

Maternal and Infant Mortality in the United States



Manisha Gupta, MPH
Public Health Researcher

Ajay K Gupta, CISSP, MBA
Chief Executive Officer



Abstract

Every year in the United States, more than 700 women die of complications related to pregnancy and childbirth, and more than 50,000 women experience a life-threatening complication (severe maternal morbidity). Maternal mortality in the United States more than doubled between 1990 and 2014, from 9.8 to 18 maternal deaths per 100,000 live births, at a time when 157 of 183 countries in a World Health Organization (WHO) study reported decreases in maternal mortality. Both maternal and infant mortality are widely considered indicators of a nation’s health and quality of health care. The United States has seen an overall improvement in infant mortality rate, declining 15% from the recent high of 6.86 infant deaths per 1,000 live births in 2005 to 5.82 in 2014. However, trends in infant and maternal mortality rates are not declining as significantly as we would hope, especially as compared with similar countries. Clearly what we are doing to address the health needs of mothers and newborn infants is not enough. Over the years, many efforts at the local, state, and national level have been made to understand the root cause of maternal and infant mortality in the United States. This paper leverages those effort to identify a comprehensive and concise list of the drivers and risk factors (Table A1) for maternal and infant mortality - so that we as a nation can relinquish the ignoble Top Spot on the list of maternal and infant mortality among developed nations.

Keywords: Maternal Mortality, Infant Mortality, Pregnancy, Childbirth, Racial Disparities, Income Disparities

Table A1 – Socio-environmental and Biological Risk Factors for Maternal and Infant Mortality		
#	Risk Factor	Issue
1	Racial Disparity	Racial disparities contribute to access to quality health services along with external stressors that reduce health outcomes.
2	Non-communicable Disease	Non-communicable diseases before and during pregnancy lead to complications for the child, putting them at risk of various chronic illnesses.
3	Socio-economic Variables	Social Class, income, access to an existing insurance coverage play a role in fertility and child health.
4	Drug Use Before and During Pregnancy	Drug use in any stage of pregnancy result in adverse outcomes for the mother and introduces the risk of drug-dependent newborns, Neonatal Abstinence Syndrome.
5	Venous Thromboembolism	Medical complication during pregnancy, delivery, or puerperium that can lead to the mother’s fatality.

Table of Contents

ABSTRACT	2
INTRODUCTION	4
KEY DEFINITIONS⁸:	9
RISK FACTORS FOR MATERNAL AND INFANT MORTALITY	10
1. Racial Disparities	13
2. Maternal Health and Non-communicable Diseases	15
Maternal Age	18
3. Socio-economic Variables	18
Maternal and Prenatal Nutrition	19
Education	19
Access to Health Insurance and Prenatal Care	20
4. Drug Use Before and After Pregnancy	21
5. Venous Thromboembolism (VTE)	22
CONCLUSION	24
REFERENCES:	26

Introduction

The United States faces alarmingly high rates of maternal and infant mortality, placing it with the highest mortality rates in both categories in the developed world. Both maternal and infant mortality has been recognized as a primary reflection of the health of a nation, due to its association with factors like health quality, healthcare access, socioeconomic conditions, and public health practices.¹ Cross-country comparisons of infant mortality place U.S. rates 71% higher than the comparable country average; 5.8 per 1000 live births vs. 3.4 per 1000 live births respectively.² The U.S. has roughly 83% more neonatal deaths, which are deaths that occur less than 28 days after birth, compared to the country average. This has been attributed to reduced health conditions at the time of birth.³ While overall infant mortality rates have decreased, U.S. rates are declining more slowly than comparable developed countries.

Regarding maternal health, the establishment of The United Nations Millennium Development Goal contributed to the 44% decline in maternal mortality worldwide from 1990–2015². Maternal mortality, on the other hand, has not improved in the United States, and appeared to increase 17%, as seen in Table 1. Among 31 Organization for Economic Cooperation and Development (OECD) countries reporting maternal mortality data, the U.S. ranks 30th, ahead of only Mexico.⁴



Table 1. Trends in Estimates of Maternal Mortality Ratio (MMR; Maternal Deaths per 100 000 Live Births), by Country and Region, 2000–2014						
Country	2000	2005	2010	2014	% change in MMR between 2000 and 2014	Average annual % change in MMR between 2000 and 2014
United States of America	18.8	20.6	22.4	23.8	-20	-1.25
More Developed Regions	17	15	13	12	48	2
Less Developed Regions	337	319	272	238	45	2.4
World	341	288	246	216	44	2.3

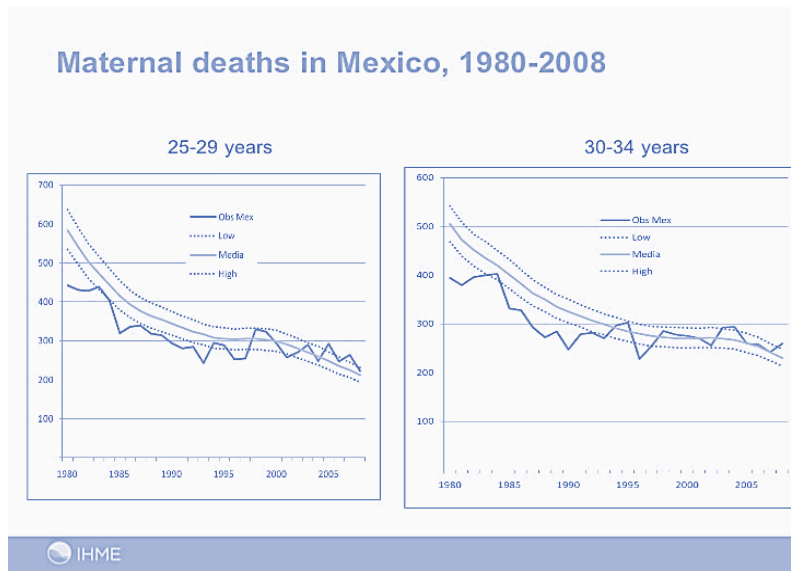
World Health Organization, Health Statistics and Information Systems (HSI)

Even within the United States, maternal mortality rates are uneven across states. The adoption of collaborative public health care efforts which look at the primary causes of death have shown success in preventing maternal deaths. Evidence-based tool kits to address two of the most common and preventable contributors to maternal death (obstetric hemorrhage and preeclampsia) and the implementation of quality improvement initiatives throughout California appear to have helped reduce maternal mortality, which has resulted in a noticeable decline from 2003 to 2014¹ in the Sunshine State. California now boasts the lowest maternal mortality rate in the nation.

Table 2. Trade and Maternal Health Outcomes
<p>THE RELATIONSHIP BETWEEN TRADE AND MATERNAL HEALTH OUTCOMES</p> <p>When assessing shifts in diet and lifestyle over the years, the most impactful change in countries has been accessing to new foods as well as improved production of foods – regarding the volume of production, not necessarily the quality of the food. Introduction of processed “Western” foods in</p>

countries that had previously relied primarily on whole foods (whole grains, fruits, vegetables, unprocessed forms of protein, among others), have also introduced a plethora of health problems. The most relevant example has been the 1986 North American Free Trade Agreement (NAFTA) on food production and quality in Mexico. Between 1988 and 1995, the average daily energy obtained by fats in Mexico increased from an estimated 24% to nearly 31% (Brooks, D. 2012). The Kantar World Panel reported that 30% of Mexican local's income is spent on highly processed junk food from foreign retailers (CNN Expansion, 2015). Exposure to unhealthy foods which are cheaper and more accessible has fueled Mexico's obesogenic environment. Maternal and child health is concerned here, because indirect causes stemming from non-communicable diseases are driving more health problems. Chronic diseases like diabetes, heart disease, cancers, and hypertension are aggravated in part by diet. Pregnancy already places a mother's body under tremendous amounts of stress. Unhealthy foods high in fats, sugars, and simple carbohydrates further increase the risk to the mother of disease during her pregnancy and throughout her lifetime. What many may now know is that such foods also place the child at risk as well – from their time in utero, through birth, and throughout their life.

The NAFTA accord illuminates the impact that national and cross-country policies can have on health outcomes for populations – and especially for vulnerable people, including mother and child.



Texas was unusual in that it saw a slight increase in maternal mortality from 2000 to 2010 followed by a doubling within 2 years in the reported maternal mortality rate. There were some changes in the provision of women's health services in Texas from between 2011 and

2015, including the closing of several women’s health clinics.¹ However, “in the absence of war, natural disaster, or severe economic upheaval, the doubling of a mortality rate within 2 years in a state with almost 400,000 annual births” is something to look into further.²

An examination of state data by risk factors, including race and ethnicity as well as detailed causes of death can help better identify state-level disparities. Health Solutions Research is developing a mechanism to isolate the leading risk factors for maternal and infant mortality considering disparities across race, socio-economic status, health care access, health status, and other factors to develop a comprehensive risk stratification that can identify an expecting mother’s overall level of risk for herself and her child. This will help the healthcare community improve care for those at greatest risk and help lower our national maternal and infant mortality rate.

Table 3. Maternal Mortality by States

Maternal mortality rates varied widely by states, ranging from a low of 4.5 deaths per 100,000 births in California to a high of 46.2 deaths per 100,000 births in Georgia, in 2018.

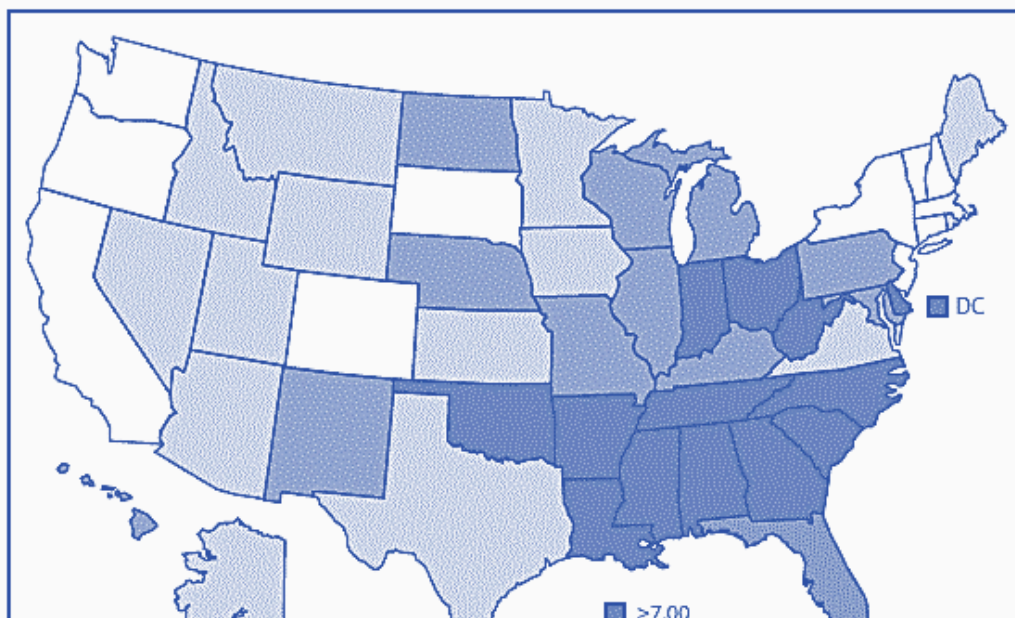
The five states with the lowest maternal mortality rates:

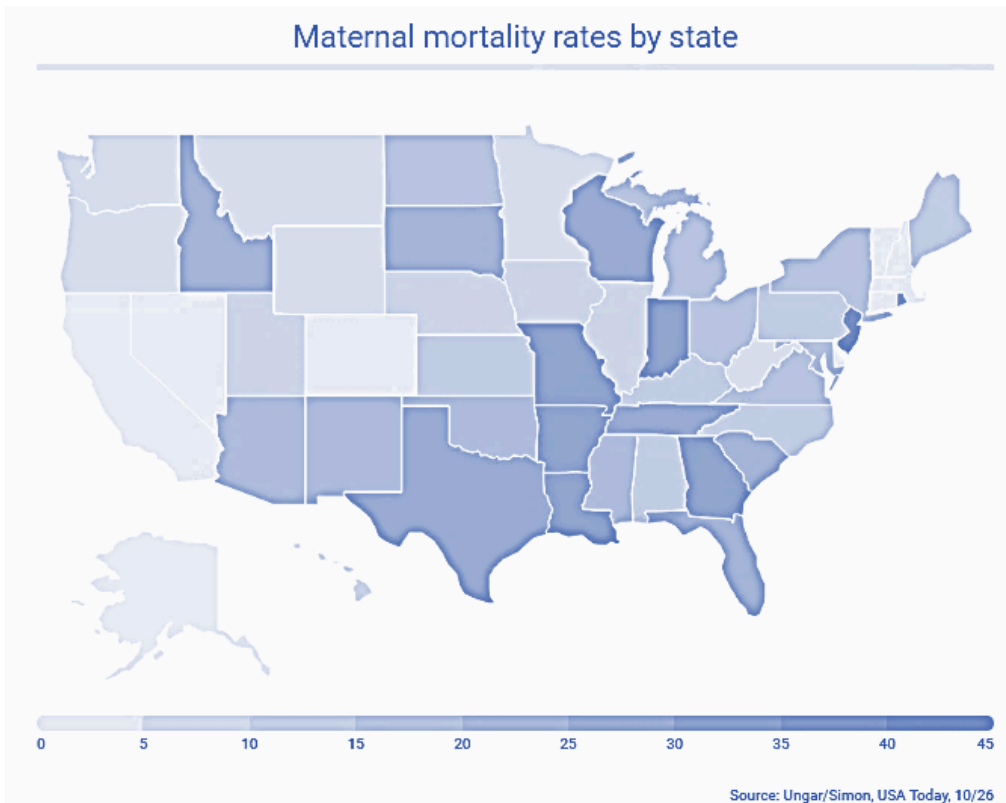
- California
- Massachusetts
- Nevada
- Connecticut
- Hawaii

The five states with the highest maternal mortality rates:

- Georgia
- Louisiana
- Indiana
- Washington, DC
- New Jersey

<https://www.advisory.com/daily-briefing/2018/11/09/maternal-mortality>





Maternal and Infant Mortality Rate, by State — the United States, 2016 CDC

Key Definitions:⁸

Infant Mortality:

Infant mortality is the death of an infant before his or her first birthday. The *infant mortality rate* is the number of infant deaths for every 1,000 live births.

Maternal Mortality:	Maternal mortality is the death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management but not from accidental or incidental causes. The <i>Maternal Mortality Ratio (MMR)</i> is the annual number of maternal deaths for every 100,000 live births.
Puerperium:	The period of about six weeks after childbirth during which the mother's reproductive organs return to their original nonpregnant condition.
Morbidity: ⁹	the relative incidence of some disease or the quality of being unhealthful.
Obesogenic Environment: ¹⁰	The sum of influences that the surroundings, opportunities, or conditions of life have on promoting obesity in individuals or populations.
Venous Thromboembolism: ¹¹	A blood clot that forms in the vein. There are two types:
Deep vein thrombosis:	Deep vein thrombosis (DVT) is a clot that forms in a deep vein, most usually in the leg, though it can develop in an arm or another vein. In women, pregnancy and the use of hormones like oral contraceptives or estrogen for menopause symptoms can also play a role in the creation of a clot.
Pulmonary embolus:	A blood clot that gets wedged into an artery of the lungs. This occurs when a DVT clot breaks free from a vein wall, travels to the lungs and then blocks some or all of the blood supply.
<u>Placental Abruption:</u>	Occurs when the placenta partially or completely separates from the inner wall of the uterus before delivery. This can

decrease or block the baby's supply of oxygen and nutrients and cause heavy bleeding in the mother.

Neonatal Abstinence Syndrome:¹²

The result of the sudden discontinuation of fetal exposure to substances that were used or abused by the mother during pregnancy.

Anticoagulant:

Commonly referred to as blood thinners, are chemical substances that prevent or reduce coagulation of blood, prolonging the clotting time.

Thromboembolic Disease:

In rare cases, a blood clot to the lungs (pulmonary embolism) never is reabsorbed by the body. Instead, a reaction occurs in which multiple small blood vessels in the lungs also become diseased.

Gestational Diabetes Mellitus:

High blood sugar levels during pregnancy. This condition can start when the mother's body is not able to make and use all the insulin it needs for pregnancy. Without enough insulin, glucose cannot leave the blood and change to energy. Glucose builds up in the blood to high levels.

Intrapartum:

The time-period is spanning childbirth, from the onset of labor through the delivery of the placenta.

Risk Factors for Maternal and Infant Mortality

When analyzing disparities across demographic and social indicators of health, we see that a variety of factors contribute to maternal and infant mortality rates in the United States. This paper highlights some of the major leading factors of maternal and infant mortality and determines their relative contribution to mortality rates in the United States.

The relationship between maternal and infant health occurs linearly, in that the chain of health outcomes for the baby, starts with the mother. As seen in the Appendix, rates of maternal and infant mortality follow similar demographic patterns. In the U.S., the Southeastern states exhibit a higher prevalence of both maternal and infant mortality. Mortality among

infants is in part driven by the health status of the mother. If the public health goal is to improve infant mortality rates, the focus should begin with improving morbidity and mortality rates for the mother.

TABLE 4 – Disparities in Maternal and Infant Mortality by States	
<p>Key facts about State-wide Disparities of Infant and Maternal Mortality: In 2016, the infant mortality rate in the United States was 5.87 infant deaths per 1,000 live births.</p> <p>By state:</p> <ul style="list-style-type: none"> - The infant mortality rate ranged from a low of 3.47 in Vermont to a nation-wide high of 9.03 in Alabama. - Rates in two other states were < 4.00 - New Hampshire at 3.67 and Massachusetts at 3.94. - Higher rates were primarily in the southern states. In addition to Alabama, two other states had rates > 8.00 - Arkansas at 8.20 and Mississippi at 8.67. - In Maryland, since 2016: <ul style="list-style-type: none"> o Maternal mortality decreased 9% from 25.7 to 23.5 deaths per 100,000 live births. o Dedicated health care providers to women’s health and reproductive health increased 7% from 76.0% to 81.2%. o The percentage of infants exclusively breastfed for six months decreased 14% from 26.6% to 23.0%. o Neonatal mortality increased 4% from 4.6 to 4.8 deaths per 1,000 live births. 	

Mortality among infants is driven by both biological, genetic, and environmental factors. Many of the causes listed below are determined by a mother’s behavior during the early developmental stages of pregnancy. While improving maternal health is the place to start for improving infant health, we still want to evaluate the factors that lead to infant mortality because some may not be immediately obvious when examining maternal health. Improvements in maternal health may not adequately influence others.

Table 5 – Socio-environmental and Biological Risk Factors for Maternal and Infant Mortality		
#	Risk Factor	Issue

1	Racial Disparity	Racial disparities contribute to access to quality health services along with external stressors that reduce health outcomes.
2	Non-communicable Disease	Non-communicable diseases before and during pregnancy lead to complications for the child, putting them at risk of various chronic illnesses.
3	Socio-economic Variables	Social Class, income, access to an existing insurance coverage play a role in fertility and child health.
4	Drug Use Before and During Pregnancy	Drug use in any stage of pregnancy result in adverse outcomes for the mother and introduces the risk of drug-dependent newborns, Neonatal Abstinence Syndrome.
5	Venous Thromboembolism	Medical complication during pregnancy, delivery, or puerperium that can lead to the mother's fatality.

Causes of Infant Mortality:¹³ Death of an infant before the age of one.

1. Birth defects- from genetic predisposition, substance use/abuse, physical trauma to the mother, exposure to diseases or infections (rubella or measles).
2. Preterm birth and low birth weight- from drug use, malnutrition, and inadequate prenatal care.
3. Sudden infant death syndrome- driven by other primary causes of infant mortality (respiratory infections, brain defects, low birth weight).
4. Maternal pregnancy complications- will be reviewed in depth throughout this paper
5. Injuries (e.g., suffocation)- typically standalone factors driven by limited education on infant care, environmental stressors, and improper living conditions.

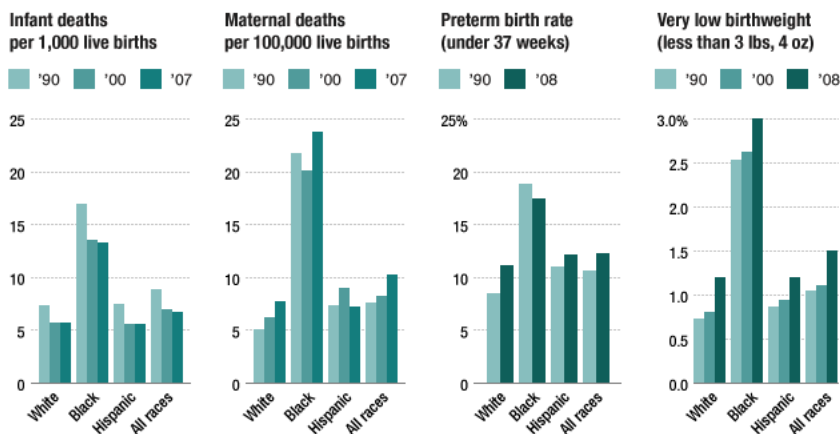


1. Racial Disparities

Racial and ethnic disparities in maternal mortality and obstetric care continue to lead to preventable adverse outcomes for mother and baby. Variations among healthcare services have been defined as differences in the quality of care received by particular groups who have similar health insurance and the same access to health services when there are no differences between these groups in their preferences and needs for treatment.¹⁴ A report from the Institute of Medicine indicated that racial and ethnic minorities in the United States are less likely to receive needed procedures, more likely to receive less useful procedures, and experienced an overall reduced quality of health services.¹⁵



When examining the implication of race on maternal health, it is often considered the most prominent factor when determining mortality risk in the United States.¹⁶ Black women die at a rate that ranges from three to four times the rate of their white counterparts—42 deaths per 100,000 live births among black women versus 12 deaths per 100,000 live births among white women as of 2010.¹⁷ This difference in risk has remained unchanged for the past six decades. Also, American Indian and Alaskan Native women also face negative outcomes compared to white women with approximately twice as many pregnancy-related deaths per 100,000 live births. Historically, women of color tend to have poorer access to quality reproductive health information and services than white women, are reportedly discriminated against in the healthcare system, and experience higher rates of disrespect and abuse.¹⁸ It was found that infant mortality rates among all races in the U.S. declined about 16 percent from 2000 to 2014. Non-Hispanic blacks saw about a 21 percent decrease during this time-period but continue to have the highest infant mortality rate among all races. American-Indian and Alaska Natives experienced a 9 percent decrease in infant mortality during this time period. Rates among Non-Hispanic blacks and American-Indian/Alaska Natives are higher than average.³ Figure 2 shows infant and maternal mortality rates by race.



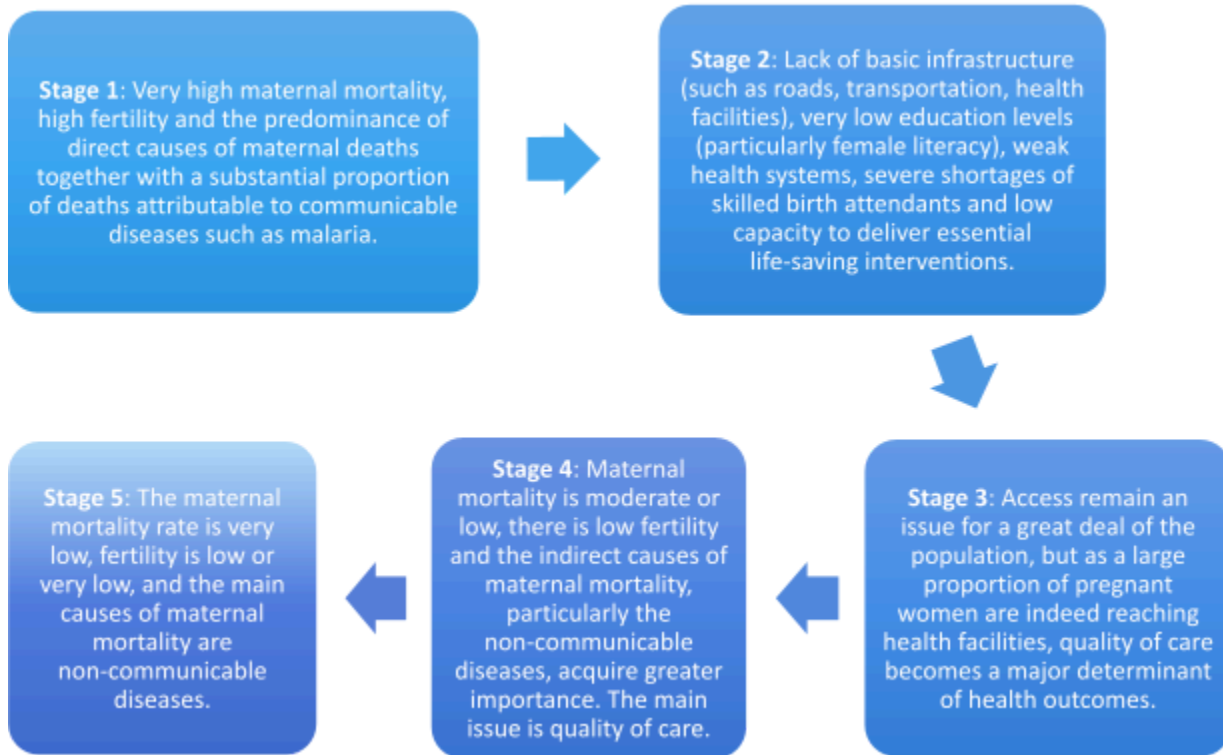
Notes
The World Health Organization defines "maternal death" as "the death of a woman while pregnant or within 42 days of termination of pregnancy."

Source: Centers for Disease Control and Prevention
Credit: Alyson Hurt/NPR

2. Maternal Health and Non-communicable Diseases

Non-communicable diseases (NCD) such as cancer, diabetes, heart disease, respiratory disease, and mental illness account for almost 65 percent of all female deaths worldwide. In the United States, women have a 1 in 8 chance of dying prematurely (ages 30-70) from a noncommunicable disease (NCD), putting the nation on par with low- and middle-income countries. Roughly 50 percent of all women deaths under 70 years of age are attributed to NCDs worldwide. NCDs increasingly affect women and children across the reproductive, maternal, newborn, and child continuum due to their existing risk of complications due to pregnancy. There has been a shift in causes of maternal deaths, called obstetric transition, defined in detail in Figure 3 below. This concept refers to changing patterns in morbidity and mortality from direct to indirect causes of maternal death. Tobacco use and exposure to secondhand smoke, unhealthy diet, physical inactivity, and harmful use of alcohol are the four main risk factors for NCDs.¹⁹ This contributes to the reduction of direct causes of obstetric death (including postpartum hemorrhages, high blood pressure, and infections) with a subsequent increase in indirect reasons stemming from NCDs, increased maternal age, and increased use of maternal care services which prevent direct pregnancy-related deaths.

Figure 3 – Obstetric Transition



Heart disease is the leading cause of death for women in the United States, affecting 1 in 4 women²⁰. This disease disproportionately affects African American women the most, which is

critical to consider as they face a variety of structural challenges affecting their health status, as mentioned throughout this paper. Risk factors of heart disease are diabetes, obesity, poor diet, physical inactivity, and excessive alcohol use. During pregnancy, changes occur to the



heart and blood vessels which put extra strain on the woman's body. Also, younger women who engage in unhealthy behaviors are putting themselves at risk of cardiovascular diseases. Death

occurs by plaque buildup in the arteries and hardening of the arteries which block blood flow to the brain and heart causing a stroke or heart attack respectively.

In the traditional sense, communicable diseases have been classified as infections spread through a specific vector of communication (air, water, contact, etc.). However, we are starting to see a trend in the role the social and physical environment plays in the transmission or increased risk of developing chronic diseases. This possibly introduces a new form of disease transmission through shared behaviors and habits. If these risk factors were prevented, an estimated 75% of premature heart disease, stroke and diabetes, and 40% of cancer could be prevented globally.¹³ Many behaviors related to NCD risk factors are initiated during adolescence, meaning that it is essential to focus on improving women's health status at a younger age. In the US, research shows that Head Start programs have life-long health value, though their educational value tends to dissipate by the 2nd or 3rd grade. In effect, Head Start programs may not make kids smarter, or *headier*, than their peers, but it may leave them healthier.

The low socio-economic, legal, and political status of many women and children also increases their exposure and vulnerability to NCD risk factors. In addition, the projected increase in urbanization leads to lifestyle changes that increase the risks of developing NCDs.

Just as there are adverse effects from in-utero exposure to environmental toxicants, there is a significant transgenerational effect of early adverse experiences on health and disease incidence in older age. Women of reproductive age who reside in the United States and suffer from chronic disease are likely putting their children at risk of also experiencing similar outcomes later on in life. For example, the case of maternal diabetes; infants of women with pre-existing or gestational diabetes have greater birth weight, fat tissue, and subsequent risk for obesity and diabetes.²¹ Maternal obesity, as measured by high body mass index, has been consistently reported to increase the risk of pregnancy complications, including thromboembolic disease, gestational diabetes mellitus, and hypertensive disorders of pregnancy.²² Focusing on the indirect causes of maternal mortality by addressing NCDs is necessary. A more holistic approach towards mother's health will be vital in improving

outcomes, especially in low-resource settings where education and interventions are more narrowly focused on complication and intrapartum care.²²

Maternal Age

The age of a mother during the pregnancy itself is a potential driver of health outcomes for both the mother herself and the child. Mean maternal age is increasing, meaning that people are waiting longer to have children. The average age shifted from 24.6 in 1970 to 26.3 in 2014.³⁷ There is the need to closely



monitor pregnancies as a mother's age increases, as the risk of chromosomal abnormalities and pregnancy complications also rises. For example, the chance of having a child affected by Down syndrome increases from about 1 in 1,250 for a woman who conceives at age 25, to about 1 in 100 for a woman who conceives at age 40.²³ The average age of first-time mothers can provide some additional insight into contributors to both maternal and infant mortality. Further discussion is needed to understand the potential of maternal age to determine health outcomes.

3. Socio-economic Variables

Compared to peer nations, the United States has seen rapid increases in maternal mortality over the last few years, except California whose maternal mortality rates as previously noted has seen a decrease from 16.9 in 2006 to 7.3 deaths to every live birth as of 2013²⁵ and further to 4.5 deaths per 100,000 live births in 2018.

The overall uptick has been seen through individual and population level demographic factors¹². Understanding how population-level factors change and relate to maternal mortality over time may provide insights into effective public health and health policy responses. Other socioeconomic variables significantly related to maternal mortality include state median income, access to quality healthcare services, access to nutritious foods, and the rates of the

uninsured. Additional factors such as advancing maternal age, increased prevalence of obesity and chronic health conditions, and changes in cesarean section rates have been proposed to explain the increase in maternal mortality over the last two decades.

Maternal and Prenatal Nutrition

There are known inequalities across groups with different socio-economic circumstances. Variables like income affect a mother's access to nutritious foods which impact



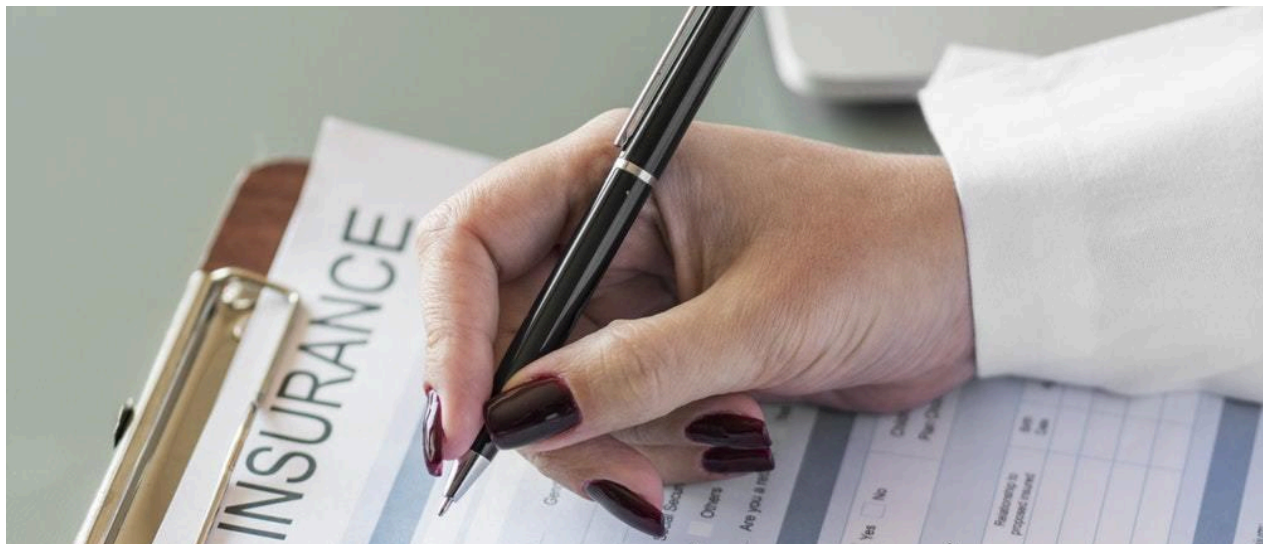
not only a mother's health but also her ability to nourish her child. Ensuring that women receive all necessary prenatal vitamins and nutrients to sustain her and her offspring's health, will contribute significantly to their health outcomes. Nutritious foods reduce the risk of malnutrition and other dietary related chronic illnesses such as obesity, diabetes, and high blood pressure. The nutritional needs during pregnancy require access to additional calories from healthy fats, protein, and carbohydrates, with sweets and processed fats, kept to a minimum. There has been an emphasis on the intake of Folic Acid, a nutrient found in green leafy vegetables, most berries, nuts, beans, citrus fruits, fortified breakfast cereals, and some vitamin supplements. Proper intake can help reduce the risk of birth defects of the brain and spinal cord (called neural tube defects). Such birth defects can lead to varying degrees of paralysis, incontinence, and sometimes intellectual disability.²⁵

Education

Research suggests that babies born to women with lower income and education levels are at higher risk of poorer outcomes, such as preterm birth or with a low birthweight. A baby’s health status is reflective of the mother’s health and the health of the physical environment. Adverse birth outcomes were most prevalent among women in the most socioeconomically disadvantaged groups. Studies also found evidence that higher levels of neighborhood poverty or unemployment were associated with a higher prevalence of low birth weight and preterm birth among African-Americans and Asians.²⁶ Current research on socio-economic disparities on maternal and infant health is centered around the mother’s education. Studies have shown that lower levels of maternal education were associated with higher maternal mortality even amongst women able to access facilities providing intrapartum care. Low income and poverty have a lasting effect on the psychological and behavioral development in children. Financial instability has an impact on children’s cognitive and academic achievement as well. Lack of education is highlighted in current literature as one of some stressors (along with limited financial resources and decision-making power) affecting women during pregnancy and childbirth, creating vulnerability and increasing the likelihood of adverse outcomes.²⁷

Access to Health Insurance and Prenatal Care

Other socio-economic factors influencing maternal health include health insurance coverage for prenatal care and early preventative care. Health insurance status and state



coverage policies reflect the establishment of a support structure for mothers and soon-to-be mothers. Assessing the role of prenatal care has been shown to curb both maternal and infant mortality rates. Insurance coverage itself prompts women to seek out care in all stages of family planning. In low-income countries, prenatal care provides the opportunity to teach hygiene, sanitation, nutrition, and recognition of certain health problems. Tetanus immunizations may be given, high-risk mothers and pregnancies can be detected through clinical examinations, and preventive and corrective measures can be taken at this time.²⁸ Responses in varying settings demonstrate a need for additional research on the value of prenatal care in the U.S. and its capability to reduce mortality and morbidity in different state situations. Health insurance coverage at all stages of pregnancy allows women to afford and access the care they need. Recent efforts to repeal portions of the Affordable Care Act that require health plans to cover maternity care as an essential benefit threaten access to care during pregnancy and Medicaid eligibility policies that drop pregnancy-related coverage sixty days after childbirth continue to aggravate the health status of women in the postpartum period. Free and affordable prenatal and reproductive care for women which are offered through community health workers and organizations like Planned Parenthood can help to alleviate much of the access problems many low-income women face. Women face access concerns within their communities. Policy efforts to address workforce shortages and the financial challenges of low-volume obstetrics are needed to keep maternity wards open. More than half of rural counties currently have no hospital that provides maternity care²⁹, and in those communities, there is a need for housing and transportation support for mothers who travel to give birth in distant communities—as well as for local emergency responses.

4. Drug Use Before and After Pregnancy

With opioid misuse on the rise in the United States, threatening the lives of people at

DRAMATIC INCREASES IN MATERNAL OPIOID USE DISORDER AND NEONATAL ABSTINENCE SYNDROME

Opioid use during pregnancy can result in a drug withdrawal syndrome in newborns called **neonatal abstinence syndrome**, or **neonatal opioid withdrawal syndrome** (NAS/NOWS), which causes **costly** hospital stays. A recent analysis showed that an estimated **32,000** babies were born with this syndrome in the United States in 2014, a more than **5-fold increase** since 2004.

EVERY ~ 15 MINUTES, A BABY IS BORN SUFFERING FROM OPIOID WITHDRAWAL.

every stage of life, drug use among women in their reproductive years (18-44)³³ introduces risks beyond the individual user. Estimates suggest that about 5% of all pregnant women use one or more addictive

substances³⁵ during their pregnancy. The relationship between perinatal drug/alcohol use and maternal, fetal, neonatal, and post-neonatal mortality has been studied extensively since women who are pregnant or are planning to be, are at a higher risk of developing a substance use disorder (SUD). Women who use illicit drugs during pregnancy have higher chances of placental abruption, premature rupture of membranes, and polyhydramnios, which is excess amniotic fluid in the amniotic sac. Research shows that smoking tobacco or marijuana, taking prescription pain relievers, or using illegal drugs during pregnancy is associated with double or even triple the risk of stillbirth.³⁴ Also, regular substance use before or during pregnancy can cause Neonatal Abstinence Syndrome (NAS) in which the baby goes through withdrawal upon birth. Short-term symptoms of withdrawal include blotchy skin coloring, diarrhea, and fever. Long-term symptoms include birth defects, low birth weight, premature birth, and small head circumference.³⁶

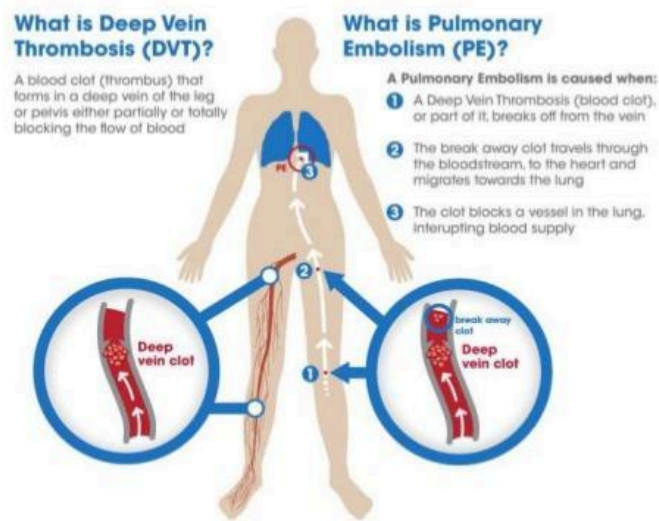
Substance use among pregnant women continues to be a significant public health problem which leads to several adverse health outcomes for both mother and infant. Outside the immediate physical complications that arise from substance use and abuse, there are additional variables leading to maternal and infant consequences, including emotional comorbidities, limited prenatal care, environmental stressors, and disrupted parental care. Taking care of drug dependency during prenatal care and primary care visits can help raise the mother's awareness of the adverse health outcomes that are associated with drug use during pregnancy.

5. Venous Thromboembolism (VTE)

In the developed world, Venous Thromboembolism (VTE), described in Figure 5 below, during pregnancy is highly associated with mortality, morbidity, and high costs within the health sector. Pregnancy and the puerperium itself are risk factors for the development of both deep venous thrombosis (DVT) and Pulmonary Embolus (PE) which are two types of VTE. Women are up to five times more likely to develop a VTE when pregnant, with the only standard of care being an anticoagulant.³⁵ Venous thromboembolism is a condition in which a blood clot forms in the deep veins. This was thought to be evolved as a protective action to prevent excessive

bleeding during miscarriage and childbirth. However, in the United States, this condition is now the leading cause of maternal death³⁶. This blockage is very difficult to diagnose and requires quick intervention and treatment, making this extremely life-threatening. This condition causes low blood pressure or shock (the inability of the heart and lungs to provide oxygen to the organs of the body), resulting in sudden death.³⁷

Venous Thromboembolism (VTE)



It is believed that cesarean sections (CS) are associated with greater risks of postpartum VTE. A meta-analysis examining this phenomenon found on average, 3 in 1,000 women will develop an embolism following their cesarean section³⁸. With roughly one-third of all births occurring via cesarean section in the United States, this places women in the U.S. at an increased risk of VTE. There is a higher risk when the CS is unplanned and in an emergency. Women in the postpartum period exhibit greater activation of coagulation compared to women with vaginal delivery (VD). It is still unclear as to why this exactly occurs, whether it is the result of the conditions leading to the CS or the procedure itself.



Conclusion

Between 1987-2014, pregnancy-related mortality rates in the U.S. more than doubled from 7.2 to 18 per 100,000 live births. Seeing that 157 out of 183 countries were able to successfully show a decline in maternal death rates, this marked increase within the U.S. is of grave concern. Efforts within this paper to identify major risk factors of maternal mortality through the analysis of state-wide disparities within the U.S. can help to isolate the behaviors and conditions contributing to these high death rates. This has the potential to drive state and national policies and reduce preventable deaths.

State-wide disparities continue to shed light on preventable drivers of both infant and maternal mortality. Progress towards the reduction of death rates is only as successful as our ability to isolate the leading causes of the mortality itself. Taking a comprehensive approach in determining what the drivers of adverse health outcomes are before, during, and after pregnancy will ensure national success in alleviating this public health crisis. Knowing that there

are a variety of socio-economic, behavioral, and medically-related factors at play, policy makers and health systems can better target interventions and follow best practices to ensure that our most vulnerable groups are receiving the care they need.



References:

1. Mathews TJ, MacDorman MF. Infant mortality from the 2005 period linked birth/infant death data set. National vital statistics reports, vol 57 no 3. Hyattsville, MD: National Center for Health Statistics. 2008.
2. Bradley Sawyer, S. G. (2017, July 7). How does infant mortality in the U.S. compare to other countries? Retrieved from Kaiser Family Foundation.
3. MacDorman, M. F., Declercq, E., & Thoma, M. E. (2017). Trends in Maternal Mortality by Sociodemographic Characteristics and Cause of Death in 27 States and the District of Columbia. *Obstetrics and Gynecology*, 129(5), 811-818.
4. Organization for Economic Cooperation and Development. [Accessed March 10, 2016]; OECD health statistics. 2015 Available from: <http://www.oecd.org/health/health-data.htm>.
5. Pregnancy-related mortality in California: causes, characteristics, and improvement opportunities. Main EK, McCain CL, Morton CH, Holtby S, Lawton ES *Obstet Gynecol*. 2015 Apr; 125(4):938-47. Effect of Removal of Planned Parenthood from the Texas Women's Health Program.
6. Stevenson AJ, Flores-Vazquez IM, Allgeyer RL, Schenkkan P, Potter JEN *Engl J Med*. 2016 Mar 3; 374(9):853-60.
7. Liptak Adam. Supreme Court Appears Sharply Divided as It Hears Texas Abortion Case. *New York Times*; Mar 2, 2016. Available from: <http://www.nytimes.com/2016/03/03/us/politics/supreme-court-abortion-texas.html>
8. World Health Organization; Maternal Mortality Ratio (per 100,000 live births). Available from: <https://www.who.int/healthinfo/statistics/indmaternalmortality/en/>
9. <https://www.vocabulary.com/dictionary/morbidity>
10. Obesogenic environments: exploring the built and food environments. Amelia Lake, Tim Townshend. *J R Soc Promot Health*. 2006 Nov; 126(6): 262–267.
11. American Heart Association; What is Venous Thromboembolism (VTE)? Retrieved from: <https://www.heart.org/en/health-topics/venous-thromboembolism/what-is-venous-thromboembolism-vte>
12. Neonatal Abstinence Syndrome. Prabhakar Kocherlakota. *Pediatrics* Aug 2014, 134 (2) e547-e561; DOI: 10.1542/peds.2013-3524
13. Centers for Disease Control and Prevention. Infant Mortality; 2016. Retrieved from: <https://www.cdc.gov/reproductivehealth/MaternalInfantHealth/InfantMortality.htm>

14. Grobman, W. A., Bailit, J. L., Rice, M. M., Wapner, R. J., Reddy, U. M., Varner, M. W., Thorp, J. M., Leveno, K. J., Caritis, S. N., Iams, J. D., Tita, A. T., Saade, G., Rouse, D. J., Blackwell, S. C., Tolosa, J. E., VanDorsten, J. P., Eunice Kennedy Shriver National Institute of Child Health and Human Development (NICHD) Maternal-Fetal Medicine Units (MFMU) Network (2015). Racial and ethnic disparities in maternal morbidity and obstetric care. *Obstetrics and gynecology*, 125(6), 1460-7.
15. Institute of Medicine. *Unequal Treatment: Confronting Racial and Ethnic Disparities in Health Care*. Washington, DC: The National Academies Press; 2003
16. Nelson, D. B., Moniz, M. H., & Davis, M. M. (2018). Population-level factors associated with maternal mortality in the United States, 1997-2012. *BMC public health*, 18(1), 1007. doi:10.1186/s12889-018-5935-2
17. Centers for Disease Control and Prevention. Pregnancy-related mortality surveillance. 2014. Available at: <http://www.cdc.gov/reproductivehealth/MaternalInfantHealth/PMSS.html>. Accessed December 19, 2018.
18. Stress model for research into preterm delivery among black women Hogue, Carol J. Rowland et al. *American Journal of Obstetrics & Gynecology* , Volume 192 , Issue 5 , S47 - S55
19. World Health Organization (WHO). *Global status report on noncommunicable diseases 2010*. 2011. Retrieved from: https://www.who.int/pmnch/topics/maternal/knowledge_summaries_15_noncommunicable_diseases/en/
20. CDC. *Million Hearts: strategies to reduce the prevalence of leading cardiovascular disease risk factors*. United States, 2011. *MMWR* 2011;60(36):1248–51.
21. Intrauterine diabetic environment confers risks for type 2 diabetes mellitus and obesity in the offspring, in addition to genetic susceptibility. Dabelea D, Pettitt DJ *J Pediatr Endocrinol Metab*. 2001 Sep-Oct; 14(8):1085-91.
22. Maternal morbidity and risk of death at delivery hospitalization. Campbell KH, Savitz D, Werner EF, Pettker CM, Goffman D, Chazotte C, Lipkind HS *Obstet Gynecol*. 2013 Sep; 122(3):627-33.
23. Hodgins S, Tielsch J, Rankin K, Robinson A, Kearns A, Caglia J (2016) A New Look at Care in Pregnancy: Simple, Effective Interventions for Neglected Populations. *PLoS ONE* 11(8): e0160562. <https://doi.org/10.1371/journal.pone.0160562>
24. Ollove, M. (2018, November 4). *A shocking number of U.S. women still die of childbirth. California is doing something about that*. Retrieved from The Washington Post :

https://www.washingtonpost.com/national/health-science/a-shocking-number-of-us-women-still-die-from-childbirth-california-is-doing-something-about-that/2018/11/02/11042036-d7af-11e8-a10f-b51546b10756_story.html?utm_term=.e0650aad6039

25. Stanford Children's Health. Nutrition During Pregnancy. Retrieved from:
<https://www.stanfordchildrens.org/en/topic/default?id=nutrition-during-pregnancy-85-P01227>
26. Pearl, M., Braveman, P., & Abrams, B. (2001). The relationship of neighborhood socioeconomic characteristics to birthweight among 5 ethnic groups in California. *American journal of public health*, 91(11), 1808-14.
27. Grown C, Gupta GR, Pande R: Taking action to improve women's health through gender equality and women's empowerment. *Lancet*. 2005, 365: 541-543.
28. Safe Mothers. (1993). Debate -- can prenatal care reduce maternal deaths? [Abstract]. 9-10. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/12286441>.
29. Reversing The Rise In Maternal Mortality Katy B. Kozhimannil. *Health Affairs* 2018 37:11, 1901 1904
30. Wendell AD. Overview and epidemiology of substance abuse in pregnancy. *Clin Obstet Gynecol*. 2013;56(1):91-96. doi:10.1097/GRF.0b013e31827feeb9
31. Tobacco, drug use in pregnancy can double risk of stillbirth. Eunice Kennedy Shriver National Institute of Child Health and Human Development.
<https://www.nichd.nih.gov/news/releases/Pages/121113-stillbirth-drug-use.aspx>. Published December 11, 2013
32. National Institutes on Drug Abuse. Substance Abuse while Pregnant and Breastfeeding. Retrieved from:
<https://www.drugabuse.gov/publications/research-reports/substance-use-in-women/substance-use-while-pregnant-breastfeeding>
33. Devis, P., & Knuttinen, M. G. (2017). Deep venous thrombosis in pregnancy: incidence, pathogenesis and endovascular management. *Cardiovascular diagnosis and therapy*, 7(Suppl 3), S309-S319.
34. Venous thromboembolic disease and pregnancy. Marik PE, Plante LAN *Engl J Med*. 2008 Nov 6; 359(19):2025-33
35. Blondon, M., Harrington, L., Hoppe, K., Righini, M., Boehlen, F., Smith, N., & Bounameaux, H. (2013). Risk of venous thrombosis after Cesarean sections: A meta-analysis. *Thrombosis Research*, 131. doi:10.1016/s0049-3848(13)70126-9

36. Yale Medicine. Pulmonary Embolism; 2019. Retrieved from:
<https://www.yalemedicine.org/conditions/pulmonary-embolism/>
37. Centers for Disease Control and Prevention (CDC). National Centers for Health Statistics; 2016.
Retrieved from: <https://www.cdc.gov/nchs/fastats/delivery.htm>
38. Stanford Children's Health. Pregnancy Over Age 30. Retrieved from:
<https://www.stanfordchildrens.org/en/topic/default?id=pregnancy-over-age-30-90-P02481>