DISSERTATION

THE INFLUENCE OF REPRODUCTIVE ACCESS RESTRICTIONS ON HEALTH BEHAVIORS, INFANT MORTALITY, AND PHYSICIAN SUPPLY

Submitted by

Kelly Ann DeBie

Department of Environmental and Radiological Health Sciences

In partial fulfillment of the requirements

For the Degree of Doctor of Philosophy

Colorado State University

Fort Collins, Colorado

Spring 2025

Doctoral Committee:

Advisor: Andreas Neophytou

Molly Gutilla
Kayleigh Keller
Jennifer Peel
David Rojas-Rueda

ABSTRACT

THE INFLUENCE OF REPRODUCTIVE ACCESS RESTRICTIONS ON HEALTH BEHAVIORS, INFANT MORTALITY, AND PHYSICIAN SUPPLY

In the past decade, there has been an increasing focus on restriction or elimination of abortion access in the United States. Of particular importance, the Dobbs v. Jackson Women's Health decision in 2022 overturned Roe v. Wade and eliminated the Constitutionally protected right to abortion. After Roe v. Wade became law in 1973, there was an observed decline in maternal mortality with highest impacts in Black maternal mortality, indicating differential impact of both the restriction and removal of reproductive access. It is hypothesized that removal of access will create many impacts and that those impacts may occur in a differential manner. This dissertation has explored the impacts of limiting reproductive care access on people in the United States. Utilizing a background in health policy, law, ethics, maternal mental health advocacy and doula care, I studied how these laws have impacted populations. Trends in out-of-state abortion seekers were analyzed corresponding with state based restrictions and the repeal of the constitutionally protected right to abortion in the Dobbs decision from 2022. Trends in infant mortality were studied to determine whether they are associated with state-level abortion restrictions in both aggregate data and data which has been disaggregated by race, ethnicity, and cause of death. Physician supply was analyzed to determine if there are changes in the overall supply of physicians as well as within the specialty of obstetricians and gynecologists practicing in impacted states. Reproductive care access is an essential component

of healthcare, and it is crucial to understand how changes in state and federal law are impacting people's health and well-being.

ACKNOWLEDGEMENTS

This work represents a culmination of everything I have ever learned, studied, and researched in my lifetime. It brings together all of my training, my professional experience, my volunteer work and advocacy, my personal tragedies and triumphs, and has given me a mechanism to contribute to establishing evidence on this, such a heavy topic indeed.

I want to start by thanking all the countless people who have shared their stories with me as I have done this research. I honor your stories and keep your secrets; I am grateful for all the whispered tales shared in hallways through tears. You are why I keep going.

I want to thank the physicians and clinic staff who have also confided in me during this research. They have been willing to share their experiences caring for patients in this volatile and uncertain environment, one that seems to be shifting in such a fluid manner it can be difficult to feel like you are on solid ground sometimes. A special thank you to Dr. Warren Hern for doing this work for as long as you have and for still doing this work today.

I want to extend heartfelt gratitude to those who have attended my conference presentations, and for the comments I have received along the way. Thank you to all those who have asked me, “what about this or what about that?”, and in the process given me more topics to study; you have given me more to think about and offered me different perspectives, for which I am grateful. Keep asking hard questions. Keep demanding more information. Keep asking for more details. Keep challenging the conclusions. Keep asking what we are controlling for and what else should be included.

I hold gratitude for everyone else out there doing this incredibly difficult work. I have learned so much from all the webinars and sessions and podcasts on everything reproductive justice related that I have been able to attend, and am especially grateful for the work of Donley Greer, Khiara Bridges, and Jennie Wetter with rePros Fight Back podcast. Thank you to Dr. Brittany Charlton for helping me conceptualize overlapping state laws and figure out how to include them both. Thank you to Dr. Julie Peterson for organizing the symposium and to all the other panelists who said, “yes, let’s do this”.

I also want to thank additional individuals who have helped in ways they might not even be aware of, and those who have offered to help with other projects I have not had time for yet. Dr. Olivia Arnold, for the breaks and the conversations and the rallying cheers. Thank you to the agricultural economics department for allowing me to think out loud about indicators and modeling. Special thanks to Dr. Scott Denning for being willing to assist with building models for something entirely different than you’ve ever built. I want to thank the statistics department for helping me learn coding – a previously unheard of achievement, and Dr. Matt Koslovsky for making sure I will never misinterpret a p-value. A hefty bit of gratitude for the CDPHE Vital Statistics Division. They have been amazingly responsive and helpful.

I wish to extend gratitude to the faculty and programs of the University of Colorado at Anschutz, but especially to the health humanities and ethics program and the Colorado Clinical and Translational Science Institute. Dr. Daniel Goldberg and Dr. Kathrine Rhine came into my life at the perfect moment in this work, allowing me to take a step back and analyze the ethical, societal, personal, and global impacts of abortion restrictions in a way I had not been able to

simply by building models and running code. They helped me reconnect with my deep love of ethical principles and find a way to incorporate them into this final product.

I want to thank my friends, my classmates, my co-GTAs, my cohort members - for the nudges and the coffee and the crying and the memes, and for not picking on an old lady too much since you knew I would always have hand cream and ibuprofen whenever you needed it. I'm proud of you all. Keep going. You can do this. I pushed you to publish and signed you up to lecture with me because I knew you could do it. And let's *always* get coffee.

Thank you to all the department staff and faculty. Your knowledge, wisdom, experience and persistence create better students.

I want to thank everyone along the way on this winding serendipitous journey – from my undergraduate bioethics professors who made me read books I still recommend to people today, my public policy professor who let me research whatever I wanted, all the hospitals I have worked in and established partnerships with, the risk management offices, the hospital ethics committees, and my law school classmates –especially the ones who recognize what it means to me that I am finally using my law degree every day again. I want to thank the staff and clients of the legal aid clinic where I trained, the postpartum mood and anxiety disorder survivors who fought for better care for those who came after them who still inspire me every day, the midwives and doulas I trained with and under, the labor and delivery teams I have shared those magic moments of hushed silence with, the people who nudged me back into this work, the mental health advocates, all those out there fighting to make the world safer for queer kids so they can grow up to become the queer elders we need, and the amazing Covid-19

response team I spent the pandemic with and who urged me to study how politics impact health.

Thank you to Dr. Jennifer Peel, for being the first to welcome me to this program, for always asking the hard questions, and for encouraging me to join the IRB. Thank you to Dr. David Rojas-Rueda, for sharing your wisdom, enthusiasm and eternally optimistic global perspective. Thank you to Dr. Kayleigh Keller, for patience and understanding, for being an absolute rock star statistician, and for helping me recognize that my models really are that complicated sometimes. Thank you to Dr. Molly Gutilla, for always pushing me to see myself the way others do, for helping me become a better instructor, and for reminding me what matters. Thank you to Dr. Andreas Neophytou, for the willingness to let me explore subjects that push boundaries, for being flexible and demanding at the same time, and for all the sensitivity analyses. So many sensitivity analyses.

I want to thank my people and my pets and the forest, rivers and lakes. I appreciate that my family did not ask why I would suddenly want to sit in the middle of the lake alone and stare at the sky, they just got me the kayak so I could. My children have been so supportive and encouraging, they have helped me remember when I need to take breaks, they have forced me to remember why I am doing all this, and they have learned to (mostly) be patient and wait until I can finish this model or paragraph or slide deck or application. They even got me a PhD sword already because they are relentlessly confident that I can do this. I have endless gratitude for my husband Tom. Thank you for pushing me to do this in the first place, even when it became clear what that meant for you in terms of doing the heavy lifting with the kids and the remote

schooling and the house and everything else in our lives. Thank you for believing in me even when I didn't believe in myself.

Last, but certainly not least, I have gratitude for all of my abundant failures. They got me here, after all.

PREFACE

"Held: The Constitution does not confer a right to abortion; Roe and Casey are overruled; and the authority to regulate abortion is returned to the people and their elected representatives".[1]

The purpose of this dissertation has been to explore the association between changes in legal abortion access and health outcomes, specifically to study the extent to which travel behavior for abortions, infant mortality broadly and disaggregated by race, ethnicity, and cause, and physician supply are associated with differences in state-level abortion laws in the United States before and after the *Dobbs v. Jackson Women's Health (Dobbs)* decision in 2022. The *Dobbs* decision reversed the legal precedent in *Roe v. Wade (Roe)* finding that there was no Constitutional right to abortion.

My interest in this work began perhaps before I was even born. My mother was sexually assaulted and became pregnant as a result of the attack. She was able to terminate the pregnancy, after which she reunited with my father. Were it not for access to safe, legal abortion, her life trajectory would have been entirely different; I would never have been born. Put simply, abortion made my life possible. This work is deeply personal to me, and ties together my educational background, my lived experience, my research interests and my passion in a way I could not have imagined when I began this program four years ago. I am grateful for the opportunity to devote energy to this work.

This research has been done with a health equity lens fixed on reproductive justice; a concept born out of Black feminism scholarship that encompasses far more than abortion. Reproductive justice centers autonomy in decisions to have or to not have children, and the security of being able to raise any children one has in a safe and nurturing environment. Additionally, this work has used intentionally inclusive language with the recognition that not all people who can become pregnant are women.

DEDICATION

This is for my daughters and for everyone who can become pregnant. May they all have the power to determine their own fates.

Finally, this is for my Mom, who went through what she did in order to make my existence possible.

TABLE OF CONTENTS

CHAPTER 1: INTRODUCTION

Background and Historical Context of Abortion in the United States

Abortion is defined as "*the termination of a pregnancy after, accompanied by, resulting in, or closely followed by the death of the embryo or fetus"*.[1] Although often discussed as only relating to elective terminations, abortion actually encompasses a broad range of pregnancy related conditions and complications, the management of several of which are essentially the same. This includes missed miscarriages, impending fetal demise, and ectopic pregnancies.[2] This substantial overlap, coupled with vagueness and unscientific terms used in state laws, has led to a pervasive lack of clarity for both providers and patients regarding what can and cannot be done, dependent now on the jurisdiction the patient happens to be in at the time of the event.[3]

Abortion may be a complicated, emotional, and politically charged subject, but it certainly is not new. Abortion has been a part of the reality of life for pregnant people for as long as there have been pregnancies.[4] Black feminist activist and politician Shirley Chisholm once wrote, *"No matter what men think, abortion is a fact of life. Women have always had them; they always have and they always will".*[5] For much of the early history of the United States, women were the primary healers within families and communities, whether as lay midwives or in their own homes[6], until the male-led development of the medical establishment saw midwives as competition, which quickly resulted in criminalization of the practice. At the time, physicians claimed midwives were, "dirty, ignorant, and unsafe", in the quest to eliminate a field dominated by Black and immigrant women[7], even though in reality the use of contaminated equipment and lack of hygiene for hospital-based deliveries spread illness and resulted in more deaths.[8] Although abortion was common throughout the 18th and 19th century, the new medical profession set out to take over women's reproductive healthcare, pushing female caregivers out entirely and relegating abortion access to a secretive network now threatened with legal consequences; one of the first major organized efforts of the American Medical Association was to make abortion illegal.[9,10]

Before *Roe*, most people in the United States, regardless of political affiliation, believed that abortion decisions should be between a patient and their doctor, with 68% of Republicans and 59% of Democrats supporting privacy in decision-making.[11(p29)] It is also estimated that prior to *Roe*, there were approximately 800,000 illegal abortions annually resulting in around 200 deaths.[12] When *Roe* became the law of the land in 1973, it became a focal point immediately for conservative groups determined to undermine the holding wherever possible, and ultimately, to overturn the decision.[13]

Roe recognized a right to privacy under the 14th amendment and established a trimester framework for when and how state governments could regulate access to abortion. The *Planned Parenthood of Southeastern Pennsylvania v. Casey (Casey)*[14] decision in 1992 restructured the legal framework for regulation of abortion access, shifting to a viability point instead of trimesters, and implemented the *undue burden* standard as it relates to restrictions. Under this case, restrictions related to access at any point in pregnancy were permissible at the state level so long as they did not rise to the level of becoming an *undue burden* to care, though that definition was not specifically clarified and would be tested in several cases in the decades between *Casey* and *Dobbs.* States were free to limit abortions beyond the point of viability entirely, a timepoint which itself is unclear and has shifted due to improvements in medical care for very early premature births.[15] Many laws states began to pass laws, referred to collectively as targeted restrictions on abortion providers (TRAP) laws, which had arguably little or nothing to do with abortion care or safety, such as doorway width requirements, waiting periods, requirement of ultrasounds or incorrect scientific information to be shared with the patient, notification laws, and more.[16]

At the federal level, new restrictions enacted after *Roe* related to abortion have impacted access for patients both within the United States and globally. Congress passed the Hyde Amendment in 1976, which restricts the use of federal funds for abortion care unless deemed medically necessary.[17] Although state-level Medicaid funds can be used for abortions if the state allows, this federal prohibition is estimated to result in the denial of care for 7.9 million low-income Americans, causing disproportionate restriction in access to people of color.[11(p251)] The Mexico City Policy, also known as the Global Gag Rule, was first announced in 1984 under Reagan, and is a partisan measure under Republican administrations which blocks US aid and use of funds for healthcare if recipient organizations abroad spend money from *any* source on abortion promotion or care.[18] It has already been reimplemented under the second Trump administration.[19]

A series of events surrounding the Supreme Court led to the *Dobbs* decision which warrant discussion here due to their relevance in the history of abortion law, and more generally, elections and political power in the United States. First, the *Citizens United v. FEC* (2010) case held that any limitation of political contributions by corporations, labor unions, or other collective entities violates the First Amendment.[20] The *Burwell v. Hobby Lobby Stores, Inc.*

(2014) case then held that closely held corporate religious employers, now viewed as covered by the First Amendment under *Citizens,* could not be required to provide contraceptive coverage in violation of their religious freedom under the 1993 Religious Freedom Restoration Act.[21]

The composition of the Supreme Court itself played a significant role in the *Dobbs* decision as well. Justice Antonin Scalia, known for his conservatism, died in February 2016. At the time, Senate Majority Leader Mitch McConnell refused to hold confirmation hearings for Merrick Garland, President Obama's nominee. McConnell claimed that the rightful appointer should be the *next* president, even though the election was not to be held for nine months and the next president would not be inaugurated for almost a full year.[22] McConnell successfully blocked the nomination. Neil Gorsuch was nominated by Trump and confirmed by the Senate in 2017.[23] Brett Kavanaugh was confirmed in 2018 for the seat vacated by Anthony Kennedy's retirement. Those two confirmations did not alter the distribution of the court given that each time, one conservative justice was replaced by another. However, the death of Ruth Bader Ginsburg in 2020, only six weeks before that year's presidential election, resulted in a dramatic change in the court. She had chosen not to retire earlier because she believed the pendulum had swung, "about as conservative as it would get".[11(p67)] Rather than yield the nomination to the next president this time, though, McConnell immediately held confirmation hearings and Amy Comey Barrett was sworn in less than a week before the election, fully shifting the majority of the court.[24]

In anticipation of changes to composition of the court and in the hope that *Roe* would eventually be overturned, several states began to pass trigger ban legislation.[25] Creative lawyering in Texas removed the state as the enforcement mechanism for a six-week abortion limit in SB8, which specified a $10,000 reward if an individual citizen won a lawsuit against anyone accused of helping someone have abortion; essentially creating a way for people to become abortion bounty hunters.[26]

Though there were a few cases with laws challenging *Roe* working their way through the federal court system in the wake of the court composition changes, the first one to make it was *Dobbs*. The opinion was first leaked, then released on June 24, 2022.[27] Justice Samuel Alito wrote, “The Constitution makes no reference to abortion, and no such right is implicitly protected by any constitutional provision, including the one on which the defenders of *Roe* and *Casey* now chiefly rely—the Due Process Clause of the Fourteenth Amendment.”[27] Trigger bans in some states went into effect immediately, others were subject to implementation requirements, while other states moved to enact new restrictions in the wake of the decision.[28] Many of those bans or restrictions have been challenged through the legal system, while others have been enjoined in the interim, or reversed then reinstituted by different levels of courts.[29] Some states have had legislative bans reversed by ballot measures.[30] As of this writing, the status of state law is still very much in flux, leading to instability and uncertainty for providers and patients dependent on which state they are located in at any given time.

The present research resides under this umbrella of instability and uncertainty in the United States, with the goal of assessing how changes in travel, infant mortality, and the distribution of physicians may be associated with changes in legal abortion access.

Gaps in the Knowledge and Importance of this Study

Given the novelty presented by the *Dobbs* decision and the unprecedented removal of a federal right protected by the US Constitution, there are substantial gaps in the knowledge about how these changes may influence health behaviors, health outcomes and structural predictors of healthcare access in the United States.

It is important to study outcomes related to abortion access because of its role as a crucial element of healthcare in the lives of people, because of its ability to impact economic trajectories and educational paths, because of the influence it has on existing children's lives, because of the connection with mental health and food stability, because of the need for autonomy in our healthcare decisions, because restrictions of access are likely to result in differential impact by income, race, and ethnicity, and because a disruption of this magnitude has the potential to changes people's lives substantially.[31] It has been previously established that maternal mortality dropped after *Roe*, particularly among Black women.[32] Research on the impacts of TRAP laws and other restrictions on abortion has shown an increased risk of cardiovascular outcomes for the pregnant individuals and is associated with increasing racial disparities for low birth weight and prematurity.[33] State-level abortion access restrictions pre-*Dobbs* have also been found associated with maternal mortality rates.[34]

In this work, I have chosen to study three specific outcomes. First, I have elected to study how travel behavior for people in other states into Colorado for abortion has changed after changes to legal access in other jurisdictions. Second, I have chosen to analyze the extent to which state-level infant mortality has been associated with abortion laws historically, and how infant mortality may have changed after bans and other gestational restrictions were implemented. Finally, as a predictor of healthcare access, I have elected to study the physician supply at the state level and its association with abortion laws.

Purpose of this Study and Research Questions

Association of Abortion Laws and Travel into Colorado for Abortion

It has been documented that people seeking abortions have been traveling to Colorado since 1967, six years before *Roe.*[35] Colorado was the first state to legalize abortion up to sixteen weeks, limited at the time to cases of rape, incest, fetal abnormality, or to protect the life of the pregnant individual; abortions could only be provided after a three physician review and with the consent of the patient's husband as applicable.[36] This bill reversed all prior Colorado laws outlawing abortion, and resulted in patients traveling into the state for provision of services, amounting to approximately one quarter of reported abortions in the first year.[35] More recently, Colorado has become one of the most liberal states regarding access to abortion with no gestational limits.[37] The consequence of open access means that patients requiring abortions beyond the limits of their states, whether under *Roe's* viability timepoint or later under a ban, had a place to receive care – if they could get here.

As abortion access has been limited in surrounding states, I hypothesized that we would find a significant increase in travel into the state of Colorado for abortions, beyond the overall baseline established by the history of travel as described above. Colorado has been collecting abortion data since the 1960s, some of which is available publicly, some of which is available upon request, and some of which is not available to protect privacy of patients and for safety concerns related to the location of providers.[38] This resource provides a way to study how abortion utilization has changed over time in datasets that include residence state as part of the collected metrics.

It is important to study travel for abortion because it can help us to understand how restrictions in other states are altering health behaviors and can establish that abortions are still being done at the same levels, or perhaps even at higher numbers, regardless of whether the location of the abortion and providers may have changed.[39] It is also important to understand that travel for abortion is limited by the constraints of reality – having the financial resources to pay for the abortion, having additional funds to cover travel including hotel costs and food, being able to take time off work, having childcare available for other children, being physically well enough to travel, not being afraid of stigma or shame or potential prosecution for abortion upon return to your home state.[40] In order for people to be able to access abortion out of state, all of those listed elements must be securely in place, and the layers of need required to travel out of state imply heavily that those without the ability to travel are most likely to be marginalized in other ways.[41] This reality may serve to only perpetuate the marginalization of communities even further.[42]

Specific to this study, it is also important to study travel for abortion given the potential impacts of increased demand on patients and providers within the state to which people are traveling for abortions. Little is known about how the changes in the number of patients visiting from out of state might burden or perhaps even overwhelm the system of care in a state such as Colorado, and what effects that increased demand may have on state residents, both patients and providers alike.

Association of Abortion Laws and Infant Mortality

Infant mortality is generally accepted to be a robust indicator of the overall health of a society[43], one that may be associated with abortion laws through several different mechanisms. How babies fare in their first year of life can tell us a lot about how underlying structures in a society are functioning. As we long ago experienced our epidemiologic shift in the US,[44] infant mortality experienced overall declines over that period. Those declines have been helped along by simultaneous public health interventions like clean water supplies, immunization against infectious diseases of childhood, and food assistance.[45] Overall, aggregated infant mortality trends in the past century have tended to tell this story as well. In 2000, 7.4/1000 infants died before their first birthday: dropping to 6.2 in 2010, and 5.2 in 2020. The decline was reassuring, and an indicator of improving population health. In 2021, though, we began seeing increases in infant mortality, and it is up to 5.6/1000 in 2021 and 2022.[46] Researchers have estimated that in the months after *Roe* was reversed, a 7% absolute increase in infant mortality developed in association with changes in abortion access.[47] Any increase in aggregate infant mortality demands further exploration to determine what the drivers may be, and whether there is any evidence of differential harm when analyzing disaggregated data.

Infant mortality may be associated with abortion access through multiple mechanisms. Abortion access laws are shaped by politics and can be indicative of overall societal priorities that have downstream impacts. Restrictions may have the effect of compelling higher risk pregnancies, under-resourced pregnancies, pregnancies in fetuses and pregnant people who are not as healthy as they ideally would be, which may increase the risk of complications, preterm delivery and increase stress.[48] In many states with bans or restrictions, there are no exceptions for fetal abnormalities.[48] Additionally, anatomy scans are not generally done until 20 weeks, past the cutoffs in many states.[49] Finally, exceptions for the health of the pregnant person can be burdensome and difficult to meet the legal threshold, difficult for practitioners to maneuver, and may not be as available as they appear.[50]

For the purposes of this dissertation, there are three main hypotheses related to the association between infant mortality and abortion laws. The first is that there are pre-existing differences in state-level infant mortality when grouping states based on the level of restrictiveness or protectiveness in their abortion laws before the fall of *Roe* or other substantial changes in legal access, done by analyzing combined data for 2018 & 2019 to provide a more stable estimate for the period before legal changes went into effect. The second is that those differences will persist in the period after the changes in abortion access have occurred, assessed using preliminary 2023 data. Finally, I hypothesize that the gaps between states grouped by exposure may increase in degree over time, essentially meaning that the disparities seen between protective and restrictive states will widen in association with these changes in state and federal law. Given the importance of exploring data to determine if there is evidence of differential impact, analysis includes aggregated data and data disaggregated by race and ethnicity. Additionally, specific groups of causes of death which may be particularly associated with abortion are explored.

Association of Abortion Laws and Physician Supply

Access to care is an essential element of healthcare[51], and it has been well established that access is not uniform across the United States, in particular regarding access to maternity care. It is estimated that 36% of all counties in the US were classified as maternity deserts in

2022 by the March of Dimes, and that these maternity care desert areas have higher rates of asthma, hypertension and smoking with lower median incomes and higher utilization of Medicaid.[52]

Physicians may choose not to practice in states that restrict their scope of care or limit what they are able to tell patients which may run contrary to ethical imperatives.[53] Some states enacting bans use enforcement mechanisms designed to eliminate abortions towards the physicians, including threats of licensure removal, jail time, and fines.[54] Given the existing landscape of maternity care, it is reasonable to believe that physicians, particularly obstetricians and gynecologists (OBGYNs), may elect to move away from abortion restrictive states, and furthermore to hypothesize that if this begins to occur, access to care issues in these states may worsen as a result.[55] Such potential downstream impacts have been covered amply in the media, but it is unknown whether these changes have begun to actually occur at the population level.[56,57] It is hypothesized that states with abortion restrictions will have lower physician supply for OBGYNs, and that the gap between restrictive and protective states may begin to increase over time.

Study Data Sources and Overview of Methods

For the purposes of this research, abortion laws were assessed at the end of the year in 2022, allowing six months for existing trigger bans to take effect after the decision or for new restrictions to be enacted, while also ensuring that outcome data occurred temporally after the point in time at which legal access was evaluated. Assessment of state laws relied heavily on a few sources including The Guttmacher Institute and Law Atlas.[37,58] Ultimately, this was a very labor-intensive section of the work due to the need to investigate whether new laws were being enforced, or whether they had been enjoined awaiting legal challenges or were subject to change after ballot measures. This challenge often required me to obtain and read lengthy court opinions in addition to legislative text. The exposure variable was primarily coded as a binary variable, with the delineation based on the common interpretation of viability under *Roe*, 24 weeks. States that moved to enact gestational limits or a ban at any point prior to 24 weeks were deemed *restrictive*, while states that either had no gestational limits or only enacted limits at or beyond 24 weeks were deemed *protective.* In some states, such as Wyoming for example, a legislative ban on abortion was not being enforced due to legal challenges in court at the time point when laws were assessed and were thus categorized as unexposed or *protective.* Some segments of the analysis utilize an exposure which was coded categorically rather than as a binary variable. This was done to determine if the degree of restrictiveness in state laws was associated with the changes seen in health outcomes. In those cases, the *protective* category remained as described above and was coded as the reference category. *Moderately Restrictive states* were categorized based on laws restricting access from after 12 weeks through 23 weeks. *Most Restrictive states* were categorized here as any state with a full ban or access limitations at any point before or until 12 weeks' gestation.

Outcome data was obtained from different sources for each section of the analysis. Travel data was acquired upon request from the Colorado Department of Public Health and Environment (CDPHE) Vital Statistics division.[38] Infant mortality data was publicly available and downloaded from CDC Wide-ranging ONline Data for Epidemiologic Research (CDC Wonder).[46] Physician supply data was sourced from the American Association of Medical Colleges

(AAMC)[59], which collects annual American Medical Association (AMA) survey data and makes some of it available publicly. When appropriate, covariates were included in adjusted models.

Data for each section was first explored with descriptive statistics and visualizations before being analyzed in statistical models chosen to best match the available data and research questions for each chapter. Selected methods for Chapters 2 & 3 feature model types that were designed to analyze how changes in policy may be associated with outcomes over time. Natural experiment methods in particular are well suited to study sudden shifts in policy or law.

Limitations

This study has potential limitations which will be described in four sections: first, as they relate to the study design; second, as they relate to the methodology in how the exposure is modeled; third, as there may be residual confounding present in included variables or uncontrolled confounding from absent variables; and finally, as they relate to the data.

First, all of the selected study designs are inherently ecological in nature given the use of aggregated state-level data. It would be inappropriate, therefore, to extrapolate these findings to individuals. Regression methods chosen may result in small changes to effect estimates, and when possible, sensitivity analyses have incorporated alternative choices to account for those potential differences. Generalized estimating equations are ideally suited to large data sets, and we are limited here by the number of jurisdictions in the United States, fifty states plus DC, as well as by the availability of data. Given that infant mortality is a rare outcome and due to the data suppression rules utilized by CDC Wonder, there is a higher degree of missingness in the data than would be ideal, especially among disaggregated groups.

Second, it must be stated that the constantly changing nature of state abortion laws is a limitation here, as is the decision regarding how to assess the laws. To construct the exposure variables for the analysis, it was necessary to select a timepoint at which to assess the laws. The end of the year 2022 was selected with intention as it allowed states six months after the *Dobbs* decision to allow trigger bans to take effect, or to enact new restrictions. This time selection also occurs prior to the observation of all mortality and physician supply outcome data in the post-*Dobbs* period. To be certain, laws have continued to change beyond that date, and the later changes in laws may be influential with regard to the outcome data modeled here. Additionally, the choice here to include only gestational restrictions in the determination of the level of state access may be a limitation, as it does not take other mechanisms to restrict access such as TRAP laws or denial of state Medicaid coverage for abortions.

Third, it is possible that confounding is at least partially explanatory for the associations found in this study. With regard to included variables, it is possible that there may be some potential for residual confounding if the variables are not accurately measured or do not adequately capture the data. It is also possible that there are other potentially explanatory variables that have been missed and are not included in the analysis.

Finally, there are limitations with the data which necessitate specific mention here. Some of the outcome data used in this study is considered preliminary. CDPHE abortion data is not expected to change much before becoming finalized, but there are likely to be changes made to infant mortality data before it finalizes. Given the public health importance of this work, it is worth doing the analysis knowing the preliminary nature of the data is a limitation. Additionally, it is known that abortion data in Colorado is underreported and represents an undercounting. It is possible that there is a degree of misclassification in the infant mortality data as well, as it related to the selection of race and ethnicity categories and in cause-specific data.

Conclusion

To address the above discussed gaps in the knowledge, this dissertation is structured to answer some of these unknowns. Chapter 2 utilized Colorado abortion data to focus on how travel behavior from individuals out-of-state has changed in association with changes in legal access in other states. Chapter 3 discusses how infant mortality is associated with abortion restrictions nationwide and begins to address the question of whether there is evidence of shifts in the overall trends in infant mortality in association with abortion law. Chapter 4 explores the association of the supply of OBGYNs, psychiatrists and family medicine physicians with eventual abortion laws at the state-level. Finally, Chapter 5 concludes with a summary of all the included research and suggests future directions in this area.

References

1. Abortion Definition & Meaning - Merriam-Webster. Accessed December 31, 2024. https://www.merriam-webster.com/dictionary/abortion

2. Donley G, Lens JW. The Harm of Overturning Roe Will Extend Beyond Abortion Patients. TIME. June 24, 2022. Accessed December 31, 2024. https://time.com/6190782/roe-overturned-pregnancy-complications-miscarriage/

3. Emergency doctors grapple with abortion bans. AAMC. Accessed December 15, 2024. https://www.aamc.org/news/emergency-doctors-grapple-abortion-bans

4. Dickinson JE. Confusion, inequity and inconsistency: Abortion in Australia. *Aust N Z J Obstet Gynaecol*. 2015;55(2):103-104. doi:10.1111/ajo.12332

5. Chisholm S. *Unbought and Unbossed*. 1st ed. HarperCollins Publishers; 2022.

6. Starr P. *The Social Transformation of American Medicine: The Rise of a Sovereign Profession & the Making of a Vast Industry: With a New Epilogue by the Author*. Updated edition. Basic Books; 2017.

7. DeJoy SB. A Public Health Ethics Analysis of the Criminalization of Direct Entry Midwifery. *J Midwifery Womens Health*. 2020;65(6):789-794. doi:10.1111/jmwh.13144

8. HALLETT C. The Attempt to Understand Puerperal Fever in the Eighteenth and Early Nineteenth Centuries: The Influence of Inflammation Theory. *Med Hist*. 2005;49(1):1-28.

9. The Criminalization of Abortion Began as a Business Tactic. HISTORY. May 15, 2019. Accessed December 31, 2024. https://www.history.com/news/the-criminalization-of-abortion-began-as-a-business-tactic

10. Thompson LM. Abortion, Contraception, and the Comstock Law's Original Medical Exemption, 1873–1936. *J Gilded Age Progress Era*. 2024;23(4):444-451. doi:10.1017/S153778142400032X

11. Dias E, Lerer L. *The Fall of Roe: The Rise of a New America*. First edition. Flatiron Books; 2024.

12. Donovan RBG Megan K. Lessons from before Abortion Was Legal. Scientific American. September 1, 2017. Accessed July 13, 2024. https://www.scientificamerican.com/article/lessons-from-before-abortion-was-legal/

13. Inside the Decades-Long Conservative Strategy to Weaken Roe v. Wade ‹ Literary Hub. Accessed January 2, 2025. https://lithub.com/inside-the-decades-long-conservative-strategy-to-weaken-roe-v-wade/

14. Planned Parenthood of Southeastern Pa. v. Casey, 505 U.S. 833 (1992). Justia Law. Accessed January 2, 2025. https://supreme.justia.com/cases/federal/us/505/833/

15. Understanding and Navigating Viability. Accessed January 2, 2025. https://www.acog.org/advocacy/facts-are-important/understanding-and-navigating-viability

16. What are TRAP Laws? Accessed January 2, 2025. https://www.plannedparenthoodaction.org/issues/abortion/types-attacks/trap-laws

17. Salganicoff A, Sobel L, Gomez I, Published AR. The Hyde Amendment and Coverage for Abortion Services Under Medicaid in the Post-Roe Era. KFF. March 14, 2024. Accessed December 27, 2024. https://www.kff.org/womens-health-policy/issue-brief/the-hyde-amendment-and-coverage-for-abortion-services-under-medicaid-in-the-post-roe-era/

18. Moss K, Published JK. The Mexico City Policy: An Explainer. KFF. October 25, 2024. Accessed December 27, 2024. https://www.kff.org/global-health-policy/issue-brief/the-mexico-city-policy-an-explainer/

19. Memorandum for the Secretary of State, the Secretary of Defense, the Secretary of Health and Human Services, the Administrator of the United States for International Development. The White House. January 25, 2025. Accessed February 6, 2025. https://www.whitehouse.gov/presidential-actions/2025/01/memorandum-for-the-secretary-of-state-the-secretary-of-defense-the-secretary-of-health-and-human-services-the-administrator-of-the-united-states-for-international-development/

20. Citizens United v. FEC, 558 U.S. 310 (2010). Justia Law. Accessed January 2, 2025. https://supreme.justia.com/cases/federal/us/558/310/

21. Burwell v. Hobby Lobby Stores, Inc., 573 U.S. 682 (2014). Justia Law. Accessed January 2, 2025. https://supreme.justia.com/cases/federal/us/573/682/

22. Kelly A. McConnell: Blocking Supreme Court Nomination “About A Principle, Not A Person.” *NPR*. https://www.npr.org/2016/03/16/470664561/mcconnell-blocking-supreme-court-nomination-about-a-principle-not-a-person. March 16, 2016. Accessed January 2, 2025.

23. 5 things we learned from the fight over Neil Gorsuch’s Supreme Court confirmation. PBS News. April 7, 2017. Accessed January 2, 2025. https://www.pbs.org/newshour/politics/5-things-learned-fight-neil-gorsuchs-supreme-court-confirmation

24. Amy Coney Barrett is confirmed to the Supreme Court, marking new era. NBC News. October 27, 2020. Accessed January 2, 2025. https://www.nbcnews.com/politics/congress/amy-coney-barrett-set-be-confirmed-supreme-court-monday-n1244748

25. Journal ABA. What are abortion trigger laws, and where do they stand? ABA Journal. Accessed January 2, 2025. https://www.abajournal.com/web/article/what-are-abortion-trigger-laws-and-where-do-they-stand

26. Arey W, Lerma K, Beasley A, Harper L, Moayedi G, White K. A Preview of the Dangerous Future of Abortion Bans — Texas Senate Bill 8. *N Engl J Med*. 2022;387(5):388-390. doi:10.1056/NEJMp2207423

27. Dobbs v. Jackson Women's Health Organization :: 597 U.S. ___ (2022) :: Justia US Supreme Court Center. Accessed December 5, 2023. https://supreme.justia.com/cases/federal/us/597/19-1392/

28. Kaufman R, Brown R, Martínez Coral C, Jacob J, Onyango M, Thomasen K. Global impacts of Dobbs v. Jackson Women's Health Organization and abortion regression in the United States. *Sex Reprod Health Matters*. 30(1):2135574. doi:10.1080/26410397.2022.2135574

29. State Policy Trends 2022: In a Devastating Year, US Supreme Court's Decision to Overturn Roe Leads to Bans, Confusion and Chaos | Guttmacher Institute. December 14, 2022. Accessed October 13, 2024. https://www.guttmacher.org/2022/12/state-policy-trends-2022-devastating-year-us-supreme-courts-decision-overturn-roe-leads

30. 2024 abortion-related ballot measures and state context. Ballotpedia. Accessed October 17, 2024. https://ballotpedia.org/2024_abortion-related_ballot_measures_and_state_context

31. Access to abortion and women's health: What the research shows. American Medical Association. July 5, 2022. Accessed January 2, 2025. https://www.ama-assn.org/delivering-care/population-care/access-abortion-and-women-s-health-what-research-shows

32. Farin SM, Hoehn-Velasco L, Pesko M. The Impact of Legal Abortion on Maternal Mortality. Published online September 1, 2021. doi:10.2139/ssrn.3913899

33. Gardner G. The maternal and infant health consequences of restricted access to abortion in the United States. *J Health Econ*. 2024;98:102938. doi:10.1016/j.jhealeco.2024.102938

34. Addante AN, Eisenberg DL, Valentine MC, Leonard J, Maddox KEJ, Hoofnagle MH. The association between state-level abortion restrictions and maternal mortality in the United States, 1995-2017. *Contraception*. 2021;104(5):496-501. doi:10.1016/j.contraception.2021.03.018

35. Colorado's Trailblazing Abortion Law Marks 50 Years. Colorado Public Radio. April 25, 2017. Accessed January 2, 2025. https://www.cpr.org/2017/04/25/colorados-trailblazing-abortion-law-marks-50-years/

36. marianne.goodland@coloradopolitics.com MG. A short history of Colorado's abortion activism from 1891 to present. Colorado Politics. May 4, 2022. Accessed January 2, 2025. https://www.coloradopolitics.com/legislature/a-short-history-of-colorados-abortion-activism-from-1891-to-present/article_310e514e-cb08-11ec-8ee7-8316682f42d6.html

37. Institute G. Interactive Map: US Abortion Policies and Access After Roe. Accessed November 30, 2023. https://states.guttmacher.org/policies/

38. Vital Statistics Program | Colorado Department of Public Health and Environment. Accessed December 8, 2024. https://cdphe.colorado.gov/center-for-health-and-environmental-data/registries-and-vital-statistics/vital-statistics-program

39. 10 Things to Know About Abortion Access Since the Dobbs Decision | KFF. Accessed January 2, 2025. https://www.kff.org/policy-watch/10-things-to-know-about-abortion-access-since-the-dobbs-decision/

40. News LMH KFF Health. More ‘navigators’ are helping women travel to have abortions. The 19th. February 12, 2024. Accessed January 2, 2025. https://19thnews.org/2024/02/abortion-access-navigators-travel/

41. Biggs MA, Kaller S, Ralph L. Barriers accessing abortion care and their association with psychological well-being. *Contraception*. 2020;101(5):355. doi:10.1016/j.contraception.2020.03.010

42. ACCESS TO HEALTHCARE AND DISPARITIES IN ACCESS. In: *2021 National Healthcare Quality and Disparities Report [Internet]*. Agency for Healthcare Research and Quality (US); 2021. Accessed January 2, 2025. https://www.ncbi.nlm.nih.gov/books/NBK578537/

43. Reidpath DD. Infant mortality rate as an indicator of population health. *J Epidemiol Community Health*. 2003;57(5):344-346. doi:10.1136/jech.57.5.344

44. Omran AR. A century of epidemiologic transition in the United States. *Prev Med*. 1977;6(1):30-51. doi:10.1016/0091-7435(77)90003-2

45. Schell CO, Reilly M, Rosling H, Peterson S, Mia Ekström A. Socioeconomic determinants of infant mortality: A worldwide study of 152 low-, middle-, and high-income countries. *Scand J Public Health*. 2007;35(3):288-297. doi:10.1080/14034940600979171

46. Multiple Cause of Death Data on CDC WONDER. Accessed November 6, 2024. https://wonder.cdc.gov/mcd.html

47. Infant Mortality Increases Across US Following Dobbs Decision. AJMC. October 25, 2024. Accessed November 25, 2024. https://www.ajmc.com/view/infant-mortality-increases-across-us-following-dobbs-decision

48. CDC. Infant Mortality. Maternal Infant Health. September 16, 2024. Accessed November 1, 2024. https://www.cdc.gov/maternal-infant-health/infant-mortality/index.html

49. Jabaz D, Jenkins SM. Sonography 2nd Trimester Assessment, Protocols, and Interpretation. In: *StatPearls*. StatPearls Publishing; 2024. Accessed October 17, 2024. http://www.ncbi.nlm.nih.gov/books/NBK570574/

50. Harris LH. Navigating Loss of Abortion Services — A Large Academic Medical Center Prepares for the Overturn of Roe v. Wade. *N Engl J Med*. 2022;386(22):2061-2064. doi:10.1056/NEJMp2206246

51. Basu S, Berkowitz SA, Phillips RL, Bitton A, Landon BE, Phillips RS. Association of Primary Care Physician Supply With Population Mortality in the United States, 2005-2015. *JAMA Intern Med*. 2019;179(4):506-514. doi:10.1001/jamainternmed.2018.7624

52. Where You Live Matters: Maternity Care Deserts and the Crisis of Access and Equity. Accessed January 2, 2025. https://www.marchofdimes.org/maternity-care-deserts-report-2023

53. Bernstein SA, Levy MS, McNeilly S, et al. Practice Location Preferences in Response to State Abortion Restrictions Among Physicians and Trainees on Social Media. *J Gen Intern Med*. 2023;38(10):2419-2423. doi:10.1007/s11606-023-08096-5

54. Frederiksen B, Ranji U, Gomez I, Published AS. A National Survey of OBGYNs' Experiences After Dobbs. KFF. June 21, 2023. Accessed July 13, 2024. https://www.kff.org/womens-health-policy/report/a-national-survey-of-obgyns-experiences-after-dobbs/

55. Sabbath EL, McKetchnie SM, Arora KS, Buchbinder M. US Obstetrician-Gynecologists' Perceived Impacts of Post–Dobbs v Jackson State Abortion Bans. *JAMA Netw Open*. 2024;7(1):e2352109. doi:10.1001/jamanetworkopen.2023.52109

56. News ABC. Doctors face tough decision to leave states with abortion bans. ABC News. Accessed December 12, 2024. https://abcnews.go.com/US/doctors-face-tough-decision-leave-states-abortion-bans/story?id=100167986

57. Why some doctors stay in US states with restrictive abortion laws and others leave | AP News. Accessed December 12, 2024. https://apnews.com/article/dobbs-anniversary-roe-v-wade-abortion-obgyn-699263284cced4bd421bc83207678816

58. Post-Dobbs State Abortion Restrictions and Protections. LawAtlas. Accessed November 15, 2024. https://lawatlas.org/datasets/post-dobbs-state-abortion-restrictions-and-protections

59. U.S. Physician Workforce Data Dashboard. AAMC. Accessed December 15, 2024. https://www.aamc.org/data-reports/report/us-physician-workforce-data-dashboard

CHAPTER 2: Association of Reproductive Access Restrictions and Out-of-State Abortion Care in Colorado, an Interrupted Time Series Analysis for 2018-2024

Introduction

Abortion access is a necessary element of healthcare, the lack of which has been deemed a public health and human rights issue by the World Health Organization.[1] Since 1973, abortion access in the United States has been shaped by the Supreme Court opinion in *Roe v. Wade (Roe)*, which recognized a Constitutional right to abortion under the 14th Amendment's privacy clause. [2] In recent years, some states passed legislation in conflict with *Roe*.[3] Texas passed State Bill 8 (SB8) in September 2021, which banned access to abortion once cardiac electrical activity could be detected,[4] around 6 weeks after the date of the last menstrual period. The average pregnancy is detected at 5.5 weeks.[5] Given the narrow window of time to elect to pursue an abortion and the short-term reality of pregnancy, the reverberations of the law were felt immediately. This law was being enforced in Texas even as it conflicted with the viability protections of *Roe* due to enforcement mechanisms relying on private citizens, not the state.[6] In 2022, the *Dobbs v. Jackson Women's Health* case overturned *Roe*, eliminating the federally protected right to abortion and relegating decisions about access to the states.[7] Many states had trigger bans in effect at the time *Roe* was overturned; others moved quickly to enact restrictions in its wake.

Changes in state laws are frequent, with some states expanding access while others are increasing restrictions. In some states, court challenges may be accompanied by pauses in the enforcement of the law pending review. In other states, voters have enshrined rights under state Constitutions that may override any legislative action. [8] As access has become increasingly limited in states with restrictions, we hypothesize that the number of patients seeking abortions who travel from states with bans or early gestational restrictions to states where abortion is legally protected would increase. It is unknown to what degree changes in travel for abortions are in fact associated with those restrictions. One study found increased travel distance for abortions after *Dobbs*[9], while another estimated abortion changes using data in the immediate period after *Dobbs*.[10] This study investigated the temporal association of changes in federal and state law with changes in the actual number of patients travelling to Colorado, a state without gestational limitations, for abortions.

Methods

Study Population and Design

We utilized an interrupted time series analysis to assess the association of changes in federal and state law with travel by out-of-state residents into Colorado for abortions. Interrupted time series methods are quasi-experimental regression discontinuity designs that use repeated observations over specified time intervals to determine a baseline time trend and estimate changes in trend which may be attributable to policy changes or other interventions or treatments applied at the population level. [11,12] These methods have been utilized in the past to evaluate policy changes[13] and legislation.[14] Based on the high number of terminations by Texas residents apparent in later years of the data set, the enforcement of a restrictive abortion access law prior to the *Dobbs* decision, and exploratory analysis of the data visually (Appendix B, Supplemental Figure B1), that state was selected for a sub-analysis in the present study.

Exposure

The exposure of interest is a binary indicator set at the month legal access to abortion shifted, which varies depending on the level of analysis. No temporal lag was included in the models given the immediate impacts of the law changes and the short-term nature of termination decisions within the time-limited scope of pregnancy in general. For the Post-*Dobbs* analysis, June 2022 was selected as the interruption point. In the Texas-specific analysis, September 2021 was selected as the interruption point. Although this law was stricter than what would have been permissible under the prevailing viability rule of *Roe* at the time, it was nevertheless being enforced statewide, prompting our selection of this earlier timepoint for this subset of the data.

Outcome

Aggregated abortion data was obtained from the Colorado Department of Health and Environment (CDPHE) included annual counts from 1967-2023, and monthly count data for reported clinic and office based abortions – including both procedural and medication abortions. Monthly data included the number of patients receiving an abortion by state of patient residence from January 2018-December 2023. Additional preliminary data for the first six months of 2024 includes only a categorization of in-state resident or out-of-state resident. 2023-24 data is preliminary but not expected to change. In all outcome data sets, any month with fewer than 3 abortions for residents of a given state was unavailable. The outcome of interest is the monthly count of abortions. There is a small percentage of abortions for which residence data was unavailable.

Statistical Analysis

The basic form of the time series model used for all groupings of data in this study is a Quasi-Poisson model for over dispersed count data with linear predictor:

$$\log(E[Y(t)])=\beta_0 + \beta_1 X(t) + \beta_2 t + \beta_c \cos(2\pi\omega t) + \beta_s \sin(2\pi\omega t).$$

In this model, Y is the number of abortions at time point t and X(t) is a binary indicator variable for time t being after the law change, where X=0 represents the time before the change and X=1 represents time after. The parameter β_0 represents the intercept term and β_1 represents the log rate ratio of abortions before and after the laws governing access were changed. $\beta_2 t$ represents time and its coefficient, modeled as a linear term. $\beta_c \cos(2\pi\omega t)$ and $\beta_s \sin(2\pi\omega t)$ taken together represent the harmonic terms used to account for any seasonal patterns present in the data, where ω represents the frequency of the periodic component and is fixed here as 1/12.[15]

The primary model for the post-*Dobbs* analysis includes all non-Colorado residents using the interruption point of June 2022. Given the high number of abortions provided to Texas residents in the data, a second post-*Dobbs* model based on the same interruption point was built excluding Texas residents, as it is assumed that the trends for Texas residents will likely be more associated with the changes in Texas law pre-dating the *Dobbs* decision, rather than

Dobbs itself. As a comparison analysis for the post-*Dobbs* model, we also constructed models for Colorado residents.

To determine the impacts of travel for abortions most influenced by distance, a proximal state analysis was also designed. Proximal states are defined as those adjacent to Colorado or adjacent to a state that shares a border with Colorado and which had greater than 50 abortions administered to their residents in Colorado in 2022. We further delineated these states into categories deemed *protective* or *restrictive* based on state law. Protective states are defined as those with either no restrictions or which only limited abortion beyond 20 weeks; restrictive states are defined as those with limitations prior to 20 weeks. In this sub-analysis, protective proximal states include Kansas, New Mexico, and Wyoming. Restrictive proximal states include Louisiana, Nebraska, Oklahoma, South Dakota, Texas, and Utah. Categorical assignment of states as protective or restrictive was determined based on state laws as of the end of 2022. [16]

Models for the Texas-specific analysis use the date of SB8, September 2021, as the interruption point. Monthly data for this group was available until December 2023. Outlier data points before the change in law which appear in Appendix B, Supplemental Figure B1 represent March and April 2020, when abortion clinics in the state were closed by the state government citing Covid-19 risk. [17] Our main Texas model retains all time points, while a sensitivity model excludes the months impacted by Covid-19 closures. This analysis also includes a negative control model using Wyoming residents to assess the presence of any unmeasured confounding. Wyoming was selected due to proximity to Colorado, having the second highest number of state residents coming to Colorado historically, abortion access there had not changed significantly in this period due to a legislative ban being deemed unenforceable until judicial review could be completed, and we would not expect them to be influenced by legal changes in Texas.

Additional sensitivity analyses for both *Dobbs* and Texas-specific models include analyses of data in nested time periods to monitor the changes over time, at 6 months, 12 months and the full time period after the respective interruption points. To visualize the changes over time and explore the relationships in the data, data was plotted using a natural spline term for time with degrees of freedom selected a priori. Post-*Dobbs* visualization includes a spline fit with five degrees of freedom for the full time period. Texas visualization includes a spline fit with five degrees of freedom for the time period after SB8, and a linear term prior to SB8. Comparison visualizations for both Colorado and Wyoming use 12 degrees of freedom, fit over the full period, to allow for more seasonal flexibility present in those groupings of data.

All analysis for this study was conducted in R version 4.3.1 and used the packages broom and tidyverse, preliminary data cleaning was performed in Microsoft Excel. This study was deemed exempt by the Colorado State University Institutional Review Board. We adhered to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guidelines.

Results

In 2018, there were a total of 8,973 reported abortions in Colorado, of which 7,902 were provided to in-state residents. Out-of-state residents represented 12% of the total in Colorado in 2018. By 2023, the total number of reported abortions had grown to 14,481, of which 10,165 were provided to in-state residents. Out-of-state residents represented 30% of the total for

2023. Less than 1% of data was missing information on state of residence. Preliminary exploration of the data clearly showed overall trend of increases in abortions in recent years as shown in Appendix B, Supplemental Figure B2. Figure 2.1 includes data visualizations for Texas residents and its comparison state, Wyoming. Data visualizations utilizing similar models for Colorado residents and all out of-state residents are available in Appendix B, Supplemental Figures B3-B4.

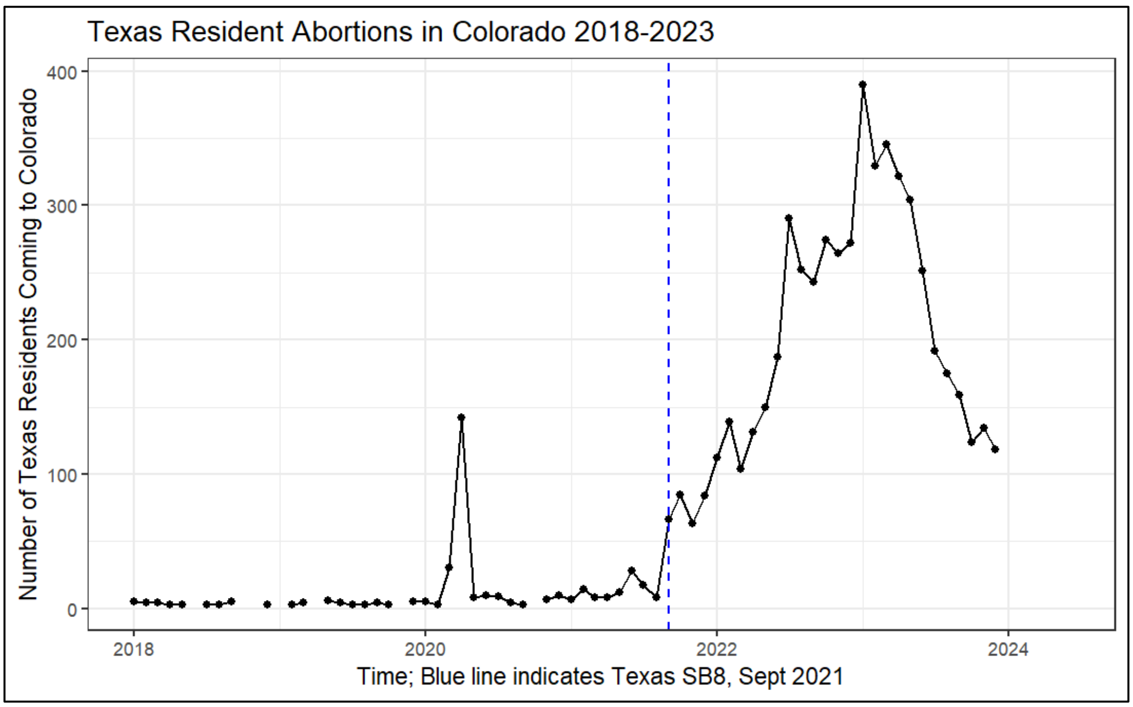


Figure 2.1: Crude monthly data for Texas resident abortions in Colorado.

The post-*Dobbs* analysis including Texas revealed that the number of abortions for out-of-state residents in Colorado was more than twice as high after the *Dobbs* decision when compared to the counts before *Dobbs.* Rate Ratio (RR): 2.14, 95% Confidence Interval (CI): 1.54, 2.99, $p<0.001$. Removing Texas residents from the analysis resulted in only a nonsignificant 16%

increase, indicating both that inclusion of Texas residents is influential, and that Texas appears to be a major driver of the results (RR: 1.16, 95% CI: 0.99, 1.34, p=0.067).

Proximal protective states had a statistically significant 24% reduction in abortions in Colorado after *Dobbs*. (RR: 0.76, 95% CI: 0.64, 0.92, p=0.005) Residents of proximal restrictive states, however, were found to have 2.67 times higher counts of abortion in Colorado post-*Dobbs* (95%CI: 1.81, 3.99, p<0.001).

Nested time models showed that through the first year post-*Dobbs*, there was a statistically significant increase in out-of-state residents seeking abortion in Colorado regardless of whether Texas residents were included or not. Proximal restrictive states were found to have statistically significant increases for all time periods, while proximal protective states showed slightly stronger decreases over time, with a negative association becoming significant over the full period. All model results for post-*Dobbs* analysis are shown in Table 2.1.

Table 2.1: Rate Ratios and 95% Confidence Intervals for Nested Time Models for the effect of change in federal law affective reproductive healthcare access for out-of-state residents travelling to Colorado for abortion services, 2018-2023. Time is modeled both as a linear term and as a harmonic term. Interruption point based on *Dobbs* federal law change (June 2022).

	All out-of-state residents including Texas	All out-of-state residents, excluding Texas	Proximal Protective States	Proximal Restrictive States
6 months after *Dobbs*	2.16 (1.72, 2.71), p<0.001	1.28 (1.08, 1.51), p=0.006	0.91 (0.74, 1.11), p=0.345	2.56 (1.83, 3.61), p<0.001
12 months after *Dobbs*	2.01 (1.66, 2.43), p<0.001	1.22 (1.07, 1.40), p=0.004	0.85 (0.72, 1.00), p=0.051	2.18 (1.61, 2.97), p<0.001
Full data	2.14 (1.54, 2.99), p<0.001	1.16 (0.99, 1.34), p=0.067	0.76 (0.64, 0.92), p=0.005	2.67 (1.81, 3.99), p<0.001

For comparison, Colorado residents had a decrease in abortions associated with the *Dobbs* decision at all time points in the nested analysis, with the overall estimate ranging between a 10-13% reduction. Colorado residents' results are shown in Table 2.2.

Table 2.2: Rate Ratios and Confidence Intervals for the effect of the change in federal law on reproductive healthcare access for Colorado residents, 2018-2023. Time is modeled as both a linear and a harmonic term. Interruption point based on *Dobbs* federal law change (June 2022).

	Rate Ratio & 95% Confidence Interval
6 months after *Dobbs*	0.87 (0.79, 0.96), p=0.008
12 months after *Dobbs*	0.90 (0.83, 0.97), p=0.007
Full data	0.88 (0.80, 0.96), p=0.011

Texas residents were over 7 times more likely to travel to Colorado for abortions after the enactment of SB8 as compared to before SB8, (RR: 7.86, 95% CI: 3.30, 20.09, p<0.001). In the sensitivity model dropping the months of Covid-19 closures before SB8, the association increased substantially to 13.12. (95% CI: 6.73, 27.14, p<0.001). When modeling nested time periods after the adoption of SB8, all options were statistically significant with strong effect estimates. As a negative control for the impact of Texas law, there was no statistically significant association found between Wyoming residents and Texas SB8. (RR 0.83, 95% CI: 0.66, 1.03, p=0.097). Results for Texas and Wyoming are shown in Table 2.3.

Table 2.3: Rate Ratios and Confidence Intervals for the effect of the change in state law on reproductive healthcare access for Texas and Wyoming residents, 2018-2023. Time is modeled with both a linear and a harmonic term. Interruption point based on Texas SB8 state law change (September 2021).

	Rate Ratio & 95% Confidence Interval
Texas residents	
6 months after SB8	7.27 (2.59, 22.35), p<0.001
12 months after SB8	5.25 (1.52, 21.00), p=0.016
Full data	7.86 (3.30, 20.09), p<0.001
Full data, excluding outliers (3/20 & 4/20)	13.12 (6.73, 27.14), p<0.001
Wyoming residents (negative control)	0.83 (0.66, 2.43), p=0.097

Across most models, we found a small statistically significant positive association with the linear term for time, indicating a long-term increase in the overall number of abortions over time. The only exceptions to this trend were within the negative control model built for Wyoming residents and the overall model for all out-of-state residents. Selected results for the influence of time are presented in Appendix B, Supplemental Table B1.

Discussion

We found evidence of increased travel behavior by out-of-state residents into Colorado for abortions associated with the *Dobbs* decision and determined that the main driver of that increase were Texas residents travelling to Colorado. Models including Texas residents resulted in much higher estimates than those excluding Texas residents. In the proximal analysis, we observed a significant positive association in restrictive states indicating increased travel into Colorado after *Dobbs* for abortions; there is a weak inverse statistically significant relationship in protective states for the full data. This indicates that residents of protective states that had traveled to Colorado in the past were less likely to do so in the year post-*Dobbs*, though the reasons for this decrease are unclear. We suspect it may be related to increased availability and protection of abortion access in their home states. [18] In association with the *Dobbs* decision, Colorado residents experienced a statistically significant decrease in abortions after *Dobbs*, which could be related to increased demand and lack of available appointments. [19] A more detailed analysis of changes to abortions for Colorado residents in association with Texas SB8 was conducted separately, available in Appendix A.

Texas residents were more than 7 times more likely to travel to Colorado for abortions after the pre-*Dobbs* passage of SB8. A notable downward trend for Texas residents is shown in Figure 1 at the tail end of the study period, with a similar trend seen for all out of state residents (Appendix B, Supplemental Figure B4).

Possible explanations include increased demand for permanent sterilization [20] or long-term birth control.[21] It is also possible that patients have become more likely to elect self-managed abortions, with terminations occurring outside of the medical system entirely. [22] Additionally, through the use of wide-ranging shield laws in some protective states, there has been an increase in telehealth providers meeting with patients in other states and mailing the medications across state lines, estimated at 7,000 prescriptions a month nationwide. [23]

These findings build on evidence that abortion restrictions are indeed altering patient behavior and increasing demand on providers in protective states such as Colorado. Barriers to care may have significant health and life impacts beyond the need to travel. In addition, there is fear that these laws may drive physicians from restrictive states, potentially worsening access in affected areas. [24]

There is early evidence of increased birth rates in affected states.[25] Consequences of being forced to continue unwanted pregnancies can include initial increases in mental distress [26], risks of pregnancy complications up to and including death [27], increased risk of experiencing poverty, and reduced employment trajectory.[28] Beyond the impact to the pregnant individual, other potential impacts include increases in utilization of the foster care system [29], increased risk of child poverty and negative developmental impacts on existing children.[30]

In spite of the later downward trend noted in data in the present study, it is important to note that the overall trends have not yet returned to baseline as of mid-2024 and may represent a permanent increase in demand within the state. Further study will help to better understand the long-term impacts. A report from the Society of Family Planning's *WeCount* series shows an overall increase nationwide in the number of abortions since *Dobbs*, but a dramatic shift in the distribution of states where those abortions are taking place.[31] This finding strengthens confidence in the conclusions found here for Colorado and indicates that other states have likely seen demand shifts due to legal changes post-*Dobbs.*[31,32]

Strengths and Limitations

Strengths of this study include the availability of monthly data in a state where abortion information is required to be reported. Although data for 2023-24 is preliminary, no significant changes are expected. We were able to model time to capture both long-term time trends and account for any seasonality present in the data.

Limitations include our exposure assessment of state laws for gestational restrictions or bans on the procedure itself, not for practice restrictions, waiting periods, or other laws impacting access. We lacked information on income in this dataset and available data regarding race and ethnicity had a high degree of missingness; as a result, we were unable to determine if there are differential impacts based on these factors. Abortion access is a crucial element of health care, and reduced access may disproportionately impact people of color, members of other marginalized groups, and those in lower resource settings. [33] Whenever possible, data on travel for abortion by race, ethnicity, and income should be studied to investigate differential impact over both the short and long term.

Additionally, this data source does not include self-managed abortion or any telehealth abortions via providers outside the state of Colorado. It is also likely that the captured data represents an undercounting of abortions due to underreporting by providers in the state.[34]

We recognize that the population able to travel is not wholly inclusive of the population that may desire abortion services. The ability to travel for abortions is determined by many other factors, such as cost, time off work, ability to travel freely without fear of prosecution or stigma, access to care for other children, and more. Those represented here meet those requirements, while many others will not and thus cannot be accounted for in this study. Furthermore, the changing legal status of access means the affected population may also change over time.

The findings in this study indicate that patients are indeed traveling to other states for abortions when they are able to do so, carrying practice implications for providers in both the protective and restrictive states in addition to all the consequences for patients who are able to obtain desired abortions and those for whom the barriers are too great.

References

1. Fact Sheet on Abortion. Accessed September 23, 2024. https://www.who.int/news-room/fact-sheets/detail/abortion

2. Roe v. Wade :: 410 U.S. 113 (1973) :: Justia US Supreme Court Center. Accessed December 5, 2023. https://supreme.justia.com/cases/federal/us/410/113/

3. Center PR. A History of Key Abortion Rulings of the U.S. Supreme Court. Pew Research Center's Religion & Public Life Project. January 16, 2013. Accessed December 8, 2023. https://www.pewresearch.org/religion/2013/01/16/a-history-of-key-abortion-rulings-of-the-us-supreme-court/

4. Hughes B. *The Texas Heartbeat Act*.; 2021. Accessed December 2, 2023. https://capitol.texas.gov/tlodocs/87R/billtext/html/SB00008F.HTM

5. Watson K, Angelotta C. The frequency of pregnancy recognition across the gestational spectrum and its consequences in the United States. *Perspect Sex Reprod Health*. 2022;54(2):32-37. doi:10.1363/psrh.12192

6. Cohen IG, Adashi EY, Gostin LO. The Supreme Court, the Texas Abortion Law (SB8), and the Beginning of the End of Roe v Wade? *JAMA*. 2021;326(15):1473-1474. doi:10.1001/jama.2021.17639

7. Dobbs v. Jackson Women's Health Organization :: 597 U.S. ___ (2022) :: Justia US Supreme Court Center. Accessed December 5, 2023. https://supreme.justia.com/cases/federal/us/597/19-1392/

8. Center PR. 2. Social and moral considerations on abortion. Pew Research Center's Religion & Public Life Project. May 6, 2022. Accessed November 17, 2023. https://www.pewresearch.org/religion/2022/05/06/social-and-moral-considerations-on-abortion/

9. Rader B, Upadhyay UD, Sehgal NKR, Reis BY, Brownstein JS, Hswen Y. Estimated Travel Time and Spatial Access to Abortion Facilities in the US Before and After the Dobbs v Jackson Women's Health Decision. *JAMA*. 2022;328(20):2041-2047. doi:10.1001/jama.2022.20424

10. Keefe-Oates B, Fulcher I, Fortin J, et al. Use of Abortion Services in Massachusetts After the Dobbs Decision Among In-State vs Out-of-State Residents. *JAMA Netw Open*. 2023;6(9):e2332400. doi:10.1001/jamanetworkopen.2023.32400

11. Bor J, Moscoe E, Mutevedzi P, Newell ML, Bärnighausen T. Regression Discontinuity Designs in Epidemiology. *Epidemiol Camb Mass*. 2014;25(5):729-737. doi:10.1097/EDE.0000000000000138

12. Kontopantelis E, Doran T, Springate DA, Buchan I, Reeves D. Regression based quasi-experimental approach when randomisation is not an option: interrupted time series analysis. *The BMJ*. 2015;350:h2750. doi:10.1136/bmj.h2750

13. Dennis J, Ramsay T, Turgeon AF, Zarychanski R. Helmet legislation and admissions to hospital for cycling related head injuries in Canadian provinces and territories: interrupted time series analysis. *The BMJ*. 2013;346:f2674. doi:10.1136/bmj.f2674

14. Hawton K, Bergen H, Simkin S, et al. Long term effect of reduced pack sizes of paracetamol on poisoning deaths and liver transplant activity in England and Wales: interrupted time series analyses. *The BMJ*. 2013;346:f403. doi:10.1136/bmj.f403

15. Hunsberger S. Parametric and semiparametric approaches to testing for seasonal trend in serial count data. *Biostatistics*. 2002;3(2):289-298. doi:10.1093/biostatistics/3.2.289

16. Institute G. Interactive Map: US Abortion Policies and Access After Roe. Accessed November 30, 2023. https://states.guttmacher.org/policies/

17. Justin R. No abortions in Texas unless the mother's life is in danger, Texas attorney general says as coronavirus spreads. The Texas Tribune. March 23, 2020. Accessed November 27, 2023. https://www.texastribune.org/2020/03/23/texas-stops-most-abortions-during-coronavirus-outbreak/

18. Post-Dobbs State Abortion Restrictions and Protections. Accessed December 13, 2023. https://lawatlas.org/datasets/post-dobbs-state-abortion-restrictions-and-protections

19. Bloom M, Birkeland · B. Wait times at Colorado abortion clinics hit 2 weeks as out-of-state patients strain system. Colorado Public Radio. July 28, 2022. Accessed April 12, 2024. https://www.cpr.org/2022/07/28/colorado-abortion-clinic-wait-times-spike/

20. Ellison JE, Brown-Podgorski BL, Morgan JR. Changes in Permanent Contraception Procedures Among Young Adults Following the Dobbs Decision. *JAMA Health Forum*. 2024;5(4):e240424. doi:10.1001/jamahealthforum.2024.0424

21. Frederiksen B, Ranji U, Gomez I, Published AS. A National Survey of OBGYNs' Experiences After Dobbs. KFF. June 21, 2023. Accessed April 13, 2024. https://www.kff.org/womens-health-policy/report/a-national-survey-of-obgyns-experiences-after-dobbs/

22. Aiken ARA, Starling JE, Scott JG, Gomperts R. Requests for Self-managed Medication Abortion Provided Using Online Telemedicine in 30 US States Before and After the Dobbs v Jackson Women's Health Organization Decision. *JAMA*. 2022;328(17):1768-1770. doi:10.1001/jama.2022.18865

23. Abortion Shield Laws: A New War Between the States - The New York Times. Accessed April 13, 2024. https://www.nytimes.com/2024/02/22/health/abortion-shield-laws-telemedicine.html

24. Heisler M, Cox-Touré T, Kaufman R. US abortion bans violate patients' right to information and to health. *The Lancet*. 2023;401(10387):1480-1482. doi:10.1016/S0140-6736(23)00808-5

25. Bell SO, Stuart EA, Gemmill A. Texas' 2021 Ban on Abortion in Early Pregnancy and Changes in Live Births. *JAMA*. 2023;330(3):281-282. doi:10.1001/jama.2023.12034

26. Biggs MA, Upadhyay UD, McCulloch CE, Foster DG. Women's Mental Health and Well-being 5 Years After Receiving or Being Denied an Abortion: A Prospective, Longitudinal Cohort Study. *JAMA Psychiatry*. 2017;74(2):169-178. doi:10.1001/jamapsychiatry.2016.3478

27. Gerdts C, Dobkin L, Foster DG, Schwarz EB. Side Effects, Physical Health Consequences, and Mortality Associated with Abortion and Birth after an Unwanted Pregnancy. *Womens Health Issues*. 2016;26(1):55-59. doi:10.1016/j.whi.2015.10.001

28. Foster DG, Biggs MA, Ralph L, Gerdts C, Roberts S, Glymour MM. Socioeconomic Outcomes of Women Who Receive and Women Who Are Denied Wanted Abortions in the United States. *Am J Public Health*. 2018;108(3):407-413. doi:10.2105/AJPH.2017.304247

29. Adkins S, Talmor N, White MH, Dutton C, O'Donoghue AL. Association Between Restricted Abortion Access and Child Entries Into the Foster Care System. *JAMA Pediatr*. 2024;178(1):37-44. doi:10.1001/jamapediatrics.2023.4738

30. Foster DG, Raifman SE, Gipson JD, Rocca CH, Biggs MA. Effects of Carrying an Unwanted Pregnancy to Term on Women's Existing Children. *J Pediatr*. 2019;205:183-189.e1. doi:10.1016/j.jpeds.2018.09.026

31. *#WeCount Report April 2022 through June 2024*. Society of Family Planning; 2024. doi:10.46621/728122kflzwf

32. Steupert M. Abortion Reporting: Wyoming (2022). Lozier Institute. August 15, 2023. Accessed December 8, 2023. https://lozierinstitute.org/abortion-reporting-wyoming-2022/

33. Wilkinson Barbara, Onwuzurike Chiamaka, Bartz Deborah. Restrictive State Abortion Bans — A Reproductive Injustice. *N Engl J Med*. 2022;386(13):1197-1199. doi:10.1056/NEJMp2119364

34. Vital Statistics Program | Colorado Department of Public Health and Environment. Accessed December 8, 2024. https://cdphe.colorado.gov/center-for-health-and-environmental-data/registries-and-vital-statistics/vital-statistics-program

CHAPTER 3: Association Between Abortion Access and Infant Mortality in the US by Race, Ethnicity and Cause

Introduction

For nearly fifty years, abortion access in the United States was shaped by *Roe v. Wade (Roe)*, which recognized a Constitutional right to abortion.[1] *Roe* remained law until it was reversed in the 2022 case, *Dobbs v. Jackson Women's Health Organization (Dobbs)*.[2] *Dobbs* shifted legal access decisions away from the federal government and to the states, several of which had trigger bans in effect. Additional states moved quickly to enact gestational limitations or bans.[3]

Among the concerns surrounding restrictions on abortion rights is the fear that there may be downstream effects on infant mortality. Pre-*Dobbs,* access limitations were associated with elevated infant mortality.[4] Historically, infant mortality rates have declined over time improvements in clean water, sanitation, and the development of vaccination against many childhood diseases.[5] In the United States, the overall rate in 2021 was 5.4 deaths per 1,000 live births, higher than in many other Western nations, though working towards the Healthy People 2030 goal of 5.0.[6] Infant mortality has also been differential by race and ethnicity historically.[7] A fair degree of state-level variation in infant mortality rates existed pre-dating any changes to abortion access.[8]

Infant mortality may be associated with abortion access through multiple mechanisms. Abortion access limitations may compel pregnancies in individuals who are less healthy and might have otherwise elected termination. Such pregnancies may become higher risk; it is estimated that approximately 12% of abortions are selected for health reasons.[9,10] Several states do not allow exceptions for fetal abnormalities.[11] The standard of care for pregnancy usually specifies the comprehensive anatomy scan is scheduled between 18-22 weeks' gestation, beyond the cutoff to abortion in many states.[12] Additionally, in states that allow abortions to protect the health of the pregnant individual, identifying whether those legal exceptions apply can be difficult and may result in delayed or refused terminations.[11]

The objective of this study was to determine whether state-level variation in infant mortality was associated with abortion laws, assessing associations temporally before and after the *Dobbs* decision. Singh and Gallo found a 7% increase in overall nationwide absolute all-cause mortality and a 10% increase in deaths due to congenital anomalies for specific months after the *Dobbs* decision.[13] This study aimed to build on those findings by using a wider range of included data, comparing restrictive states to protective ones, disaggregating data by race and ethnicity, and adjusting for potential confounders. Additionally, we aimed to understand how trends in infant mortality in states affected by abortion restrictions compare to trends in abortion protective states.

Methods

Study Population, Design and Outcomes

The study population includes all infants residing in the United States during the combined pre-*Dobbs* years of 2018/2019 and in 2023. All outcome data was obtained from CDC Wide-Ranging Online Data for Epidemiologic Research (CDC Wonder), in the Multiple Cause of Death dataset. Data reflects deaths that occur after the time of live birth, but prior to the first birthday, by state of residence. We included and combined two years of mortality data pre-*Dobbs*, 2018-2019, to provide a more stable estimate. These years were also chosen to avoid of overlap with the Covid-19 pandemic which may have impacted mortality.[14] Data was downloaded as counts and as rates per 1,000 people in the under one-year population.

We first focused on all-cause infant mortality which combines all infant deaths into one summary state-level measure. We then disaggregated data, separating rates of all-cause mortality into the following groups: white non-Hispanic, Black non-Hispanic, other races non-Hispanic, and Hispanic. The other race category includes the following groups: American Indian or Alaska Native; Asian; Native Hawaiian or Other Pacific Islander; More than one race. Fewer than 10 observations in any category resulted in full suppression of the data, fewer than 20 observations resulted in rates being deemed unreliable, and thus unavailable.[15] Due to infant mortality being a rare outcome, any further disaggregation by race and ethnicity would have greatly increased the degree of missingness, and we were unable to explore race/ethnicity with a greater degree of granularity.

In addition to the all-cause mortality analysis, we assessed cause-specific infant mortality rates for deaths coded with P-codes and Q-codes under the International Classification of Diseases (ICD-10) system.[16] P-code deaths include causes of death originating in the perinatal period, defined as the time from before birth through 28 days after birth. Q-code deaths include causes of death related to congenital abnormalities, deformities, chromosomal issues, and related conditions. A list of summary cause-of-death codes that fall into these cause of death categories is available in Appendix C, Supplemental Table C1. These were selected to explore the possibility that deaths for these causes may be associated with differences in abortion access.

Exposure of Interest

The exposure of interest are state-level abortion gestational limits or bans assessed at the end of 2022,[17] selected for two reasons: first, to allow six months post-*Dobb* for enaction of trigger bans or other new restrictions; second, to address the need for temporality and ensure the exposure occurred before any 2023 deaths. The exposure was classified as a binary variable and as a three-level categorical variable for sensitivity analysis as described below.

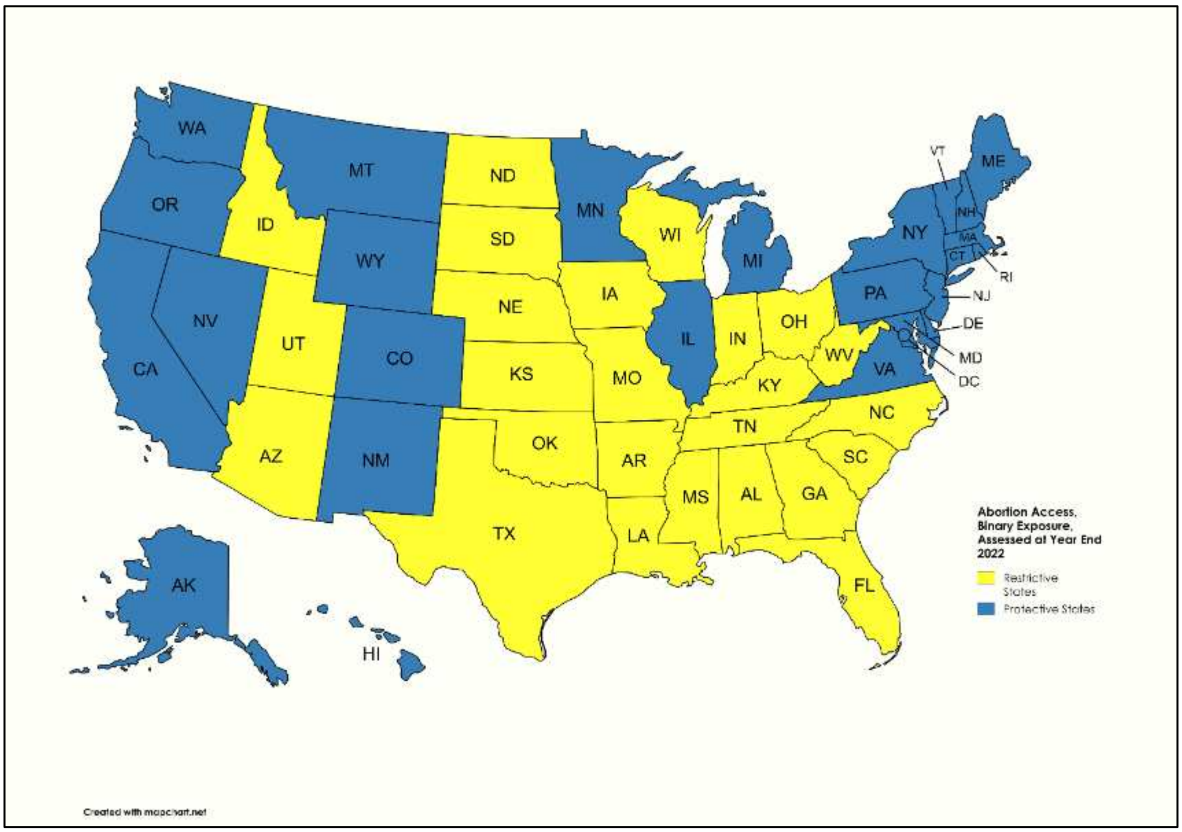


Figure 3.1: Map of United States plus District of Columbia Showing Binary Exposure of State-Level Abortion Access Assessed at Year End, 2022. Restrictive states are those that either had a total ban or gestational limitations before 24 weeks/viability. Protective states are those that either had no gestational limits or only imposed limits at or after 24 weeks/viability. Map created using mapchart.net.

The binary indicator of state-level abortion laws is designed as a logic term with exposed and unexposed states. States without restrictions, or that only had limitations beyond the point of viability or 24 gestational weeks, were considered unexposed or *protective*. States with bans or restrictions limiting abortion at any point in pregnancy prior to viability or 24 weeks were considered exposed or *restrictive*. States with restrictions or bans deemed unenforceable pending judicial review, were considered *protective*. Figure 3.1 shows binary state-level abortion laws.

Sensitivity models used categorical exposure, which allowed us to groups states to analyze whether the degree of restriction was associated with differences in mortality. States were assigned to one of three groups, again based on the status of access at the end of 2022. *Protective* states were again defined as those either without gestational restrictions or which limit access only after viability or 24 weeks, considered unexposed, and set as the reference category. *Moderately Restrictive* states had laws restricting access from after 12 weeks through 23 weeks. *Most Restrictive* states were those with a full ban or access limitations at any point before or until 12 weeks' gestation. Appendix C, Supplemental Figure C1 shows the categorical state map.

Covariates

Adjusted models included covariates chosen to address potential state-level confounding. The diversity index is a calculated measure created by the US Census Bureau, included here to account for difference in the racial and ethnicity compositions of states.[18] Pre-pregnancy Body Mass Index (BMI) is included as a predictor of potential pregnancy complications,[19]obtained from the CDC Wonder birth database representing the state-level average for 2018-2023.[15] Smoking rates during pregnancy were obtained from the National

Center for Health Statistics for 2021.[15] State-level poverty rates for 2022 were obtained from the US Census Bureau.[20] Finally, the state-level total fertility rate was included to account for both the age of the pregnant individual and as a measure of parity, as having more children is directly connected with being older at the time of the most recent pregnancy. This data was obtained from a National Vital Statistics Reports issued in 2022.[21] Total fertility rates are described as the number of lifetime births per 1,000 women given current birth rates by age for each state.

Statistical Analysis

We first compared mortality rates before and after *Dobbs* using t-tests to determine if there were significant differences in the rates when comparing *protective* and *restrictive* states. Next, we constructed separate pre-*Dobbs* and post-*Dobbs* Poisson regression models for each time point utilizing count data with a population offset term, which allowed adjustment for populational distribution differences among the states. Finally, we compared the data over time using generalized estimating equations (GEE) to determine if there was any evidence of a change in mortality rates comparing *protective* and *restrictive* states between the pre-*Dobbs* timepoint and post-*Dobbs* time point, based on a product term between the binary abortion law exposure and pre-post time indicator in the model. GEEs account for correlation in data structures; here we utilized an exchangeable correlation structure with log link.[22,23] This approach can be useful in policy analysis allowing comparison of differences in pre- and post-policy trends in 'exposed' and 'control' units.[24] GEE models utilized provided mortality rates per 1,000 people in the under one-year population on July 1.

Analysis for this study was conducted in R version 4.3.1 using the packages broom and tidyverse, preliminary data cleaning was performed in Microsoft Excel. This study was deemed exempt by the University Institutional Review Board. We adhered to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guidelines.

Results

Table 3.1 includes information on all covariates and time-specific infant mortality rates by binary exposure, with p-value for the difference between them using t-tests. There were statistically significant differences in the mean covariate values for all variables with the exception of the diversity index. Appendix C, Supplemental Table C2 includes details grouped by categorical exposure.

Table 3.1: Mean covariate values and mortality rates categorized by binary exposure. P-values shown are from t-tests comparing the values and rates between *protective* and *restrictive* states.

	Protective States + DC (N=26)	Restrictive States (N=25)	p-value
Covariates			
Diversity Index	52.0	46.7	0.2
Average Pre-Pregnancy BMI	27.3	27.0	0.001
% Smoking During Pregnancy	5.0	7.2	0.02
Poverty Rate	11.2	13.5	0.001
Total Fertility Rate	1560	1770	<0.001
2018/2019 Mortality Rates (per 1000 in the <1yr population)			
All-Cause, Aggregated	5.1	6.4	<0.001
Disaggregated by race/ethnicity			
Non-Hispanic Black	11.3	13.3	0.01

Non-Hispanic White	4.1	5.3	<0.001
Hispanic	5.0	5.4	0.2
Non-Hispanic Other Races	4.5	5.3	0.1
Cause-Specific, Aggregated			
P-Codes	2.5	2.9	0.01
Q-Codes	1.0	1.4	<0.001
2023 Mortality Rates (per 1000 in the <1yr population)			
All-Cause, Aggregated	4.8	6.3	<0.001
Disaggregated by race/ethnicity			
Non-Hispanic Black	8.5	11.6	<0.001
Non-Hispanic White	4.0	5.2	<0.001
Hispanic	4.9	5.9	0.01
Non-Hispanic Other Races	3.4	5.9	<0.001
Cause-Specific, Aggregated			
P-Codes	2.4	3.0	<0.001
Q-Code	0.9	1.3	<0.001

Higher infant mortality rates were found across most groups of data for *restrictive* states when compared with *protective* states both before and after *Dobbs,* demonstrating that differences in state-level mortality rates associated with variation in abortion laws post-*Dobbs* existed pre-*Dobbs*, and that those differences persisted after the decision. This data also shows wide differences in mortality rates for groups disaggregated by race and ethnicity, highest among non-Hispanic Black infants when compared with other groups in both *protective* and *restrictive* states. The only groups found not to have significant differences were the Hispanic and Non-Hispanic Other Races groups in the 2018/2019 pre-*Dobbs* data. When we look at both timepoints, we see that while overall all-cause and most disaggregated groups are continuing to experience declining infant mortality over time, this is not the case in all groups. Crude infant mortality rates appear higher for Hispanic infants, non-Hispanic Other Races infants, and P-code mortality in 2023 than in 2018/2019 for *restrictive* states. Figure 3.2 shows the annual mortality rates visually for *restrictive* and *protective* states from 2018 to 2023 in aggregate, as well as disaggregated by race and ethnicity.

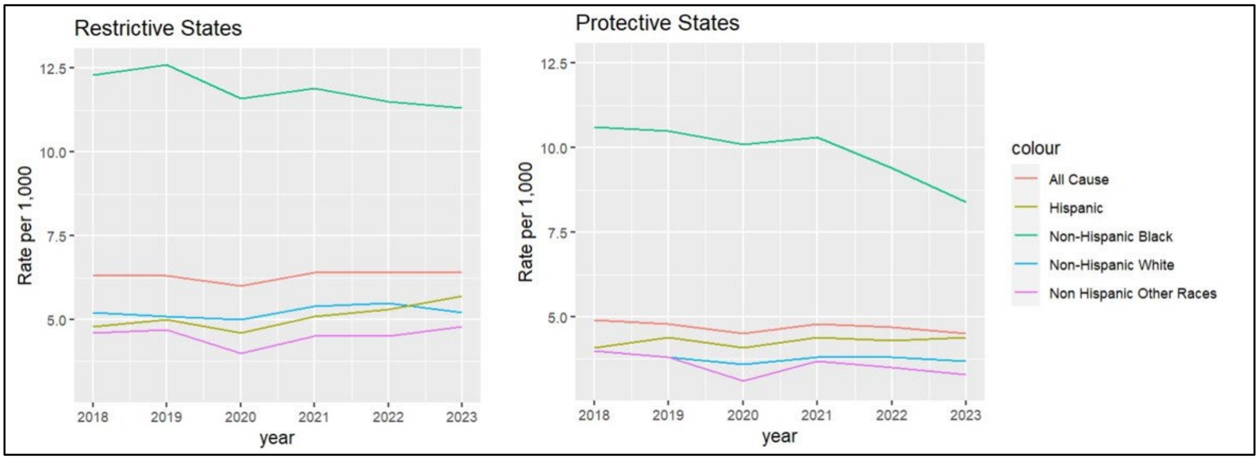


Figure 3.2: Unadjusted nationwide infant mortality rates 2018-2023, shown in aggregate and disaggregated race and ethnicity groups, faceted by binary abortion law exposure.

Results from Poisson models comparing *restrictive* states to *protective* states are presented both as crude estimates and adjusted estimates in Table 3.2. For pre-*Dobbs* overall all-cause data, *restrictive* states had 31% higher infant mortality than *protective* states in unadjusted models (Rate Ratio [RR]: 1.31, 95% confidence interval [CI]: 1.19, 1.43, p<0.001), and 18% higher infant mortality in adjusted models (RR: 1.18, 95% CI: 1.07, 1.30, p<0.001). In disaggregated models, statistically significantly higher mortality was identified in all race and ethnicity groups except non-Hispanic other races. In cause-specific models, there was significantly higher mortality in *restrictive* states for both perinatal-related deaths and congenital/chromosomal abnormality related deaths.

Table 3.2: Rate ratio, 95% confidence interval and p-value for Poisson regression models using annual state-level count data with population offset, shown with crude estimates, adjusted estimates, and p-values, comparing *restrictive* states to *protective* states for each timepoint.

	2018/2019		**2023**	
	Crude	*Adjusted*	*Crude*	*Adjusted*
All-Cause, Aggregated	1.31 (1.19, 1.43), p<0.001	1.18 (1.07, 1.30), p<0.001	1.41 (1.37, 1.48), p<0.001	1.26 (1.21, 1.32), p<0.001
Disaggregated by race/ethnicity				
Non-Hispanic Black	1.18 (1.14, 1.22), p<0.001	1.18 (1.12, 1.25), p<0.001	1.34 (1.27, 1.42) p<0.001	1.30 (1.21, 1.41), p<0.001
Non-Hispanic White	1.32 (1.28, 1.36), p<0.001	1.16 (1.11, 1.22), p<0.001	1.39 (1.32, 1.45), p<0.001	1.21 (1.12, 1.29), p<0.001
Non-Hispanic Other Races	1.19 (1.11, 1.28), p<0.001	1.11 (0.99, 1.24), p=0.07	1.46 (1.32, 1.61), p<0.001	1.26 (1.07, 1.48), p=0.005
Hispanic	1.15 (1.11, 1.20), p<0.001	1.09 (1.01, 1.16), p=0.02	1.29 (1.22, 1.37), p<0.001	1.21 (1.10, 1.33), p<0.001
Cause-Specific, Aggregated				
P-code	1.22 (1.18, 1.25), p<0.001	1.20 (1.15, 1.25), p<0.001	1.32 (1.27, 1.37), p<0.001	1.31 (1.24, 1.40), p<0.001
Q-code	1.36 (1.31, 1.53), p<0.001	1.14 (1.06, 1.21), p<0.001	1.43 (1.34, 1.53), p<0.001	1.20 (1.09, 1.33), p<0.001

In post-*Dobbs* models, all point estimates increased relative to the pre-*Dobbs* point estimates indicating even higher mortality in *restrictive* states when compared to *protective* states. The overall all-cause infant mortality was found to be 38% higher in the crude model (RR: 1.38, 95% CI: 1.34, 1.41, p<0.001), and 23% higher in the adjusted model (RR: 1.23, 95% CI: 1.18, 1.28, p<0.001). All-cause aggregated infant mortality thus went from an 18% difference before *Dobbs* to a 23% difference after *Dobbs.* All models in the post-*Dobbs* period held significant results, with the *restrictive* states having higher infant mortality across all groups disaggregated by race and ethnicity as well as in cause-specific models.

Our sensitivity analysis for the Poisson models explored whether there were differences in the degree of limitation in abortion laws for categorical models revealed that states classified as *moderately restrictive* states had uniformly higher infant mortality when compared to the reference *protective states* for all crude and adjusted models. Results for *most restrictive states* were less consistent as some models yielded non-significant findings for data disaggregated by race and ethnicity. Categorical sensitivity results shown in Appendix C, Supplemental Table C3.

Results from GEE models aiming to assess if differences between *restrictive* and *protective* states changed after *Dobbs* are summarized in Table 3.3.

Table 3.3: Rate ratio, 95% confidence interval and p-value for product term in generalized estimating equation models using annual state-level mortality rates, shown with crude and adjusted estimates, comparing *restrictive* states to *protective* states over time. The product term estimates shown here represent the interaction between binary abortion law exposure and time.

	Crude	***Adjusted***
All-Cause, Aggregated	1.05 (0.97, 1.13), p=0.23	0.95 (0.89, 1.01), p=0.21
Disaggregated by race/ethnicity		
Non-Hispanic Black	1.17 (1.06, 1.29), p=0.002	1.18 (1.06, 1.30), p=0.001
Non-Hispanic White	0.98 (0.91, 1.06), p=0.68	0.98 (0.91, 1.06), p=0.67
Non-Hispanic Other Races	1.36 (1.16, 1.60), p<0.001	1.39 (1.18, 1.63), p<0.001
Hispanic	1.60 (0.88, 2.91), p=0.12	1.60 (0.88, 2.92), p=0.12
Cause-Specific, Aggregated		
P-Code	1.07 (0.97, 1.19), p=0.18	1.08 (0.97, 1.20), p=0.14
Q-Code	0.99 (0.89, 1.10), p=0.88	0.99 (0.89, 1.11), p=0.90

Overall aggregated all-cause mortality analysis results were not consistent with a change in differences over time, but Non-Hispanic Black and non-Hispanic Other Races groups were both found to have indications of diverging mortality trends going from pre-*Dobbs* to post-*Dobbs* in *restrictive* states when compared with *protective* states in both the crude (RRs 1.16

(95% CI: 1.05, 1.27, p=0.003) and 1.26 (95% CI: 1.06, 1.51, p=0.01) respectively) and adjusted models (RRs 1.16 (95% CI: 1.06, 1.28, p=0.002) and 1.31 (95% CI: 1.09, 1.56, p=0.004) respectively). Categorical sensitivity model results shown in Appendix C, Supplemental Table C4.

Discussion

Abortion *restrictive* states had higher infant mortality compared to *protective* states, both before *Dobbs* decision and afterwards. We found evidence of disparities in mortality rates for non-Hispanic Black infants when compared with other groups in both *protective* and *restrictive* states, with non-Hispanic Black infant mortality approaching double the rates of other groups, indicating that there is substantial work to be done towards achieving the twin aims of public health.[25] Declining infant mortality overall is one of the twin aims where substantial progress towards has been made, but the second aim of decreasing disparities between groups remains a clear issue in this respect nationwide, one that we must be called upon urgently to address.[26] We observed evidence that some of the crude mortality rates between pre-*Dobbs* and post-*Dobbs* in disaggregated groups appear to have stopped decreasing and may have begun to trend upwards, which are potential signals of changes running counter to the overall goal of reducing infant mortality and ensuring those benefits are equitable in nature.[27]

When comparing *restrictive* states to *protective* states in adjusted Poisson models, we found higher infant mortality at both time points in *restrictive* states, with higher point estimates in the post-*Dobbs* models. We did not find evidence of significant change in the differences between states over time when looking at aggregated data, however there was evidence of a widening gap in data disaggregated by race and ethnicity, specifically pertaining to non-Hispanic Black and non-Hispanic Other Race groups. Our results provide early indications that these changes may lead to even greater racial and ethnic disparities, demonstrating the need to look beyond aggregated data[13] for a fuller picture of changes in infant mortality.

We were primarily interested in all-cause mortality for our analysis because it is a broad general measure of population health[28], but we also wanted to look specifically at causes of death which are the most likely to be related to changes in abortion access[29]. We observed higher perinatal-related mortality in *restrictive* states compared to *protective* ones. Deaths related to congenital conditions were also found to be higher in *restrictive* states, with no current evidence of change in the gap between *restrictive* and *protective* states over time.

Strengths of this study include the use of nationwide data from CDC Wonder, the ability to disaggregate the full data set by race and ethnicity as well as look at specific causes of death to explore whether there was evidence of differences among groups. We were also able to utilize different model types to compare state-level mortality by abortion law exposure and analyze those trends over time. Additionally, we included a robust list of potential confounders.

Limitations include the data suppression rules utilized by CDC Wonder, which leads to some missingness among disaggregated data groups especially given that infant mortality is, thankfully, a rare outcome. We were also unable to utilize rate data using births instead of the estimated population as the denominator as it is unavailable for any disaggregated groups.[30] We recognize there may be inconsistencies in how accurately cause-specific coding is reported, which could result in outcome misclassification; all-cause data is more likely to be accurate given that it is easier to identify whether a death occurred than it is to accurately document a cause[31].

The need to assess state laws at a point in time to create the exposure variable is a limitation here given the constantly evolving nature of state laws. We did not include other legal mechanisms that might also impact abortion access such as facility requirements or waiting periods. Finally, there is potential for unaddressed confounders and residual confounding particularly regarding the Diversity Index and its ability to represent the demographic breakdown of each state. With respect to comparison of trends between states over time it is unlikely that any time-varying confounders would coincide with *Dobbs* in a way that can explain observed differences in outcome trends between protective and restrictive states over what is a relatively short period of time.

Results found in this study may require changes in prioritization of public health efforts, both to address the changes in infant mortality overall in affected states, but also specifically to address the differential impact based on race and ethnicity, as well as cause-specific mortality increases we are seeing for perinatal related deaths. Providers, policymakers, and other stakeholders in these areas need to be aware of these changes and should make decisions accordingly to ensure the best care possible for pregnant individuals and children born in these states.

Conclusion

We found substantial evidence of higher infant mortality rates in states with *restrictive* abortion laws as compared to *protective* states both before and after *Dobbs*, as well as signals that may indicate the gaps between those states have increased since *Dobbs* in some ethnic/racial groups. In particular, we identified early evidence that gaps may be widening for non-Hispanic Black and non-Hispanic Other Races groups. The public health policy implications here are profound as abortion restrictions may be exacerbating existing disparities in infant mortality.

References

1. Roe v. Wade :: 410 U.S. 113 (1973) :: Justia US Supreme Court Center. Accessed December 5, 2023. https://supreme.justia.com/cases/federal/us/410/113/

2. Dobbs v. Jackson Women's Health Organization :: 597 U.S. ___ (2022) :: Justia US Supreme Court Center. Accessed December 5, 2023. https://supreme.justia.com/cases/federal/us/597/19-1392/

3. State Policy Trends 2022: In a Devastating Year, US Supreme Court's Decision to Overturn Roe Leads to Bans, Confusion and Chaos | Guttmacher Institute. December 14, 2022. Accessed April 25, 2024. https://www.guttmacher.org/2022/12/state-policy-trends-2022-devastating-year-us-supreme-courts-decision-overturn-roe-leads

4. Pabayo R, Ehntholt A, Cook DM, Reynolds M, Muennig P, Liu SY. Laws Restricting Access to Abortion Services and Infant Mortality Risk in the United States. *Int J Environ Res Public Health*. 2020;17(11):3773. doi:10.3390/ijerph17113773

5. MacDorman MF, Mathews TJ. The Challenge of Infant Mortality: Have We Reached a Plateau? *Public Health Rep*. 2009;124(5):670. doi:10.1177/003335490912400509

6. Reduce the rate of infant deaths — MICH-02 - Healthy People 2030 | odphp.health.gov. Accessed March 9, 2025. https://odphp.health.gov/healthypeople/objectives-and-data/browse-objectives/infants/reduce-rate-infant-deaths-mich-02

7. *Infant Mortality in the United States, 2020: Data From the Period Linked Birth/Infant Death File*. National Center for Health Statistics (U.S.); 2022. doi:10.15620/cdc:120700

8. Products - Data Briefs - Number 295 - January 2018. June 6, 2019. Accessed October 4, 2024. https://www.cdc.gov/nchs/products/databriefs/db295.htm

9. Healy J. With Roe Set to End, Many Women Worry About High-Risk Pregnancies. *The New York Times*. https://www.nytimes.com/2022/06/20/us/abortion-high-risk-pregnancy.html. June 20, 2022. Accessed October 17, 2024.

10. Biggs MA, Gould H, Foster DG. Understanding why women seek abortions in the US. *BMC Womens Health*. 2013;13:29. doi:10.1186/1472-6874-13-29

11. Felix M, Sobel L, Published AS. A Review of Exceptions in State Abortion Bans: Implications for the Provision of Abortion Services. KFF. June 6, 2024. Accessed October 17, 2024. https://www.kff.org/womens-health-policy/issue-brief/a-review-of-exceptions-in-state-abortions-bans-implications-for-the-provision-of-abortion-services/

12. Jabaz D, Jenkins SM. Sonography 2nd Trimester Assessment, Protocols, and Interpretation. In: *StatPearls*. StatPearls Publishing; 2024. Accessed October 17, 2024. http://www.ncbi.nlm.nih.gov/books/NBK570574/

13. Singh P, Gallo MF. National Trends in Infant Mortality in the US After *Dobbs*. *JAMA Pediatr*. Published online October 21, 2024. doi:10.1001/jamapediatrics.2024.4276

14. Barry MC, Pathak EB, Swanson J, et al. Epidemiology of COVID-19 in Infants in the United States: Incidence, Severity, Fatality, and Variants of Concern. *Pediatr Infect Dis J*. 2024;43(3):217. doi:10.1097/INF.0000000000004201

15. CDC WONDER. Accessed October 13, 2024. https://wonder.cdc.gov/

16. CDC. ICD-10-CM. Classification of Diseases, Functioning, and Disability. June 11, 2024. Accessed October 13, 2024. https://www.cdc.gov/nchs/icd/icd-10-cm/index.html

17. Post-Dobbs State Abortion Restrictions and Protections. LawAtlas. Accessed November 15, 2024. https://lawatlas.org/datasets/post-dobbs-state-abortion-restrictions-and-protections

18. Bureau UC. 2020 Census: Racial and Ethnic Diversity Index by State. Census.gov. Accessed March 15, 2024. https://www.census.gov/library/visualizations/2021/dec/racial-and-ethnic-diversity-index.html

19. Vats H, Saxena R, Sachdeva MP, Walia GK, Gupta V. Impact of maternal pre-pregnancy body mass index on maternal, fetal and neonatal adverse outcomes in the worldwide populations: A systematic review and meta-analysis. *Obes Res Clin Pract*. 2021;15(6):536-545. doi:10.1016/j.orcp.2021.10.005

20. Bureau UC. Poverty in the United States: 2022. Census.gov. Accessed October 13, 2024. https://www.census.gov/library/publications/2023/demo/p60-280.html

21. National Vital Statistics Reports Volume 73, Number 2, April 4, 2024.

22. Halekoh U, Højsgaard S, Yan J. The *R* Package **geepack** for Generalized Estimating Equations. *J Stat Softw*. 2006;15(2). doi:10.18637/jss.v015.i02

23. Liang KY, Zeger SL. Longitudinal data analysis using generalized linear models. *Biometrics*. 1986;78(1):13-22.

24. French B, Heagerty PJ. Analysis of Longitudinal Data to Evaluate a Policy Change. *Stat Med*. 2008;27(24):5005-5025. doi:10.1002/sim.3340

25. Horn L. Public health and social justice: Forging the links. *South Afr J Bioeth Law*. 2015;8(2):26. doi:10.7196/sajbl.437

26. Headen IE, Elovitz MA, Battarbee AN, Lo JO, Debbink MP. Racism and perinatal health inequities research: where we have been and where we should go. *Am J Obstet Gynecol*. 2022;227(4):560-570. doi:10.1016/j.ajog.2022.05.033

27. Ramos SZ, Rose B, Werner EF, Amutah-Onukagha N, Siegel M. Systemic racism and Non-Hispanic Black to Non-Hispanic White disparities in infant mortality at the county level. *J Perinatol*. 2024;44(12):1724-1731. doi:10.1038/s41372-024-02048-5

28. Reidpath DD. Infant mortality rate as an indicator of population health. *J Epidemiol Community Health*. 2003;57(5):344-346. doi:10.1136/jech.57.5.344

29. Gardner G. The maternal and infant health consequences of restricted access to abortion in the United States. *J Health Econ*. 2024;98:102938. doi:10.1016/j.jhealeco.2024.102938

30. Provisional Mortality by Multiple Cause of Death. Accessed December 21, 2024. https://wonder.cdc.gov/wonder/help/mcd-provisional.html#Infant%20Mortality

31. Wojcik MH, Yuen JC, Hansen A, Leeman KT. Mortality in the Neonatal Intensive Care Unit: Improving the Accuracy of Death Reporting. *J Perinatol Off J Calif Perinat Assoc*. 2022;42(5):671-676. doi:10.1038/s41372-021-01214-3

CHAPTER 4: The Association of Abortion Restrictions and Physician Supply in the United States

The Association of Abortion Restrictions and Physician Supply in the United States

Introduction

On June 24, 2022, the *Dobbs v. Jackson Women's Health*[1] decision overturned *Roe v. Wade*[2], resulting in the unprecedented removal of the federally protected right to abortion, and shifting decision making about abortion access to the states. This decision, along with actions taken to limit abortion access before and since, have elicited concerns of downstream effects rippling through society. A major concern relates to the available supply of physicians in association with the level of abortion restrictions, primarily within the specialty of obstetrics and gynecology (OBGYN). There has been substantial media coverage surrounding fears that changes in legal access may drive physicians, specifically OBGYNs, from abortion restrictive states,[3,4] while other media reports have focused on physicians determined to remain in restrictive states to ensure adequate care for patients.[5]

Prior studies have found that practice location for physicians is influenced by the types and structure of health insurance coverage in an area[6] and may be associated with state-level malpractice laws for some specialties, though not OBGYNs.[7] Specifically, OBGYN rates are known to vary geographically in association with rurality[8], directly related to concerns about maternity care deserts and travel distance required for care.[9]

Access to care is an essential element of healthcare[10], and it has been established that access is not uniform across the United States, in particular regarding access to maternity care, and especially among rural areas.[9] It is estimated that 36% of all counties in the US were classified as maternity deserts in 2022 by the March of Dimes, and that these maternity care desert areas have higher rates of asthma, hypertension and smoking with lower median incomes and higher utilization of Medicaid.[11] State-level abortion access and practice restrictions prior to the *Dobbs* decision have been found associated with fewer doctors, higher maternal mortality and higher infant mortality.[12,13] Were physicians to leave impacted states in high enough numbers after *Dobbs*, there is a possibility that these documented geographic shortages could be made worse.

The variation in and changing nature of state abortion laws brings uncertainty for providers who may be unsure of the scope of limitations on practice, what the enforcement mechanisms for any violation may be, where the burden of proof lies in contested claims of violation of the law, and potential threats of imprisonment, fines, and removal of the license to practice medicine. Consequently, there have been concerns regarding scope of practice, delays in care to determine legality of treatment, and in some cases restrictions on care provided to patients for obstetric emergencies.[14]

Of particular interest here, one study used administrative data to determine if there was any evidence of OBGYNs moving from states with abortion bans to abortion-rights protective states, finding no evidence that this has begun to occur, though the authors hypothesize that the workforce impact of abortion bans may take years to manifest.[15] Qualitative studies indicate that family medicine physicians are worried about the erosion of trust between doctors and patients due to abortion restrictions, and have concerns regarding training competencies impacting the workforce long-term.[16] The quantitative association of family medicine and other specialties with abortion law is unknown. To address this gap using data from a different source, our study uses physician data collected by the American Medical Association (AMA) and expands the scope of the research to include other clinical specialties that may be associated with abortion law, psychiatrists and family medicine/general practice (family medicine).

Methods

Study Population and Outcome

The study population includes nearly all practicing physicians in the United States in the American Medical Association Physician Professional Data (AMA PPD)[17], which includes both member and nonmember physicians. AMA PPD data is then made available by the American Association of Medical Colleges (AAMC) in aggregate and released annually on their website, where it is posted as the number of total physicians in each state and the District of Columbia (DC) within each specialty[18]. Data reflecting the pre-*Dobbs* timepoint was collected from the AMA Physician Masterfile on December 31, 2018. The physician workforce datafile was downloaded for each state and DC separately. The data for the post-*Dobbs* timepoint was collected from the AMA PPD on December 31, 2023.[18] We collected information about four groups of physicians: OBGYNs, family medicine (general practice physicians are included in the category of family medicine here), orthopedic surgeons, and psychiatrists (including addiction medicine, addiction psychiatry, psychiatry, psychoanalysis and psychosomatic medicine). Our primary focus pertains to OBGYNs under the hypothesis that this is the group most likely to experience changes in practice location in association with changes in abortion law given the mechanisms outlined above. We selected family medicine physicians and psychiatrists to explore whether there is any evidence of an association among these specialties with abortion laws given their potential proximity to abortion care.[16,19] Finally, orthopedic surgeons were selected as a negative control group under the hypothesis that they are unlikely to have their practice locations associated with any differences in abortion law.

Exposure of Interest

The exposure of interest is a binary logic variable constructed to represent state-level abortion law pertaining to gestational limitation on access, assessed at December 31, 2022. This date was selected for ascertainment of state law for two reasons. First, this point in time occurred six months after the *Dobbs* decision, allowing trigger bans sufficient time to go into effect in states that already had them in place, while also allowing states time to enact new restrictions in the wake of the decision. Second, this date was chosen for temporality such that data representing our post-*Dobbs* timepoint was collected one full year after the date of exposure assessment. States that eventually enacted and were enforcing any ban or gestational restrictions before 24 weeks at the time of assessment were considered exposed or *restrictive*, while states that either had no gestational limitations on access or only after 24 weeks were considered unexposed or *protective*.[20] The geographic distribution of states is shown in Figure

4.1. Twenty-five states plus the District of Columbia are categorized as *protective*, while the remaining twenty-five states are categorized as *restrictive*.

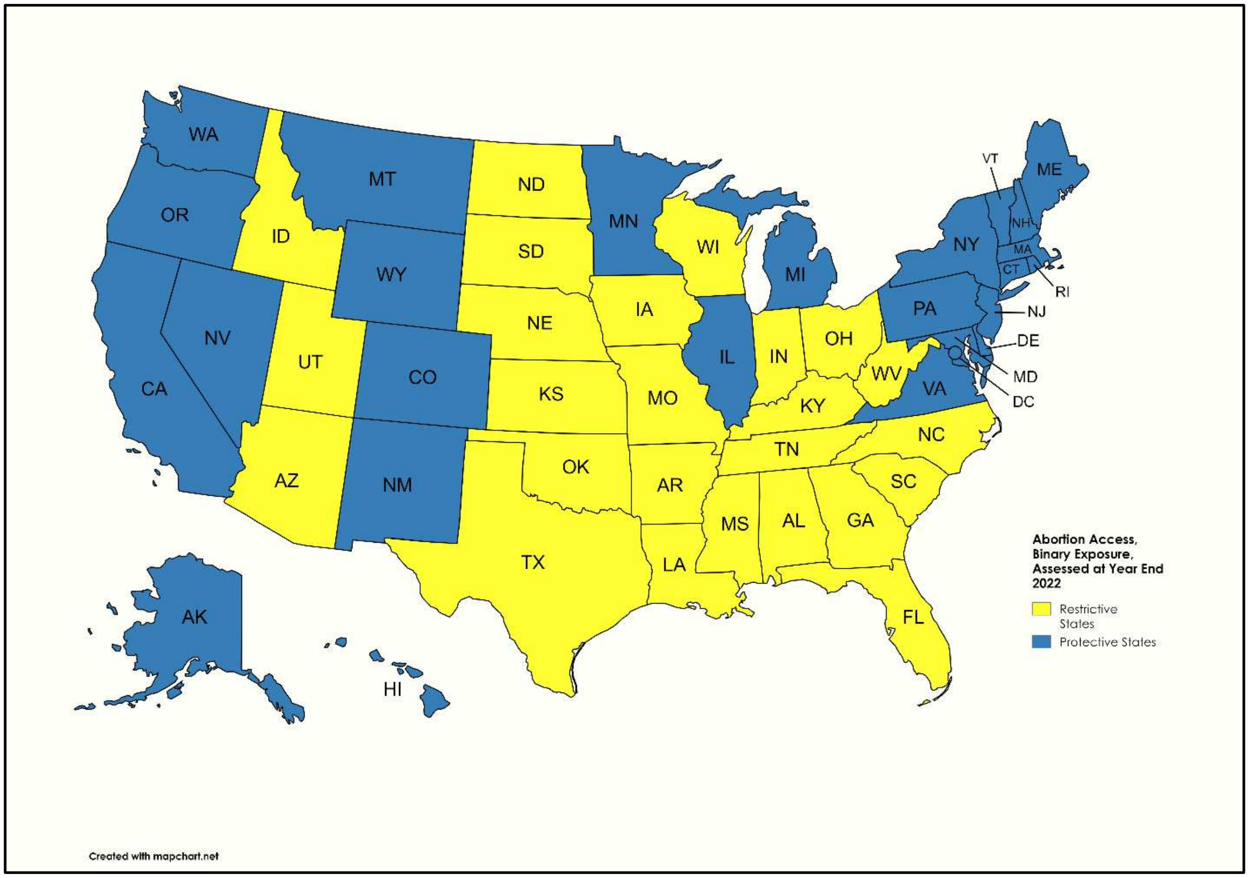


Figure 4.1: Map of United States plus District of Columbia Showing Binary Exposure of State-Level Abortion Access Assessed at Year End, 2022. Restrictive states are those that either had a total ban or gestational limitations before 24 weeks/viability. Protective states are those that either had no gestational limits or only imposed limits at or after 24 weeks/viability. Map created using mapchart.net.

Covariates

Adjusted models included covariates chosen to account for any potential that these variables may be partially explanatory in any association found between abortion laws and physician supply due to upstream common causes relating to the economy and healthcare structures within each state. Covariates included are the mean state-level salary for each specialty and the number of staffed hospital beds per 100,000 in the population for each state. Salary information was obtained from the Bureau of Labor Statistics Occupational Employment and Wage Statistics Survey from 2020, which represents an average of three years of data.[21] Data on the number of staffed hospital beds was obtained from the American Hospital Directory, which was converted based on state population for appropriate comparison.[22] Population offset terms were added to adjust for populational differences among the states, using estimates from the United States Census for each year.[23,24]

Statistical Analysis

To determine the extent to which variation in physician supply is associated with abortion laws, we first compared state-level physician rates for each specialty before and after *Dobbs* using t-tests to determine if there were significant differences in the rates when comparing *protective* and *restrictive* states. We then fit negative binomial regression models to compare the number of physicians in each specialty before and after the *Dobbs* decision, incorporating an offset term which allows for adjustment for populational distribution differences among the states. Model results compare *restrictive* states to *protective* states and are presented both as crude and adjusted estimates. As sensitivity analysis Quasi-Poisson regression models were constructed for post-*Dobbs* physician data. Finally, a combined exposure metric was created to include both state-level abortion laws and state-level policy tallies measuring protectiveness or restrictiveness of the LGBTQ+ community, as measured by the Movement Advancement Project, under the assumption that the two types of laws together represent the level of restriction on autonomy within each state[25]. A detailed description of the combined exposure category levels is included in Appendix D, supplemental materials.

Analysis for this study was conducted in R version 4.3.1 and used the packages broom and tidyverse, preliminary data cleaning was performed in Microsoft Excel. This study was deemed exempt by the Colorado State University Institutional Review Board. We adhered to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guidelines.

Results

For both timepoints studied in this analysis, the mean rate of physicians per 100,000 in the state population was found to be higher in *protective* states than in *restrictive* states for all specialties selected. When using a t-test, this difference was statistically significant for OBGYNs, psychiatrists, and orthopedic surgeons. *Restrictive* states have a higher mean number of staffed hospital beds per 100,000 residents than *protective* states. Salary information is included in Table 4.1 as well, with no significant differences between *protective* and *restrictive* states. All descriptive statistics are shown in Table 4.1.

Table 4.1: Mean crude rate of physicians and staffed hospital beds per 100,000 residents, and mean salary per specialty, categorized by binary exposure. P-values shown are from t-tests comparing the values and rates between *protective* and *restrictive* states.

		Total	Protective States + DC	Restrictive States	p-value
OBGYNs	*2018*	12.9	14.7	11.1	<0.001
	2023	13.0	14.8	11.1	<0.001
Family medicine	*2018*	39.3	40.7	39.1	0.595
	2023	41.2	42.2	40.2	0.537
Psychiatrists	*2018*	11.8	15.5	8.0	<0.001
	2023	12.1	15.7	8.4	<0.001
Orthopedic surgeons	*2018*	6.4	6.9	5.9	0.003
	2023	6.2	6.7	5.8	0.004
Staffed hospital beds		216	199	233	0.013
OBGYN salary		290,000	292,000	288,000	0.748
Family medicine salary		246,000	240,000	252,000	0.341
Psychiatrist salary		236,000	240,000	233,000	0.618
Orthopedic surgeon salary		372,000	373,000	372,000	0.966

Results from negative binomial models with a population offset comparing *restrictive* states to *protective* states are presented both as crude estimates and adjusted estimates in Table 4.2. For pre-*Dobbs* 2018 data, we see that overall, states which later became abortion-rights *restrictive* were found to have a 24% (Rate Ratio (RR): 0.76, 95% Confidence Interval (CI): 0.69, 0.84, p<0.001) lower rate of OBGYNs when compared to *protective* states in crude models, and a 28% (RR: 0.72, 95% CI: 0.65-0.80, p<0.001) lower rate in adjusted models. Models for OBGYNs in 2023 yielded nearly identical results. The number of family medicine providers was found not to be associated with the later divergence in abortion restrictions at either time point. The number of psychiatrists was highly significantly associated with eventual differences in abortion restrictions both before and after the change in legal access, with a 52% lower rate of psychiatrists found in adjusted 2023 models comparing *restrictive* states with *protective* ones. Finally, orthopedic surgeons were found to be associated with 2022 abortion laws only in crude models. Adjusting for other potential confounders resulted in confidence intervals crossing the null for both time points. All model results are shown in Table 4.2.

Table 4.2: Rate ratio and 95% confidence interval for negative binomial regression models using annual state-level physician count data with population offset, shown with crude and adjusted estimates, comparing *restrictive* states to *protective* states for each timepoint.

	2018		**2023**	
	Crude RR and 95% CI, p-value	**Adjusted RR and 95% CI, p-value**	**Crude RR and 95% CI, p-value**	**Adjusted RR and 95% CI, p-value**
OBGYNs	0.76 (0.69, 0.84), p>0.001	0.72 (0.65, 0.80), p<0.001	0.76 (0.68, 0.84), p<0.001	0.71 (0.64, 0.78), p<0.001
Family Medicine	0.96 (0.83, 1.12), p=0.597	1.03 (0.87, 1.22), p=0.916	0.95 (0.82, 1.11), p=0.534	1.01 (0.85, 1.20), p=0.913
Psychiatrists	0.52 (0.43, 0.63), p<0.001	0.46 (0.38, 0.56), p<0.001	0.54 (0.44, 0.65), p<0.001	0.48 (0.39, 0.57), p<0.001
Orthopedic Surgeons	0.88 (0.82, 0.95), p=0.002	0.92 (0.83, 1.03), p=0.916	0.89 (0.82, 0.96), p=0.004	0.91 (0.81, 1.01), p=0.079

Sensitivity models based on 2023 physician data using an alternative model type for comparison show similar results (Table 4.3), with significant associations again identified in adjusted models for OBGYNs and psychiatrists. The sensitivity model built using the combined exposure metric including LGBTQ+ policies showed that progressing to higher levels of autonomy restriction yielded an increasingly large difference in the supply of OBGYNs in 2023 data in comparison to abortion and LGBTQ+ rights protective states. All combined exposure metric results are shown in Appendix D, Supplemental Table D2.

Table 4.3: Rate ratio and 95% confidence interval for Quasi-Poisson regression sensitivity models using 2023 physician count data with population offset, shown with crude and adjusted estimates, comparing *restrictive* states to *protective* states for each timepoint.

	Crude RR and 95% CI, p-value	**Adjusted RR and 95% CI, p-value**
OBGYNs	0.81 (0.75, 0.88), p<0.001	0.80 (0.74, 0.86), p<0.001
Family Medicine	0.95 (0.84, 1.08), p=0.433	0.98 (0.86, 1.12), p=0.773
Psychiatrists	0.56 (0.46, 0.67), p<0.001	0.50 (0.42, 0.61), p<0.001
Orthopedic Surgeons	0.91 (0.84, 0.97), p=0.018	0.94 (0.85, 1.05), p=0.289

Discussion

Our nationwide analysis shows that there are statistically significant lower numbers of OBGYNs in states that become abortion-rights *restrictive* compared to those defined as abortion-rights *protective* in adjusted models both before and after changes in abortion law in the wake of *Dobbs*. The differences identified do not indicate that there has been any significant change between 2018 and 2023, with essentially the same results found year to year – for now. This finding is in agreement with a similar study of OBGYNs using administrative data.[26]

Similarly, psychiatrists were found to be significantly associated with the level of abortion laws both before and after *Dobbs*, with no evidence to indicate that there have been meaningful changes over time. *Protective* states were found to have more than twice the number of psychiatrists per 100,000 compared to *restrictive* states. In contrast, the supply of family medicine physicians was not found to be associated with eventual abortion laws and the supply of orthopedic surgeons was only associated in unadjusted crude models. The association between orthopedic surgeons and abortion laws was not statistically significant in adjusted models, indicating that the covariates were at least partially explanatory for that relationship.

Associations identified in this study among OGBYNs and psychiatrists with the binary measure of abortion law cannot be described as causal in nature, nor should they be interpreted as such, particularly for 2018 data, given that the laws had not changed at that time point and neither group could have been exposed. Instead, the identified associations are likely related to state-level mechanisms that eventually played a role in whether new gestational limitations or bans on abortion access were implemented, namely rurality[27], and the interplay between political partisanship and religion.[28]

As discussed by Strasser et. al, the lack of any measurable change in practice location nationwide among OBGYNs here may simply reflect the short timeframe since legal changes have taken effect[26], particularly given that the available data reflects the end of 2023, lagging behind current reality by over a year as of this writing. There is the possibility that there may have been more movement in the intervening time since that data was collected. 2024 AMA PPD data will likely not be available on the AAMC website until November 2025.[18]

This dataset includes only currently practicing physicians, not those in early career training, and represents those who have already chosen a practice location. Moving is a large undertaking for those in settled career stages, involving selling and buying homes, considerations related to medical licensure in other states, and partner/family dynamics. It has been demonstrated that younger OBGYNs are more likely to relocate, and those moves tend to be more frequently towards urban areas with lower poverty.[29]

Regarding the future supply of OBGYNs, one study found a small but statistically significant decrease in OBGYN residency applications in association with abortion restrictions when comparing applications from the 2023 application cycle to those from the prior year before the *Dobbs* decision, which may indicate fewer future physicians desiring a location with abortion restrictions.[30] It is important to recognize that state-level restrictions on access to healthcare also impact physicians themselves when they interface with the system as patients rather than as providers, which may be an additional motivating factor in decisions about practice location.[31]

Although we did not find evidence of worsening supply in association with abortion laws nationwide, there are indications that it has substantially worsened in individual states. Idaho in particular is seeing dramatic declines in the rates of OBGYNs[32,33], and closures of hospital labor and delivery units.[34] Of concern, Idaho has the lowest percentage of currently practicing OBGYNs under the age of 40 in the nation, at only 5.7% in comparison to the nationwide average of 14.9%,[18] which may predict worsening shortages in the future.

Strengths of this study include the use of physician reported data gathered by the AMA, the largest medical association in the country, robust statistical methods and sensitivity analysis. Our ability to include anti-LGBTQIA+ legislation in the combined exposure metric models as an additional potential explanation for the differences in state-level physician supply here is a strength given that both types of laws have similar mechanisms restricting autonomy, connected to upstream common causes.

Limitations here may include confounding by unaccounted variables and the possibility of residual confounding, particularly as it relates to salary information. Salary information was obtained from employer-based surveys and may not fully reflect the salaries of individual physicians. There was more missingness in the income data for orthopedic surgeons than other specialties, which could result in residual confounding. We are unable to account for any variability in the distribution of physicians within individual states. It is possible that physicians may reside in one state but hold licenses to practice in other states as well through the Interstate Medical License Compact Commission[35], which may result in an unknown degree of misclassification most likely to impact psychiatrists of the specialties under study here given the potential for telehealth is larger in that area of medicine.

Conclusion

We found a statistically significant relationship between abortion laws and physician supply for OBGYNs and psychiatrists when comparing *restrictive* states to *protective* states but found no evidence to indicate that the differences between states based on abortion laws have increased in the year after the *Dobbs* decision. We recommend following this data over time to assess whether any changes in the distribution of physicians begin to manifest.

References

1. Dobbs v. Jackson Women's Health Organization :: 597 U.S. ___ (2022) :: Justia US Supreme Court Center. Accessed December 5, 2023. https://supreme.justia.com/cases/federal/us/597/19-1392/

2. Roe v. Wade :: 410 U.S. 113 (1973) :: Justia US Supreme Court Center. Accessed December 5, 2023. https://supreme.justia.com/cases/federal/us/410/113/

3. News ABC. Doctors face tough decision to leave states with abortion bans. ABC News. Accessed December 12, 2024. https://abcnews.go.com/US/doctors-face-tough-decision-leave-states-abortion-bans/story?id=100167986

4. Lodewick C. OB/GYNs are rethinking their careers post-Roe, signaling that the doctor shortage could get even worse. Fortune. Accessed December 12, 2024. https://fortune.com/2022/06/24/roe-v-wade-supreme-court-ruling-obgyn-doctor-shortage/

5. Why some doctors stay in US states with restrictive abortion laws and others leave | AP News. Accessed December 12, 2024. https://apnews.com/article/dobbs-anniversary-roe-v-wade-abortion-obgyn-699263284cced4bd421bc83207678816

6. Escarce JJ, Polsky D, Wozniak GD, Pauly MV, Kletke PR. Health Maintenance Organization Penetration and the Practice Location Choices of New Physicians: A Study of Large Metropolitan Areas in the United States. *Med Care*. 1998;36(11):1555.

7. Chou CF, Lo Sasso AT. Practice Location Choice by New Physicians: The Importance of Malpractice Premiums, Damage Caps, and Health Professional Shortage Area Designation. *Health Serv Res*. 2009;44(4):1271-1289. doi:10.1111/j.1475-6773.2009.00976.x

8. Barreto T, Jetty A, Eden AR, Petterson S, Bazemore A, Peterson LE. Distribution of Physician Specialties by Rurality. *J Rural Health*. 2021;37(4):714-722. doi:10.1111/jrh.12548

9. Fontenot J, Brigance C, Lucas R, Stoneburner A. Navigating geographical disparities: access to obstetric hospitals in maternity care deserts and across the United States. *BMC Pregnancy Childbirth*. 2024;24:350. doi:10.1186/s12884-024-06535-7

10. Basu S, Berkowitz SA, Phillips RL, Bitton A, Landon BE, Phillips RS. Association of Primary Care Physician Supply With Population Mortality in the United States, 2005-2015. *JAMA Intern Med*. 2019;179(4):506-514. doi:10.1001/jamainternmed.2018.7624

11. Where You Live Matters: Maternity Care Deserts and the Crisis of Access and Equity. Accessed January 2, 2025. https://www.marchofdimes.org/maternity-care-deserts-report-2023

12. U.S. Maternal Health Divide: Limited Services and Worse Outcomes | Commonwealth Fund. Accessed November 19, 2023.

https://www.commonwealthfund.org/publications/issue-briefs/2022/dec/us-maternal-health-divide-limited-services-worse-outcomes

13. Rader B, Upadhyay UD, Sehgal NKR, Reis BY, Brownstein JS, Hswen Y. Estimated Travel Time and Spatial Access to Abortion Facilities in the US Before and After the Dobbs v Jackson Women's Health Decision. *JAMA*. 2022;328(20):2041-2047. doi:10.1001/jama.2022.20424

14. Emergency doctors grapple with abortion bans. AAMC. Accessed December 15, 2024. https://www.aamc.org/news/emergency-doctors-grapple-abortion-bans

15. Strasser J, Schenk E, Luo Q, Chen C. Lower obstetrician and gynecologist (OBGYN) supply in abortion-ban states, despite minimal state-level changes in the 2 years post-Dobbs. *Health Aff Sch*. 2024;2(12):qxae162. doi:10.1093/haschl/qxae162

16. Roper KL, Robbins SJ, Day P, Shih G, Kale N. Impact of State Abortion Policies on Family Medicine Practice and Training After Dobbs v Jackson Women's Health Organization. *Ann Fam Med*. 2024;22(6):492-501. doi:10.1370/afm.3183

17. AMA Physician Professional Data™. American Medical Association. January 21, 2025. Accessed January 23, 2025. https://www.ama-assn.org/about/physician-professional-data/ama-physician-professional-data

18. U.S. Physician Workforce Data Dashboard. AAMC. Accessed December 15, 2024. https://www.aamc.org/data-reports/report/us-physician-workforce-data-dashboard

19. Wang Y, Weiss KJ. Post-Dobbs Psychiatric Exceptions in Abortion-Restricting States. *Psychiatr Serv*. 2024;75(7):710-712. doi:10.1176/appi.ps.20240212

20. Post-Dobbs State Abortion Restrictions and Protections. LawAtlas. Accessed November 15, 2024. https://lawatlas.org/datasets/post-dobbs-state-abortion-restrictions-and-protections

21. Featured OES Searchable Databases : U.S. Bureau of Labor Statistics. Bureau of Labor Statistics. Accessed December 9, 2024. https://www.bls.gov/oes/data.htm

22. American Hospital Directory - Hospital Statistics by State. Accessed December 9, 2024. https://www.ahd.com/state_statistics.html

23. Bureau UC. 2018 National and State Population Estimates. Census.gov. Accessed November 15, 2024. https://www.census.gov/newsroom/press-kits/2018/pop-estimates-national-state.html

24. Bureau UC. State Population Totals and Components of Change: 2020-2023. Census.gov. Accessed April 27, 2024. https://www.census.gov/data/tables/time-series/demo/popest/2020s-state-total.html

25. Movement Advancement Project | Snapshot: LGBTQ Equality by State. Accessed August 13, 2024. https://www.lgbtmap.org/equality-maps

26. Strasser J, Schenk E, Luo Q, Chen C. Lower OBGYN Supply in Abortion Ban States, Despite Minimal State-Level Changes in the 2 Years Post-Dobbs. *Health Aff Sch*. Published online November 27, 2024:qxae162. doi:10.1093/haschl/qxae162

27. Health Disparities in Rural Women. Accessed January 23, 2025. https://www.acog.org/clinical/clinical-guidance/committee-opinion/articles/2014/02/health-disparities-in-rural-women

28. Bindeman J, Jarvis J. The Complex Relationship Between Abortion, Politics, and Religion. In: Bindeman J, ed. *The Mental Health Clinician's Handbook for Abortion Care*. Springer Nature Switzerland; 2024:221-234. doi:10.1007/978-3-031-61453-8_14

29. Xierali IM, Nivet MA, Rayburn WF. Relocation of Obstetrician–Gynecologists in the United States, 2005–2015. *Obstet Gynecol*. 2017;129(3):543. doi:10.1097/AOG.0000000000001901

30. Hammoud MM, Morgan HK, George K, et al. Trends in Obstetrics and Gynecology Residency Applications in the Year After Abortion Access Changes. *JAMA Netw Open*. 2024;7(2):e2355017. doi:10.1001/jamanetworkopen.2023.55017

31. Marshall AL, Sharma D, Hsu G, Pecker LH, Cushman M. Abortion access and the US medical workforce: a looming crisis for hematology. *Lancet Haematol*. 2022;9(12):e874-e875. doi:10.1016/S2352-3026(22)00324-6

32. Pfannenstiel K. Idaho is losing OB-GYNs after strict abortion ban. But health exceptions unlikely this year. • Idaho Capital Sun. Idaho Capital Sun. April 5, 2024. Accessed November 27, 2024. https://idahocapitalsun.com/2024/04/05/idaho-is-losing-ob-gyns-after-strict-abortion-ban-but-health-exceptions-unlikely-this-year/

33. Palermo A. Idaho has lost 22% of its practicing obstetricians in the last 15 months, report says. Idaho Statesman. February 20, 2024. Accessed December 16, 2024. https://www.idahostatesman.com/living/health-fitness/article285692341.html

34. News ABC. Idaho hospital says it is ending labor and delivery services amid "political climate." ABC News. Accessed December 16, 2024. https://abcnews.go.com/Health/idaho-hospital-ending-labor-delivery-services-amid-political/story?id=98038409

35. Cross-state licensing process now live in 30 states. American Medical Association. April 26, 2021. Accessed February 2, 2025. https://www.ama-assn.org/practice-management/digital/cross-state-licensing-process-now-live-30-states

CHAPTER 5: Conclusion

Research Summary

This research aimed to assess the associations between changes in abortion law and travel behavior, infant mortality, and physician supply. Using a variety of statistical methods chosen to best suit the specific research questions for each section and the available data for section outcomes, we have been able to identify an association between changes in travel for abortions to the state of Colorado by out-of-state residents and changes in abortion access. Infant mortality data was found to have associations with pre-existing differences among states based on categorization of whether or not they would later move to restrict abortion. Furthermore, there are found signals that the gaps between state-level infant mortality associated with abortion laws may be widening for some groups of infants in data disaggregated by race and ethnicity. Likewise, the pre-existing state-level physician supply for OBGYNs and psychiatrists was found to be significantly associated with eventual state-level differences in abortion access after the *Dobbs v. Jackson Women's Health Organization (Dobbs)*[1] decision.

The second chapter of this analysis focused on travel into Colorado, an abortion-rights protective state. In addition to providing significant evidence on the increase in travel behavior of out-of-state residents into Colorado for abortions associated with changes in the law, a secondary analysis beyond what is included here was able to demonstrate changes in abortion utilization for in-state residents as well, in what may be some of the first research studying how residents of abortion rights protective states may have experienced changes after the *Dobbs* decision.

The infant mortality analysis in the third chapter took the step of disaggregating data by race, ethnicity, and cause of death to determine if the overall changes found by other researchers were distributed equally among groups, going beyond the overall aggregated associations in other published works[2]. The results show that there are indeed differential associations, providing more evidence about the relationships between policy and health outcomes for racial and ethnic groups in comparison to one another, as well as between states regarding differences in legal access. In order to address differential health outcomes, we must first determine whether and to what extent those differences exist at all[3]. Work such as this helps to lay the foundation for policymakers, providers, and health systems, creating evidence to demonstrate when decisions may impact people in different ways, particularly when those decisions may exacerbate already inequal health outcomes. Additional analyses beyond the scope of this dissertation focused with specificity on infant mortality in the state of Texas. Due to pre-*Dobbs* changes to abortion access in that state, there is more post-intervention data available to study how the changes in the law are associated with infant mortality[4]. Those additional nine months of data may serve, with time, as a preliminary indicator of the trends we may begin seeing in states that moved to enact restrictions in the wake of *Dobbs.*

Finally, the fourth chapter focused on the association between the supply of different specialties in medicine with abortion law, finding significantly fewer practicing obstetricians/gynecologists and psychiatrists in states that later moved to enact abortion restrictions. The available number of physicians practicing in each state is a crucial component of the healthcare system and a piece of the structural determinants of health[5,6]. The state level landscape of obstetricians and gynecologists is quite varied and related to the existence of maternity care deserts in rural areas in particular[7–9]. As was shown here, that pre-existing variation occurred in association with the eventual decisions states made regarding abortion access. There is nothing to indicate that it is worsening in states with abortion restrictions as of data from the end of 2023. It will be important to follow this over time to see if changes to baseline physician supply in these specialties which are already differential by abortion law begin to shift.

The Contribution of this Work

The value of this work is that it builds on growing evidence in a rapidly changing setting to a body of literature regarding the links between abortion access and health outcomes. The novelty of these changes in abortion access present a wide array of unknowns and uncertainty, and work such as this helps to fill some of the gaps created by sudden policy changes.

The public health and ethical implications of the findings identified in this research are worthy of discussion here. First, regarding the travel segment of the research, it is important to recognize that data can only represent those who were able to travel. This truth leaves out all those who were unable to travel for any reason, whether it was related to cost, stigma, fear of prosecution or civil lawsuits upon return, lack of available time off work or lack of childcare. The implication here is that those least able to travel are likely to consequently be the most likely to continue pregnancies that might have been terminated had local access to abortion been more readily available. In effect, privilege here works to allow continued access to abortion through travel to other states. Abortion travel funds may serve to help alleviate some of the financial costs when available in sufficient amount but cannot address the other aspects.

Regarding infant mortality, there are several implications based on our findings. Any sudden increase in the absolute rate of aggregate infant mortality is an enormous red flag waving in our faces that something is very wrong. For it to be appearing in this vulnerable group of our population is especially concerning, particularly given that the downward trend in infant mortality has been ongoing for decades.[10] There is evidence of substantially higher infant mortality in the states that moved to restrict abortion access even before they did so – which indicates potential deficiencies in their overall public health system, medical system, social support structure, and perhaps other societal programs which may not be yielding enough protective qualities for the infants of those states. Those differences in comparison with protective states increased after abortion laws changed, indicating that there may be additional harms associated with those laws for the infants in these states. We have failed abundantly in the pursuit of the twin aims of public health because we have not been able to adequately address the mechanisms allowing racial and ethnic disparities to persist in infant mortality, and in some cases, worsen.[11] As this work builds on evidence of even more harms being distributed in an unequal manner, I believe we have an ethical duty to shine light on these differences and demand better of our systems and structures. These rates were already higher for non-white infants, and here there is some evidence that things are getting even worse – the gap is indeed growing. When the stated intent of many of these laws is to protect life, all these results run in direct contradiction of that intent, providing evidence instead that abortion restrictions are temporally associated with increases in infant mortality.

The identified association of physician supply with abortion law also carries implications, for there are already fewer OBGYNs available in states with abortion restrictions, often overlapping locations known to fit the definition of maternity care deserts[7,12]. If physicians do begin to leave these states in response to changes in the law, this may worsen over time, further exacerbating shortages of providers in these areas. Even if these physicians do not leave abortion-restrictive states, there is already a statistically significant difference in the availability of providers when compared with abortion rights- protective states, which could carry downstream consequences for both maternal and infant mortality among other health outcomes.[13] This research also identified that psychiatrists are significantly fewer in states with restrictions, and the long-term impacts of this shortage may be felt in several ways, some of which may be connected to abortion care restrictions.[14,15]

Additionally, it is worth mentioning that these laws are nearly always passed in conflict with the will of the people, violating the ethical ideal that elected representatives function in alignment with the desire and best interests of their constituents.[16]

Strengths and Limitations of this Research

This research draws its conclusions using models designed to analyze the temporal associations between changes in policy and law and health, providing a stronger link between the exposures and outcomes in a causal framework than simple associations. Use of predominately publicly available data is also a strength here because of my expressed interest in having data open to the public and encouragement of replication. Communities deserve to have full access to information about the drivers of health and how changes in policy may be impacting groups differentially. This work also includes a substantial amount of sensitivity analyses which utilize slightly different mechanisms, may include slightly different periods, or make slightly different assumptions, nearly all of which agree with the primary results, lending robustness to the findings.

There are limitations warranting discussion as well, related to limitations in the model selection, limitations in the data itself, and limitations to inference and generalizability. Model selection can potentially be a concern because choices in selected model are necessarily defined by the assumptions each model makes, and under what circumstances they best perform. Every attempt has been made to select the best fitting model, though there is a recognition that there may be alternatives. Specifically, generalized estimating equations function best in larger data sets, and here we are necessarily constrained by the number of states, plus DC. Much of the outcome data used in the first and second chapters of this dissertation are preliminary and may change prior to finalization. Given the public health significance of this research, it was important to continue with the work even with this limitation. Data suppression rules, particularly in the context of a rare outcome such as infant mortality, have meant that I was unable to disaggregate race and ethnicity data with desired granularity, instead being forced to group other race categories together in order to have enough observations. There is always the potential of residual confounding in adjusted models and the possibility of uncontrolled confounding for variables we have neglected to include in the analysis. Generalizability may be an issue, especially in the travel portion of this work, as geography and distance needed to travel are crucial elements in the decision-making process for people seeking abortions. Colorado is uniquely distant from other large population centers, and the findings here may not be generalizable to other abortion-rights protective states that may be closer to states with restrictions. Finally, all findings here are made at the population level only and cannot be extrapolated to individuals, though the overarching goal of these studies was to assess population health.

Other Potential Implications of Abortion Restrictions and Suggestions for Additional Research

Beyond the outcomes studied here, there are many other potential implications of restrictions to abortion and limitations on reproductive autonomy. It is well documented that abortion is safer than pregnancy, with deaths related to abortions estimated at only 0.43 per 100,000 abortions[17] while there are 23.8 deaths related to pregnancy for every 100,000 live births[18]. Many researchers are currently studying changes to maternal mortality in association with access changes presently. The risks of pregnancy include gestational diabetes, hypertension of pregnancy, blood clots, anemia, bleeding, eclampsia and more.[19] Denial of abortion can result in changes to economic trajectory[20] and cause mental health impacts[21]. Delays in abortion can also result in pregnancies being revealed, which may carry consequences for the pregnant individual as well. Beyond the pregnant individual, there are potential impacts of denial abortions on existing children[22], the potential for increased utilization of the foster care system[23], and an increase in abandoned babies[24].

The changes in legal access may have consequences for the provision of healthcare that extend beyond choice of practice location. Providers may elect to perform anatomy scans or other testing earlier in pregnancy to try and detect anomalies sooner.[25] We may begin to see expansion of providers willing to write prescriptions of medication abortions[26], increased interest in advanced provision or over the counter dispensing[27] and continued increase in self-managed abortion[28]. Although findings here have not yet indicated shifting physician supply in association with abortion law as of the end of 2023, there are indications that medical students may take abortion law into consideration when choosing where to practice, which would have consequences downstream on the supply of physicians.[29]

State laws continue to shift at this writing, and it is unknown how the recent change in the federal administration may affect access to abortion. There are likely to be challenges to medication abortion access, whether through mechanisms related to the Comstock Act, limitations on FDA approvals, or something else entirely.[30] Many states have enacted shield laws to protect providers and patients, though we do not yet know whether they will function as intended under challenge.[31]

Underlying the *Dobbs* decision was an explicitly stated interest in increasing the number of available infants for adoption.[1] In an environment where abortion is banned or inaccessible, it is impossible to believe that reproductive decisions made by pregnant individuals surrounding relinquishment of infants are made from a fully autonomous place.[32(p67)] There are demonstrated substantial differences in the economic status of those who relinquish and those who adopt; parents giving up children having a much lower net worth and lower education level. A stated governmental interest in increasing adoption reeks of inequality in a system that already provides the rich babies from poorer individuals.[33]

Future Directions and Next Steps

In addition to following physician supply data forward in time to further determine if changes to practice location distribution in association with abortion law begins to shift, I will focus the analysis using the combined exposure metric which includes state-level anti-LGTBQ+

laws. I have been asked to study the connection between abortion law, mental health, and suicide in the United States and will be starting on that work as well.

I intend to explore constructing a tool that will incorporate elements of travel costs along with distance to clinics, gestational week, and other variables in cooperation with faculty in other departments at Colorado State once I have defended this portion of my work. I will also be embarking on writing a manuscript, or perhaps even a book, on the ethical issues surrounding abortion restrictions with a collaborator from the University of Colorado at Anschutz.

This work is deeply personal and important to me, and I will keep doing my best to create reliable, robust evidence of the impacts of changes in legal access to abortion.

References

1. Dobbs v. Jackson Women's Health Organization :: 597 U.S. ___ (2022) :: Justia US Supreme Court Center. Accessed December 5, 2023. https://supreme.justia.com/cases/federal/us/597/19-1392/

2. Singh P, Gallo MF. National Trends in Infant Mortality in the US After *Dobbs*. *JAMA Pediatr*. Published online October 21, 2024. doi:10.1001/jamapediatrics.2024.4276

3. Ramos SZ, Rose B, Werner EF, Amutah-Onukagha N, Siegel M. Systemic racism and Non-Hispanic Black to Non-Hispanic White disparities in infant mortality at the county level. *J Perinatol*. 2024;44(12):1724-1731. doi:10.1038/s41372-024-02048-5

4. Gemmill A, Margerison CE, Stuart EA, Bell SO. Infant Deaths After Texas' 2021 Ban on Abortion in Early Pregnancy. *JAMA Pediatr*. 2024;178(8):784-791. doi:10.1001/jamapediatrics.2024.0885

5. Barreto T, Jetty A, Eden AR, Petterson S, Bazemore A, Peterson LE. Distribution of Physician Specialties by Rurality. *J Rural Health*. 2021;37(4):714-722. doi:10.1111/jrh.12548

6. Basu S, Berkowitz SA, Phillips RL, Bitton A, Landon BE, Phillips RS. Association of Primary Care Physician Supply With Population Mortality in the United States, 2005-2015. *JAMA Intern Med*. 2019;179(4):506-514. doi:10.1001/jamainternmed.2018.7624

7. Fontenot J, Brigance C, Lucas R, Stoneburner A. Navigating geographical disparities: access to obstetric hospitals in maternity care deserts and across the United States. *BMC Pregnancy Childbirth*. 2024;24:350. doi:10.1186/s12884-024-06535-7

8. Sonenberg A, Mason DJ. Maternity Care Deserts in the US. *JAMA Health Forum*. 2023;4(1):e225541. doi:10.1001/jamahealthforum.2022.5541

9. Where You Live Matters: Maternity Care Deserts and the Crisis of Access and Equity. Accessed January 2, 2025. https://www.marchofdimes.org/maternity-care-deserts-report-2023

10. MacDorman MF, Mathews TJ. The Challenge of Infant Mortality: Have We Reached a Plateau? *Public Health Rep*. 2009;124(5):670. doi:10.1177/003335490912400509

11. Faden RR, Powers M. Health inequities and social justice. The moral foundations of public health. *Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz*. 2008;51(2):151-157. doi:10.1007/s00103-008-0443-7

12. Strasser J, Schenk E, Luo Q, Chen C. Lower OBGYN Supply in Abortion Ban States, Despite Minimal State-Level Changes in the 2 Years Post-Dobbs. *Health Aff Sch*. Published online November 27, 2024:qxae162. doi:10.1093/haschl/qxae162

13. Labor pains: The OB-GYN shortage. AAMC. Accessed February 10, 2025. https://www.aamc.org/news/labor-pains-ob-gyn-shortage

14. Wang Y, Weiss KJ. Post-Dobbs Psychiatric Exceptions in Abortion-Restricting States. *Psychiatr Serv*. 2024;75(7):710-712. doi:10.1176/appi.ps.20240212

15. Biggs MA, Kaller S, Ralph L. Barriers accessing abortion care and their association with psychological well-being. *Contraception*. 2020;101(5):355. doi:10.1016/j.contraception.2020.03.010

16. Public Opinion on Abortion. Pew Research Center. May 13, 2024. Accessed October 17, 2024. https://www.pewresearch.org/religion/fact-sheet/public-opinion-on-abortion/

17. Kortsmit K. Abortion Surveillance — United States, 2020. *MMWR Surveill Summ*. 2022;71. doi:10.15585/mmwr.ss7110a1

18. Hoyert DL. Maternal Mortality Rates in the United States, 2020. Accessed January 20, 2025. https://stacks.cdc.gov/view/cdc/113967

19. Keegan G, Francis M, Chalmers K, et al. Trauma of abortion restrictions and forced pregnancy: urgent implications for acute care surgeons. *Trauma Surg Acute Care Open*. 2023;8(1). doi:10.1136/tsaco-2022-001067

20. Foster DG, Biggs MA, Ralph L, Gerdts C, Roberts S, Glymour MM. Socioeconomic Outcomes of Women Who Receive and Women Who Are Denied Wanted Abortions in the United States. *Am J Public Health*. 2018;108(3):407-413. doi:10.2105/AJPH.2017.304247

21. Londoño Tobón A, McNicholas E, Clare CA, et al. The end of Roe v. Wade: implications for Women's mental health and care. *Front Psychiatry*. 2023;14. doi:10.3389/fpsyt.2023.1087045

22. Foster DG, Raifman SE, Gipson JD, Rocca CH, Biggs MA. Effects of Carrying an Unwanted Pregnancy to Term on Women's Existing Children. *J Pediatr*. 2019;205:183-189.e1. doi:10.1016/j.jpeds.2018.09.026

23. Abortion Restrictions May Be Linked to Rise in Children Entering Foster Care | Harvard Medical School. November 16, 2023. Accessed January 3, 2025. https://hms.harvard.edu/news/abortion-restrictions-may-be-linked-rise-children-entering-foster-care

24. Number of babies abandoned in Texas twice what it was 10 years ago as abortion restrictions tighten. Yahoo News. December 31, 2024. Accessed January 3, 2025. https://www.yahoo.com/news/number-babies-abandoned-texas-more-013035407.html

25. More patients rely on early prenatal testing as states toughen abortion laws. PBS News. February 13, 2024. Accessed January 20, 2025.

https://www.pbs.org/newshour/health/more-patients-rely-on-early-prenatal-testing-as-states-toughen-abortion-laws

26. Raifman S, Gurazada T, Beaman J, et al. Primary care and abortion provider perspectives on mail-order medication abortion: a qualitative study. *BMC Womens Health*. 2024;24:382. doi:10.1186/s12905-024-03202-z

27. Biggs MA, Schroeder R, Kaller S, Grossman D, Scott KA, Ralph LJ. Changes in Support for Advance Provision and Over-the-Counter Access to Medication Abortion. *JAMA Netw Open*. 2025;8(1):e2454767. doi:10.1001/jamanetworkopen.2024.54767

28. Ralph L, Schroeder R, Kaller S, Grossman D, Biggs MA. Self-Managed Abortion Attempts Before vs After Changes in Federal Abortion Protections in the US. *JAMA Netw Open*. 2024;7(7):e2424310. doi:10.1001/jamanetworkopen.2024.24310

29. Training Location Preferences of U.S. Medical School Graduates Post Dobbs v. Jackson Women's Health. Research and Action Institute. doi:10.15766/rai_2rw8fvba

30. What Trump's 2024 election win could mean for abortion rights in the U.S. Accessed January 20, 2025. https://www.nbcnews.com/health/womens-health/abortion-rights-under-trump-rcna178998

31. Abortion Shield Laws: A New War Between the States - The New York Times. Accessed April 13, 2024. https://www.nytimes.com/2024/02/22/health/abortion-shield-laws-telemedicine.html

32. Sisson GE. *Relinquished: The Politics of Adoption and the Privilege of American Motherhood*. First edition. St. Martin's Press; 2024.

33. Ge X, Natsuaki MN, Martin D, et al. Bridging the Divide: Openness in Adoption and Post-adoption Psychosocial Adjustment among Birth and Adoptive Parents. *J Fam Psychol JFP J Div Fam Psychol Am Psychol Assoc Div 43*. 2008;22(4):529-540. doi:10.1037/a0012817

APPENDICES

APPENDIX A

Abortion Changes Among Residents of an Abortion Rights Protective State

There have been substantial changes in abortion access at the state and national level. Texas state legislators passed SB8 in 2021, enacting a six-week gestational limit.(1) Access to safe, legal abortion is necessary for comprehensive healthcare.(2) While research has focused on residents of states enacting restrictions, less is known about changes for residents of states where abortion access remains legal. Colorado is a full abortion access state with no gestational limitations.(3) Leveraging data on abortion procedures performed in Colorado, we sought to determine whether SB8 in Texas was associated with changes in abortion for Colorado residents.

Methods: We analyzed monthly abortion count data from January 2018- June 2024 from the Colorado Department of Public Health and Environment, including information on residence state and gestational week at the time of the abortion. Generalized linear Quasi-Poisson regression interrupted time series models compared rates before and after changes in the law, adjusting for both long-term time trends and seasonality using September 2021 as the interruption point. We assumed no confounders beyond time and selected a study design well-suited to analyze policy change using repeated observations of data. No lag-to-effect was included given the time-limited nature inherent in pregnancy. This study was deemed exempt by the Colorado State University Institutional Review Board. We adhered to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guidelines.

Results: The percentage of abortions provided in Colorado to out-of-state residents increased from 13% in 2020 to 30% in 2023. Figure A1 shows raw data for Texas residents traveling to Colorado for abortions and indicates a clear rise after the implementation of SB8. Figure A2 visualizes the raw data for Colorado residents using the same interruption point, showing an increase in second trimester procedures temporally matching the demand for procedures from Texas residents, peaking six months after SB8. Adjusting for time trends, regression results show that Colorado residents were overall 11% more likely to have procedures in the first trimester, and 83% more likely to have procedures in the second trimester after SB8 compared to the time before Texas SB8. Rate Ratio (RR) First trimester: 1.11, 95% confidence interval (CI): 1.00, 1.24, p=0.04; Second trimester:1.83, 95% CI: 1.55-2.17, p<0.001.

Discussion: We found a statistically significant increase in abortions for Colorado residents in association with the implementation of Texas' SB8. This aligns with reports from area clinicians who experienced dramatic increases in patient demand after SB8, also reported by the media, resulting in delayed appointments for everyone.(4) Second trimester findings concur with the work of Dindinger, et al, who previously studied changes in gestational age at the time of abortion in Colorado through the end of 2022 in association with SB8.(5) Potential consequences of delayed procedures for may include increased cost, increased complexity of the procedure, the emotional toll of waiting, and the potential for having the pregnancy revealed. Although travel from Texas residents to Colorado for abortions has declined, it has not returned to baseline. The increase found in second trimester abortions for Colorado residents appears to have resolved, offering reassurance of healthcare capacity to adjust to increased demand. Expanded access to telehealth services, increased self-managed abortion or care in other protective states may also be alleviating strain on the system.(6) Strengths of this study include the use of monthly data in the selected design. The possibility of unmeasured confounding, the available data representing a likely undercounting of abortions, and residence misclassification are potential limitations of these findings. We also recognize that these data can only capture information for those able to travel, and do not include individuals without the money, support, and resources to do so.

Figure A1: Raw Texas resident monthly abortion counts in Colorado. Vertical line indicates implementation date of SB8.

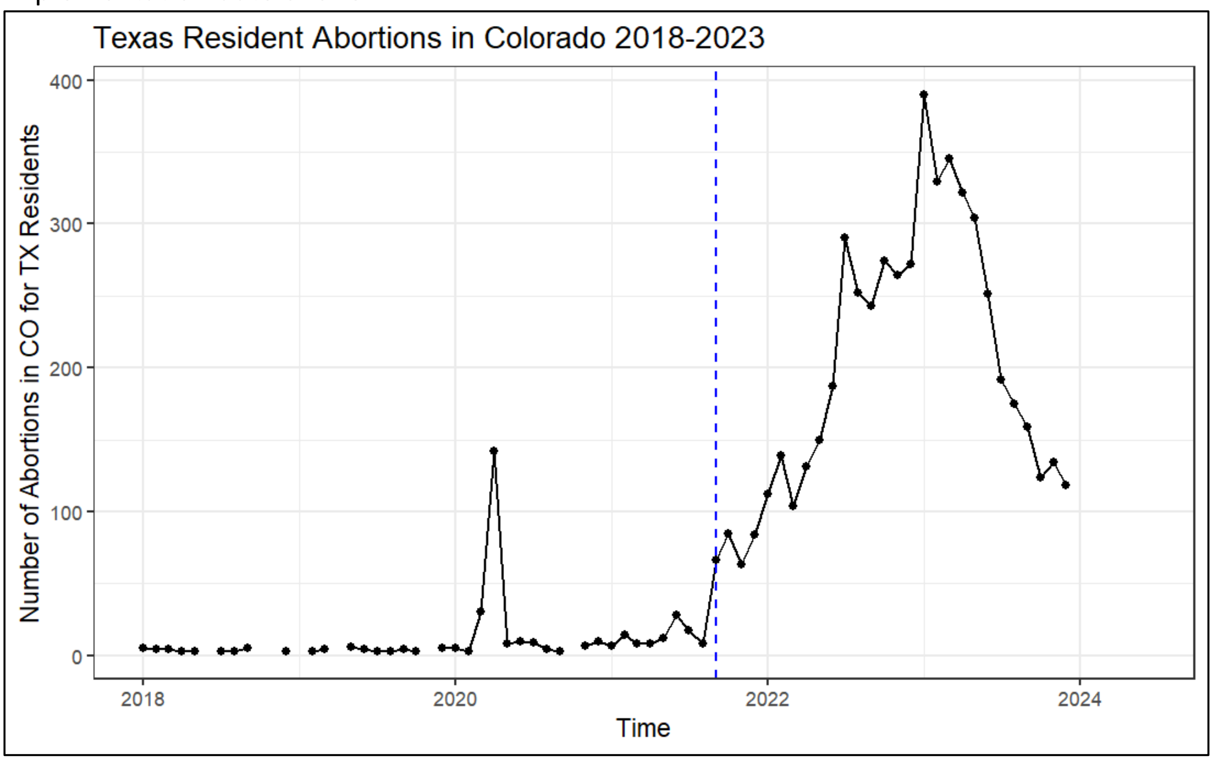
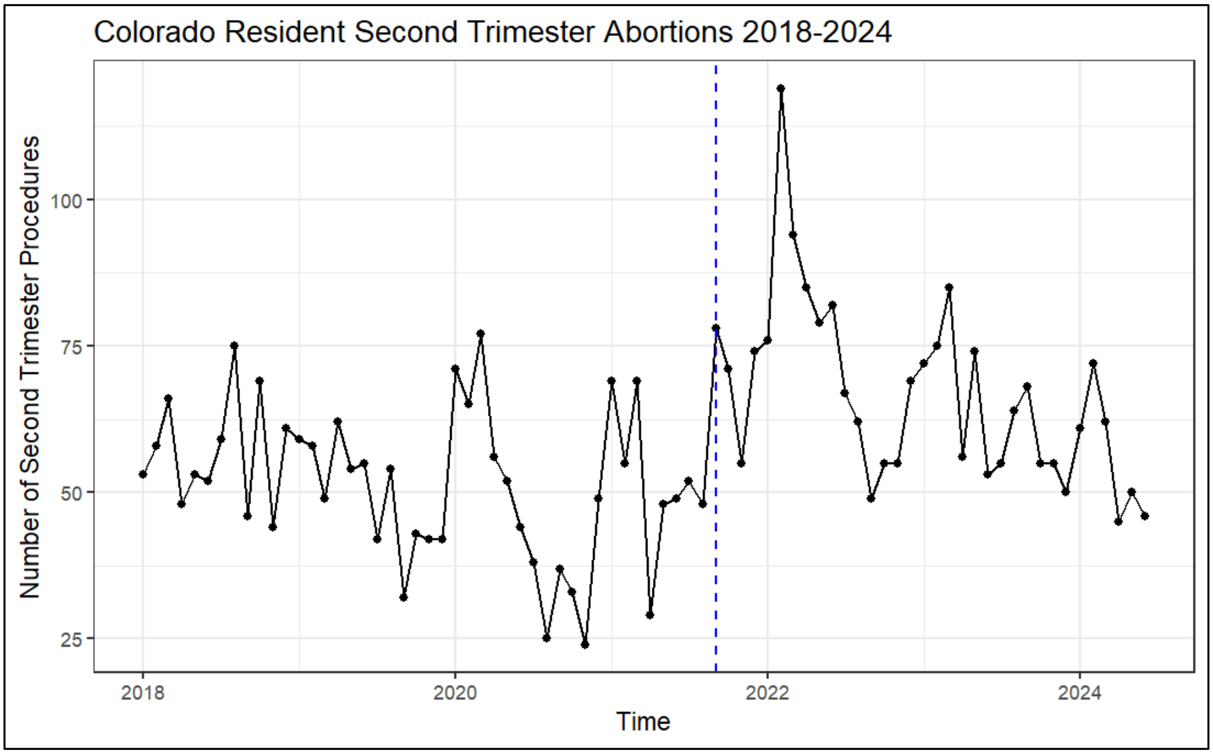


Figure A2: Raw monthly second trimester abortion counts. Vertical line indicates implementation date of Texas SB8.



References:

1. Hughes B. The Texas Heartbeat Act [Internet]. Chapter 171, Health and Safety Code, SB 8 Sep 1, 2021. Available from: https://capitol.texas.gov/tlodocs/87R/billtext/html/SB00008F.HTM

2. Espey E, Dennis A, Landy U. The importance of access to comprehensive reproductive health care, including abortion: a statement from women's health professional organizations. Am J Obstet Gynecol. 2019 Jan 1;220(1):67–70.

3. Center for Reproductive Rights [Internet]. [cited 2023 Dec 1]. Colorado. Available from: https://reproductiverights.org/maps/state/colorado/

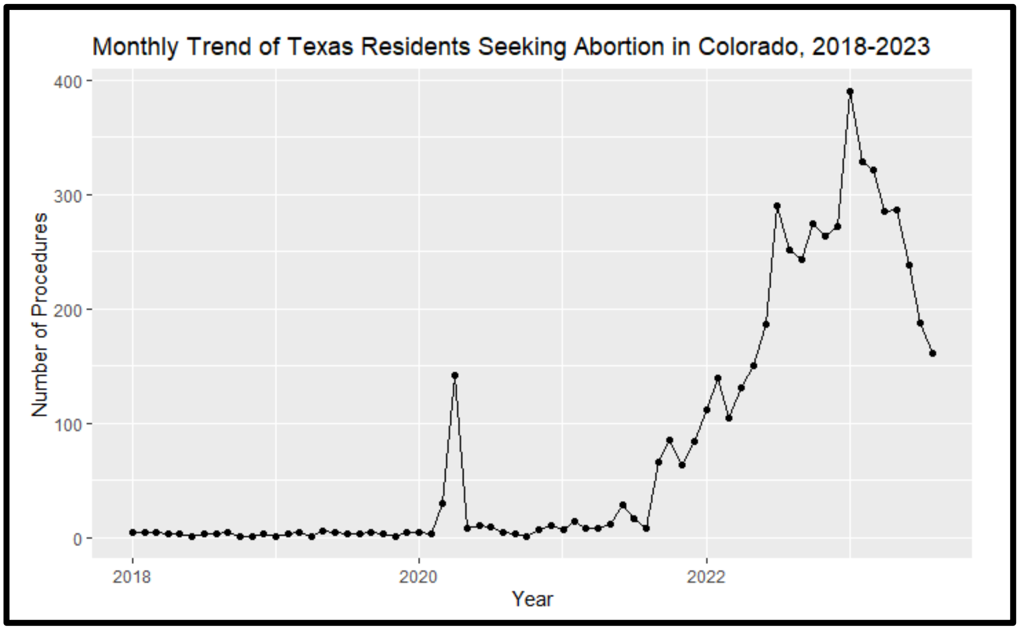
4. Sneed T. CNN. 2022 [cited 2024 Nov 23]. Texas abortion seekers flooded out-of-state clinics after six-week ban went into effect | CNN Politics. Available from: https://www.cnn.com/2022/02/24/politics/abortion-texas-clinics-surge/index.html

5. Dindinger E, Coleman-Minahan K, Sheeder J, Fang N. O07The impact of the texas abortion ban on gestational age at time of abortion in a large-volume colorado clinic. Contraception. 2022 Dec 1;116:70.

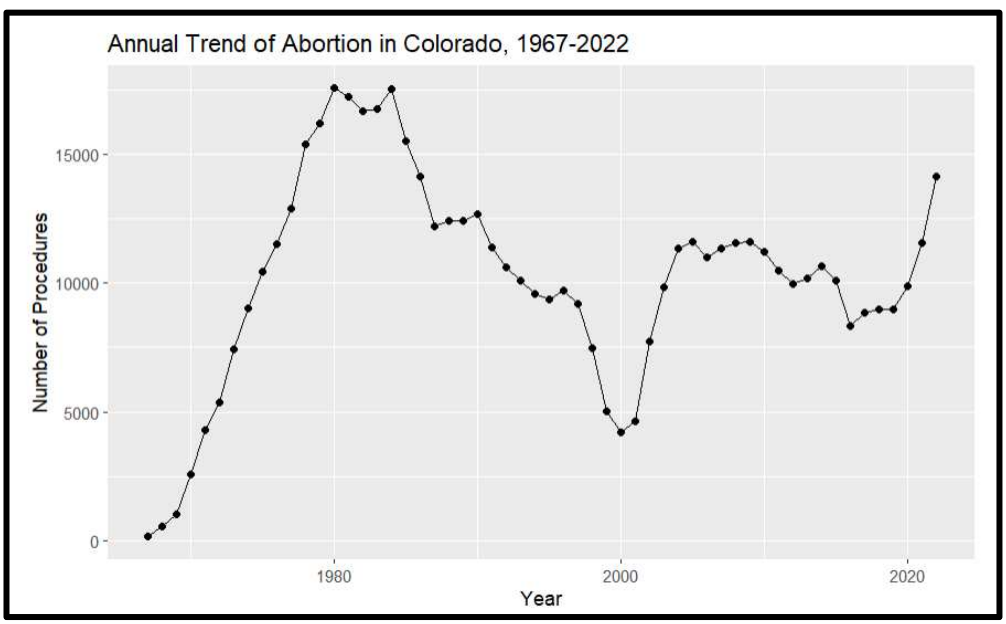
6. #WeCount report April 2022 through June 2024 [Internet]. Society of Family Planning; 2024 Oct [cited 2024 Oct 23]. Available from: https://societyfp.org/wecount-report-8-june-2024-data/

APPENDIX B

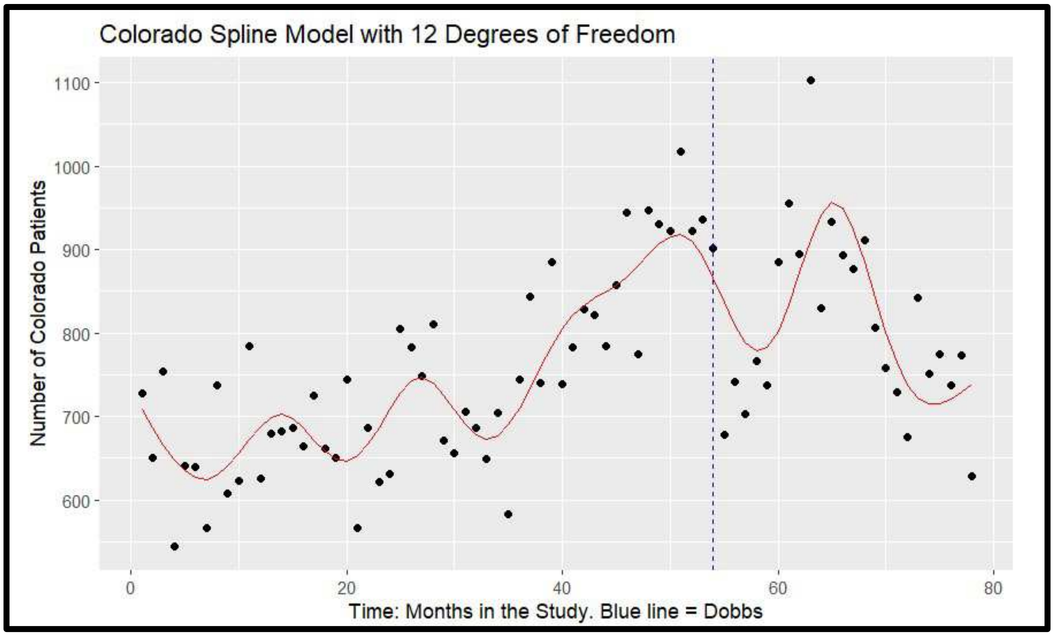
Supplemental Materials for Chapter 2 - Association of Reproductive Access Restrictions and Out-of-State Abortion Care in Colorado, an Interrupted Time Series Analysis for 2018-2024



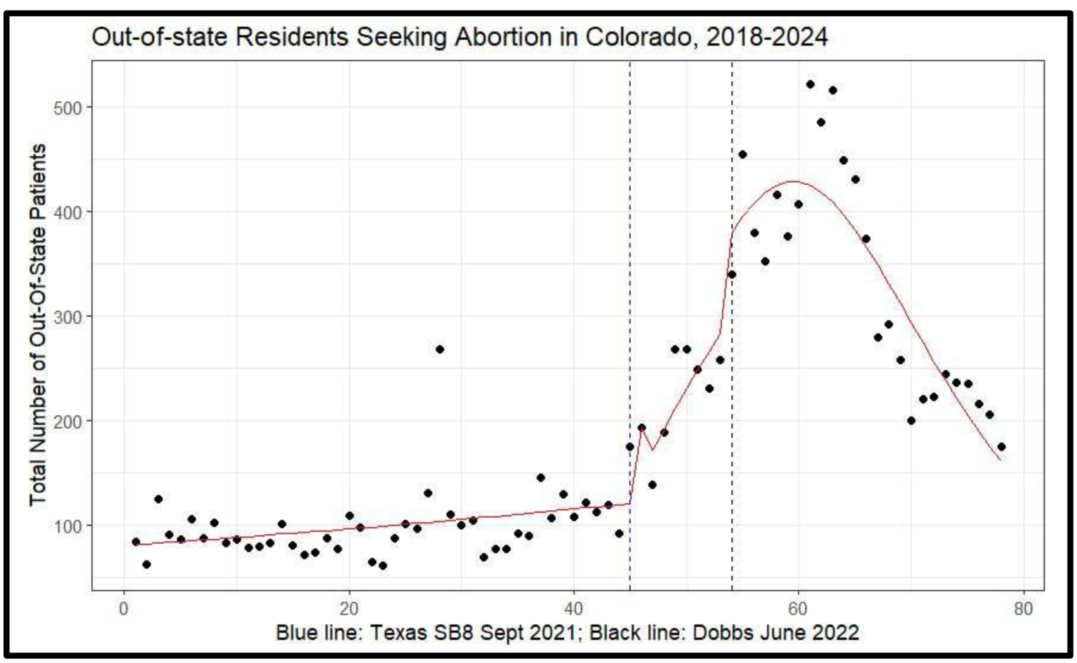
Supplemental Figure B1: Texas Residents Seeking Abortion in Colorado, 2018-2023. Each dot represents monthly count of patients.



Supplemental Figure B2: Annual Trend of All Abortions Occurring in Colorado, 1967-2022. Each dot represents monthly count of patients.



Supplemental Figure B3: Count data for Colorado residents seeking abortion in Colorado, 2018-2023. Each dot represents monthly count of patients. Vertical line indicates legal change under analysis. Red line represents fitted predictions from natural spline fit for time with 12 degrees of freedom for full time period under study.



Supplemental Figure B4: Count data for all out-of-state residents seeking abortion in Colorado. Vertical lines indicate legal changes under analysis. Each dot represents monthly count of patients. Vertical line indicates legal change under analysis. Red line represents fitted predictions from natural spline fit for time with 5degrees of freedom for full time period under study.

Supplemental Table B1: Selected Point Estimates and Confidence Intervals for Linear Time, Indicated by the Change in Number of Abortions by Residence per Month. Results shown with modeled interruption point. P-values included for interpretation due to very small estimates and narrow confidence intervals.

	Rate Ratio & 95% Confidence Interval for Time	p-value for time
Post-Dobbs Analysis (Dobbs)	1.01 (1.00, 1.01)	0.062
Post-Dobbs Analysis excluding TX (Dobbs)	1.01 (1.00, 1.01)	0.030
Colorado (Dobbs)	1.01 (1.00, 1.01)	<0.001
Proximal Protective States (Dobbs)	1.00 (1.00, 1.01)	0.041
Proximal Restrictive States (Dobbs)	1.03 (1.02, 1.04)	<0.001
Texas (SB8)	1.03 (1.01, 1.05)	0.009
Wyoming (SB8)	1.00 (1.00, 1.01)	0.999

APPENDIX C

Supplemental Materials for Chapter 3 - Association Between Abortion Access and Infant Mortality in the US by Race, Ethnicity and Cause

Supplemental Table C1: ICD-10 Subcategories for P-Codes and Q-Codes.

P-Codes	
P00-P04	Newborn affected by maternal factors and by complications of pregnancy, labor, and delivery
P05-P08	Disorders of newborn related to length of gestation and fetal growth
P09	Abnormal findings on neonatal screening
P10-P15	Birth trauma
P19-P29	Respiratory and cardiovascular disorders specific to the perinatal period
P35-P39	Infections specific to the perinatal period
P50-P61	Hemorrhagic and hematological disorders of newborn
P70-P74	Transitory endocrine and metabolic disorders specific to newborn
P76-P78	Digestive system disorders of newborn
P80-P83	Conditions involving the integument and temperature regulation of newborn
P84	Other problems with newborn
P90-P96	Other disorders originating in the perinatal period
Q-Codes	
Q00-Q07	Congenital malformations of the nervous system
Q10-Q18	Congenital malformations of the eye, ear, face, and neck
Q20-Q28	Congenital malformations of the circulatory system
Q30-Q34	Congenital malformations of the respiratory system
Q35-Q37	Cleft lip and cleft palate
Q38-Q45	Other congenital malformations of the digestive system
Q50-Q56	Congenital malformations of the genital organs
Q60-Q64	Congenital malformations of the urinary system
Q65-Q79	Congenital malformations and deformations of the musculoskeletal system
Q80-Q89	Other congenital malformations
Q90-Q99	Chromosomal abnormalities, not elsewhere classified

Supplemental Table C2: Mean covariate values based on categorical exposure. Year specific mean mortality rates presented, grouped by *protective, moderately restrictive* and *most restrictive* exposure.

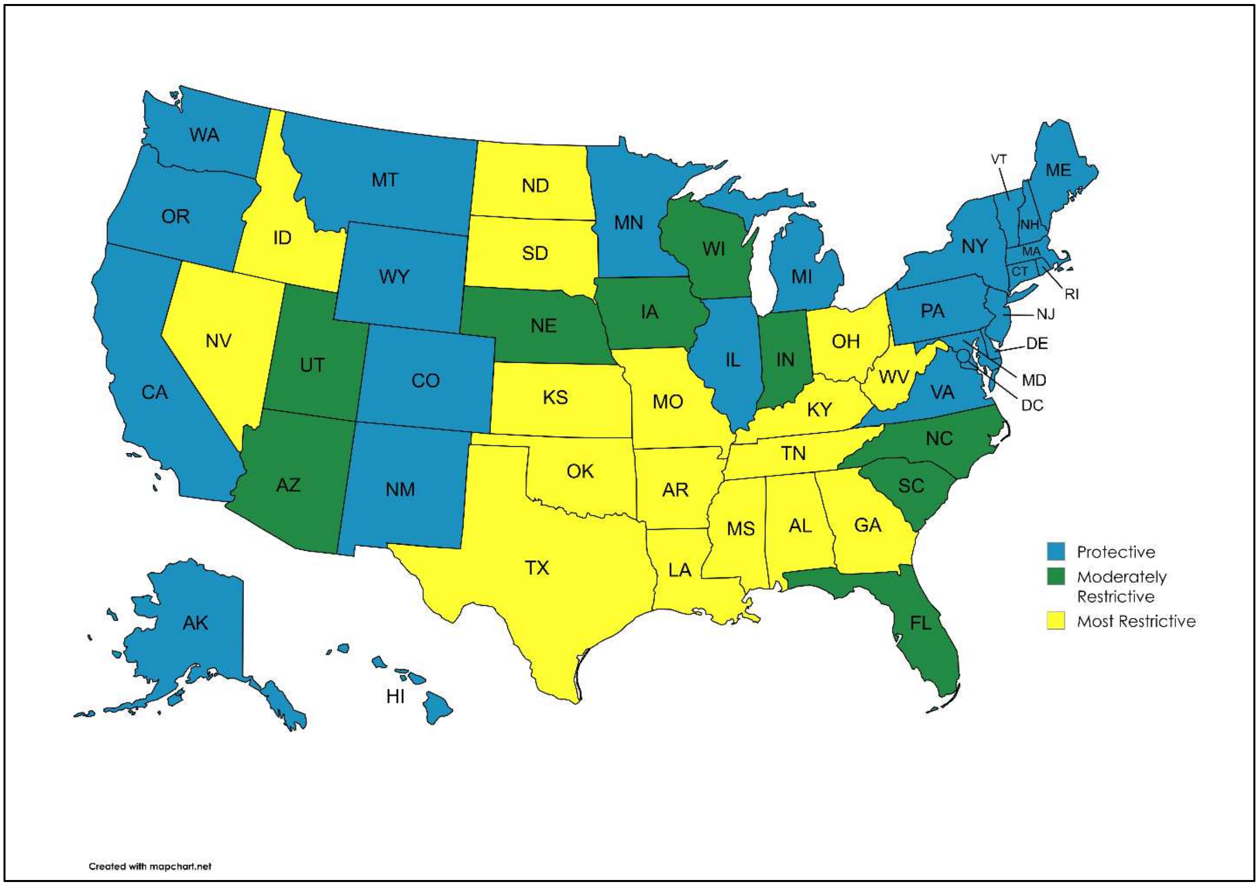
	Protective States + DC (N=26)	Moderately Restrictive States (N=10)	Most Restrictive States (N=15)
Covariates			
Diversity Index	52.0	47.4	46.2
Average Pre-Pregnancy BMI	27.3	27.7	28.1
% Smoking During Pregnancy	5.0	5.7	8.2
Poverty Rate	11.2	11.8	14.7
Total Fertility Rate	1560	1750	1780
2018/2019 Mortality Rates (per 1000 in the <1yr population)			
All-Cause, Aggregated	5.1	6.0	6.7
Disaggregated by race/ethnicity			
Non-Hispanic Black	11.3	13.8	13.0
Non-Hispanic White	4.1	4.8	5.6
Hispanic	5.0	5.5	5.3
Non-Hispanic Other Races	4.5	5.3	5.2
Cause-Specific, Aggregated			
P-Codes	2.5	2.8	3.0
Q-Codes	1.0	1.3	1.5
2023 Mortality Rates (per 1000 in the <1yr population)			
All-Cause, Aggregated	4.9	6.0	6.6
Disaggregated by race/ethnicity			
Non-Hispanic Black	9.0	12.2	12.4
Non-Hispanic White	4.0	4.8	5.4
Hispanic	5.0	5.9	5.7
Non-Hispanic Other Races	3.9	5.9	6.1
Cause-Specific, Aggregated			
P-Codes	2.5	3.0	3.0
Q-Code	0.9	1.2	1.4

Supplemental Table C3: Rate ratio, 95% confidence interval and p-value for Poisson regression models using annual state-level count data with population offset, shown with crude and adjusted estimates, comparing moderately restrictive and most restrictive states to protective states for each timepoint using categorical exposure. Protective states are set as the reference category.

	Moderately Restrictive States		**Most Restrictive States**	
	Crude	**Adjusted**	**Crude**	**Adjusted**
2018/2019				
All-Cause	1.26 (1.23, 1.29), p<0.001	1.18 (1.14, 1.22), p<0.001	1.33 (1.31, 1.36), p<0.001	1.16 (1.12, 1.21), p<0.001
Non-Hispanic Black	1.21 (1.16, 1.27), p<0.001	1.19 (1.12, 1.25), p<0.001	1.16 (1.12, 1.21), p<0.001	1.17 (1.10, 1.25), p<0.001
Non-Hispanic White	1.22 (1.18, 1.27), p<0.001	1.15 (1.10, 1.21), p<0.001	1.39 (1.34, 1.44), p<0.001	1.20 (1.13, 1.27), p<0.001
Hispanic	1.20 (1.14, 1.27), p<0.001	1.09 (1.01, 1.17), p=0.02	1.12 (1.07, 1.18), p<0.001	1.05 (0.95, 1.17), p=0.33
Non-Hispanic Other Races	1.37 (1.25, 1.49), p<0.001	1.19 (1.06, 1.33), p=0.003	1.07 (0.98, 1.16), p=0.07	0.89 (0.77, 1.03), p=0.12
P-Code	1.21 (1.17, 1.25), p<0.001	1.20 (1.15, 1.29), p<0.001	1.22 (1.18, 1.26), p<0.001	1.19 (1.13, 1.26), p<0.001
Q-Code	1.31 (1.24, 1.38), p<0.001	1.14 (1.07, 1.23), p<0.001	1.40 (1.33, 1.47), p<0.001	1.11 (1.02, 1.20), p=0.02
2023				
All-Cause	1.32 (1.28, 1.37), p<0.001	1.23 (1.18, 1.29), p<0.001	1.41 (1.37, 1.46), p<0.001	1.22 (1.16, 1.29), p<0.001
Non-Hispanic Black	1.35 (1.26, 1.45), p<0.001	1.29 (1.19, 1.40), p<0.001	1.28 (1.21, 1.37), p<0.001	1.22 (1.10, 1.34), p<0.001
Non-Hispanic White	1.25 (1.18, 1.33), p<0.001	1.17 (1.08, 1.26), p<0.001	1.43 (1.36, 1.51), p<0.001	1.25 (1.14, 1.36), p<0.001
Hispanic	1.29 (1.20, 1.38), p<0.001	1.18 (1.07, 1.29), p<0.001	1.22 (1.15, 1.31), p<0.001	1.09 (0.95, 1.24), p=0.24
Non-Hispanic Other Races	1.59 (1.40, 1.80), p<0.001	1.39 (1.18, 1.63), p<0.001	1.36 (1.21, 1.53), p<0.001	1.17 (0.96, 1.44), p=0.12
P-Code	1.33 (1.26, 1.39), p<0.001	1.30 (1.22, 1.39), p<0.001	1.26 (1.20, 1.32), p<0.001	1.21 (1.12, 1.31), p<0.001
Q-Code	1.30 (1.20, 1.41), p<0.001	1.16 (1.05, 1.28), p=0.005	1.46 (1.36,1.56), p<0.001	1.22 (1.07, 1.38), p=0.002

Supplemental Table C4: Rate ratio, 95% confidence interval and p-value for product term in generalized estimating equation models using annual state level mortality rates, shown with crude and adjusted estimates, comparing moderately restrictive and most restrictive states to protective states over time. Interaction term shown here represents the interaction between the categorical abortion law exposure and time. Protective states are set as the reference category.

	Moderately Restrictive States		**Most Restrictive States**	
	Crude	**Adjusted**	**Crude**	**Adjusted**
All-Cause	1.04 (0.97, 1.11), p=0.32	1.04 (0.97, 1.11), p=0.30	1.02 (0.93, 1.10), p=0.72	1.02 (0.94, 1.10), p=0.70
Non-Hispanic Black	1.10 (0.97, 1.24), p=0.14	1.10 (0.97, 1.25), p=0.15	1.21 (1.09, 1.34), p<0.001	1.22 (1.11, 1.35), p<0.001
Non-Hispanic White	1.00 (0.93, 1.09), p=0.92	1.00 (1.00, 1.00), p=0.76	0.95 (0.87, 1.04), p=0.28	0.95 (0.87, 1.04), p=0.27
Hispanic	1.56 (0.85, 2.86), p=0.16	1.56 (0.85, 2.86), p=0.16	1.61 (0.88, 2.94), p=0.12	1.61 (0.88, 2.94), p=0.12
Non-Hispanic Other Races	1.18 (0.89, 1.58), p=0.25	1.23 (0.92, 1.63), p=0.16	1.34 (1.15, 1.56), p<0.001	1.38 (1.18, 1.62), p<0.001
P-Code	1.08 (0.98, 1.19), p=0.12	1.09 (0.99, 1.20), p=0.10	1.02 (0.91, 1.15), p=0.67	1.03 (0.91, 1.16), p=0.62
Q-Code	0.98 (0.85, 1.13), p=0.83	0.98 (0.85, 1.13), p=0.81	1.00 (0.89, 1.11), p=0.99	1.00 (0.90, 1.11), p=0.98



Supplemental Figure C1: Map of United States plus District of Columbia Showing Categorical Exposure of State-Level Abortion Access Assessed at Year End, 2022. Map created using mapchart.net.

APPENDIX D

Supplemental Materials for Chapter 4 - The Association of Abortion Restrictions and Physician Supply in the United States

In order to assess the association between the combination of abortion and LGBTQ+ state laws, we constructed a leveled categorical variable. To do this, we utilized the same binary variable as described above for abortion law, and data from the Movement Advancement Project for LGBTQ+ laws. The more restrictive a state is regarding LGBTQ+ policies, the lower the score, which includes negative scores for some states. Conversely, a higher MAP score represents a state with policies more protective of the rights of the LGBTQ+ population. Results shown in Supplemental Table D2 indicate that there may be a dose-response type of relationship between overall autonomy restrictions measured by the combination of laws and the supply of OBGYNs and psychiatrists. As the level of restrictions increase, the availability of physicians in those specialties declines in comparison to the reference group. Results for family medicine physicians and orthopedic surgeons were mostly null, with one area of statistical significance within each group.

Supplemental Table D1: Description of combined exposure categories.

Combined Exposure Category	Binary Abortion Law	MAP Score	Number of States
Reference Group	Unexposed/Protective	>10	23
Level 1	Unexposed/Protective	Between (-5) and 10	4
Level 2	Exposed/Restrictive	Any positive MAP score	10
Level 3	Exposed/Restrictive	Between 0 and (-5)	4
Level 4	Exposed/Restrictive	Lower than (-5)	10

Supplemental Table D2: Adjusted rate ratio and 95% confidence interval for negative binomial regression models using a combined exposure metric for abortion law and LGBTQ policy, in comparison with the reference group.

	OBGYNs	**Family Medicine**	**Psychiatrists**	**Orthopedic Surgeons**
Level 1	0.78 (0.64, 0.96), p=0.002	1.59 (1.23, 2.07), p<0.001	0.55 (0.39, 0.80), p<0.001	0.92 (0.67, 1.28), p=0.63
Level 2	0.75 (0.66, 0.84), p<0.001	1.13 (0.93, 1.37), p=0.22	0.54 (0.43, 0.67), p<0.001	0.87 (0.77, 0.99), p=0.03
Level 3	0.74 (0.61, 0.90), p=0.002	0.96 (0.75, 1.25), p=0.75	0.46 (0.33, 0.66), p<0.001	0.99 (0.83, 1.20), p=0.96
Level 4	0.65 (0.57, 0.75), p<0.001	1.08 (0.89, 1.32), p=0.63	0.42 (0.33, 0.54), p<0.001	0.92 (0.79, 1.08), p=0.83

LIST OF ABBREVIATIONS

AAMC – American Association of Medical Colleges

AMA – American Medical Association

BLS – Bureau of Labor Statistics

BMI – Body Mass Index

CDC Wonder - CDC Wide-ranging ONline Data for Epidemiologic Research

CDPHE – Colorado Department of Public Health and Environment

DC – District of Columbia

Dobbs – Dobbs v. Jackson Women's Health Organization

GEE – generalized estimating equation

OBGYN – obstetrician/gynecologist

Moderately Restrictive – categorical exposure states with laws restricting access from after 12 weeks through 23 weeks

Most Restrictive – categorical exposure states with a full ban or access limitations at any point before or until 12 weeks' gestation

Protective – states which are protective of abortion rights, defined as either without gestational limitations or which only limit access at or beyond 24 weeks, in binary and categorical models

Restrictive – binary exposure states which are restrictive of abortion access, defined as any state with a ban or gestational limitation in effect prior to 24 weeks

Roe – Roe v. Wade

SB8 – Texas State Bill 8, "The Texas Heartbeat Act"

States – 50 US states, plus the District of Columbia

TRAP – targeted restrictions on abortion providers