Article

An evaluation of the trends in U.S. maternal deaths based on abortion policies from 2018 to 2021

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SUMMARY

Maternal deaths in the United States (U.S.) are increasing. Even though abortion is recognized as a safe component of health care to save a mother's life, it is highly regulated in the U.S. where many states have adopted abortion restriction laws. In 2021, more abortion restrictions were enacted by U.S. states than any year since 1973. Our objective was to evaluate the trends in U.S. maternal deaths based on abortion policies in different states from 2018 through 2021. We hypothesized that states with abortion restrictions will have more maternal deaths than states without restrictions. We used the Centers for Disease Control and Prevention Wide-ranging ONline Data for Epidemiologic Research (CDC WONDERS) database to collect maternal deaths and live births in all 50 states from 2018 through 2021. We used policy information published by Guttmacher Institute to categorize the states into three buckets – protective, neutral, and restrictive. We calculated the maternal mortality ratio (MMR), which is maternal deaths per 100,000 live births. We found that the MMR in restrictive states was higher than neutral and protective states every year from 2018 through 2021. The MMR in restrictive states reached the highest value of 58.1 in 2021 (Restrictive 58.1, 95% CI 66.5–49.7; Protective 37.1, 95% CI 48.2–26.02) which showed a 72% increase from 2018. Our results demonstrated an association between abortion restriction and increased MMRs.

INTRODUCTION

Maternal deaths are increasing in the United States (U.S.) (1–4). Between 2000 and 2014, the maternal mortality ratio (MMR) in the U.S., calculated as maternal deaths per 100,000 live births, increased from 9.8 to 21.5 (5–6). On the contrary, most of the countries in a World Health Organization's (WHO) study have had a decreasing MMR between 2000 and 2014 (7). Pregnancy-related complications may lead to maternal death without intervention. To save a mother's life, abortion is recognized as a safe intervention by WHO (8). The U.S. Supreme Court ruled in Roe v. Wade (1973) that the Constitution protected the rights to have an abortion. However, between 2011 and 2021, a total of 624 state laws restricting or protecting abortion were adopted (9). An example of a restrictive policy is limiting access to abortion after a certain gestational period. Conversely, a protective policy expands access to reproductive health services, including abortion, by requiring health plans to cover the cost of abortion, for example (9).

Because of the overturn of Roe v. Wade in 2022, American states are now allowed to determine restrictions on abortion independent of the federal government. For women living in a restrictive state who need an abortion, they are left with the following options: leaving the state in order to meet healthcare needs, unwillingly having the baby, adopting deadly alternatives like self-induced abortions using off-brand medication, or using black-market abortions (10). This can have numerous negative effects on the woman's health such as infections, hemorrhaging, or complications from unverified medications. Additionally, more restrictive abortion policies further restrict access to abortion, which can be considered a heavy-handed method to further social agendas against those with already limited resources (11). Thus, women and families who are marginalized or considered vulnerable populations further experience hardships and limited medical access to abortions due to transportation and financial reasons.

The overturning of Roe v. Wade allowed states to mandate their policy regarding abortion, and different states have adopted different policies either protecting or restricting access to abortion. However, it is unclear as to how maternal mortality is impacted by the restrictive or protective abortion policies implemented by different states. We aimed to see if there was any association between the states' abortion policy and maternal mortality. We hypothesized that restrictive states will have higher maternal mortality compared to protective and neutral states. We calculated MMR with Data from United States' CDC WONDER database (12). We categorized the states into neutral, protective and restrictive bucket based on policy data from the Guttmacher Institute (13). We found that the MMR in restrictive states was higher than neutral and protective states every year from 2018 through 2021. The MMR in restrictive states increased by 72% from 2018 to 2021 which was higher than neutral and protective states.

RESULTS

We queried the United States' CDC WONDER database for the maternal deaths and live births. We used policy information published by Guttmacher Institute to categorize the states into three buckets – protective, neutral, and restrictive (**Figure 1**) (12–13). The protective bucket contained all the states categorized as "Protective", "Very Protective" and "Most Protective" by Guttmacher Institute (13). The neutral bucket contained states with "some restrictions/protections". States classified as "Most Restrictive", "Very Restrictive", and "Restrictive" were combined into the restrictive bucket. We calculated the MMR of restrictive, neutral and protective states (**Table 1**).

In 2018, we saw that restrictive states had the highest MMR of 33.7. Neutral states had the lowest MMR (17.41) in 2018. Only three neutral states reported maternal deaths in 2018

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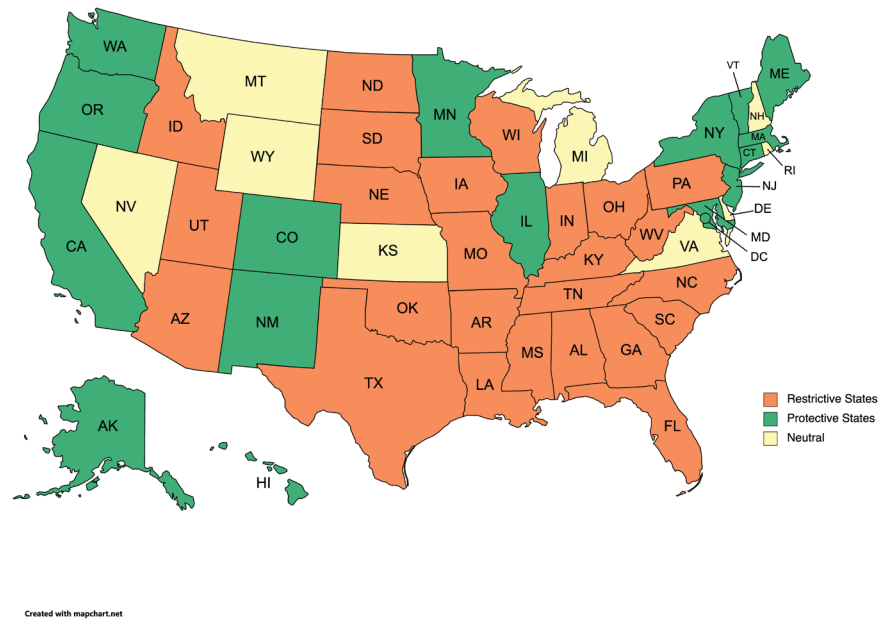
Figure 1: Simplified classification of states. States were classified using policy information from Guttmacher Institute (13). Restrictive, protective, and neutral states are shown in orange, green, and yellow colors respectively. Maternal death information was unavailable for neutral states Wyoming, Rhode Island, New Hampshire, Montana and Delaware for the years 2018–2021 in CDC dataset.

	2018	**2019**	**2020**	**2021**
Restrictive	33.70 (5.11, 29.743)	37.08 (32.11, 42.06)	44.68 (38.09, 51.28)	58.13 (49.71, 66.56)
Neutral	17.41 (27.22, 40.18)	33.78 (31.28, 36.27)	38.50 (33.34, 43.65)	40.38 (27.98, 52.78)
Protective	23.32 (18.60, 28.04)	25.28 (19.00, 31.56)	27.25 (20.26, 34.24)	37.15 (26.02, 48.28)

Table 1: Mean MMR by States' Abortion Policies from 2018 to 2021. Each cell represents the mean MMR of the states belonging to a certain category (Restrictive, Neutral, or Protective) in a certain year (2018 to 2021). The numbers in parenthesis represent 95% CI.

which might be reason for neutral states having the lowest MMR in 2018. From 2019 to 2021, protective states had the lowest mean MMR compared to neutral and restrictive states during this time. From 2019 through 2021, neutral states' mean MMR remained higher than protective states, and lower than restrictive states. Throughout 2018 to 2021, restrictive states had the highest mean MMR compared to neutral and protective states (**Figure 2**). From 2019 to 2021, there is no overlap between the 95% CIs of mean MMR of protective and restrictive states (protective: 2019 (19.00, 31.56), 2021 (26.02, 48.28); restrictive: 2019 (32.11, 42.06), 2021 (49.71, 66.56)) (**Figure 3**).

In 2019 we saw neutral and restrictive states' MMR increased to 33.7 and 37.08, respectively, which is an increase of 12% and 94%, respectively. Protective states' MMR in 2019 increased by only 8.1% (from 23.3 to 25.2). From 2019 to 2020, we saw that restrictive states MMR jumped up by

20.4% while the protective states' MMR increased by only 7.7% and neutral states' MMR increased by 13.97%. In restrictive states, the mean MMR increased from 33.7 in 2018 to 58.13 in 2021, which is a 72% increase. In protective states, the mean MMR increased from 23.31 in 2018 to 37.15 in 2021. In general, mean MMR increased from 2018 to 2021 across all categories of states. The difference in the mean MMR between protective states and restrictive states increased from 2018 to 2021.

DISCUSSION

Restrictive states had the highest mean MMR for the years analyzed in this study. Neutral or protective states had lower mean MMR than restrictive states. When we looked at 95% CI of mean MMR, we did not see any overlap between protective and restrictive state. We demonstrated a relationship between abortion restriction and increased MMRs. We saw that the
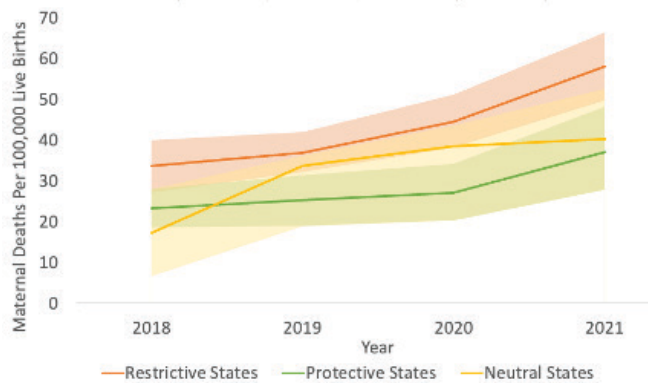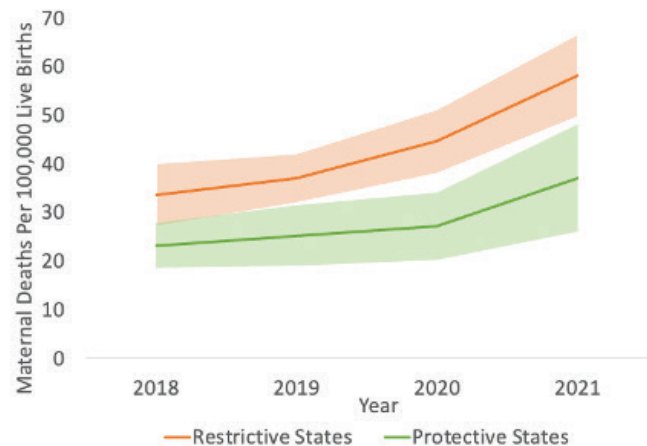
Figure 2: Mean MMR with 95% CI for restrictive, protective and neutral states, from 2018 to 2021. Colored lines showing mean MMR in restrictive (orange), protective (green), and neutral (yellow) states. Shaded areas represent 95% CI in restrictive (orange), protective (green), and neutral (yellow) states.

Figure 3: Mean MMR of restrictive and protective states with 95% CI, from 2018 to 2021. Colored lines showing mean maternal mortality ratio in restrictive (orange) and protective (green) states. Shaded areas represent 95% CI in restrictive (orange) and protective (green) states. No overlap between the 95% CIs indicates that the difference in MMR in these two categories of states is a true difference.

restrictive states always had a higher MMR than the neutral or protective states from 2018 to 2021. Previous literature demonstrated similar findings when data from 1995 to 2017 were considered (14). Our findings could be used to further investigate the policies adopted by states and determine if the policies are restricting access to healthcare and deprioritizing maternal outcomes.

We did not show that abortion restriction is causing the increase in maternal death. The findings that restrictive states have higher maternal mortality could be due attributed to various factors, including socio-economic conditions. With the knowledge of this association, restrictive states may take actions to improve the access to abortion, which may benefit their residents. Further studies are required to determine how these states can mitigate the impact of their policies. It is also possible that restrictive policies are disproportionately impacting certain groups of population who might benefit more from protective policies. More studies are required to identify such groups and how to support them.

A limitation of this research is that some states in the CDC dataset did not have maternal death data for certain years. There were only nine states in the neutral group. Moreover, there was missing data for five states (Wyoming, Rhode Island, New Hampshire, Montana and Delaware) in this group which decreased the group's mean MMR. Missing data in the neutral group was the highest in 2018, when only three states in this group reported maternal mortality. This might be the reason for neutral states having the lowest MMR in 2018. Even though the neutral group was impacted by a lack of data, it did not impact our overall results concerning restrictive and protective states.

We did not consider population variations in our study. It is possible that certain population groups in the restrictive states are disproportionately impacted more than others which caused an overall increase of the state's MMR. Future studies can focus on identifying such groups and compare the MMR of those groups from restrictive and protective states to investigate the impact of protective policies. We also did not consider any other data sources apart from CDC to compare the results.

In conclusion, we showed there is an association between the states' abortion policy and maternal mortality. Our analysis showed that states with restrictive abortion policies have higher maternal mortality rate compared to those with neutral or protective policies. These findings have important implications for understanding the impact of state's abortion policy and identify areas for intervention to reduce maternal mortality in the U.S.

MATERIALS AND METHODS
Data Source and Study Population
The United States' Center for Disease Control and Prevention (CDC) WONDER database is a publicly available data source with a wide variety of public health and vital statistics data that are nationally representative (12). This data source allows public health researchers to set different groupings and filters to abstract and analyze data to answer epidemiological questions about the U.S. population.

We queried the United States' CDC WONDER database for all the maternal deaths that occurred between 2018 to 2021 for each state. At the time of our query (November to December 2023), maternal death data was available only up to 2021. To identify maternal deaths between 2018 and 2021 that occurred during the pregnancy, childbirth, and puerperium periods, we used ICD-10 Code O00-99 as a filter for cause of death in CDC database. We also queried the CDC WONDER database for all live births that occurred during 2018-2021.

Classification of States Based on Abortion Policies
We used policy data from the Guttmacher Institute to classify abortion restriction policies by state (13). We combined "Most Restrictive," "Very Restrictive" and "Restrictive" states into the restrictive category. We reclassified states with "Some restrictions/protections" as neutral states. Lastly, states that were "Protective," "Very Protective" and "Most Protective"

were combined into the protective category. We colored the U.S. map with these three categories (**Figure 1**).

Statistical Analyses

The MMR measures the number of deaths among mothers for every 100,000 live births (14). We used MMR as a measure of analysis because it is an international measure designed to express obstetric risk and accurately describes what happens in the population in terms of the number of maternal deaths and live births. We calculated the MMR using the following formula:

$$Maternal\ Mortality\ Ratio\ (MMR) = \frac{Number\ of\ Maternal\ Deaths}{Number\ of\ Live\ Births} \times 100,000$$

We calculated the MMR for each state for each year from 2018 through 2021. We grouped states by their abortion policy category: restrictive, protective, or neutral. Next, we calculated the mean MMRs in these abortion policy categories for each year and plotted the mean MMRs for the years 2018 to 2021. Additionally, we computed the 95% CI for the MMRs of restrictive, protective and neutral states and plotted the CIs around the mean MMR. We used Microsoft Excel for statistical analyses and display of data.

REFERENCES

1. MacDorman, Marian F., et al. "Trends in Maternal Mortality by Sociodemographic Characteristics and Cause of Death in 27 States and the District of Columbia." *Obstetrics & Gynecology*, vol. 129, no. 5, May 2017, pp. 811–818. https://doi.org/10.1097/AOG.0000000000001968.
2. MacDorman, Marian F., et al. "Recent Increases in the U.S. Maternal Mortality Rate: Disentangling Trends From Measurement Issues." *Obstetrics & Gynecology*, vol. 128, no. 3, Sept. 2016, pp. 447–455. https://doi.org/10.1097/AOG.0000000000001556.
3. Fleszar, Lauren G., et al. "Trends in State-Level Maternal Mortality by Racial and Ethnic Group in the United States." *JAMA*, vol. 330, no. 1, July 2023, pp. 52–61. https://doi.org/10.1001/jama.2023.9043.
4. Moaddab, Amirhossein, et al. "Health Care Disparity and Pregnancy-Related Mortality in the United States, 2005–2014." *Obstetrics & Gynecology*, vol. 131, no. 4, Apr. 2018, pp. 707–712. https://doi.org/10.1097/AOG.0000000000002534.
5. Lu, Michael C. "Reducing Maternal Mortality in the United States." *JAMA*, vol. 320, no. 12, 2018, pp. 1237–1238. https://doi.org/10.1001/jama.2018.11652.
6. "Pregnancy Mortality Surveillance System." *Centers for Disease Control and Prevention*. https://www.cdc.gov/maternal-mortality/php/pregnancy-mortality-surveillance/index.html. Accessed 21 Mar. 2023.
7. World Health Organization. "Trends in Maternal Mortality: 1990 to 2013 - Estimates by WHO, UNICEF, UNFPA, The World Bank and the United Nations Population Division." *World Health Organization*, 2014.
8. Kapp, N. and Lohr, P.A. "Modern Methods to Induce Abortion: Safety, Efficacy and Choice." *Best Practice & Research Clinical Obstetrics & Gynaecology*, vol. 63, 2020, pp. 37–44. https://doi.org/10.1016/j.bpobgyn.2019.11.008.
9. Nash, Elizabeth. "State Policy Trends 2021: The Worst Year for Abortion Rights in Almost Half a Century." *Guttmacher Institute*, Dec. 2021, https://www.guttmacher.org/article/2021/12/state-policy-trends-2021-worst-year-abortion-rights-almost-half-century. Accessed 19 Jan. 2023.
10. Matsuura, Hiroyuki. "Abortion Tourism in a Post-Roe v. Wade Era." *Biodemography and Social Biology*, vol. 67, no. 2, Apr.–Jun. 2022, pp. 99-101. https://doi.org/10.1080/19485565.2022.2100051.
11. Coen-Sanchez, Katherine, et al. "Repercussions of Overturning Roe v. Wade for Women Across Systems and Beyond Borders." *Reproductive Health*, vol. 19, no. 1, Aug. 2022, p. 184. https://doi.org/10.1186/s12978-022-01490-y.
12. "CDC WONDER Database." *Centers for Disease Control and Prevention*. wonder.cdc.gov. Accessed 15 Dec. 2023.
13. "Map: U.S. Abortion Policies and Access After Roe." *Guttmacher Institute*. https://states.guttmacher.org/policies/. Accessed 11 Dec. 2023.
14. Addante, Annalisa N., et al. "The Association between State-Level Abortion Restrictions and Maternal Mortality in the United States, 1995-2017." *Contraception*, vol. 104, no. 5, Nov. 2021, pp. 496-501. https://doi.org/10.1016/j.contraception.2021.03.018.