

Access to Care, Outcomes, and Birthing Unit Closures: Results from a Mixed Methods Study in Iowa



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# **EXECUTIVE SUMMARY**

lowa has experienced the closure of 41 birthing units since 2000. During the 2019 lowa Obstetrician Summit, there was great concern surrounding the impact these closures may be having on maternal and infant health outcomes. The purpose of this evaluation was to examine what is happening in affected areas, and identify opportunities for lowa home visiting and family support programs to help. The current evaluation is Phase I of an ongoing evaluation effort. Phase I investigated the effects of birthing facility closures in Iowa through 2018, and found that hospital closures were related to some birth outcomes and maternal care outcomes. It also identified bright spots of opportunity where service systems appear to be making connections for women in affected areas. Using both quantitative analysis of administrative data and qualitative interviews with home visiting stakeholders. this study demonstrated the value of multiple data approaches to uncover relevant patterns and explore the lived experiences of families in areas affected by birthing unit closures. Specifically, findings highlight important subgroups of individuals that may be affected differently by the closures, with some bright spots of resilience that could be further explored or expanded to support families. We also identify opportunities where Iowa's home visiting network can work in conjunction with other maternal health and early childhood partners across the state to ensure women get connected with the prenatal care they need and have access to birthing supports. This Phase I report concludes with recommendations for the ongoing evaluation for Phase II, which will include updated records including the most recent closures and more detailed analysis based on findings from the current Phase I report.

In counties where the only birthing unit closed, findings indicated:

- Higher county-level rates of inadequate prenatal care (no visit in the first trimester or fewer than 4 total visits);
- Higher county-level rates of severe inadequate prenatal care (no visit in the first trimester AND fewer than 4 total visits); and
- o Later county-level average initiation of prenatal care.

For individual women giving birth, some were found to more easily navigate prenatal care than others: Positive findings in counties where birthing units closed:

- The year leading up to unit closures, mothers who were first-time pregnant, teenagers, single, and WIC/Medicaid recipients attended more prenatal care visits than similar mothers who gave birth at other times.
- The year before unit closures, mothers receiving WIC or Medicaid started prenatal care earlier and were less likely to receive inadequate prenatal care compared to similar mothers who gave birth at other times,
- Mothers who gave birth in the year after a facility closure, single mothers and those receiving either WIC or Medicaid attended more prenatal visits. WIC and Medicaid recipients also started prenatal care earlier and were less likely to receive inadequate care if they gave birth in the year following a facility closure.

Challenges in counties where birthing units closed:

- Older mothers, mothers with previous children, married mothers, mothers not receiving WIC/Medicaid, and those with lower education attended fewer total prenatal care visits the year before a hospital closed their birthing unit.
- Mothers not receiving WIC/Medicaid and those with lower levels of education also started prenatal care later and were more likely to receive inadequate prenatal care than were similar mothers who gave birth when birthing units were not closed.
- Mothers with lower education started prenatal care substantially later than did mothers with higher levels of education. The disparity was amplified among lower educated mothers who gave birth in the year before or the year after a facility closure.
- Married mothers, mothers not receiving WIC or Medicaid, and mothers with lower education levels attended fewer visits if they gave birth in the year after a closure, with those not receiving WIC/Medicaid and with lower education also starting prenatal care later, relative to similar mothers who gave birth at other times.

Interviews with family support workers in impacted counties revealed similar trends. Providers highlighted some of the challenges that women face when accessing care, particularly in rural areas. These included difficulties finding transportation, accessing prenatal care, navigating care with accepted insurance type (particularly for border counties), and the impact of the closure on the relationships between the community, medical and home visiting providers, and patients.

Resulting from a process of data discovery and exploration discussions with I2D2 community advisory group members representing a range of health service professionals in Iowa, we propose the following recommendations for home visiting programs to support women in counties affected by birthing unit closures:

- Continue to strengthen connections with other programs that could help women stay connected with the care they need - specifically including Women, Infants, and Children (WIC) and Medicaid.
- Build supports for travel/transportation particularly for women in rural areas.
- Consider alternative strategies when prenatal care is needed but is not sufficiently "easy" to navigate given work schedules, travel time, insurance barriers, and child care challenges.
- Strengthen relationships between home visiting programs, maternal health programs and existing birthing facilities in order to foster trust and community. Consider sponsoring prenatal care clinics in collaboration with neighboring birthing facilities.
- Target outreach for families that may be disconnected. Particularly older mothers, mothers with previous children, mothers not already receiving WIC or Medicaid, and especially mothers who did not graduate from high school.

#### **INTRODUCTION**

Between January 2000 and December 2021, 41 of Iowa's community-level hospitals closed their birthing units. These closures include both closure of the entire hospital and closure of the birthing unit within a hospital (See Table 1 for the full details). In many cases, these closures have left the county without a birthing facility.

# **TABLE 1. BIRTHING UNIT CLOSURES SINCE 2000**

COUNTY	HOSPITAL NAME	YEAR OF CLOSURE
Fremont	Grape Community Hospital	2000
Jefferson	Jefferson County Health Center	2000
Hardin	Eldora Regional Medical Center	2000
Jones	Jones Regional Medical Center	2000
Dubuque	Mercy Medical Center	2004
Fayette	Mercy Hospital of Franciscan Sisters	2004
Decatur	Decatur County Hospital	2004
Humboldt	Humboldt County Memorial Hospital	2004
Audubon	Audubon County Memorial Hospital	2005
Buchanan	Buchanan County Health Center	2005
Page	Clarinda Regional Health Center	2005
Sac	Loring Hospital	2005
Adams	Alegent Health Mercy Hospital	2006
Mitchell	Mitchell County Regional Health Center	2008
Lyon	Sanford Merrill Medical Center	2010
Ida	Horn Memorial Hospital	2012
Jackson	Jackson County Regional Health Ctr	2012
Lee	Keokuk Area Hospital-Keokuk	2013
Marion	Knoxville Hospital & Clinics	2014
Davis	Davis County Hospital	2014
Polk	Mercy Medical Center - West Lakes	2016
Greene	Greene County Medical Center	2016
Carroll	Manning Regional Healthcare Center	2016
Appanoose	Mercy Medical Center - Centerville	2017
Hardin	Ellsworth Municipal Hospital (Hansen Family Hospital)	2018
Osceola	Osceola Community Hospital, Inc	2018
Clayton	Guttenberg Municipal Hospital	2018
Washington	Washington County Hospital and Clinics	2018
Emmet	Avera Holy Family Health	2018
Lucas	Lucas County Health Center	2018
Hamilton	Van Diest Medical Center	2018
Van Buren*	Van Buren County Hospital	2019
Marshall*	Unity Point Health-Marshalltown	2019
Henry*	Henry County Health Center	2020
Polk*	UnityPoint Iowa Lutheran	2020

Table 1 continued		
Woodbury*	MercyOne Siouxland Medical Center - Sioux City	2020
Montgomery*	Montgomery County Hospital- Red Oak	2020
Muscatine*	UnityPoint Trinity - Muscatine	2020
Sioux*	Hegg Hospital	2021
Chickasaw*	MercyOne New Hampton	2020
Monona*	Burgess Health Center	2021

Notes: \* indicates the closure was not included in these analyses due to inadequate or non-existent birth data following the closure.

A shortage of obstetricians and gynecologists has been reported as one major factor behind the large number of birthing facility closures with 66 of the 99 counties in the state lacking medical professionals in these areas (Leys, 2019). Hospitals are experiencing staffing shortages in addition to low utilization of birthing units, and communities are struggling to keep these facilities accessible and open. Researchers suggests that these closures may place individuals who are already facing increased challenges at further risk of experiencing negative outcomes for mothers and their children. This is particularly true in rural communities, which include roughly 40% of the population inhabiting 97% of the state (USDA, 2022). One North Carolina study found that decreased access to rural birthing units disproportionately affected Medicaid recipients (Sullivan et al., 2021). Compared to their counterparts living in urban areas, mothers in rural areas are at greater risk of being younger than 18 years of age, unmarried, uninsured, and having an unintended pregnancy. Even without hospital closures, these women tend to have to travel further distances to receive prenatal care than do women in urban areas (Hulme, 1999). In rural facilities without a birthing unit in Iowa, over 50% of patients have a driving time between 30 and 59 minutes to a labor and delivery unit while an additional 10% of patients are more than 60 minutes away (Hunter, 2019). To further complicate these challenges, the reimbursement rate for Medicaid births is well below the actual cost of performing the delivery and caring for the mother and infant in their subsequent hospital stay (Hunter, 2019).

In 2019, an Iowa Obstetrician Summit highlighted the ongoing challenge of birthing unit closures across the state and indicated that these closures are accompanied by increasing trends of complex and high-risk births. Home visiting programs in Iowa have identified this trend of birthing unit closures as a point of potential intervention among their target service population of higher-risk mothers. As the provider of federal and state home visiting programs, the Iowa Department of Public Health (IDPH) commissioned the current investigation to explore the impact of closure of birthing facilities on communities in Iowa. This report includes three separate analyses conducted to better understand the impact of birthing unit closures. The first two analyses use administrative data obtained by Iowa's Integrated Data System for Decision-Making (I2D2), while the third comprised a new data collection effort.

- 1) County-level analysis of the prevalence of birth risks in counties with and without a birthing facility;
- 2) Individual-level analysis of child and maternal outcomes in counties with and without a birthing facility; and
- 3) Qualitative analysis of interviews conducted with home visiting stakeholders in affected counties.

The researchers then merged the results from the three analyses for comparison and interpreted for convergence (or divergence) of results.

#### **METHODS**

#### COUNTY LEVEL ANALYSIS OF BIRTHING HOSPITAL CLOSURES

#### **Purpose**

County level analyses provided a broad overview of the impact of hospital closures on at-risk children and mothers across the state. This level of analysis sought to examine potential relationships between closures and outcomes for at-risk mothers and infants.

#### Sample

This analysis included administrative data derived from Vital Statistics Birth Records provided by the Iowa Department of Public Health from 1995 to 2017. The full dataset consisted of 892,031 records for children born in the state of Iowa regardless of their current residence state or county. For this analysis, the dataset was limited to children who resided in Iowa at the time of birth, limiting the data to 704,523 records. For each of the 704,523 records the analytic variables were averaged within each county over the 1995-2017 span. Counties were then divided into three groups for analysis (see table 2): counties that had an open birthing facility, counties that had no open birthing facility (i.e., at some point the facility was closed), and counties that never had a birthing facility. The 23 counties that never had a birthing facility (n = 23) and counties that had at least one birthing facility remain open, even if another facility in that county closed (n= 53). Some of the 41 unit closures listed in table 1 occurred in counties where another unit remained open, so were not included in the "closed" category.

#### TABLE 2. FACILITY STATUS CATEGORIES AND SAMPLE SIZE OF BIRTHS

HOSPITAL STATUS	SAMPLE SIZE
Never had a hospital (23)	n = 62,285
At least 1 birthing unit open in the county (53)	n = 584,696
Closed the only facility in the county (23)	n = 56,950

This provided for an analysis of birth risk variables from 76 total counties. Because this Phase I evaluation analysis was restricted to birth records prior to 2018, counties that closed the only facility after 2018 were considered a county with an open birthing facility. Table 3 presents a full list of variables used and how they were calculated from the original administrative data.

#### **TABLE 3. ANALYTIC VARIABLES DERIVED FROM VITAL STATISTICS**

ANALYTIC VARIABLE	VARIABLE DEFINITION
WIC received	Mother was receiving benefits from the Women, Infants & Children (WIC) program during pregnancy.
Medicaid delivery	Primary source of payment for delivery was Medicaid.
Poverty	Mothers were receiving WIC (where WIC receipt is 180-185% FPL) during pregnancy or used Medicaid as primary source of payment for delivery.

Table 3 continued	
Low maternal education	Children born to mothers who were 20 years old or older at time of birth and had completed less than a high school education.
Teenage mother	Mothers who were younger than 20 years old at time of birth.
Single mother	Mothers who were not married at the time of birth.
Inadequate prenatal care	Mothers who did not receive prenatal care during their first trimester OR had fewer than 4 prenatal visits throughout their pregnancy.
Severe inadequate prenatal care	Mothers who did not receive prenatal care during their first trimester AND had fewer than 4 prenatal visits throughout their pregnancy.
Tobacco use	Use of cigarettes in the three months before or during pregnancy.
Cumulative risk	Sum of 7 birth risks (inadequate prenatal care, preterm/low birth weight, teenage mother, single mother, low maternal education, smoking during pregnancy, and poverty).
2 or more risks	If number of cumulative risks associated with child is 2 or greater then $Risk_2P = 1$ . If number of cumulative risks associated with child is 1 or less then $Risk_2P = 0$ .
3 or more risks	If total number of risks associated with child is 3 or greater than $Risk_3P = 1$ . If total number of risks associated with child is 2 or less than $Risk_3P = 0$ .
Pre-pregnancy diabetes	The diagnosis of diabetes for the mother before pregnancy.
Gestational diabetes	The diagnosis of diabetes for the mother during pregnancy.
Pre-pregnancy hypertension	The diagnosis of hypertension for the mother before pregnancy.
Gestational hypertension	The diagnosis of hypertension for the mother during pregnancy.
Other outcomes	Total number of other pregnancy outcomes that did not result in a live birth.
Month prenatal care initiated	The month in the pregnancy when prenatal care began.
Number of prenatal care visits	The sum of all prenatal care visits attended.
Induction of labor	Indication of whether the labor was induced (initiation of uterine contractions by medical or surgical means for the purpose of delivery before the spontaneous onset of labor).
Preterm birth	Children born prior to 36 weeks gestation.
Gestation	The best obstetric estimate of the infant's gestational age in completed weeks based on the clinician's final estimate of gestation.
Low birth weight	Children born weighing less than 2500 grams.
Infant birth weight	The weight of the infant at birth (in grams).

#### INDIVIDUAL LEVEL ANALYSIS OF BIRTHING HOSPITAL CLOSURES

#### **Purpose**

We conducted individual-level analyses including the timing of birth relative to birthing unit closures and other relevant characteristic and risk variables to examine direct and indirect effects of closures on child and mother outcomes. First, analyses examined how risk factors related to maternal outcomes (e.g., prenatal care and labor induction) and to infant outcomes (e.g., gestational age and birth weight). Second, analyses assessed whether the closure of birthing facilities in lowa counties directly influenced mother and child outcomes. Finally, analyses examined potential indirect influences on these outcomes through amplification of risk effects in areas where closures have occurred among mothers and infants most likely to be impacted by the timing of the relevant facility closure.

#### Sample

Initial data included birth records from 1999-2017 (described earlier for the county-level analyses). Preliminary data screening indicated the need to eliminate cases born before 1999 due to substantial missing data for most or all of the risk variables. An additional group of cases (n = 192) were removed due to either missing county information at birth location (n = 6) or residence (n = 186). Finally, three additional cases were eliminated due to lack of child date of birth, making determination of birth relative to closure timing impossible. The final sample for the individual analyses included records for 703,931 mothers and infants.

#### **Facility Closure**

Birthing facility closures were restricted to occurrences between 01/01/1999 – 12/31/2018 due to birth record limits at 1999 and 2017 (see Table 1). These limits allowed for determination of births occurring one year before the facility closed (e.g., 1999 births for a 2000 closure) and one year after the facility closed (e.g., 2006 births for a 2005 closure). We included births in the year before a facility closure to examine potential anticipatory influences on mother and infant outcomes. The hypothesis was that there may be real or perceived disruptions to services following the announcement of a closure and potential phasing out or reduction of services as the closure date approaches. Timing determination excluded nine individuals born in their residence county on the exact date of the facility closure raising ambiguity about classification as pre-closure or post-closure births. The resulting analysis sample included 5,017 children born in the year before any facility closure and 4,343 children born in the year after any facility closure between 1999 and 2018.

#### Mother and Child Variables

The individual-level analyses used all variables described above in Table 3 with the exception of poverty, severe inadequate prenatal care, cumulative risk (2 or more, 3 or more), and the count of other (previous) birth outcomes. These variables were omitted in favor of examining each component of combined risks (e.g., WIC and Medicaid instead of the combined proxy variable "poverty") or due to inclusion of predictors/outcomes within the cumulative risk measures. In place of previous birth outcomes, the individual-level analyses included indicators for first pregnancy and for whether mothers had previous children.

#### **Control Variables**

A preliminary set of linear and logistic regression analyses examined relationships between all mother characteristics and both mother and infant outcomes. Results indicated that mother's age, existing and gestational health conditions, and infant gender were consistently related to the primary outcomes of interest, but the directional nature of the associations was not necessarily consistent. As such, this set of variables was retained as a block of statistical controls for each analysis. Specific results detailing the relationships between each of the control measures and each of the mother/infant outcomes are available in Appendix A.

#### Analytic Approach and General Model

Primary analyses were conducted using hierarchical mixed linear or generalized mixed logistic models, as appropriate for continuous or categorical (binary) outcomes. All analyses included the set of control variables (mother's age, existing/gestational diabetes/hypertension, and infant gender). All models included a random intercept term to adjust standard errors for nonindependence of observations from the same counties. For example, two children from Kossuth county will be more similar than any child from Kossuth county will be to any child from Polk county. Inclusion of the random intercept terms also corrects effect estimates for existing county-level variability in both predictors and outcomes. Note that the variability in outcomes due to county was consistently small, but not trivial, and that failure to account for clustering impacts both model coefficients and tests of statistical significance through inflation of Type I error rates. Finally, analyses were limited to singleton births to reduce complexities involving relationships with specific outcomes, including prenatal care visits, gestational age, and birth weight. Specific details regarding the general statistical modeling approach are available in Appendix A.

# QUALITATIVE ANALYSIS OF BIRTHING HOSPITAL CLOSURES

Eight counties of interest were identified by IDPH and the research team for targeted interviews. The counties identified had family support programs with close connections to a community that was affected by a birthing unit closure (i.e., within the county or in a neighboring, "overflow" county). These counties included Appanoose, Jefferson, Lee, Marshall, Page, Van Buren, Wayne and Woodbury as they had experienced the closure of a birthing facility or served an area in which they were one of the only counties that still had a birthing facility. Emails were sent by IDPH and the research team to 23 providers. Ten providers responded resulting in 9 interviews with 17 individuals in June of 2021. The interview sessions were conducted and recorded over a secure video conferencing software with providers in all identified counties except for Wayne. Providers being interviewed held a variety of positions within their county including home visitor, parent educator, program director/manager, and service coordinator.

Participants were asked questions in five areas related to the closure of birthing facilities (see Table 4 for interview questions). Interviews lasted between 15 and 30 minutes. If participants were not able to answer specific questions they were skipped. This most commonly occurred with the questions asking about the facility pre-closure as the participant may not have been in their current position before the closure. Interviews were transcribed with a virtual transcription service, corrected for inaccuracies in transcription, and qualitatively coded into common themes which formed across all responses.

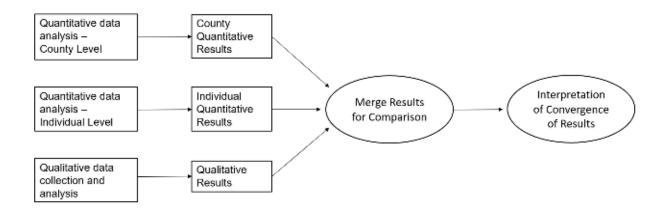
Area 1 – Pre- Birthing Facility Closure	<ol> <li>In your opinion, what were the circumstances that prompted the birthing facility closure?         <ul> <li>A. When did this occur?</li> </ul> </li> <li>What was prenatal, postpartum care, and delivery like for your clients prior to the birthing facility closure?</li> </ol>
Area 2 – Post Birthing Facility Closure (Immediately Following)	<ol> <li>How was the birthing facility closure managed?</li> <li>What were the impacts of the birthing facility closure on prenatal care, delivery, and postpartum care for your clients?</li> <li>What could have made the birthing facility closure go smoother for your clients?</li> </ol>
Area 3: Post Birthing Facility Closure (as of June 2021)	<ol> <li>Where are your clients receiving their prenatal care, postpartum care, and delivering?         <ul> <li>a. Where are your clients with high risk pregnancies and births receiving their prenatal, postpartum care, and delivering?</li> </ul> </li> <li>How has the birthing facility closure impacted your clients' prenatal care, postpartum care, and delivery?</li> <li>In addition to the birthing facility closure what additional barriers are your clients facing in regards to prenatal care, postpartum care, and delivery?</li> </ol>
Area 4: Post Birthing Facility Closure & Covid- 19 Impacts	<ol> <li>How has COVID-19 interacted with the birthing facility closure and impacted prenatal care, postpartum care, and delivery for your clients?</li> <li>Were your clients able to take advantage of the increase in telehealth visits for their prenatal and postpartum care?</li> <li>Did this combat some of the challenges associated with the birthing facility closure?</li> </ol>
Area 5: County Response & Recommendations	<ol> <li>What are some things that the county has done in response to the birthing facility closure that have worked well?</li> <li>What are some things that the county has done in response to the birthing facility closure that have not worked well?</li> <li>What would make prenatal care, postpartum care, and delivery accessible for your clients following the closure of the birthing facility?</li> </ol>

#### **TABLE 4. INTERVIEW QUESTIONS**

# STUDY DESIGN

Findings from these three threads of analyses were analyzed separately and brought together for comparison and then interpretation using a convergent parallel mixed-methods design as shown in figure 1.

# FIGURE 1. STUDY DESIGN MODEL



#### **FINDINGS**

#### COUNTY LEVEL FINDINGS

The researchers conducted comparisons to determine whether county rates for each risk factor, or averages for other outcomes, differed between counties where the only birthing facility closed and counties where facilities remained open. Table 5 displays means and standard deviations for each risk factor that reflect county-level percentages, except where otherwise indicated. As indicated in bold, counties where the only birthing facility closed evidenced rates of inadequate prenatal care and severe inadequate prenatal care that were significantly higher than the rates in counties where facilities remained open. In addition, the average start of prenatal care was significantly later in counties where the only birthing facility closed in comparison to average initiation of care in counties where facilities remained open. Finally, rates of pre-pregnancy diabetes were significantly higher in counties where facilities remained open in comparison to the rate in counties where the only facility closed. However, both rates were very low at less than 1%.

# TABLE 5: COMPARISON OF OPEN AND CLOSED COUNTY RATES AND OUTCOMES

		Closed Birthing Facility		Open Birthing Facility			
Analytic Variable	M	SD	М	SD	df <sup>a</sup>	t	р
PERCENT OF BIRTHS							
WIC Received	38.02 %	7.97	38.73 %	11.31	58.37	0.31	.757
Poverty	49.57 %	9.73	50.10 %	12.36	52.70	0.20	.840
Low Maternal Education	11.03 %	6.85	9.99 %	6.51	40.03	-0.62	.540
Teenage Mother	7.08 %	2.66	7.21 %	2.49	39.42	0.20	.840
Single Mother	33.71 %	8.07	35.62 %	8.79	45.44	0.92	.363
Inadequate Prenatal Care	11.67 %	5.05	8.61 %	2.99	28.91	-2.71	.011
Severe Inadequate Prenatal Care	3.18 %	3.75	1.39 %	1.10	23.66	-2.25	.034
Medicaid Delivery	41.53 %	9.08	41.76 %	11.46	52.34	0.10	.924
2 or More Risks	45.30 %	7.30	44.49 %	11.23	62.51	-0.37	.710
3 or More Risks	24.45 %	6.62	25.12 %	7.53	47.29	0.39	.702
Pre-pregnancy Diabetes	0.61 %	0.31	0.79 %	0.38	51.06	2.18	.034
Gestational Diabetes	6.01 %	1.90	6.21 %	1.43	33.31	0.46	.646
Pre-pregnancy Hypertension	1.38 %	0.67	1.34 %	0.51	33.58	-0.26	.800
Gestational Hypertension	5.93 %	1.46	6.01 %	1.60	45.55	0.22	.828
Other Birth Outcomes	39.61 %	4.74	40.54 %	4.70	41.61	0.79	.436
Induction of Labor	29.46 %	4.70	29.52 %	5.46	48.29	0.06	.956
Preterm Birth	4.43 %	1.41	4.23 %	1.59	46.91	-0.55	.583
Low Birth Weight	5.59 %	1.63	5.39 %	1.75	44.83	-0.48	.637
AVERAGES							
Number of Cumulative Risks <sup>1</sup>	1.45 risks	0.22	1.42 risks	0.33	60.34	-0.38	.705
Month Prenatal Care Initiated <sup>2</sup>	2.84 mths	0.21	2.72 mths	0.19	38.11	-2.23	.032
Number of Prenatal Care Visits <sup>2</sup>	11.42 visits	0.99	11.73 visits	0.80	35.11	1.34	.189
Gestation (weeks) <sup>2</sup>	38.69 wks	0.18	38.70 wks	0.18	43.44	0.09	.921
Infant Birth Weight (grams) <sup>2</sup>	3375.41 g	45.76	3373.54 g	47.43	43.31	-0.16	.873

<sup>a</sup> Satterthwaite corrected degrees of freedom for unequal variances tests.

<sup>1</sup> Average count of total risks.

<sup>2</sup> Average outcome (i.e., months, visits, weeks, grams)

#### INDIVIDUAL LEVEL FINDINGS

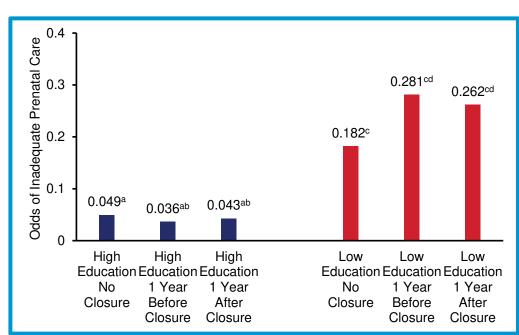
#### Maternal Outcomes

#### Inadequate Prenatal Care

Overall (regardless of birthing unit closure), all risk factors were related to later starts to prenatal care, attending fewer total prenatal care visits, and a higher likelihood of receiving inadequate care. However, this pattern was reversed for mothers who were pregnant for the first time.

Controlling for identified variables (see Appendix A), mothers who gave birth in the year before a facility closure, first time pregnant, teen, single, and WIC/Medicaid recipient mothers all attended more total prenatal care visits. Those receiving WIC or Medicaid also started prenatal care earlier and were less likely to receive inadequate prenatal care. Alternatively, older mothers, mothers with previous children, married mothers, mothers not receiving WIC/Medicaid, and those with lower education all attended fewer total prenatal care visits. Furthermore, those not receiving WIC/Medicaid and those with lower levels of education also started prenatal care later and were more likely to receive inadequate prenatal care than were similar mothers who gave birth at other times.

For mothers who gave birth in the year after a facility closure, single mothers and those receiving either WIC or Medicaid attended more prenatal visits. WIC and Medicaid recipients also started prenatal care earlier and were less likely to receive inadequate care if they gave birth in the year following a facility closure. Alternatively, married mothers, mothers not receiving WIC or Medicaid, and mothers with lower education levels attended fewer visits if they gave birth in the year after a closure. Furthermore, mothers who were not receiving WIC/Medicaid and with lower education started prenatal care later, relative to similar mothers who gave birth at other times.



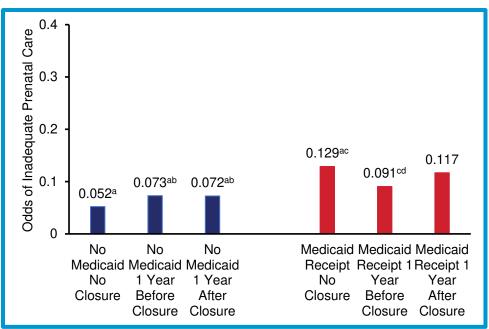
# FIGURE 2. INADEQUATE PRENATAL CARE BY MATERNAL EDUCATION

Mothers with at least a HS education are significantly less likely to receive inadequate prenatal care if they give birth in the years surrounding a facility closure. Less educated mothers (i.e., did not graduate HS), on the other hand, face a significantly higher likelihood of receiving inadequate prenatal care if they give birth in the year before or the year after a facility closure, in relation to mothers with less education who give birth at other times.

*Note:* Superscripts indicate statistically significant differences such that ab differs from a, c differs from a, and cd differs from c.

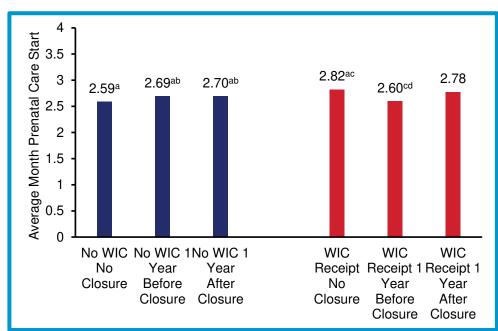


Generally, mothers receiving Medicaid are more likely to experience inadequate prenatal care than are mothers who do not receive Medicaid. However, among those mothers who do not receive Medicaid, the likelihood of inadequate prenatal care is significantly higher if giving birth in either the year before or the year after a facility closure. Alternatively, among mothers who do receive Medicaid, the likelihood of inadequate prenatal care is lower when giving birth in the year before (significantly) or the year after (marginally) a facility closure.



Note: Superscripts indicate statistically significant differences such that ab differs from a, c differs from a, and cd differs from c.

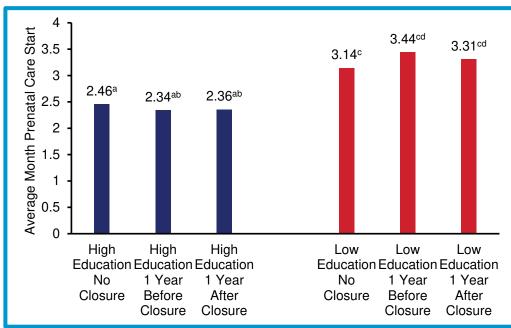




Mothers receiving WIC at the time of birth generally started prenatal care significantly later (approximately 12 days on average) than mothers not receiving WIC. However, mothers not receiving WIC had significant delays in the start of prenatal care when they gave birth in the year before or the year after a facility closure. Alternatively, mothers receiving WIC started prenatal care significantly earlier when they gave birth in the year before a facility closure and slightly earlier when they gave birth in the year following a facility closure.

Note: Superscripts indicate statistically significant differences such that ab differs from a, c differs from a, and cd differs from c.

# FIGURE 5. PRENATAL CARE INITIATION BY MATERNAL EDUCATION BY FACILITY CLOSURE STATUS

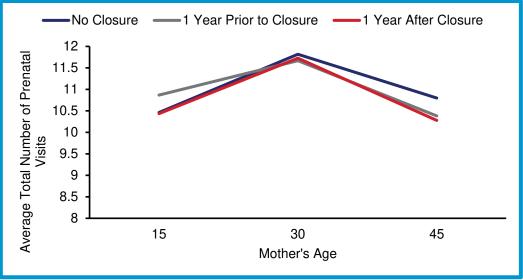


Mothers with lower education started prenatal care substantially later than did mothers with higher levels of education. This disparity was amplified among lower educated mothers who gave birth in the year before or the year after a facility closure. Alternatively, mothers with higher levels of education started prenatal care earlier if they gave birth in the year before or the year after a facility closure.

Note: Superscripts indicate statistically significant differences such that ab differs from a, c differs from a, and cd differs from c.

# FIGURE 6. PRENATAL CARE VISITS BY MATERNAL AGE BY FACILITY CLOSURE STATUS

Both younger and older mothers attend fewer total prenatal care visits in comparsion to mothers in the age range around 30. Mothers at age 30 attended significantly fewer visits on average when they gave birth in the year before a facility closure and slightly fewer visits on average when they gave birth in the



yare after a facility closure. Furthermore, the decline in total number of visits among mothers over the age of 30 was accelerated significantly for those who gave birth in either year surrounding facility closure.

# FIGURE 7. PRENATAL CARE VISITS BY MARITAL STATUS BY FACILITY CLOSURE STATUS



Single mothers attended significantly fewer total prenatal care visits than did married mothers. However. single mothers who gave birth in the year before or the year after a facility closure attended more total visits, on average, than did single mothers who gave birth at other times. Alternatively, among married mothers, those who gave birth in the year before or in the year after a facility closure attended significantly fewer total visits, on average, than did married mothers who gave birth at other times.

Note: Superscripts indicate statistically significant differences such that ab differs from a, c differs from a, and cd differs from c.

#### Induced Labor

induction is

inadequate prenatal

facility closure were

to experience labor

induction than were

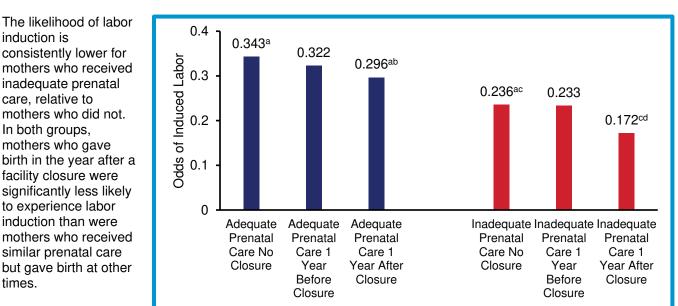
similar prenatal care

times.

care, relative to

In both groups, mothers who gave

Mothers pregnant for the first time were more likely to experience induced labor but all other risk variables were related to a lower likelihood of induction. Closure status related reasonably consistently to lower likelihood of induction among mothers who gave birth in the year after a closure but the likelihood of induced labor among mothers who gave birth in the year before a closure was not different from general rates of labor induction.



# FIGURE 8. LIKELIHOOD OF INDUCED LABOR BY PRENATAL CARE BY HOSPITAL CLOSURE STATUS

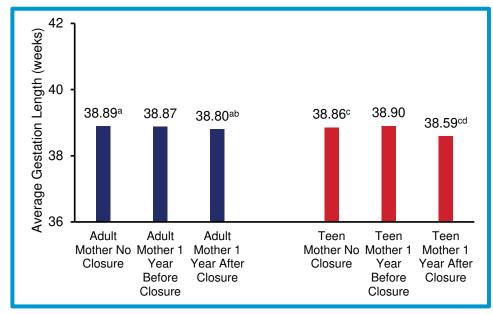
Note: Superscripts indicate statistically significant differences such that ab differs from a, c differs from a, and cd differs from c.



# Infant outcomes

# Infant Gestational Age in Weeks and Likelihood of Preterm Birth (< 36 Weeks)

Risk variables were related to gestational age and the likelihood of preterm birth as expected but all mothers, regardless of risk factors, generally experienced shorter gestation durations if they gave birth in the year after a facility closure. Closure status was not consistently related to the likelihood of preterm birth beyond relationships with the various risk factors. These findings are similar to those of Kozhimannel et al. (2018) who also found increased likelihood of preterm birth, but only following a birthing facility closure.

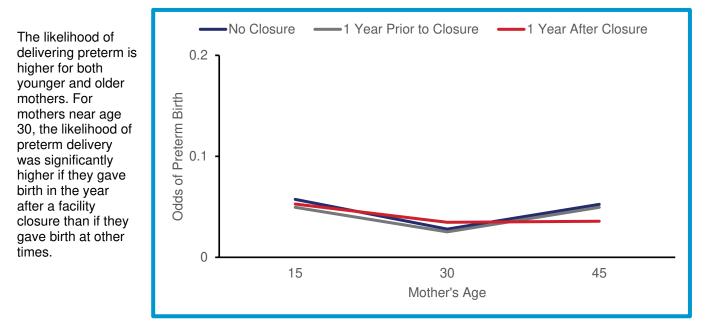


# FIGURE 9. GESTATIONAL AGE BY MOTHERS AGE BY FACILITY CLOSURE STATUS

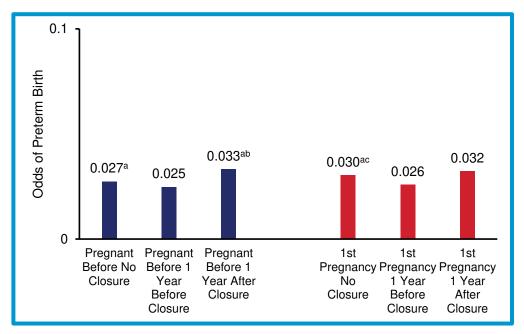
Gestation duration was shorter, on average, for teen mothers, relative to mothers over the age of 19. Mothers in both groups experienced shorter gestation durations if they gave birth in the year following a facility closure than did mothers of comparable ages who gave birth at other times. Gestation durations did not differ, on average, for either group of mothers if births occurred in the year leading up to a facility closure.

Note: Superscripts indicate statistically significant differences such that ab differs from a, c differs from a, and cd differs from c.

# FIGURE 10. LIKELIHOOD OF PRETERM BIRTH BY MATERNAL AGE BY FACILITY CLOSURE STATUS



# FIGURE 11.LIKELIHOOD OF PRETERM BIRTH BY FIRST TIME PREGNANCY BY FACILITY CLOSURE STATUS

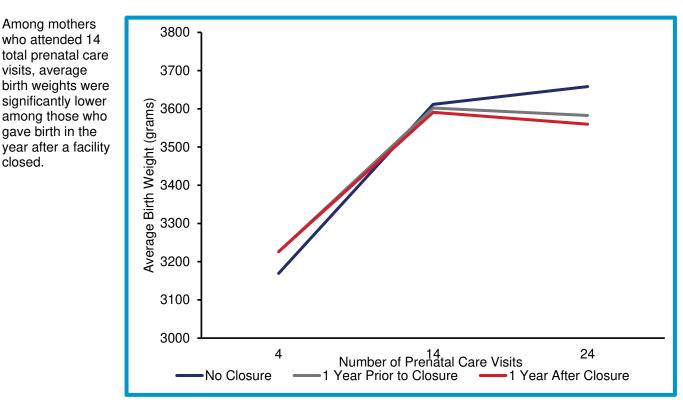


The likelihood of preterm birth is significantly higher (1.109 times) among mothers pregnant for the first time, relative to mothers who have been pregnant before. Among mothers with previous pregnancies, the likelihood of preterm birth was significantly higher (1.211 times) among those who gave birth in the year after a facility closure. Facility closure timing did not relate to differences in the likelihood of preterm birth among mothers pregnant for the first time.

Note: Superscripts indicate statistically significant differences such that ab differs from a, c differs from a, and cd differs from c.

# Birth Weight in Grams & Likelihood of Low Birth Weight (< 2500 grams)

Infant birth weights were lower and the likelihood of being underweight was higher for mothers who were younger, older, first-time pregnant, teens, single, WIC or Medicaid recipients, lower educated, late to start prenatal care, or attended fewer total prenatal visits. Conversely, mothers with previous children tended to have heavier babies and were less likely to deliver underweight infants. Facility closure had no influence on birth weight in all cases, with the exception of the relationship involving total number of prenatal care visits. Children born to mothers who attended approximately 14 total visits were lighter if they were born in the year after a facility closure. In addition, the general increase in birth weight corresponding to attendance at more prenatal visits was dampened significantly among infants born in either the year before or the year after a facility closure.



# FIGURE 12. BIRTH WEIGHT BY PRENATAL CARE VISITS BY FACILITY CLOSURE STATUS

The full set of all individual-level findings and supporting regression tables is contained in Appendix A.

# QUALITATIVE FINDINGS

Upon qualitative coding of the 9 interview transcripts, four themes emerged. Subthemes also emerged for themes 1, 2, and 4. See table 6 for themes and sub-themes.

# TABLE 6 – INTERVIEW THEMES

Theme 1	<ul><li>Transportation challenges</li><li>Burden on high-risk clients</li></ul>
Theme 2	<ul> <li>Impacts on prenatal care</li> <li>Limited attendance and access</li> <li>Induction observations</li> </ul>
Theme 3	Insurance challenges
Theme 4	Impacts on Relationships <ul> <li>Hospital and community</li> <li>Client and medical provider</li> </ul>

# Theme 1 – Transportation Challenges

Across interviews with participants, one of the most commonly mentioned barriers to prenatal care, postpartum care, and delivery following the closure of a birthing facility was transportation. Providers shared that challenges included the distance to open facilities, the time commitment required to travel to these facilities, the cost of transportation to clients, and the impacts on childcare for clients' older children. A subtheme emerged around the burden on clients who are considered high risk, as providers shared that these challenges are intensified for clients who are considered high risk or whose infants are considered high risk.

"...the costs associated with gas and driving that way, some of our families do not have cars." "Some families \$20 is like \$1000 to some people. It's a lot of money."

"I know a few moms use the transportation program they have through Medicaid, but it's not very easy to work with. I don't know if you're familiar with it, but we have families that have to wait two hours after their appointment to be picked up and brought home. So, when they have little ones at home with a childcare provider, it's kind of hard, not knowing, oh, I'll be back at 1, 2, maybe even 6 p.m. being gone like the whole day. That's the biggest struggle."

"So I don't think [travel for prenatal care is] as big of an issue [for clients that are employed] because obviously if they have a job, they're able to get there, so they have some form of transportation and daycare. It's the ones that honestly don't have any job and are sitting at home with their kiddos, and that's where the real struggle lies."

"They're going to Missouri to have their children. They're going to a different state because it's closer in the long run."

"What some families have to do, and these are the ones that have means to do it, the ones that don't have the family or the care...these are usually the ones that are already kinda went through [it], and they kinda know a little bit how their body works, they'll get a hotel the night before to make sure they're there if they're able. But not everyone can afford a motel. Not everyone has sitters that can watch them that whole time where like that's another thing."

"if they're...so far dilated, they can't be transported, so they sit in the ER, and they wait and deliver in the ER and then...mom and baby, get transported to, you know, local hospital."

"I had a woman that just lost a child, first child, and so they had to drive 45 minutes while she's bleeding, going there and just the emotional experience is still the ride for everyone else in the car to the hospital. I mean, it's an emotional experience no matter what, but getting across town and getting cared for rather than have to do the long drive in the early morning."

# Burden on High-Risk Clients

"If they're high risk, they gotta go [to *city name*], and I just had that situation with a mom, and oh goodness, she lived in ... that was over an hour, and she already had four children, so that was a really scary situation."

"Plus, once they are high-risk and they have to go to [*city name*], a lot of times the kids have to stay in the hospital, and that's a hardship for the parents to get back and forth to the hospital."

"They're trying to care for kids at home and stay with the [high risk] newborn at the hospital. You know, they don't allow them to stay in the hospital. They have the Ronald McDonald House, which is often full, or they have another area...But again, they're usually full because, as we all know, most of the preterm babies are in there long time. So those rooms are occupied, and you know they don't open up a whole lot. So that creates a bad hardship on them getting back and forth. Oftentimes, they just have to stay home. They can't be with their baby."

"[One client] refused to leave [the hospital] and slept in her car because she was afraid with this child... because the first child they went home, and she almost gave birth in her car and they had to turn back around because the 45-minute drive. So with this child... she's like, I'm not leaving, so she spent hours in the parking lot, and she ended up having it that night. But she just like, I'm not taking the chance of being on the road, and it's very stressful for father. Can you imagine her as a mother driving, you know, and they've got that going on."

# Theme 2: Impact on Prenatal Care

The second theme to emerge was the impact that the closure of birthing facilities had on access and attendance to prenatal and postpartum care. Providers shared that their clients are delaying the start of prenatal care appointments or skipping appointments due to the challenges associated with the availability of facilities. Providers shared that these impacts trickle down to pediatricians and that, in addition to a lack of access to prenatal and postpartum care, there are very few pediatricians available for infant and child medical care. A surprising sub-theme emerged around the trend of increasing rates of birth inductions. Providers shared that they have noticed an increase in the number of inductions, and some proposed that they may be due to the increased travel time to birthing facilities since the closures.

#### Limited Attendance and Access

"Some people just schedule appointments, and then they end up canceling because they don't have so and so to watch the kids or you know whoever was supposed to take them decided they couldn't go. It seems that a lot of them try to keep those appointments but then you have a select few that are like, hmm, everything was fine in my last appointment, so it'll be alright. Which is scary because things can change, so I think that's the biggest thing with that is they just it's just like, they don't know what to do, I mean, they're kind of in a rock and hard place and then if you try to find public transportation to take them anywhere. Obviously, it costs an arm and a leg, so, and they don't have that."

"A lot of people just... went without prenatal care since they had to travel... So, they actually just stopped receiving prenatal period because they didn't have any means to get any other places. Then they might have to go to an ER somewhere ready to deliver."

"We're seeing less family's going to get prenatal care early on during their pregnancy. They're waiting until the second trimester or unless they have something that they are concerned about. Just delayed that care."

"I think the families don't have the adequate gas money to get to their appointments or don't have somebody to give him a ride. They'll just cancel and then go a month out. So, I would say the amount of times they should be going has lessened."

"In the beginning that...they go and they find, you know, they get the proof that they're pregnant, but then their actual first prenatal isn't until later. And they're really missing that point of how to take care of themselves, you know until they actually get in for their first appointment."

"I remember some of them being kind of irritated that they didn't have a good pediatrician in [county] yeah, they can go to family doctor but that's not the same as a pediatrician.

"Yes, we had an amazing pediatrician... and she moved back where she was from we really don't have a pediatrician in this 3 County area that I'm aware of right now."

# Induction Observations

"A lot of the doctors around here that they see do not like to do inductions. And the moms are always like, ugh, just take it now, and they're like, no we're not gonna do it, ... so they get frustrated more with it because I think, by that time, obviously they're ready to be done and that extra travel time, they're just like, let's just do this."

"Talking to families a lot of times, a lot of them is when they're planning to have the baby. They know exactly.... I just think that's a way they can kinda have an idea of when they're gonna do it. "

"I think that the doctors schedule when they're, the babies are going to be born, it's like okay we'll to induce you on this day, you know, and it's not really their due date but it's convenient."

"We have family right now that said she's going to get induced at 37 weeks and I was like what? And it's because well in case she goes early. You know, this way it's planned out."

# Theme 3: Insurance Challenges

A third theme emerged around insurance and the impact of public insurance on prenatal care, postpartum care, and delivery. Providers shared that clients who utilized public insurance often could not choose their birthing facility or care team. Very often clients had to travel greater distances to receive care at a hospital covered by their public insurance.

"Iowa City University is one of our big hospitals and a lot, oh yeah, a lot of insurances only you can go to Iowa City. If you are like on certain government insurance you have to go to Iowa City."

"I really think like, going back to that power of choice. That power gets taken away from them, oh you're on Medicaid. You're going to this specific Community Center or whatever for your care. So, this is just how it's going to go. Like they lose that power of choice, which can be really frustrating, but also defeating so I think there's a trickle impact and that's between OB's and between pediatricians. If you don't feel like you get to truly choose and control and that your feedback matters in that, why would they continue to follow through with that care?"

"The parents did not have insurance cause they both work and they had five children and he had one child before he was paying child support on. So, it's not that they had low income but they had a lot of people they were providing for. So, on paper it looked like they made too much for anything but they didn't make enough to pay hundreds and hundreds of dollars of insurance and where they worked did not provide it for them. But they didn't qualify for anything. So, the mom finally qualified for it after she was pregnant but the thing was she had to wait and then so she had to do the application, go through the process, and might not have gotten to the doctor as soon as she should've trying to get insurance to go. So, for the working, or what I call are the working families I find insurance a much more difficult piece than the ones that are just, they're incomes much lower. There's more insurances for them than the middle, that's what I experience right now."

"I have a very clear example that just happened recently, we had a mom that really wants to do a vbac. She had a cesarean section, her first child, she's Medicaid and she really wants to do a vbac. Well in order to do a vbac, you have to have a certain OB that does it and the current place she's going will not even consider it. Well, I called

one of the top OB places here in town and because she has Medicaid... they require that she has a referral from her primary care physician to go to this OB place. ... the doctors that she's going to won't even consider a vbac, they're telling her no. She would like a second opinion, but now the people that are telling her no are also telling her no to a referral. So literally, she just got landlocked all because of her health insurance."

"A few of my families...they struggle with getting birth control, because either they have to pay as well or they were told no you have to pay for this birth control because probably because of the sliding fee or something. One of [my clients] was always wanting to have birth control but because of issues or something she could not because of transportation as well...she couldn't get the birth control that she needed and she got pregnant again. In this one will be her 6<sup>th</sup> child."

# Theme 4: Impacts on Relationships

A fourth theme emerged about the impact of closures on relationships. Providers shared that the closure of birthing facilities had impacts on the community as a whole as well as clients' relationships with their medical providers. Regarding community impact, providers shared concern over the lack of connection between their agencies and the hospitals since the closure of local birth facilities. They indicated that this had negatively impacted the continuity of care for clients. Regarding the impact on the relationship between clients and medical providers, participants reported clients' lack of familiarity with medical providers since the closures.

#### Hospital and community

"Well, I think there was a big impact, I think the whole thing, you know, if you think about OB, that's where it starts. Ob you deliver, you continue your care with your either, family practice or pediatrician. They grow up. They tend to deliver in the same hospital facility and then the cycle kinda starts over. So now I don't think there is even, I don't even know if there's any [pediatricians] left.... I don't think there's any pediatrics at all."

"I think when before the OB closed you know they knew about our agency, they knew who we were. If we had a family that you know, what's newer to the community or just very high risk, we worked closely, you know, for the sake of this family. They know about our agency, they knew our faces, so they would contact us. ... We have three different languages, available Spanish, Quran, and Burmese. So, it was very easy for us if a family was not understanding for us to you know, meet them [at the hospital] and maybe try to get some insight. But yeah, that is not an option them going to the bigger cities now. A lot of the times are not understanding all of the information that they're getting. sometimes with families that are newer to the community newer to this country, this is her first pregnancy here. They don't know how this works."

#### Client and medical provider

"You have to change doctors and everything ... if you've always doctored with the same person, so that's the biggest reaction I hear going to bigger hospitals [clients] are being made to change in the middle of [it], if you're a mom four times or a new mom, you lose the personal touch of it."

"You go from your OB experience to give birth and then your postnatal and you have so many different providers throughout that process. And you know, for many of our families, they've been through a lot, it's traumatic and so to build trust takes a lot for them, so to go through all these different providers can be kind of scary and challenging and a barrier in and of itself."

"Another challenge. Is that some of them prefer a woman doctor over a male. And so, sometimes that is hard, especially when they go to a clinic that there might be one female and all the rest are male and, you know, and a lot of them, it really, it really bothers them if they don't get a female doctor."

#### DISCUSSION

This evaluation is part of a phased evaluation project to inform state efforts to support families living in areas with birthing unit closures. The purpose of this Phase I report was to use both quantitative and qualitative data to gain a better understanding of what is happening in lowa counties where birthing units have closed, and inform strategic approaches to ensure women in lowa have access to the services they need, when they need them. Overall, Phase I findings supported hypotheses that there are some groups of women who are having challenges accessing the prenatal care they need, and in turn, are having poorer birth outcomes than women not affected by these closures. They also identified relative "bright spots" that suggest some women who are already connected with services including WIC and Medicaid are evidencing a greater likelihood of support to access prenatal care services. The following discussion will provide a review of the findings, in context of other literature and with input from the community advisory group discussions with lowa stakeholders that inform ideas for future work and additional intervention supports that could be recommended to improve outcomes for lowa women. It also concludes with recommendations informing Phase II analyses (which are underway).

#### **Transportation**

Qualitative interview results suggested that family support workers who work directly with clients in a county with no open birthing facility observed a negative impact on access to prenatal care, delivery, and postpartum care. Family support workers shared that the closure of birthing facilities has placed an undue burden on clients who now have to travel greater distances for obstetric care. They shared that this is especially true for individuals who are considered high-risk. In a recent study by the University of Iowa, residents living in small towns, especially those with birth complications, have seen the largest increase in travel times affected by unit closures. Parts of the state consistently experience travel times of over 30 minutes (Carrel et al., 2022). Providers indicated that the increased travel associated with the closure of birthing facilities has a significant negative impact on prenatal care visits, sharing that their clients are less likely to attend prenatal care visits due to this increased travel. This burden in time, cost, and availability of care is also documented in other published discussions surrounding birthing facility closures (Gehr, 2021; Hunter, 2019). These findings also suggest that future work could benefit from additional studies that could quantify the distance mothers have to travel to receive prenatal care, give birth, and obtain postpartum care where birthing facilities close. Examining links between distance traveled and outcomes related to prenatal care and infant health would elucidate both subgroups of mothers who need the most assistance and mothers who have successfully accessed alternative sources of care that might be close by even though their county birthing facility closed.

#### Inadequate Prenatal Care

The quantitative results in this study support the observations shared by providers by documenting disproportionate women in counties with closures experiencing less prenatal care. Individuals in these counties are less likely to receive prenatal care during their first trimester and attend at least four prenatal visits throughout their pregnancy. Additionally, counties without a birthing facility have a later average initiation of prenatal care than counties with an open birthing facility.

To explore whether and how individual characteristics were related to outcomes compared to the closure events, we supplemented the county-level work with individual level analyses. These results suggested that overall (regardless of hospital status), all individual risk factors explored in this study were predictive of later starts to prenatal care, attending fewer total prenatal care visits, and a higher likelihood of receiving inadequate care except for first-time mothers. Next, we explored how subgroups of women faired when hospitals closed, considering comorbid risk factors and other characteristics that also affect prenatal care. Some subgroups showed a more positive response than was anticipated, whereby first-time pregnant, teen, single, and WIC/Medicaid recipient mothers attended more prenatal care visits in the year before a facility closure compared to similar mothers during other times. Those receiving WIC or Medicaid also started prenatal care earlier and were less likely to receive inadequate prenatal care when birth occurred during the year leading up to a facility closure. Among mothers who gave birth in the year following a facility closure, single mothers and those receiving either WIC or Medicaid attended more prenatal visits. WIC and Medicaid recipients also started prenatal care earlier and were less likely to receive inadequate more prenatal visits. WIC and Medicaid recipients also started prenatal care earlier earlier and were less likely to receive inadequate care.

Alternatively, some groups experienced worse outcomes the year before and after a birthing unit closure. Older mothers, mothers with previous children, married mothers, mothers not receiving WIC/Medicaid, and those with lower education attended fewer total prenatal care visits when birth occurred in the year before closure. Furthermore, those not receiving WIC/Medicaid and those with lower levels of education started prenatal care later and were more likely to receive inadequate prenatal care than were similar mothers who gave birth at other times. The year after a closure, married mothers, mothers not receiving WIC or Medicaid, and mothers with lower education levels started prenatal care later and attended fewer prenatal visits if they gave birth in the year following a closure.

These results were also corroborated in the qualitative analysis, as family support workers described their high-risk clients as having limited access and low attendance to prenatal visits. These findings provide support for a need to identify opportunities for some mothers (such as those with low education and those who are not already connected with some type of service system such as WIC or Medicaid) to better access prenatal care earlier in their pregnancy, and stay connected to ensure they receive the care they need. It also suggests opportunities to learn more about "what's working" for some subgroups of women so we can expand supports. lowa efforts to get teen moms, single moms, and moms who are connected with WIC and Medicaid seems to be working – these moms are getting into care earlier. Additional work should document what's working in these cases, and identify ways to expand this to other moms.

#### Infant Birth Weight

Findings suggest that there was very little direct impact of facility closure on infant birthweight, but rather, other factors were more related to birthweight. Regardless of facility status, infant birth weights were lower and the likelihood of being underweight was higher for mothers who were younger, older, first-time pregnant, teens, single, WIC or Medicaid recipients, lower educated, late to start prenatal care, or attended fewer total prenatal visits. Conversely, mothers with previous children tended to have heavier babies and were less likely to deliver underweight infants. Facility closure had no influence on birth weight in all cases, except the relationship involving the total number of prenatal care visits. Children born to mothers who attended approximately 14 total visits were lighter if they were born in the year after a facility closure. In addition, the general increase in birth weight corresponding to attendance at more prenatal visits was significantly dampened among infants born in either the year before or the year after a facility closure.

#### **Gestational Age**

Facility closure was also not directly related to infant gestational age, overall. For all births, risk variables are related to gestational age and the likelihood of preterm birth as expected. However, regardless of risk factors, all mothers generally experienced shorter gestation durations if they gave birth in the year <u>after</u> a facility closure. However, closure status did not relate consistently to the likelihood of preterm birth above relationships with the various risk factors. These findings are consistent with those of Kozhimannel et al., (2018) who found an increased likelihood of preterm birth, but only in the year following a closure. There was no significant difference in gestational age at the county level regarding whether or not the county had an open birthing unit.

#### Labor induction

There was one exploration that suggested different results between the quantitative analysis and the qualitative reports. Interview reports suggested that there might be more inductions happening as a result of birthing unit closures. Quantitative data using the birth records statewide over time, however, did not support this suggestion (at least up through the 2017 closures, which were not included in this report). Closure status was reasonably consistently associated with a lower likelihood of induction among mothers who gave birth in the year following a closure, and the likelihood of induced labor among mothers who gave birth in the year prior to a closure was not different from general rates of labor induction. Given that this report did not include closures after 2017, and the qualitative reports were collected in 2021, future research should examine the quantitative data including the more recent closures to see if these interview suggestions may be more relevant in recent years.



#### RECOMMENDATIONS FROM FAMILY SUPPORT WORKERS

The family support workers interviewed provided valuable insight into how their county and clients have (or have not) been able to deal with a birthing unit closure. They volunteered ideas of increasing the accessibility of prenatal care, postpartum care, and delivery services for clients since the birthing facility closures. Responses were often concentrated on transportation and satellite care. Providers recommended a transportation voucher to offset the financial burden of increased transportation costs. Regarding care, providers recommended a part-time satellite medical provider or obstetrician to provide care to clients locally.

"If there could be some with transportation that they can try to figure out with maybe a gift card or something, a voucher to get to their appointment, I don't know if that would ever work out, but a suggestion."

"I think if they would just maybe even have an OB come down once every month or something and try to get in so many clients in a couple days, you know, kinda thing. Something where it would be more accessible to those clients that could walk to the hospital, or that could get somebody to watch their kids for 20-30 minutes while they have a test done or go out and just see the OB and have a check of their bloodwork or whatever, I think it would make things a lot easier for them."

#### LIMITATIONS

The current study is Phase I of an ongoing evaluation in partnership with Iowa public health leadership. It sought to examine some of the impacts of birthing unit closures in Iowa, and inform programming efforts as well as future analysis. A strength of its approach includes the use of multiple methods of investigation (quantitative and qualitative) conducted at multiple levels of analysis (county-level and individual-level). Synthesis of quantitative results across the county-level, individual-level, and family support provider level bolsters confidence in, and highlights the importance of, our findings. While we see our mixed-methods approach as a strength, some limitations deserve consideration and can be helpful to inform future work.

**First, county level data were aggregated across time.** At the county level, data were aggregated over time and closure occurrence, such that each county was coded as closed or open. While this approach provides an overall picture of the general differences between counties defined by facility closure, it potentially clouds that picture by omitting general timing effects that might occur for all counties. In addition, the aggregate rate or mean in a particular county could reflect multiple years of 'open' status with a closure occurring relatively late (e.g., 2017) for that county, or the reverse where the aggregated value reflects a large passage of time since an early closure (e.g., 2002). Finally, the county-level analyses did not include additional factors that might contribute to differential rates/averages of the outcomes under investigation. Analyses conducted at the individual level attempted to address some of this limitation, by including timing effects and expanding to include multiple factors known to impact maternal care, infant development, and the health of both mothers and children.

Second, administrative data sometimes lacked consistent variables over time and were limited to closures before 2019. For example, records did not provide a consistent and unambiguous way to include an index of tobacco use prior to and during pregnancy across all years of interest. Similarly, the individual level analyses could not consistently construct a reliable index of maternal weight changes during pregnancy over time. Both factors (tobacco use and dramatic weight changes) are highly documented in existing literature and could be important factors to include in future work, if they could be made available from the birth records or other sources. Additionally, birth records for this report were limited to 1990-2017, resulting in the exclusion of five counties who had more recent closures post- 2017 (Chickasaw 2020, Henry 2020, Marshall 2019, Sioux 2021, Van Buren 2019). Although closures in 2018 were included in the analyses, birth record limitations did not allow for the examination of post-closure outcomes for these counties.

Third, qualitative interviews were limited to family support systems. While these interviews provided a necessary and unique perspective, future work should include other health care professionals and affected families to clarify some of the observations made by family support workers and provide additional primary experiences.

#### **RECOMMENDATIONS FOR FUTURE WORK**

To inform Phase II of this evaluation project, we provide four recommendations to continue understanding the impact of birthing unit closures and inform our service system approaches to meeting the needs of lowa families.

- 1. Expand analyses to include all closures, with particular attention to differences in counties that experience the most recent closures from 2018-2021.
- 2. Explore potential additional variables that might be available in birth records or other administrative data, particularly those that may help us understand more about women with low education levels that need connections with care. Additional work could also be done here to explore travel times, distances to various types of prenatal care options, and accessibility of other services (e.g., Title V Maternal Health Services, WIC clinics, Medicaid offices or providers, family support services).
- 3. Collect and analyze more data about what counties are currently doing to address the needs of pregnant women, and look for opportunities to replicate and expand those that are working.
- 4. Connect with other Maternal Health initiatives occurring within the state of Iowa, such as the Maternal Health Innovation Grant and Iowa Maternal Quality Care Collaborative, to coordinate a comprehensive response to the impact of birthing unit closures.

With respect to the last recommendation, we know that service providers at state and local levels have been working hard to address the potential gaps in prenatal care, maternal health care, and infant care left by these birthing unit closures. As evident by the findings that highlight how mothers who are connected with WIC and Medicaid may be more likely to also be connected with prenatal care services --- we know there are solutions that are working. We need to document those, study what's working, for whom, under what circumstances, and expand access to successful solutions. More research should be done to highlight what's working and how some of the "bright spots" that are helping coordinate care can be replicated. Additional research focusing on the existence/establishment, quality, and accessibility of replacement services such as Share Care programs, that provide in-county prenatal care and assist with setup for out-of-county delivery would be prudent. Examining the degree to which these services and programs can (or do) provide early and consistent prenatal care and smooth the transition to an appropriate birthing facility could demonstrate reduced negative impacts on prenatal care and birth outcomes among mothers and infants residing in counties where the only birthing facility has (or soon will be) closed.

Additional work should be done to further understand findings related to mothers with lower education levels. Understanding more about who these women are, where they can be connected with services, and identifying potential other risk factors they may be experiencing can help our service systems address needs. The amplification of detrimental impacts on prenatal care among these mothers when giving birth in the years surrounding facility closures calls for deeper investigation into mechanisms that create the most considerable barriers to care and ways to connect existing programming or develop new programming to surmount those barriers. For example, although facility closures amplified existing risks among lower-educated mothers. the receipt of support services (i.e., WIC and/or Medicaid) appeared to offset the severity of closure impacts. Mothers receiving WIC or Medicaid face general risks relative to mothers not receiving those supports. But in the context of birthing facility closure, Medicaid and WIC recipients experienced more positive outcomes than their fellow support service recipients who gave birth outside of the two years surrounding a facility closure. Additional research into mechanisms stemming from (e.g., travel assistance) or connected to (e.g., co-located Title V programming) WIC and/or Medicaid receipt could elucidate existing factors that mitigate adverse facility closure effects and focus efforts at connecting those factors to mothers in need. Of particular concern, and yet unstudied, are lower educated mothers who do not receive existing supports, such as WIC or Medicaid. Additional investigation into the potential amplification of risk in the absence of buffering supports among these women is paramount in the interest of reducing negative outcomes involving the care and health of mothers and children.

#### CONCLUSION

Decreased access to birthing units can pose a dangerous risk as the United States is currently experiencing a sharp increase in maternal morbidity and mortality compared to other developed countries (World Bank, 2019). Access to care is critical for maternal and infant well-being. Low rates of prenatal care through pregnancy are associated with increased adverse outcomes for the infant, including stillbirth, premature birth, low birthweight, being small for their gestational age, and higher rates of admission into the neonatal intensive care unit (Malhi et al., 2019). Additionally, inadequate prenatal care is associated with increased odds of postpartum depression and anxiety disorder, low initiation of breastfeeding, and reduced odds of infant immunization (Heaman et al., 2019).

Adverse outcomes such as these are within the purview of home visiting programs and demonstrate an actionable intervention point, especially in counties with decreased access to prenatal care. Findings surrounding main individual-level results such as gestational age, preterm births, and birth weight are inconsistent. However, the link between hospital closures and inadequate prenatal care was more consistent and suggestive of a negative indirect effect on outcomes due to the closure.

lowa service systems are working hard to address the impacts of birthing unit closures – and evidence suggests there are many places where access to care is in place – but we need to know more and expand what is working so all women can benefit.

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# **APPENDIX A - Complete Individual-Level Results**



# Statistical Modeling Approach

As indicated above, analyses of mother and infant outcomes employed regression models appropriate for the continuous or binary distribution of each specific outcome. A consistent model specification that included the set of control variables, a risk variable (focal predictor), dichotomous indicators of birth in the year before or after a closure (moderators), and interaction terms between risk and closure timing was used throughout the individual-level analyses. In addition, each analysis examined simple effects of closure at each level of the risk variable, or at meaningful points of the risk variable when risks reflected continuous measures. The model specification allows for consistent interpretation of effects across each of the analyses conducted as described below.

#### Risks (Focal Predictors)

Specification of risk variables in the analysis model typically (with the exception of mother's age, month prenatal care started, and total number of prenatal visits) reflected a dichotomous absence/presence indicator. Direct effects of the risk predictors in the model indicate the mean difference (for continuous) or difference in the likelihood (for dichotomous) of the outcome among between mothers with or without the risk when those mothers gave birth at all times in all counties other than the two years surrounding a facility closure in a particular county. For continuous risk variables, the direct effect reflects the same mean difference (or difference in likelihood) in the outcome between risk/no risk mothers but specifically for mothers at the point where the continuous risk variable was centered (e.g., age 30 for mother's age).

# Facility Closure Timing (Moderators)

In counties where the only facility closed, the number of days between closure and birth for each child in the corresponding county was computed. Closure indicators were computed to contrast children born within 365 days of a facility closure either in the year before (prior) or the year after (post). The two closure indicators were then entered simultaneously into each regression model to predict mother and infant outcomes.

As coded, the prior- and post-closure indicators compare the children born before or after a closure to all other children who were not born within the same closure timing when those children were born to a mother without the particular risk characteristic (or at the centering point for continuous risks). Note that this creates a referent group of children who were born in counties where no closure occurred <u>and</u> children within counties where closures did occur but did so further back or ahead of the child's birth. Effects of the closure variables indicate the mean difference or difference in the likelihood of the outcome between mothers who gave birth in the year before/after a facility closure and mothers who gave birth at times or in counties other than the two years surrounding facility closure when mothers did not possess the specific risk characteristic.

#### **Risk by Closure Interactions**

Closure by risk interactions were computed as cross-product terms and entered into the model simultaneously with the controls and direct effects of risk and closure. Interaction effects indicate the difference in the effect of a particular risk variable across closure timing (e.g., the generally higher likelihood of an outcome due to risk is amplified by closure timing). Alternatively, and equally accurately, interactions indicate the difference between mothers with the risk characteristic who gave birth within the year before/after a facility closure and mothers with the risk characteristic who gave birth at other times.

#### Simple Effects of Closure

Because interest in the current analyses centered on determining whether facility closure timing influenced important outcomes for mothers and infants, the latter interaction interpretation above was preferred throughout the discussion of the analysis results. To accompany the primary results of each analyses, simple effects analyses were conducted to also obtain differences in outcomes between mothers without the risk characteristic who gave birth within the year before/after a facility closure and mothers without the risk characteristic who gave birth at other times. Together, the set of simple effects provide evidence of impacts due to closure timing among both mothers with the risk characteristic and mothers without the risk characteristic. These quantities are presented with the general risk effect in the tables (A.2 - A.9) that follow.



#### **Control Variables**

Relationships between each of the control variables and each of the mother and infant outcomes appear in Table A.1 below. The results below indicate the general relationships between the measures across each of the specific risk variables. With very few exceptions, slight variation in the relationships between controls and outcomes were observed in combination with different specific risks but in all cases, the variation was minimal.

		Mother and Infant Outcomes							
Control Variables	Prenatal Care Start (Months)	Prenatal Care Visits (Total)	Inadequate Prenatal Care	Labor Induction	Gestational Age (Weeks)	Preterm Birth	Birth Weight (Grams)	Low Birth Weight	
Intercept	2.506*	11.815.	0.061*	0.335*	38.909*	0.028*	3529.035*	0.029	
Mother's Age (Linear)	-0.012*	0.011*	0.974*	0.993*	-0.007*	0.997*	7.207*	0.990*	
Mother's Age (Quadratic)	0.003*	-0.005*	1.006*	0.999*	-0.001*	1.003*	-0.805*	1.004*	
Pre-pregnancy Diabetes (Yes = 1)	0.151*	1.022*	1.437*	1.162*	-1.260*	3.184*	123.087*	1.402*	
Gestational Diabetes (Yes = 1)	0.057*	0.819*	1.051	2.534*	-0.947*	2.661*	-237.118*	3.238*	
Pre-pregnancy Hypertension (Yes = 1)	0.173*	0.778*	1.125*	1.661*	-0.360*	1.165*	24.769*	0.916*	
Gestational Hypertension (Yes = 1)	-0.093*	0.569*	0.753*	4.399*	-1.077*	3.281*	-240.936*	3.788*	
Infant Gender (Female = 1)	-0.007*	0.066*	0.989	1.020*	0.067*	0.865*	-121.239*	1.160*	

Note: Values for Inadequate Prenatal Care, Labor Induction, Preterm Birth and Low Birth Weight are odds ratios. All other values are in metric specified in parentheses.

#### Maternal Outcomes

#### Inadequate Prenatal Care

Each of the risk variables, with the exception of first pregnancy, was predictive of significant delays to the start of prenatal care. While first-pregnancy mothers started care earlier, the delay among previously pregnant mothers was similar to the delays observed in the other risk categories. Mothers in all risk categories, aside from those with low education tended to start prenatal care earlier if they gave birth in the year before a facility closure or in the year following a facility closure. Interestingly, mothers who did not receive WIC or Medicaid significantly delayed the start of prenatal care when they gave birth in the year before or after a facility closure.

Table A.2. Predicted Average Start of Prenatal Care (in months) by Risk Factors and Facility Closure Timing

	Risk Variables										
	Mother's	1 <sup>st</sup>	Previous	Teenage <sup>1</sup>	Single	WIC	Medicaid	Low	Prenatal	Prenatal	Inadequate
	Age (30)	Pregnancy	Children	Mother	Mother	Receipt	Receipt	Education	Care Start	Care Visits	Prenatal
									(3)	(14)	Care
Intercept	2.508*										
Linear	-0.012*										
Quadratic	0.003*										
1 Year Prior	-0.056*										
1 Year After	-0.055*										
1 Year Prior (Linear)	0.001										
1 Year Prior (Quadratic)	-0.001										
1 Year After (Linear)	0.004										
1 Year After (Quadratic)	0.001										
Intercept		2.540*	2.332*	2.617*	2.468*	2.591*	2.544*	2.457*			
Risk (see column)		-0.184*	0.226*	0.430*	0.373*	0.230*	0.387*	0.685*			
1 Year Prior		-0.097*	-0.040°	-0.074	-0.128*	-0.224*	-0.162*	0.301*			
1 Year After		-0.075*	-0.041ª	-0.044	-0.106*	-0.046	-0.051	0.167*			
I Teal Alter		-0.075	-0.041	-0.044	-0.100	-0.040	-0.051	0.107			
No Risk (Opposite Risk)		0.184*	-0.226*	-0.430*	-0.373*	-0.230*	-0.387*	-0.685*			
1 Year Prior		-0.055*	-0.111*	-0.065*	-0.057*	0.102*	0.085*	-0.115*			
1 Year After		-0.035	-0.085*	-0.054*	-0.052*	0.102	0.128*	-0.099*			

Note: Numbers in parentheses for continuous predictors (Mother's age, Prenatal Care Start, and Prenatal Care Visits) indicate centering points. All risk models controlled for the mother's age (linear/nonlinear), existing/gestational diabetes/hypertension, and infant gender

<sup>1</sup>Mother's age was removed from the model to accurately reflect the difference between teen and non-teen mothers

- Younger and older mothers delayed the start of prenatal care relative to mothers around age 30, who initiated prenatal care slightly earlier when they gave birth in the year before or after a facility closure.
- Mothers pregnant for the first time tended to start prenatal care earlier than mothers with previous pregnancies but all mothers started prenatal care earlier when they gave birth in the year before or after a facility closure.
- Mothers with previous children started prenatal care later than did mothers without children but all mothers initiated prenatal care slightly earlier when they gave birth in the year before or after a facility closure.
- Teen mothers started prenatal care later than did adult mothers and did not demonstrate an earlier start to care in the years surrounding a facility closure.
- Single mothers started care later than did married mothers but also started care earlier in the years surrounding a facility closure, relative to single mothers who gave birth at other times.
- Mothers who received WIC or Medicaid started prenatal care later than did mothers who received neither support. Among WIC/Medicaid recipients, earlier starts to care were observed for recipient mothers who gave birth in the year before a closure but the start of prenatal care did not differ in the year following a facility closure.
- Mothers with lower levels of education started prenatal care later generally, and demonstrated further delayed initiation of care when giving birth in the year before or the year after a facility closure.

Each of the risk variables, with the exception of first pregnancy, was predictive of significantly fewer prenatal care visits. While first-pregnancy mothers attended more visits, the decrease among previously pregnant mothers was similar to the decreases observed in the other risk categories. Mothers in all risk categories, aside from those with low education and mothers with previous children, attended significantly more prenatal care visits if they gave birth in the year before a facility closure and tended to attend more visits when giving birth in the year following a closure. This pattern is reversed for mothers without risk, where the total number of visits tends to decrease when birth occurred in the year before or the year after a facility closure.

						Risk Va	ariables				
	Mother's	1 <sup>st</sup>	Previous	Teenage <sup>1</sup>	Single	WIC	Medicaid	Low	Prenatal	Prenatal	Inadequat
	Age (30)	Pregnancy	Children	Mother	Mother	Receipt	Receipt	Education	Care Start	Care Visits	Prenatal
									(3)	(14)	Care
Intercept	11.818*										
Linear	0.011*										
Quadratic	-0.005*										
1 Year Prior	-0.149*										
1 Year After	-0.091										
1 Year Prior	-0.027*										
(Linear)											
1 Year Prior	0.001										
(Quadratic)											
1 Year After	-0.017*										
(Linear)											
1 Year After	-0.001										
(Quadratic)											
Intercept		11.720*	12.384*	11.649*	11.904*	11.756*	11.889*	11.959*			
Risk		0.557*	-0.731*	-0.671*	-0.684*	-0.189*	-0.671*	-1.636*			
(see column)		0.557	-0.731	-0.071	-0.004	-0.189	-0.071	-1.030			
1 Year Prior		0.167*	-0.194*	0.411*	0.393*	0.641*	0.475*	-1.525*			
1 Year After		-0.085	-0.083	0.035	0.162°	0.058	0.061	-1.044*			
No Risk		-0.557*	0.731*	0.671*	0.684*	0.189*	0.671*	1.636*			
Opposite Risk)						0.105	0.071	1.030			
1 Year Prior		-0.152*	0.167*	-0.104*	-0.278*	-0.149*	-0.108	0.088*			
1 Year After		-0.079	-0.066	-0.097°	-0.193*	-0.267*	-0.296*	0.017			

Table A.3. Predicted Number of Total Prenatal Care Visits by Risk Factors and Facility Closure Timing

Note: Numbers in parentheses for continuous predictors (Mother's age, Prenatal Care Start, and Prenatal Care Visits) indicate centering points. All risk models controlled for the mother's age (linear/nonlinear), existing/gestational diabetes/hypertension, and infant gender 'Mother's age was removed from the model to accurately reflect the difference between teen and non-teen mothers

- Younger and older mothers attended fewer total prenatal care visits, with mothers near age 30 attending fewer visits when giving birth in the year before or after a facility closure. Further, the disparity in total visits attended among mothers who gave birth in the year before a closure increased for older (over 30) mothers
- Mothers pregnant for the first time attend more prenatal care visits and increased attendance when giving birth in the year before a facility closure, whereas mothers who had been pregnant before attended fewer total visits if they gave birth in the before a closure.

- Mothers with previous children attended fewer total visits generally, and attended even fewer total prenatal care
  visits if they gave birth in the year prior to a facility closure.
- Teen mothers attended fewer prenatal care visits generally, but attended more prenatal visits when they gave birth in the year before a facility closure.
- Single mothers attended fewer total visits but tended to attend more visits when giving birth in the years surrounding a facility closure. Alternatively, total visits declined among married mothers who gave birth in the year before or after a closure.
- Mothers who received WIC or Medicaid generally attended fewer total visits, but mothers receiving either support attended more total visits when giving birth in the years surrounding a facility closure. Alternatively, mothers receiving neither support attended fewer visits when giving birth in the year before or the year after a closure.
- Mothers with lower levels of education attended fewer total visits and even fewer when they gave birth in the year before or the year after a closure in comparison to lower educated mothers who gave birth at other times. Total visits surrounding closures did not differ among higher educated mothers.

All of the risk variables were related to higher likelihood of receiving inadequate prenatal care, with the exception of first pregnancy, where first-pregnant mothers were approximately half as likely to receive inadequate care relative to mothers who had been pregnant before. Among mothers in the risk categories, all but those with previous children and those with lower education were less likely to receive inadequate care if they gave birth in the year before a facility closed. Among mothers without particular risks, facility closure was less related to inadequate care, with the exception of heightened likelihood among mothers who did not receive WIC or Medicaid and lower likelihood among those with higher education.

						Risk V	/ariables				
	Mother's Age (30)	1 <sup>st</sup> Pregnancy	Previous Children	Teenage <sup>1</sup> Mother	Single Mother	WIC Receipt	Medicaid Receipt	Low Education	Prenatal Care Start	Prenatal Care Visits	Inadequat Prenatal
									(3)	(14)	Care
Intercept	0.06*										
Linear	0.97*										
Quadratic	1.01*										
1 Year Prior	1.02										
1 Year After	1.00										
1 Year Prior	1.01										
(Linear)											
1 Year Prior	1.00										
(Quadratic)											
1 Year After	1.01										
(Linear)											
1 Year After	1.00										
(Quadratic)											
Intercept		0.07*	0.04*	0.08*	0.05*	0.07*	0.05*	0.05*			
Risk		0.58*	1.91*	2.26*	2.46*	1.48*	2.47*	3.68*			
(see column)		0.56	1.91	2.20	2.40	1.40	2.47	3.06			
1 Year Prior		0.77*	0.98	0.73*	0.74*	0.67*	0.70*	1.55*			
1 Year After		0.97	1.02	0.95	0.871	1.00	0.91	1.44*			
No Risk		1.71*	0.52*	0.44*	0.41*	0.68*	0.41*	0.27*			
Opposite Risk)		1.71		L1618			\$2.41	0.27			
1 Year Prior		0.95	0.75*	0.93	1.07	1.26*	1.40*	0.73*			
1 Year After		1.01	0.96	1.02	1.11	1.16	1.39*	0.86*			

Table A.4. Odds Ratios from Models Predicting the Likelihood of Inadequate Prenatal Care

Note: Numbers in parentheses for continuous predictors (Mother's age, Prenatal Care Start, and Prenatal Care Visits) indicate centering points. All risk models controlled for the mother's age (linear/nonlinear), existing/gestational diabetes/hypertension, and infant gender <sup>3</sup>Mother's age was removed from the model to accurately reflect the difference between teen and non-teen mothers

- Consistent with delayed start of care and attendance at fewer care visits, the likelihood of receiving inadequate prenatal care was higher for mothers on both ends of the age continuum.
- Mothers pregnant for the first time were less likely to receive inadequate prenatal care than were mothers who had been pregnant before and the likelihood decreased further among first pregnancy mothers when they gave birth in the year before a facility closure.
- Mothers with previous children were more likely to receive inadequate prenatal care in relation to mothers who did
  not have previous children but the likelihood was unaffected by closure status.
- Teen mothers and single mothers were more likely to receive inadequate prenatal care than were adult mothers and married mothers, respectively. Among those teen mothers and single mothers who gave birth in the year before a facility closure, the likelihood of inadequate care declined for both groups.

- Mothers who received WIC or Medicaid were generally more likely to receive inadequate prenatal care. The likelihood of inadequate care among mothers receiving either support decreased when they gave birth in the year before a facility closure. Alternatively, mothers who did not receive WIC or Medicaid experienced higher likelihoods of inadequate care when they gave birth in either the year before or after a facility closure.
- Mothers with lower levels of education were more likely to experience inadequate prenatal care with increasing
  likelihood of inadequate care occurring in the years before or after a facility closure. Alternatively, mothers with
  higher education were less likely to experience inadequate prenatal care, generally, and less likely if they gave
  birth in the year before or the year after a closure.

# Likelihood of Labor Induction

All of the risk variables, except first pregnancy, were related to significantly lower likelihood of labor induction. Alternatively, mothers in the corresponding non-risk groups (e.g., married mothers with higher levels of education who did not receive WIC or Medicaid) were consistently more likely to experience induced labor. Although not statistically significant in each instance, the general pattern of lowered induction likelihood among mothers who gave birth in the year after a facility closure is consistent. Generally, the likelihood of labor induction did not change among mothers who gave birth in the year before a facility closure.

Table A.5. Odds Ratios from Models Predicting the Likelihood of Labor Induction

						Risk V	/ariables				
	Mother's Age (30)	1" Pregnancy	Previous Children	Teenage <sup>1</sup> Mother	Single Mother	WIC Receipt	Medicaid Receipt	Low Education	Prenatal Care Start	Prenatal Care Visits	Inadequat Prenatal
									(3)	(14)	Care
Intercept	0.34								0.34	0.42*	
Linear	0.99"								0.97	1.09*	
Quadratic	0.99								0.99	0.99*	
1 Year Prior	0.95								0.93	0.96	
1 Year After	0.86								0.87	0.86*	
1 Year Prior (Linear)	0.99								1.00	1.00	
1 Year Prior (Quadratic)	1.00								1.01	1.00	
1 Year After (Linear)	1.00								1.00	0.99	
1 Year After (Quadratic)	1.00								0.99	1.00	
Intercept		0.33*	0.40*	0.34*	0.34*	0.37*	0.37*	0.35"			0.34*
Risk		1.19"	0.81	0.97*	0.97*	0.91	0.91	0.68*			0.69"
(see column)											
1 Year Prior		1.05	0.92*	0.99	0.96	0.98	0.98	0.88			0.99
1 Year After		0.95	0.81*	0.85	0.87*	0.85*	0.87	0.90			0.73*
No Risk Opposite Risk)		0.84*	1.24	1.04*	1.03*	1.10	1.10	1.48			1.46*
1 Year Prior		0.90*	0.99	0.94*	0.93*	0.98	0.98	0.95			0.94*
1 Year After		0.81	0.92	0.85*	0.82*	0.82	0.81	0.84"			0.86*

Note: Numbers in parentheses for continuous predictors (Mother's age, Prenatal Care Start, and Prenatal Care Visits) indicate centering points. All risk models controlled for the mother's age (linear/nonlinear), existing/gestational diabetes/hypertension, and infant gender 'Mother's age was removed from the model to accurately reflect the difference between teen and non-teen mothers

- Labor induction was most likely in the middle range of mother ages, being less likely for younger and older mothers. Among mothers aged 30, the likelihood of induction was lower for those who gave birth in the year after a facility closure.
- Mothers pregnant for the first time were more likely to experience induced labor, regardless of closure timing, whereas mothers who had been pregnant before were less likely to experience induced labor if they gave birth in the year before or the year after a facility closure.
- Mothers with previous children were less likely to experience induced labor than were mothers who did not have
  previous children and the likelihood of induction was reduced further for those mothers with previous children who
  gave birth in the years surrounding a facility closure.
- Teen mothers and single mothers were less likely to experience induced labor than were adult mothers and married mothers, respectively. Likelihood of induction was slightly but not consistently significantly lower among teen and single mothers who gave birth in the year following a facility closure.

- Mothers who received WIC or Medicaid were less likely to experience induced labor than were mothers who do not receive either support. Facility closure was unrelated to likelihood of induction among WIC/Medicaid recipients, but those mothers receiving neither support were less likely to experience induction when giving birth in the year after a facility closure.
- Mothers with lower levels of education were less likely to experience labor induction than were mothers with higher education and facility closure timing was unrelated to induction rates among lower educated mothers. Among mothers with higher levels of education, induction likelihood was lower when they gave birth in the year following a facility closure.

#### Infant Outcomes

# Gestational Age and Preterm Birth

All of the risk variables, except first pregnancy, start of prenatal care, and total number of prenatal care visits were negatively related to gestational age. Mothers pregnant for the first time tended to experience longer gestational durations. The positive associations between prenatal care start and total visits partly reflects the time component in both variables and the gestational age outcome. With reasonable consistency, mothers who gave birth in the after a facility closure tended to experience shorter gestation durations than did mothers at other times, even when holding the start of prenatal care or the total number of prenatal visits constant.

Table A.6. Predicted Average Gestational Age (in weeks) by Risk Factors and Facility Closure Timing

						Risk V	/ariables				
	Mother's	1 <sup>s1</sup>	Previous	Teenage <sup>1</sup>	Single	WIC	Medicaid	Low	Prenatal	Prenatal	Inadequate
	Age (30)	Pregnancy	Children	Mother	Mother	Receipt	Receipt	Education	Care Start	Care Visits	Prenatal Care
									(3)	(14)	
Intercept	38.910								38.946*	39.271	
Linear	-0.007*								0.043*	0.105	
Quadratic	-0.001"								-0.006*	-0.009"	
1 Year Prior	-0.060°								-0.010	-0.101	
1 Year After	-0.086"								-0.085*	-0.143"	
1 Year Prior {Linear}	0.004								0.007	-0.012	
1 Year Prior (Quadratic)	0.002*								0.003	0.004*	
1 Year After {Linear}	0.010*								-0.001	-0.010	
1 Year After (Quadratic)	0.001								0.001	0.004*	
Intercept		38.87*	39.07*	38.89"	38.92"	38.89"	38.93*	38.91"			38.92*
Risk (see column)		0.24	-0.21	-0.04*	-0.14	-0.07*	-0.20*	-0.07*			-0.21*
1 Year Prior		0.02	-0.01	0.04	0.01	-0.03	-0.06	0.08			0.12
1 Year After		-0.13*	-0.07*	-0.27*	-0.08	-0.13ª	-0.06	-0.10			-0.10
No Risk (Opposite Risk)		-0.24	0.21	0.04	0.14	0.07*	0.20*	0.07*			0.21*
1 Year Prior 1 Year After		-0.02 -0.09*	-0.01 -0.15*	-0.02* -0.09*	-0.04 -0.10	-0.02 0.07	0.01	-0.03 -0.09*			-0.03 -0.11*

Note: Numbers in parentheses for continuous predictors (Mother's age, Prenatal Care Start, and Prenatal Care Visits) indicate centering points. All risk models controlled for the mother's age (linear/nonlinear), existing/gestational diabetes/hypertension, and infant gender <sup>1</sup>Mother's age was removed from the model to accurately reflect the difference between teen and non-teen mothers

- Gestation duration was shorter among younger and older mothers. For average aged mothers, gestation was marginally shorter in the year before and significantly shorter in the year after a facility closure.
- Gestation duration was longer among mothers who were pregnant for the first time but all mothers experienced shorter gestation durations when they gave birth in the year after a facility closure.
- Gestation duration was shorter for mothers with previous children and for teen mothers relative to mothers without children and adult mothers, respectively. Mothers in all four groups (previous/no previous children; teen/adult) experienced shorter gestation durations when they gave birth in the year following a facility closure.
- Single mothers also experienced shorter gestation durations than did married mothers. However, only married mothers experienced shorter durations when giving birth in the year after a facility closure.
- Mothers receiving either WIC or Medicaid experienced shorter gestation durations than did mothers who did not
  receive either support. Gestation durations among mothers who received either support tended to be shorter in the
  year following a facility closure.

- Gestation duration was shorter among mothers with lower levels of education relative to mothers with higher levels
  of education but those with lower education did not experience differential durations surrounding facility closures.
- Earlier start and attendance at more prenatal care visits increased gestation duration. Gestation duration was shorter for mothers who gave birth in the year after a facility closure, relative to mothers with similar start timing or visit totals who gave birth at other times.
- Gestation duration was shorter among mothers who received inadequate prenatal care relative to mothers who
  received adequate prenatal care. Gestation duration was generally shorter for mothers, regardless of the adequacy
  of prenatal care, if they gave birth in the year following a facility closure.

Each of the risk variables was significantly related to the likelihood of delivering preterm. Across the various risk and no risk categories, the likelihood of preterm birth was typically higher, though not significantly so, among mothers who gave birth during the year after a facility closure. Conversely, the likelihood of preterm delivery was generally lower among mothers who gave birth in the year before a facility closure. Although consistent, none of the pre-closure reductions achieved statistical significance.

Table A.7. Odds Ratios from Models Predicting the Likelihood of Preterm Birth

						Risk V	'ariables				
	Mother's	1 <sup>st</sup>	Previous	Teenage <sup>1</sup>	Single	WIC	Medicaid	Low	Prenatal	Prenatal	Inadequat
	Age (30)	Pregnancy	Children	Mother	Mother	Receipt	Receipt	Education	Care Start	Care Visits	Prenatal
									(3)	(14)	Care
Intercept	0.028*								0.025*	0.012*	
Linear	0.997*								0.927*	0.804*	
Quadratic	1.003								1.020*	1.004*	
1 Year Prior	0.902								0.888	0.797	
1 Year After	1.242								1.112	1.184	
1 Year Prior (Linear)	1.003								0.980	0.911	
1 Year Prior (Quadratic)	1.000								0.987	0.991	
1 Year After (Linear)	0.990								0.984	0.993	
1 Year After (Quadratic)	0.998								0.997	0.998	
Intercept		0.027*	0.033*	0.031*	0.026*	0.027*	0.024*	0.027*			0.027*
Risk		1.109*	0.805*	1.471*	1.380*	1.040*	1.410*	1.183*			1.645*
(see column)		1.109	0.805	1.471	1.380	1.040	1.410	1.163			1.043
1 Year Prior		0.848	0.881	1.051	0.823	0.951	0.788	1.002			0.805
1 Year After		1.063	1.190'	1.256	0.984	1.331	1.282	1.211			1.248
No Risk Opposite Risk)		0.902*	1.242*	0.680*	0.725*	0.962*	0.709*	0.845*			0.608*
1 Year Prior		0.904	0.889	0.8643	0.927	0.842	0.976	0.870			0.899
1 Year After		1.211*	1.119	1.154*	1.276*	0.981	0.947	1.165*			1.148

Note: Numbers in parentheses for continuous predictors (Mother's age, Prenatal Care Start, and Prenatal Care Visits) indicate centering points. All risk models controlled for the mother's age (linear/nonlinear), existing/gestational diabetes/hypertension, and infant gender <sup>1</sup>Mother's age was removed from the model to accurately reflect the difference between teen and non-teen mothers

- The likelihood of preterm delivery was higher for both younger and older mothers, with significantly higher likelihood among those who gave birth in the year after a facility closure. The likelihood of preterm birth did not differ from that of mothers who gave birth at other times.
- Although the likelihood of preterm delivery was higher for mothers who were pregnant for the first time, mothers
  who were pregnant before experienced significantly higher risk of delivering preterm if they gave birth in the year
  after a facility closure.
- Conversely, mothers with previous children were less likely to deliver preterm than were mothers without previous children. The likelihood of preterm birth among mothers with and without previous children did increase (marginally) when birth occurred in the year following a facility closure.
- Both teen mothers and single mothers were more likely to deliver preterm. Facility closure was unrelated to preterm likelihood for either group, but among married mothers, those who gave birth in the year after a facility closure faced a higher likelihood of preterm delivery than did married mothers who gave birth at other times.
- The likelihood of preterm birth was generally higher among mothers who received either WIC or Medicaid. Although not statistically significant, mothers receiving either form of aid faced heightened likelihood of preterm delivery when giving birth in the year after a facility closure.

- Mothers with lower education were more likely to give birth preterm. Lower educated mothers giving birth in the year after a facility closure faced a similarly elevated risk of preterm birth as higher educated mothers when giving birth in the year after a facility closure but the increase was not statistically significant for either group.
- The likelihood of preterm delivery decreases as prenatal care starts earlier and mothers attend more total visits, generally, though both relationships flatten. Facility closure did not alter either relationship between the likelihood of preterm birth and prenatal care start or the number of total visits.
- Mothers who received inadequate prenatal care were more likely to deliver preterm. Although mothers who gave birth in the year after a facility closure were slightly more likely to deliver preterm, regardless of adequate prenatal care, the heightened risk was not statistically significant.

# Birth Weight and Low Birth Weight

Each of the risk variables was significantly related to birth weight. Birth weights did not differ significantly across facility closure timing for any of the risk variables, with the exception of the total number of prenatal visits attended. When holding the number of total prenatal visits constant, infants were born at lower average birth weights when mothers gave birth in the year before (marginally) or in the year after (significantly) a facility closure. The marginal interactions between post closure and linear/quadratic visit totals suggest potential differences in the general relationship between visits and birth weight in the year following a facility closure.

Table A.8. Predicted Average Birth Weights (in grams) by Risk Factors and Facility Closure Timing

	Risk Variables										
	Mother's Age (30)	1 <sup>st</sup> Pregnancy	Previous Children	Teenage <sup>1</sup> Mother	Single Mother	WIC Receipt	Medicaid Receipt	Low Education	Prenatal Care Start	Prenatal Care Visits	Inadequate Prenatal
									(3)	(14)	Care
Intercept	3529.08*								3528.72	3611.66*	
Linear	7.21								-6.52*	24.41	
Quadratic	-0.81								-1.04*	-1.99	
1 Year Prior	-4.52								2.89	-12.96	
1 Year After	-3.00								-3.95	-22.90*	
1 Year Prior (Linear)	0.10								0.87	-1.38	
1 Year Prior (Quadratic)	0.26								1.79	0.92	
1 Year After (Linear)	-0.47								-2.05	-5.09°	
1 Year After (Quadratic)	-0.07								0.35	0.49"	
Intercept		3535,26*	3485.72*	3492.64*	3542.81	3537.50 <sup>+</sup>	3549.79*	3535.38			3534.89
Risk		-35.38	56.12	-147.56	-104.32	-61.47	-101.70	-85.37*			-98.50 <sup>*</sup>
(see column)											
1 Year Prior		8.22	6.32	19.40	21.25	16.13	2.54	22.81			31.34
1 Year After		-0.58	-5.28	-13.13	4.54	-15.06	-16.55	12.22			10.37
No Risk Opposite Risk)		35.38*	-56.12	147.56	104.32	61.47	101.70	85.37*			98.50 <sup>*</sup>
1 Year Prior		2.75	1.83	3.19	-4.66	-17.36	-9.06	2.72			1.27
1 Year After		-6.73	-4.33	-4.23	-8.22	-5.77	-0.50	-3.97			-5.65

Note: Numbers in parentheses for continuous predictors (Mother's age, Prenatal Care Start, and Prenatal Care Visits) indicate centering points. All risk models controlled for the mother's age (linear/nonlinear), existing/gestational diabetes/hypertension, and infant gender <sup>3</sup>Mother's age was removed from the model to accurately reflect the difference between teen and non-teen mothers

- Birth weights were lower, on average, for infants born to mothers who were younger, older, pregnant for the first time, teenagers, single, WIC or Medicaid recipients, under educated, or who had received inadequate prenatal care by either delaying care initiation or attending fewer total visits.
- Only mothers who had previous children gave birth to heavier infants, on average, compared to mothers who did not have previous children.
- Among mothers who attended the average number of total prenatal visits (12-14), those who gave birth in the year after a facility closure had children with lower birth weights than did mothers who attended the same number of visits but gave birth at other times.
- Facility closure timing had no further direct impact on infant birth weights.

Mother's age, earlier start to prenatal care, attending more prenatal care visits, and having previous children were all associated with lower general likelihood of underweight birth. Alternatively, the likelihood of underweight birth was

higher for mothers in the remaining risk categories. Facility closure timing had no influence on differential likelihood of delivering underweight.

						Risk V	/ariables				
	Mother's	1.4	Previous	Teenage <sup>1</sup>	Single	WIC	Medicaid	Low	Prenatal	Prenatal	Inadequat
	Age (30)	Pregnancy	Children	Mother	Mother	Receipt	Receipt	Education	Care Start	Care Visits	Prenatal
									(3)	(14)	Care
Intercept	0.03*								0.03*	0.02*	
Linear	0.99*								0.99	$0.86^{*}$	
Quadratic	1.01*								1.01*	1.01*	
1 Year Prior	0.93								0.87	1.08	
1 Year After	1.16								1.07	1.14	
1 Year Prior (Linear)	1.01								0.97	1.04	
1 Year Prior (Quadratic)	1.00								1.00	1.00	
1 Year After (Linear)	0.99								0.97	1.02	
1 Year After (Quadratic)	1.00								0.97	1.00	
Intercept		0.03*	0.04*	0.03*	0.03*	0.03*	0.02*	0.03*			0.03*
Risk		1.17*	0.76*	1.70*	1.62*	1.23*	1.65*	1.42*			1.66*
(see column)		1.17	0.70	1.70	1.02	1.25	1.05	1.42			1.00
1 Year Prior		0.87	0.86	0.96	0.86	0.92	0.89	0.74			0.86
1 Year After		0.98	1.04	1.07	0.90	0.95	1.00	1.11			0.87
No Risk Opposite Risk)		0.86*	1.32*	0.59*	0.62*	0.81*	0.61*	0.70*			0.60*
1 Year Prior		0.91	0.94	0.89	0.93	0.95	1.00	0.92			0.91
1 Year After		1.08	1.04	1.05	1.16	1.02	0.96	1.04			1.07

Table A.9. Odds Ratios from Models Predicting the Likelihood of Low Birth Weight (< 2500 grams)

Note: Numbers in parentheses for continuous predictors (Mother's age, Prenatal Care Start, and Prenatal Care Visits) indicate centering points. All risk models controlled for the mother's age (linear/nonlinear), existing/gestational diabetes/hypertension, and infant gender <sup>3</sup>Mother's age was removed from the model to accurately reflect the difference between teen and non-teen mothers

- The likelihood of underweight birth was significantly higher among mothers who were younger, older, pregnant for the first time, teenagers, single, WIC or Medicaid recipients, under educated, or who had received inadequate prenatal care by either delaying care initiation or attending fewer total visits.
- Mothers with previous children were significantly less likely to give birth to an underweight infant than were mothers who did not have previous children.
- Facility closure timing had no direct impact on the likelihood of underweight birth.