Development of a Composite Risk Index to Examine the Impact of Diverse State Policy on Population Level Maternal and Neonatal Outcomes

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Abstract

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Despite major successes in some reproductive health outcomes over the last several decades, more work is needed that enables the state-level reproductive autonomy of birthing people, especially minoritized communities. Assessing the composite effect of state policies that impact reproductive autonomy by restricting or enabling the ability to make independent choices around reproduction represents a novel way to examine the effect of upstream policy determinants on reproductive health. This research first systematically reviewed existing data to understand the impact of state laws on reproductive health care outcomes, and then used publicly available data from CDC Wonder and PubMed, and primary data from a Delphi panel, and state laws for all 50 states. Specific aims included: (1) Summarizing associations between health policies and reproductive health care outcomes and their impacts using systematic review; (2) Creating a composite risk index as a function of state policies and examining its association with severe maternal morbidity and mortality, preterm birth, and low birthweight; and (3) Examining if the index is associated with racial disparities in preterm birth and low birthweight. Results from our systemic review documented that most studies have focused solely on abortion, as well as evaluations of single policies. Additionally, we identified several policy gaps, including heartbeat laws and criminalization of substance use during pregnancy.

We found that more reproductive autonomy enabling states had higher rates of severe maternal morbidity, but lower rates of maternal mortality, preterm birth, and rates of racial disparities in preterm birth and low birthweight. This research provided insight into the impact of state-policy on reproductive health outcomes, and the impact of structural racism on racialized disparities.

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Acknowledgments

Doctoral Committee

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PhD Program Peers

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Chapter 1: Introduction

The United States (US) has some of the highest rates of maternal and neonatal morbidity and mortality of any high-income country,[1,2] and incurs some of the highest related costs.[3] Severe maternal morbidity, which includes unexpected life-threatening outcomes of labor and delivery (e.g. blood transfusion), and neonatal morbidity, including low birthweight and preterm birth, have impacts on individual and population health. Importantly, **rates of these outcomes in the US have been steadily increasing for the past twenty years**.[4,5] Even more alarmingly, **racial disparities in these outcomes have increased over time**. For example, Black women currently have a 3 to 4 times higher risk of maternal mortality, compared with White women.[6] Increasing attention is being paid to how structures and policies (e.g., legislation) that affect access and utilization of reproductive health care and autonomy may impact maternal and neonatal morbidity and mortality, and racialized disparities in these outcomes.[7] **Reproductive autonomy, or the ability to decide and control contraceptive use, pregnancy, and childbearing, is critical to health**. Policies impacting women's access to information on sexual health, ability to obtain a preferred contraceptive method, utilize prenatal care or other health services, take maternity leave, or successfully breastfeed their infants, impact reproductive autonomy by restricting or enabling their ability to make independent choices whether or not to have children and to care for their children in the way they desire. Evidence suggests that greater reproductive autonomy as measured by a composite index of political participation, employment and earnings, economic autonomy, and reproductive rights (i.e., abortion services without parental consent laws or waiting period, public funding for abortions, percent of counties with an abortion provider, pro-choice governor or state legislature, publicly funded infertility treatments, maternity stay law,

and gay/lesbian couples can adopt) is associated with lower rates of maternal morbidity, neonatal morbidity, and infant mortality.[8,9] **Notably, policies that limit reproductive autonomy such as forced sterilization, disproportionately impact low-income and Black women and their children, who are most at risk of maternal and neonatal morbidity and mortality**.[10,11] Thus such policies may drive or exacerbate existing racialized disparities in maternal and neonatal morbidity and mortality. There is substantial variation in state laws and policies that impact women's reproductive autonomy. Despite the 1973 Roe v. Wade Supreme Court case that legalized abortion nationally, states continue to independently legislate access and utilization of abortion services,[12] through mandatory waiting periods, laws determining who can perform or refuse to perform abortions, and determining whether insurance can cover or deny coverage for abortion.[13,14] Beyond abortion, state policy can also impact reproductive autonomy through determining access and availability of comprehensive sex education, coverage for all types of safe and effective contraception, and expansion of Medicaid eligibility. While there is evidence that states with the most restrictive abortion laws are more likely to have additional laws that restrict reproductive autonomy,[15] many states have laws that both restrict and enable reproductive autonomy. For example, Ohio requires fetal pain counseling to utilize abortion services and passed a ban on abortion after twenty weeks gestation (i.e. restrictive; 2015); but also expanded Medicaid eligibility (i.e. enabling; 2014).[16] **The cumulative impact of the combination of laws shaping reproductive autonomy on maternal and neonatal morbidity and health care utilization, and racial disparities in these outcomes, is poorly understood**.

Therefore, the present dissertation takes a stepped approach to understanding the current state of laws' impact on reproductive outcomes and developing a tool to comprehensively assess the influence of state-level laws on reproductive outcomes, and racial disparities in these outcomes. Specifically, we proposed to summarize associations between health policies and reproductive health care outcomes and their impacts using systematic review, to build a composite risk index to predict severe maternal morbidity and mortality, as a function of reproductive autonomy, and to assess its associations with neonatal morbidity, health care utilization, and racial disparities in these outcomes. The specific aims proposed are:

Aim 1. Systematically review the post-implementation Patient Protection and Affordable Care Act literature to understand associations between state-level reproductive health policies and reproductive health care outcomes and describe policy impacts on reproductive health outcomes among women aged 18 and older.

Aim 2. Create a composite risk index as a function of state legislative policies that either restrict or enable reproductive autonomy and examine its association with severe maternal morbidity, maternal mortality, preterm birth, and low birthweight.

Aim 3. Examine if the composite risk index is associated with racial disparities in neonatal morbidity, as measured by preterm birth and low birthweight.

Innovation

1. The proposed dissertation is the first study to develop a tool that enables examining the comprehensive effects of state-level policy on maternal and neonatal outcomes, as well as racial disparities in low birthweight and preterm birth. Current literature is limited to the

evaluation of effects of single state policies specific to reproductive health on maternal and neonatal outcomes. No previous research has comprehensively examined the effect of state policy on both maternal and neonatal outcomes. Further, this will be the first study to explicitly examine the collective role of these policies in observed state-level racial health disparities in preterm birth and low birthweight, this proposal will contribute to a critical gap in knowledge regarding the ability to comprehensively measure state-level reproductive health policies and to determine their associations with maternal and neonatal outcomes, and related disparities.

2. The relationship between health policy, maternal and neonatal outcomes, and racial disparities in these outcomes, requires a unique intersectional perspective, which has not previously been applied. This proposal is informed by a reproductive justice framework and Critical Race Theory. Reproductive justice refers to the idea that all people, regardless of economic status, race or ethnicity, immigration status, sexual preference, or gender identity, have reproductive rights, including the rights to "maintain personal bodily autonomy, have children, not have children, and parent the children… in safe and sustainable communities".[17,18] No previous literature has used a reproductive justice framework to holistically and quantitatively study the relationship between state-level policy and maternal and neonatal outcomes. Additionally, this work is uses Critical Race Theory, a new way of examining the structural causes of racialized health disparities, including all factors that condition living (e.g., racism, housing, policy).[19] These foundational works have guided the types of policies that will be included, including non-reproductive health specific policies that are hypothesized to have direct and

indirect effects on healthcare access, utilization, and maternal and neonatal morbidity and mortality, with differential effects on Black women.

Conceptual Framework

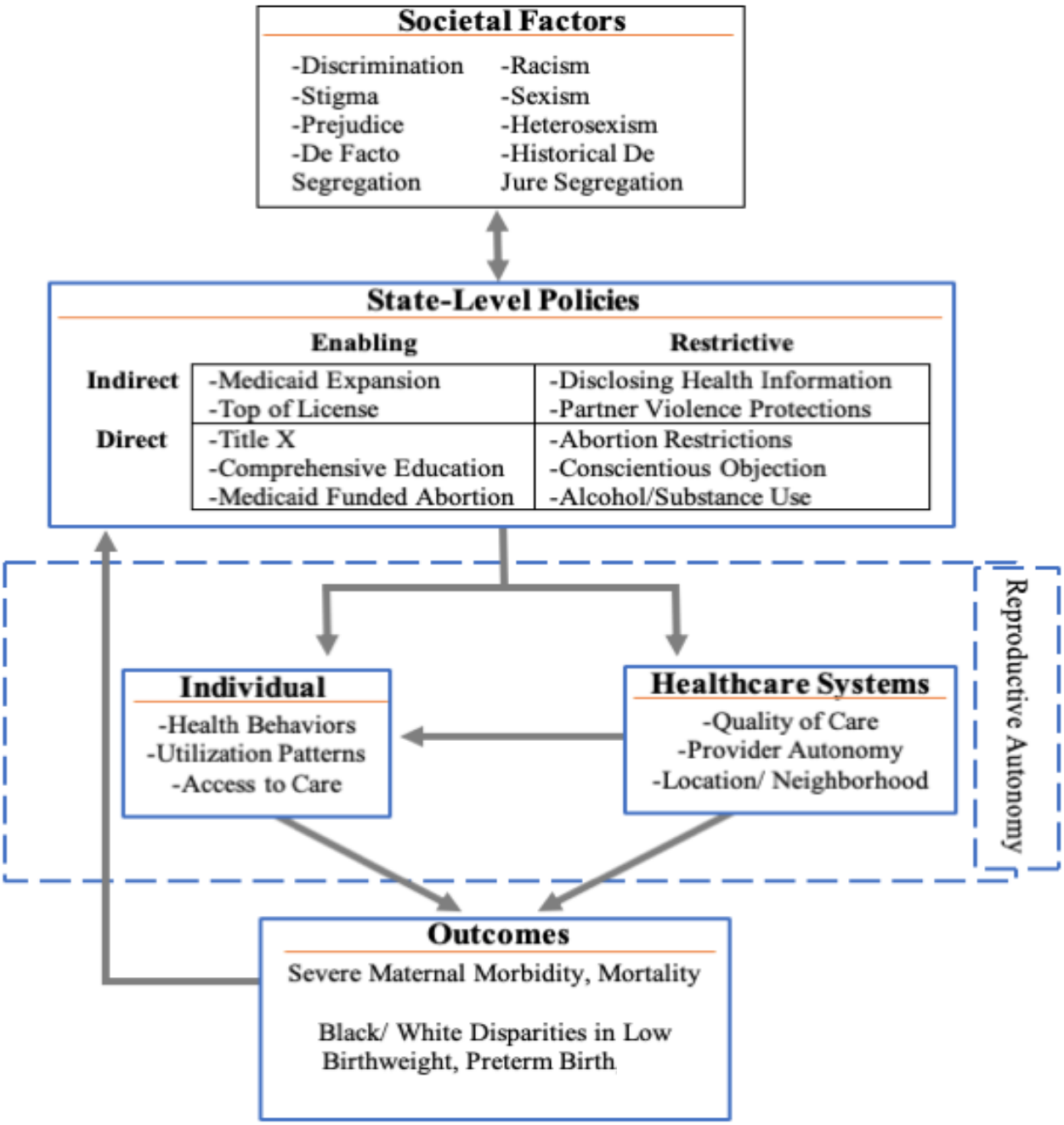
This model and this proposed dissertation are influenced by a reproductive justice framework with a health equity lens (Figure 1).[17–19] In this model, reproductive autonomy is hypothesized to be shaped by societal factors and state-level policies. Societal factors, including historical and present-day racism, sexism, and discrimination are upstream determinants that bidirectionally shape state policies. State policies can be either indirect or direct, and enabling or restrictive, resulting in a unique reproductive autonomy environment in each state. These policies control the access and utilization of women's health services on both the individual and healthcare systems level, which in turns influences maternal morbidity and mortality, neonatal morbidity, and health care utilization, and racial disparities in these outcomes.

Taking a vulnerable populations approach that recognizes the effects of social conditions,[20] this model depicts how fundamental and ubiquitous causes[21,22] (e.g. poverty, racism) shape state-level policies creating differential pathways to care for Black women compared with White women. Through restricted access to resources, and opportunities that improve well-being and reduce risk of negative outcomes.[22] Individual and behavioral risk factors are an expression of these fundamental and ubiquitous causes and are linked to women's position in society, creating vulnerable populations by exposing them to other risks (i.e. risk of risks).[21,22] As an example, at the societal level, the Patient Protection and Affordable Care Act (ACA) legislated no cost-sharing

for contraception, effectively reducing cost as a barrier to access.[23,24] However, a growing body of evidence suggests a majority of women report gender, income, or race-based discrimination during a healthcare encounter, with those experiencing discrimination reporting use of less effective contraceptive methods, regardless of cost.[25]

Chapter 1 Figures

Chapter 1 Figure 1. Conceptual Model



Chapter 2: Impact of State-Level Reproductive Health Legislation on Access to and Use of Reproductive Health Services and Reproductive Health Outcomes: A Systematic Scoping Review in the Affordable Care Act Era

INTRODUCTION

Reproductive autonomy includes determining the timing, number, and spacing of pregnancies, and access to accurate information and resources necessary to make voluntary informed choice.[26] In the United States, a shifting political landscape shapes reproductive autonomy with new laws that restrict or enable access to reproductive health services.[14] At the federal level, judicial cases such as *Roe v. Wade*,[12] laws such as the Hyde amendment, and most recently the Patient Protection and Affordable Care Act (ACA) mandatory coverage of contraception have both enabled and restricted access to reproductive health services. Broadly, the ACA aimed to improve access through the number of persons insured and quality of health services, and to decrease healthcare costs.[27] To achieve these goals, the ACA contained a long list of provisions implemented in stages from 2010 to 2017, and many of the provisions directly and indirectly affect reproductive autonomy.[28] For example, the ACA covered preventive health care benefits without cost sharing (e.g., mammograms, contraception, and prenatal care), provided Medicaid coverage for childless adults with low incomes (although a Supreme Court decision made this expansion optional for states), and banned discrimination owing to preexisting conditions (e.g., pregnancy), gender, or age, among others (Figure 1).[28] These provisions shape reproductive autonomy through removing barriers to health care services, decreasing associated costs of insurance and health services, and ensuring a more equitable insurance market.

Although federal law has critical implications for reproductive autonomy, access to reproductive health services is often determined at the state level, and state reproductive health legislation plays an essential role in shaping reproductive autonomy. Multiple organizations, including the American Civil Liberties Union and the American College of Obstetricians and Gynecologists, have called for the repeal of legislative restrictions on reproductive autonomy owing to associations with adverse reproductive health outcomes.[29,30]

State reproductive legislation varies widely in terms of targets and mechanisms for legislating reproductive autonomy. For example, targets of state laws restricting abortion access may be facilities, providers, the individual, or some combination of these.[14,31] Such laws create barriers to accessing abortion care; they include 24- to 72-hour waiting periods that impose delays on patients and increasingly early gestational limits that put abortions out of reach of many who seek them.[14] These restrictions have important implications for reproductive autonomy and outcomes. For example, up to 37% of Medicaid-eligible women continue unwanted pregnancies under restricted abortion-related Medicaid funding.[32]

Importantly, abortion access is only one way in which state laws legislate reproductive autonomy and affect reproductive health outcomes. Laws that impact information on and access to contraception and sexual health, obtaining a preferred contraceptive method, using prenatal care or other medical services, and the availability of a range of labor and delivery services can also influence reproductive autonomy.[33] For example, a lack of access to contraception and misconceptions about fertility risk are associated with unintended pregnancy (a type of

pregnancy that accounts for nearly one-half of all pregnancies in the United States), and vary by income and age.[34–39] Lack of access and information can also increase risk for late initiation of prenatal care, which is associated with preterm birth and low birthweight.[32,40] Other state-level policies may indirectly contribute to decreased reproductive autonomy and adverse outcomes. For example, the criminalization of drug and alcohol use during pregnancy may lead to delayed or forgone prenatal care owing to concerns regarding stigmatization, loss of parental rights, and incarceration.[41] Notably, laws that indirectly impact reproductive autonomy are difficult to define. State laws can also increase reproductive autonomy and improve outcomes by removing access barriers for reproductive health services. For example, Medicaid programs that cover doula services may enable reproductive autonomy and reduce rates of cesarean delivery among those at higher risk for these outcomes.[42]

Given the multitude of ways in which state legislation can limit and enable reproductive autonomy, there is a need to assess the state of research on policy impacts at the state level and to broadly summarize literature in terms of the associations between such legislation and access to and use of reproductive health services and outcomes. To address this gap in the literature, we systematically reviewed the literature on the association between state-level reproductive health legislation and reproductive health service access, use, and outcomes to qualitatively describe the impact of these policies on reproductive health outcomes in the post-ACA era among adult women.

METHODS

Search Strategy

We conducted a comprehensive systematic search of PubMed for articles published between March 2010 (post-ACA implementation) through August 31, 2019. Articles were restricted to study periods post-ACA implementation for two primary reasons: 1) the ACA greatly expanded sexual and reproductive health coverage, so articles published before it are still relevant but exist in a different social context, and 2) many provisions of the ACA were federally mandated, but states were left to determine their scope and application (e.g., Medicaid expansion). To conduct the search, we first consulted with a research librarian to develop a search strategy that focused on four key areas: 1) maternal health, 2) reproductive health, 3) legislation, and 4) health policy. Legislation was defined as state-level laws whose apparent purpose was to affect contraceptive information and care, abortion care, prenatal care, or labor and delivery care. Outcomes included use of reproductive health services (e.g., use of contraception, abortion access, and maternity care), as well as health outcomes (e.g., cesarean deliveries). We searched PubMed in these areas, using relevant medical subject headings and free-text words for each of the study components. Specifically, search terms included:

> (maternal health[mh] OR "maternal health" OR maternal health services[mh] OR "reproductive health" OR reproductive health[mh] OR reproductive health services[mh] OR maternal welfare[mh]) AND (law OR laws OR legislation OR "health policy" OR “health policies” OR health policy[mh]) AND (female OR women OR mother[tw] OR mothers[tw]) AND English[la] AND 2008:3000[pdat] NOT (Animals[mh] NOT Humans[mh]) AND

("united states" OR united states[mh] OR us[tiab] OR us[ad] OR "u.s."[tiab] OR "u.s."[ad] OR "usa"[tiab] OR "usa"[ad] OR "u.s.a."[tiab] OR "u.s.a."[ad])

The search was restricted to articles published in the United Stated and in English. Reference lists of all identified systematic reviews and opinion pieces were searched for potentially relevant original research articles.

We excluded studies that were 1) not original research (including opinion pieces, biographies, and brief reports), 2) qualitative or mixed-methods studies, or 3) descriptive studies. The goal of this work was to conduct a preliminary assessment of the size and scope of the available research, and systematic reviews of qualitative or mixed-methods literature require very sensitive search criteria to retrieve all studies or for information to be reported.[43] Additionally, we excluded studies that did not use the state as the unit of analysis and where individual states were unidentifiable, because we were interested in aggregate comparisons of the impact of state laws. We further excluded those studies that included individuals under 18, owing to the different laws that minors are exposed to.

Data Review

All titles and abstracts were reviewed by a single reviewer (A.B.); articles that met inclusion criteria based on initial review were reviewed in full by the first author (A.B.) and one of three other independent reviewers (J.B., A.H., C.P.). Reviewers were not blinded to manuscript

authorship. After review of all articles potentially meeting inclusion criteria, all reviewers met to finalize included articles; disagreements were arbitrated by the senior author (J.K.). Agreement before arbitration was 91% (*n* = 5) and after was 100%.

Data Extraction

A standardized abstraction form (Supplemental Figure 1) was adapted from one previously developed by the senior author[44] to extract data in the following areas on each article reviewed in full: 1) study design, 2) research objective, 3) states included, 4) study population, 5) inclusion and exclusion criteria, 6) independent and dependent variable description and measurement, 7) statistical methods, 8) results, 9) conclusions, and 10) strengths and limitations.

RESULTS

A total of 1,559 articles were identified by the primary search in PubMed (Figure 2). After title and abstract review, 56 articles (3.59%) were reviewed in full. A review of the reference lists yielded an additional five articles, of which two met inclusion criteria for full review. After full article review a total of eight articles (14.3%) were identified that met the inclusion criteria. All articles included in the final review are summarized in Table 1. Of the eight studies included, two evaluated all 50 states and Washington, DC; one evaluated two states (Oregon and Washington); and the remaining studies evaluated only single states (Texas, Arizona, Ohio, and Utah). Three of the eight studies were cross-sectional, and five used pre- and post-study design.

In terms of topics covered, one-half of the studies (*n* = 4) focused solely on abortion legislation. These studies examined waiting periods for abortion services, two-visit requirements, and targeted regulation of abortion providers laws. Other topics included legislation regarding family planning funding (*n* = 1), maternity care (*n* = 2), and a composite score of policies related to reproductive autonomy (*n* = 1). Findings are described elsewhere in this article based on the topic of the legislation (i.e., family planning, maternity care, abortion, composite).

Abortion

Four studies explored the impact of abortion legislation on abortion-related outcomes[45–48] Gerdts et al. (2016) examined the barriers experienced by women seeking abortion after House Bill 2 in 2013 resulted in the closure of more than one-half of the facilities providing abortion in Texas. Passage and implementation of Bill 2 was associated with increased likelihood of greater travel distance for abortion services, higher out-of-pocket costs, and difficulty getting to the nearest clinic. Upadhyay et al. (2016) sought to examine the association between a 2011 Ohio law that mandated the use of the U.S. Food and Drug Administration–approved protocol (as opposed to an evidence-based protocol) for mifepristone and use and outcomes of medication abortion. The U.S. Food and Drug Administration protocol consisted of a higher, more expensive dose of oral mifepristone, and a lower dose of oral misoprostol (administered 48 hours later) compared with the evidence-based protocol. Compared with the pre-law period, in the post-law period frequency of medication abortion decreased by 17%, a greater number of women seeking medication abortion required at least one additional intervention (4.9% vs 14.3%), and the average patient costs increased by 16%. Similarly, Williams et al. (2018) studied the combined

effects of two legislative efforts to regulate abortion in Arizona (A.R.S. 36–2153 and 36–2155). The laws explicitly banned advanced practice clinicians from performing medication abortions with mifepristone, imposed a 24-hour waiting period, and required two separate in-person clinic visits before abortion services could be provided. After the enactment of the laws, compared with before enactment, the overall proportion of counties with abortion clinics decreased by 20%, the proportion of medication abortions performed decreased by 17.4%, and the proportion of abortions that were performed before 14 weeks gestation decreased by 3.3%. Also examining the impact of waiting periods on abortion access and use, Roberts et al. (2016) examined the effects of a 2012 law in Utah that required a 72-hour waiting period for abortion on the proportion of abortion seekers who had received abortions by the follow-up interview 3 weeks later. They found that most women were unconflicted about their decisions when they sought care and remained so, and those with low decisional conflict had higher odds of having received an abortion.

Family Planning

Only one study examined the impact of family planning legislation, specifically on access to and use of contraception.[49] Woo et al. (2016) assessed the impact of a law that banned Planned Parenthood from a state-funded family planning program in Texas that supported access to and coverage of depot medroxyprogesterone acetate (i.e., hormonal contraceptive injections). After the ban, more than 20% of women missed a dose of contraception owing to barriers (no baseline or comparison value is reported), with the most common reason being difficulty finding a provider. Additionally, compared with the National Survey of Family Growth, Texas participants

used less effective contraception for more than 1 year after the ban. A major limitation of this study is that conclusions of the study were limited by low response rates, limiting representativeness and generalizability.

Maternity Care

Two studies examined state-level policy related to maternity care.[50,51] Muoto et al. (2016) evaluated the impact of Medicaid reform in Oregon, including the association of care coordination with prenatal care use (i.e., early prenatal care initiation, prenatal care adequacy, and disparities in prenatal care use by insurance type). The researchers found that, after the implementation of coordinated care in 2012, there were significant increases in early prenatal care initiation and an overall decrease in disparities across insurance types. However, no difference was observed in adequacy of prenatal care received. Yang et al. (2016) sought to estimate the association between midwifery practice laws and birth-related and neonatal outcomes. The authors found that states with autonomous midwifery practice laws (i.e., not requiring supervision) had lower adjusted odds of cesarean delivery, preterm birth, and low birthweight, compared with states without such laws. Notably, these two studies are the examples included in this review that examined the effects of legislation that was not explicitly crafted to restrict reproductive autonomy.

Composite Policy Score

One study created a composite risk score based on five types of state-level policies to measure reproductive autonomy and the percentage of women living in counties with an abortion

provider.[52] These laws included 1) mandatory parental consent or notification laws for minors seeking abortion, 2) mandatory waiting periods for abortion services, 3) restrictions on public funding for abortion, 4) expanded eligibility for Medicaid family planning services, and 5) mandatory sex education in schools. Wallace et al. (2017) then examined the association of the composite risk score with preterm birth and low birthweight. The authors found that states with higher composite scores, indicating the greatest reproductive autonomy, had the lowest rates and odds of low birthweight and preterm birth relative to states with lower composite scores.

DISCUSSION

This systematic review sought to qualitatively summarize the literature with respect to the impact of state-level reproductive legislation affecting reproductive autonomy on reproductive health outcomes. Only eight studies met the inclusion criteria and the majority of these focused on specific states rather than all states. One-half of the identified studies focused on associations between abortion-related legislation and outcomes; the others examined family planning, maternity care, and a composite score of laws, and assessed outcomes related to contraception, prenatal care use, and birth outcomes. Findings across studies suggest that laws that restrict reproductive autonomy seem to be associated with higher state-level rates of adverse outcomes.

Our review highlights that the role of state-level policies in access to and use of reproductive health care services and outcomes requires further scholarly attention. In addition to the domains covered here, there is a need to broaden the breadth of laws examined, including policies that directly and indirectly affect use of services. Such policies include poverty relief,

spousal and partner protections, rural access to and quality of health services, bundled payments for obstetric and gynecological services, and the social determinants of health, to name a few, and there is a need to develop metrics that holistically characterize the state-level policy effects on reproductive autonomy. For example, a law that directly affects reproductive health care services is the criminalization of substance use during pregnancy. Research on the individual level has suggested a negative association between the criminalization of drug and alcohol use during pregnancy and the timely initiation of prenatal care, yet work at the state level is lacking.[53–55] Importantly, this legislation may decrease the reproductive autonomy of birthing people through a fear of criminalization, losing their children, or stigma. Alternatively, an example of a law that may indirectly affect service access and use is the 2013–2014 Medicaid primary care reimbursement increase. Although this initiative did not include prenatal or obstetric care, it did increase access to primary care, which in turn may be associated with increased likelihood of timely initiation of prenatal care through increased awareness of and engagement with the medical system,[56] potentially increasing reproductive autonomy through education and familiarity with a medical provider. However, additional research may be limited by a lack of reproductive health funding; insufficient training for researchers, practitioners, and clinicians in this topic area; inadequate access to robust, high-quality data; study design challenges related to policies that change from year to year and differ slightly between states; and the continued emphasis on biological mechanisms rather than social determinants of health, including policy.

Additionally, most of the literature focused on single laws without quantifying the relative impact of different types of laws or fully characterizing reproductive autonomy within a state. A potential

solution, used by one study in our review, is to create a composite score of state-level policies. A composite score may allow for the ordering and ranking of which policies are most effective at improving reproductive health outcomes through increasing reproductive autonomy and facilitating or removing barriers to accessing reproductive health care services. However, there are benefits and drawbacks of composite risk scores that need to be considered. For example, composite scores can better reflect the complex and multidimensional policy environment while summarizing multiple data measures, which can increase reliability. In contrast, composite scores lose information if the underlying data components are not transparent; require more complex methods, testing, and analysis; and affect the validity and quality of conclusions if a proven method (e.g., component item/measure analysis) is not used.[57] Nonetheless, this systematic review emphasizes that there is a growing body of quality evidence indicating that policies that restrict reproductive autonomy are associated with poor health and outcomes for parents and children.

Importantly, we identified several key gaps in the state-level literature. For example, our search criteria did not yield any studies on substance use policies, heartbeat laws, personhood laws, or physician-informed consent script laws, or how these policies might be differentially applied across subpopulations. However, this may be due either the paucity of research available, as well as our inclusion criteria that analyses must be on the state level. For example, two studies stand out as having been identified through our search terms, but were ultimately found to be ineligible for this review based on our predetermined inclusion and exclusion criteria. The work by Angelotta, Weiss, Angelotta, and Friedman (2016) focused on the association between medication-assisted treatment for pregnant women with opioid use disorders and state child

abuse laws for illicit drug use during pregnancy, and that by Stevenson, Flores-Vazquez, Allgeyer, Schenkkan, and Potter (2016) assessed the rates of contraceptive method provision and method continuation, and Medicaid covered childbirth before and after Planned Parenthood was barred from providing health care services using public funds in Texas. Both of these studies, while covering highly relevant topics, were excluded as the analysis was not at the state level. All included studies relied on quasi-experimental designs that potentially biased results. Specifically, with the exception of one study,[47] most did not consider the potential impact of on-going trends that were independent of the policy under study or the broader policy landscape. These methodological limitations, along with gaps in the literature, highlight the difficulty of conducting rigorous state-level reproductive health policy research. This area of work is limited by a lack of governmental funding prioritization, insufficient institutional training, controversial and often politicized topics (e.g., abortion), and methodological limitations (e.g., sample size). Overcoming these barriers and prioritizing research on state laws' impacts will help to better elucidate the role of policy in shaping the reproductive autonomy environment and its potential implications for the health of birthing people and their children, families, and communities. Considering the successes of other research on the state level (e.g., on the Children's Health Insurance Program and Medicaid), additional research on state-level reproductive health policy stands to contribute substantially to the current literature, policy decision making, and interventions.[58]

This systematic review has numerous strengths. To our knowledge, it is the first to systematically review and qualitatively describe policy effects on reproductive health access, use, and related outcomes at the state level. Additionally, the broad nature of our search terms allowed us to

potentially capture policies that are not directly reproductive health related (e.g., Medicaid), but may influence outcomes. Nevertheless, the results of our review should be considered in context of several limitations. A key limitation is that we did not explicitly search for laws that would indirectly impact reproductive autonomy because these laws are more difficult to characterize and identify. Additionally, our review only used published academic findings and may be limited by publication bias. Although broad, our search strategy may be incomplete; however, additional searching of reference lists of systematic reviews was done to minimize that threat.

IMPLICATIONS FOR PRACTICE AND/OR POLICY

Our review highlights that the restrictive or enabling nature of state-level laws on reproductive autonomy are important factors to consider when evaluating reproductive health outcomes and existing and future policy development. In this highly controversial and politicized space[59] our review shows a gap in non–abortion-related literature. Future research should assess whether holistic measures of reproductive autonomy predict reproductive outcomes, with particular focus on health disparities, including laws that may directly and indirectly affect outcomes. Policymakers, funders, and researchers must identify and remove barriers to the conduct of such research. Barriers may include funding, methodology, and politics. Their removal may be achieved through increased funding for reproductive health, device and contraception testing, and fellowships and traineeships for students, university faculty, and clinicians. Further, prioritizing research on the social determinants of health, including policy, on reproductive health outcomes could support improved policy decision making and interventions. It might also help us to better understand some of the state-level disparities we observe in maternal morbidity and

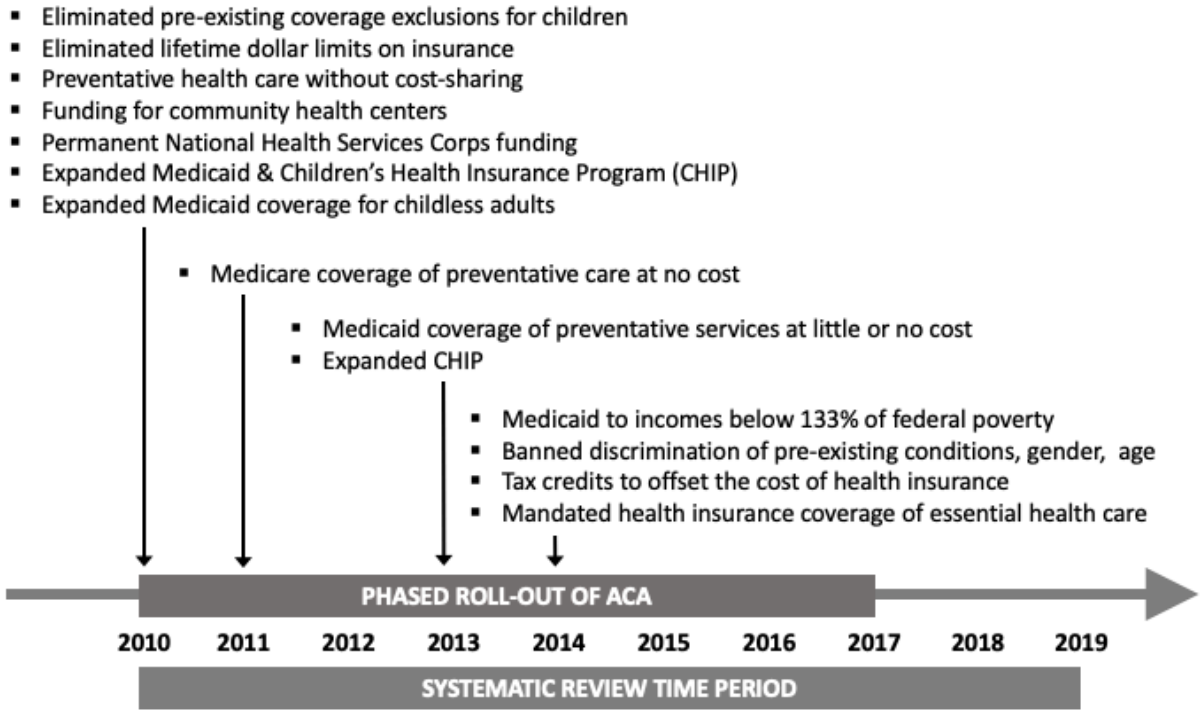
mortality, preterm birth, low birthweight, and other conditions that affect a large proportion of our population. Additionally, policymakers and clinicians should be informed of the importance of such laws on care seeking behavior, access, and use of reproductive health services.

CONCLUSIONS

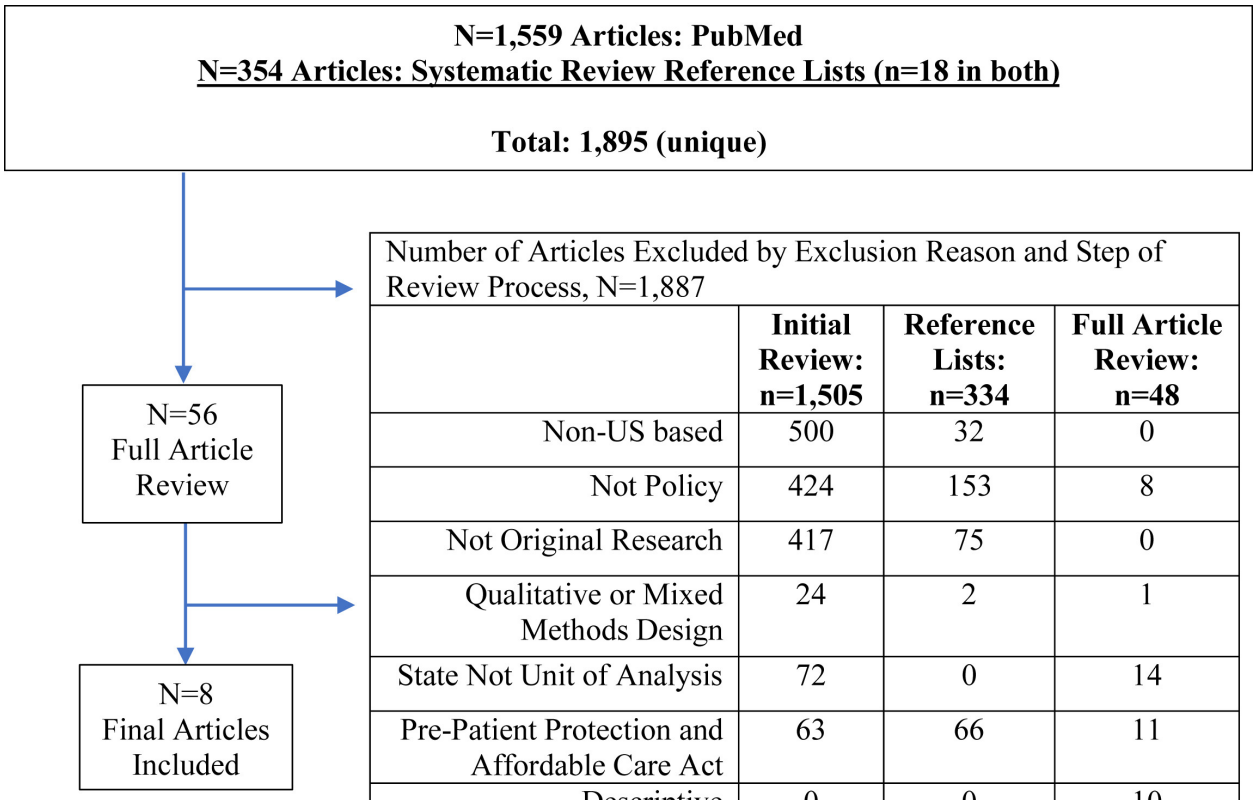
There is a need for additional research, rigorous study designs that account for multiple policies that may have a cumulative effect on reproductive health care access and use, inclusion of more laws within and between states, and work that covers the entire United States, including territories and tribal lands. Relatedly, the preponderance of studies focused solely on abortion legislation indicates that more research is needed that rigorously and holistically evaluates the relationship between reproductive health autonomy and related health outcomes.

Chapter 2 Tables and Figures

Chapter 2 Figure 1. Example Provisions of the Patient Protection and Affordable Care Act (ACA) that Impact Reproductive Autonomy, by Year



Chapter 2 Figure 2. Flow Diagram



Number of Articles Excluded by Exclusion Reason and Step of Review Process, N=1,887

	Initial Review: n=1,505	Reference Lists: n=334	Full Article Review: n=48
Non-US based	500	32	0
Not Policy	424	153	8
Not Original Research	417	75	0
Qualitative or Mixed Methods Design	24	2	1
State Not Unit of Analysis	72	0	14
Pre-Patient Protection and Affordable Care Act	63	66	11
Descriptive	0	0	10
Systematic Reviews	5	6	0
Includes Minors	0	0	4

Note: Could have been excluded for more than one reason. First reason recorded here.

Note: Reference lists of systematic reviews from the initial review were searched for relevant articles

Chapter 2 Table 1. Study and Types of Outcomes by Category of Legislation

First, Last Author (Year)	State(s)	Type of Policy	Study Design	Study Period	N	Outcome(s)
Abortion						
Gerdts C, Potter JE (2016)	Texas	HB2. A Targeted Regulation of Abortion Provider law that restricts abortion services in 4 ways: 1) physician performing abortions must have admitting privileges at a hospital within 30 miles of the facility, 2) medication abortion must be administered according to the mifepristone label approved by the Food and Drug Administration (with some exceptions), 3) most abortions at or after 20 weeks "post fertilization" are banned, and 4) all abortions must be performed in facilities meeting the requirements of an ambulatory surgical center.	Cross-sectional	2014	398	Distance to nearest clinic in 2013, 2014 and clinic at interview. Burdens on access to abortion care: 1) high out-of-pocket costs, 2) an overnight stay, 3) a delay in getting an abortion appointment, 4) not obtaining preferred type of abortion.
Upadhyay UD, Roberts SC (2016)	Ohio	2011 Ohio law requiring use of U.S. Food and Drug Administration protocol for mifepristone and misoprostol for medication abortion. The protocol, approved in 2000, requires a higher, more expensive dose of mifepristone, and a lower dose of misoprostol (administered 48 hours after mifepristone). Additionally, the protocol limits use up to 49 days after last menstrual period.	Pre–post, interrupted time series	Pre: 01/2010–01/2011 Post: 02/2011–10/2014	Pre: 1,156 Post: 1,627	1. Defined as requiring repeat misoprostol, repeat mifepristone, aspiration, blood transfusion, surgery, or hospital admission. 2. Continuing pregnancy, incomplete or possible incomplete abortion, acute hemorrhage, or infection. 3. Side effects included nausea, vomiting, fever, chills, fainting, dizziness, diarrhea, pain, swelling, fatigue, headache, and vaginal discharge.
Williams SG, Kerns JL (2018)	Arizona	2011 A R S. 36–2153 and 36–2155: 24-hour waiting period requiring two separate in-person clinic visits before obtaining abortion and ban on advanced practice clinicians inducing medication abortions by prescribing mifepristone.	Pre–post	Pre: 2009–2010 Post: 2012–2013	43,692 abortions comparing medication vs. aspiration and 47,088 abortions comparing abortions before and after 14 weeks gestation.	Abortion performed by aspiration or by medication (mifepristone) and abortion performed before or after 14 weeks gestation.
Roberts SC, Upadhyay UD (2016)	Utah	72-hour waiting period for abortion and two visits required before an abortion.	Pre–post	2013–2014	309	Predictors of and reasons for not having an abortion.
Family planning						
Woo CJ, Potter JE (2016)	Texas	The ban of a large care provider (Planned Parenthood) from a state-funded family planning program.	Pre–post	Last quarter 2011–October 2014	216	Contraceptive methods used by interviewees after the ban (in place of depot medroxyprogesterone acetate).
Maternity care						
Yang YT, Kozhimannil KB (2016)	All 50 states and Washington, DC	Autonomous midwifery practice laws for certified nurse midwives (defined as not requiring physician supervision or contractual practice agreements).	Cross-sectional (the other part of the analysis used data before the ACA and was not state-level analysis)	2013	12,106,161 births	Labor induction, cesarean delivery, preterm birth (<37 weeks), and low birthweight (<2,500 g).
Muoto I, Snowden JM (2016)	Oregon and Washington	Medicaid Coordinated Care Organization.	Pre–post	2008–2013	554,697 births	Early prenatal care initiation and adequacy of prenatal care.
Composite policy score						
Wallace ME, Theall K (2017)	All 50 states and Washington, DC	Policies on 1) mandatory parental consent or notifications laws for minors seeking abortion, 2) mandatory waiting periods for abortion services, 3) restrictions on public funding for abortion, 4) expanded eligibility for Medicaid family planning services, and 5) mandatory sex education in schools.	Cross-sectional	2012	3,948,761 births	Preterm birth (<37 weeks) and low birthweight (<2,500 g).

Chapter 2 Figure 3. Standardized Research Article Abstraction Form

Initial Full Text Research Article Review	
Title:	
First Author, Last Author:	
Journal (Year):	
Include:	☐ Yes ☐ No (Most appropriate reason must be indicated below)
Exclude:	☐ Not based in the United States of America ☐ Not original research (e.g. editorial, review, expert opinion) ☐ Not policy related ☐ Not quantitative research ☐ State is not the unit of analysis ☐ Pre- Patient Protection and Affordable Care Act (circa March, 2010) ☐ Systematic review or meta-analysis ☐ Not a full-length article, or full-length article not available
Study Information	
Study Design:	☐ Cross-sectional/descriptive (observational) ☐ Cohort/longitudinal (observational) ☐ Case-control (observational) ☐ Randomized control trial (experimental) ☐ Other (e.g. implementation study) Describe:
Research Question/Objective:	
State(s) Included:	
Polic(y|ies) Included:	
Study Population: (describe the target population, e.g. age, citizenship, location, etc.)	
Inclusion/Exclusion Criteria: (list specific criteria)	
Total N in Analytic Sample:	
Study Measures	
Independent/Exposure Variable (s): (if multiple	

exposures/independent variables include information for each, adding lines as needed)	
Description: (describe the independent/exposure variable(s))	
Measurement: (describe how measurement of the independent/exposure variable(s) was operationalized. Relevant information could include the scale that was used, timing of the measurement, methods of data collection, any validity information, etc)	
N with Independent Variable/Exposure:	
Dependent/Outcome Variable(s): (if multiple exposures/independent variables include information for each, add lines as needed)	
Description: (describe the. dependent/outcome variable(s))	
Measurement: (describe how measurement of the dependent/outcome variable(s) was operationalized. Relevant information could include the scale that was used, timing of the measurement, methods of data collection, any validity information, etc)	
***N with Dependent Variable/Outcome*:**	
Comments:	

Analysis	
Statistical Methods: (describe what statistical methods were used, including statistical tests, regression methods, or others)	
Comments:	
Results and Conclusion	
Main Results: (provide primary results, this may include percentages, p-values, relative risks, odds ratios, etc, whenever possible include 95% confidence intervals, ensure that the reference group or groups being compared is specified)	
Conclusion:	
Strengths: (Author identified and not identified)	
Limitations: (Author identified and not identified)	
Comments:	

Chapter 3: Development of a Composite Risk Index of Reproductive Autonomy Using State Laws: Association with Maternal and Neonatal Outcomes

INTRODUCTION

Reproductive autonomy is the ability to decide about and control contraceptive use, pregnancy, and childbearing.[60] Reproductive autonomy can be enabled or restricted though access to information on sexual health, ability to obtain contraceptives, and access to prenatal care or other health services. In the United States, reproductive autonomy is legislated at the federal and state levels, with considerable variation by state. Although states with restrictive abortion policies are more likely to have other laws that similarly restrict reproductive autonomy, most states have laws that both enable and restrict reproductive autonomy.[15] Evidence from analyses of individual state policies demonstrates that policies that increase reproductive autonomy are associated with a range of positive reproductive health outcomes, including lower rates of cesarean delivery and preterm birth, through increasing access to needed contraceptive, abortion, and other health services.[50,51] Conversely, policies that restrict reproductive autonomy are associated with increased likelihood of adverse reproductive health outcomes[45,46,48,61] through increased rates of unintended pregnancy and unsafe abortion.

Rates of maternal morbidity and mortality in the United States (US) are among the highest of any high-income country.[62] While approximately 700 maternal deaths occur in the US each year, these deaths are only the most extreme outcome of a cascade of events.[63] Severe maternal morbidity (SMM) – unexpected life-threatening outcomes of labor and delivery that result in significant consequences to maternal health[64] – has increased nearly 200% in recent decades, affecting at least 50,000 women annually and significantly contributing to rising rates of maternal

mortality.[65] Thus, SMM is a critical indicator of population level maternal mortality risk.[65] Given the interdependent nature of maternal and neonatal outcomes, it is unsurprising that preterm birth and low birthweight, key indicators of neonatal health, are also higher in the US compared to other high-income nations.[66,67] Notably, while overall rates of adverse maternal and child outcomes in the US are unacceptably high there is considerable variation in rates between states. For example, the 2013-2017 five-year estimate for maternal mortality was lowest in Alaska and highest in Louisiana (12.4 vs 72.0 per 100,000 live births).[68] Similarly, in 2017 preterm birth was lowest in Vermont and highest in Mississippi (7.52 vs 13.6 per 100 live births).[69]

Given the considerable state-level variation in reproductive autonomy and maternal and neonatal outcomes, increasing attention is being paid to the relationship between state policies that restrict or enable reproductive autonomy and SMM and neonatal outcomes .[33] However, there is a scant literature on the cumulative and variable ways in which policies impact reproductive autonomy and related outcomes.[13]s Prior literature was limited to either examination of single individual laws that either restricted or enabled reproductive autonomy or to a limited set of indicators (those related to abortion, family planning, sex education) of the reproductive autonomy environment.[8,9,52,70–73] While individual policies are an important determinant of reproductive autonomy and the many manifestations of it, the cumulative impact of the combination of policies on maternal and neonatal outcomes requires further scholarly attention. This evidence is critical for informing advocacy and evidence-based decision-making with the goal of improving maternal and neonatal outcomes.[74,75] Therefore, we sought to develop a novel composite policy index to quantify reproductive autonomy at the state-level,

based on presence of a broad range of enabling and restrictive policies, and to test its association of reproductive autonomy with SMM, mortality, preterm birth, and low birthweight. We hypothesized that greater state-level reproductive autonomy measured by our composite risk index, would be associated with lower rates of severe maternal morbidity, pregnancy-related mortality, preterm birth, and low birthweight.

METHODS

Development of Reproductive Autonomy Composite Index

We sought to develop a holistic measure of state-level reproductive autonomy based on state-level policies. Reproductive and non-reproductive health policies for initial inclusion were determined through literature review.[13] After consultation with a research librarian, sexual and reproductive health and policy search terms were used to systematically search PubMed. From this, policies were grouped into broad policy categories (e.g. family planning), which were hypothesized to characterize a state's reproductive autonomy environment. Policy categories for inclusion were then assessed through expert agreement using a modified Delphi Panel method.

Delphi Panel

We used an iterative modified Delphi method to inform decisions on which policy categories to include in our reproductive autonomy index. The Delphi method is a group facilitation technique to obtain consensus on expert opinions through a set of iterative survey rounds.[76] Survey rounds continue until expert agreement is reached. Experts specializing in reproductive health and policy were recruited to participate from community non-profits, academia, consulting, and the

government (See Supplemental Table 1, Delphi panel characteristics). Experts were recruited through community organizational meetings (Seattle) on perinatal health, websites of known organizations (e.g., Guttmacher), and expert referral and snowball sampling.[77] Sixteen experts participated. Electronic surveys were completed confidentially and experts were asked to rate survey items to establish agreement. The initial survey included 12 policy categories, and experts could suggest additional policy categories after each survey round (e.g. poverty programs). Policy categories were rated using a five-choice Likert scale, where "1" represented extremely disagree and "5" extremely agree with policy inclusion among those thought to impact reproductive autonomy. Percent agreement was used to calculate consensus, between 0 (i.e. lack of agreement) and 1 (i.e. perfect agreement).[78] Strong agreement of > 0.8 was the cutoff for category inclusion. After each round, expert responses were summarized in aggregate and reported back to experts.[79] We conducted 2 rounds of surveys, after an initial pilot stage.

Composite Index Construction

Based on results from our iterative Delphi panel, eight of 12 initial and 1 additional (i.e. poverty programs) policy categories were included in index construction (See Supplemental Table 2, policy categories by Delphi panel phase). The specific policies within each category were obtained from publicly available data, namely state-specific policies directly and indirectly related to reproductive health from women's health policy non-profit organizations (e.g. Guttmacher, Kaiser Family Foundation), and state and federal congressional databases for all 50 states prior to January 1, 2016 (See Supplemental Table 3, number of restrictive and enabling policies by state). Individual policies within each category were then determined to either be enabling

(assigned +1 if present) or restrictive (assigned -1 if present). For each state the sum of the total restrictive policies was then subtracted from the sum of enabling policies yielding a score where higher numbers indicate more state environments with greater enabling reproductive autonomy and lower numbers indicate more restrictive reproductive autonomy environment. We evaluated the composite policy index as a continuous variable and, in separate analyses, as a quartile-based categorical variable ranging from the most restrictive quartile (1) to the most enabling quartile (4).

Data Set

We used publicly available data for all 50 states from the Centers for Disease Control and Prevention (CDC), National Center for Health Statistics, underlying cause of death, and natality files[80,81] to enumerate live births to mothers aged 15-44, and US resident maternal pregnancy-related deaths between January 1, 2016 and December 31, 2018. We accessed CDC data through CDC Wonder Online Database; these data include underlying cause-of-death and maternal morbidity information obtained from check boxes used on state birth and death certificates. Although government agencies and the published research literature use the terminology "maternal" we acknowledge that this population includes more than cis-gendered women, such as transgender men.

Measures

Primary Outcome Variables

Our outcomes were aggregated 2016 through 2018 state-level rates of SMM (US resident and non-resident) and pregnancy-related mortality (only US residents), preterm birth and low birthweight. SMM was defined as having any of the following conditions noted during delivery as indicated on birth certificate data: Maternal transfusion, admission to the intensive care unit, perineal laceration, ruptured uterus, or an unplanned hysterectomy. Maternal mortality was defined using a standard definition of pregnancy-related mortality as it captures postpartum deaths including those from 42 days to a year postpartum, which comprise 31% additional pregnancy-related deaths.[82] Pregnancy-related mortality, includes any death during pregnancy, labor, delivery, or the puerperium period (up to 1 year post-delivery) that is a direct consequence of pregnancy, as indicated by presence of International Statistical Classification of Diseases and Related Health Problems - 10th Revision (ICD-10) codes (A34, O00-O95, O96, O98-O99).[83,84] Preterm birth was defined by obstetric/clinical gestation estimate and last menstrual period, as indicated on birth certificate data and low birthweight was defined as neonate weight <2,500 grams. Aggregated state-level outcome crude rates were calculated by dividing the total outcomes in a state by the total number of live births. State-level SMM rates were calculated per 10,000 live births, state-level pregnancy-related mortality rates were calculated per 100,000 live births. State-level rates of preterm birth and low birthweight were calculated per 100 live births.

CDC suppresses sub-national data estimates with fewer than 10 cases.[85] Therefore, for our one outcome with state-level outcomes with N <10, pregnancy-related mortality (N=7; Delaware, Maine, New Hampshire, North Dakota, Rhode Island, Vermont, Wyoming), we created three sets of estimates for state level pregnancy-related mortality. In order to bracket the true effect, we

first calculated risk estimates assuming the minimum number of pregnancy-related deaths for that state (N=0), and then calculated risk estimates assuming the maximum number of pregnancy-related deaths for that state (N=9). Finally, we left estimates as missing to calculate estimates without the suppressed state values.

Covariates

Covariates included state-level proportions of live births to those that were white, Black, and Hispanic. There is considerable variation in maternal morbidity and mortality by race and ethnicity and we anticipated that state demographics might also have an indirect influence on policies.[63,86]

Statistical Analysis

Simple and multivariable linear regression were performed to evaluate the association of the reproductive autonomy composite index score and the score quartiles with SMM, pregnancy-related mortality, preterm birth and low birthweight. There were an unequal number of states within each quartile due to some states sharing the same composite policy index score. Robust standard errors were used to account for heteroskedasticity. We considered 2-sided $P < 0.05$ to be statistically significant. All analyses were performed with Stata 15.1.[87] The University of Washington Institutional Review Board reviewed and determined this work as exempt non-human subjects research.

RESULTS

Eight policy categories were selected by Delphi panel for inclusion, including Medicaid expansion, family planning, abortion-related, comprehensive sex education, confidentiality of medical procedures, prenatal care, occupational-related, and poverty programs (See Supplemental Table 2, policy categories by Delphi panel phase). A total of 106 policies were included within these 8 categories and grouped under 13 subcategories as either restrictive (N=5) or enabling (N=8) for reproductive autonomy (See Supplemental Table 4, number of restrictive and enabling policies by category). Three policy categories did not have a restrictive policy (i.e. Medicaid expansion, confidentiality of medical procedures, prenatal care). Most policies were abortion-related, overall and by restrictive or enabling subcategory. The number of policies per category varied by state (See Supplemental Table 3, number of restrictive and enabling policies by state). Our state-level composite policy index ranged from 0 to 53, with Mississippi being the most restrictive and California being the most enabling state. After grouping states into quartiles of the composite policy index, 16, 9, 13, and 12 states were in quartile 1, 2, 3, 4, respectively, with higher scores and quartiles representing more enabling states (See Supplemental Table 5, states by quartile of policy index; Figure 1).

Based on CDC Wonder data, during the study period (2016-2018) there were a total of 11,530,785 births nationally. There were 154,384 cases of SMM (50 states) and 2,846 (43 states) pregnancy-related deaths. Rates of SMM and pregnancy-related mortality varied by state and score quartile. The mean rates of SMM and pregnancy-related mortality were 148.6 per 10,000 and 26.8 per 100,000, respectively (Table 1). Compared to states in the most restrictive quartile (1), those in the most enabling quartile (4) had higher crude rates of SMM (162.7 vs 119.0 per 10,000), but

lower crude rates of pregnancy-related mortality (20.4 vs 32.8 per 100,000). The mean rates of preterm birth and low birthweight were 6.45 per 100 and 8.24 per 100, respectively.

In unadjusted linear regression models on maternal outcomes, a one-unit increase in the composite policy score, indicating a more enabling reproductive autonomy environment, was associated with a 1.14 per 10,000 higher rate of SMM (95% confidence interval [95% CI]: 0.21, 2.04; Table 2). Conversely, every one-unit increase in the composite score was associated with a 0.31 per 100,000 lower rate of pregnancy-related mortality (95% CI: -0.49, -0.12). Similar associations were observed in sensitivity analyses assuming the minimum and maximum numbers of pregnancy-related mortality for states with fewer than 10 pregnancy-related deaths (N=43; minimum: -0.39; maximum: -0.25). Unadjusted models using the quartile-based policy index yielded similar results. While SMM rates in states in the most enabling quartile were 43.7 per 10,000 higher than for those in the most restrictive states, mortality rates were 12.3 per 100,000 lower. After adjustment results remained consistent for both SMM and pregnancy-related mortality. Importantly, six of the seven states with suppressed mortality data are in the more enabling quartiles, with four in quartile three and two in quartile four.

In unadjusted models on neonatal outcomes, a one-unit increase in the policy score was associated with a -0.03 (95% CI: -0.05, -0.01), -0.04 (95% CI: -0.07, -0.02), and -0.05 (95 % CI: -0.08, -0.02) per 100 lower rate of low birthweight and preterm birth, respectively. (Table 3) In quartile-based analyses, point estimates were largely consistent with decreasing rates for states with more enabling policies. However, significant rate differences were seen only in comparing

states in the most enabling quartile to states in the most restrictive quartile. The most enabling quartile was associated with a -1.09 (95% CI: -1.98, -0.19), -1.45 (95% CI: -2.46, -0.45), and -1.78 (95% CI: -2.96, -0.59) per 100 lower rate of low birthweight and both preterm birth estimates, respectively compared to the most restrictive quartile. After adjustment of the continuous policy index model, both estimates of preterm birth remained significant, but were partially attenuated. After adjustment of the quartile-based policy index model, only preterm birth measured by last menstrual period remained significant when comparing the most restrictive quartile to the most enabling quartile.

DISCUSSION

In this large national study, we developed a novel composite policy index to measure state-level reproductive autonomy as represented by state policies and then assessed associations between the composite risk index and SMM, pregnancy-related mortality, preterm birth, and low birthweight. Contrary to our initial hypothesis, states with the most enabling reproductive autonomy environment were more likely to have higher rates of SMM, compared to the most restrictive states. However, consistent with our hypothesis, the composite index was associated with lower rates of pregnancy-related mortality and preterm birth.

Few studies have examined the role of reproductive health policy domains outside of abortion and family planning.[88] Several scholars and the Institute for Women's Policy Research (IWPR) have previously used an index of nine component indicators (based on IWPR methodology) of reproductive rights (i.e., mandatory parental consent/notification laws for minors receiving

abortions, abortion waiting periods, public funding restrictions for abortions, percent of women living in counties with at least one abortion provider, pro-choice governors or legislatures, Medicaid expansion or state Medicaid family planning eligibility expansions, infertility treatment coverage, same-sex marriage or second-parent adoption for same-sex relationship individuals, and mandatory sex education) to descriptively examine the status of reproductive rights by state,[71] the relationship of the index with neonatal outcomes,[8,9,52,89] prevalence of major depression and post-traumatic stress disorder in women,[72] and postpartum depression symptomology.[73] Importantly, indices based on this methodology are limited to a few policies and do not recognize the additional key ways in which reproductive autonomy can be enabled or restricted. For example, these indices did not include workplace protections for maternity leave and accessible chestfeeding spaces, two policies which enable reproductive autonomy. Nevertheless, consistent with our findings regarding pregnancy-related mortality and preterm birth, the majority of these studies found that greater reproductive rights or autonomy were associated with improved outcomes. Notably, two-thirds of pregnancy-related deaths in the US are considered to be preventable,[90] and multiple professional and advocacy organizations support state policy interventions as a critical means for reducing pregnancy-related mortality.[91,92] Our findings support these assertions, and demonstrate that supporting and enacting state policies that increase reproductive autonomy can potentially save lives and improve neonatal health.

Our findings regarding reproductive autonomy and SMM and low birthweight were unexpected. Potential explanations for these seemingly contradictory results regarding SMM include

variability in validity of reporting and competing risks. There are continued concerns regarding maternal morbidity and mortality reporting related to the use of check boxes on birth certificates. Evidence suggests that the check boxes may under-capture morbidity cases compared to hospital discharge data,[93] and may overestimate pregnancy-related mortality if relying solely on obstetric codes without maternal mortality review committee review.[94] To date, CDC has supported 25 states in establishing maternal mortality review committees, and 40 states have established and administered committees through legislation.[95] The goal of these committees is to reduce preventable morbidity and mortality.[96] However, these review committees frequently focus solely on mortality and not SMM. Further, the political environment of a given state likely influences the robustness of these committees potentially leading to a greater focus on maternal mortality and fewer resources put towards ascertainment of SMM. This could result in more complete ascertainment of SMM in states with greater reproductive autonomy. Alternatively, SMM and pregnancy-related mortality may represent competing risks in which more enabling states have a lower rate of pregnancy-related mortality, which in turn would result in an increased rate of SMM, due to greater likelihood of survival of unexpected life-threatening outcomes of labor and delivery. Our findings regarding low birthweight are not consistent with published literature that has demonstrated a relationship between lower reproductive rights scores and increased risk of low birth weight.[52,89] This could potentially be attributed to a difference in sample and statistical methods, with previous work using individual-level data.

Although this work has a number of strengths, namely the inclusion of all fifty states, the expert opinion guided selection of policy groups, and easily reproducible methods, there are several

limitations. First, although representing 106 policies over 8 policy groups, it is possible we have not included all of the policy-level determinants that impact reproductive autonomy. Second, this study was cross-sectional and we are unable to make conclusions on the effect of a policy's duration or the differences in effect size by policy. For example, policies that have been in effect for a longer duration would be more likely to show an effect, and some policies may be more influential than others, however, our composite measure assumed comparable effects for each policy. Finally, introduction of the maternal mortality checkbox varied across states from 2003-2018, potentially introducing bias, however by 2016, 47 states had adopted the checkbox.[97]

CONCLUSIONS

Reproductive autonomy is impacted by the cumulative number of policies that either restrict and/or enable women's decisional capacity. We developed a novel composite index to quantify reproductive autonomy based on state policies. Our findings suggest that greater reproductive autonomy is associated with improved maternal and neonatal outcomes, with the possible exception of SMM. More research is needed that investigates the association of reproductive autonomy composite measures with additional reproductive, and maternal and child health outcomes.

Chapter 3 Tables and Figures

Chapter 3 Table 1. Characteristics of Delphi Panel Experts by Phase

	Total	**Pilot**	**Phase 1**	**Phase 2**
	N	N (%)	N (%)	N (%)
Age				
20-29	2	0 (0%)	2 (22%)	0 (0%)
30-39	5	3 (75%)	1 (11%)	1 (33%)
40-49	5	0 (0%)	4 (44%)	1 (33%)
50-59	3	0 (0%)	2 (22%)	1 (33%)
60+	1	1 (25%)	0 (0%)	0 (0%)
Race				
white	7	2 (50%)	4 (44%)	1 (33%)
Black/African American	5	0 (0%)	3 (33%)	2 (66%)
South Asian	2	1 (25%)	1 (11%)	0 (0%)
Latinx	1	0 (0%)	1 (11%)	0 (0%)
Female	13	3 (100%)	8 (89%)	2 (66%)
Organization				
Non-profit	6	2 (50%)	4 (44%)	0 (0%)
Academia	8	0 (0%)	5 (56%)	3 (100%)
Consulting	1	1 (25%)	0 (0%)	0 (0%)
Government	1	1 (25%)	0 (0%)	0 (0%)
Profession				
Manager	4	3 (75%)	1 (11%)	0 (0%)
Consultant	1	1 (25%)	0 (0%)	0 (0%)
Clinician	6	0 (0%)	5 (33%)	1 (33%)
Researcher/Faculty	5	0 (0%)	3 (33%)	2 (66%)
State of Residence				
Washington	12	4 (100%)	6 (67%)	2 (66%)
Minnesota	3	0 (0%)	2 (22%)	1 (33%)
New York	1	0 (0%)	1 (11%)	0 (0%)
Total Respondents		4	9	3

Note-
Manager includes: Family planning manager (p:1), non-profit manger (p:1), executive director (p:1), program manager (p1:1)
Clinician includes nurse midwife (p1:2), OB/GYN (p1:1), social worker and doula (p1:1), physician and researcher (p1:1)
Researcher includes research and evaluation manager (p1:1), faculty (p1:2) (p2:2)

Chapter 3 Table 2. Delphi Panel Percent Agreement by Policy Category and Phase

	Pilot	Phase 1	Phase 2
Medicaid Expansion	100	100	NA
Family Planning	100	100	NA
Abortion-Related	100	100	NA
Comprehensive Sex Education	100	100	NA
Confidentiality of Medical Procedures	100	100	NA
Title X	50	-	-
Prenatal Care	100	100	NA
Substance Use in Pregnancy	33	-	-
Tubal Ligation	50	-	-
Occupational-Related	100	100	NA
Population Control Programs	50	-	-
Spousal and Partner Abuse Protections	50	-	-
Poverty Programs	NA	NA	100

Note: Agreement of 80 (0.8*100) was used as a cutoff for inclusion -- "moderate"
NA = Not Assessed, agreement was reached in previous round

Chapter 3 Table 3. Number of Restrictive and Enabling Policies per Policy Category

	Total N=106	**Restrictive N=53**	**Enabling N=53**
Medicaid Expansion	2	0	2
Family Planning	15	5	10
Abortion-Related	49	38	11
Comprehensive Sex Education	14	5	9
Confidentiality of Medical Procedures	2	0	2
Prenatal Care	9	0	9
Occupational-Related	8	2	6
Poverty Programs	7	3	4

Chapter 3 Table 4. Rates of Maternal and Neonatal Outcomes by Quartile of the Composite Risk Index Measuring Reproductive Autonomy

	Total Mean (SD)	**Quartile 1 Mean (SD)**	**Quartile 2 Mean (SD)**	**Quartile 3 Mean (SD)**	**Quartile 4 Mean (SD)**
Severe Maternal Morbidity (per 10,000; N=50)	148.6 (46.4)	119.0 (36.9)	155.8 (46.9)	167.0 (47.8)	162.7 (41.1)
Pregnancy-Related Mortality (per 100,000; N=43)	26.8 (9.33)	32.8 (10.5)	26.9 (9.20)	23.7 (4.92)	20.4 (4.98)
Preterm Birth (LMP; per 100; N=50)	6.86 (1.65)	7.66 (1.78)	7.31 (1.62)	6.54 (1.56)	5.91 (1.12)
Preterm Birth (OCGE; per 100; N=50)	6.45 (1.39)	7.08 (1.51)	6.89 (1.34)	6.18 (1.30)	5.65 (1.02)
Low Birthweight (per 100; N=50)	8.24 (1.21)	8.69 (1.47)	8.46 (1.12)	8.16 (1.24)	7.60 (0.66)

SD: Standard Deviation
LMP: Last Menstrual period
OCGE: Obstetric/Clinical Gestation Estimate

Chapter 3 Table 5. Severe Maternal Morbidity and Pregnancy-Related Mortality, 2016-2018

	Severe Maternal Morbidity (per 10,000)	Pregnancy-Related Mortality (per 100,000)		
	Coefficient (95% CI) N=50	Minimum Coefficient (95% CI) N=50[1]	Maximum Coefficient (95% CI) N=50[1]	Suppressed Coefficient (95% CI) N=43[1]
Policy Index-Continuous				
Unadjusted Policy Index	1.14 (0.21, 2.07)*	-0.39 (-0.63, -0.14)**	-0.25 (-0.42, -0.07)**	-0.31 (-0.49, -0.12)**
Adjusted Policy Index	1.22 (0.40, 2.03)**	-0.32 (-0.52, -0.12)**	-0.20 (-0.37, -0.02)*	-0.25 (-0.47, -0.02)*
Policy Index-Quartiles				
Unadjusted Policy Index				
1st Quartile	Referent	Referent	Referent	Referent
2nd Quartile	36.8 (0.64, 73.0)*	-3.84 (-12.8, 5.14)	-5.56 (-13.5, 2.42)	-5.89 (-14.2, 2.39)
3rd Quartile	48.0 (15.3, 80.6)**	-14.3 (-23.8, -4.89)**	-6.82 (-13.2, -4.02)*	-9.10 (-15.6, -2.65)**
4th Quartile	43.7 (13.4, 74.0)**	-13.7 (-22.1, -5.19)**	-8.57 (-16.6, -0.52)*	-12.3 (-18.7, -5.91)***
Adjusted Policy Index				
1st Quartile	Referent	Referent	Referent	Referent
2nd Quartile	40.2 (14.6, 65.9)**	-4.88 (-13.4, 3.65)	-2.16 (-9.75, 5.43)	-3.68 (-11.4, 4.06)
3rd Quartile	43.6 (11.6, 76.2)**	-12.7 (-21.9, -3.38)**	-7.71 (-13.7, -1.77)*	-9.23 (-15.3, -3.15)**
4th Quartile	44.7 (12.9, 76.5)**	-11.8 (-20.4, -3.28)**	-6.46 (-14.2, 1.32)	-9.87 (-16.1, -3.61)**

95% CI: 95 Percent Confidence Interval

[1]CDC suppresses data with cell sizes fewer than 10. Due to this, we have created a minimum (count set to 0) and maximum (count set to 9), and suppressed (count set to missing)

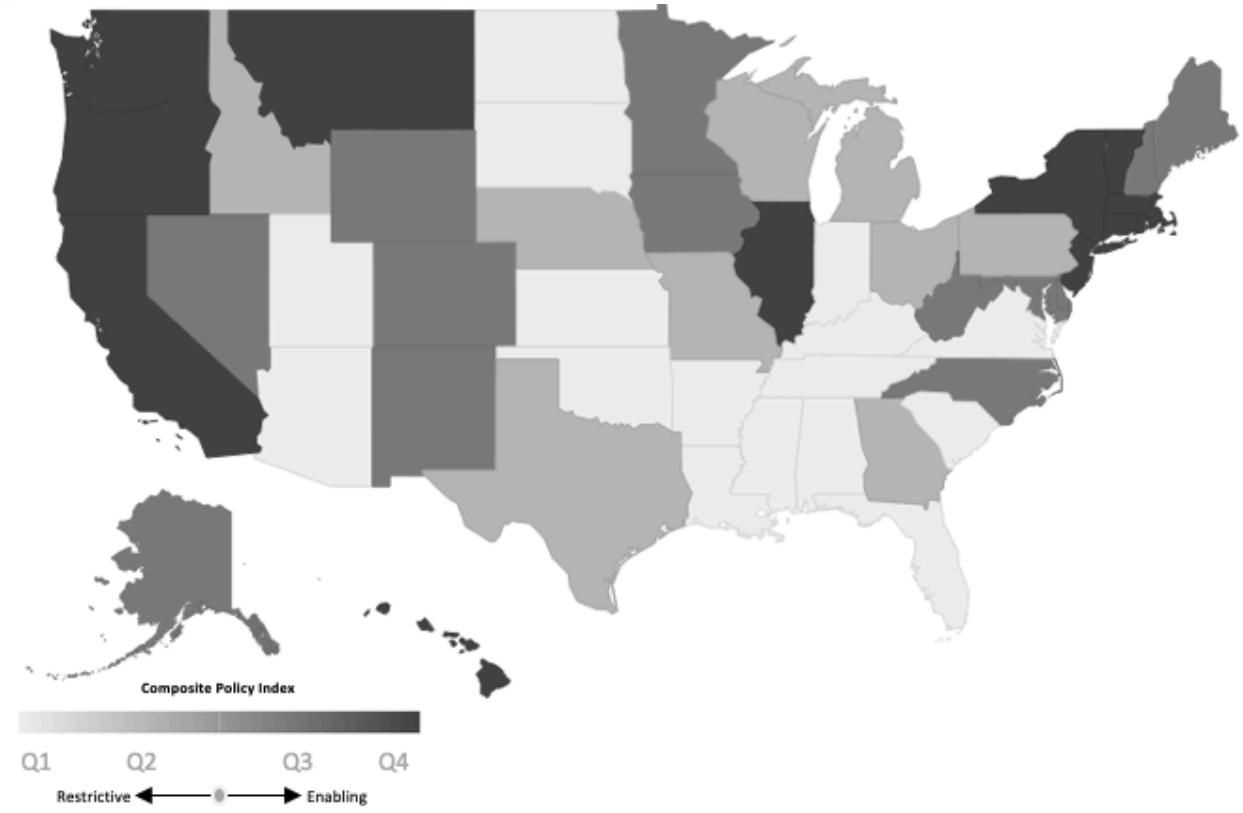
*P <0.05; ** P <0.01; ***P <0.001

Chapter 3 Table 6. Preterm Birth and Low Birthweight, 2016-2018 Among all Live Births to Mothers Aged 15-44

	Low Birthweight (per 100)	Preterm Birth (Obstetric/Clinical Gestation Estimate; per 100)	Preterm Birth (Last Menstrual Period; per 100)
	Coefficient (95% CI)	**Coefficient (95% CI)**	**Coefficient (95% CI)**
Policy Index-Continuous			
Unadjusted Policy Index	-0.03 (-0.05, -0.01)*	-0.04 (-0.07, -0.02)**	-0.05 (-0.08, -0.02)*
Adjusted Policy Index	-0.01 (-0.03, 0.01)	-0.02 (-0.03, -0.005)**	-0.02 (-0.04, 0.006)*
Policy Index-Quartiles			
Unadjusted Policy Index			
1st Quartile	Referent	Referent	Referent
2nd Quartile	-0.31 (-1.29, 0.67)	-0.32 (-1.42, 0.77)	-0.53 (-1.82, 0.76)
3rd Quartile	-0.53 (-1.41, 0.35)	-0.92 (-1.90, 0.06)	-1.15 (-2.30, 0.11)
4th Quartile	-1.09 (-1.98, -0.19)*	-1.45 (-2.46, -0.45)**	-1.78 (-2.96, -0.59)**
Adjusted Policy Index			
1st Quartile	Referent	Referent	Referent
2nd Quartile	0.04 (-0.43, 0.52)	0.21 (-0.22, 0.64)	0.11 (-0.39, 0.61)
3rd Quartile	0.05 (-0.70, 0.79)	-0.10 (-0.59, 0.38)	-0.18 (-0.76, 0.40)
4th Quartile	-0.39 (-0.87, 0.08)	-0.54 (-1.11, 0.03)	-0.67 (-1.29, -0.05)*

95% CI: 95 Percent Confidence Interval
*P <0.05; ** P <0.01

Chapter 3 Figure 1. States by Quartile (Q1-Q4) of the Composite Policy Index as a Function of State-Level Policies



Chapter 3 Supplementary Table 1. Number of Enabling and Restrictive Policies per Policy Category by State

	Enabling Policy Categories (N=8)									Restrictive Policy Categories (N=5)					
	Enabling Total	Medicaid Expansion	Family Planning	Abortion Related	Confidentiality of Medical Procedures	Prenatal Care	Occupational Related	Comprehensive Sex Education	Poverty Programs	Restrictive Total	Family Planning	Abortion Related	Comprehensive Sex Education	Occupational Related	Poverty Programs
ALABAMA	9	0	2	1	0	2	0	4	0	22	1	14	3	2	2
ALASKA	10	1	1	3	0	2	2	0	1	13	0	10	0	1	2
ARIZONA	12	1	4	3	0	1	2	1	0	29	3	20	3	1	2
ARKANSAS	15	1	3	2	0	5	3	0	1	29	4	18	3	2	2
CALIFORNIA	37	1	7	6	1	5	6	9	2	7	1	2	2	1	1
COLORADO	17	1	3	0	1	2	4	5	1	10	3	3	1	1	2
CONNECTICUT	21	1	5	3	0	4	4	2	2	9	1	5	1	0	2
DELAWARE	11	1	4	0	0	1	2	2	1	10	0	7	1	0	2
FLORIDA	9	0	1	1	0	3	1	3	0	26	3	17	3	1	2
GEORGIA	14	0	3	3	0	1	2	3	2	19	2	12	2	1	2
HAWAII	26	1	7	3	0	4	3	6	2	9	0	6	1	0	2
IDAHO	8	0	0	3	0	2	2	1	0	19	2	12	0	2	3
ILLINOIS	25	1	6	2	0	6	4	5	1	14	3	6	3	0	2
INDIANA	13	1	1	3	0	4	1	2	1	28	1	21	2	2	2
IOWA	16	1	5	0	0	0	2	7	1	10	1	6	0	2	1
KANSAS	8	0	0	1	0	3	1	1	2	24	2	18	0	2	2
KENTUCKY	9	1	0	0	0	3	2	2	1	22	0	17	1	2	2
LOUISIANA	14	0	1	2	0	2	3	5	1	28	1	21	4	1	1
MAINE	19	0	5	4	0	1	2	6	1	14	4	7	1	0	2
MARYLAND	21	1	6	3	1	3	2	3	2	11	1	6	0	1	3
MASSACHUSETTS	25	1	7	3	0	6	4	2	2	10	1	6	0	1	2
MICHIGAN	18	1	4	3	0	2	2	5	1	26	0	20	3	1	2
MINNESOTA	20	1	3	5	0	3	4	3	1	17	1	12	1	0	3
MISSISSIPPI	8	0	1	3	0	0	2	2	0	31	4	19	5	1	2
MISSOURI	17	0	4	2	0	4	2	4	1	27	1	21	1	1	3

MONTANA	22	1	6	3	0	5	3	2	2	7	1	5	0	0	1
NEBRASKA	9	0	0	2	0	2	2	1	2	21	0	18	0	2	1
NEVADA	13	1	2	2	0	3	2	2	1	12	0	6	1	2	3
NEW HAMPSHIRE	15	1	6	0	0	3	2	3	0	7	1	4	0	1	1
NEW JERSEY	24	1	4	1	0	7	3	6	2	8	0	3	1	1	3
NEW MEXICO	15	1	5	1	0	1	2	3	2	9	1	5	1	0	2
NEW YORK	29	1	5	5	1	6	4	4	3	9	1	5	1	0	2
NORTH CAROLINA	20	0	6	4	0	3	1	5	1	23	2	14	3	2	2
NORTH DAKOTA	7	1	0	2	0	1	1	1	1	20	0	15	2	1	2
OHIO	11	1	0	1	0	4	2	2	1	22	0	19	2	0	1
OKLAHOMA	13	0	1	3	0	3	2	2	2	29	1	23	2	2	1
OREGON	31	1	7	4	1	4	4	7	3	5	1	2	1	0	1
PENNSYLVANIA	17	1	2	3	0	4	2	3	2	22	1	17	1	0	3
RHODE ISLAND	21	1	3	1	0	4	5	6	1	10	1	7	1	0	1
SOUTH CAROLINA	12	0	2	2	0	1	1	5	1	26	1	18	4	1	2
SOUTH DAKOTA	6	0	0	2	0	2	1	0	1	25	1	19	1	2	2
TENNESSEE	12	0	0	0	0	5	3	4	0	25	3	16	2	2	2
TEXAS	13	0	2	2	0	3	2	4	0	22	2	14	3	1	2
UTAH	13	0	2	2	0	4	1	2	2	31	0	23	4	2	2
VERMONT	18	1	5	1	0	2	4	4	1	5	0	2	1	0	2
VIRGINIA	12	0	1	2	0	4	2	2	1	27	1	21	2	1	2
WASHINGTON	30	1	8	7	1	4	2	4	3	8	1	3	1	1	2
WEST VIRGINIA	16	1	4	2	0	4	2	2	1	8	0	4	0	2	2
WISCONSIN	17	0	7	4	1	0	1	2	2	22	1	14	2	2	3
WYOMING	9	0	2	1	0	1	1	2	2	10	1	6	0	2	1

Chapter 3 Supplementary Table 2. States by Quartile, Ordered by Composite Index (0-53 points)

Q1 (N=16)	Q2 (N=9)	Q3 (N=13)	Q4 (N=12)
Mississippi (0)	Nebraska (11)	Alaska (20)	Rhode Island (34)
South Dakota	Idaho	North Carolina	Illinois
Utah	Ohio	Wyoming	Connecticut
Arizona	Missouri	Delaware	Vermont
Florida	Texas	Nevada	Montana
Kansas	Michigan	Minnesota	Massachusetts
Oklahoma	Pennsylvania	Maine	New Jersey
Indiana	Georgia	New Mexico	Hawaii
Virginia	Wisconsin (18)	Iowa	New York
Louisiana		Colorado	Washington
Arkansas		West Virginia	Oregon
South Carolina		New Hampshire	California (53)
Kentucky		Maryland (33)	
Tennessee			
Alabama			
North Dakota (10)			

Chapter 4: Association of Reproductive Autonomy and Rates of State-Level Racialized Disparities in Preterm Birth and Low Birthweight

INTRODUCTION

Preterm birth (PTB) and low birthweight (LBW) are leading causes of infant mortality in the United States, accounting for an estimated 25% of all neonatal deaths.[98] Additionally, PTB and LBW are associated with short- (e.g., infections) and long-term (e.g., developmental delay) health consequences and are standard population measures of maternal and child health.[99–101] Overall, PTB (gestation <37 weeks) and LBW (weight <2,500 grams) affect roughly 1 in 10 and 1 in 12 of births, respectively.[102,103]

Although rates of PTB and LBW have decreased in recent years striking disparities persist across racialized groups for both outcomes.[98,104] For example, in 2013, the PTB rate for Black infants was roughly 6 percentage points higher than in white infants (16.3% vs. 10.2%) and the rate of LBW was similarly elevated among Black versus white infants (13.1% vs. 7.0%).[105] Observed racialized disparities in PTB and LBW may partially explain widening inequality in infant mortality, with Black infants having a 2.3 times higher mortality rate than white infants. These disparities in PTB and LBW and infant mortality endure even after accounting for geography, income and income inequality, poverty, educational and insurance status, and are at least partially reflective of and sharing the same root causes as similar racial disparities in maternal morbidity and mortality.[106–108] Structural racism, a system created by western colonization reinforces and perpetuates racialized inequity and is driven in part by laws at the state-level, and is likely the "fundamental cause" of minoritized disparities in the United States. Therefore, investigation of the influence of state-level laws on racialized disparities is timely and important.

Reproductive autonomy, or the ability to decide about and control contraceptive use, pregnancy, and childbearing,[60] is enabled or restricted at the federal and state level. Reproductive autonomy is legislated though access to contraceptives, sexual health information, and to health services (e.g., prenatal care). Evidence from individual state policy analyses suggests that individual reproductive autonomy enabling policies are associated with overall lower rates of PTB and LBW.[50,51,109] Further, some literature indicates that Black women from states with more restrictive reproductive laws were more likely to give birth to LBW infants compared to Black women from states with more enabling laws.[89] Additionally, one study used a composite risk score to characterize the overall state reproductive rights environment (e.g., Medicaid eligibility for family planning, mandatory sex education) and found that, relative to states with greater reproductive autonomy, to those with more restricted reproductive autonomy had higher odds of PTB, LBW, and cesarean section.[110] Further, some enabling policies, such as Medicaid expansion, have been shown to reduce Black-white racialized disparities in PTB and LBW in states that expanded Medicaid versus those that did not.[111] However, additional research that incorporates more comprehensive measures of states' reproductive autonomy environment is needed to understand state policy's' impact on racialized disparities in neonatal outcomes.[13,112,113]

Therefore, our objective was to examine if a composite state-level index of reproductive autonomy, developed based on state-level laws,[13] was associated with state-level Black-white racialized disparities in PTB and LBW. We hypothesized that greater state-level reproductive

autonomy measured by our composite index of state-levels laws would be associated with decreased state-level racial disparities in PTB and LBW.

METHODS

We used data for 45 states for PTB and all 50 states for LBW from the Centers for Disease Control and Prevention (CDC), National Center for Health Statistics natality file for all live-births to U.S. resident mothers aged 15-44 between January 1, 2016, and December 31, 2018. We accessed CDC data through CDC Wonder Online Database; data are derived from checkboxes on birth certificates.[81,114] CDC suppresses sub-national data estimates with fewer than 10 cases.[85] Therefore, states with fewer than N <10 cases of PTB (N=5; Idaho, Montana, South Dakota, Wyoming, and Vermont) were excluded from the analysis.

Measures

The independent variable was a composite risk index of state-level policies that characterize each state's reproductive autonomy. The composite index was created by first using a Delphi panel of reproductive health experts to determine state policy categories that affect reproductive autonomy. A total of eight policy categories were included: Medicaid expansion, family planning, abortion-related, comprehensive sex education, confidentiality of medical procedures, prenatal care, occupational-related, and poverty programs. Second, state-level policies for each category were collected from publicly available data, for example women's health policy-related non-profit organizations. 106 state-level laws were collected. Third, individual policies were determined to be either enabling (assigned +1 if present) or restrictive (assigned -1 if present).

Lastly, the sum of the total restrictive policies for each state was then subtracted from the sum of enabling policies for each state. Lower scores on the composite risk index represent more reproductive autonomy restrictive states, and higher scores represent more enabling states. Full development details have been previously described.[115] The risk index was operationalized both as a continuous variable and as a categorical variable, in which the index was grouped into quartiles from the most restrictive quartile (1) to the most enabling quartile (4).

The two outcomes included in this study were state-level Black-white disparities in PTB and LBW. PTB was defined two ways: 1) as gestation <37 weeks measured by obstetric/clinical gestation estimate and 2) calculated based on last menstrual period (LMP). LBW was defined as neonate weight <2,500 grams, as indicated on birth certificate data. Both outcomes were generated by aggregating race-specific rates (calculated by dividing the total number of outcomes in one racial group by the total number of births in that same racial group) and then subtracting the white outcome rates from the Black outcome rates. State-level racialized disparity rates were calculated out of 100 live births, with lower rates indicating a smaller racialized disparity.

Analysis

We performed simple linear regression to evaluate the association of the reproductive autonomy composite policy index and the index quartiles with racial disparities in preterm birth and low birthweight. No adjustment variables were used due to concerns that they acted as mediators on the causal pathway or were associated with the outcome only.[116,117] Robust standard errors were used to account for heteroskedasticity. The omnibus F-test was used to estimate a

difference in means. We considered 2-sided $P < 0.05$ to be statistically significant. All analyses were performed with Stata 15.1.[87] The University of Washington Institutional Review Board reviewed and determined this work as exempt non-human subjects research.

RESULTS

During the study period there were 10,297,437 Black-white births in the 50 United States. (Table 1) Overall rates of PTB and LBW were 6.46 per 100 and 8.24 per 100, respectively. Compared with white births, Black births had higher overall rates of PTB (Obstetric/clinical gestation estimate: 14.1 vs. 4.93; Last menstrual period: 14.9 vs. 5.22 per 100) and LBW (12.5 vs. 7.10 per 100).

The racial disparity rates in PTB and LBW varied by state. The Black-white racialized disparity in PTB by obstetric/clinical gestation estimate ranged from 3.04 (Maine) to 13.9 (Alaska) per 100 live births (Figure 1). Similar findings were observed for PTB estimated by last menstrual period (2.47 [Maine] to 15.0 [Alaska] per 100; Figure 2). The Black-white disparity in LBW ranged from 1.06 (Vermont) to 8.72 (Wisconsin) per 100 live births.

In regression models, every one-unit increase in the policy index was associated with -0.05 (95% CI: -0.09, -0.01) and -0.06 (95 % CI: -0.10, -0.01) per 100 lower Black-white racialized disparity in PTB by obstetric/clinical gestation exam and last menstrual period, respectively (Table 2). When the policy index was entered into the model as a categorical variable based on quartiles, there

was no observable association for obstetric/clinical gestation exam or last menstrual period, (omnibus test = 0.14, 0.24, respectively).

In models assessing LBW, every one-unit increase in the policy index was associated with -0.05 (95% CI: -0.08, -0.01) per 100 lower rates of the Black-white racial disparity in LBW. Additionally, the most enabling quartiles (3 and 4) were associated with 1.21 (95% CI: -2.38, -0.05) and 1.62 (95% CI: -2.89, -0.35) per 100 lower rates of the Black-white racialized disparity in LBW compared to the most restrictive quartile (1).

DISCUSSION

In this national cross-sectional study, we used a previously developed composite risk index of state-level reproductive autonomy[115] and assessed associations between the index and state-level Black-white racialized disparities in PTB and LBW. Consistent with our initial hypothesis, states with the most enabling reproductive autonomy environment were also more likely to have smaller racialized disparities in PTB and LBW compared to the most restrictive states. However, even in the most enabling states, disparities in adverse income outcomes across racialized groups remained.

United States policy, public health, and medical care have a past and present-day context that is shaped by systematic racism.[118–120] Importantly, many reproductive-related policies that are restrictive are specifically designed to limit or disproportionately impact the reproductive autonomy of women of color.[121] For example, the Hyde Amendment with few exceptions bans

federal funds for abortion services, including Medicaid, a joint federal and state funded program, as well as coverage through insurance plans for federal employees, for servicemembers, and Veterans.[122,123] Further, using the Hyde Amendment as a roadmap, Thirty-two states and Washington DC additionally prohibit the use of state funds toward abortion services.[123] Notably, due to factors such as persistent income inequality and restricted employment opportunities driven by systemic racism, Black Americans are more likely to be uninsured or insured by Medicaid and therefore more likely to be impacted by these policies.[124] Compounded by increasingly diverse and disproportionate participation in the military by race and gender,[125] Hyde also disproportionately limits access by Black Americans to crucial and desired abortion care. Similarly, state-level policies such as punitive laws regarding substance use in pregnancy frequently disproportionately target women of color.[126] Our findings lend further support to the assertion that many state laws that restrict reproductive autonomy either implicitly or explicitly target the health and seek to assert control over Black pregnant and birthing people.[127]

Our findings regarding racialized raw disparity rates in LBW and PTB are similar to other published literature and further explain the relationship between racism and health. In work by Riley et al., that used 135 state-laws over 16 domains (e.g., abortion, criminal justice, education, environment, health and welfare, housing and transportation) to characterize state-level political orientation found that infants born in states with left-leaning (i.e., liberal policy orientations) had lower odds of LBW and PTB compared to right-leaning, with the strongest associations among white births.[112] Notably, racism is an ubiquitous social determinant of health and health care that is independent of political leanings. For example, left-leaning programs such as Medicaid that are

intended to improve overall birth outcomes may potentially fail to consider societal context and are more favorable towards white births. For example in studies prior to the ACA, among mothers on Medicaid, even after adjustment for maternal age, state, length of hospital stay, and C-section status, Black mothers still had higher risks of pre-eclampsia, placental abruption, preterm birth, small for gestational age infant, fetal death/still birth, and maternal death.[128] However, post-ACA Medicaid expansion appears to be associated with narrowing racialized disparities in maternal and infant outcomes possibly due to the emphasis on continuous coverage that includes standard preventive care (e.g. contraception, STI testing).[111,129]

Although our study has a number of strengths, results should be interpreted in light of its limitations. First, our independent variable is comprised of a diverse set of policies covering multiple reproductive policy categories; however, it is possible we have not included all of the policy-level determinants that impact reproductive autonomy particularly for other minoritized populations, such as coverage of assistive reproductive technology for LGBTQIA+ birthing people. Further, our index does not allow for differentiating length of exposure to a policy, where fully implemented policies may have a different effect than new policies. Second, this study was cross-sectional and we are unable to make causal conclusions; however, cross-sectional studies serve as a strong foundation for more in-depth subsequent studies. Third, we are not able to account for maternal state-to-state mobility, which may lead to misclassification of the reproductive autonomy environment of some individuals in this study. Finally, our measures of preterm birth were limited in sample size, which may impact our ability to detect a difference using our policy index as quartiles.

CONCLUSIONS

State-level racialized disparities in low birthweight and preterm birth are impacted by reproductive autonomy determined by state-level policies. Our findings suggest that greater reproductive autonomy is associated with lower rates of state-level racialized disparities. These findings suggest that the effect of structural racism through policy, a fundamental cause of health disparities, may partially drive observed disparities and provide preliminary foundation for policy reform in more restrictive states. More research is needed that investigates additional neonatal outcomes and incorporates advanced methods and study designs to better understand the mechanisms underlying the relationship between state reproductive autonomy environment and birth outcomes, including longitudinal analyses that account for policy year and state-level effects. Importantly, future research and policy work should be centered on equity by prioritizing the impact on reproductive autonomy and outcomes of programs and policies, such as Temporary Assistant for Needy Families that primarily target low income women of color.

Chapter 4. Tables and Figures

Chapter 4 Table 1. Rates of Preterm Birth and Low Birthweight per 100 Live Births, by Race and Quartile of Composite Policy Index

	Total	**Black**	**white**
	N (%)	**N (%)**	**N (%)**
Births	10,297,437 (100%)	1,829,051 (17.8%)	8,468,386 (82.3%)
	Mean (SD) Per 100	**Mean (SD) Per 100**	**Mean (SD) Per 100**
Preterm Birth (N=45; Obstetric/Clinical Gestation Estimate)	6.46 (1.39)	14.1 (2.33)	4.93 (0.62)
Quartiles of Policy index			
1st Quartile	6.98 (1.56)	14.4 (1.80)	5.11 (0.55)
2nd Quartile	6.99 (1.29)	15.5 (1.35)	5.16 (0.46)
3rd Quartile	6.18 (1.30)	13.0 (2.81)	4.91 (0.77)
4th Quartile	5.65 (1.02)	13.4 (2.47)	4.54 (0.53)
Preterm Birth (N=45; Last Menstrual Period)	6.86 (1.65)	14.9 (2.66)	5.22 (0.75)
Quartiles of Policy index			
1st Quartile	7.50 (1.88)	15.3 (2.20)	5.45 (0.63)
2nd Quartile	7.49 (1.52)	16.5 (1.90)	5.54 (0.57)
3rd Quartile	6.54 (1.56)	13.8 (3.18)	5.16 (0.98)
4th Quartile	5.91 (1.12)	13.9 (2.52)	4.73 (0.51)
Low Birthweight	8.24 (1.21)	12.5 (2.08)	7.10 (0.82)
Quartiles of Policy index			
1st Quartile	8.46 (1.53)	12.9 (2.23)	7.10 (0.58)
2nd Quartile	8.71 (1.02)	13.8 (1.93)	7.30 (0.52)
3rd Quartile	8.16 (1.23)	12.9 (1.88)	7.33 (1.30)
4th Quartile	7.60 (0.66)	11.2 (1.61)	6.66 (0.44)

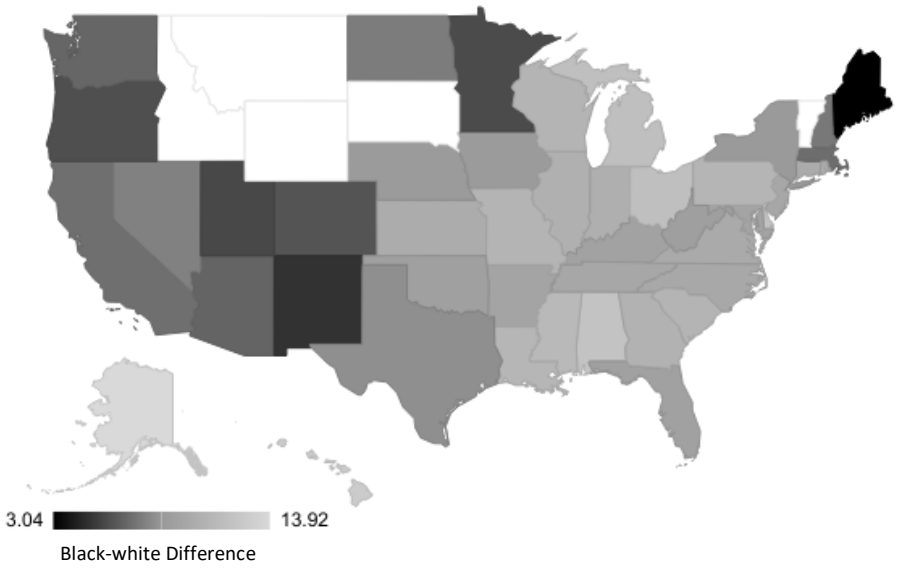
%: Percent
SD: Standard Deviation
95% CI: 95 Percent Confidence Interval
*P <0.05; ** P <0.01; ***P<0.001

Chapter 4 Table 2. Association of State Level Reproductive Autonomy Composite Policy Index with Racial Disparities in Preterm Birth and Low Birthweight per 100 Live Births, 2016-2018

	Preterm Birth (N=45) (Obstetric/Clinical Gestation Estimate)	**Preterm Birth (N=45) (Last Menstrual Period)**	**Low Birthweight**
	Coefficient (95% CI)	**Coefficient (95% CI)**	**Coefficient (95% CI)**
Policy Index, Continuous	-0.05 (-0.09, -0.01)*	-0.06 (-0.10, -0.01)*	-0.05 (-0.08, -0.01)**
Policy, Quartiles	F >0.14	F >0.24	F >0.05
1st Quartile	Referent	Referent	Referent
2nd Quartile	0.38 (-1.02, 1.78)	0.12 (-1.56, 1.81)	-0.14 (-1.65, 1.37)
3rd Quartile	-1.49 (-3.57, 0.60)	-1.61 (-3.89, 0.67)	-1.21 (-2.38, -0.05)*
4th Quartile	-0.82 (-2.57, 0.93)	-1.10 (-2.86, 0.66)	-1.62 (-2.89, -0.35)*

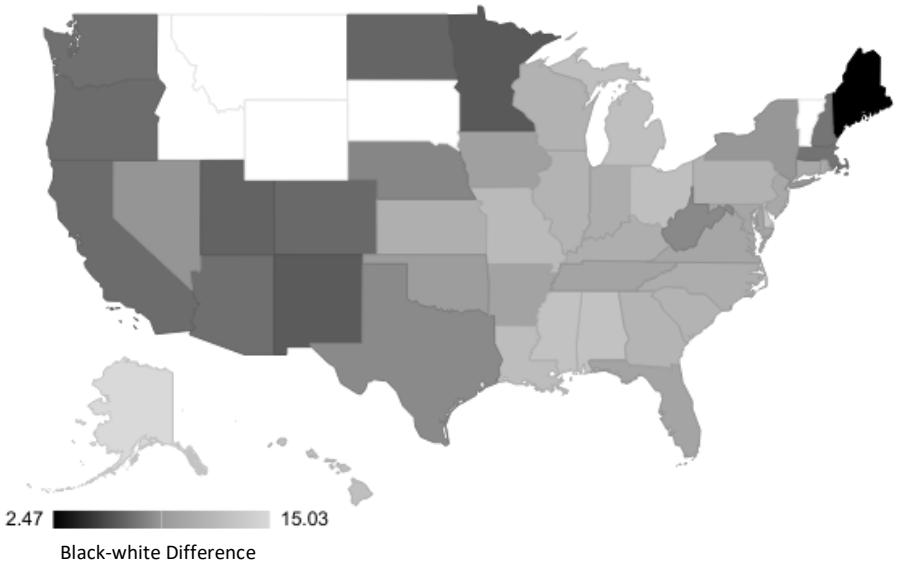
95% CI: 95 Percent Confidence Interval
*P <0.05; ** P <0.01
F: Omnibus F-Test
Analyses are unadjusted

Chapter 4 Figure 1. State-Level Racial Disparity Rates in Preterm Birth by Obstetric/Clinical Gestation Estimate



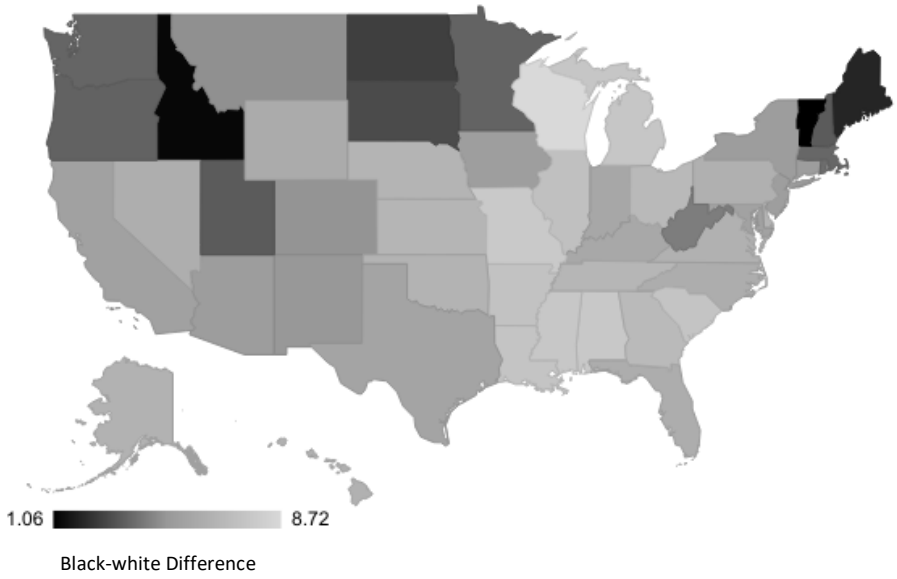
Note: Idaho, Montana, South Dakota, Wyoming, and Vermont are missing.

Chapter 4 Figure 2. State-Level Racial Disparity Rates in Preterm Birth by Last Menstrual Period



Note: Idaho, Montana, South Dakota, Wyoming, and Vermont are missing.

Chapter 4 Figure 3. State-Level Racial Disparity Rates in Low Birthweight



Chapter 5: Conclusions

In this body of work, we established the state of the literature on ways in which state laws influence adverse maternal and neonatal outcomes, developed a novel tool to more comprehensively measure state-level reproductive autonomy enabled or restricted due to state laws, and tested whether that tool was associated with diverse maternal and neonatal outcomes, as well as disparities in those outcomes. We found that most the current reproductive health policy literature has focused on only abortion and evaluation of single laws. Additionally, we found that more enabling states, as defined by our composite risk index, had higher rates of severe maternal morbidity, but lower rates of maternal mortality, preterm birth, low birthweight, and racial disparities in preterm birth and low birthweight.

Findings from this work together indicate enabling policies that support reproductive autonomy improve maternal and neonatal outcomes at the state level. Importantly, enabling policies can also reduce the observed racialized disparity in preterm birth and low birthweight.

Enabling the state-level reproductive autonomy of women, especially women of color, is critical for improving the population-level health outcomes maternal mortality, preterm birth, and low birthweight and increasing equity in these outcomes. As of January 2020, in the midst of the COVID-19 pandemic that affected the ability to access critical reproductive health information and services, 97 enabling reproductive health and rights policies were enacted, however 30 restrictive policies were enacted (categories include: abortion, maternal mortality, contraceptive and infertility coverage, incarcerated persons, family planning and sexually transmitted infection services, and sex education).[130,131] Although the amount of enabling policies enacted have been trending upward in recent years, while restrictive policies have

trended downward, overall rates of pregnancy-related mortality, and alarmingly, racial disparities in pregnancy-related mortality remain high.[131,132] American Indian or Alaskan Native and Black women have rates that are 2- and 3-times higher than white women.[131,132] Similar findings are observed for preterm birth and low birthweight.[133,134] These estimates and policies vary greatly across geographic location and community. In states where reproductive autonomy is more restricted and with greater populations of Black birthing women, policy needs to be introduced and enacted that is designed to meet the needs of the populations they serve to improve the health of all communities.

Addressing the policy determinants of health is an intervention that addresses current negative health outcomes, but also reproductive health outcomes that may be driven by systematic racism. Creating a reproductive autonomy enabling environment benefits the individual by reducing mortality, preterm birth, and low birthweight, through access and utilization of critical reproductive health services and information. Using this novel composite risk index comprised of state-level policies that characterize the state reproductive autonomy environment can help identify states and reproductive outcomes of interest, as well as prioritization of legislative efforts to improve health on the population-level.

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