FEAR IN THE DELIVERY ROOM

How Medical Liability, Midwifery Care, and Reproductive Education Affect Cesarean Section Rates in the United States

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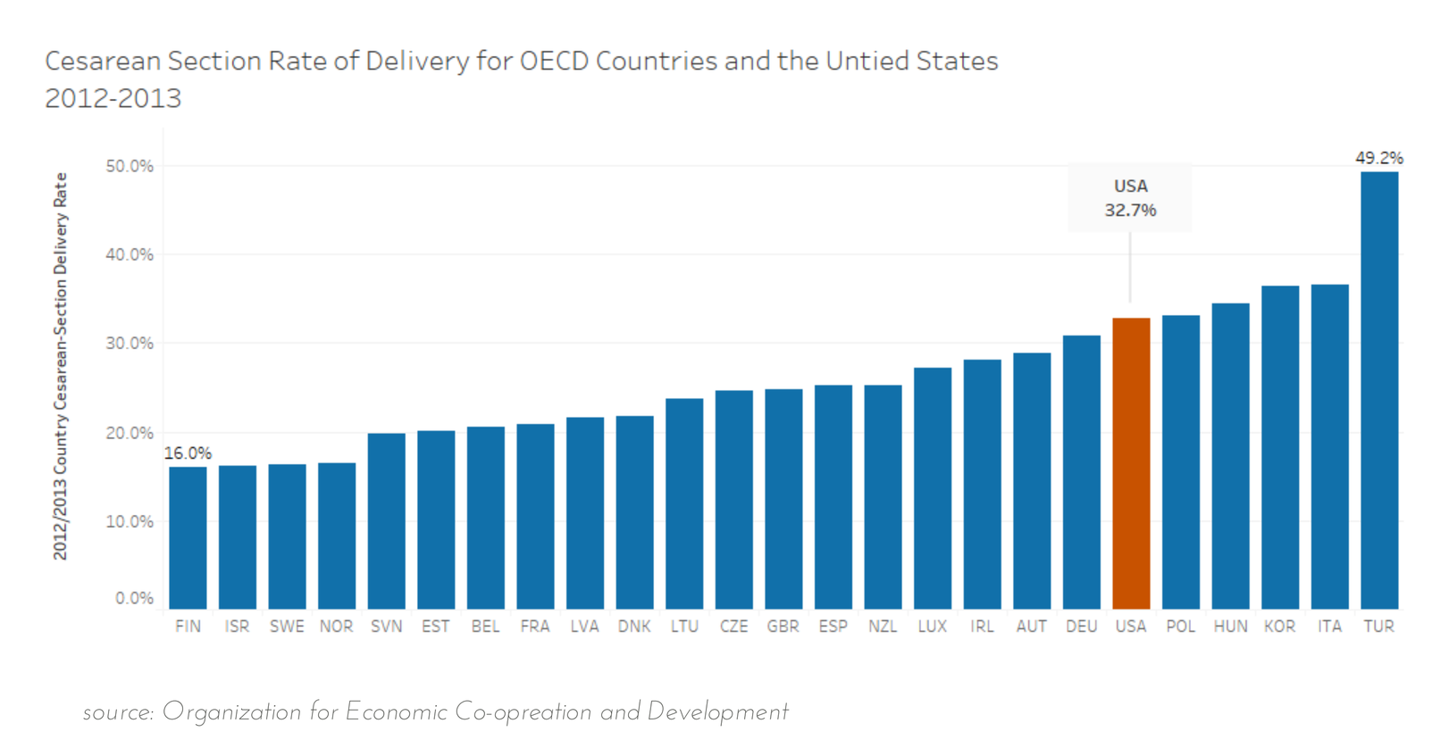
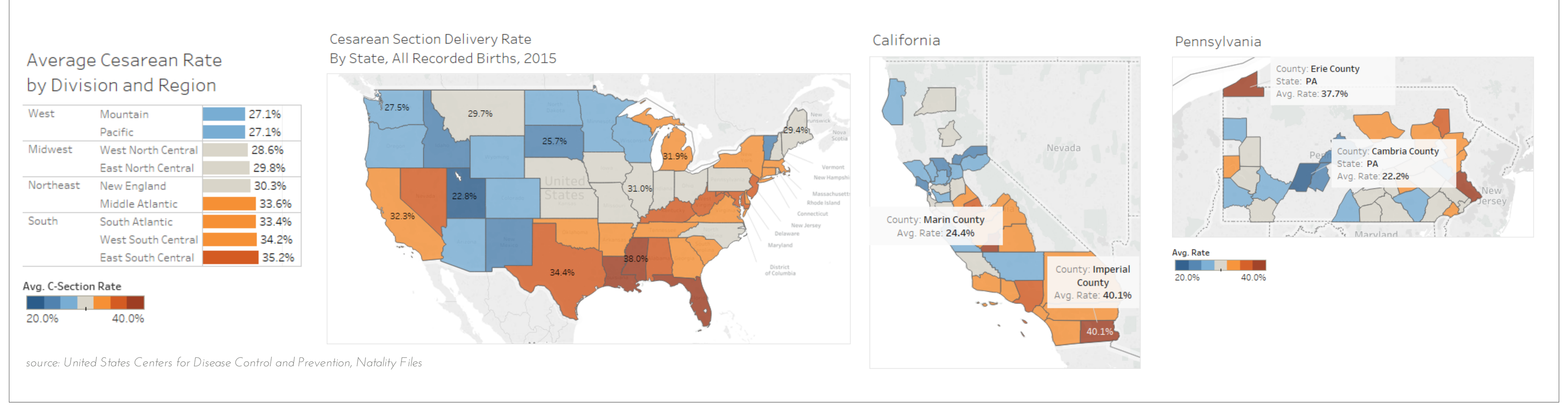
Since 1985, the international healthcare community has considered the ideal rate for Cesarean sections to be between 10-15%.

-World Health Organization

The United States has one of the highest rates of cesarean deliveries compared to OECD countries.



Rates vary widely across the United States, across U.S. Census Bureau regions, and even across counties within a state.



Average Cesarean Rate by Division and Region
West
Mountain 27.1%
Pacific 27.1%
Midwest
West North Central 28.6%
East North Central 29.8%
Northeast
New England 30.3%
Middle Atlantic 33.6%
South
South Atlantic 32.4%
West South Central 34.2%
East South Central 35.2%
Avg. C-Section Rate
20.0%
40.0%
Cesarean Section Delivery Rate By State, All Recorded Births, 2015
California
Pennsylvania
source: United States Centers for Disease Control and Prevention, Natality Files

Significance

Cesarean-section births carry risks, including infection, hemorraging, injury to organs, extended hospital stays, and extended recovery time (American Pregnancy Association, 2008).

Cesareans are also costly. Payments for care are nearly 50% greater for women who have cesarean deliveries (Garvey, 2013), with an average differential of $20,000 between vaginal and cesarean delivery (The Lamp, 2013).

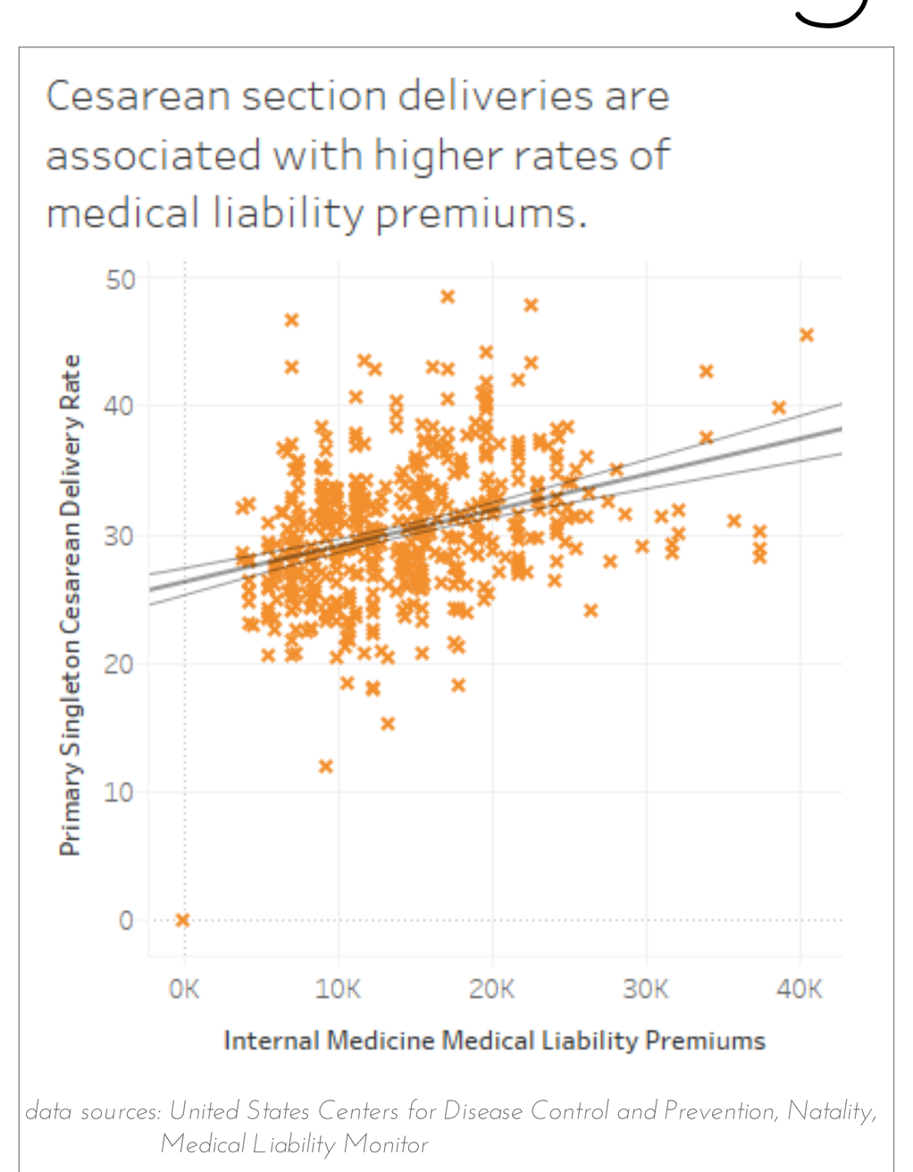
Goal:

Develop a predictive model to identify counties with a cesarean-section delivery rate above 30% for primary singleton births in counties with population of 100,000 people or more.

Why is the Cesarean delivery rate so high?

Why are cesarean section deliveries so high in the United States, and what causes some counties to have higher rates than others? Chen et al. (2004) identified maternal and infant health characteristics as predictors for cesarean births. Miller and Shriver (2012) identified broader structural economic factors as contributing to cesarean deliveries. But these models predict risk factors at the individual level, and only capture a portion of the risk associated with higher cesarean deliveries. Murthy et al. (2007) found that higher rates of primary cesarean delivery were associated with increased medical professional liability premiums. Research from Sweden (Nilsson et al., 2012) and the United States (Arcia , 2013) identified fear of childbirth (FOC) as a factor that increases the likelihood of cesarean-section delivery in low-risk pregnancies. Can we build a model that takes these aspects into consideration to determine which counties in the United States area at greater risk for high cesarean delivery births?

Medical Liability

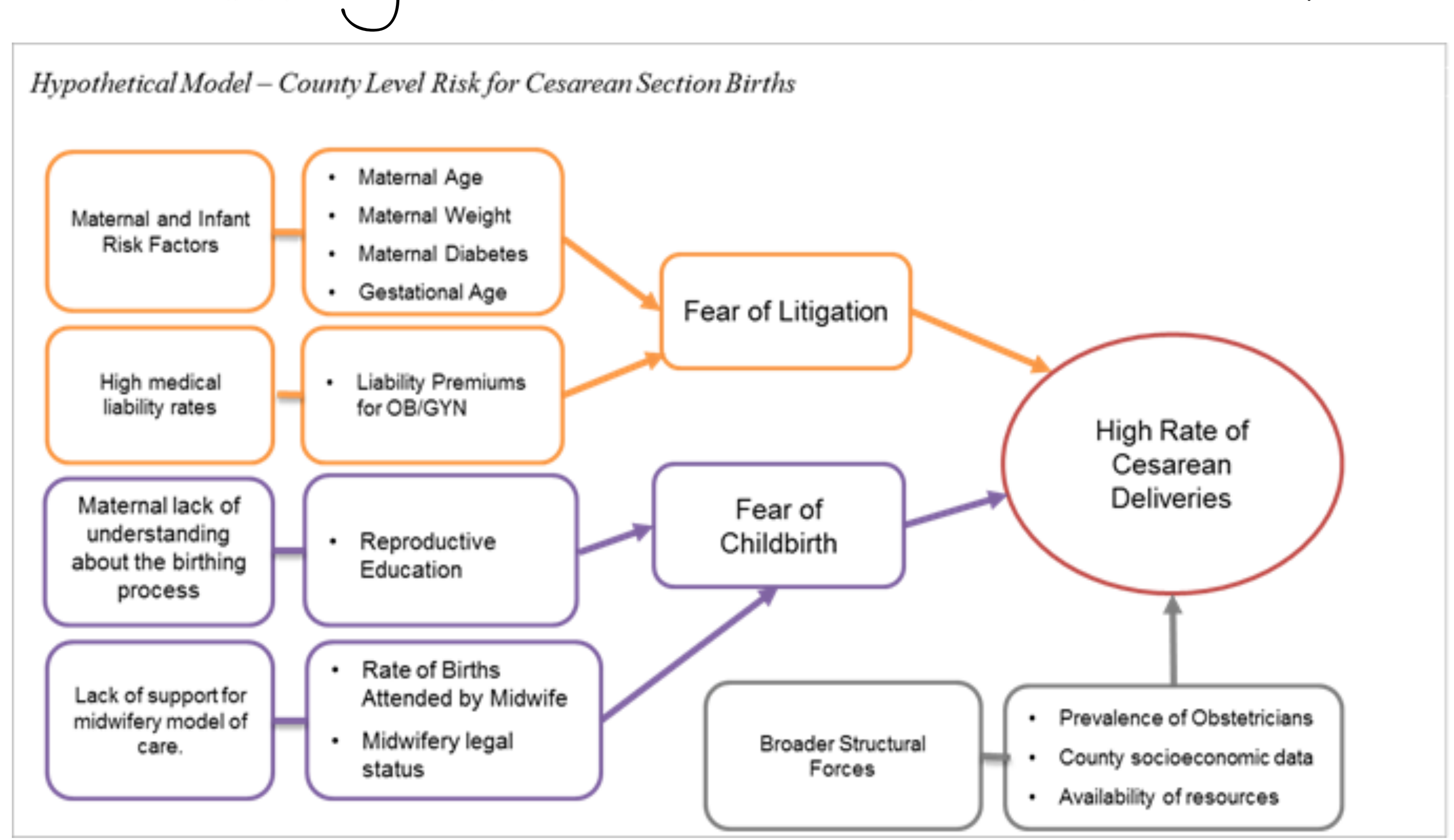


Cesarean section deliveries are associated with higher rates of medical liability premiums.
Primary Singleton Cesarean Delivery Rate
Internal Medicine Medical Liability Premiums
0K
10K
20K
30K
40K
data sources: United States Centers for Disease Control and Prevention, Natality Files, Medical Liability Monitor

Rising medical liability premiums have been shown to affect medical professionals' decision making. Between 2001 and 2005, the median liability premiums in the United States increased from $40,093 to $74,447.

Many medical students found that they were unprepared for the litigious environment of medicine and indicated that they did not receive formal education in liability/malpractice issues during residency; they identified liability-related issues as influencing decision-making in their residency practice (Blanchard et al., 2012). Providers, therefore, find themselves practicing "defensive medicine." Studdert et al. (2005) defined "defensive medicine" as "a deviation from sound medical practice that is induced primarily by threat of liability." Actions associated with defensive medicine include excessive diagnostic procedures and tests as well as avoidance of procedures that are perceived to increase the risk of litigation. In their research, Studdert et al. found that defensive medicine was strongly correlated with the perceived burden of insurance premiums. Murthy, Grobman, Lee, and Holl (2007) found that higher rates of primary cesarean delivery were associated with increased medical professional liability premiums.

Contributing Factors to Cesarean Births

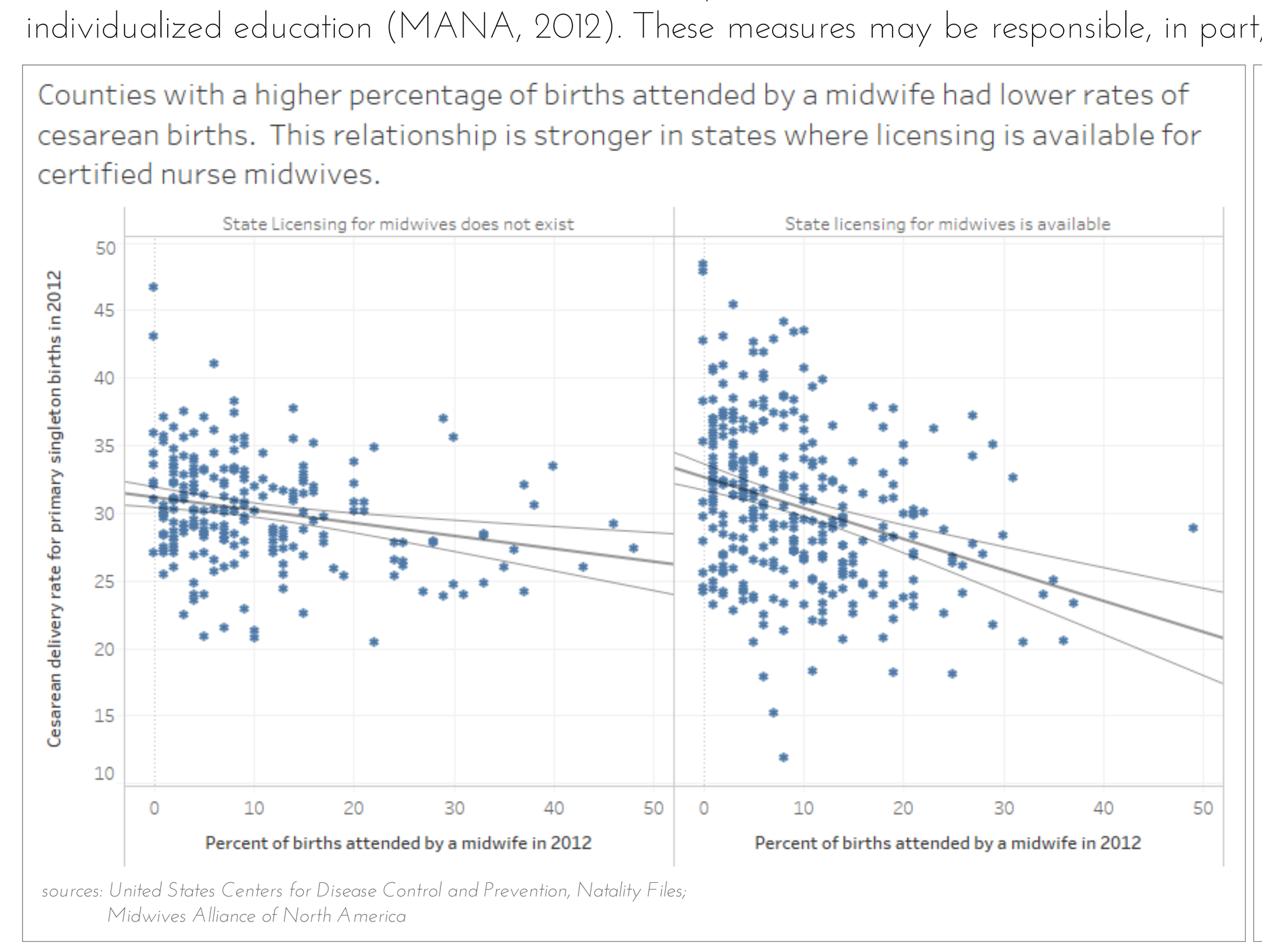


Hypothetical Model – County Level Risk for Cesarean Section Births
Maternal and Infant Risk Factors
Maternal Age
Maternal Weight
Maternal Diabetes
Gestational Age
High medical liability rates
Liability Premiums for OB/GYN
Fear of Litigation
Maternal lack of understanding about the birthing process
Reproductive Education
Fear of Childbirth
High Rate of Cesarean Deliveries
Lack of support for midwifery model of care.
Rate of Births Attended by Midwife
Midwifery legal status
Broader Structural Forces
Prevalence of Obstetricians
County socioeconomic data
Availability of resources

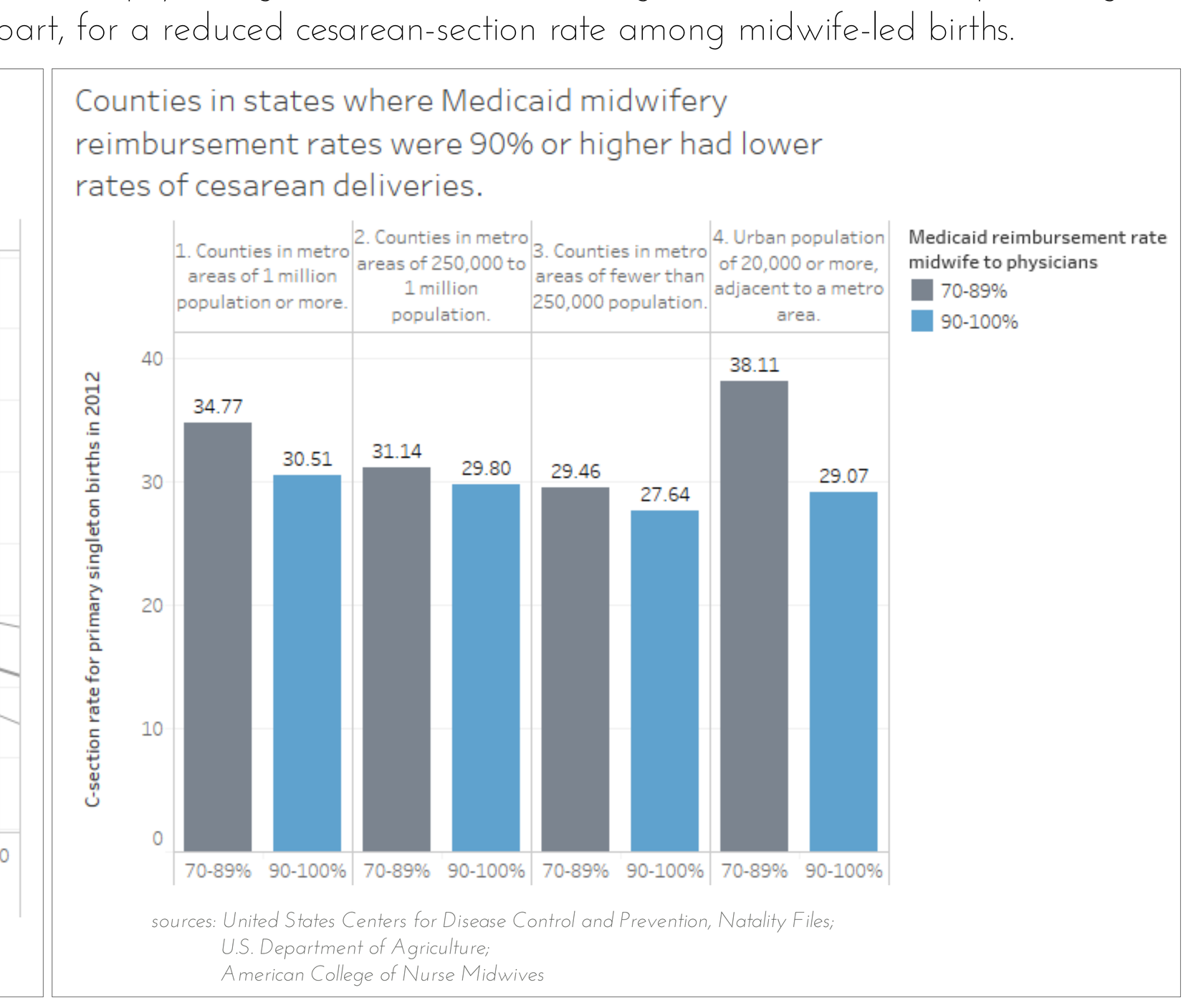
Midwifery Care

Expectant mothers tend to experience more supportive care under a midwife. Focusing on the psychological well-being of the expectant mother can help prepare the woman for the childbirth experience. Women under midwife-led care have reported fewer instances of severe fear of childbirth than women who receive obstetric care (Hall et al., 2009), and a preference for cesarean-section has been shown to be greater among women who are more fearful of delivery (Arcia, 2013). Tully and Ball (2013) suggested that the current perception of childbirth as "unpredictable, frightening and/or potentially dangerous" (Tully & Ball, 2013, p.109) is what leads to high rates of obstetric intervention.

The Midwife Association of North America emphasizes a model of care that monitors the psychological and social well-being of the mother while providing individualized education (MANA, 2012). These measures may be responsible, in part, for a reduced cesarean-section rate among midwife-led births.

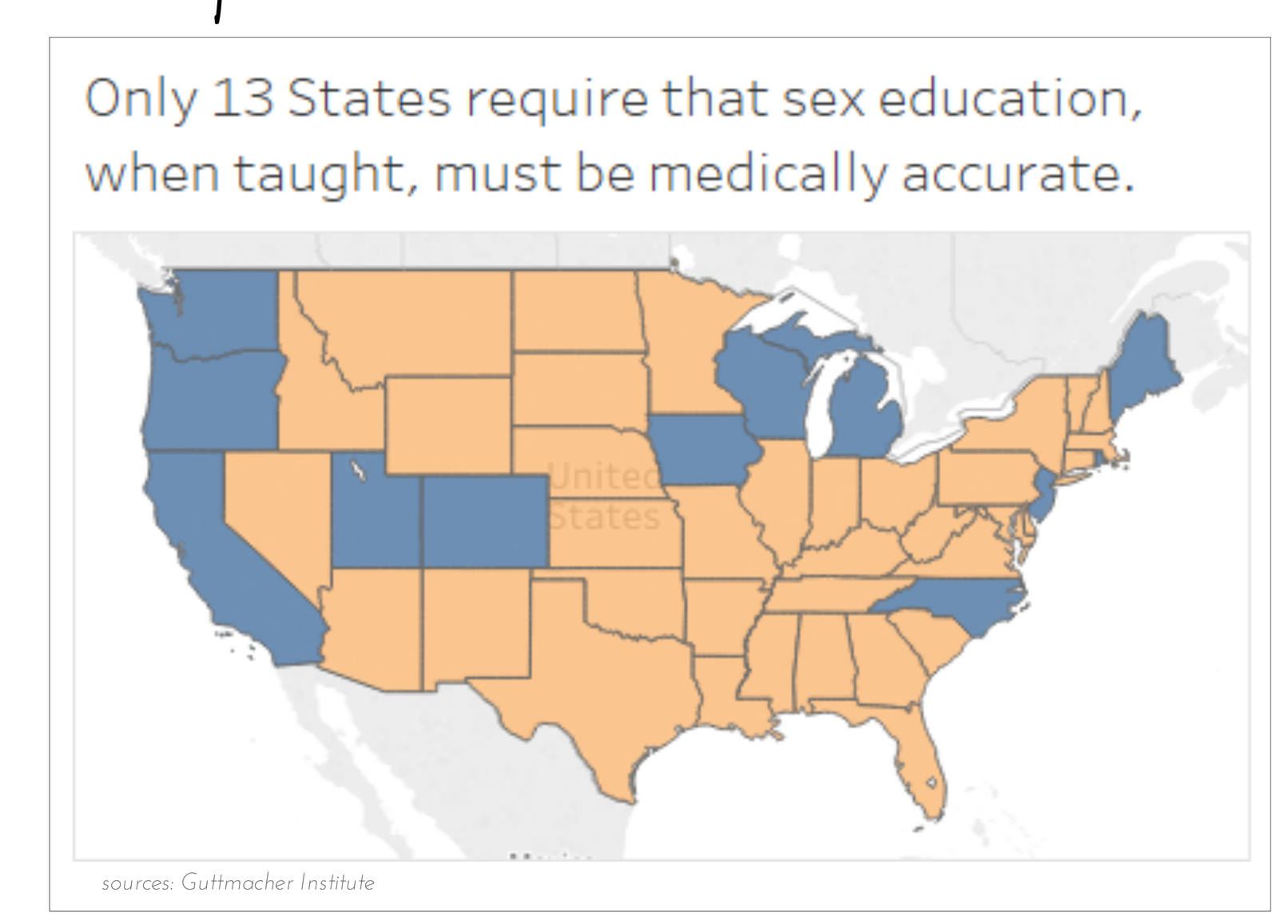


Counties with a higher percentage of births attended by a midwife had lower rates of cesarean births. This relationship is stronger in states where licensing is available for certified nurse midwives.
State Licensing for midwives does not exist
State licensing for midwives is available
Cesarean delivery rate for primary singleton births in 2012
Percent of births attended by a midwife in 2012
sources: United States Centers for Disease Control and Prevention, Natality Files, Midwives Alliance of North America



Counties in states where Medicaid midwifery reimbursement rates were 90% or higher had lower rates of cesarean deliveries.
1. Counties in metro areas of 1 million population or more.
2. Counties in metro areas of 250,000 to 1 million population
3. Counties in metro areas of fewer than 250,000 population.
4. Urban population of 20,000 or more, adjacent to a metro area.
Medicaid reimbursement rate midwife to physicians
70-89%
90-100%
C-section rate for primary singleton births in 2012
34.77
30.51
31.14
29.80
29.46
27.64
38.11
29.07
70-89%
90-100%
sources: United States Centers for Disease Control and Prevention, Natality Files, U.S. Department of Agriculture, American College of Nurse Midwives

Reproductive Education

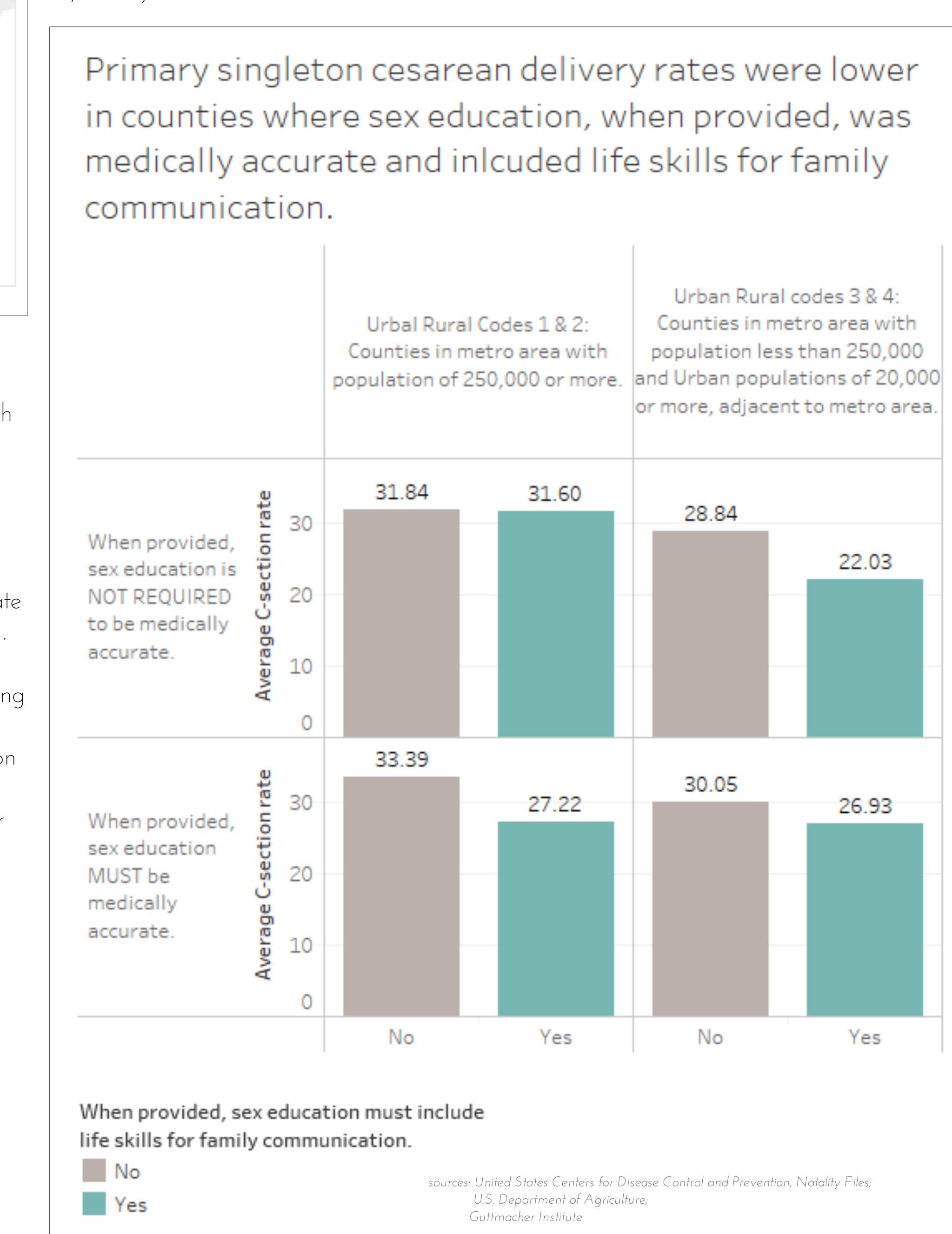


The level of comfort and social acceptance in discussing reproductive health varies across communities in the United States. Fear of childbirth among female college students has been associated with a lack of knowledge about childbirth (Cleeton, 2001).

And contrary to popular belief, high school students lack the understanding of the specifics of how contraceptives work to prevent pregnancy (Smith, Realini, Buzi, & Martinez, 2011). Students appreciate facilitators of sex education who allow open dialog (Smith et al., 2011). However, in communities where parents and school officials favor an "abstinence-only" curriculum, teachers have expressed fear that discussing controversial sex education topics, including contraception, could jeopardize their careers (Donvan, 1998). The fear of communication on part of the school officials may lead to fewer open and honest conversations about reproductive health, thereby reducing the transfer of knowledge on reproductive issues such as childbirth.

The World Health Organization has established a link between maternal education and maternal mortality (Karlsen et al., 2011)

A longitudinal study of a region of Sweden and a region of Australia found that pregnant women who were considered "fearful" of birth were over three times more likely to prefer a caesarean than women who were not identified as "fearful" (Haines, Rubertsson, Pallant, & Hildingsson, 2012). Another study on fear of childbirth found that concerns about control and safety and a "devaluing of the female body and birth process" were the main reasons women requested cesarean section during a healthy and normal first pregnancy (Fenwick et al., 2008).



Primary singleton cesarean delivery rates were lower in counties where sex education, when provided, was medically accurate and inlcuded life skills for family communication.
Urbal Rural Codes 1 & 2: Counties in metro area with population of 250,000 or more.
Urban Rural codes 3 & 4: Counties in metro area with population less than 250,000 and Urban populations of 20,000 or more, adjacent to metro area.
When provided, sex education is NOT REQUIRED to be medically accurate.
When provided, sex education MUST be medically accurate.
Average C-section rate
31.84
31.60
28.84
22.03
33.39
27.22
30.05
26.93
No
Yes
No
Yes
When provided, sex education must include life skills for family communication.
No
Yes
sources: United States Centers for Disease Control and Prevention, Natality Files, U.S. Department of Agriculture, Guttmacher Institute

Data Collection

This research contains data from the following sources.

1. Birth Data from the Centers for Disease Control and Prevention: total cesarean-section deliveries by county, birth order, maternal age, gestational age, and medical attendant (2012). Birth data is only available for counties with a population of at least 100,000 people
2. Rural-Urban Continuum Codes from the US Department of Agriculture (2013).
3. Medical Liability Insurance Premium Data from Medical Liability Monitor (2012)
4. Reproductive education data from the Guttmacher Institute (2012).
5. Midwifery insurance reimbursement rate data from the American College of Nurse-Midwives (2013)
6. State legal status for midwives from the Midwives Alliance of North America (2012).
7. Demographic data from the U.S. Department of Health and Human Services, Area Health Resources Files (2012).

Method

1. Data Prep Final data set included 511 counties in the United States.
2. Randomly split into training and test sets. Split evenly across Census Regions
3. Apply supervised discretization to continuous variables.
4. Calculated odds ratios for each discrete variable against dependent variable.
5. Retain variables where the univariate test has a p-value of <0.25 (as recommended by Hosmer and Lemeshow, 2000)
6. Group variables by respective model group: Maternal and Infant Risk Factors, Medical Liability, Reproductive Education, Support for Midwifery Care, and Broader Structural Forces.,
7. Identify top performing variables in each group and include in consideration for final model.
8. Select final model based on Variation Inflation Factors (seeking VIF of less than 2 for all variables), a low Akaike information criterion score (AIC), and out-of-sample model performance.

Results

Univariate Logistic Regression

Univariate Results –Medical Liability Factors	Variable Description–Yes=1	n (of sample of 337)	OR	p-value
ML: Internal Rates-High	Discretized - Medical Liability Premiums for Internal Practice greater than $15,759	119	4.19	0.000
ML: OB GYN Rates High	Discretized – Medical Liability Premiums for OB/GYN practice was greater than $69,450	130	3.35	0.000

Univariate Results – Reproductive Education Factors	Variable Description–Yes=1	n (of sample of 337)	OR	p-value
RE: family communication	When provided, sex education must include life skills for family communication.	91	0.275	0.000
RE: Abstinence	When provided, sex education must include information on the importance of sex only within marriage.	176	2.172	0.000
RE: Medically Accurate	When provided, sex or HIV education must be medically accurate (y=1).	113	0.42	0.003
RE: Life Skills Healthy Decision Making	When provided, sex education must include life skills for healthy decision-making.	152	0.498	0.002

Univariate Results – Midwifery Care Factors	Variable Description–Yes=1	n (of sample of 337)	OR	p-value
MW: Attending	Discretized - Percent of births attended by a midwife was greater than 7.1%	158	0.407	0.000
MW: Medicaid 90-100	The Medicaid reimbursement rate for midwives was 90% or greater.	239	0.341	0.000
MW: Medicaid 100	Medicaid covers midwifery at a rate equal to physicians.	176	0.464	0.001
MW: Medicaid 80-89%	The Medicaid reimbursement rate for midwives was between 80% and 89%.	68	2.236	0.005
MW: Medicaid 70-79%	The Medicaid reimbursement rate for midwives was between 70% and 79%.	30	3.307	0.008

Univariate Results –Broader Structural Forces	Variable Description–Yes=1	n (of sample of 337)	OR	p-value
SF: Region W or MW	County is within the West or Midwest Census Region	139	0.232	0.000
SF: Region W	County is within the West Census Region	60	0.193	0.000
SF: Region S	County is within the South Census Region	127	2.957	0.000
SF: Region MW	County is within the Midwest Census Region	79	0.503	0.009
SF: Region NE	County is within Northeast Census Region	71	1.784	0.350
SF: Urban Rural 1	County is in a metro area with a populationof1 million or more	145	2.473	0.000
SF: Urban Rural 2	County is in metro area of a population of 250,000 to 1 million	103	0.723	0.171
SF: Urban Rural 3	County is in a metro area with a population fewer than 250,000	81	0.414	0.001
SF: Female PopHigh	Discretized -County population of adult females greater than 115,785	149	2.21	0.000
SF: GINI-high	Discretized - GINI estimat e for county greater than 0.4864	49	2.93	0.002
SF: Per Capita IncomeHigh	Discretized -County income per capita in 2012 greater than $40,894	168	1.48	0.072
SF: PovertyHigh	Discretized -Percent of population that lives in poverty greater than 6.1%	167	0.71	0.116

Univariate Results –Maternal and Infant Risk Factors	Variable Description–Yes=1	n (of sample of 337)	OR	p-value
RF: Maternal Age 40plus -high	Discretized -% of births to mothers age 40 and greater was higher than 1.1%	178	2.28	0.000
RF: Gestation Under 37wks	Discretized -% of births with gestational age of less than 37wks was greater than 10.1%	103	2.73	0.000
RF: Health Female Diabetic	Discretized -%of women in county that are diabetic was greater than 7.1%	264	2.77	0.000

Multivariable Logistic Model

Variable Name	Variable Description	estimate	SE	Pr(>|z|)		OR	95% CI(OR)
(Intercept)	(Intercept)	-0.1061	0.4545	0.81542		0.90	0.37 - 2.19
RF: Gestation Under 37wks	Discretized -% of births with gestational age of less than 37wks was greater than 10.0%	0.9388	0.3174	0.00310		2.56	1.38 - 4.82
RF: Maternal Age 40plus	Discretized -% of births to mothers age 40 and greater was higher than 1.1%	0.8056	0.3005	0.00734	**	2.24	1.25 4.07
ML: Internal Rates-High	Discretized -Medical Liability Premiums for Internal Practice greater than $15,759	0.9339	0.2898	0.00127	**	2.54	1.45 - 4.52
MW: Attending	Discretized -Percent of births attended by a midwife was greater than 7.1%	-0.7707	0.2688	0.00414	**	0.46	0.27 - 0.78
ME: Medicaid 90-100	The Medicaid reimbursement rate for midwives was 90% or greater.	-0.7833	0.3101	0.01155	**	0.46	0.25 - 0.84
RE: Abstinence	When provided, sex education must include information on the importance of sex only within marriage.	0.6726	0.2912	0.02092	*	1.96	1.11 - 3.49
SF: Region W or MW	County is within the West or Midwest Census Region	-0.8536	0.2779	0.00213	*	0.43	0.25 - 0.73
SF: UrbanRural 1	County is in a metro area with a population of 1 million or more	0.609	0.312	0.05097	**	1.84	1.00 - 3.41
SF: Urban Rural 3	County is in a metro area with a population fewer than 250,000	-0.5006	0.3527	0.15586	.	0.61	0.30 - 1.20

Signif.codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1
(Dispersion parameter for binomial family taken to be 1)

Null deviance: 466.51 on 336degrees of freedom
Residual deviance: 351.39on 327degrees of freedom

AIC: 371.39
GLM, Family=binomial
n=337
in sample accuracy: 0.748
test accuracy: 0.724
final accuracy: 0.740

Summary & Conclusion

Medical liability premiums, reproductive education, midwifery care, along with socioeconomic and demographic factors, work in concert to influence the mode of delivery for primary births in the United States. This research supports previous work identifying midwifery care and medical liability as influencers on cesarean section rates in the United States. The additional consideration of reproductive education, or lack thereof, along with a county level analysis, supports the hypothetical model that a maternal fear of childbirth combined with a fear of medical liability is contributing to high cesarean section rate for primary singleton births in the United States.

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