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# Maternal Mortality in the U.S.

Christine Shipley

**ABSTRACT.** While the global maternal mortality ratio has decreased, the U.S. maternal mortality ratio has increased over recent decades. The U.S. has the worst maternal mortality ratio among developed countries. This paper examines potential explanations for the increase in the U.S. maternal mortality ratio, including problems in how the data are reported, medical intervention, and poverty. Potential remedies for issues are discussed. I conclude that even though all three factors have likely contributed to the rise in the maternal mortality ratio, the total effect of the factors is not clearly known and most likely does not fully explain the rise in the maternal mortality ratio.

## I. Introduction

In 2011, a neonatal intensive care nurse, Lauren Bloomstein, was expecting her first child at the age of 33. She was healthy, and her pregnancy was considered low risk. She proactively cared for herself throughout her pregnancy; her husband, who was a doctor, helped monitor her daily blood pressure. During childbirth, everything seemed to be going smoothly, and her healthy child was born. Less than 24 hours later, however, Lauren died from pre-eclampsia, a pregnancy complication characterized by high blood pressure. What happened? Unfortunately, questions regarding maternal mortality are not rare in the U.S., and answers are not always clear.

In response to recent decades of rising maternal mortality in the U.S., Congress passed the Preventing Maternal Death Act of 2018. This was considered a huge milestone in efforts to improve maternal health in the U.S. One major question remains: *Where should funding and resources be allocated to improve maternal health?* The large number of potential factors contributing to the rise in U.S. maternal mortality makes it difficult to efficiently allocate resources to attempt to reverse the trend. This paper examines the relationship of reported maternal mortality rates to the quality of data, medical intervention, and poverty. It also provides a broad analysis of how to improve maternal health.

## II. Current State of Maternal Health

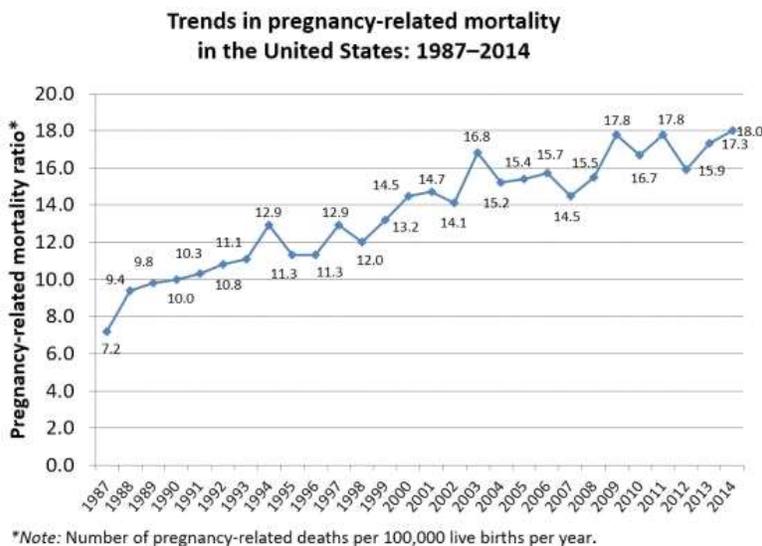
Maternal death is defined by the World Health Organization as “the death

of a woman while pregnant or within 42 days of termination of pregnancy, regardless of the duration of pregnancy, from any cause related to direct or indirect obstetric death” (Population Research Institute 2014). While the World Health Organization emphasizes the difference between the maternal mortality rate and the maternal mortality ratio, most studies use the two terms interchangeably to mean the number of maternal deaths per 100,000 live births. This ratio is used as one of the main measures of a country’s well being and is a sensitive measure of health system strength, access to quality care, and coverage of effective interventions to prevent maternal mortality (Jarosz and Mather 2017, 14). High maternal mortality can reflect a lack of access to care and inadequate or discriminatory treatment (Jarosz and Mather 2017, 14). Losing a mother can be devastating to a family. It can create lost opportunities for older children, long-term negative effects on the health of the newborn child, and negative effects on the socioeconomic position of the family (Maruthappu, Ng, Williams, Atun, Agrawal, and Zeltner 2014, 1216).

Actions to reduce maternal mortality are being taken on a global level. The World Health Organization has improving maternal health as one of its key priorities. Its actions include increased research, providing evidence-based clinical and programmatic guidance, setting global standards, and providing technical support (World Health Organization 2016). With these initiatives, the global maternal mortality ratio, including both developing and developed countries, has fallen by 45 percent since 1990 (United Nations 2015).

The 20th century marked a progressive decrease in maternal mortality in the U.S. One major factor contributing to the decrease was the introduction of antibiotics (Thomasson and Treber 2008, 79). In contrast, the 21st century has not seen major improvements. The maternal mortality in the U.S. is relatively low compared to developing countries. The U.S., however, has the highest maternal mortality ratio among the Organization for Economic Co-operation and Development (OECD) countries, even though the U.S. spends the most on healthcare per person. Most OECD countries are developed countries. According to the Centers for Disease Control and Prevention (CDC), the U.S. maternal mortality ratio increased from 7.2 in 1987 to 18 in 2014 (CDC 2018). Jarosz and Mather (2017) found women in Generation X faced higher rates of maternal mortality than Baby Boomers and concluded progress has stalled for women. As maternal mortality has been decreasing in other OECD

countries, the high and rising maternal mortality ratio for the U.S., reflected in the chart below, is alarming.



Source: CDC (2018)

There is significant variation in the maternal mortality ratio among states in the U.S. This variation is thought to be caused by differences in funding for state healthcare services, quality of available healthcare, and various demographic variables (Moaddab, Dildy, Brown, and Zhoobin 2016, 869). To address this, the Preventing Maternal Death Act of 2018 was passed by Congress. The bill directs the Department of Health and Human Services (HHS) to establish a program under which HHS may make grants to states for the following purposes: reviewing pregnancy-related and pregnancy-associated deaths; establishing and sustaining a maternal mortality review committee to review relevant information; ensuring the state department of health develops a plan for ongoing healthcare provider education; disseminating a case abstraction form to aid information collection for HHS review and preserve its uniformity; providing for the public disclosure of information included in state reports (Congress.gov 2018). The objectives of this bill are to aid HHS in taking steps to improve maternal health outcomes and to support states in their

work to save and sustain the health of mothers. The direct reasons for the increasing maternal mortality ratio in the U.S. remain unclear. It is important, however, to investigate the potential factors contributing to this increase. Understanding the potential factors will provide clearer direction for allocating resources to effectively reverse the trend.

### **III. Potential Factors**

#### **A. QUALITY AND REPORTING OF DATA**

The CDC's National Center for Health Statistics is the source for maternal mortality statistics in the U.S. Every year the CDC requests all 50 states, New York City, and Washington DC to voluntarily send copies of death certificates for all women who died during pregnancy or within 1 year of pregnancy. Epidemiologists then analyze the data to determine the cause of death related to pregnancy. The statistics calculated from this method have been criticized in recent decades due to underreporting and death certificate inconsistencies. These statistics are known to have limitations and are prone to misclassification bias, underreporting bias, and a lack of information on important confounding variables (Goffman, Madden, Harrison, Merkatz, and Chazotte 2007, 598).

The change in data collecting method for maternal mortality may explain at least part of the increasing ratio in the U.S. Studies based on data from the 1980s to the 1990s identified significant underreporting of maternal mortality (Horon 2004; Berg and Tucker 1996). Data on maternal mortality from the CDC's National Vital Statistics System were solely based on death certificates. Death certificates during this time did not have adequate measures of maternal mortality. This could have led to underreporting. In response to these findings, a pregnancy question was added to the U.S. standard death certificate in 2003 to improve accuracy of reporting maternal mortality (MacDorman, Declercq, Cabral, and Morton 2016, 448). National statistics calculated from data after 2003 were still not accurate, however. Not every state used the revised standard death certificate immediately. A few states added pregnancy questions inconsistent with the 2003 standard. Delayed adoption of the revised death certificate and inconsistencies among pregnancy questions led to data incompatibilities and hindered accurate trend analysis (MacDorman et al 2016, 447). The U.S. has not published an official maternal mortality rate since 2007 as a result of this.

The addition of the pregnancy question resulted in the increase in reporting maternal mortality on death certificates, thus increasing the maternal mortality ratio (MacDorman et al 2016, 448). Data incompatibilities, however, make it difficult to measure how much the U.S. maternal mortality ratio was affected by the increased accuracy in reporting. In the study by MacDorman et al (2016, 448), a trend analysis method was developed to estimate the maternal mortality ratio for the U.S. with data from 2000 to 2014. California and Texas were outliers and were left out of the model. The unadjusted maternal mortality ratio increased from 9.9 in 2000 to 23.0 in 2014. When the model was adjusted for delays in adopting the revised death certificate, the ratio increased from 18.8 in 2000 to 23.8 in 2014. The model estimated 20.1 percent of the observed increase in the maternal mortality ratio was due to an actual increase and 79.9 percent was due to improvements in reporting (MacDorman et al 2016, 452). The study concluded that the increase in the maternal mortality ratio was mainly due to administrative changes. Yet reporting improvements did not account for the entire increase in the maternal mortality ratio.

Clark, Belfort, Dildy, Herbst, Meyers, and Hankins (2008, 91-92) examined medical records of maternal deaths between 2000 and 2006 from Hospital Corporation of America facilities. Advanced techniques were used to collect data, such as matching death and birth certificates data, reviewing medical records, and interviewing specialists when necessary. They concluded that the maternal mortality ratio for approximately 1.5 million pregnancies was 6.3 per 100,000 live births; this was 30 percent lower than the reported ratio of the U.S. at the time (Clark et al 2008, 93). This lower ratio could be the result of the in-depth data collecting method used in the study. Another factor potentially leading to a lower ratio is variation in healthcare quality in the study's facilities and nationwide facilities. A study by Goffman et al (2007) used data from 1995 to 2001. Higher maternal deaths compared to national statistics were found during the time of the study. The data collecting method used in this study may have contributed to the higher ratio reported. The healthcare facility where data were collected accepts referral of women at high risk of morbidity or mortality, potentially leading to the higher ratio (Goffman et al 2007, 599). Reasons for the lower and higher ratios compared to the national ratio were not clearly determined.

Researchers and medical professionals agree that the reporting of data

played a prominent role in the increase in the maternal mortality ratio since 2003. Yet reporting changes do not fully explain the increase, and maternal mortality has increased over the past 25 years regardless of administrative improvements (Jarosz and Mather 2017, 14). Another commonly identified factor potentially contributing to the increase in the maternal mortality ratio is medical intervention.

#### B. MEDICAL INTERVENTION

Prior to the 20th century in the U.S., hospitals were generally noisy and dirty. Most births occurred at a home with only five percent of all births occurring in hospitals in 1900 (Thomasson and Treber 2008, 77). During the first half of the 20th century, hospitals made remarkable transformations and improvements. Factors contributing to these improvements were changes in hospital procedures, physician training, and advancements in medical technology. Consumers had a newfound confidence in hospitals' abilities to provide effective medical care. By 1935, half of all births occurred in hospitals (Thomasson and Treber 2008, 77). Even with the development of better training and technology, maternal mortality in the U.S. did not decline as births shifted from homes to hospitals. Historians have argued maternal mortality in the early 20th century remained stagnant due to increased operative intervention by physicians (Thomasson and Treber 2008, 77). Compared to home births, hospital births had more experimentation and intervention (Thomasson and Treber 2008, 78). Two large studies published in the 1930s claimed between half and two-thirds of maternal deaths occurred due to poorly trained obstetricians relying too often on operative techniques (Thomasson and Treber 2008, 78).

One operative technique, cesarean delivery, is even more common today. In 1965, the U.S. cesarean delivery rate was 4.5 percent of all births; in 2014, nearly 32 percent of all births were cesarean deliveries (National Partnership for Women & Families 2016). Researchers have found cesarean delivery rates have increased regardless of age, number of infants women are having, extent of health problems, race, and ethnicity (Declercq, Menacker, and MacDorman 2005, 867-872). Cesarean delivery is now one of the most common operating room procedures. The increase in the cesarean delivery rate has led many to question the relationship between medical interventions, such as cesarean delivery, and the increasing maternal mortality ratio in the U.S. Cesarean

delivery can be safer than vaginal birth for certain high-risk conditions, however, it is known to pose greater risk of harm in low-risk women (National Partnership for Women & Families 2016). The leading professional obstetric societies in the U.S. concluded women have not benefited from this increase in medical intervention (National Partnership for Women & Families 2016). Cesarean delivery has distinct risks compared to vaginal delivery such as a greater chance of infection, injury, and need for emergency hysterectomy (Kozhimannil, Law, and Virnig 2013, 527). Other risks include persistent pain, compromised establishment of breastfeeding, and complications with later deliveries (Kozhimannil, Law, and Virnig 2013, 527).

Vadnais and Sachs (2006) sought to determine the risk of maternal death with cesarean delivery by reviewing literature from 1987 to 2003. Nine studies were reviewed and consisted of retrospective studies, a control trial, a retrospective cohort study, a case control study, and a meta-analysis study. Vadnais found maternal mortality ratios ranging from 6 to 54 per 100,000 live births. Vadnais and Sachs (2006, 246) concluded none of the studies had adequate statistical power to establish a relationship between cesarean delivery and maternal mortality. The strongest studies of those reviewed by Vadnais and Sachs (2006, 246) suggested there was not an increased risk of maternal death with cesarean delivery compared to vaginal delivery.

Other studies have found an apparent association between cesarean delivery and maternal mortality. Clark et al (2008, 91-95) examined the causal relationship of cesarean delivery to maternal mortality. Data were collected from the Hospital Corporation of America on the cause of death, preventability, and the causal relationship to method of delivery. The cesarean delivery rate at the facilities during the time of the study was at or above the U.S. national average; the sample therefore was considered a good representation of the U.S. population in regard to cesarean delivery (Clark et al 2008, 94). Results confirmed a significant positive association between cesarean delivery and maternal mortality. The risk of death caused by cesarean delivery was approximately 2 per 100,000 live births compared with 0.2 for vaginal births, and the difference was statistically significant (Clark et al 2008, 94). In most cases, however, mortality was related to the indication for cesarean delivery rather than to the operation itself.

To compare maternal and contributing factors among the leading causes of maternal mortality, a study by Main, McCain, Morton, Holtby,

and Lawton (2015, 938) used the state of California's data from 2002 to 2005. At the time of the study, one in eight U.S. births occurred in California, which was more than 500,000 annual births a year (Main et al 2015, 938). California is heavily populated with extensive demographic diversity, so the data collected was considered a sufficient sample of the population. The California Department of Public Health sponsored the California Pregnancy-Associated Mortality Review in 2006 to collect medical records and various reports for each maternal death for this study (Main et al 2015, 939). A committee was then formed to extensively analyze the cause of each death, contributing factors, chance to alter the outcome, and potential improvements.

The study concluded the maternal mortality ratio for the time period was approximately 9.86 deaths per 100,000 live births; the five leading causes of maternal mortality were cardiovascular disease, pre-eclampsia, hemorrhage, venous thromboembolism, and amniotic fluid embolism (Main et al 2015, 940). Venous thromboembolism is a blood clot starting in a vein. Cesarean delivery was the most frequent method of delivery among the five leading causes of pregnancy-related maternal mortality, and 64 percent of venous thromboembolism cases were repeat cesarean deliveries (Main et al 2015, 941). The results of this study corresponded with a study that used data from France (Deneux-Tharaux, Carmona, Bouvier-Colle, and Breart 2006). Deneux-Tharaux et al (2006, 541) found cesarean delivery was significantly associated with an increased risk of maternal death due to venous thromboembolism. It also concluded cesarean delivery was associated with an increased risk of readmission for venous thromboembolism. A study by Kamilya, Seal, Mukherji, Bhattacharyya, and Hazra (2010, 248) used data from India to assess maternal mortality and causes using detailed records. Excluding all maternal deaths caused by pre-existing conditions and complications, Kamilya et al (2010, 249-250) found cesarean delivery was associated with increased risk of maternal death when compared to vaginal delivery. Kamilya et al (2010, 250) also found cesarean delivery was significantly associated with an increased risk of maternal death due to venous thromboembolism, infection, and anesthesia complications.

In the study by Goffman et al (2007, 597-598), demographic, medical, and obstetric data were collected from the Weiler Hospital of Albert Einstein College of Medicine and Montefiore Medical Center from 1995 to 2001. One of the medical factors statistically significantly associated with increases in maternal death and near-miss cases was whether the

patient had a previous cesarean delivery. Using CDC data from 2005 to 2014, the study by Moaddab et al (2016, 873) found cesarean delivery was statistically associated with an increased maternal mortality ratio. The correlation was weak, however. This study did not examine the causal relationship of cesarean delivery to maternal mortality. Therefore, it should be emphasized the positive relationship between cesarean delivery and increased maternal mortality may be the result of pre-existing conditions that led to the need for cesarean delivery and not the surgery itself.

The net effect of cesarean delivery on maternal mortality remains unclear. It is important to continue to study the effects of cesarean delivery as well as other medical interventions. Understanding the effects could lead to improvements in medical procedures in order to decrease the maternal mortality ratio. For future analysis, it is important to review studies and data that are recent. Outdated sources will not reflect current obstetric improvements (Kamilya et al 2010, 248). It is also crucial to consider the causal relationship of method of delivery to maternal mortality; future studies should analyze whether the maternal death would have occurred if another method of delivery had been used.

One major difficulty most of these studies faced was lack of statistical power. Though data may have been more accurately collected for these samples compared to the CDC method of solely using death certificates, the U.S. maternal mortality ratio is still a relatively low number. This leads to a lack of statistical power and difficulties in identifying and assessing potential risk factors associated with medical interventions. Long term complications of cesarean delivery may be important when analyzing the implications for maternal health. Documenting and studying long term complications, however, can be difficult and time consuming. Long term complications have not been heavily studied but should be considered in future research. It is important to not only look at administrative and medical factors when understanding the increase in the maternal mortality ratio but also socioeconomic factors.

### C. POVERTY

The U.S. poverty rate often fluctuates with economic expansion and recession cycles. Since the Great Recession, the national poverty rate has decreased (Jarosz and Mather 2017, 2). Despite the decrease in overall poverty, the poverty rate for women of reproductive age has increased.

The proportion of women aged 30 to 34 living in poverty has increased among women in the Millennial Generation compared to the previous generations (Jarosz and Mather 2017, 12-13). The increase in poverty among women has heavily affected young, unmarried women with children (Jarosz and Mather 2017, 4). It is commonly recognized that higher poverty rates within a country can have an adverse effect on health outcomes, including infant and maternal health. The increase in the poverty rate among women in the U.S. may be a contributing factor in the increasing maternal mortality ratio.

There is sufficient historical and contemporary evidence supporting the idea that the burden of maternal mortality is carried disproportionately by the poor (Ensor, Cooper, Davidson, Fitzmaurice, and Graham 2010, 7). It is not poverty itself that necessarily leads to higher maternal mortality; rather, it is other contributing factors highly associated with poverty that tend to lead to higher maternal mortality. Lifestyle factors highly associated with poor women are obesity, pre-existing medical conditions, stress, and depression (Nagahawatte and Goldenberg 2008, 80-84).

Previous studies have found that a lower socioeconomic status is associated with poorer health outcomes and increased morbidity among women (Nagahawatte and Goldenberg 2008, 81). The highest prevalence of obesity is in women with low socioeconomic status (Nagahawatte and Goldenberg 2008, 83). In the study by Goffman et al (2007, 599-600), obese women were three times more likely to experience severe morbidity or mortality during pregnancy. Venous thromboembolic, pre-eclampsia, cesarean delivery, hemorrhage, and anesthesia complications were associated with obesity (Goffman et al 2007, 600). In the study by Main et al (2015, 941), women who died during pregnancy were significantly more likely to be obese before pregnancy. Women in poverty also experience food insufficiencies and insecurities, which may lead to hunger and malnutrition (Nagahawatte and Goldenberg 2008, 82-83). Hunger and malnutrition can be detrimental to a woman's health, especially if she is pregnant. Low levels of macronutrients are associated with decreased blood flow and maternal infections (Nagahawatte and Goldenberg 2008, 83).

The relationship between poverty and the use of healthcare is also critical. Poverty is associated with a decreased use of healthcare services (Nagahawatte and Goldenberg 2008, 82); this could be due to inability to pay for available services, lack of time or other non-monetary resources such as a car, or prior negative experiences due to discrimination. Poor

women are shown to be less connected with the obstetric services (Nagahawatte and Goldenberg 2008, 81). This disconnection can be detrimental if a pregnancy-related emergency occurs.

Previous research has shown poor women receive less prenatal care (Esperat, Feng, Zhang, and Owen 2007). Women who receive prenatal care are often screened for conditions and given treatment for those conditions (Nagahawatte and Goldenberg 2008, 81). Effective treatment can lead to the decreased risk of complications during pregnancy and maternal death. In the study by Clark et al (2008, 93), most maternal deaths occurred during the third trimester in women who were classified as low-risk early in their pregnancy. This finding supports the importance of frequent prenatal visits, especially during the third trimester. In the study by Goffman et al (2007, 598), the level of prenatal care was measured and included in the model using an index; the index included the number of prenatal visits during pregnancy. The study concluded that the level of prenatal care was not associated with risk of maternal mortality (Goffman et al 2007, 599). The actual effectiveness of prenatal care in reducing maternal mortality is still not clear and should be further investigated.

Currently, there is not a lot of research focusing specifically on poverty and maternal mortality within the U.S. One reason for this may be due to poverty and socioeconomic status being hard to measure. Another reason for the lack of research may be the focus on poverty and infant health in recent decades, rather than maternal health. There are many potential factors associated with high levels of poverty that may contribute to the increasing maternal mortality ratio in the U.S. Factors range from lifestyle to healthcare and obstetric services. Though the relationship between poverty and maternal mortality can be complex, further analysis should continue in order to develop effective ways to combat both poverty among women and its effects on maternal mortality.

## **IV. Analysis**

### **A. PROMINENT FACTORS**

The quality and reporting of data, medical intervention, and poverty should all be considered to understand the rise in the maternal mortality ratio in the U.S. With studies varying in timespan, data collecting methods, and model factors, it is difficult to conclude the specific

importance of these factors. There is also a plethora of other factors potentially contributing to the maternal mortality ratio not discussed in this paper. Other factors include prominent race and ethnic disparities in maternal mortality, increases in depression and suicide among women of reproductive age, age, opioid and other drug addictions, health system policies, and health infrastructure. Though these factors were not discussed, they may potentially contribute to the increasing maternal mortality ratio. These factors should continue to be analyzed in future studies regarding maternal mortality and maternal health. There are ways to address the three factors discussed in this paper in order to decrease the maternal mortality ratio in the U.S.

## B. POTENTIAL REMEDIES

### *Maternal Mortality Reporting*

One major problem that should be addressed immediately is the data regarding maternal mortality. Without a consistent, quality method for reporting, states cannot accurately calculate maternal mortality statistics, and the maternal mortality ratio for each state cannot be determined with certainty. Since state data are used to calculate the national maternal mortality ratio, the U.S. ratio also cannot be determined with certainty. This hinders the tracking of progress and does not produce accurate international comparisons. Inaccurate data hinders the ability of researchers and medical professionals to better understand maternal mortality.

Horon (2004, 478-482) studied the extent to which maternal deaths are underreported on death certificates. Maternal mortality statistics were calculated in the study by linking death certificates with birth and fetal death records and reviewing medical records. Statistics calculated in the study were then compared to the standard statistics that were calculated solely based on death certificates. Horon (2004, 480) found maternal mortality was substantially underestimated when mortality ratios were based solely on maternal deaths reported on death certificates. Lack of complete reporting has led to misconceptions regarding the magnitude of the problem and the leading causes of maternal deaths (Horon 2004, 482).

The study by Horon (2004) did not use data from 2003 or later that was affected by the addition of the pregnancy question. While the addition of the pregnancy question to the death certificate has led to an

increase in reporting accuracy, a more comprehensive reporting method should be undertaken. Death certificates are a crucial source; however, death certificates alone do not identify all maternal deaths (Horon 2004, 482). Most studies reviewed in this paper did not solely use death certificates; they also used other methods such as matching death and birth certificate data, reviewing medical records, creating committees to analyze preventability, and interviewing specialists. Initiatives to improve the quality of states' data should be continued by enforcing a comprehensive reporting method to ensure consistency in data used for national statistics. When the pregnancy question was added in 2003, the delayed adoption by some states was mainly due to funding issues (MacDorman et al 2016, 454). If a standard method is undertaken and enforced, funding should be adequately provided to states to avoid delayed adoption.

California was the only state between 2000 and 2014 to have a decreasing maternal mortality ratio. It heavily relied on its data to identify common and preventable causes of maternal deaths. The California Healthcare Foundation and the California Department of Public Health have taken many initiatives to reduce the state's maternal mortality ratio. One initiative was the development of the California Maternal Quality Care Collaborative (CMQCC), a nonprofit group with expertise in evaluating variation in the quality of maternity care and leading hospital quality improvement programs (California Health Care Foundation 2015). Hospital administrators, nurses, doctors, and midwives initially gathered data on maternal deaths in California. Continued data collection is now carried out through the Maternal Data Center, which is an online system where doctors and nurses can link hospital patient discharge data with state birth certificate data (California Maternal Quality Care Collaborative 2019). This online system rapidly generates metrics on maternal care services for hospital clinicians and administrators. The states of Washington and Oregon have since adopted this system framework. A similar framework for the other states may be effective in providing better reporting and benchmark statistics for hospitals. While improving the quality and reporting of data should be one of the main focuses, actions to decrease medical intervention and improve medical intervention outcomes should also be taken.

### ***Cesarean Deliveries***

The total effects of cesarean delivery on maternal mortality remain unclear. The use of cesarean delivery should not be taken lightly, and the

unnecessary use of the operation should be avoided. According to the World Health Organization, cesarean deliveries should not exceed 15 per 100 live births to optimize maternal and infant outcomes (Molina, Weiser, Lipsitz, Esquivel, Uribe-Leitz, Azad, Shah, Semrau, Berry, Gawande, and Haynes 2015, 2264). Molina et al (2015, 2266) found, using global data, the optimal amount of cesarean deliveries was approximately 19 per 100 live births, higher than estimated by the World Health Organization. While there are differences among current research regarding the optimal global cesarean delivery rate, there is no denying that the U.S. has a high cesarean delivery rate at 32 percent. To reduce the high cesarean delivery rate in the U.S., potential reasons for the increase should be understood. The main reasons contributing to this increase are the low priority of enhancing women's ability to give birth, refusal to offer vaginal birth after cesarean delivery, casual attitudes about surgery and variation in practice style, incentives to practice in a manner efficient for providers, limited awareness of harms associated with cesarean delivery, and women's trust in maternity care (National Partnership for Women & Families 2016).

Enhancing women's ability to give birth can be done by providing care that supports natural, physiologic processes. Increasing the role of midwives and accessibility to midwifery care may be ways to combat the rising cesarean delivery rate. A midwife is a trained health professional who helps healthy women and their babies before, during, and after pregnancy. Midwifery care has been shown to support physiologic processes and often uses patience and watchful waiting, positioning and movement, oral nourishment, and other approaches to enable a comforting and calm environment for labor. This type of care has been shown to decrease the likelihood of a cesarean delivery (Buckley 2015, 145-153). The Netherlands, known for having a low maternal mortality ratio and cesarean delivery rate, supports the principle that pregnancy and childbirth are physiological processes and gives midwives the role of primary caregiver for low risk women (Verstraeten, Mijovic-Kondejewski, Takeda, Tanaka, and Olson 2015, 27-28). The Netherlands also supports the principle that medicalization of obstetric care should be avoided and actively opposed (Amelink-Verburg and Buitendijk 2010, 217). The Netherlands' emphasis on midwifery is thought to help decrease the likelihood of medical intervention during childbirth. Sweden saw a significant decrease in maternal mortality in the 20th century. Sweden supports the principle that midwives play a critical role in

women's pregnancies; its decrease in maternal mortality is thought to be the result of an alliance between physicians and highly competent, locally available midwives (Hogberg 2004, 1312). Therefore, actively increasing the role of midwives in the U.S. may help decrease cesarean delivery rates as well as improve overall maternal health.

Due to concerns about maternal complications associated with uterine rupture, vaginal birth after cesarean delivery (VBAC) has decreased substantially over recent decades (Pare, Quinones, and Macones 2005, 75). Pregnant women who want VBAC often face resistance from their physicians even if the women are at low risk. Many hospitals in the U.S. do not provide care for women who choose a vaginal birth after having a cesarean delivery for their previous pregnancies; this is due to the current guidelines for VBAC in the U.S. and physicians' fear of malpractice (VBAC.com 2017). The decline in VBAC rates has been linked to the rise in cesarean delivery rates. Many of the recent concerns in the U.S. about the safety of VBAC have ignored the consequences of repeat cesarean deliveries (Pare, Quinones, and Macones 2005, 75-83). Repeat cesarean deliveries have been shown to put women at increased risk of complications from surgery. Repeat cesarean deliveries have also been shown to use more resources than VBAC, such as an increase in average hospital days for a mother post cesarean delivery (Pare, Quinones, and Macones 2005, 82). Many countries support VBAC and take actions to mitigate the risks involved with VBAC instead of avoiding the option of VBAC completely. The relationship between VBAC and maternal health for the U.S. should be further investigated. Changing current guidelines and properly training physicians for VBAC may help decrease the cesarean delivery rate as well as empower women to choose the method of delivery right for them.

Society is becoming more tolerant of medical operations. Healthcare providers, hospital administrators, and women are becoming more comfortable with medical intervention. The cesarean delivery rate varies among states and hospitals. Kozhimannil, Law, and Virnig (2013, 529) found that cesarean delivery rates for 593 U.S. hospitals ranged from 7.1 to 69.9 per 100 live births in 2009. For low-risk pregnancies, the study found cesarean delivery rates varied from 2.4 percent to 36.5 percent (Kozhimannil, Law, and Virnig 2013, 429). Most of the variation is thought to be due to practice style rather than differences in need and preferences of women (National Partnership for Women & Families 2016). The variation in rates may also be an indicator of healthcare

quality. Kozhimannil, Law, and Virnig (2013, 532) concluded state-led quality improvement programs tied to Medicaid payment policies or reporting requirements are potential ways policy could affect hospital policies and practices; nearly half of U.S. births are paid for by Medicaid.

Cesarean delivery is shown to be more costly than vaginal delivery (Kozhimannil, Law, and Virnig 2013, 527). Extra pay is usually not provided to physicians who patiently support a longer vaginal birth. This may provide hospitals greater opportunities to profit from cesarean deliveries (National Partnership for Women & Families 2016). Vaginal deliveries generally take a longer time and are more spontaneous than cesarean deliveries, so a planned cesarean delivery is an efficient way for a physician to organize his or her work schedule. Providing incentives to practice in a manner that focuses on benefitting mothers rather than benefitting the providers may help decrease the cesarean delivery rate.

As mentioned previously, studies have found maternal mortality caused by venous thromboembolism was associated with cesarean delivery. The risk of venous thromboembolism has been shown to be reduced with either medical or mechanical thromboprophylaxis (Clark et al 2008, 94). Main et al (2015, 942) found among women who died from venous thromboembolism, care was inconsistent, and only one patient received any form of medical or mechanical thromboprophylaxis. A policy of universal use of medical or mechanical thromboprophylaxis for women undergoing cesarean delivery may significantly decrease the risk of cesarean delivery complications (Clark et al 2008, 94). Standards emphasizing proper training of physicians when handling hemorrhage and pre-eclampsia may also be undertaken since these two conditions were also common among maternal deaths for both cesarean and vaginal deliveries. Main et al (2015, 940-943) found hemorrhage and pre-eclampsia were most likely to have a good to strong chance of preventability. Delayed response to warning signs, ineffective care, inadequate staff knowledge, system protocol issues, and coordination of care were factors that contributed to many preventable deaths (Main et al 2015, 940-943). Berg, Harper, Atkinson, Bell, Brown, Hage, Mitra, Moise, and Callaghan (2005, 1233) found improved quality of medical care was the most important factor in preventing maternal deaths from hemorrhage. Standards improving the quality and consistency of care may help decrease risks associated with cesarean delivery and decrease risk of maternal death.

The relationship between cesarean delivery and maternal health

should be further investigated. Potential remedies discussed in this paper regarding cesarean delivery are not an exhaustive list. More medical, social, and economic initiatives may be developed as research on the effects of medical intervention continues. Future research on what is causing this increase in cesarean delivery rate is needed to provide more elaborate recommendations in decreasing the rate.

### ***Poverty***

The relationship between poverty and overall health has been frequently studied. As mentioned earlier, poverty has been shown to have a negative effect on overall health. It has been assumed poverty most likely has a negative effect on maternal health and may lead to an increased risk of maternal death. More research, however, is necessary to make any clear connections between poverty and maternal mortality.

Policy interventions could address the increase in poverty among women of reproductive age. Research has found married couples, the older population, and lower middle-class families have benefited from the social safety-net more than single mothers (Jarosz and Mather 2017, 5). Social safety-net programs focusing on poor families, specifically single mothers and their children, may provide some relief. Policies improving economic security may also help reduce the maternal mortality ratio because the ratio has been shown to be highest among the high-poverty population (Jarosz and Mather 2017, 14). The relationship between economic security and maternal mortality for a developed country, specifically the U.S., needs to be further investigated to draw any solid conclusions. Providing affordable and accessible services to women in poverty may help decrease pregnancy complications, thus decreasing the maternal mortality ratio. Federal and state laws restricting reproductive health services and abortion have been tied to the increasing maternal mortality ratio (Jarosz and Mather 2017, 14). Providing affordable and accessible prenatal care for women may also help increase the use of health services and decrease maternal mortality.

To mitigate the effects of both poverty and medical intervention, educating women about pregnancy regardless of socioeconomic status, race, ethnicity, and geographic location is vital. Educating women will empower them to take control of their health and to take advantage of the opportunities they believe are best for themselves and their children. Japan is known for its improvement of infant and maternal health and has

been considered one of the global leaders in infant and maternal health. Since the 1940s, Japan has continually updated an informative guide known as the “Maternal and Child Health Handbook.” This guide includes birth planning, pregnancy-related health check-up schedules, information on emergency care, delivery, postnatal care, family planning, immunization, and infant and child health until the age of six (Bhuiyan and Nakamura 2008). It is issued to every woman regardless of origin, immigration status, and socioeconomic status and has been adopted by many countries. Research has shown that the guide is highly used in Japan by families (Nakamura 210, 261) especially regarding child health. A standard guide focusing on maternal health and options available may be an effective way for the U.S. to educate pregnant women. For a “Maternal and Child Health Handbook” program to be most effective, health professionals and healthcare workers must be supportive, and a healthcare delivery system must exist (Nakamura 2010, 263).

## V. Conclusion

There are many factors potentially contributing to the increase in the U.S. maternal mortality ratio over recent decades. While changes in data quality and reporting, increased cesarean delivery rate, and increased poverty rate among women of reproductive age have often been tied to the increase in the maternal mortality ratio, these factors do not make up an exhaustive list of explanations. More research is required in order to better understand the relationships among factors and maternal mortality. It is crucial to start somewhere, however, and actions to reverse the maternal mortality ratio trend and to improve overall maternal health in the U.S. should be taken immediately. Potential actions include developing and enforcing a more comprehensive reporting method, enforcing medical standards, providing safety-net programs, providing accessible and quality healthcare, and educating and empowering women.

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