



Policy Matters

Variation in Restrictive Abortion Policies and Adverse Birth Outcomes in the United States from 2005 to 2015



Sara K. Redd, PhD, MSPH^{a,b,*}, Kelli Stidham Hall, PhD, MS^{b,c,d},
Monica S. Aswani, DrPH, MSPH^e, Bisakha Sen, PhD, MA^{e,f},
Martha Wingate, DrPH, MPH^f, Whitney S. Rice, DrPH, MPH^{b,d}

^a Department of Health Policy and Management, Rollins School of Public Health, Emory University, Atlanta, Georgia

^b Center for Reproductive Health Research in the Southeast (RISE), Emory University, Atlanta, Georgia

^c Department of Population and Family Health, Mailman School of Public Health, Columbia University, New York, New York

^d Department of Behavioral, Social, and Health Education Sciences, Rollins School of Public Health, Emory University, Atlanta, Georgia

^e Department of Health Services Administration, School of Health Professions, University of Alabama at Birmingham, Birmingham, Alabama

^f Department of Health Care Organization and Policy, School of Public Health, University of Alabama at Birmingham, Birmingham, Alabama

Article history: Received 7 January 2021; Received in revised form 5 October 2021; Accepted 14 October 2021

ABSTRACT

Background: Since 2011, U.S. states have enacted more than 400 policies restricting abortion access. As structural determinants, abortion policies have the potential to influence maternal and child health access, outcomes, and equity through multiple mechanisms. Limited research has examined their implications for birth outcomes.

Methods: We created a state-level abortion restrictiveness index composed of 18 restrictive abortion policies and evaluated the association between this index and individual-level probabilities of preterm birth (PTB) and low birth-weight (LBW) within the United States and by Census Region, using data from the 2005–2015 National Center for Health Statistics Period Linked Live Birth-Infant Death Files. We used logistic multivariable regression modeling, adjusting for individual- and state-level factors and state and year fixed effects.

Results: Among 2,500,000 live births, 269,253 (12.0%) were PTBs and 182,960 (8.1%) were LBW. On average from 2005 to 2015, states had approximately seven restrictive abortion policies enacted, with more policies enacted in the Midwest and South. Nationally, relationships between state restrictiveness indices and adverse birth outcomes were insignificant. Regional analyses revealed that a 1 standard deviation increase in a state's restrictiveness index was associated with a 2% increase in PTB in the Midwest (marginal effect [ME], 0.25; 95% confidence interval [CI], 0.04–0.45; $p < .01$), a 15% increase in LBW in the Northeast (ME, 1.24; 95% CI, 0.12–2.35; $p < .05$), and a 2% increase in LBW in the West (ME, 0.12; 95% CI, 0.01–0.25; $p < .05$).

Conclusion: Variation in restrictive abortion policy environments may have downstream implications for birth outcomes, and increases in abortion restrictions were associated with adverse birth outcomes in three out of four Census Regions.

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Funding Statement: This research was supported by a predoctoral fellowship from the Center for Reproductive Health Research in the Southeast (RISE) and in part with grant support from the Society of Family Planning Research Fund (SFPRF11-18). The views and opinions expressed are those of the authors, and do not necessarily represent the views and opinions of SFPRF.

* Correspondence to: Sara K. Redd, PhD, MSPH, Department of Health Policy and Management, Rollins School of Public Health, Emory University, 1518 Clifton Road, NE, Atlanta, GA 30322.

E-mail address: skredd@emory.edu (S.K. Redd).

Abortion Policy and Access Patterns in the United States

Abortion is one pregnancy resolution option available to people experiencing a pregnancy. Although abortion is a common, safe health care service (Upadhyay et al., 2015a; White, Carroll, & Grossman, 2015), multiple factors affect an individual's ability to access abortion services. Policy-level factors have historically played an important role in the abortion access

landscape, increasingly so in recent years (American Public Health Association, 2015; Bentele, Sager, & Aykanian, 2018; Guttmacher Institute, 2020a). Since 2011, at least 424 restrictive abortion policies have been implemented by state legislatures, comprising more than one-third of all abortion restrictions enacted since *Roe v. Wade* (Guttmacher Institute, 2020b). The literature base examining restrictive abortion policies points to their negative implications for access to abortion care, including decreased availability of abortion providers (Grossman et al., 2014; Texas Policy Evaluation Project, 2015; Williams, Roberts, & Kerns, 2018), difficulty securing appointments (Baum, White, Hopkins, Potter, & Grossman, 2016; Gerdts et al., 2016a; Jones & Jerman, 2016; Texas Policy Evaluation Project, 2015), delays in abortion care (Bitler & Zavodny, 2001; Gerdts et al., 2016a; Grossman et al., 2014; Zane et al., 2015), greater travel time and distance (Baum et al., 2016; Fuentes et al., 2016; Gerdts et al., 2016a; Jerman, Frohwirth, Kavanaugh, & Blades, 2017; Jones & Jerman, 2013; Lindo, Myers, Schlosser, & Cunningham, 2020; Reeves, Blumenthal, Jones, Nichols, & Saporta, 2015; Roberts, Turok, Belusa, Combellick, & Upadhyay, 2016), and increased financial burden, including out-of-pocket costs associated with travel and lost wages (Baum et al., 2016; Fuentes et al., 2016; Gerdts et al., 2016a; Jerman et al., 2017; Medoff, 2015; Roberts et al., 2016; Sanders, Conway, Jacobson, Torres, & Turok, 2016).

Collectively, the influx of restrictive abortion policies has made the environment around abortion access markedly more hostile in most states and multiple regions. Analyses from the Guttmacher Institute indicate that, as of 2020, 29 states demonstrate hostility to abortion rights, and 58% of women of reproductive age are living in states considered hostile or very hostile to abortion services, meaning they had four or five (hostile), or six (very hostile) abortion restrictions in effect (Guttmacher Institute, 2020b). However, state adoption of restrictive abortion policies—thus, their hostility toward abortion access—varies substantially by U.S. Census Region. States in the Midwest and South have enacted more restrictive abortion policies than those in the Northeast and West; as of 2020, 10 of 12 Midwestern states (83%) and 14 of 16 Southern states (88%) demonstrate hostility to abortion rights, compared with one of nine Northeastern states (11%) and four of 13 Western states (31%) (Guttmacher Institute, 2020b). As restrictions have mounted disproportionately in the Midwest and South, abortion service delivery in these regions has been disproportionately depleted, with these regions experiencing the largest declines in the number of abortion providers (Jones & Jerman, 2017) and the largest increases in the percentage of counties and people living in counties with no abortion clinic (Jones & Jerman, 2017; Jones, Zolna, Henshaw, & Finer, 2008).

Restrictive Abortion Policies as Upstream Determinants of Health

As explained by Crear-Perry et al. (2021), it is critically important to examine structural determinants of health, including policies, practices, institutions, and cultural norms, that dictate the distribution of power and resources across the sociopolitical environment of the United States. Addressing structural determinants of health is imperative to advancing equitable access to social determinants of health (Solar & Irwin, 2010) and, ultimately, improving maternal health outcomes and equity (Crear-Perry et al., 2021). A growing body of evidence has investigated the health effects of state laws influencing upstream social determinants of health (Siegler, Komro, & Wagenaar, 2020). Restrictive abortion policies serve as

structural determinants of health that dictate who can access abortion and through what means, operate with other co-occurring structural determinants of health to shape the options available to those who cannot access abortion, and have downstream implications for health outcomes and equity. Given the sustained legislative attacks on access to abortion services in the United States, additional understanding of how restrictive abortion policies may influence health outcomes in this context is paramount.

Inability to access abortion services due to policy in the state or geographic region in which one lives may result in some pregnant people continuing unwanted pregnancies. Analyses exploring downstream effects of restrictive abortion policies report associations with pregnancy-related outcomes, including increased likelihood of planning to continue a pregnancy (Upadhyay, McCook, Bennett, Cartwright, & Roberts, 2021) and reductions in abortion rates (Brown, Hebert, Gilliam, & Kaestner, 2020; Fischer, Royer, & White, 2018; Grossman et al., 2014; Hall et al., 2020; Lindo et al., 2020; New, 2011; Oakley, 2003). As such, restrictive abortion policies may contribute to adverse birth outcomes via various pathways. First, compared with legal induced abortion, pregnancy and childbirth are markedly less safe and associated with more pregnancy-related morbidities and mortality (Grimes, 2006; Raymond & Grimes, 2012), thus increasing the risk of adverse birth outcomes (Geller et al., 2018). Indeed, prior studies have found associations between restrictive abortion policies and increased rates of maternal and infant mortality (Hawkins, Ghiani, Harper, Baum, & Kaufman, 2020; Karletsos, Stoecker, Vilda, Theall, & Wallace, 2021; Pabayo et al., 2020; Vilda et al., 2021) and demonstrated that being unable to access wanted abortion services has negative implications for birth outcomes, including increased risk of eclampsia, postpartum hemorrhage, and maternal mortality (Biggs, Upadhyay, McCulloch, & Foster, 2017; Gerdts, Dobkin, Foster, & Schwarz, 2016b; Upadhyay, Biggs, & Foster, 2015b).

In addition, people who continue an unwanted pregnancy may face additional structural determinants of the health care system that may contribute to adverse birth outcomes, including lack of insurance coverage, shortages of primary care and obstetric providers, and inability to access affordable, comprehensive, and culturally appropriate care (Crear-Perry et al., 2021). States with highly restrictive abortion environments also generally have fewer policies supporting the health and well-being of pregnant people, their children, and their families, such as Medicaid expansion, generous Medicaid income eligibility limits for pregnant people, expanded family/medical leave, and sex and HIV education mandates (Ibis Reproductive Health and Center for Reproductive Rights, 2020). Environments with inadequate access to comprehensive reproductive health services, including and beyond abortion care, and supportive social policies restrict the reproductive autonomy of residents and endanger their health, including via increased rates of preterm birth (PTB), low birthweight (LBW), and maternal and infant mortality (Ibis Reproductive Health and Center for Reproductive Rights, 2014; Krieger et al., 2015; Roberts, 2017; Ross & Solinger, 2017; Wallace, Evans, & Theall, 2017).

Last, being unable to access comprehensive reproductive health care due to abortion policies likely contributes to increased psychosocial stress for the pregnant person, which subsequently increases the risk for adverse birth outcomes (Alderdice, Lynn, & Lobel, 2012; Hobel, Goldstein, & Barrett, 2008; Lobel, DeVincent, Kaminer, & Meyer, 2000; Monk et al., 2020; Osborne & Monk, 2013; Pabayo et al., 2020). This stress may be compounded by

other external factors, including navigating substantial structural determinants to obstetric care and residing in the historical and contemporary sociopolitical context of the United States, resulting in added psychosocial strains on the pregnant person. In addition, research demonstrates being unable to access wanted abortion services increases the risk of physical violence from the male involved in the pregnancy and experiences of anxiety and poor self-esteem for the pregnant person, all of which contribute to prenatal stress (Biggs et al., 2017; Roberts et al., 2014). Thus, it is reasonable to hypothesize that restrictive abortion policies would be associated with poorer birth outcomes for pregnant people living in the United States. Furthermore, because states in the Midwest and South have implemented more restrictive abortion policies (Guttmacher Institute, 2018), individuals living in these regions may be more vulnerable to the consequences of living in hostile environments toward abortion rights, including adverse birth outcomes. In addition, these regions are also subject to higher rates of adverse birth outcomes, with the Midwest and South having higher rates of PTB and LBW compared to the Northeast and West (March of Dimes Perinatal Data Center, 2020). These differences may be a reflection of increased social and structural barriers to health care, such as restrictive abortion policies, in these regions.

Methodological Gaps in the Literature and Research Objective

Although prior research has set a scientific foundation on which to understand the influence of restrictive abortion policies on health, notable conceptual and methodological gaps in the literature remain. For instance, most existing studies rely on one source of publicly available policy data collected by third parties, which often do not disclose information on how data were collected and defined, potentially resulting in underspecified or inaccurate policy data (Burriss, 2014; Burriss, Hitchcock, Ibrahim, Penn, & Ramanathan, 2016). In addition, although a handful of studies investigate the relationship between restrictive abortion policies (Coles, Makino, Stanwood, Dozier, & Klein, 2010; Hawkins et al., 2020; Karletsos et al., 2021; Pabayo et al., 2020; Vilda et al., 2021) (or a reproductive rights index; Wallace et al., 2017) and adverse birth outcomes, limitations associated with these analyses inspire further examination of this relationship. Furthermore, to our knowledge, existing studies have not explored regional variation in the relationship between restrictive abortion policies and adverse birth outcomes.

In order to expand on the current evidence base, we used a structural determinants lens to focus on the role of policy as a structural determinant of population health and sociopolitical contexts and environments within which birthing people live (Crear-Perry et al., 2021). In this population-based study, we evaluated the relationship between a state's restrictive environment toward abortion access, measured using a comprehensive index of 18 state-level restrictive abortion policies, and two individual-level adverse birth outcomes—PTB and LBW—in the United States and in each U.S. Census Region from January 1, 2005, through December 31, 2015.

Material and Methods

Data Sources and Measures

The Institutional Review Board of Emory University deemed this project exempt from review as it does not constitute human subjects research.

Outcomes

We defined PTBs as births occurring before 37 weeks' gestation (World Health Organization, 2010) and used a binary indicator for birth before 37 weeks (1) versus 37 weeks or after (0). We classified births as LBW when less than 2,500 grams (World Health Organization, 2010) and used a binary indicator for infant birthweight of less than 2,500 grams (1) versus 2,500 grams or more (0). We obtained outcome data from the National Center for Health Statistics (NCHS) Period Linked Live Birth-Infant Death Files (National Center for Health Statistics), which contain births occurring in all states and Washington, D.C., from 2005 to 2015. We selected the 2005 to 2015 study period to approximate a natural experiment regarding abortion policy enactment, spanning years with relatively little policy activity (i.e., 2005–2008) and those with substantial variation in restrictive abortion policy enactment (i.e., 2011–2015) (Nash, Gold, Mohammed, Ansari-Thomas, & Cappello, 2018).

Exposure

We created an aggregate state-level abortion restrictiveness index of 18 policies that reduce abortion access or provision (Table 1). We sourced policy data from the National Association for the Repeal of Abortion Laws (NARAL) Pro-Choice America's State Government Law and Policy databases (NARAL Pro-Choice America) and LawAtlas's Abortion Law Project (The Policy Surveillance Program, 2019). We validated data collected by one source (either NARAL or LawAtlas) using the other source or via original legal research by the study team using NexisUni. We coded policies using a binary 0/1 coding scheme to indicate if a policy was in effect in a given state and year, beginning with the year the policy was enacted. We included enjoined policies in the index, as policy implementation is often ambiguous and policies may still affect provider and patient behavior even when enjoined (Hatzenbuehler et al., 2017). However, if a policy was ruled unconstitutional, we excluded it from the index.

The final exposure measure was a state-level abortion restrictiveness index representing a count of the number of enacted restrictive abortion policies in a given state and year. The minimum number of policies a state could have was zero, and the maximum 18. We lagged the restrictiveness index by 1 year to acknowledge that policies enacted in a given year would likely not affect infant outcomes until the subsequent year, given the 9-month gestation period. We standardized the restrictiveness index to improve interpretation of the measure, given the range in variation in enacted restrictive abortion policies between states. Thus, we interpreted parameter estimates as a change given a 1 standard deviation (SD), in this instance, four-policy, increase in a state's restrictiveness index.

Stratification variable: region

Given the regional clustering of our exposure and outcomes, we examined regional variation of the focal relationship by stratifying the main analyses by U.S. Census Region.

Covariates

We controlled for individual- and time-varying state-level demographic, economic, political, and policy characteristics that the structural determinants of health framework and existing literature suggest may be associated with either adverse birth outcomes or state policymaking decisions (Austin & Harper, 2019; Bitler & Zavodny, 2001; 2004; Blank, George, & London, 1996; Crear-Perry et al., 2021; Hawkins et al., 2020; Levine, Trainor, & Zimmerman, 1996; Medoff, 2012; New, 2011; Oakley,

Table 1
Restrictive Abortion Policies in Restrictiveness Index: Definitions and Data Sources

Policy	Definition	Data Source
1. Abortion Facility Licensing Requirements	Requires clinics to follow uniquely imposed licensure schemes	NARAL data validated by LawAtlas
2. Bans on Abortion Coverage for State Employees	Bans insurance coverage of abortions for state employees	NARAL data validated by LawAtlas
3. Bans on Private Insurance: All Plans	Restricts coverage of abortion in all private plans offered in state	NARAL data validated by LawAtlas
4. Bans on Private Insurance: Health Exchange Plans Only	Restricts coverage of abortion in plans offered through health insurance exchanges	NARAL data validated by LawAtlas
5. Ban on Public Funding	Prohibits the use of state funds except in those cases when federal funds are available (i.e., rape, incest, endangerment of person's life)	NARAL data, supplemented and validated by LawAtlas and original legal research
6. Gestational Age Limits (Pre-Viability)	Prohibits abortions past a specified point in pregnancy	NARAL data validated by LawAtlas
7. Hospitalization Requirements	Requires that abortions past a certain gestational age be performed in a hospital	NARAL data validated by LawAtlas
8. Licensed Physician Requirements	Requires only licensed physicians to provide abortions	NARAL data validated by LawAtlas
9. Medication Abortion Restrictions: Physician Requirements	Requires only licensed physicians to provide medication abortion	LawAtlas data validated by original legal research
10. Medication Abortion Restrictions: In-Person Administration Requirements	Requires provider be physically present and administer medication abortion in person	LawAtlas data validated by original legal research
11. Mandatory Counseling Requirements	Requires anyone seeking abortion to be counseled on at least one of the following: the purported link between abortion and breast cancer, the ability of a fetus to feel pain, or long-term mental health consequences of abortion	NARAL data validated by LawAtlas
12. Mandatory Ultrasound Requirements	Requires providers to perform an ultrasound on each patient prior to abortion; providers required to show and describe the image or offer to show the image	LawAtlas data validated by original legal research
13. Mandatory Waiting Periods	Requires person seeking abortion to wait a specified period of time (usually 24 hours) between receiving counseling and abortion procedure	NARAL data validated by LawAtlas
14. "Partial-Birth" Abortion Bans	Bans the intact dilation and evacuation procedure; contains additional penalties for those who perform it	NARAL data validated by LawAtlas
15. Parental Involvement Laws	Requires parental involvement (e.g., consent, notification) prior to minor receiving abortion	NARAL data validated by LawAtlas
16. Physician Hospital Admitting Privilege Requirements	Requires physicians providing abortions to have admitting privileges at a hospital within specified distance of abortion facility	NARAL data validated by LawAtlas
17. Provider Refusal Clauses	Allows providers, hospitals, institutions, etc. to refuse to perform or participate in abortion services	NARAL data validated by LawAtlas
18. Second Physician Requirements	Requires a second physician to be present during certain abortion procedures after certain gestational age	NARAL data validated by LawAtlas

Abbreviations: NARAL, National Abortion and Reproductive Rights Action League. Gestational age, age of a pregnancy in weeks. Intact dilation and evacuation procedure = a variation of the dilation and evacuation procedure that involves the removal of an intact fetus. Admitting privileges = the right of a doctor, by virtue of membership as a hospital's medical staff, to admit patients to a particular hospital or medical center for providing specific diagnostic or therapeutic services to such patient in that hospital.

2003; Pabayo et al., 2020; Sen, Wingate, & Kirby, 2012; Sudhinaraset, Vilda, Gipson, Bornstein, & Wallace, 2020; Wallace et al., 2017). At the individual level, we controlled for pregnant parent sociodemographic characteristics (i.e., age, race, ethnicity, education level, marital status) and health risk factors (i.e., number of births and prenatal care visits, diabetes, chronic hypertension, pregnancy-associated hypertension, and eclampsia) and infant characteristics (i.e., sex and plurality) using data from the Period Linked Live Birth-Infant Death files. At the state level, we controlled for demographic characteristics (i.e., percentage of population that were high school graduates, married, and people of color), economic characteristics (i.e., poverty, uninsured, and unemployment rates), and political and policy characteristics (i.e., state party composition, average monthly Temporary

Assistance for Needy Families benefits [adjusted to 2010 dollars], Medicaid expansion, and Medicaid family planning expansion) using data from a variety of sources, including the American Community Survey, Bureau of Labor Statistics, Current Population Survey, Guttmacher Institute, National Center for Vital Statistics, and the National Conference of State Legislatures.

Analysis

Descriptive analysis

To describe the sample and state landscapes during the study period, we conducted univariate statistical analyses of individual- and state-level characteristics and stratified these analyses by U.S. Census Region (Table 2). We calculated the mean number of

Table 2Individual-Level Characteristics of NCHS Period Linked Live Birth-Infant Death File Sample ($n = 2,500,000$) and State-Level Characteristics of U.S. States and Washington, D.C., Stratified by U.S. Census Region: 2005–2015

	No. (%) or Mean \pm SD				
	U.S.	Midwest ($n = 473,645$)	Northeast ($n = 360,077$)	South ($n = 860,762$)	West ($n = 555,516$)
Individual-Level Characteristics					
Race					
American Indian/ Alaska Native	25,959 (1.1)	4,944 (1.0)	1,220 (0.3)	6,834 (0.8)	12,961 (2.3)
Asian/ Pacific Islander	142,334 (6.3)	18,633 (3.9)	29,013 (8.1)	32,861 (3.8)	61,827 (11.1)
Black	356,518 (15.9)	67,090 (14.2)	61,388 (17.0)	198,592 (23.1)	29,448 (5.3)
White	1,725,189 (76.7)	382,978 (80.9)	268,456 (74.5)	622,475 (72.3)	451,280 (81.3)
Ethnicity					
Hispanic	532,443 (24.0)	50,285 (10.7)	64,739 (18.7)	200,728 (23.4)	216,691 (39.6)
Non-Hispanic	1,690,953 (76.0)	421,118 (89.3)	281,508 (81.3)	657,228 (76.6)	331,099 (60.4)
Age, years					
≤ 19	197,071 (8.8)	40,030 (8.4)	22,352 (6.2)	89,787 (10.4)	44,902 (8.1)
20–29	1,171,901 (52.1)	255,561 (54.0)	164,035 (45.6)	470,914 (54.7)	281,391 (50.6)
30–39	817,889 (36.3)	167,198 (35.3)	159,583 (44.3)	279,720 (32.5)	211,388 (38.1)
≥ 40	63,139 (2.8)	10,856 (2.3)	14,107 (3.9)	20,341 (2.4)	17,835 (3.2)
Education					
< High school graduate	404,170 (18.9)	74,209 (15.8)	49,929 (15.5)	167,731 (20.3)	112,301 (21.4)
High school graduate or GED	569,822 (26.6)	118,164 (25.2)	78,553 (24.4)	237,707 (28.8)	135,398 (25.8)
Some college	568,116 (26.5)	134,405 (28.6)	77,569 (24.1)	217,215 (26.3)	138,927 (26.5)
\geq College graduate	601,021 (28.0)	142,571 (30.4)	116,188 (36.0)	204,233 (24.7)	138,029 (26.3)
Married	1,350,429 (60.0)	288,055 (60.8)	221,980 (61.7)	490,321 (57.0)	350,073 (63.0)
Number of Live Births					
1 or 2	1,603,321 (71.6)	333,221 (70.8)	268,870 (75.1)	614,166 (71.8)	387,064 (69.9)
3 or 4	529,668 (23.7)	114,169 (24.2)	74,028 (20.7)	203,751 (23.8)	137,720 (24.9)
5 through 7	104,320 (4.7)	23,375 (5.0)	15,060 (4.2)	37,097 (4.4)	28,788 (5.2)
Prenatal Care Visits	11.2 \pm 4.1	11.45 \pm 3.96	11.04 \pm 3.75	11.02 \pm 4.17	11.48 \pm 4.10
Comorbidities					
Diabetes	116,066 (5.2)	26,887 (5.7)	20,651 (5.8)	41,192 (4.8)	27,336 (4.9)
Eclampsia	5,498 (0.3)	1,210 (0.3)	801 (0.2)	2,098 (0.2)	1,389 (0.3)
Chronic hypertension	29,659 (1.3)	6,665 (1.4)	5,045 (1.4)	13,401 (1.6)	4,548 (0.8)
Pregnancy-associated hypertension	98,763 (4.4)	22,905 (4.9)	13,366 (3.7)	42,637 (5.0)	19,855 (3.6)
Infant Sex					
Female	1,098,776 (48.8)	231,400 (48.9)	176,164 (48.9)	420,261 (48.8)	270,951 (48.8)
Male	1,151,224 (51.2)	242,245 (51.1)	183,913 (51.1)	440,501 (51.2)	284,565 (51.2)
Plurality					
Singleton birth	2,172,889 (96.6)	456,598 (96.4)	345,768 (96.0)	832,159 (96.7)	538,364 (96.9)
Multiple birth	77,111 (3.4)	17,047 (3.6)	14,309 (4.0)	28,603 (3.3)	17,152 (3.1)
Region					
Midwest	473,645 (21.0)	-	-	-	-
Northeast	360,077 (16.0)	-	-	-	-
South	860,762 (38.3)	-	-	-	-
West	555,516 (24.7)	-	-	-	-
Preterm Birth	269,253 (12.0)	55,980 (11.8)	40,149 (11.2)	115,323 (13.4)	57,801 (10.5)
Low Birthweight	182,960 (8.1)	37,338 (7.9)	29,097 (8.1)	77,827 (9.0)	38,698 (7.0)
State-Level Characteristics					
High School Graduates (%)	87.2 \pm 3.5	89.2 \pm 1.9	88.5 \pm 2.5	84.3 \pm 2.8	88.2 \pm 3.6
Marriage (%)	49.8 \pm 4.5	51.7 \pm 2.5	49.1 \pm 2.9	48.0 \pm 5.9	51.0 \pm 3.5
People of Color (%)	22.5 \pm 13.7	15.0 \pm 5.1	17.1 \pm 10.4	29.7 \pm 12.3	23.8 \pm 17.2
Poverty (%)	14.1 \pm 3.2	13.1 \pm 1.8	11.6 \pm 2.2	16.5 \pm 3.3	13.6 \pm 2.9
Unemployment (%)	6.3 \pm 2.2	5.8 \pm 2.2	6.3 \pm 2.0	6.7 \pm 2.0	6.3 \pm 2.4
Uninsured (%)	14.9 \pm 4.8	12.3 \pm 2.4	11.1 \pm 3.0	17.1 \pm 4.7	17.4 \pm 4.4
Average Monthly TANF Payment (\$USD 2010)	328.9 \pm 111.4	308.4 \pm 67.3	424.0 \pm 77.4	240.7 \pm 73.3	397.5 \pm 109.2
Legislature Composition					
Democratic	237 (42.3)	26 (19.7)	73 (73.7)	73 (39.0)	65 (45.5)
Republican	228 (40.6)	72 (54.6)	14 (14.2)	86 (46.0)	56 (39.1)
Split/Unicameral	96 (17.1)	34 (25.7)	12 (12.1)	28 (15.0)	22 (15.4)
Medicaid	79 (14.1)	17 (12.9)	22 (22.2)	16 (8.6)	24 (16.8)
Expansion (%)					
Medicaid Family Planning	284 (50.6)	77 (58.3)	34 (34.3)	124 (66.3)	49 (34.3)
Expansion (%)					
Restrictiveness Index	6.9 \pm 4.0	9.4 \pm 3.4	4.6 \pm 2.9	8.4 \pm 3.7	4.2 \pm 3.1

Abbreviations: GED, general educational development diploma; TANF, Temporary Assistance to Needy Families.

Note: For individual-level characteristics, categorical variables are unweighted counts and weighted proportions of each measure and continuous variables are means and standard deviations of each measure for the stratified random sample from the NCHS Period Linked Live Birth-Infant Death Files. For state-level characteristics, categorical variables are unweighted state-year counts and weighted proportions of each measure from 2005–2015 and continuous variables are means and standard deviations of each measure from 2005–2015 for all 50 states and Washington, D.C.

Table 3
Average Number of Enacted Restrictive Abortion Policies in the United States and by Census Region, Overall and by Year: 2005 to 2015

Year	United States	Census Region			
		Midwest	Northeast	South	West
2005	6.0 ± 3.1	7.9 ± 2.4	4.4 ± 3.1	7.2 ± 2.9	3.6 ± 2.2
2006	6.0 ± 3.2	8.0 ± 2.4	4.4 ± 3.1	7.2 ± 2.9	3.6 ± 2.2
2007	6.0 ± 3.2	8.0 ± 2.4	4.4 ± 3.1	7.3 ± 3.0	3.7 ± 2.3
2008	6.0 ± 3.2	8.0 ± 2.4	4.4 ± 3.1	7.3 ± 3.0	3.7 ± 2.3
2009	6.2 ± 3.3	8.1 ± 2.4	4.4 ± 3.1	7.4 ± 3.0	4.0 ± 2.7
2010	6.4 ± 3.4	8.3 ± 2.6	4.6 ± 2.9	7.8 ± 3.3	4.1 ± 2.9
2011	7.1 ± 4.2	10.0 ± 4.0	4.6 ± 2.9	8.3 ± 3.6	4.5 ± 3.7
2012	7.5 ± 4.4	10.5 ± 3.9	4.7 ± 2.8	8.8 ± 3.7	4.8 ± 4.0
2013	8.0 ± 4.8	11.4 ± 3.9	4.8 ± 3.1	9.9 ± 4.2	4.7 ± 3.8
2014	8.2 ± 4.9	11.5 ± 3.9	4.8 ± 3.1	10.3 ± 4.5	4.8 ± 3.8
2015	8.3 ± 5.0	11.6 ± 3.8	4.8 ± 3.1	10.5 ± 4.5	4.9 ± 3.9
Overall (2005–2015)	6.9 ± 4.0	9.4 ± 3.4	4.6 ± 2.9	8.4 ± 3.7	4.2 ± 3.1
Value (%) Change, 2005–2015	2.4 (39.4%)	3.7 (46.2%)	0.3 (7.4%)	3.4 (46.7%)	1.2 (34%)

Note: Results show the mean and standard deviation of the number of restrictive abortion policies enacted in each year, among all 50 states and Washington, D.C., and stratified by U.S. Census Region. Also shown is the absolute value and percentage change in the number of enacted restrictive abortion policies over the study period.

enacted restrictive abortion policies in the United States overall and by region for each year and calculated the absolute value and percentage change from 2005 to 2015 to examine how the restrictiveness index changed over time (Table 3). To visualize geographic and annual variation in restrictive abortion policies, we created maps depicting the number of enacted restrictive abortion policies in each state in 2005 and 2015 (Figure 1).

Main analysis

We investigated the relationship between state-level restrictive abortion policies and individual-level probabilities of PTB and LBW using two-way (i.e., state and year) fixed effects (FE) modeling (Woolridge, 2010). We estimated the following multivariable logistic regression models:

$$Y_{ist} = \beta_0 + \beta_1 RI_{s(t-1)} + \beta_2 X_{1ist} + \beta_3 X_{2st} + \rho_s + \tau_t + \epsilon_{ist}$$

Equation 1

In the preceding equation, i denotes an individual, s denotes the state, and t denotes the year. Y_{ist} represents the outcomes. $RI_{s(t-1)}$ represents the standardized lagged restrictiveness index, or a standardized measure of the number of restrictive abortion policies in effect in a state, s , during the previous year ($t-1$). X_{1ist} is

the full vector of individual-level covariates, and X_{2st} is the full vector of state-level covariates. ρ_s denotes state FEs accounting for time-invariant heterogeneity across states, and τ_t denotes year FEs accounting for national secular trends in the outcomes. Last, ϵ_{ist} represents the error term. We clustered standard errors at the state level to account for serial correlation of observations within states (Bertrand, Duflo, & Mullainathan, 2004). For brevity, we only present and describe results from the exposure on our outcomes in Table 4; results from full regression models are presented in Supplemental Tables 1 and 2. We present all results as marginal effects.

We conducted collinearity diagnostics to identify the presence of multicollinearity of our predictors; no collinearity issues were identified (all Variance Inflation Factor values < 4). Due to computing capacity issues associated with our modeling strategy and the large number of observations from the NCHS files ($N = 44,992,972$), we drew a 5% stratified random sample, stratified by state and year, using proportional allocation, resulting in a final analytical sample size of $n = 2,500,000$. To test robustness of results, we twice repeated this sampling procedure (with replacement); results were consistent across the repeated samples. We conducted data management and analyses using SAS 9.4 and Stata/SE 16.0.

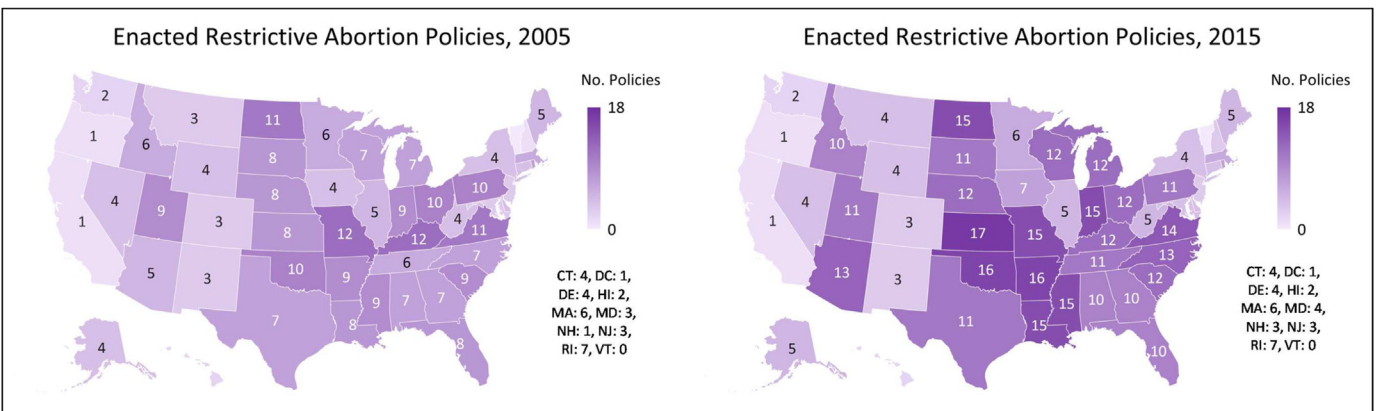


Figure 1. Number of enacted restrictive abortion policies among 50 U.S. states and Washington, D.C.: 2005 and 2015.

Table 4

Marginal Effect of Standardized Abortion Restrictiveness Index on Probability of Preterm Birth and Low Birthweight in the United States and by Census Region: Period Linked Live Birth-Infant Death Files, 2005–2015

	(1) United States	(2) Midwest	(3) Northeast	(4) South	(5) West
Preterm Birth	−0.000452 [−0.00334 to 0.00244]	0.00248* [0.000393 to 0.00456]	0.0150 [−0.00102 to 0.0311]	0.00260 [−0.00148 to 0.00667]	0.00359 [−0.000221 to 0.00741]
P(PTB)	0.1199	0.1183	0.1117	0.1341	0.1046
Sample Size	2,049,919	446,861	306,005	793,361	503,692
Low Birthweight	−0.00240 [−0.00483 to 0.0000215]	−0.00238 [−0.00494 to 0.000168]	0.0124* [0.00120 to 0.0235]	−0.000897 [−0.00522 to 0.00342]	0.00123* [0.0000125 to 0.00245]
P(LBW)	0.0813	0.0788	0.0809	0.0904	0.0697
Sample Size	2,052,895	447,080	306,213	793,744	505,858

Note: Results are marginal effects and 95% confidence intervals (CIs) from multivariable logistic regression models estimating the effect of a standardized restrictive abortion policy index on the probability of preterm birth (PTB) and low birthweight (LBW) within all 50 states and Washington, D.C., and within each U.S. Census region. Also displayed are probabilities of both outcomes within the United States and each region, and sample sizes for each model. Final sample size for each model varied and included people who were not missing any data on exposure, outcome, and covariates. All models adjust for individual-level sociodemographic characteristics, state-level sociodemographic, economic, and political characteristics, and state and year fixed effects. Standard errors clustered at the state level. p -values significant at * $p < .05$, ** $p < .01$, *** $p < .001$.

Subanalysis: main analysis stratified by U.S. Census Region

To investigate regional differences in the relationship between restrictive abortion policies and adverse birth outcomes, we stratified main analysis models by U.S. Census Region.

Results

Descriptive Analysis

Individual- and state-level characteristics of sample

Most of the sample was White (77%), non-Hispanic (76%), between 20 and 29 years of age (52%), high school graduates (27%) or had attended some college (27%), married (60%), and living in the South (38%) or West (25%) (Table 2). Most reported this as their first or second live birth (72%), and a small percentage reported comorbidities including diabetes (5%) and pregnancy-associated hypertension (4%). Slightly fewer than half of births were female (49%) and nearly all were singleton (97%). Twelve percent of births were PTB and 8% were LBW; both outcomes were highest in the South. At the state level, 87% of state populations were high school graduates, 50% were married, and 23% were people of color on average over the study period. Average state poverty and uninsured rates ranged between 14% and 15%, and the unemployment rate was 6%. State legislatures were split between Democratic (42%) and Republican control (41%). Few states had expanded Medicaid (14%), whereas more than half had expanded their Medicaid family planning programs via a Section 1115 waiver or State Plan Amendment (51%). The number of policies enacted in a given state and year ranged from zero (Vermont throughout study period) to 17 (North Dakota in 2015), with the average across the study period being approximately seven (6.9) (Table 2).

State restrictive abortion policy landscape

On average in 2005, states had six restrictive abortion policies enacted (Table 3). As seen in Table 3 and Figure 1, states in the Northeast and West had the lowest average number of enacted restrictive policies (4.4 and 3.6, respectively), and states in the Midwest and South had the highest average number of enacted restrictive policies (7.9 and 7.2, respectively). In 2015, the average number of enacted restrictive abortion policies in U.S. states rose to 8.3, a 39% increase from 2005. The Northeast and West had the lowest average number of enacted restrictive policies (4.8 and 4.9, respectively), and the Midwest and South had the highest

(11.6 and 10.5, respectively). Although nearly every state enacted restrictive abortion policies between 2005 and 2015, indicated by the overall darkening of Figure 1 from 2005 (left) to 2015 (right), the Midwest and South experienced the largest increases (46% and 47%, respectively).

Regression Analyses

Adjusted regression models from the main analysis indicated that the relationship between a state's restrictiveness index and probability of PTB or LBW was not significant (Column 1, Table 4). Adjusted regression models from the subanalysis indicated that the relationship between a state's restrictiveness index and probability of PTB or LBW varied regionally (Columns 2–5, Table 4). In the Midwest, a 1-SD (approximately four-policy) increase in a state's restrictiveness index was associated with a 0.25 percentage point increase in the probability of PTB (95% confidence interval [CI], 0.04–0.45; $p < .01$), translating to a 2.1% relative increase from probability of PTB among those living in the Midwest (11.83%). In the Northeast, South, and West, the relationship between a state's restrictiveness index and probability of PTB was not significant.

In the Northeast, a 1-SD increase in a state's restrictiveness index was associated with a 1.24 percentage point increase in the probability of LBW (95% CI, 0.12–2.35; $p < .05$), translating to a 15.3% relative increase from probability of LBW among those living in the Northeast (8.09%). In the West, a 1-SD increase in a state's restrictiveness index was associated with a 0.12 percentage point increase in the probability of LBW (95% CI, 0.01–0.25; $p < .05$), translating to a 1.8% relative increase from probability of LBW among those living in the West (6.97%). In the Midwest and South, the relationship between a state's restrictiveness index and probability of LBW was not significant.

Discussion

Over the past decade, state legislators have increasingly used legislation to regulate abortion access. Yet, little is known about how restrictive abortion policy variation influences population health, particularly among infants. We sought to fill this gap by examining the relationship between state and Census Region legal environment toward abortion access, measured using a restrictiveness index, and two adverse birth outcomes nationally.

Restrictive Abortion Policies Play Negligible Role in Adverse Birth Outcomes Nationally

Across the entire United States, we did not find a significant relationship between a state's standardized restrictiveness index and our outcomes after controlling for relevant covariates. This absence of significance is not necessarily unexpected, nor does it suggest that restrictive abortion policies do not have implications for the health of pregnant people and their children. As mentioned previously, the policy environment surrounding abortion is extraordinarily complex. Due to the sheer number of policies enacted during the study period, in addition to unmeasured variation in policy severity, interpretation, and implementation, it was difficult to create an appropriate counterfactual—a critical element for causal inference—in this analysis (Shadish, Cook, & Campbell, 2002). In addition, although our 11-year study period includes a highly active period of restrictive abortion policymaking, state legislators have continued to enact restrictive abortion policies at a prolific pace beyond our study years (Nash, Mohammed, Cappello, & Naide, 2020); thus, our study period does not capture the variation in abortion policymaking beyond 2015 and ongoing implications for adverse birth outcomes, which may contribute to our null findings.

Restrictive Abortion Policies Detrimental to Birth Outcomes in Midwest, Northeast, and West

Upon stratifying analyses by region, we observed that the relationship between a state's standardized restrictiveness index and our outcomes varied regionally. Increased exposure to restrictive abortion policies was associated with a 2% increase in the probability of PTB in the Midwest, a 15% increase in the probability of LBW in the Northeast, and a 2% increase in the probability of LBW in the West. Although some of these associations are small in magnitude, they remain meaningful given their implications for the health of infants born in the United States, particularly at the population level. Infants born preterm or LBW may be more likely to experience negative short- and long-term outcomes, such as health issues during infancy, cognitive and physical disabilities, and lower educational attainment (Logan, Holcombe, Manlove, & Ryan, 2007; Martin & Osterman, 2018; Womack, Rossen, & Martin, 2018).

These results necessitate reflection on why we observe relationships in some regions and not others. One explanation involves evaluating two factors: 1) the variation in restrictive abortion policies in each region, and 2) the social, economic, and political context of each region that make regions more or less vulnerable to aftereffects of policy change. For example, the Midwest and South experienced the largest variation in restrictive abortion policies from 2005 to 2015; thus, we expected to observe a negative association between restrictive abortion policies and birth outcomes in these regions. Although results supported our expectations in the Midwest, we did not observe significant relationships between restrictive abortion policies and birth outcomes in the South. However, this discrepancy may be due to environmental differences between the two regions.

Contextually, the South has historically been and continues to be politically and socially conservative; maintains the highest poverty, unemployment, and uninsured rates; and has the lowest rates of access to and utilization of health care services, largely due to structural barriers to health care (Agency for Healthcare Research and Quality, 2017; Stephens, Artiga, &

Paradise, 2014; Weakliem & Biggert, 1999). For instance, many states in the South have been resistant to efforts to increase health coverage (Stephens et al., 2014), including Medicaid expansion, and the region suffers shortages in primary care and obstetric providers, particularly in rural areas (Dall, Chakrabarti, Storm, Elwell, & Rayburn, 2013; Rayburn, 2017; Zhang, Lin, Pforsich, & Lin, 2020). In addition, the South maintains the highest rates of many poor health outcomes, including PTB and LBW (March of Dimes Perinatal Data Center, 2020). Because the South maintains a higher baseline level of disadvantage compared with other regions (Goldhagen et al., 2005), the increase in restrictive abortion policies may not have had as substantial an effect on health outcomes in the South as compared with the Midwest. More explicitly, because pregnant people in the South are already navigating limited access environments, they may not be as vulnerable to adverse birth outcomes associated with variation in restrictive abortion policies compared with pregnant people living in the Midwest, a region with comparatively fewer structural and systemic barriers to care.

Conversely, the negative implications of restrictive abortion policies may be increasingly apparent in more advantaged regions with fewer structural barriers to care. For instance, the Northeast and West, which experienced less variation in restrictive abortion policies, have the lowest poverty and unemployment rates, are more socially and politically progressive, and have better access to health care (Stephens et al., 2014; Weakliem & Biggert, 1999). In addition, these regions have lower rates of negative health outcomes, including PTB and LBW (March of Dimes Perinatal Data Center, 2020). Because these regions are more advantaged, and thus would potentially be more vulnerable to increased restriction, we might expect to see the negative effects of enacted restrictive abortion policies in these regions. Indeed, our findings support this explanation, as we observed associations between a state's restrictiveness index and LBW in both regions.

Limitations

Despite having conceptual and methodological strengths, this analysis contains limitations. Although using a restrictiveness index improved on conceptual gaps in the literature, using an index measure did not allow us to isolate effects of specific restrictive abortion policies. The substantial overlap in policy implementation within states and over time created a landscape far from a "clean" natural experiment, thus inhibiting examination of one specific abortion policy without encountering other policies that might have affected our outcomes. Thus, we deemed using an index a methodologically feasible and appropriate solution. In addition, the composite restrictiveness index did not reflect varying levels of restrictiveness of different abortion policies, and instead weighed every policy equally. However, the goal of this analysis to examine the effects of variation in the *restrictiveness of an environment* toward abortion access on adverse birth outcomes, rather than teasing out which policies were more or less influential. Because we were interested in assessing the effects of the overall anti-abortion climate rather than comparing restrictive abortion policies, we deemed using a cumulative measure of the number of enacted policies appropriate. Nevertheless, the limitations of the restrictiveness index highlight areas for future research, including examination of the varying degree to which different restrictive abortion policies influence access to and availability of abortion care and subsequent health outcomes.

As mentioned previously, although our study period spans a highly active decade of restrictive abortion policymaking, our results may not be generalizable to or reflective of other time periods outside our study window. Last, FE modeling limitations include unmeasured time-varying confounding and inefficiency associated with little within-cluster variation (Hirai & Kaufman, 2017). The latter becomes a concern for the Northeast, which experienced little variation in restrictive abortion policies during the study period. Because only states whose restrictiveness index changed over time contribute to effect estimation, there may not be sufficient variability in the Northeast to detect effects with reasonable generalizability; thus, results from the Northeast should be viewed with these limitations in mind.

Implications for Practice and/or Policy

Despite its limitations, our findings build on prior research, demonstrating that restrictive environments toward abortion access may impose burdens for physical health in addition to limiting reproductive autonomy. These findings have important implications for the policymaking sphere, and could bolster policymaker efforts to oppose prospective and repeal existing restrictive abortion policies. In addition, this research could provide vital evidence in ongoing and prospective legal challenges surrounding current restrictive abortion policies, such as the Mississippi 15-week gestational age limit law waiting to be reviewed by the U.S. Supreme Court (Sobel, Ramaswamy, & Salganicoff, 2020).

Conclusions

Understanding the health implications of policies regulating access to health care is an imperative component of policy evaluation. This study critically examines the effects of restrictive abortion policies on adverse birth outcomes, and indicates that policies reducing abortion access may have negative health implications for infants born in the Midwestern, Northeastern, and Western United States, including increased probabilities of PTB and LBW. Given the rising rates of PTB and LBW in the United States, our findings suggest that restrictive abortion policies may be contributing to these trends. These findings set a foundation for further research exploring the effects of restrictive abortion policies on health, social, and economic outcomes, paying particular attention to how these relationships may differ among people of different sociodemographic groups.

Supplementary Data

Supplementary data related to this article can be found at <https://doi.org/10.1016/j.whi.2021.10.006>.

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- Kelli Stidham Hall, PhD, MS, is Associate Professor in the Heilbrunn Department of Population & Family Health at Columbia University's Mailman School of Public Health and adjunct Associate Professor with tenure at Emory University's Rollins School of Public Health.
- Monica S. Aswani, DrPH, MSPH, is Assistant Professor in the Department of Health Services Administration at the University of Alabama at Birmingham's School of Health Professions.
- Bisakha Sen, PhD, MA, is Professor in the Department of Health Care Organization and Policy at the University of Alabama at Birmingham's (UAB) School of Public Health and in the Department of Health Services Administration at UAB's School of Health Professions.
- Martha Wingate, DrPH, MPH, is Professor in the Department of Health Care Organization and Policy at the University of Alabama at Birmingham's School of Public Health.

Author Descriptions

Sara K. Redd, PhD, MSPH, is Postdoctoral Fellow in the Department of Health Policy and Management at Emory University's Rollins School of Public Health and with the Center for Reproductive Health Research in the Southeast.

Whitney S. Rice, DrPH, MPH, is Assistant Professor in the Department of Behavioral, Social and Health Education Sciences at Emory University's Rollins School of Public Health and Director of the Center for Reproductive Health Research in the Southeast.