with outcomes are discussed, and included in the logistic regression models. Independently, race (p=.038), CHD

severity (p=.011), and smoking during pregnancy (p=.028) were significantly associated with cardiovascular complications (Table 2b). Medicaid enrollment history (p=.001), smoking during pregnancy (p<.001), being obese during pregnancy (p=.006) and drug-use during pregnancy (p=.017) were significantly associated with complications at delivery (Table 2c). Age at pregnancy (p=.009) and being obese during pregnancy (p<.001) were significantly associated with complications in pregnancy (Table 2d). There were no significant associations between Medicaid enrollment history or covariates and neonatal/fetal loss (Table 2e).

Logistic Regression Models

Cardiovascular Complications

There was no association between cardiovascular complications in pregnancy and history of Medicaid enrollment among those who were 18.999 years or younger at pregnancy (aOR=.92; 95% CI .42, 2.01; p=.823) or among those who were 19 years or older at pregnancy (aOR=1.04; 95% CI .73, 1.47; p=.828) (Table 3a).

Complications at Delivery

Unlike cardiovascular complications in pregnancy, complications noted at delivery were associated with Medicaid enrollment history. Among women who were 19 years or older at pregnancy, crude results suggest that those who were occasionally enrolled in Medicaid were about 1.5 times as likely to have complications at delivery as those who were continuously enrolled in Medicaid (OR=1.56; 95% CI 1.19, 2.04; p=.001). In the first model, when adjusting for race, CHD severity and urban/rural residence, a similar trend was examined (aOR=1.55; 95% CI 1.18, 2.03; p=.001). Likewise, additional adjustment for smoking, drug use and being obese during pregnancy did not meaningfully alter the odds ratio (aOR=1.59; 95% CI 1.21, 2.09; p=.001). Conversely, there was no significant association between Medicaid enrollment history

and complications at delivery among those who were 18.999 years or younger at pregnancy (aOR=1.36; 95% CI .80, 2.30; p=.253) (Table 3b).

Complications in Pregnancy

There was no association between complications in pregnancy and history of Medicaid enrollment among those who were 18.999 years or younger at pregnancy (aOR=1.04; 95% CI .57, 1.89; p=.90) or among those who were 19 years or older at pregnancy (aOR=.90; 95% CI .69, 1.17; p=.44) (Table 3c).

Neonatal/Fetal Loss

There was no association between neonatal/fetal loss and history of Medicaid enrollment among those who were 18.999 years or younger at pregnancy (aOR=.65; 95% CI .40, 1.06; p=.08) or among those who were 19 years or older at pregnancy (aOR=.95; 95% CI .73, 1.122; p=.68) (Table 3d).

Discussion

The purpose of the current study was to determine whether prevalence of pregnancy-related complications differed by Medicaid enrollment history among pregnant women with CHD. While history of Medicaid enrollment was not a significant predictor of cardiovascular complications, complications during pregnancy or neonatal/fetal loss, it was a significant predictor of complications during delivery. Specifically, among women who were 19 years or older at pregnancy, those who were occasionally enrolled in Medicaid were more likely to have complications during delivery than those who were continuously enrolled. First, this finding indicate that continuous Medicaid enrollment may be protective against complications during delivery among those who are 19 years or older at pregnancy. Second, this finding suggest that age at pregnancy moderates the relationship between history of Medicaid and complications at

delivery. This is an important finding, given that most individuals with CHD typically begin to have lapses in care as they transition into adulthood around the age of 19 due to lack of or inconsistent medical coverage and thus are more likely to experience negative health outcomes (10,11,14).

Furthermore, previous studies have found that women who are uninsured or receive inconsistent medical coverage are less likely to receive prenatal care and have fewer prenatal care visits during pregnancy (32,33). Lack of adequate prenatal care has been associated with increased risk of premature delivery (32,34,35). While the current study did not assess prenatal care history, the above finding may be indicative of lack of continuous adequate prenatal care among women who were pregnant at 19 years or older and were only occasionally enrolled in Medicaid.

There are several plausible explanations as to why an association was not found between Medicaid enrollment history and cardiovascular complications, complications in pregnancy or neonatal/fetal loss among both age group. For instance, since CHD increases the risk of pregnancy-related co-morbidities and complications such as gestational diabetes or hypertension, enrollment in Medicaid may not always serve as a significant protective factor among this population (39,40,41). Furthermore, given the scope of this study, only Medicaid enrollment history was accounted for, and so, although individuals were classified as being occasionally enrolled in Medicaid, this does not mean that they were uninsured during the gaps of time when they were not covered by Medicaid. Rather, given that insurance coverage often changes over the course of one's lifetime, it is likely that some of these women may have received other forms of medical coverage either through an employer or through private insurance options during the periods in which they were not eligible or enrolled in Medicaid. Similarly, since there are no data

regarding the medical history of those who were occasionally enrolled during the time period they were not enrolled in Medicaid, it is unknown if they became pregnant during the gaps in Medicaid coverage. A woman who was occasionally enrolled and had her first pregnancy outside of her Medicaid enrollment period could have had complications that were not noted in her Medicaid history. It could also be the case that she received adequate counseling during lapses of Medicaid coverage and avoided pregnancy-related complications during prior pregnancies.

Limitations

This is the first study of its kind to examine the relationship between Medicaid coverage and pregnancy-related complications among pregnant women with CHD. In addition, it is the first to use historical Medicaid data (which allowed for large sample size) to assess this relationship. While the extensive availability of years of this Medicaid data was a major strength of this study, it also comes with limitations.

One major limitation was the size of the three Medicaid enrollment groups. Unfortunately, there was underrepresentation of women with CHD who were eligible for Medicaid coverage because they became pregnant (n=321). The absence of this group in final analyses may have impacted the findings; given that we would have expected to see differences between those who were continuously or occasionally enrolled compared to those who only became enrolled during pregnancy. Furthermore, although there was an adequate number of pregnant CHD women who were continuously enrolled in Medicaid, this group was approximately half in size (n=557) in comparison to the group of pregnant women with CHD who were occasionally enrolled (n=1,242). There are two plausible explanations for the underrepresentation of the pregnancy eligible Medicaid enrolled group and the continuously enrolled in Medicaid group. First, the current sample could in fact be an accurate representation

of the trend in the general population of women with CHD (i.e., there is only a small sample of individuals with CHD who are continuously enrolled in Medicaid and a small sample who only are enrolled during pregnancy). Second, there are no existing standards regarding Medicaid enrollment based on the time period one is enrolled in insurance. Thus, another plausible explanation is misclassification of groups reflecting different Medicaid enrollment histories.

Another major limitation of the study stems from accuracy of reporting in regards to study variables such as complications experienced by women during pregnancy. It is plausible that records of complications during delivery are more complete and accurate than records of complications during pregnancy. While complications occurring during delivery are a one-time event, the accurate reporting of complications during pregnancy (e.g., gestational diabetes and gestational hypertension) is dependent upon the frequency that a woman visited her physician, and whether prenatal claims include these details. For example, it is plausible that a woman who did not visit her physician frequently during pregnancy could have had gestational diabetes that was never diagnosed. Past studies have found that lack of medical coverage is a major cause of lapse in health care among CHD patients, and so, this could be especially true among those CHD pregnant women who were occasionally enrolled in Medicaid who may have had a history of sporadic physician visits due to lack of coverage (11,14).

Furthermore, due to the nature of Medicaid claims data, coding and billing of claims are often subject to error. There are many errors that can occur doing the billing process such as incorrect codes, mismatched medical codes, undercoding, upcoding, leaving codes out altogether or poor documentation (49). For example, studies have found that Medicaid claims often underestimate outpatient services and are inconsistent with medical records data (50,51). In regards to outpatient services, because only one diagnosis can be noted on the claims form for

reimbursement, this is often problematic for patients presenting with multiple chronic conditions and maybe experiencing multiple complications (52).

Conclusion

It estimated that about 10% to 22% of adults with CHD are uninsured, while studies have found 67% of adults with CHD have reported difficulty in securing health insurance or needing to change jobs in order to ensure medical coverage (47). Among this population, lack of or inconsistent medical coverage has been associated with lapse in care. Thus, applying the Social Ecological Model framework to understand how factors at the policy level, especially access to health care coverage, impacts health outcomes of those living with CHD is an important approach to the study of the relationship between Medicaid enrollment history and subsequent pregnancy-related complications among women with CHD. The findings of the current study, indicate that more research is needed to further examine this relationship, especially with the inclusion of women with CHD who only become eligible for Medicaid because of their pregnancy. Subsequently, to assess this relationship, there is a need for additional data sources that provide more accurate reporting of Medicaid medical histories for CHD patients. Furthermore, such data need to provide more detailed information regarding the specific complications experienced, in order to better understand which complications may be associated with Medicaid enrollment status.

The majority of pregnant women with CHD in this study were occasionally enrolled in Medicaid, and findings indicated that in regards to complications at delivery, continuous enrollment was protective among women who were pregnant at age 19 or older. Moreover, in Georgia, only about 15% of women are covered by Medicaid before pregnancy compared to about 60% who receive Medicaid due to a pregnancy. Thus, the re-evaluation of Medicaid

eligibly in Georgia and subsequently the re-assessment of SSI disability eligibility for adults may be warranted (30). Gaps and discrepancies in health care coverage, especially among adults, may provide support for the expansion of Medicaid in Georgia so that more women of reproductive age would be eligible to receive preventive and specialized medical services prior to pregnancy to ensure quality care before and through delivery. This is especially critical for those with pre-existing conditions such as CHD that may increase the risk of pregnancy-related complications.

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TABLES

Table 1. Demographic Characteristics of Pregnant Women with CHD, 1999-2013

N = 1,799	
	N (%)
History of Medicaid Enrollment	
Continuous	557 (31.0%)
Occasional	1242 (69.0%)
Age at Pregnancy	
$\leq$ 18.999	388 (21.6%)
$\geq$ 19	1411 (78.4%)
Race	
Black	978 (54.4%)
White	821 (45.6%)
CHD Severity	
Severe	254 (14.1%)
Mild/Moderate	1384 (76.9%)
ISO74555	161 (8.9%)
Geography	
Urban	1323 (73.5%)
Rural	476 (26.5%)
Maternal Behavioral Risk Factors noted in Diagnostic Codes	
Smoking	140 (7.8%)
Obese	125 (6.9%)
Drug use	38 (2.1%)
Complications Noted in Diagnostic Codes	
Cardiovascular Complications	206 (11.5%)
Complications at Delivery	1426 (79.3%)
Complications in Pregnancy	419 (23.3%)
Neonatal/Fetal Loss	476 (26.5%)

Table 2a. Association of Selected Variables with Medicaid Enrollment History

	Continuous	Occasional	
	N (%)	N (%)	X^2, P-Values
Age at Pregnancy			X^2=1.28,p=.258
≤ 18.999	111 (28.6%)	277 (71.4%)	
≥ 19	446 (31.6%)	965 (68.4%)	
Race			X^2=7.75,p=.005**
Black	330 (33.7%)	648 (66.3%)	
White	227 (27.6%)	594 (72.4%)	
CHD Severity			X^2=3.79,p=.151
Severe	89 (35.0%)	165 (65.0%)	
Mild/Moderate	426 (30.8%)	958 (69.2%)	
ISO74555	42 (26.1%)	119 (73.9%)	
Urban/Rural Residence			X^2=.994,p=.319
Urban	401 (30.3%)	922 (69.7%)	
Rural	156 (32.8%)	320 (67.2%)	
Smoking			X^2=.484,p=.487
No or unknown	510 (30.7%)	1149 (69.3%)	
Yes	47 (33.6%)	93 (66.4%)	
Obese			X^2=.294,p=.588
No or unknown	521 (31.1%)	1153 (68.9%)	
Yes	36 (28.8%)	89 (71.2%)	
Drug-Use			X^2=1.32,p=.251
No or unknown	542 (30.8%)	1219 (69.2%)	
Yes	15 (39.5%)	23 (60.5%)	

*p-value <0.05; **p-value<0.01; ***p-value <0.001

Table 2b. Association of selected variables with Cardiovascular Complications

	Absent	Present	
	N (%)	**N (%)**	**X^2, P-Values**
History of Medicaid Enrollment			X^2=.001,p=.972
Continuous	493 (88.5%)	64 (11.5%)	
Occasional	1100 (88.6%)	142 (11.4%)	
Age at Pregnancy			X^2=3.52,p=.060
18.999>	354 (91.2%)	34 (8.8%)	
19 <	1239 (87.8%)	172 (12.2%)	
Race			X^2=4.32,p=.038*
Black	880 (90.0%)	98 (10.0%)	
White	713 (86.8%)	108 (13.2%)	
CHD Severity			X^2=9.04,p=.011*
Severe	213 (83.9%)	41 (16.1%)	
Mild/Moderate	1230 (88.9%)	154 (11.1%)	
ISO74555	150 (93.2%)	11 (6.8%)	
Urban/Rural Residence			X^2=.854,p=.355
Urban	1166 (88.1%)	157 (11.9%)	
Rural	427 (89.7%)	49 (10.3%)	
Smoking			X^2=4.85,p=.028*
No or unknown	1477 (89.0%)	182 (11.0%)	
Yes	116 (82.9%)	24 (17.1%)	
Obese			X^2=1.86,p=.172
No or unknown	1487 (88.8%)	187 (11.2%)	
Yes	106 (84.8%)	19 (15.2%)	
Drug-Use			X^2=.112,p=.738
No or unknown	1560 (88.6%)	201 (11.4%)	
Yes	33 (86.8%)	5 (13.2%)	

*p-value <0.05; **p-value<0.01; ***p-value <0.001

Table 2c. Association of Selected Variables with Complications at Delivery

	Absent	Present	
	N (%)	**N (%)**	**X^2, P-Values**
Medicaid Enrollment History			X^2=11.98,p=.001***
Continuous	143 (25.7%)	414 (74.3%)	
Occasional	230 (18.5%)	1012 (81.5%)	
Age at pregnancy			X^2=.414,p=.520
≤ 18.999	85 (21.9%)	303 (78.1%)	
≥ 19	288 (20.4%)	1123 (79.6%)	
Race			X^2=.922,p=.337
Black	211 (21.6%)	767 (78.4%)	
White	162 (19.7%)	659 (80.3%)	
CHD Severity			X^2=3.75,p=.153
Severe	62 (24.4%)	192 (75.6%)	
Mild/Moderate	273 (19.7%)	111 (80.3%)	
ISO74555	38 (23.6%)	123 (76.4%)	
Urban/Rural Residence			X^2=.093,p=.761
Urban	272 (20.6%)	1051 (79.4%)	
Rural	101 (21.2%)	375 (78.8%)	
Smoking			X^2=15.32,p<001***
No or unknown	362 (21.8%)	1297 (78.2%)	
Yes	11 (7.9%)	129 (92.1%)	
Obese			X^2=7.43,p=.006**
No or unknown	359 (21.4%)	1315 (78.6%)	
Yes	14 (11.2%)	111 (88.8%)	
Drug-Use			X^2=5.65,p=.017*
No or unknown	371 (21.1%)	1390 (78.9%)	
Yes	2 (5.3%)	36 (94.7%)	

*p-value <0.05; **p-value<0.01; ***p-value <0.001

Table 2d. Association of Selected Variables with Complications in Pregnancy

	Absent	**Present**	
	N (%)	**N (%)**	**X^2, P-Values**
Medicaid Enrollment History			X^2=.40,p=.525
Continuous	422 (75.8%)	135 (24.2%)	
Occasional	958 (77.1%)	284 (22.9%)	
Age at pregnancy			X^2=6.90,p=.009**
≤ 18.999	317 (81.7%)	71 (18.3%)	
≥ 19	1063 (75.3%)	348 (24.7%)	
Race			X^2=.06,p=.804
Black	748 (76.5%)	230 (23.5%)	
White	632 (77.0%)	189 (23.0%)	
CHD Severity			X^2=.03,p=.984
Severe	194 (76.4%)	60 (23.6%)	
Mild/Moderate	1063 (76.8%)	321 (23.2%)	
ISO74555	123 (76.4%)	38 (23.6%)	
Urban/Rural Residence			X^2=.131,p=.717
Urban	1012 (76.5%)	311 (23.5%)	
Rural	368 (77.3%)	108 (22.7%)	
Smoking			X^2=.01,p=.935
No or unknown	1273 (76.7%)	386 (23.3%)	
Yes	107 (76.4%)	33 (23.6%)	
Obese			X^2=55.26,p<.001***
No or unknown	1318 (78.7%)	356 (21.3%)	
Yes	62 (49.6%)	63 (50.4%)	
Drug-Use			X^2=.003,p=.954
No or unknown	1351 (76.7%)	410 (23.3%)	
Yes	29 (76.3%)	9 (23.7%)	

*p-value <0.05; **p-value<0.01; ***p-value <0.001

Table 2e. Association of Selected Variables with Neonatal/Fetal Loss

	Absent	Present	
	N (%)	**N (%)**	**X2, P-Values**
Medicaid Enrollment History			X^2=1.24,p=.266
Continuous	400 (71.8%)	157 (28.2%)	
Occasional	923 (74.3%)	329 (25.7%)	
Age at pregnancy			X^2=.002,p=.965
$\leq$ 18.999	285 (73.5%)	103 (26.5%)	
$\geq$ 19	1038 (73.6%)	373 (26.5%)	
Race			X^2=.780,p=.377
Black	711 (72.7%)	267 (27.3%)	
White	612 (74.5%)	209 (25.5%)	
CHD Severity			X^2=.554,p=.758
Severe	191 (75.2%)	63 (24.8%)	
Mild/Moderate	1016 (73.4%)	368 (26.6%)	
ISO74555	116 (72.0%)	45 (28.0%)	
Urban/Rural Residence			X^2=.952,p=.329
Urban	981 (74.1%)	342 (25.9%)	
Rural	342 (71.8%)	134 (28.2%)	
Smoking			X^2=2.58,p=.109
No or unknown	1212 (73.1%)	447 (26.9%)	
Yes	111 (79.3%)	29 (20.7%)	
Obese			X^2=.681,p=.409
No or unknown	1235 (73.8%)	439 (26.2%)	
Yes	88 (70.4%)	37 (29.6%)	
Drug-Use			X^2=.583,p=.445
No or unknown	1293 (73.4%)	468 (26.6%)	
Yes	30 (78.9%)	8 (21.1%)	

*p-value <0.05; **p-value<0.01; ***p-value <0.001

Table 3a. Crude and Adjusted Odds Ratios of the Relationship between History of Medicaid Enrollment and Cardiovascular Complications

	Cardiovascular Complications						
		<18.999 yrs. old			>19 yrs. old		
	Crude[+]	Crude[+]	Model 1	Model 2	Crude[+]	Model 1	Model 2
	OR (95% CI)						
History of Medicaid Enrollment							
Continuous	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Occasional	.99 (.73-1.36)	.82 (.39-1.75)	.92 (.42-2.01)	.91 (.42-2.01)	1.04 (.74-1.47)	1.04 (.73-1.47)	1.04 (.73-1.47)
Race							
White	---	---	1.0	1.0	---	1.0	1.0
Black	---	---	.48 (.22-1.01)	.50 (.23-1.08)	---	.75 (.54-1.03)	.77 (.55-1.08)
CHD Severity							
Severe	---	---	1.0	1.0	---	1.0	1.0
Mild/Moderate	---	---	.26 (.11-.64)***	.25 (.10-.63)***	---	.79 (.52-1.21)	.80 (.53-1.22)
ISO74555	---	---	.24 (.06-.99)*	.22 (.05-.94)*	---	.40 (.18-.91)	.41 (.18-.93)*
Urban/Rural Residence							
Urban	---	---	1.0	1.0	---	1.0	1.0
Rural	---	---	1.14 (.53-2.47)	1.19 (.55-2.61)	---	.74 (.50-1.09)	.75 (.51-1.11)
Smoking							
No	---	---	---	1.0	---	---	1.0
Yes	---	---	---	2.10 (.59 – 7.56)	---	---	1.44 (.85-2.44)
Obese							
No	---	---	---	1.0	---	---	1.0
Yes	---	---	---	1.65 (.35-7.82)	---	---	1.41 (.85-2.44)
Drug-Use							
No	---	---	---	1.0	---	---	1.0
Yes	---	---	---	.57 (.05-7.11)	---	---	.99 (.34-2.91)

*p-value <0.05; **p-value<0.01; ***p-value <0.001

[+]Crude: history of Medicaid enrollment and cardiovascular complications

^Model 1 is adjusted for race, severity and geography

^^Model 2 is additional adjusted for smoking, obesity and drug-use

Table 3b. Crude and Adjusted Odds Ratios of the Relationship between History of Medicaid Enrollment and Complications at Delivery

	Complications at Delivery						
		<18.999 yrs. old			>19 yrs. old		
	Crude[+]	Crude[+]	Model 1	Model 2	Crude[+]	Model 1	Model 2
	OR (95% CI)						
History of Medicaid Enrollment							
Continuous	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Occasional	.419 (1.52-1.93)	1.396 (.83-2.34)	1.34 (.797-2.25)	1.36 (.80-2.30)	1.56 (1.19-2.04)***	1.55 (1.18-2.03)***	1.59 (1.21-2.09)***
Race							
White	---	---	1.0	1.0	---	1.0	1.0
Black	---	---	.89 (.55-1.46)	.95 (.58-1.57)	---	.91 (.70-1.19)	1.01 (.77-1.33)
CHD Severity							
Severe	---	---	1.0	1.0	---	1.0	1.0
Mild/Moderate	---	---	1.34 (.62-2.80)	1.33 (.62-2.84)	---	1.28 (.90-1.82)	1.34 (.94-1.91)
ISO74555	---	---	.76 (.29-1.99)	.75 (.29-1.97)	---	.91 (.70-1.19)	1.19 (.69-2.66)
Urban/Rural Residence							
Urban	---	---	1.0	1.0	---	1.0	1.0
Rural	---	---	.76 (.45-1.28)	.80 (.47-1.35)	---	1.03 (.76-1.40)	1.06 (.78-1.44)
Smoking							
No	---	---	---	1.0	---	---	1.0
Yes	---	---	---	3.09 (.67-14.23)	---	---	3.48 (1.72-7.04)***
Obese							
No	---	---	---	1.0	---	---	1.0
Yes	---	---	---	4.61 (.60-35.45)	---	---	1.93 (1.05-3.51) *
Drug-Use							
No	---	---	---	1.0	---	---	1.0
Yes	---	---	---	1.56 (.17-13.94)	---	---	7.50 (1.01-55.67)*

*p-value <0.05; **p-value<0.01; ***p-value <0.001
[+]Crude: history of Medicaid enrollment and complications at delivery
^Model 1 is adjusted for race, severity and geography
^^Model 2 is additional adjusted for smoking, obesity and drug-use

Table 3c. Crude and Adjusted Odds Ratios of the Relationship between History of Medicaid Enrollment and Complications in Pregnancy

	Complications in Pregnancy						
		<18.999 yrs. old			>19 yrs. old		
	Crude+	Crude+	Model 1	Model 2	Crude+	Model 1	Model 2
	OR (95% CI)						
History of Medicaid Enrollment							
Continuous	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Occasional	.93 (.73-1.17)	1.03 (.58-1.81)	1.02 (.57-1.82)	1.04 (.57-1.89)	.92 (.71-1.19)	.92 (.71-1.20)	.90 (.69-1.17)
Race							
White	---	---	1.0	1.0	---	1.0	1.0
Black	---	---	.63 (.37-1.07)	.64 (.37-1.10)	---	1.23 (.88-1.45)	1.06 (.81-1.37)
CHD Severity							
Severe	---	---	1.0	1.0	---	1.0	1.0
Mild/Moderate	---	---	1.32 (.52-3.34)	1.29 (.50-3.31)	---	.96 (.68-1.35)	.94 (.67-1.33)
ISO74555	---	---	1.51 (.48-4.76)	1.51 (.47-4.87)	---	.96 (.57-1.62)	1.02 (.60-1.73)
Urban/Rural Residence							
Urban	---	---	1.0	1.0	---	1.0	1.0
Rural	---	---	1.35 (.77-2.34)	1.52 (.86-2.69)	---	.89 (.67-1.19)	.93 (.70-1.24)
Smoking							
No	---	---	---	1.0	---	---	1.0
Yes	---	---	---	1.75 (.63-4.86)	---	---	.91 (.57-1.45)
Obese							
No	---	---	---	1.0	---	---	1.0
Yes	---	---	---	5.90 (2.19-15.89)***	---	---	3.48 (2.32-5.21)***
Drug-Use							
No	---	---	---	1.0	---	---	1.0
Yes	---	---	---	1.31 (.23-7.48)	---	---	.85 (.35-2.05)

*p-value <0.05; **p-value<0.01; ***p-value <0.001
+Crude: history of Medicaid enrollment and complications in pregnancy
^Model 1 is adjusted for race, severity and geography
^^Model 2 is additional adjusted for smoking, obesity and drug-use

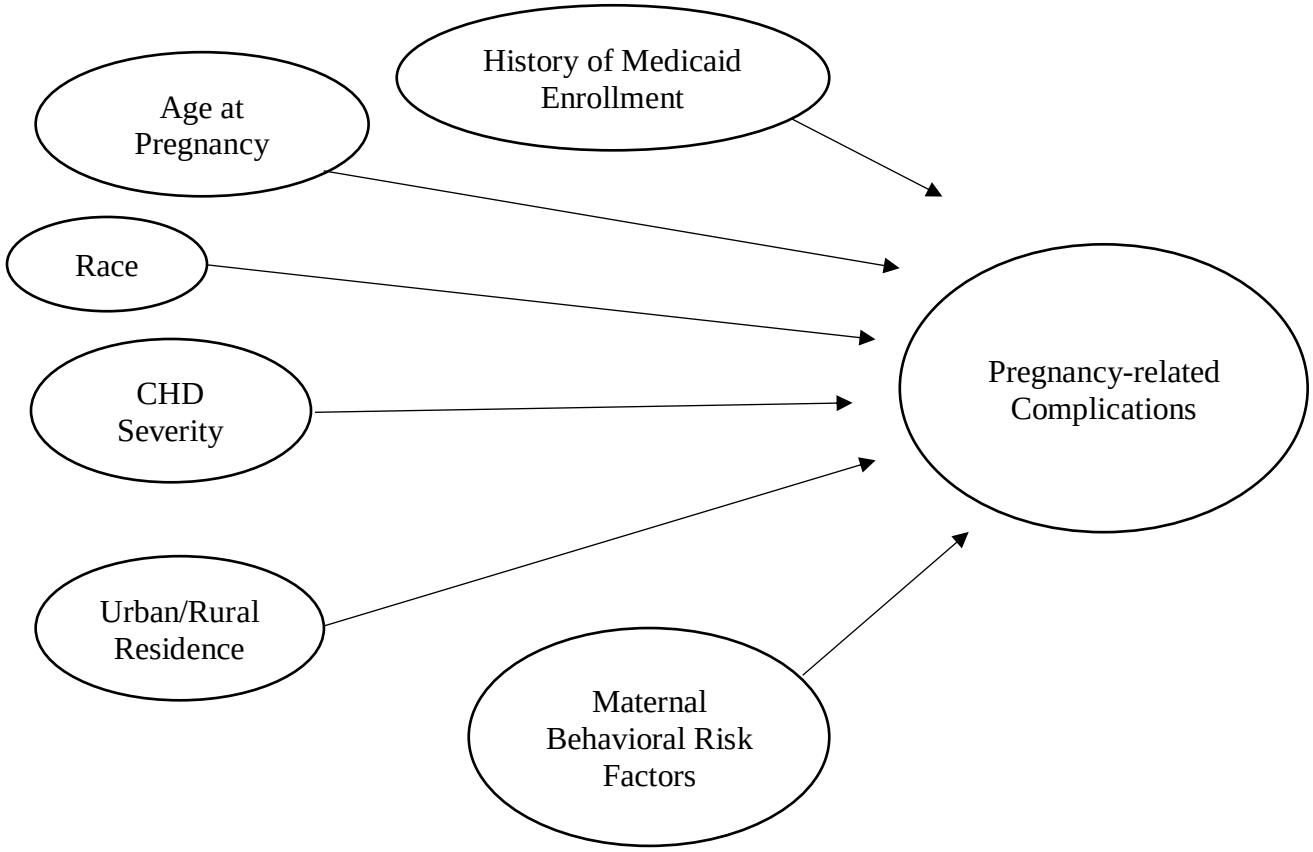
Table 3d. Crude and Adjusted Odds Ratios and 95% Confidence Intervals for the Relationship between History of Medicaid Enrollment and Neonatal/Fetal Loss

	Neonatal/Fetal Loss						
		<18.999 yrs. old			>19 yrs. old		
	Crude[+]	Crude[+]	Model 1	Model 2	Crude[+]	Model 1	Model 2
	OR (95% CI)						
History of Medicaid Enrollment							
Continuous	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Occasional	.88 (.70-1.10)	.67 (.41-1.08)	.66 (.41-1.08)	.65 (.40-1.06)	.95 (.74-1.22)	.96 (.74-1.24)	.95 (.73-1.22)
Race							
White	---	---	1.0	1.0	---	1.0	1.0
Black	---	---	1.04 (.66-1.64)	1.01 (.64-1.62)	---	1.34 (.90-1.45)	1.09 (.85-1.40)
CHD Severity							
Severe	---	---	1.0	1.0	---	1.0	1.0
Mild/Moderate	---	---	1.08 (.51-2.27)	1.05 (.50-2.20)	---	1.11 (.79-1.56)	1.09 (.78-1.54)
ISO74555	---	---	1.03 (.39-2.74)	1.01 (.38-2.69)	---	1.24 (.74-2.05)	1.24 (.75-2.06)
Urban/Rural Residence							
Urban	---	---	1.0	1.0	---	1.0	1.0
Rural	---	---	.99 (.60-1.64)	.98 (.59-1.63)	---	1.18 (.90-1.55)	1.19 (.91-1.56)
Smoking							
No	---	---	---	1.0	---	---	1.0
Yes	---	---	---	.86 (.30-2.50)	---	---	.72 (.45-1.16)
Obese							
No	---	---	---	1.0	---	---	1.0
Yes	---	---	---	1.05 (.36-3.04)	---	---	1.21 (.79-1.88)
Drug-Use							
No	---	---	---	1.0	---	---	1.0
Yes	---	---	---	.39 (.04-3.32)	---	---	.86 (.36-2.03)

*p-value <0.05; **p-value<0.01; ***p-value <0.001
[+]Crude: history of Medicaid enrollment and Neonatal/Fetal loss
^Model 1 is adjusted for race, severity and geography
^^Model 2 is additional adjusted for smoking, obesity and drug-use

FIGURES

Figure 1. DAG



APPENDICES

Appendix A. Source of Information on Medicaid Variables

Medicaid Data	Element Name	Variable
Personal Summary Record (PS)	Max Uniform Eligibility Codes, BOE (Basis of Enrollment), Eligible Restricted Benefits Flag, Eligible Race/Ethnicity Code, Eligible Birthdate and Eligible Sex Code	History of Medicaid Enrollment, Race, Age at Pregnancy, Sex
Inpatient Record (IP)	Diagnosis Code, Eligible Race/Ethnicity Code, Eligible Birthdate and Eligible Sex Code	Pregnancy-related complications, CHD Severity, Age at Pregnancy, Sex, Race, Maternal Behavioral Risk Factors
Other Services Record (OT)	Eligible Race/Ethnicity Code, Eligible Birthdate, Eligible Sex Code and Diagnosis Code,	Race, Age at Pregnancy, Sex and Pregnancy-related complications, CHD Severity

Appendix B. Congenital Heart Defect ICD-9-CM Codes and Marelli's* Congenital Heart Defect Severity Ratings

Severity	Severity Code	ICD-9-CM	ICD-9-CM Description
Severe	1	745.0	Common Truncus
Severe	1	745.1	Transposition of the Great Arteries (TGA)
Severe	1	745.10	Complete TGA (dextro-TGA), NOS or classical
Severe	1	745.11	DORV, or incomplete TGA
Severe	1	745.12	Corrected TGA (levo-TGA)
Severe	1	745.19	TGA OS
Severe	1	745.2	Tetralogy of Fallot
Severe	1	745.3	Single Ventricle, or cor triloculare
Severe	1	745.6	Endocardial Cushion Defect (aka AVSD)
Severe	1	745.60	Endocardial Cushion Defect (aka AVSD) unspecified
Severe	1	745.61	ASD-1 (primum)
Severe	1	745.69	Endocardial Cushion Defect (aka AVSD) Other
Severe	1	746.01	Pulmonary valve atresia or absence
Severe	1	746.1	Tricuspid atresia, stenosis or absence
Severe	1	746.7	HLHS
Severe	1	747.11	Interrupted aortic arch
Severe	1	747.41	Total anomalous pulmonary venous return (TAPVR)
Shunts	2	745.4	VSD
Shunts	2	745.5	ASD2 or PFO
Shunts	2	745.8	Other specified defect of septal closure
Shunts	2	745.9	Unspecified defect of septal closure
Shunts	2	747.0	PDA
Shunts	2	747.1	Coarctation of aorta
Shunts+Valve	3		(depends on ICD codes of the combination)
Valve	4	746.0	Anomalies of pulmonary valve
Valve	4	746.00	Pulmonary valve anomaly, unspecified
Valve	4	746.02	Pulmonary valve stenosis
Valve	4	746.09	Pulmonary valve anomaly, other
Valve	4	746.2	Ebstein Anomaly
Valve	4	746.3	Aortic valve stenosis
Valve	4	746.4	Aortic insufficiency or bicuspid/unicuspid aortic
Valve	4	746.5	Mitral stenosis or mitral valve abnormalities
Valve	4	746.6	Mitral insufficiency
Valve	4	747.3	Anomalies of Pulmonary artery
Valve	4	747.31	Pulmonary artery atresia, coarctation, or hypoplasia
Valve	4	747.39	Anomalies of Pulmonary artery, other
Other	5	745.7	Cor biloculare
Other	5	746.8	Other Specified anomalies of heart

Other	5	746.81	Subaortic stenosis
Other	5	746.82	cor triatrium
Other	5	746.83	Infundibular or subvalvar pulmonary stenosis
Other	5	746.84	Obstructive anomalies of heart
Other	5	746.85	Coronary artery anomaly
Other	5	746.87	Malposition of heart or apex
Other	5	746.89	Other specified anomaly of heart (various types)
Other	5	746.9	Unspecified defect of heart
Other	5	747.2	Other anomaly of the aorta
Other	5	747.20	Anomalies of aorta, unspecified
Other	5	747.21	Anomaly of aortic arch
Other	5	747.22	Atresia or stenosis of aorta
Other	5	747.29	Other anomaly of aorta
Other	5	747.4	Anomalies of great veins
Other	5	747.40	Anomalies of great veins, unspecified
Other	5	747.42	Partial anomalous venous return (PAPVR)
Other	5	747.49	Other anomalies of great veins
Other	5	747.9	Unspecified anomalies of circulatory system

Note. Gray *= Only kept as separate defect if isolated CHD.*

* Marelli AJ, Mackie AS, Ionescu-Ittu R, et al. Congenital heart disease in the general population: changing prevalence and age distribution. *Circulation* 2007; 115(2):163-72.

Appendix C. Clinical Classifications Software (CCS) for ICD-9-CM Codes Used to Group the Four Pregnancy-related Complication Outcomes

Cardiovascular Complications

CCS Group Description	CCS	ICD-9-CM Codes
Cardiovascular Disorders	181	648.50,648.51,648.52,648.53,648.54,648.60,648.61,648.62, 648.63, 648.64
Maternal Heart Complications	195	668.10,668.11,668.12,668.13,668.14

Complications at delivery

CCS Group Description	CCS	ICD-9-CM Codes
Preterm Labor	184	644.20,644.21
	219	764.00,764.01,764.02,764.03,764.04,764.05,764.06,764.07, 764.08,765.0,765.00,765.01,765.02,765.03,765.04,765.05, 765.06,765.07,765.08,765.09,765.1,765.10,765.11,765.12, 765.13,765.14,765.15,765.16,765.17,765.18,765.19,765.21, 765.22,765.23,765.24,765.25,765.26,765.27,765.28,V21.31, V21.32,V21.33, V21.34,V2.135
	222	774.2
Complications of Pregnancy, Delivery and Puerperium	181	646.80,646.81,646.82,646.83,646.84,646.90,646.91,646.93, 648.70,648.71,648.72,648.73,648.74,648.90,648.91,648.92, 648.93,648.94,649.50,649.51,649.53,649.60,649.61,649.62, 649.63,649.64,V23.87
	191	792.3
	193	664.00,664.01,664.04,664.10,664.11,664.14,664.20,664.21, 664.24,664.30,664.31,664.34,664.40,664,41,664.44,664.50, 664.51,664.54,664.60,664.61,664.64,664.80,664.81,664.84, 664.90,664.91,664.94
	195	649.70,649.71,649.73,651.83,654.00,654.01,654.02,654.03, 654.04,654.10,654.11,654.12,654.13,654.14,654.30,654.31, 654.32,654.33,654.34,654.40,654.41,654.42,654.43,654.44, 654.70,654.71,654.72,654.73,654.74,654.80,654.81,654.82, 654.83,654.84,654.90,654.91,654.92,654.93,654.94,655.20, 655.21,655.23,659.00,659.01,659.03,659.10,659.11,659.13, 665.30,665.31,665.34,665.40,665.41,665.44,665.50,665.51, 665.54,665.60,665.61,665.64,665.70,665.71,665.72,665.74, 665.80,665.81,665.82,665.83,665.84,665.90,665.91,665.92, 665.93,665.94,667.00,667.02,667.04,667.10,667.12,667.14, 671.00,671.01,671.02,671.03,671.04,671.10,671.11,671.12, 671.13,671.14,674.80,674.82,674.84,675.00,675.01,675.02, 675.03,675.04,675.10,675.11,675.12,675.13,675.14,675.20, 675.21,675.22,675.23,675.24,675.80,675.81,675.82,675.83, 675.84,675.90,675.91,675.92,675.93,675.94,676.00,676.01, 676.02,676.03,676.04,676.10,676.11,676.12,676.13,676.14, 676.20,676.21,676.22,676.23,676.24,676.30,676.31,676.32, 676.33,676.34,676.40,676.41,676.42,676.43,676.44,676.50, 676.51,676.52,676.53,676.54,676.60,676.61,676.62,676.63, 676.64,676.80,676.81,676.82,676.83,676.84,676.90,676.91,

		676.92,676.93,676.94,677,679.00,679.01,679.02,679.03, 679.04
	224	404.1,760.3,760.4,760.5,760.6,760.8,760.9,761.0,761.1, 761.2, 761.3

Complications in Pregnancy

CCS Group Description	CCS	ICD-9-CM Codes
Gestational Diabetes	286	648.00,648.01,648.02,648.03,648.04,648.80,648.81,648.82, 648.83,648.84
Gestational Hypertension	183	642.00,642.01,642.02,642.03,642.04,642.10,642.11,642.12, 642.13,642.14,642.20,642.21,642.22,642.23,642.24,642.30, 642.31,642.32,642.33,642.34,642.90,642.91,642.92,642.93, 642.94
	224	760.0

Neonatal/Fetal Loss

CCS Group Description	CCS	ICD-9-CM Codes
Pregnancy Loss	177	634.00,634.01,634.02,634.10,634.11,634.12,634.20,634.21, 634.22,634.30,634.31,634.32,634.40,634.41,634.42,634.50, 634.51,634.52,634.60,634.61,634.62,634.70,634.71,634.72, 634.80,634.81,634.82,634.90,634.91,634.92
	178	635.00,635.01,635.02,635.10,635.11,635.12,635.20,635.21, 635.22,635.30,635.31,635.32,635.40,635.41,635.42,635.50, 635.51,635.52,635.60,635.61,635.62,635.70,635.71,635.72, 635.80,635.81,635.82,635.90,635.91,635.92,636.00,636.01, 636.02,636.10,636.11,636.12,636.20,636.21,636.22,636.30, 636.31,636.32,636.40,636.41,636.42,636.50,636.51,636.52, 636.60,636.61,636.62,636.70,636.71,636.72,636.80,636.81, 636.82,636.90,636.91,636.92,637.00,637.01,637.02,637.10, 637.11,637.12,637.20,637.21,637.22,637.30,637.31,637.32, 637.40,637.41,637.42,637.50,637.51,637.52,637.60,637.61, 637.62,637.70,637.71,637.72,637.80,637.81,637.82,637.90, 637.91,637.92,638.0,638.1,638.2,638.3,638.4,638.5,638.6, 638.7,638.8,638.9
	179	639.0,639.1,639.2,639.3,639.4,639.5,639.6,639.8,639.9
	180	633.0,633.00,633.01,633.1,633.10,633.11,633.2,633.20, 633.21, 633.8, 633.80,633.81,633.9,633.90,633.91
	181	630,631,631.0,631.8,632,646.00,646.01,646.03
	195	651.30,651.31,651.33,651.40,651.41,651.43,651.50,651.51, 651.53, 651.60,651.61,651.63
	196	651.70,651.71,651.73
	224	761.4,779.6
Fetal Death/Stillborn	181	V271,V273,V274,V276,V277
	195	656.40,656.41,656.43
	220	768.0, 768.1

Appendix D. Clinical Classifications Software (CCS) for ICD-9-CM Codes Used to Group Maternal Behavioral Risk Factors

CCS Group Description	CCS	ICD-9-CM Codes
Smoking during Pregnancy	181	649.00,649.01,649.02,649.03,649.04
Obesity during Pregnancy	181	649.10,649.11,649.12,649.13,649.14,649.20,649.21,649.22, 649.23,649.24
Drug Use during Pregnancy	661	648.30,648.31,648.32,648.33,648.34,655.50,655.51,655.53, 760.72,760.73,760.75