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Anna E. Carson April 24, 2018

Labor and Delivery Unit Closures in Rural Georgia from 2012-2016: A Mixed-Methods Investigation

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Master of Public Health, 2018

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An Abstract of
A thesis submitted to the Faculty of the
Rollins School of Public Health of Emory University
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Abstract

Labor and Delivery Unit Closures in Rural Georgia from 2012-2016: A Mixed-Methods Investigation

By
Anna Elizabeth Carson

Obstetric provider coverage in rural Georgia has worsened in the past ten years, with nine rural labor and delivery units closing between 2012 and 2016. Georgia consistently has the highest maternal mortality rate in the nation and faces increased adverse health consequences from this decline in obstetric care. The purpose of this study is to explore what factors may be associated with rural hospital labor and delivery unit (LDU) closures in Georgia between 2012 and 2016. This study describes differences between hospitals in rural Georgia that closed LDUs and those which remained open from 2012 to 2016 through a quantitative analysis of 2011 baseline regional, facility, and patient level data, as well as a qualitative analysis of newspaper articles addressing the closures. Primary factors associated with closure include lower 2011 birth volume among LDUs, lower average annual births per provider, higher proportion of deliveries in Primary Care Service Area (PCSA) of residence, higher birth volume at nearest hospital, higher proportion of black patients, and higher proportion of Medicaid and self-pay patients. Qualitative results indicate financial distress primary contributed to closures, but also suggest that low birth volume and obstetric provider shortage impacted closures as well. Reports and presentations by the Georgia Maternal and Infant Health Research Group (GMIHRG) were found to stimulate news article publication regarding LDU closure, indicating the effectiveness of research and advocacy on LDU closure publicity. In effort to prevent further LDU closure and poor maternal health outcomes, this study recommends increasing attention to hospital LDU risk factors, advocating for communities vulnerable to closure, and developing creative healthcare delivery methods post-closure.

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Glossary

CNM – Certified Nurse Midwife

FDI – Financial Distress Index

FP – Family Practitioner

GA – Georgia

GDPH - Georgia Department of Public Health

GMIHRG – Georgia Maternal and Infant Health Research Group

GOGS – Georgia OBGYN Society

HRSA - Health Resources and Services Administration

LDU – Labor and Delivery Unit

MCH – Maternal and Child Health

MSA – Metropolitan Statistical Area

OB – Obstetrician

OMB - Office of Management and Budget

PCSA – Primary Care Service Area

USDA - United States Department of Agriculture

Introduction

Obstetric care shortage is not a new problem for rural Georgia, but the past ten years have seen a worsening of adequate obstetric care coverage (Spelke, Zertuche, & Rochat, 2016). Georgia residents face serious poor health outcomes resulting from inadequate care provision. As of 2012, Georgia had the highest maternal mortality rate of 28.7 deaths per 100,000 live births and 11th highest infant mortality rate of 6.98 infant deaths per 1000 live births (*Georgia Maternal Mortality: 2012 case review*, 2015). Lacking appropriate obstetric care puts women and infants at greater risk of poor prenatal care, obstetric crisis, and insufficient postnatal care (Katy B. Kozhimannil, Henning-Smith, Hung, Casey, & Prasad). The closure of nine rural labor and delivery units (LDU) in Georgia between 2012 and 2016 exacerbated the paucity of care in the state. Consequently, LDU closures in Georgia present severe implications for the health of Georgia mothers, babies, and families.

This phenomenon of rural LDU closure has become prevalent in other US states as well, as evidenced through several multi-state studies that analyze factors associated with hospital LDU closure (Hung, Henning-Smith, Casey, & Kozhimannil, 2017; Hung, Kozhimannil, Casey, & Moscovice, 2016; Katy B. Kozhimannil et al.). Previous studies have included rural hospitals from a variety of states, but, thus far, there is no literature on Georgia-specific rural LDU closures that identifies reasons for closure, gaps in care, and possible solutions.

This project answers the question: what facility, regional, and patient-level factors in 2011 may be associated with rural hospital LDU closures between 2012-2016? To address this question, this paper (1) analyzes quantitative facility, regional, and patient- level factors associated with rural hospital LDU closure or non-closure and (2) assesses qualitative reasons for hospital closures through analyzing newspaper articles addressing rural LDU closures in

Georgia. These findings may be used to identify Georgia-specific predictors of LDU closures and to develop innovative ways to avoid LDU closure and increase appropriate obstetric services in rural regions.

Chapter I. Literature Review

National Rural Hospital Closures

Across the United States, rural communities have faced increasing numbers of hospital shut-downs or service restrictions. Along with an increase in complete closures of rural hospitals, a growing number of rural hospitals, which remain open, have closed their obstetric services. From 2004 to 2014, 45% of rural counties in the US had no hospital obstetric services, and 9% of additional rural counties lost all hospital obstetric services (*ACOG Committee Opinion No. 586: Health disparities in rural women. Obstetrics and Gynecology*, *123*, 2014; Hung et al., 2017). More than 28 million women of reproductive age live in rural US counties, hence these closures have serious national impact (Hung et al., 2017).

Reasons for these closures include a variety of factors such as birth volume, decline in providers, proximity to another hospital, poor hospital finances and high regional unemployment, and regional population demographics such as high percentage black and Hispanic (Holmes, Kaufman, & Pink, 2017). These previously studied factors suggest that hospital closures may be predictable – and that the impact of closure may disproportionately affect individuals of specific racial and socio-economic backgrounds (Holmes et al., 2017). For example, between 2010 and 2013, rural LDUs most likely to close had fewer than 240 births per year and were located in lower income communities with fewer primary care physicians (Hung et al., 2016). Further significant risk factors for the loss of obstetric services at rural hospitals include following (Hung et al., 2017; Hung et al., 2016):

- Fewer obstetricians and family physicians per women of reproductive age and per capita
- Higher percentage of non-Hispanic black women of reproductive age
- Lower median household incomes
- More restrictive state Medicaid income eligibility thresholds for pregnant women
- Low birth volume

- Critical Access Hospital status
- Hospital accreditation

Financial Burdens

Rural LDU and hospital closures are primarily attributed to financial shortfalls (Balasubramanian & Jones, 2016). Obstetric services often have high fixed costs and low reimbursements, leading to LDU financial loss in hospitals with low birth volume (Shah, 2018). One 2017 study developed a financial distress index (FDI) to predict hospital closures, in response to the growing number of rural shut-downs. The FDI forecasted that in 2015, 8.01% of rural hospitals were at high risk of financial distress, 16.3% were mid-high, 46.8% were mid-low, and 28.9% were low risk (Holmes et al., 2017). One of the major reasons for the high rate of financial-related closures has to do with rural hospitals treating a higher proportion of patients on Medicaid compared to urban hospitals (Hung et al., 2017). Rates of reimbursement for childbirth under Medicaid are lower than for private insurance. These low reimbursement rates, combined with a 2% reduction in Medicare payments to providers in 2011, has resulted in rural hospitals not receiving adequate payment for childbirth services (Hung et al., 2017; Nelson, 2017). As a result, obstetric services tend to be among the first service lines to be cut when a hospital faces financial distress (Hung et al., 2017).

Consequences for Lack of Access

Women who lack access to nearby obstetric care bear the inconvenience and cost of increased travel times to seek maternity care. They may experience negative outcomes associated with increased distance to care, including higher risk of infant mortality and out-of-hospital birth (Hung et al., 2017). A recent study of nearly 5 million births across 1,086 US counties demonstrated that in counties not adjacent to an urban center, the loss of hospital-based obstetric

care was significantly associated with increased births in hospitals without LDUs (3.06%) and increased rate of preterm births (0.67%) compared to counties with continual obstetric services (K. B. Kozhimannil, Hung, Henning-Smith, Casey, & Prasad, 2018). This means that LDU closures leave rural women, already more susceptible to undetected underlying health conditions, facing increased risk of delivering in a facility without the obstetric services to meet their needs. Delayed care can lead to higher incidence of obstetric emergencies, and small rural hospitals often do not have the resources such as blood banks to care for obstetric emergencies exacerbated by delays (Mann, McKay, & Brown, 2017). Additionally, associations have been found between LDU closures and subsequent lack of prenatal care for women living in the closure regions (Shah, 2018). Ultimately, women and infants may experience harmful health consequences due to lack of access to the appropriate level of obstetric care.

Obstetric Care Providers

The national decrease in rural obstetric providers corresponds to recent trends in LDU closures. From 2000 to 2010, maternity care provision by family physicians declined from 23.3% to 9.7%, with a majority of remaining providers being female (Tong et al., 2013). Female providers are more likely to take time off for raising children, hence their average length of practice is less than that of their male counterparts (Tong et al., 2013). A study regarding obstetrician (OB) recruitment in the Pacific Northwest identified that rural providers had more interest in hiring partners familiar with their community, whereas urban providers looked to hire individuals with specialized skills (F. Fialkow, M. Snead, & Schulkin, 2017). Reasons that providers left rural communities included low reimbursement, limited social and marital options, and lack of access to specialized care. Further work in Georgia (explored below) provides more insight to OB recruitment and retention factors.

Possible Solutions

Researchers and policy makers have proposed various solutions to provide obstetric care in rural areas affected by hospital service closures. One idea called the "Maternal Health Compact" includes linking lower care hospitals with tertiary care hospitals to integrate transportation and telehealth services (Mann et al., 2017). This method of service delivery can facilitate appropriate transfer for critical cases while not requiring lower care hospitals to invest in intensive equipment and training. Additionally, telemedicine can provide a powerful solution to delivering advanced care to sparsely populated areas. These services can give access to consultation, referral, and training from regional hospitals (Hung et al., 2017). Lastly, high levels of care competency for low risk patients can be managed in a low volume setting, e.g. by nurse midwives, but tertiary care, especially for high risk patients, requires a high volume hospital to maintain the appropriate level of equipment and specialized staff (Hung et al., 2017).

Georgia Context

Obstetric care shortage has been a longstanding problem for rural Georgia, with adequate obstetric care coverage worsening in the past ten years. This shortage of care has been exacerbated because nine LDUs closed in hospitals outside Atlanta Metropolitan Statistical Area (MSA) between 2012 and 2015. Georgia has the 11th highest infant mortality rate (6.98 infant deaths per 1000 live births) in the United States, and the highest maternal mortality ratio (28.7 mothers die from pregnancy-associated causes for each 100,000 live births) (*Georgia Maternal Mortality: 2012 case review*, 2015). Recent state efforts to decrease premature births have helped lower Georgia's preterm delivery rate from 12.7% in 2013 to 10.8% in 2016 (*Premature Birth Report Card*, 2013; *Premature Birth Report Card*, 2016). However, from 2013 to 2016, the March of Dimes has lowered Georgia's rating from "C" to "D" due to persistent issues in care provision

(*Premature Birth Report Card*, 2013; *Premature Birth Report Card*, 2016). Following the troubling national trend in rural LDU closure, Georgia may face increase threats to maternal and infant health care as a result of these closures.

Defining Rural Regions

Regionalization presents significant complications when estimating health use patterns in rural areas. For example, the definition of "rural" areas differs greatly based on sources such as Health Resources and Services Administration (HRSA), United States Department of Agriculture (USDA), Office of Management and Budget (OMB), and even the Georgia Department of Public Health (GDPH) ("Defining Rural Population," ; "Population Definitions,"). These diverse characterizations of "rural" hospitals and populations can obstruct consistent results and meaningful applications of health research. Furthermore, health use patterns of rural residents may differ greatly from one rural region to the next depending on factors such as access to transportation and proximity to urban areas. Although this study does not examine rural health use patterns based on the gold standard method of residential address, it attempts to describe rural Georgia populations and estimate childbirth delivery patterns through county and regional classifications. The Office of Management and Budget defines non-Metro counties as those with fewer than 50,000 residents ("Defining Rural Population,"). This study distinguishes "rural" hospitals as those located in Primary Care Service Areas (PCSA) that contain individual counties with less than 50,000 people. PCSAs are regional units which represent patient healthcare utilization patterns and typically include one or more counties ("Primary Care Service Area Data Download "). This unit provides the best way to characterize and evaluate healthcare usage in rural settings for this study.

Literature on Georgia Obstetric Providers

The Georgia Maternal and Infant Health Research Group (GMIHRG) has conducted extensive research on obstetric provider shortage, provider attitudes on remaining in Georgia, and barriers to prenatal care. These results have been used to inform policy makers of the state of maternal health in Georgia to motivate evidence-based decision making (Zertuche, Spelke, Julian, Pinto, & Rochat, 2016). A study of 82 surveyed non-MSA PCSAs in 2011 showed that 52 % were deficient in obstetric care; 16 % had a shortage and 37 % lacked obstetric providers entirely. There were no delivering family practitioners (FP) in 89 % of PCSAs and no certified nurse midwives (CNM) in 70 % (Spelke et al., 2016). As of 2016, PCSAs completely devoid of obstetric care had risen to 44%, PCSAs without delivering FPs had risen to 91% and those without CNM had increased to 76% (Carson & Pinto, 2017). Overall, sufficient obstetric provider workforce has worsened across the state.

A study of obstetricians, maternal-fetal medicine specialists, certified nurse midwives, and maternal and infant health leaders in Georgia indicated that providers faced significant financial barriers in service delivery, including low Medicaid reimbursement, high proportions of self-pay patients, and high cost of medical malpractice insurance (Pinto, Rochat, Hennink, Zertuche, & Spelke, 2016). This finding aligns with national associations between LDU closures and both lower median household incomes and restrictive Medicaid eligibility (Hung et al., 2017; Hung et al., 2016). Further challenges in provision of obstetric care in rural Georgia were related to late initiation of prenatal care and lacking collaboration between obstetric providers. Proposed essential components to effective models of care included continuity, efficient use of resources, and risk-appropriate services (Pinto et al., 2016).

A subsequent study of GMIHRG surveys of Georgia OB residents and CNM students indicated that 24.4 % (19/78) of residents and 53.6 % (15/28) of CNM students expressed

interest in practicing in rural Georgia. Both medical residents and CNM students were more likely to desire to practice in rural Georgia with the offer of any of six financial incentives ($p < 0.001$). Respondents expressed concerns about Georgia's political environment surrounding reproductive healthcare, which focused more on anti-abortion measures than supporting obstetric care. The study concluded that increasing rurally-focused financial incentive programs and emphasizing the role of CNMs may alleviate obstetric provider shortages in Georgia (Smulian et al., 2016).

Lastly, another GMIHRG study interviewing women who gave birth in Georgia between July and August 2013 analyzed barriers to prenatal care access through the “Three Delays to Care” Framework (Meyer et al., 2016). This study identified delays in a women’s decisions to seek prenatal care (such as awareness of pregnancy and stigma); delays in accessing an appropriate healthcare facility (such as choosing a doctor and receiving insurance coverage); and delays in receiving adequate and appropriate care (such as continuity of care and communication). Moreover, many participants had perceptions of low self-worth and believed this influenced their prenatal care seeking (Meyer et al., 2016). This study highlighted the need for consistent communication and care to best serve pregnant women in Georgia.

These studies have comprehensively assessed the distribution of obstetric providers across the state, barriers to providing care, obstetric provider attitudes toward working in rural areas, and patient care-seeking behaviors. These findings establish the need for improved access to obstetric care through increasing incentives and strengthening maternal healthcare systems. Because women face delays in seeking care, providing access to quality and continuous obstetric care in rural areas is critical to improve birth outcomes. These studies focus on provider- and

patient- level influences on care but do not address factors which affect Georgia's rural hospital LDU closures.

Project Motivation

Hospital closures in GA have serious implications for the health of GA mothers, babies, and families. Increasingly, rural hospitals in the US are unable to sustain LDUs due to issues includes finances, birth volume, and provider availability. Many researchers have conducted studies about the influencers and impact of rural LDU closures across the US – but these studies have not featured GA. Many state and national newspapers, however, have raised the issues of rural hospital access in GA through articles featuring recent LDU closures. Despite this attention to national rural LDU closures and Georgia provider shortage, there is no literature on GA-specific rural LDU closures to identify reasons for closure, gaps in care, and possible solutions.

This project aims to answer the question: what facility, regional, and patient-level factors in 2011 may be associated with rural hospital LDU closures between 2012-2016? This study quantitatively assesses regional, facility, and patient level factors associated with rural Georgia LDU closures from 2012-2016, as well as qualitatively assesses news articles referencing LDU closures over the same time period. Through identifying contributors to rural LDU closure, this study contextualizes the issue in Georgia and may guide further research and policy to both prevent future LDU closures and respond to shortages of obstetric care.

Chapter II. Methods

Research Design

This study was a secondary data analysis designed as a "flipped" case-control study of rural hospitals which closed their LDU from 2012-2016 (case) and hospitals which retained their LDU over the same time period (control). The study design flipped traditional approaches because the exposure included factors at the patient- and regional- levels and the outcome was closure status at the facility level. All quantitative data was from 2011 to consistently compare baseline characteristics of LDUs before the closure events, which follows the design of a recent study by Hung et. al evaluating rural LDU closures (Hung et al., 2016). All data for analysis was previously collected by the Georgia Department of Public Health's Online Analytical Statistical Information System (OASIS), the Georgia Maternal and Infant Health Research Group (GMIHRG), the United States Census Bureau, and Emory's MCH Linked Vital Records Data Repository.

Regional Assessment

Purpose: This assessment was conducted to identify and map rural hospitals with open and closed LDUs, analyze distances between hospitals, and characterize population changes, racial demographics, and birth volume in the regions of open and closed LDUs.

Sampling Frame

Hospitals in the sample have the following inclusion criteria:

1. PCSAs were outside of Atlanta MSA.
2. Individual counties within each PCSA did not have populations greater than 50,000 in 2011. (The cumulative PCSA population may exceed 50,000, however.)
3. Facilities were the single hospital provider within their PCSA in 2011.

The sample included facilities which were the single providers in the PCSA because these hospitals provided the majority of services in the area, and discontinuing services likely had a

greater impact on the region than in PCSAs with multiple hospitals (Balasubramanian & Jones, 2016). Although this study analyzed predictive factors of hospitals closures, the intention was to focus on "rural" hospitals that served as the main providers of care to remote areas.

The *case* sample included hospitals which closed LDUs between 2012-2016, and *control* sample included hospitals which retained LDUs during the same time period (Table 1). Regional-level data included all PCSAs of facilities that meet the inclusion criteria. Patient-level data included all patients who delivered in hospitals in 2011 that meet the inclusion criteria. Only resident births were counted in the sample due to data availability.

According to this sampling frame, the following PCSAs, counties, and facilities were included:

- Total LDU Open in 2011: 32
- LDU Closed 2012-2016: 6
- LDU Open 2012-2016: 26

PCSA	Counties	Facility
12	Lumpkin County	Chestatee Regional Hospital - Sunlink
48	Johnson and Washington Counties	Washington County Regional Medical Center
50	Burke County	Burke Medical Center
57	Emanuel County	Emanuel Medical Center
80	Cook County	Memorial Hospital of Adel
91	Appling County	Appling Healthcare System
4	Fannin County	Fannin Regional Hospital
5	Union County	Union General Hospital
8	Stephens County	Stephens County Hospital
9	Franklin County	Ty Cobb Healthcare System - Cobb Memorial Hospital
10	Banks and Habersham Counties	Quorum Health Resources - Habersham County Medical Center
14	Pickens County	Netcare Health Systems - Mountainside Medical Center

44	Upson and Lamar Counties	Upson Regional Medical Center
47	Baldwin County	Quorum Health Resources - Oconee Regional Medical Center
58	Montgomery and Toombs Counties	Meadows Regional Medical Center
60	Laurens and Treutlen Counties	Fairview Park Hospital
62	Dodge County	Dodge County Hospital
64	Pulaski and Wilcox Counties	Taylor Regional Hospital
65	Crisp County	Crisp Regional Hospital
68	Schley and Sumter County	Sumter Regional Hospital
72	Miller and Seminole County	Donalsonville Hospital
73	Decatur County	Memorial Hospital of Bainbridge (and Manor)
74	Grady County	Grady General Hospital
75	Thomas County	Archbold Medical Center - J. D. Archbold Memorial Hospital
78	Colquitt County	Colquitt Regional Medical Center
79	Tift and Turner Counties	Tift Regional Medical Center
86	Irwin County	Irwin County Hospital
87	Ben Hill County	Dorminy Medical Center
88	Atkinson and Coffee County	Coffee Regional Medical Center
90	Bacon County	Bacon County Hospital
92	Long and Wayne Counties	Wayne Memorial Hospital
94	Pierce and Ware Counties	Satilla Health Services - Satilla Regional Medical Center / Mayo Clinic Waycross

Table 1. All hospitals included in the sample

Data Sources: Population data was retrieved from online archives of the United States Census Bureau for 1950 and 1980, and from the Georgia Department of Public Health County's OASIS database for 2010. Hospital data was retrieved from the GMIHRG 2011 obstetric provider survey database.

Study Procedures: Population data was aggregated into regions based on LDU closure status and labeled as “closed” and “open.” Population data was plotted in scatter plots and bar graphs to show changes in total numbers of residents and birth volumes.

Facility Assessment

Measurement

The following variables of interest were identified due to demonstrated associations in previous studies about LDU shortages (Hung et al., 2017; Hung et al., 2016) and previous studies on obstetric workforce in Georgia (Pinto et al., 2016; Spelke et al., 2016). The variables are represented according to their level of analysis:

Regional Level

Source: US Census, OASIS ("Online Analytical Statistical Information System," 2017)

1. Number of females age 15-44 in PCSA
2. Number of live births in PCSA
3. Net change in population (2001 to 2011) in PCSA
4. Median family income in PCSA

Variables 1-2 provided information on the population in need of obstetric and gynecological services in the region, which demonstrated how service demand was associated with LDU closure. Variable 3-4 provided information about the tax base and economic status of the region, which demonstrated how regional finances were associated with LDU closure.

Facility Level

Data Source: Georgia Maternal and Infant Health Research Group (GMIHRG), Georgia Department of Public Health

5. Number of providers (obstetrician, certified nurse midwife, family practitioner)

6. Age of providers
7. Average annual births per provider
8. Number of live births total

Variables 5-7 regarding providers reflected how the availability of physician workforce was associated with closure. The number of live births was used to demonstrate how differences in birth volume is associated with closure, as this variable has been identified as a major contributor to hospital closure in past studies (Hung et al., 2017; Hung et al., 2016).

Patient Level

Data Source: Emory's MCH Linked Vital Records Data Repository.

Inclusion: All patients that delivered at facilities in rural Georgia hospitals in 2011.

1. County of residence
2. Payor status (Medicaid, private, other)
3. Race/ethnicity
4. Number of prenatal visits
5. Rate of low birth weight and preterm birth

Variable 1 was used to determine if women delivered in the hospital located within their residential PCSA. Variables 2-3 has been demonstrated to be a determinant of hospital LDU closures in past studies (Hung et al., 2017; Hung et al., 2016). Variables 4-5 were used as proxies to assess women's access to care in the region prior to delivery. For the patient sample, only Georgia residents were included due to incomplete patient records for non-resident births. In total, fewer than 160 births in LDUs within the sample were to non-residents, 107 of which occurred in one hospital on the state border. In regard to annual births per provider, the number of births included all resident and non-resident births.

Secondary data was safely stored on the researcher's personal computer under password-protected documents. No identifiers such as names or addresses will be included in the data files. All patient-level and facility-level data was aggregated to case and control groups, which protected identity concerns for small populations. After analysis, all patient level data was destroyed.

Internal validity was ensured through including all facilities, regions, and maternal patients that fall under the sampling frame. The study is not intended to be generalized past rural hospitals in Georgia, but external validity was attempted through defining "rural" consistently with other studies on rural hospitals.

Data Analysis

Data was analyzed with SAS software. All information was aggregated to 2 groups based on LDU closure status, at the facility or PCSA region level. Due to the small sample size, all analyses compared median values across facilities by closure status and assessed these values for statistical significance with the Mann-Whitney test for nonparametric distributions. This test is appropriate for small sample sizes and independent data samples which may not be normally distributed (LaMorte, 2017). The median two-sample test was used, which tests the null hypothesis that there is no difference between the median values of the two treatment groups.

When comparing two patient-level proportions, such as black and white patients by LDU closure status, all patient data was aggregated by closure status. Chi-squared tests for association at the 5% level of significance were conducted, and odds ratios were reported for all significant associations. The association between black/white race and closure status was adjusted for confounding by payor status.

Patient-Level Data. To assess variables with many sub-categories such as race, payor status, and Kotelchuck index, chi-square tests of proportions were conducted to identify whether the distribution of factors were significantly different between the two groups. In this test, the null hypothesis was that the proportion of patient race is comparable for both closed and open LDUs. Results with $p<0.05$ indicated that the distribution differed between closed and open LDUs.

Facility-Level Data. For the facility-level variable "county of residence," the proportion of deliveries within vs. outside county of residence was calculated by the number of births within residence divided by the total number of births.

For provider data, the number of providers for each facility were compared. Average age and births per provider were taken for each facility individually, and the median values across facilities were compared by closure status. Number of OB equivalents was calculated based on the expected annual delivery load for each type of provider and represented by the following formula, utilized in GMIHRG data analysis (Spelke et al., 2016):

$$OB\ Equivalents = 1 * OBs + \left(\frac{1}{1.55}\right) * CNM + \left(\frac{0.70}{1.55}\right) * FPs$$

Annual births per provider were calculated by the number of 2011 facility births divided by number of OB equivalents.

Distance analysis. All hospitals with 1 or more births in 2011 according to GDPH birth data were plotted on the map. All hospitals with <5 births were examined online for evidence of LDU. Those which did not advertise having an LDU were assumed to have had deliveries in the ER and were not included in the sample of birth hospitals but were represented on the maps. All addresses were verified on Google for accuracy. All birth hospitals and rural open and closed LDU were plotted in Google My Maps. Hospitals located outside the state of Georgia were not

included in the sample. All urban centers with >50,000 population for neighboring states – Florida, Alabama, Tennessee, South Carolina, and North Carolina were plotted from Census Urban Areas (Statistics, 2017).

Distance to the nearest birth hospital was measured as the shortest driving mileage between Georgia hospitals, as estimated by Google maps. This distance was ascertained by measuring the driving distance between all two hospitals and choosing the shortest route in miles. If two distances had the same number of miles, the one with the shorter driving time was chosen. All hospitals were included, even those in the LDU closure sample. Distance to an urban center was analyzed according to the number of miles to the closest urban center, including those outside the state of Georgia. Distance to nearest hospital was compared by LDU closure status through assessing median values with the Mann-Whitney test.

Regional-Level Data. 32 PCSAs were made up of 44 counties. For numerical variables including population size and number of births, the sum of the counties was calculated. To analyze the average family income value by PCSAs, for those PCSAs which incorporated 2 counties, a population-proportion weight was developed for each county by dividing the population of one county by the total population of both counties (shown below). This population-proportion weight was multiplied by the value of each variable of interest for the counties, and then summed for all counties in the PCSA. Then, the median values for all PCSA according to closure status were calculated and evaluated with a non-parametric test for significance.

A= population County A
B= population County B
X=value of Variable A for County A
Y= value of Variable A for County B
P= total value for PCSA

$$P = \left(X * \frac{A}{(A+B)}\right) + \left(Y * \frac{B}{(A+B)}\right)$$

A predictive model was not developed from study data due to the small LDU sample size and therefore low predictability power. Rather, the data was intended to be descriptive, with certain results suggested for consideration as predictive factors for rural Georgia LDU closures.

Qualitative News Assessment

Sampling Frame

The sample included newspaper articles and Georgia OBGYN Society (GOGS) reports published between 2012-2016 featuring hospital LDU closure in Georgia. Google Scholar and the Emory Newspaper Database (EBSCO) were used to search for newspaper articles published between 2012-2016. Keywords included "Georgia", "labor and delivery unit closure", "rural", "obstetric services." The lay term "stops delivering babies" was later implemented to identify a wider range of news headings. Additional sources were retrieved from key contacts including the Georgia OBGYN Society, Georgia Health News, and the Georgia Hospital Association. Duplicate news articles were noted and removed from the sample.

Data Analysis

Date of publications including news articles, GOGS articles, and GOGS presentations were plotted over time along with date of LDU closures. All news articles were categorized according to publishing source. Newspaper data was analyzed using MAXQDA software. Content and thematic analysis were used to analyze newspaper articles related to LDU closure in rural Georgia. A codebook was developed with key themes derived from the data, and articles were coded to identify these themes. Results of thematic analysis were presented through in-depth thematic descriptions grounded in the data and illustrated through exemplar quotes. The data was categorized and conceptualized in a visual explanatory framework. To provide

enhanced context for the rural LDU closure phenomenon, quotes from external correspondence with key informants were included, as well as summaries of a few articles published after 2016 regarding rural economics.

Chapter III. Results – Quantitative: Regional Analysis

This section outlines the location of birth hospitals in Georgia, indicates the timeline of hospital closures, and details the population demographics and birth volume of the sample region. Note: Regions which experienced LDU closure in 2011 are referred to as "closed LDU regions" compared to "open LDU regions," although the closures had not yet occurred at the time the baseline data was collected.

Across the state of Georgia, 101 hospitals delivered babies in 2011. Of these hospitals, 32 were rural hospitals with LDUs, 58 were non-rural hospitals with LDUs, and 11 were hospitals without LDUs which delivered babies, likely in the emergency room (Figures 1a-b). While non-LDU births were distributed across the state, the highest proportion occurred in the south of the state, where birth hospitals are sparser. After 2011, 26 rural hospitals retained LDU services (*rural open*) and 6 rural hospitals ceased LDU services (*rural closed*) (Figure 2)

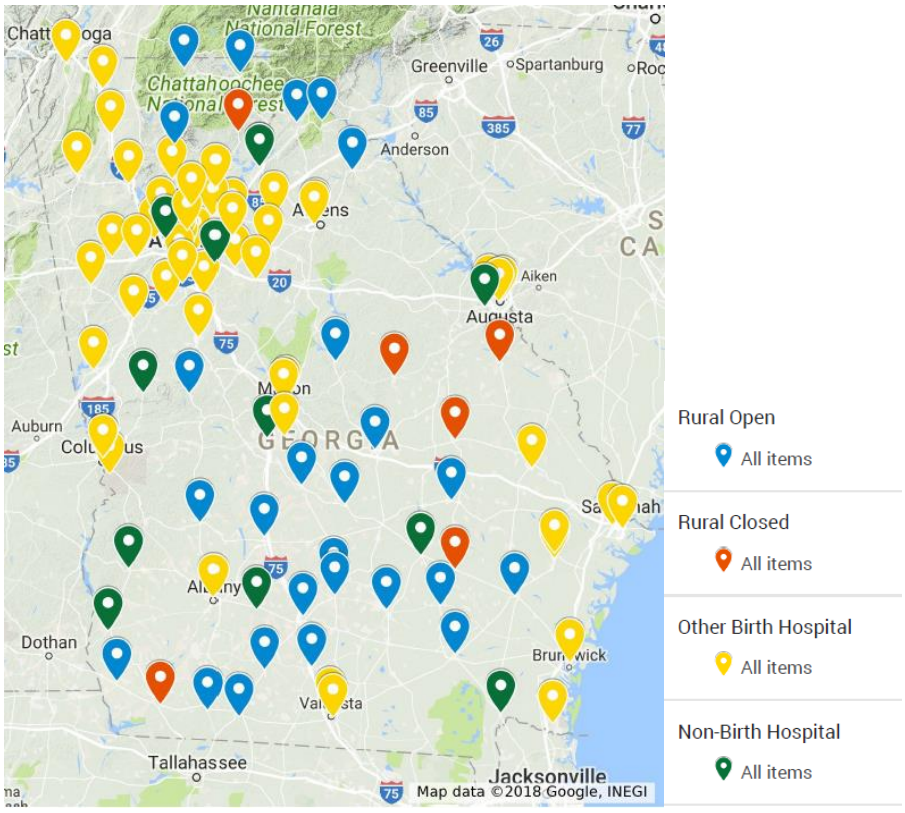

Figure 1a. All Georgia hospitals which delivered babies in 2011.

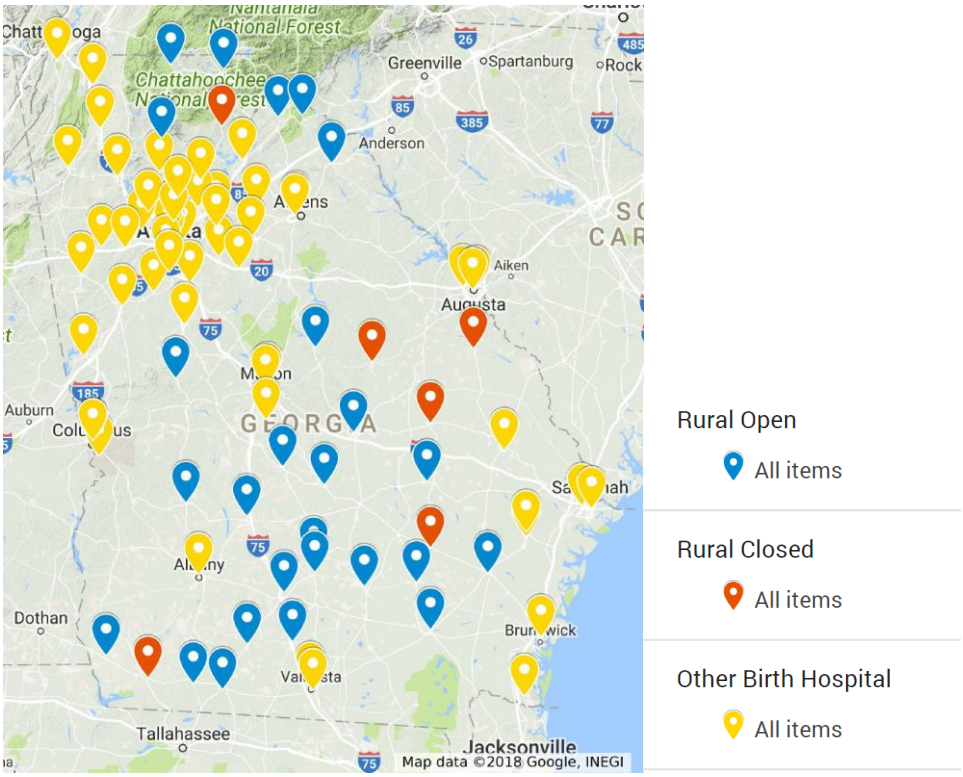

Figure 1b. All Georgia birth hospitals including rural hospitals with LDUs in 2011.

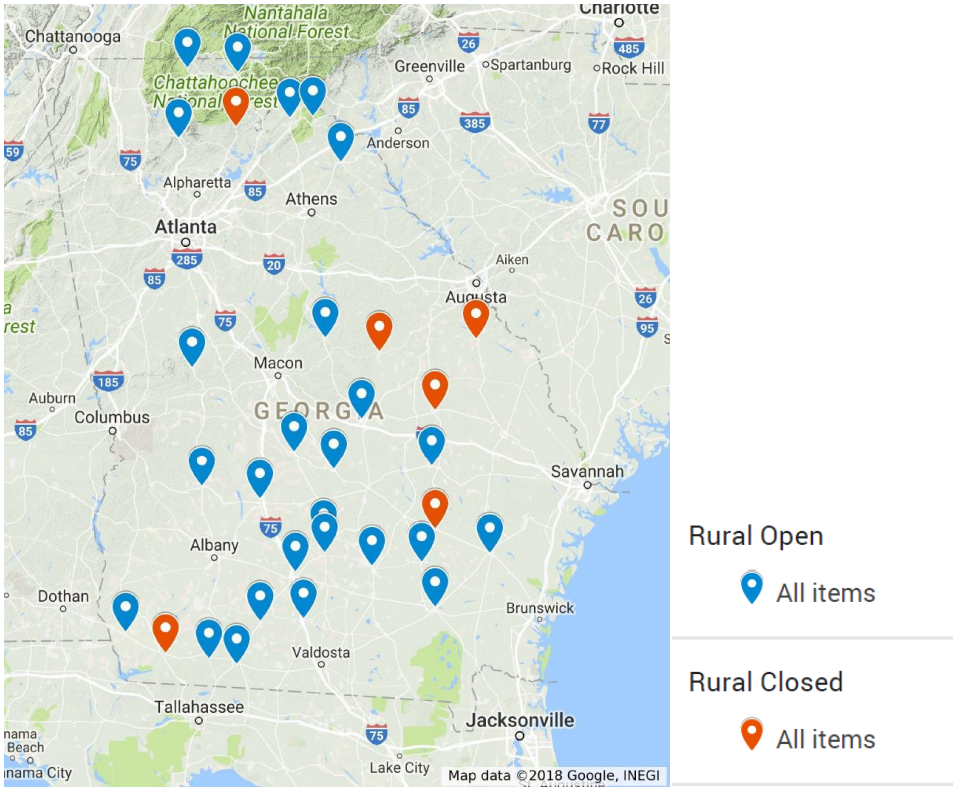

Figure 2. Sample of rural birth hospitals in Georgia with both closed and open LDUs after 2011.

Six rural hospitals in the sample closed LDUs between 2012 and 2012, indicated in the timeline below (Figure 3). These closures occurred at relatively regular intervals, with one closure in 2012, two in 2013, two in 2014, and one in 2015.

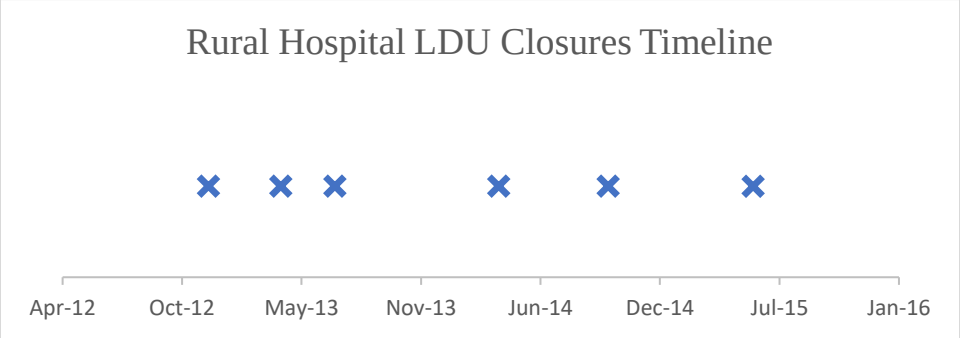

Figure 3. Intervals of rural LDU closure.

In 1950, the population of Georgia was 3,444,578 – with 43.5% of the population living in urban cities with over 50,000 people. This study sample, which includes counties within the PCSA of the selected rural hospitals, experienced significant population growth from 1950 to 2010. The total population of these rural areas was approximately 692,969 in 1950, 755,300 in 1980, and 1,010,262 by 2010. The rate of population increase between 1950 and 1980 was 9% as compared to 33% from 1980 to 2010. Rates of population increase differed only slightly between regions with closed LDUs compared to open LDUs. Regions with open LDUs saw an 11% increase from 1950-1980 and 34% increase from 1980-2010. Regions with closed LDUs saw an 1% increase from 1950-1980 and 34% increase from 1980-2010. Overall, those with open LDUs saw an 46% increase from 1950 to 2010, whereas closed LDUs saw a 33% increase over the same period (Figure 4).

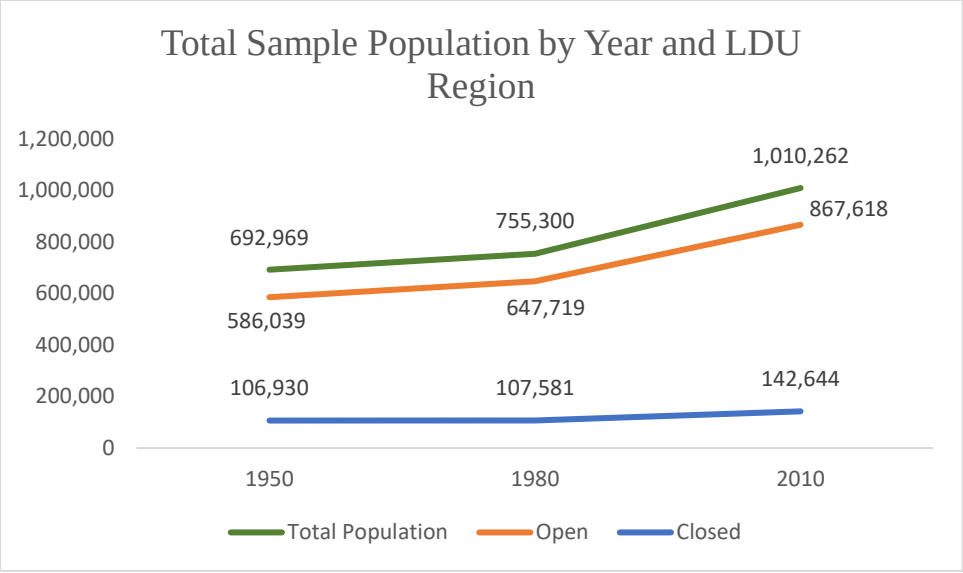

Figure 4. Change in total sample population by year, stratified by open and closed LDU regions.

Between 1980 and 2010, the total female population age 14-45 in the sample grew from 169,179 to 187,332 (10.7%) (Figure 5). In regions that experienced LDU closure in 2011, the population of all females age 14-45 increased 13.6% from 1980-2010, compared to a 9.2% increase in regions that did not experience LDU closure. This indicates that regions with closed LDUs were continuing to experience population growth for females of reproductive age.

In 1980, black women age 14-44 accounted for 28.6% of the sample population, and white women age 14-44 accounted for 71.1%. In 2010, black women accounted for 30.3% of the sample population, and white women 70.1%. Overall, the proportion of black women increased slightly compared to white women in the total sample. However, when stratified by open and closed LDU regions, the black female population decreased by 4.8% between 1980-2010 in closed LDU regions, whereas the white female population increased by 17.8%. In open LDU regions, the black female population increased by 21.1% compared to the white female population increase of 8.0%. Although the sample size is very small and does inflate the extent of black female population growth, this trend indicates that prior to the 2011 LDU closures, the

proportion of black women of reproductive age had decreased in regions which experienced a closed LDU and increased in regions with open LDUs.

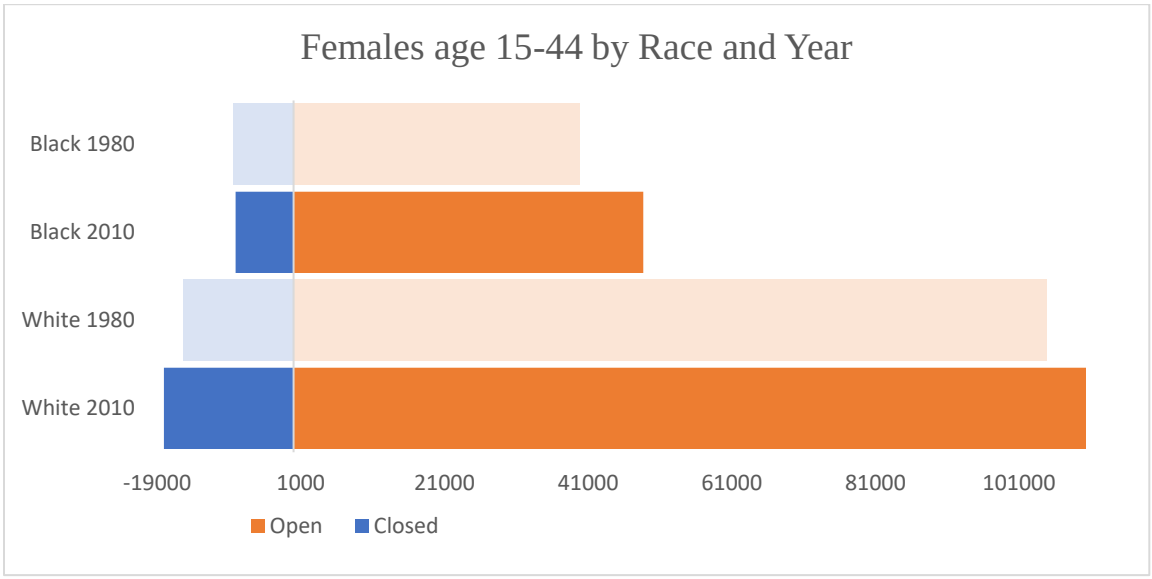

Figure 5. Proportion of black and white women in open and closed LDU regions by year.

From 1994-2011, annual births in the total sample region fluctuated between a minimum of 12,452 births per year and maximum of 14,949 births per year (Figure 6). From 2006-2011 there has been a steady decline in births in the total sample region (Figure 7). Number of births in the regions with both open and closed LDUs closely mirrors the patterns of the total births. In regions with closed LDUs, the number of births fluctuated between a minimum of 1,763 to a maximum of 2,137. Regions with open LDUs saw a net decrease in birth volume of 1,877 from 2006-2011 compared to a decrease of 332 births in closed LDU regions. Decrease in birth volume is relatively consistent between categories.

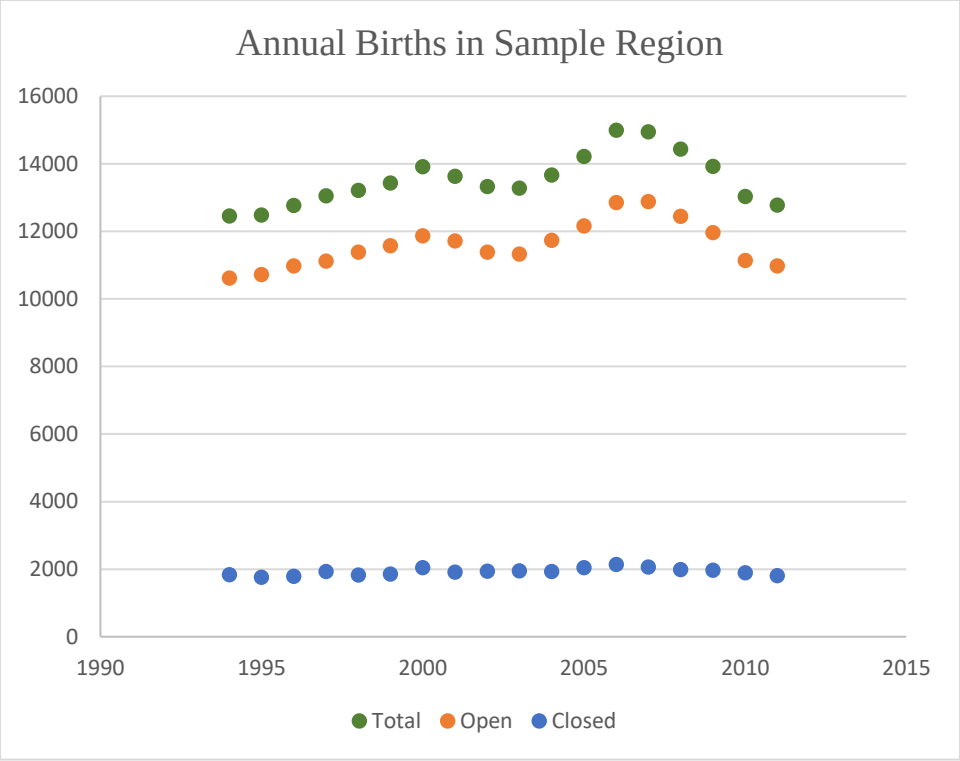

Figure 6. Aggregate annual births in sample region by LDU closure status.

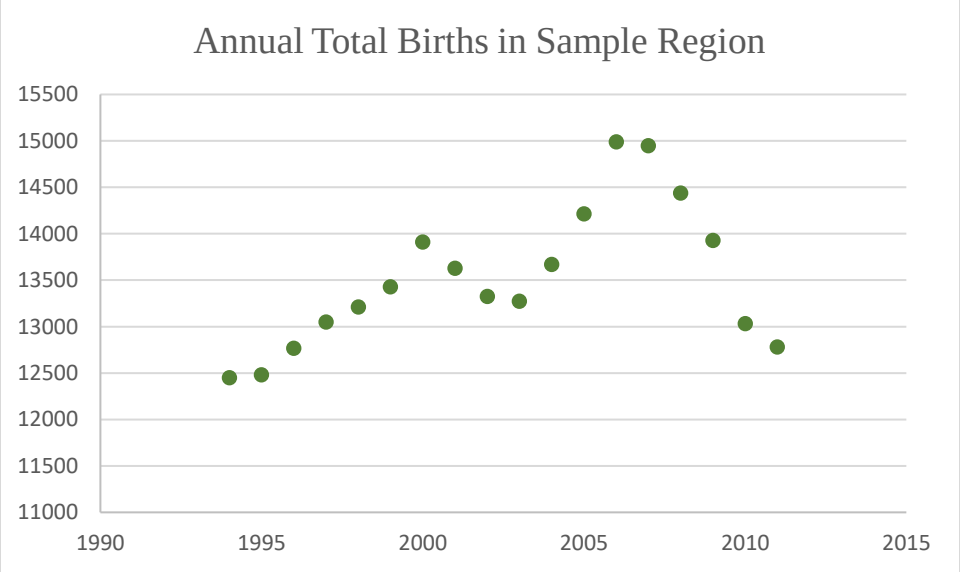

Figure 7. Aggregate annual births in total sample region.

Chapter IV. Results – Quantitative: Facility & Patient Analysis

This section presents overall facility- and regional- results for closed and open LDUs, explores significant associations, and displays data in graphs and charts. Note: Facilities which experienced LDU closure in 2011 are referred to as "closed LDUs" compared to "open LDUs," although the closures had not yet occurred at the time the baseline data was collected.

Prior to exploring the different factors between open and closed LDUs in 2011, several variables were compared from 2001 to 2011 to assess whether major changes occurred over a 10-year period and determine if 2011 represented a data anomaly. Open and closed LDUs were grouped together and assessed on select variables (Table 2).

In comparing average values between 2001 and 2011 for both closed and open LDUs, no significant changes are observed. Closed facilities display a 2.7% increase in average births per facility, and open facilities display a 2.5% decrease in average births per facility. Across all facilities in the sample, the mean number of births per facility decreased by 2.0%. Preterm birth rate and number of births delivered in country of residence decreased in both closed and open LDUs. Number of births delivered out of country of residence increased for both groups. These minimal changes from 2001-2011 indicate that key measures remained relatively stable over a 10-year period, hence 2011 data is appropriate for the basis of the study.

Closed

Variable	Year	Mean (SD)	Min-Max
# Births per Facility	2001	182.17 (84.89)	95-331
	2011	187.17 (63.89)	110-274
Preterm Birth Rate	2001	0.14 (0.40)	0.07-0.20
	2011	0.12 (0.02)	0.08-0.14
Low Birth Weight Rate	2001	0.07 (0.03)	0.03-0.1
	2011	0.09 (0.02)	0.07-0.13
# Delivered in County of Residence	2001	136.5 (69.46)	53-247
	2011	125.17 (42.54)	57-178
# Delivered out of County of Residence	2001	45.67 (23.71)	22-84
	2011	62.00 (32.68)	13-97

Open

Variable	Year	Mean (SD)	Min-Max
# Births per Facility	2001	470.69 (295.81)	16-709
	2011	459.04 (266.04)	111-1105
Preterm Birth Rate	2001	0.12 (0.06)	0.03-0.31
	2011	0.11 (0.03)	0.06-0.19
Low Birth Weight Rate	2001	0.08 (0.04)	0.01-0.19
	2011	0.08 (0.03)	0.05-0.14
#Delivered in County of Residence	2001	270.35 (183.43)	11-575
	2011	243.08 (165.17)	35-573
# Delivered out of County of Residence	2001	200.35 (148.41)	5-562
	2011	215.96 (150.74)	22-600

Table 2. 2001 and 2011 LDU data by closure status

All variables of interest were compared between open and closed LDUs (Table 3). Factors of most significance included 2011 birth volume between groups, average annual births per provider, proportion of deliveries in PCSA, birth volume at nearest hospital, patient race, and patient payor method. All results are explored in detail below (hyperlinks available within variable "Category"). All units of observation are at the facility/PCSA level (n=32), except those at the patient label indicated by a † in the variable name or category name.

Facility- and Patient- Level Factors by LDU Closure Status (2011)

Category	Variable	Total	Open LDU	Closed LDU	Significance
	Facilities *n(%)*	32	26 (81.3%)	6 (18.7%)	--
Birth Volume	†Facility Births *n(%)*	13,058	11,935 (91.4%)	1,123 (8.6%)	--
	Facility Births *mean (SD)*	--	459.04 (266.04)	187.17 (63.89)	* (p=0.02)
	Facility Births *median (min-max)*	--	443.5 (16-1132)	180.5 (95-331)	* (p=0.0007)
	Births to PCSA residents *n(%)*	11,754	9,949 (84.6%)	1,805 (15.4%)	--
	Births to PCSA residents *median (min-max)*	--	309 (101-776)	313 (213-361)	
Location of Residence v. Delivery	Proportion county residential=delivery *median % (min-max)*	--	54.0% (7-90%)	66.0% (49-88%)	* (p=0.0373)
	†Deliver in PCSA of residence *%*	7,711	58.30%	67.05%	* (p<0.0001)
	†Deliver outside PCSA of residence *%*	5,347	41.70%	32.95%	* (p<0.0001)
Hospital Proximity	Birth volume in nearest hospital *median (min-max)*	--	334 (110-2564)	927 (118-3445)	* (p=0.037)
	Distance to nearest birth hospital *median (min-max)*	--	25.0 (7-37)	26.5 (19-30)	
	Distance to urban area *median (min-max)*	--	43.0 (26-65)	41.5 (21-69)	
Obstetric Providers	OB *median (min-max)*	82	2 (0-6)	3 (1-5)	
	CNM *median (min-max)*	15	0 (0-3)	0 (0-4)	
	FP *median (min-max)*	11	0 (0-4)	0 (0-2)	
	OB equivalent *median (min-max)*	96.65	2.32 (1-7.94)	4.27 (1-5.58)	
	Average OB age *median (min-max)*	--	47 (40-60)	47 (40-52.4)	

	Average annual births per provider *median (min-max)*	--	142.87 (55.5-490)	58.01 (23.86-110)	* (p=0.0075)
Birth Outcomes	Preterm birth rate per 100 births *median (min-max)*	--	11 (6-19)	12 (8-14)	
	Low birth weight rate per 100 births *median (min-max)*	--	8 (5-14)	10 (9-13)	
Regional Characteristics by PCSA	Median family income *median (min-max)*	--	$34,503 ($31,123-50,582)	$33,588 ($30,427-43,704)	
	Females 14-45 years *median (min-max)*	178,365	4,811 (1,646-12,226)	4,398 (3,281-6,405)	
	Population 2011 *median (min-max)*	940,178	25,607 (8,413-6,1530)	23,036 (17,125-31,086)	
†**Patient Race**	White *%*	7,267	56.22%	49.60%	*
	Black *%*	4,300	32.17%	41.05%	*
	Unknown *%*	1,081	8.33%	7.75%	*
	Multiracial *%*	260	2.09%	0.89%	*
	Asian *%*	108	0.85%	0.62%	*
	Native Hawaiian/American Indian/Alaskan Native *%*	42	0.35%	0.09%	*
	Proportion Black *n(%)*	4,300	3,839 (36.4%)	461 (45.3%)	* (p<0.0001)
	Proportion White *n(%)*	7,267	6,710 (63.6%)	557 (54.7%)	* (p<0.0001)
†**Patient Payor Method**	Medicaid *%*	7,913	60.21%	64.74%	*
	Commercial *%*	1,782	14.49%	4.72%	*
	Other *%*	1,581	11.98%	13.45%	*
	Self-pay *%*	941	7.13%	8.01%	*
	Other Govt *%*	580	4.78%	0.89%	*
	Champus *%*	106	0.52%	3.92%	*
	Unknown *%*	155	0.90%	4.27%	*
	Proportion Medicaid & Self-Pay *n(%)*	9,540	8,669 (83.4%)	871 (94.3%)	* (p<0.0001)
	Proportion Commercial *n(%)*	1,782	1,729 (16.6%)	53 (5.7%)	* (p<0.0001)

Table 3. All quantitative results comparing open and closed LDUs. All units of observation are at the facility/PCSA level (n=32), with the exception of those at the patient label indicated by a † in the variable name or category name.

Birth Volume

Median births by PCSA residents did not differ significant by LDU closure status, with a mean birth volume of 313 births for PCSAs with closed LDUs and 309 births for PCSAs with open LDUs, but the maximum number of deliveries was much higher for PCSAs with open LDUs (Figure 8). Closed LDUs had a significantly lower number of births in 2011 compared to open LDUs, with mean values of 187.2 v. 459.0 (Figure 9) and median values of 180.50 v. 443.5 (Figure 10) ($p<0.05$). Significant changes were not seen in mean birth volume between 2001 to 2011 (Figure 9). This finding indicates that birth volume in facilities that closed had been consistently lower than those which stayed open over the previous 10-year period. In total, open facilities delivered 86% of births in the sample (1,123 v. 11,935) (Figure 10).

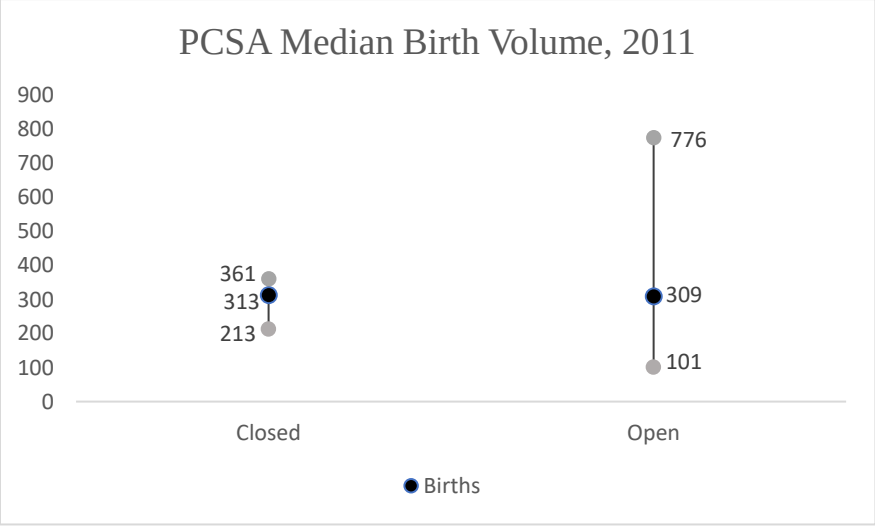

Figure 8. Number of births per PCSA by LDU closure status.

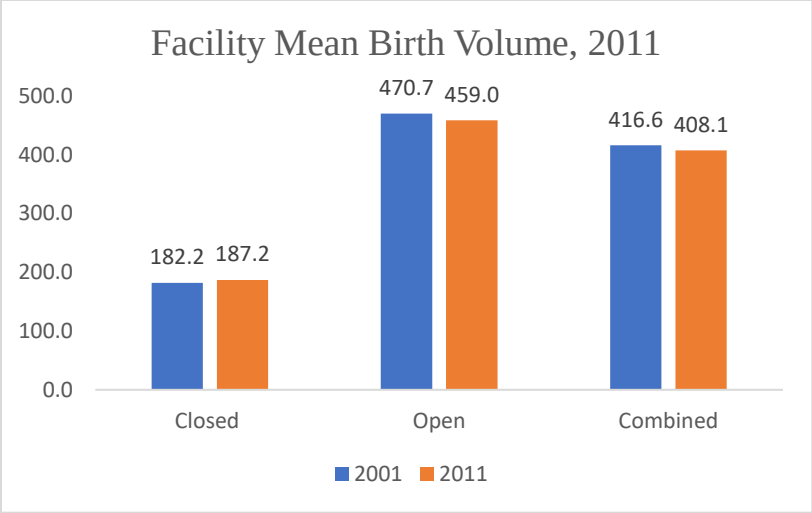

Figure 9. Mean number of births per all facilities by LDU closure status.

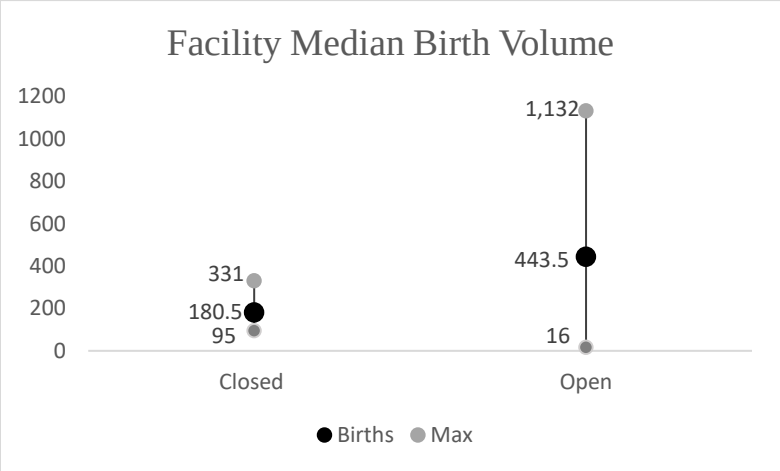

Figure 10. Median number of births per all facilities by LDU closure status (p=0.0007).

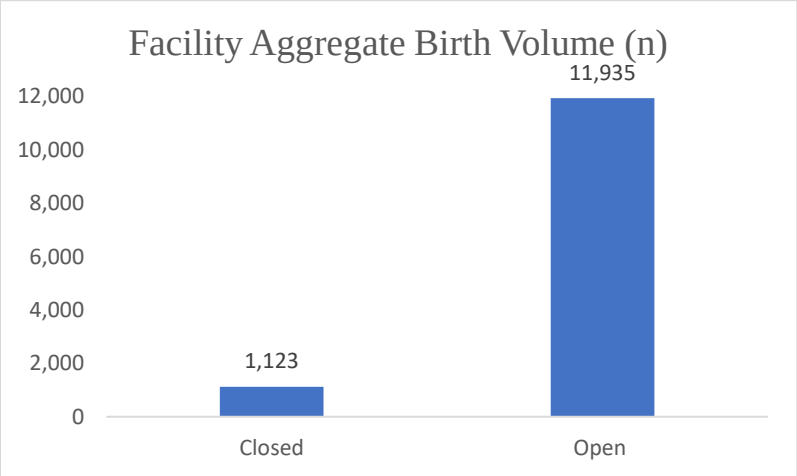

Figure 11. Total 2011 births by LDU closure status.

Location of Residence v. Delivery

Among patients who delivered at a rural hospital, a chi-squared test of independence determined a significant association between delivery within PCSA of residence and LDU closure status. 67.1% of patients delivering in a closed LDU lived within the PCSA of the delivery hospital, compared to 58.3% of patients delivering in an open LDU ($p<0.0001$) (Figure 12). By converse, 32.95% of patients delivering in a closed LDU lived outside the PCSA of delivery, compared to 41.7% of patients delivering in open LDUs. This indicates that a greater percentage of patients in open LDUs travelled from their PCSA to receive care compared to patients delivering in closed LDUs. Among those who delivered at open LDUs, the odds of travelling from one's PCSA of residence to deliver is 1.46 (95% CI: 1.28, 1.66) the odds of travelling for those who delivered at closed LDUs. In other words, the odds of delivering outside one's PCSA was 46% higher for those who delivered in open LDUs. **Limitation**: This measurement does not track where in the PCSA the patients lived and only serves as a crude estimation of travel patterns.

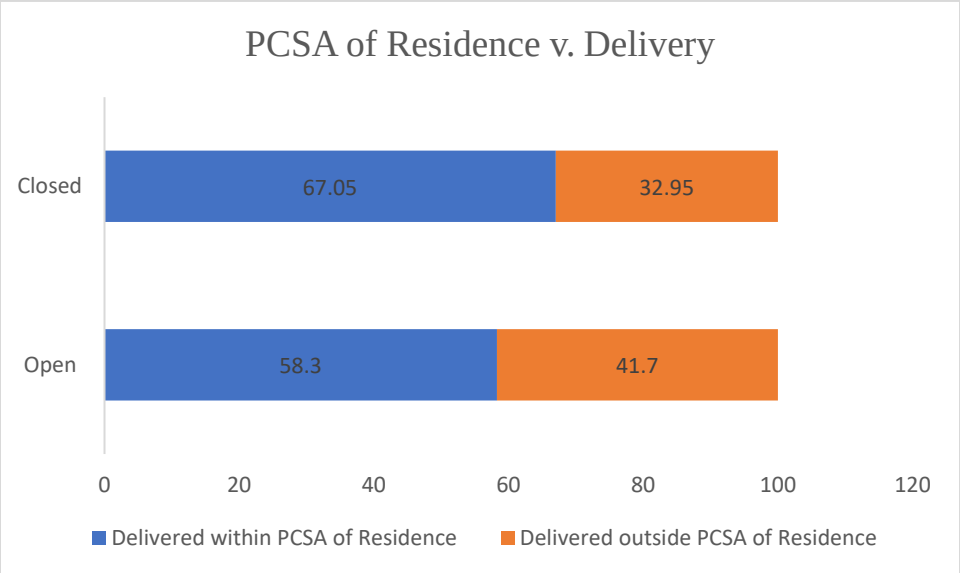

Figure 12. Proportion of patients who delivered within their PCSA of residence by closed and open LDUs ($p<0.0001$).

Another, more specific way to estimate extent of travel for delivery involves assessing the proportion of women who delivered outside their county of residence. Because some PCSAs include more than one county, this measurement gives a slightly more specific estimate. A one-sided Mann-Whitney test for parametric distributions indicated a lower median proportion of births delivered in the mother's county of residence among open LDUs (54.0%) compared to closed LDUs (66.0%) (p=0.04) (Figure 13). By this measurement, a slightly higher proportion of patients at open LDUs delivered outside their county than outside their PCSA (46.0% v. 42.0%). This finding indicates that a higher proportion of women in LDUs that remained opened travelled from their county of residence to deliver, confirming the PCSA-based analysis.

Limitation: Similar to analysis by PCSA, relative distance travelled from one's home is not measured.

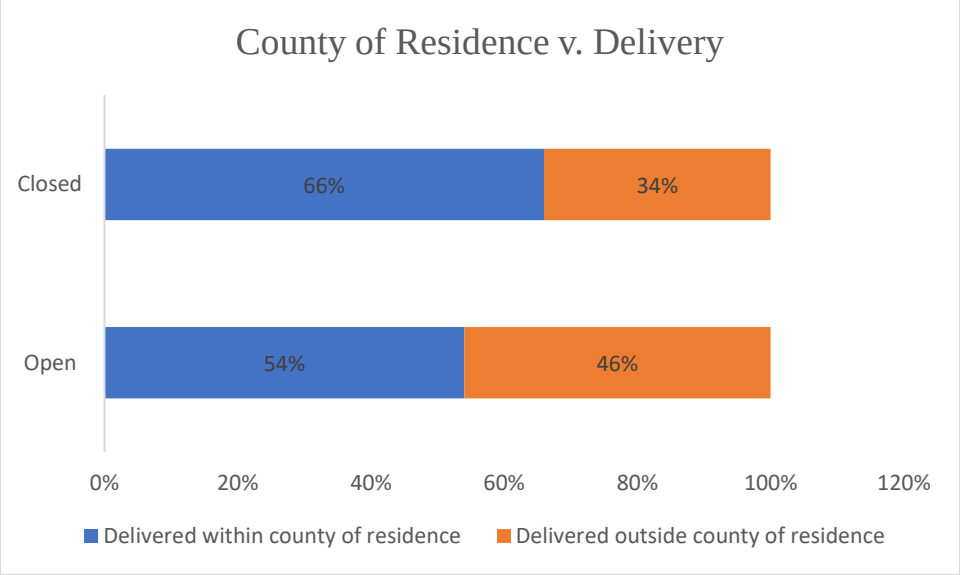

Figure 13. Proportion of patients who delivered within their PCSA of residence by LDU closure status (p=0.0373).

Hospital Proximity

A one-sided Mann-Whitney test for parametric distributions indicated that closed LDUs had higher birth volumes at their nearest birth hospital than did open LDUs (p=0.037). The median number of births at the nearest hospital for open LDUs was 334 compared to 927 for closed LDUs (Figure 14). There is no significant difference between closure status and distance to closest birth hospital, with a median distance of 25 miles to nearest birth hospital for open LDU and 26.5 miles for closed LDU. There is likewise no significant difference between closure status and distance to urban area, with a median distance of 43 miles for open LDU and 41.5 miles for closed LDU. **Limitation:** Only Georgia hospitals were included in this analysis, which likely missed closer hospitals that were in neighboring states. Additionally, this measurement included all hospitals in the calculation, which may cross-reference facilities already in the sample.

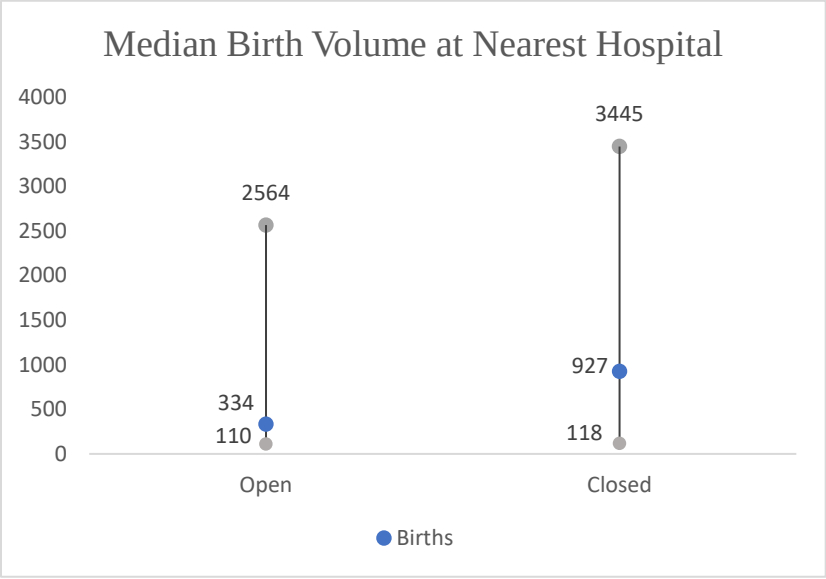

Figure 14. Median number of deliveries at closest birth hospital (p=0.037).

Obstetric Providers

Across all facilities, there were a total of 83 OBs, 15 CNMs and 11 FPs (Table 4). The aggregate number of "OB Equivalents" was 74.61 for all open LDUs and 22.03 for closed LDUs. A two-sample Mann-Whitney test to compare nonparametric samples indicated no significant difference between provider data by closure status, with the exception of annual average births for provider (Figure 15). The median average annual births per provider among closed LDUs was 58.01 (23.86-110) compared to 142.87 (55.5-490) at open LDUs (p=0.0075). This finding corresponds to average facility birth volume data which is higher for open LDUs than closed LDUs.

	Total	Open	Closed
OBs	83	65	17
CNMs	15	10	5
FP	11	7	4
OB Equivalents	96.64	74.61	22.03

Table 4. Aggregate Providers by Open and Closed LDU.

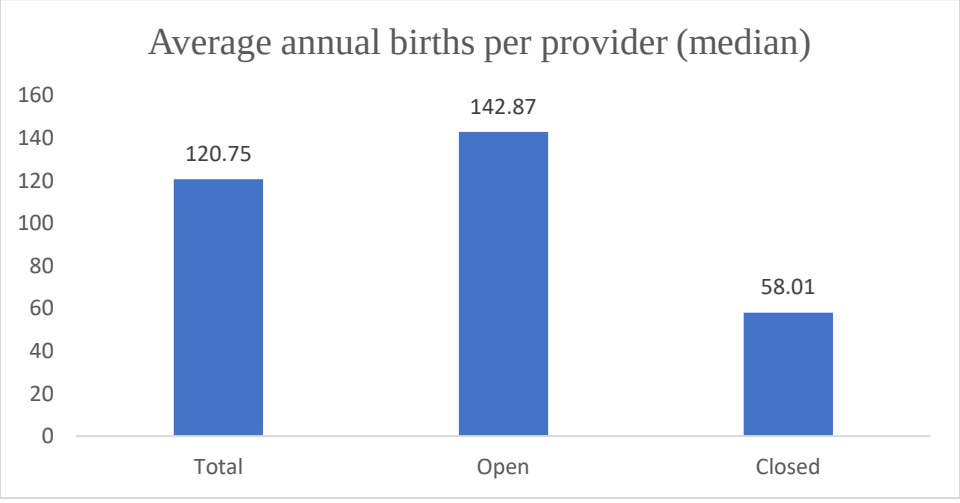

Figure 15. Median values of average annual births per providers by LDU closure status (p=0.0075).

Birth Outcomes

Median rates of preterm babies per 100 births were comparable across all facilities, with a rate of 11 (6-19) for open facilities and 12 (8-14) for closed facilities. Likewise, no statistically significant difference was seen in rates of very low birth weight, with a rate of 8 (5-14) for open facilities and 10 (9-13) for closed facilities.

Prenatal Care

The Kotelchuck index measures adequacy of prenatal care through a scale of 1-4. A score of 1 represents inadequate care of <50% expected prenatal visits, 2 is intermediate (50-70%), 3 is adequate (80-109%), and 4 is adequate plus (110%+). A score of -1 indicates missing data. According to a chi-squared test for proportions, the distribution of patients by Kotelchuck Index significantly differs based on LDU closure status ($p<0.0001$) (Figure 16). The difference in distribution, however, is not meaningfully different between groups.

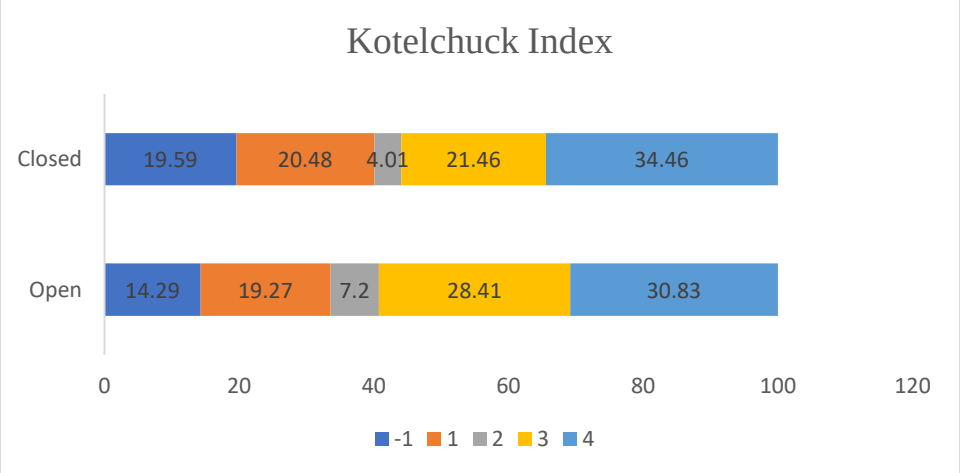

Figure 16. Distribution of Kotelchuck index by LDU closure status.

Regional Characteristics by PCSA

For PCSAs within the sample, there is no significant difference between median family income, population of females age 14-40 years, and total population by closure status. Median family income for PCSAs with open LDUs is $34,503 compared to $33,588 in PCSAs with closed LDUs. The range of income, however, is higher for open LDUs ($31,123-$50,582) than closed LDUs ($30,427-$43,704). The median population of females age 14-44 in PCSAs with open LDUs is 4,811 compared to 4,398 in PCSAs with closed LDUs. Likewise, the total population in PCSAs with open LDUs is 25,607 compared to 23,036 in PCSAs with closed LDUs. Although the median female and total populations are slightly lower in PCSAs with closed LDUs, these values are not statistically significant.

Patient Race

For 2011 patient data, there were 11,935 patient records for closed LDUs and 1,123 patient records for open LDUs. Among mothers delivering in 2011, 49.6% at closed LDUs were white compared to 56.2% at open LDUs and 41.1% were black compared to 32.2% at open LDUs (Figure 17). At open LDUs, 0.9% of mothers were multiracial compared to 2.1% at closed LDUs , 0.6% vs. 0.9% Asian, and 0.1% vs. 0.3% Native Hawaiian/American Indian/Alaska Native. At closed LDUs, 7.8% of mothers were of unknown race compared to 8.3% at open LDUs. “Unknown” race may attributable to Hispanic individuals. Overall, open LDUs had a higher proportion of both white and other non-black patients compared to closed LDUs. According to a chi-squared test for proportions, the distribution of patients by race significantly differs based on LDU closure status ($p<0.0001$).

A higher proportion of black women delivered in LDUs which closed compared to those which stayed open. This contrasts with the difference in the proportion of black and white

women in the two sample regions. In the sample regions, the total proportion of black and white women does not significantly differ by closure status (Figure 18).

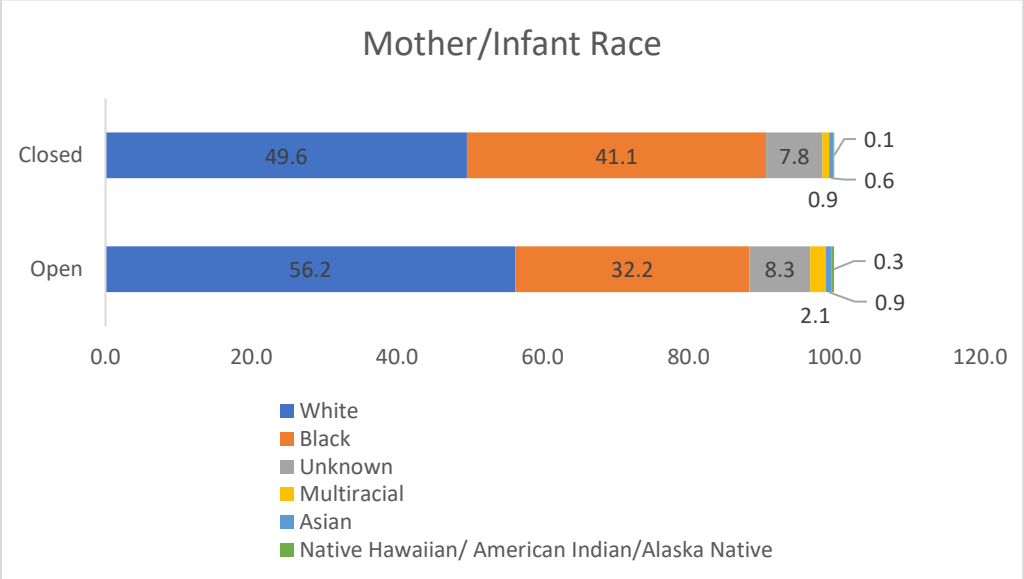

Figure 17. Distribution of mother by race according to LDU closure status.

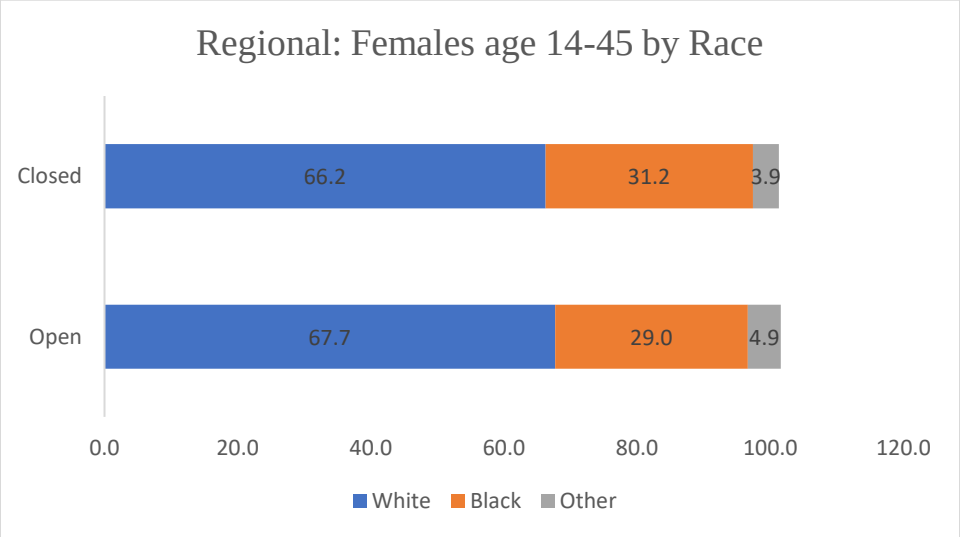

Figure 18. The proportion of black and white women in the region by LDU closure status.

Among patients of black and white race alone, a chi-squared test of independence determined that 45.3% of patients from closed LDUs were black, compared to 36.4% of patients from open LDUs ($p<0.0001$). By converse, 54.7% of patients from a closed LDU were white, compared to 63.6% of patients from open LDUs (Figure 19). Black or white race is shown to be

associated with LDU closure status. Among patients of black and white race that delivered at a LDU that remained open, the odds of being white was 1.45 (95% CI: 1.27, 1.65) the odds of being white at a LDU that closed. When controlling for payor status as a confounder, among patients of black and white race that delivered at a LDU that remained open, the odds of being white was 1.31 (95% CI: 1.15, 1.49) the odds of being white at a LDU that closed.

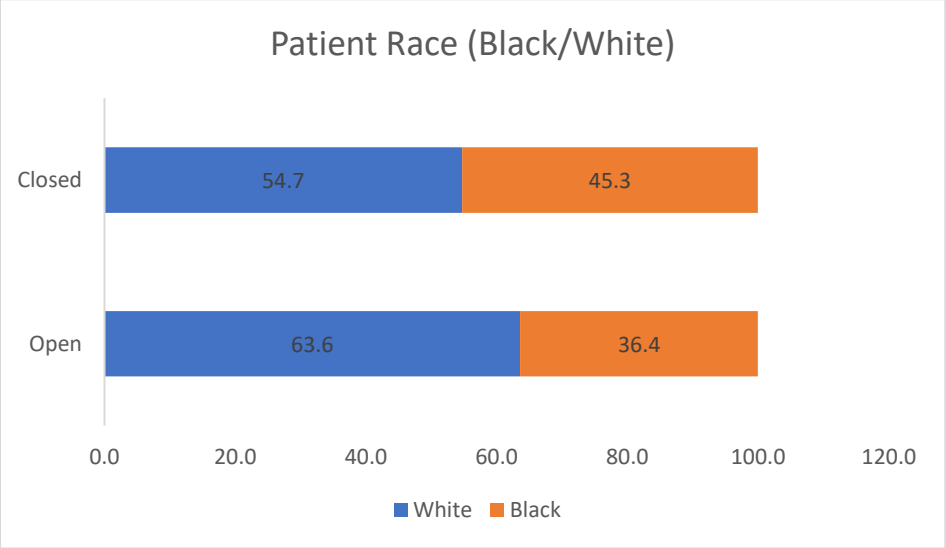

Figure 19. Distribution of patients by white/black race (89% of total patients) (p<0.0001).

Patient Payor Status

Closed LDUs demonstrated higher rates of Medicaid, Self-Pay, Champus, Other and Unknown payor methods. Open LDUs demonstrated higher rates of Commercial Insurance and Other Government Assistance (Figure 20). According to a chi-squared test for proportions, the distribution of payor methods among closed LDUs is significantly different from the distribution of payor methods among open LDUs (p<0.0001).

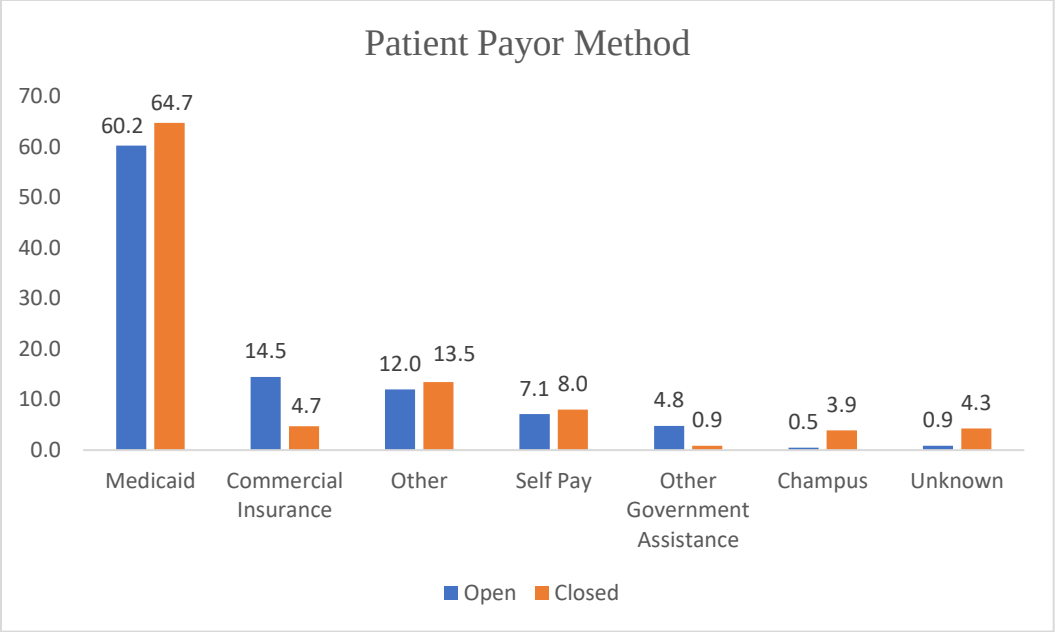

Figure 20. Proportion distribution of patient payer groups by LDU closure status ($p<0.0001$)

Individual insurance plans were categorized into "payor groups" to conduct more generalized analyses:

- **Assistance:** Medicaid Managed Care, Champus, Medicaid, Medicaid Applicants, Georgia Better Health, Medicare, Other Government Assistance, Self-pay, Medicare Managed Care, Workers Compensation, PeachCare
- **Commercial:** Commercial Insurance, BCBS, HMO/Managed Care, Other Non-specified Managed care, PPO, POS
- **Other:** Other, Unknown

When considering 3 patient payor groups: assistance, commercial, and "other," 77.6% of closed LDU patients were in the "assistance" payor group compared to 72.6% of open LDU patients, 4.7% of closed LDU patients were in the "commercial" payor group compared to 14.5% of open LDU patients, and 17.7% of closed LDU patients were in the "other" payor group compared to 12.9% of open LDU patients (Figure 21).

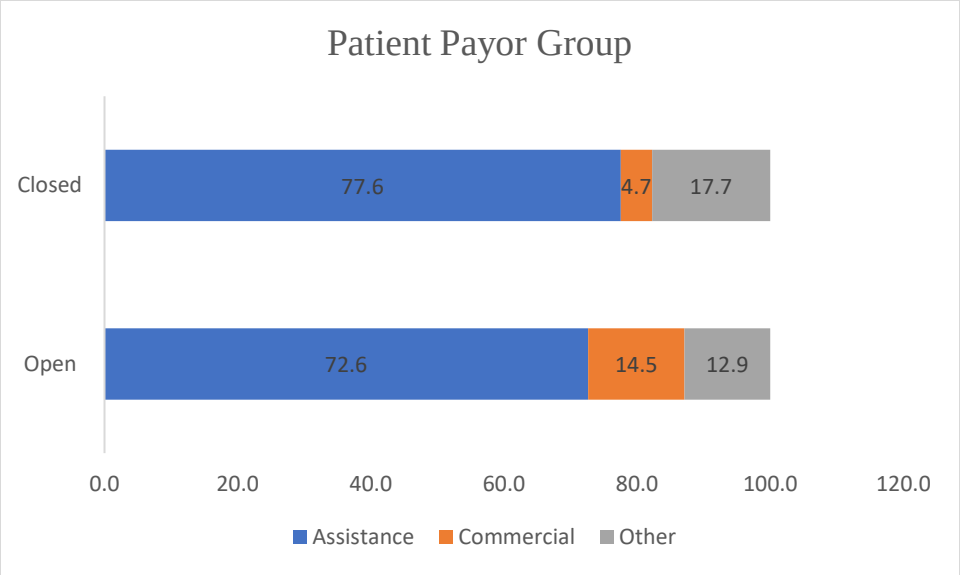

Figure 21. Distribution of patient payor group by open/closed LDU

Among patients with known payor status ("commercial" v. "assistance"), a chi-squared test of independence determined that 94.3% of patients from a closed LDU were on a form of healthcare assistance or self-pay, compared to 83.4% of patients from an open LDU, a significant difference ($p<0.0001$). By converse, 5.7% of patients from a closed LDU had some form of commercial insurance compared to 16.6% of patients from open LDUs (Figure 22). Known patient payor group status is associated with LDU closure. Among patients with known payor status that delivered at a LDU that remained open, the odds of having commercial insurance was 3.28 (95% CI: 2.47, 4.35) the odds of having commercial insurance at a LDU that closed.

Limitations: Assessing the distribution of "commercial" vs. "assistance" among all known payor status involved removing, the "other" category, which included 1,736 patients out of 13,058 (13% of the data). The higher proportion of "other/unknown" category for closed LDU patients may contribute to skewed results in patient payor group coverage. Additionally, the patient base was small overall, with 10,398 patients in open LDUs and 924 in closed LDUs.

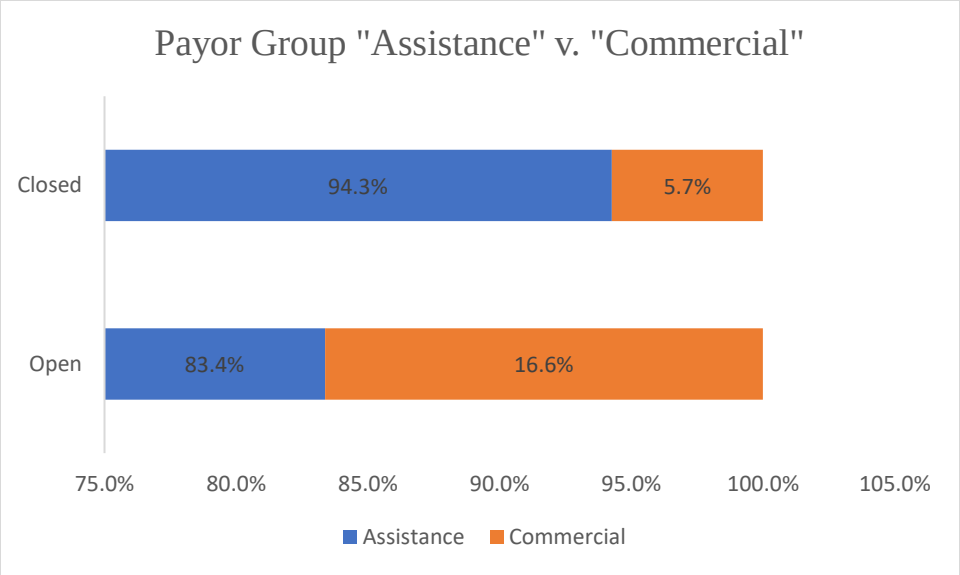

Figure 22. Distribution of known patient payor group (87% of total patients) ($p<0.0001$).

Overall, the facility- and patient- level assessment indicated that factors most associated with hospital closure include lower 2011 birth volume, lower average annual births per provider, higher proportion of deliveries within PCSA and county of residence, higher birth volume at nearest hospital, higher proportion black patients, and higher proportion Medicaid and self-pay patients.

Chapter V. Results – Qualitative: LDU in the News

Articles

Online searches conducted on November 2017 – April 2018 through Google News and Emory Newspaper Database (EBSCO) with the keywords “Georgia”, “labor and delivery unit closure”, “rural”, “obstetric services”, and “stops delivering babies” yielded 29 article results. All online news sources from 2012-2016 that included at least one Georgia hospital with an LDU closure were included. 10 articles were excluded because they did not feature Georgia in the discussion of LDU closures or they were outside the sample timeframe. In addition, reports from the Georgia OBGYN Society (GOGS) were included. Articles which were direct reprints of other articles were excluded because they provided no new information. Lastly, the results include comments from an email correspondence with Pat Cota, former executive director of GOGS, as well as two additional articles providing rural economic context.

Among the final 20 sources (Table 5), 18 were published from GA, 2 out of state (Florida and South Carolina), and 1 national (Kaiser Health News). Two of these articles were reprintings of an original source (Georgia Health News), so for the purposes of analysis only 18 discrete sources were included as providing unique information. Excluded sources included national publications such as The Atlantic, NPR, and Huffington Post which covered rural obstetrical closure but did not focus on GA (Table 6).

News Source (with hyperlink)	Date	Title
Georgia Health News	7/22/2011	A doctor who couldn't afford to stay in Ga.
Georgia OBGYN Society	5/1/2012	Obstetric Provider Shortage in Georgia
Georgia Health News	1/28/2013	Born far from home: Fewer rural hospitals delivering babies
Georgia Health News	2/4/2013	Small rural hospital closes doors; more may follow
Georgia Health News	3/27/2013	Georgia's rural hospitals feeling the rough times
AccessWDUN.com	4/29/2013	Chestatee Regional Hospital will no longer deliver babies
Atlanta Journal Constitution	7/31/2013	Georgia joins federal whistleblower lawsuit alleging Medicaid fraud
Georgia OBGYN Society	6/1/2014	Exploring the Causes and Consequences of Georgia's Obstetric Provider Shortage
Atlanta Journal Constitution	6/27/2014	South Fulton Medical to stop delivering babies, lay off 80
Georgia Health News	4/13/2015	2 more hospitals closing baby delivery units
The Florida Times Union*	4/14/2015	Two more Georgia hospitals closing OB/GYN units
Policy Best*	4/30/2015	2 Rural Georgia Hospitals Closing Baby Delivery Units
Atlanta Journal Constitution	5/12/2015	More Georgia rural hospitals opt out of birthing babies
wrdw.com	5/13/2015	UPDATE| Emanuel Medical Center OB/GYN center to close at end of June
41 NBC.Com	8/9/2015	Sandersville OBGYN Struggles To Stay Open After Labor and Delivery Unit Closes at Local Hospital
Georgia Health News	9/4/2015	Poverty and pregnancy should not be fatal in Georgia
Dalton Daily Citizen	9/26/2015	Loss of labor and delivery units strain rural health care
Bluffton Today	12/6/2015	Fewer options as hospitals close labor, delivery units
Kaiser Health News	8/19/2016	Giving Birth in Georgia Is Too Often a Deadly Event
Georgia Trend	11/1/2016	Oooh Baby Baby: Georgia hospitals are making a big commitment to welcoming their tiniest patients.
The Augusta Chronicle	11/29/2016	Options on where to give birth become fewer as hospitals close labor, delivery units

*Repeat article

Table 5. All new articles included in sample

News source	Georgia	Out of State	National	Total
Included	18 (86%)	2 (10%)	1 (5%)	21
	Atlanta Journal Constitution, Dalton Daily Citizen, The Augusta Chronicle, Georgia Trend, Georgia Health News, 41 NBC, Policy Best*	The Florida Times Union* Bluffton Today	Kaiser Health News	
Excluded	1 (10%)	1 (10%)	8 (80%)	10
	Atlanta Journal Constitution	The Washington Post	The Atlantic, Huffington Post (2), Kaiser Health News (2), Healthline, Managed Care Magazine, National Public Radio	

*Repeat article

Table 6. Distribution of news sources

From 2012-2016, many news articles were published regarding rural Georgia LDU closure. Additionally, GOGS published several updates and provided presentations regarding shortages in obstetric services. The month and year of publication are displayed in Figure 22. The highest concentration of news articles occurred from November 2012 – May 2013 and from March 2015 – October 2015. When overlaid with the timeline of hospital closures, the concentration occurs around the time of the first three closures between December 2012 – July 2013, and then again around the time of the June 15 closure (Figure 23).

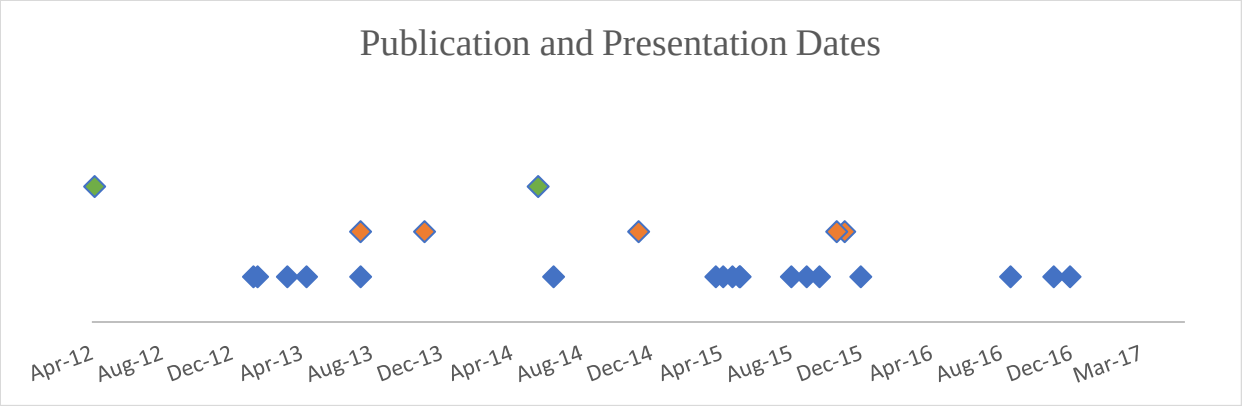

Figure 22. Dates of publication: GOGS reports (green), newspapers (blue), GOGS presentations (orange)

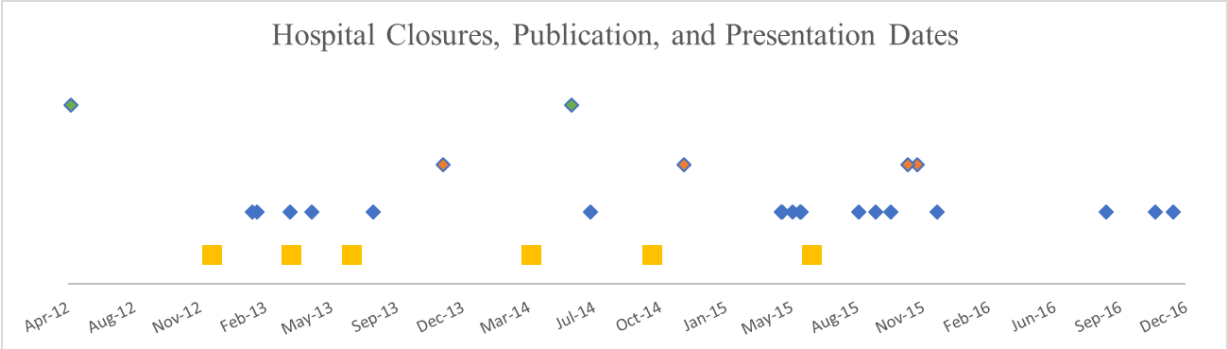

Figure 23. Dates of LDU Closure (yellow square) and publication: GOGS reports (green), newspapers (blue), GOGS presentations (orange)

The primary aim of the news article analysis was to answer the question: what factors may contribute to hospital closure? The secondary aim was to explore the impacts of hospital closure. The content of the articles provided the following themes regarding contributors to and impacts of closure, identified with exemplars in Table 7 and described in detail afterwards.

The following content is analyzed from the 18 unique articles.

	Theme	***Exemplar Quotes***
	Financial Deficits	▪ *"Financial problems recently led Calhoun Memorial Hospital in Arlington in southwest Georgia to close its doors. Earl Whiteley, the hospital's CEO, cited as a major reason the increase in charity care that the 25-bed facility incurred.* ▪ *"You just can't continue to give away free care," Whiteley said in a recent interview. (Georgia Health News, 2013)* ▪ *"Low Medicaid reimbursements are a commonly cited factor in the closures of high-cost labor and delivery operations" (Dalton Daily Citizen, 2015)* ▪ *"Small town hospitals face a financial challenge in keeping birth centers open" (Atlanta Journal Constitution, 2015)*

Contributors to Closure	Doctor Shortage	▪ *"'The ability to keep physicians in rural areas is probably at one of the worst points ever,' Lewis says. Many rural hospitals, because of low reimbursements and patient volumes, have stopped delivering babies." (Georgia Health News, 2011)* ▪ *"'More than 40 counties lack OB providers, and few than 75 of 180 hospitals in the states have labor and delivery units,' Pat Coda of the Georgia OBGYN society said." (Georgia Health News, 2015)* ▪ *"The OB-GYN workforce is aging, the average number of work hours is declining, and a large number of OB-GYNS are retiring from obstetrics early or not practicing obstetrics altogether because of high malpractice premiums." (Augusta Chronicle, 2016)*
	Few Deliveries	▪ *"'Given the high overhead, a hospital must deliver 500 babies or more a year to break even on that service,' says Stephen Shepherd, CEO of Burke Medical Center. 'In rural areas, getting up to 500 babies is tough.''' (Georgia Health News, 2015)* ▪ *"About two-thirds of [Emmanuel County] babies have been delivered out of the county in larger neighboring hospitals. 'As a result, the small number of deliveries at Emmanuel Medical Center is not sustainable,' the hospital said in a news release." (Dalton Daily Citizen, 2015)*
	Other Hospital Priorities	▪ *"'We made this decision [to close the delivery unit] so we can focus on other areas that are doing well and will benefit the community more,' Connor said, citing emergency services, primary care, and orthopedics." (Georgia Health News, 2015)*
Impacts of Closure	Transportation	▪ *"Unless a birth is considered so imminent that it's an emergency — in which case the delivery is performed in Burke's ER — pregnant women must travel 25 miles or so to Augusta to have their babies." (Georgia Health News, 2013)* ▪ *"[LDU closure] is affecting not only pregnant women, who must travel greater distances to get prenatal care or possibly go without, but also new mothers who need care after birth." (Atlanta Journal Constitution 2016)*
	Health Outcomes	▪ *"A long car ride to the delivery room can raise the chance of a bad health outcome for the baby or the mother, Browne adds." (Georgia Health News, 2013)* ▪ *"[Distance] can also put pressure on obstetricians in those urban hospitals to induce early - a practice many organizations and hospitals say should be avoided if at all possible - because the mother lives an hour or more away." (Bluffton Today, 2015)* ▪ *"'I'm 100 percent positive we'll have worsening [patient] outcomes as a county,' Banks-Jackson said Monday. For patients without a car, 'I seriously doubt they'll get prenatal care.'" (Georgia Health News, 2015)* ▪ *"'When a labor and delivery unit closes, there is little prenatal or postnatal care,' Lewis said. There's a much higher chance of a birth problem, he added." (Atlanta Journal Constitution, 2016)* ▪ *"Providers may not recognize hemorrhage during childbirth and thus may delay urgent care. Blood supplies may not be sufficient, especially in small or rural hospitals." (41 NBC, 2015).*
	Economy	▪ *"[A] rural area's ability to attract businesses is partly tied to the availability of a hospital and other health care services." (Georgia Health News, 2013)* ▪ *"When labor and delivery units close, physicians are usually left to decide whether to make it as a gynecologist or to leave the community to find work elsewhere." (Georgia Health News, 2015)*

Table 7. Exemplars of identified news article themes.

Trends in Closure

Financial Deficits

In news sources from 2013 to 2016, financial difficulty was most highlighted as impacting LDU closure through high cost of obstetric services not adequately met by Medicaid or insurance reimbursement. Articles stated that there were not enough patients with health insurance, both private and public, in these rural areas to cover the costs. For example, in 2014, Emmanuel Hospital lost $700,000 from its birthing unit and only delivered 120 babies. An article published in 2013 identified that high unemployment in northeast Georgia contributed to residents lacking medical insurance. One 2015 source explained that Medicaid covered 60% of Georgia births among the total state population and a higher percentage among rural residents. For example, a 2015 article reported that 85% of babies born in Swainsboro were covered through Medicaid. Another source indicated that Medicaid paid approximately one-third the amount private insurers paid for labor and delivery. A 2016 article reported that Georgia OBs had received the first Medicaid pay increase in 14 years, but this Medicaid increase did not reimburse hospital fees.

A 2011 article projected that if Georgia expanded Medicaid under the ACA, hundreds of thousands more residents would be covered. Four years later, several 2015 articles reported that not only had Georgia rejected Medicaid expansion, but the Affordable Care Act (ACA) cut indigent care funding to rural hospitals. Policy advocates and healthcare providers were reported to encourage expanding Medicaid under the ACA, but opposition claimed that Georgia could not afford it. As a result, rural hospitals were reported to reevaluate services that lose money.

Doctor Shortage

As early as July 2011, before the closures in focus, newspapers featured accounts of Georgia OBs leaving rural practices due to financial difficulties. An article entitled "A doctor who couldn't afford to stay in Georgia" suggested that if Georgia accepted healthcare reform, the state may have the opportunity to increase Medicaid reimbursement and keep OBs in rural practices. In 2013, a news article indicated that rural hospitals struggled to develop the economic quality of life necessary to recruit doctors to the community. Along these lines, GMIHRG's 2014 front page issue in the GOGS report provided detailed information about the challenges obstetric providers face, including prohibitive expense, insufficient reimbursement, high liability costs, predominantly vulnerable and high-risk population, and poor collaboration. Furthermore, reasons for the decline in providers included aging of the OB workforce, decline of expected work hours, and early retiring of physicians. According to a 2015 news source, at least 40 counties had no obstetrical providers such as OBs or midwives. Many 2015 articles cited the shortage of OBs, usually referencing experts at GOGS and GMIHRG.

Few Deliveries

Beginning in 2015 news articles, low birth volume became more frequently cited as a reason for hospital closure, usually in conjunction with financial issues. One source quotes Jimmy Lewis, CEO of HomeTown Health, reporting that a hospital needs 350 deliveries per year to stay open. Another source, quoting Stephen Shepherd of Burke Medical Hospital, reported a minimum birth volume of 500 deliveries needed to financially break even. Several articles stated that the effect of low birth volume in the county was compounded by women opting out of delivering in the closest hospital to where they live. For example, in 2014, 240 babies were born to Emmanuel county residents, but only 120 were delivered at Emmanuel Hospital. An article

featuring Barrow Regional Hospital also stated that many women in Barrow county choose to deliver in neighboring counties.

Impact of Closure

Transportation

From 2013 on, most articles reported projected health implications of LDU closure on affected populations. The most commonly cited impact was the increased distance to medical care. In the wake of several LDU closures, articles in 2015 reported that nearly a quarter of the state's women had to drive a minimum of 45 minutes to receive prenatal care. Several sources quoted experts who explained that low-income patients have higher risk of undiagnosed or untreated health issues and therefore face increased vulnerability when health services are inaccessible. Several articles cited research that the risk of prematurity is 1.5 times higher if the mother must drive more than one hour to deliver. Another source stated that when mother face a choice between paying for gas to drive to an appointment or for food, they will choose to feed their children. Overall, the articles emphasized the LDU closure greatly impacting access to quality care.

Health Outcomes

News sources from 2013 to 2016 stated that increased distance to care is linked to a reduction in prenatal and postnatal care as well as increase in preterm births. One doctor interviewed in 2015 stated that the distance rural women travel to receive care sometimes pressures OBs to induce early so that a mother can received planned delivery care at an appropriate facility – a practice which is not recommended. An article reported that areas lacking services have been shown to have higher infant mortality rates. Similarly, because maternal mortality and morbidity often stems from underlying adverse health conditions, lacking routine

preventative healthcare was reported to exacerbate problems in the preconception and pregnancy period. Lastly, several sources claimed that small rural hospitals lacking sufficient blood supplies may not be able to adequately address hemorrhage – the leading cause of maternal mortality. In several articles, experts claimed that not will only poor women suffer as a result of lack of care, but all women in the community. According to comments by Pat Cota in 2018, "the closing of the OB unit is the bellwether" to the dissolution of women's healthcare in rural communities. She explained that after OBs stop practicing, women are left without care – which exacerbates chronic health problems and leads to health outcomes such as Georgia's ranking of 50th in maternal mortality.

Economy/Employment

Two 2013 articles predicted that communities would struggle to maintain economic stability after LDU closures. They reported that hospitals often represent top employers in a region, hence closures typically result in the loss of many jobs. Articles in 2015 report that the greatest economic loss comes to OBs and obstetric service providers, who are left with uncertain futures in the community. These providers may attempt to provide gynecological services but face the challenge of few patients and births. These reports indicate that LDU closures not only threaten maternal and infant health outcomes but economic stability.

OB Services in the Future

Moving Forward

In 2015, many hospitals, such as Northside and Athens Regional, were reported to combat the threat of closure by offering specialty services as well as combined midwifery practice. An article stated that Barrow Hospital would initiate telemedicine services. Some hospitals demonstrated commitment to continue providing services at a loss – but this may not be

feasible for many hospitals. Across many articles, experts suggested solution including counties subsidizing obstetric services and Georgia establishing regional birthing centers. In 2013, an article reported Pat Cota's recommendation to develop care models with adequate payment for OBs to provide care to rural women. By 2015, articles reported Cota's recommendation to gather a statewide expert team to retain labor and delivery services. The most recent reports did not indicate that successful solutions had been found, but rather continued to emphasize the critical nature of LDU closures.

GMIHRG Contribution

When asked to comment about the publicity of rural LDU closure, Pat Cota provided the following statement:

> "As far as articles and publicity: I believe it was that work that GMIHRG did, presentations to the legislature and other publicity that began to bring attention to the problem. Prior to that work, no one had ever counted or plotted the closures or identified the issue. So the work of GMIHRG was monumental in bringing the issue to light and showing the acceleration of the closures. Prior to that it was probably minimally newsworthy, except maybe in the local community of the closure."

As demonstrated in many of the 18 non-GOGS articles, GMIHRG and Pat Cota were often cited in the media through quotes and statistics. Additionally, GMIHRG's work has influenced political advocacy in Georgia. In April 2012, Representative Stacey Abrams (Minority Leader, Democrat, District 89) presented Emory University's Department of Gynecology and Obstetrics, giving a Grand Rounds talk about the importance of physician advocacy in the political realm (Zertuche et al., 2016). Abrams referenced the importance of GMIHRG in the opposition to HB 954 (a bill which enacted increased regulations on abortion):

> ''I want to congratulate [GMIHRG]. We would not have been able to amend that bill had it not been for the work that you did; [... it] was really essential. We didn't stop [the bill], but we were able to cripple it a little bit.''

Overall, the work of GMIHRG has not only stimulated discussion about LDU closure and obstetric shortage in the news, but also has paved the way for legislative action.

Additional News Data

In order to better explain the economic factors contributing to the significant themes of finances, a few more recent articles were assessed that contextualize the economic climate of both Georgia and rural US but fall outside the prescribed newspaper sampling frame. These two articles do not provide a comprehensive assessment of Georgia's rural climate but were relevant during the time of data analysis.

Georgia's Rural Economic Climate

The Georgia legislature has recognized that rural population and economic decline is a serious problem, as two-thirds of the state population growth is confined in the seven metro counties surrounding Atlanta and Savannah. Individuals who leave for a college education are not returning to their hometown, and 36 counties experience higher death than birth rates. As a result, civic leadership and competence has declined. Georgia previously attempted to address this issue by cutting retirement tax to encourage retirees, but the authors acknowledge the flaw in this plan, in that "older people require more healthcare access – not less. And Georgia's rural hospital system is in the midst of a slow collapse." Currently, Georgia legislature is looking to attract specific skilled individuals to resettle in rural areas through the 2018 "Rural Relocate and Reside" bill. This incentive provides a one-time 10-year state income tax deduction of $50,000 for individuals relocating to 124 out of the 159 counties that have experienced less than 5% growth in the past 5 years. Incentivizing individuals to live in rural areas will require greater healthcare access, highlighting the need for increased investment in healthcare infrastructure.

Galloway, Jim. "The next new idea: Paying people to move to rural Georgia." December 22, 2017. Atlanta Journal Constitution.

The United States' Rural Economic Climate

The United States has been following an economic trend where financial power increasingly resides in metro areas. The 53 largest metro areas accounted for 96.4% of the nation's population growth since 2014, and 73% of employment growth from 2010-2016. Communities of less than 250,000 made a negative contribution of -6.5% to the nation's growth since 2010, and 14% of the US population lives in declining communities. Much of this trend is fueled by the tech-related work in metro areas. Authors recommend political attention:

> *Still, none of us is under any illusion that more and bolder responses—from government, the private sector, and philanthropy—are anything but imperative, even as the politics highlighted by Brownstein make them more challenging. As the evidence of big-city pull away and small-town and rural decline accumulates, it doesn't seem right that a great nation would leave the shape of its long-term economic geography entirely to the vagaries of today's tech-fueled market.*

As the economic struggles for rural populations becomes increasingly severe, key economic powers such as government and industry will need to rethink how to address geographic discrepancies in employment and infrastructure to best support large segments of the US population.

Muro, Mark and Whiton, Jacob. "Geographic gaps are widening while U.S. economic growth increases." January 23, 2018. The Brookings Institute: The Avenue.

Conceptual Framework

The following diagram synthesizes data retrieved from news sources pertaining to the closure of rural LDUs (Figure 23).

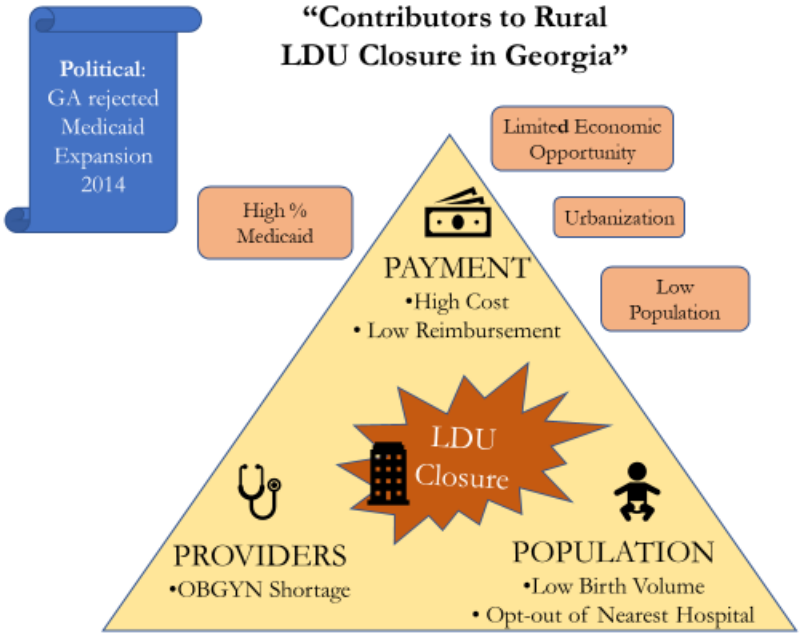

Figure 23. Contributors to Rural LDU Closure in Georgia

The article review provided information regarding reasons for LDU closure and projected impact on rural health outcomes. The three major contributors to rural LDU closure include payment, population, and providers (Figure 23). For **payment**, financial distress served as a major contributor to LDU closure due to the high cost of obstetric procedures and low reimbursement from Medicaid or self-pay patients. For **patients**, the lower population in rural areas combined with the preference of some patients to opt out of delivering at their nearest birth hospital led to unsustainably low birth volumes at LDUs that closed. For **providers**, the shortage of OBs in rural Georgia due to high malpractice costs, an aging physician workforce, and early retirement leads to insufficient LDU staff. Contextual factors influence these contributors to

closure, such as urbanization, limited rural economic opportunity, low population, and high proportion of residents on Medicaid. Georgia's rejection of Medicaid expansion under the ACA in 2014 further exacerbated these contextual factors by denying increased rural resident coverage through Medicaid.

As far as health impacts, experts projected that LDUs closer will worsen poor health outcomes due to increased distance to care and decreased preventative health services. Furthermore, LDU closures may impact economic stability through decreasing employment and reducing services necessary to attract new residents. The frequent referencing of GOGS and GMIHRG across articles, along with the timeline of LDU closure-related news publications following GOGS reports and presentations, demonstrates how GMIHRG has effectively led the publicity and political advocacy for rural obstetric coverage.

Chapter VI. Discussion

Georgia's trend in rural LDU closures is influenced by several factors including regional demographics and patterns of care-seeking, but mainly stems from rural economic distress observed across the country (Balasubramanian & Jones, 2016; Holmes et al., 2017). The results of this study confirm national trends in hospital closure related primarily to birth volume and financial difficulty (Balasubramanian & Jones, 2016; Hung et al., 2017; Hung et al., 2016; Katy B. Kozhimannil et al.; K. B. Kozhimannil et al., 2018). This study provides a more nuanced exploration of specific regional- and patient- level factors that may be associated with rural LDU closure through both quantitative and qualitative approaches. This study both suggests potential risk factors for future closures and highlights the health burden from LDU closures on affected populations. Primary factors associated with closure include lower baseline (2011) birth volume, lower average annual births per provider, higher proportion of deliveries in PCSA of residence, high birth volume at nearest hospital, higher proportion black patients, and higher proportion Medicaid and self-pay patients.

The significantly higher median birth volume in hospitals which remained open compared to those which closed (444 v. 181) was consistent with previous studies (Holmes et al., 2017; Hung et al., 2017; Hung et al., 2016; Katy B. Kozhimannil et al.; K. B. Kozhimannil et al., 2018). Likewise, this study found a higher rate of average annual births per provider in open LDUs compared to closed LDUs (142.9 v. 58). News article data confirmed these findings through many sources which identified low birth volume and fewer births per provider as major contributors to LDU closure. Corresponding with prior research, this study showed closed LDUs to have neighboring hospitals with higher median birth volume than open LDUs (927 v. 334) (Holmes et al., 2017). This finding may indicate that LDUs which closed were closer to hospitals

which likely had better services because of higher patient volume, whereas those which remained open faced less “competition” from nearby hospitals. These results were corroborated by several news articles which stated that many rural Georgia residents opted out of delivering in their closest hospital.

Despite median births per resident not differing significantly by those in regions with open and closed LDUs, hospital utilization patterns by birth volume, PCSA/county of residence, race, and payor status were associated with LDU closure. Crude estimations of travel patterns indicated that a higher proportion of women travelled outside their PCSA and county of residence to deliver in open LDUs compared to those delivering in closed LDUs (PCSA: 41.7% vs 33.95%; county: 56% v. 34%), suggesting an early preference toward hospitals which ultimately remained open. Overall, the odds of delivering outside one’s PCSA of residence for mothers at open LDUs was 1.46 the odds for mothers at closed LDUs (95% CI: 1.28, 1.66). These patterns may be exacerbated by birth volume at neighboring hospitals being much higher, and therefore quality of care being more reputable, for closed LDUs.

A comparison of racial demographics by region and facility indicated that while the proportion of black women age 14-44 in the region did not differ significantly between open and closed LDUs (29% v. 31.2%), the proportion of black women delivering at open facilities was significantly less than those delivering at closed facilities (32.2% v. 41.1%). Among all patients of black and white race, the odds of being white for mothers delivering at open LDUs was 1.31 the odds of being white at closed LDUs, after controlling for payor status (95% CI: 1.15, 1.49). This finding indicates a discrepancy in service utilization that does not match the underlying demographics. In fact, the proportion of black women of reproductive age decreased in PCSAs with closed LDUs from 1980 to 2010, in contrast to the trend for white women in the same age

category. This observation suggests that black women may have been relocating out of the closed LDU region for some time but still needed to seek care in these facilities which ultimately closed. By contrast, factors such as increased mobility may have allowed more white women to travel to receive care at LDUs which remained open. Overall, the finding that the LDUs which closed had served higher proportions of black women in 2011 compared to those which remained open suggests that black women may be disproportionately impacted by rural LDU closure.

Lastly, the significant difference in patient payor method confirmed previous studies, with closed LDUs having a higher proportion of patients on Medicaid and self-pay than open LDUs (94.3% v. 83.4%) (Hung et al., 2017; Hung et al., 2016; Katy B. Kozhimannil et al.; K. B. Kozhimannil et al., 2018). Among patients with known payor status, the odds of having commercial insurance for those at open LDUs was 3.28 the odds of having commercial insurance for those at closed LDUs (95% CI: 2.47, 4.35). These findings were overwhelmingly confirmed by the news articles, the majority of which highlighted financial issues causing LDU closures.

The newspaper analysis revealed high concern in Georgia about LDU closure and decreasing obstetric workforce. Many of the articles cited the work of GMIHRG, and many publications were seen to follow GOGS updates and presentations – indicating that this model of translational research successfully impacted both legislature and public knowledge. Aside from financial and population-level dynamics, the articles suggest that OBs leaving rural practice may present a warning sign for LDU closures. Many OBs and experts shared concerns about the increased travel distance for women already at risk for birth complications. Ultimately, from 2012-2016, news sources in Georgia reported that LDU closures stem from economic difficulties, will likely continue to occur without serious interventions, and present severe threats to the health of rural women.

Limitations of the study, listed throughout the results section, include the small sample size of closed LDUs, high numbers of unknown variables for race and payor method, and imprecise residence information to estimate distance travelled to deliver. This study overcomes these limitations through utilizing all possible data, and therefore provides a robust descriptive analysis of rural LDU closure in Georgia, rather than generalizable results.

Chapter VII. Implications

This study suggests several avenues for future research into rural LDU closure and provides recommendations to address LDU closure in Georgia. Further research into patients' choice of LDUs may better explain trends in travel, neighboring hospital birth volume, and patient racial make-up. Results show that closed LDUs had neighboring hospitals with higher birth volume, suggesting the need for further research into the impact of "competing" hospital services on rural LDU sustainability. The higher proportion of women in open LDUs delivering outside their PCSA/county of residence suggests an early preference toward delivering in LDUs that remain open – which could be investigated as an early marker for LDU closure risk.

Additionally, results showing that a higher proportion of black patients deliver in closed LDUs compared to open LDUs, despite there being no regional difference in proportion of black residents, could be further researched to explore factors such as mobility and care-seeking behaviors that may influence LDU choice. Further research into black migration patterns in Georgia may better explain the observed decline in the number of black women of reproductive age from counties that eventually experienced LDU closure. Lastly, the assessment of birth outcomes such as prenatal care, preterm birth, and low birth weight, which did not differ by LDU closure status, provides baseline data to evaluate any post-LDU closure changes in regional health outcomes.

Recommendations to address LDU closures sourced from the news analysis include increasing Medicaid reimbursement, recruiting OBs, and developing new models of maternity care. The significantly increased odds of closure among hospitals with larger black populations underscores the severe potential consequences of LDU closures for black women's health. In the US, black women are three times more likely to experience maternal mortality than white

women, and are therefore especially vulnerable to negative health outcomes resulting from deteriorating access to care (Carpenter, 2017; *Georgia Maternal Mortality: 2012 case review*, 2015). These findings do not establish a strong correlation between factors of race and LDU closure, but suggest that minority populations – who disproportionately bear the burden of poor health outcomes – may be at greater risk to losing healthcare facilities in rural Georgia, potentially due to less political or economic influence. In order to address the high rates of maternal mortality and morbidity among black women, legislators and healthcare systems should consider increasing political and financial priority for sustaining rural Georgia hospitals and LDUs. To combat Georgia's high rates of pregnancy-associated mortality, maternal morbidity, and preterm birth across all residents, attention must be given to preventing future closures and meeting the healthcare needs of those impacted by the decline in obstetric services.

Overall, this study provides strong implications for the impact of race, payor method, care seeking patterns, and birth volume on LDU closures. Furthermore, this study shows the efficacy of research and advocacy on increasing publicity about the patterns and implications of LDU closures. These results may be used to both inspire further research into rural LDU closures in Georgia, as well as direct policy makers and hospital associations to pay specific attention to LDUs experiencing risk factors indicated in this study. By better understanding the context for LDU closures, champions of Georgia maternal and infant healthcare can work to prevent future closures, advocate for communities vulnerable to closures, and develop effective methods to serve those impacted by past closures.

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