MATERNAL MORBIDITY AND MORTALITY

What Do We Know? How Are We Addressing It?

National Institutes of Health
Office of Research on Women's Health

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www.nih.gov/women/maternalhealth

Understanding Maternal Morbidity and Mortality (MMM) in the Context of the Health of Women

MATERNAL HEALTH covers the health of women during the preconception, pregnancy, and postpartum periods. A series of important events and changes—physical, emotional, and social—occur before, during, and well after the 40 weeks of gestation and the first year after childbirth. These changes are natural but can be stressful, and they have health consequences across a woman's life course.

The U.S. Department of Health and Human Services (HHS) defines women's health as "diseases and conditions ... experienced by women across the lifespan and in the social context of their lives." HHS sees pregnancy as an important part of the overall health of women. The National Institutes of Health (NIH), which is the Nation's foremost medical research agency, encourages scientists to study pregnancy as part of the life course.

The World Health Organization (WHO) defines ***maternal morbidity*** as "any health condition attributed to and/or aggravated by pregnancy and childbirth that has a negative impact on the woman's wellbeing."[1]

The U.S. Centers for Disease Control and Prevention (CDC) states: "***Severe maternal morbidity*** (SMM) includes unexpected outcomes of labor and delivery that result in significant short- or long-term consequences to a woman's health."[2]

Severe Maternal Morbidity (SMM): What Are the Trends?

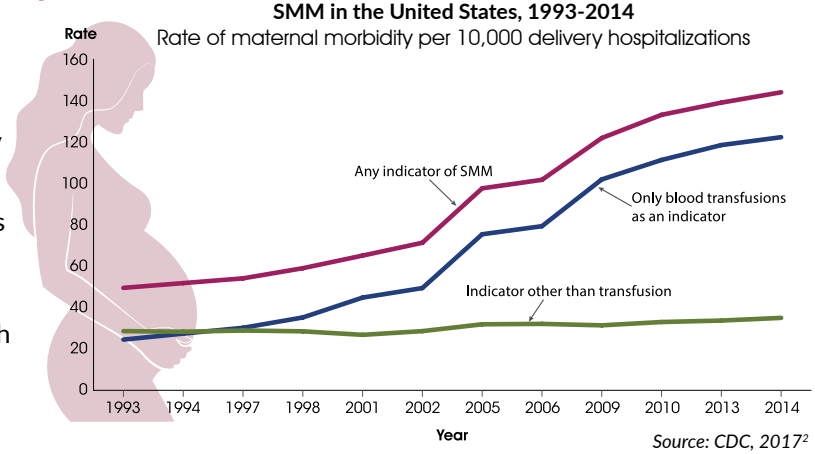
SMM affected more than **50,000 women** in the United States in 2014.[2] Rates of SMM **have nearly doubled during the past decade**.[2]

The need for blood transfusions is the most common indicator of SMM.[2]

For every pregnancy-related death in the United States, 70 women experience a "near miss" (SMM).[2]

SMM in the United States, 1993-2014

Rate of maternal morbidity per 10,000 delivery hospitalizations



Source: CDC, 2017[2]

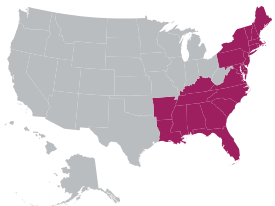
Who Is Most Affected by SMM?

More likely to occur for women who are:

- Age 20 or younger
- Age 40 or older
- Receiving Medicaid
- Residents of a low-income ZIP Code.

Source: Fingar et al., 2018[3]

More likely to occur at hospitals located in:



Source: Fingar et al., 2018[3]

From 2012–2015, compared with White women, the incidence of SMM was:

- 166% higher for Black women
- 122% higher for Hispanic women
- 117% higher for Asian/Pacific Islander women
- 148% higher for American Indian/Alaska Native women

Source: Admon et al., 2018[4]

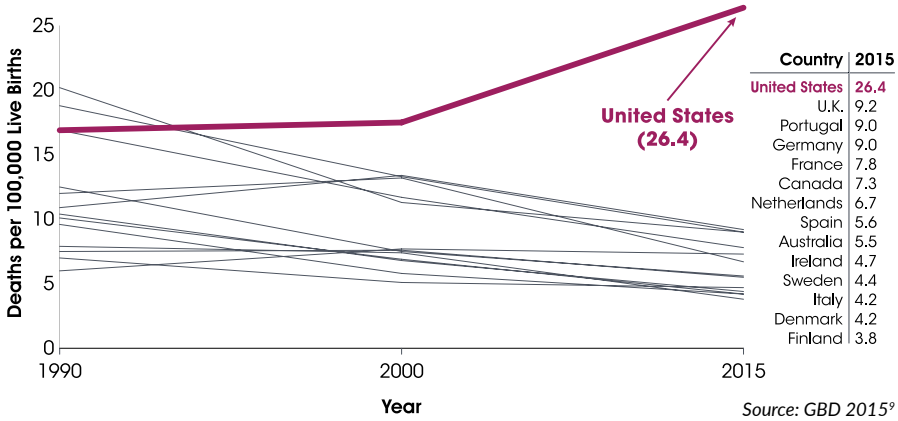
According to WHO: "Maternal death is the death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management but not from accidental or incidental causes."[5]

The CDC uses the term "pregnancy-related death" and defines it as "the death of a woman while pregnant or within 1 year of the end of a pregnancy—regardless of the outcome, duration, or site of the pregnancy—from any cause related to or aggravated by the pregnancy or its management, but not from accidental or incidental causes."[6]

Maternal Mortality: What Are the Trends?

Each year, about **700 women die** in the United States as a result of pregnancy or delivery complications.[7] Experts estimate that approximately **50%** of maternal deaths are preventable.[8]

United States Has Highest Maternal Mortality Among High-Income Countries[9]



Country	2015
United States	26.4
U.K.	9.2
Portugal	9.0
Germany	9.0
France	7.8
Canada	7.3
Netherlands	6.7
Spain	5.6
Australia	5.5
Ireland	4.7
Sweden	4.4
Italy	4.2
Denmark	4.2
Finland	3.8

Source: GBD 2015[9]
Credit: Rob Weychert/ProPublica.

While the U.S. maternal mortality rate increased by 16.7%, global maternal mortality rates decreased during the same period (1990–2015).[10]

Maternal Mortality: Who Is Most Affected?

Pregnancy-related Mortality Ratios, 2011–2014
(deaths per 100,000 live births)

White 12.4 | Black 40 | Other races 17.8

Source: CDC, 2018[6]

In 2015, in-hospital mortality for deliveries was **three times higher** for Blacks than for Whites.[3]

Factors such as education and higher socioeconomic status do not mitigate the elevated risks of SMM and maternal mortality among Black women.[11]

Among women living in the United States, **16.1%** of pregnancy-related deaths from 2011–2013 occurred in women born in another country.[12]

From 2011–2013, **30%** of pregnancy-related deaths occurred in women 35 years of age or older.[12]

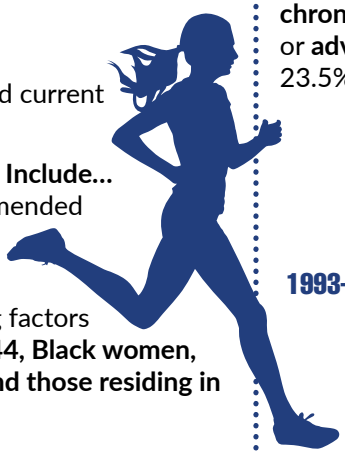
What Factors Influence MMM?

Preconception Health

Preconception health is the health of women prior to becoming pregnant during their reproductive years.[13]

Risk Factors Include...
diabetes, hypertension, and current cigarette smoking

Health-Promoting Factors Include...
normal weight and recommended physical activity



Generally, risk factors are highest and health-promoting factors lowest for: **women ages 35–44, Black women, women without insurance, and those residing in Southern states**.[13]

From 2008–2012, **43%** of women delivering in a hospital had risk factors for SMM—**a preexisting chronic disease**, **a pregnancy-associated disease**, or **advanced maternal age**. This represents a 23.5% increase since 1993–1997.[14]

Behavioral Risk Factors

Smoking
Smoking during pregnancy increases the risk of complications, such as placenta previa, placental abruption, and premature rupture of the membranes.[15]

Among pregnant women between 2010 and 2013:

- **About 16%** used tobacco during the past month
- **About 11%** had tobacco dependence during the past month[16]

Overweight and Obesity
Among pregnancy-related deaths from 2011–2013, **16.9%** occurred among women who were obese before pregnancy.[12]

In 2014, **about half** of women **were overweight or obese** before they became pregnant.[17]

Opioid Use

Between 2004–2005 and 2014–2015, opioid-related deliveries increased from 1.5 to 6.5 per 1,000 delivery hospitalizations.[18]

The percentage of pregnancy-associated deaths involving opioids **more than doubled** between 2007 and 2016.[19]

The increase in pregnancy-associated deaths involving opioids was more prominent among White women.[19]

In 2016, 78% of pregnancy-associated deaths involving opioids were due to heroin or synthetic opioids (e.g., fentanyl)—an increase of 17% since 2007.[19]

Prenatal Care

Poor prenatal care utilization—late onset of care, fewer visits, or both—significantly increases the risks of insufficient gestational weight gain, prenatal smoking, premature rupture of membranes, precipitous labor, no breastfeeding, maternal postnatal underweight, and postpartum smoking.[20]

In 2016, **15% of women received inadequate prenatal care.**

Younger women, women with less education, women having a fourth or higher-order birth, and non-Hispanic Native Hawaiian and other Pacific Islander women were least likely to begin care in the first trimester of pregnancy and have at least adequate prenatal care.[21]

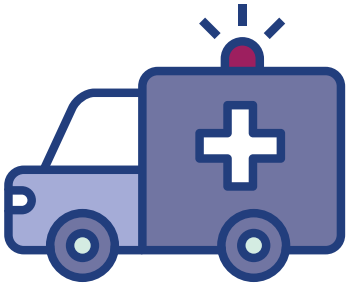
Among women who had pregnancy-related deaths and whose prenatal care status was known, **8.5%** had not received any prenatal care and **24.5%** started prenatal care in their second or third trimester.[12]

Severe Maternal Morbidity: Short-term Risks

SMM is stressful and affects the woman, her family and friends, and the overall community. For example, women who experience SMM may be at increased risk of post-traumatic stress disorder symptoms during the 6–8 weeks after delivery.[22]

Single-state studies suggest that

1. Subsequent hospitalizations during the year after delivery may be higher for women who experience SMM, even when those with preexisting chronic conditions are excluded,[23]
2. Women with SMM may have an increased likelihood for emergency department visits 90 days after delivery,[24] and
3. Women with hypertensive disorders of pregnancy (HDP) had higher hospitalization readmission rates for cardiovascular disease, with Black women having a higher rate than White and Hispanic women.[25]



The average hospital cost of a delivery without SMM was **$4,300**, compared with **$11,000** for a delivery with any SMM, from 2011 to 2012.[26]

How Does Maternal Health Affect Women Across the Life Course?

Condition During Pregnancy	Risk for Disease in Later Life
Gestational diabetes mellitus (GDM): Prevalence is estimated at 7.6% in the United States.[27]	**Increased risk of type 2 diabetes mellitus (T2DM):** Among women with GDM, 52.2% developed a glucose metabolism disorder 10 to 14 years postpartum, compared with 20.1% of those without GDM—a more than threefold increased risk.[28]
Preeclampsia: About 5% of all hospital deliveries involved preeclampsia/eclampsia in 2014.[29] 	**Increased risk of hypertension (HTN), cardiovascular disease (CVD), or cardiovascular accident (CVA):** Women with early-onset (<34 weeks) hypertensive disorders of pregnancy have more than twice the risk of developing incident CVD and more than a fourfold risk of developing incident HTN.[30] Preeclampsia increases the risk of incident heart failure in later life fourfold.[31] Preeclampsia doubles the risk of coronary heart disease, stroke, and death because of coronary heart disease or CVD.[31]
Complicated vaginal delivery: The vast majority of hospital stays for vaginal delivery (91.3%) involved at least one complicating condition in 2009.[32] Forceps vaginal delivery numbered 16.2 per 1,000 stays.[32] Perineal laceration (any degree of tear of the tissues that separate the vagina from the anus) numbered 585.7 per 1,000 stays.[32]	**Increased risk of pelvic floor disorders:** Five to ten years after a first delivery: • Forceps delivery increased the odds of pelvic floor disorders—e.g., almost a threefold risk for overactive bladder and nearly double the risk for pelvic organ prolapse (POP).[33] • A history of spontaneous perineal laceration more than doubled the risk for POP.[33] • Operative vaginal delivery increased the risk for POP more than sevenfold.[34] • Operative vaginal delivery was associated with almost double the risk of anal incontinence and POP compared with spontaneous vaginal delivery.[35]
Depression/Anxiety: 6.4% of women in the first trimester, 3.9% of women in the third trimester, and 6.9% of postpartum women (3–5 months) experienced serious psychological distress (SPD)* during the past month.[36] The overall prevalence of postpartum depressive symptoms was 11.5% for women in 27 states in 2012.[37] Among women ages 14–49 who were hospitalized for delivery from 2004 to 2013, 2.8% had a diagnosis of depression and/or anxiety.[38]	**Increased risk of depression and anxiety:** Servicewomen who were first-time mothers and experienced postpartum depression from 1998 to 2010 were more than seven times more likely to experience depressive disorders, more than three times more likely to experience anxiety disorders, and more than four times more likely to experience bipolar disorders subsequently compared with women without postpartum depression.[39] Women whose postpartum depression persisted for 8 months showed elevated depressive symptoms up to 11 years after childbirth, according to a study of U.K. mothers.[40]

**SPD was assessed with questions about how nervous, hopeless, restless or fidgety, sad or depressed, or worthless the respondent felt and to what extent everything felt like an effort.*

What Are the Opportunities for Intervention or Prevention?

Prevention and Intervention Strategies	Impact on Risk for Disease in Later Life
Troglitazone[41]	Reduced incidence of T2DM by 50% in Hispanic women with previous GDM.[41]
Pioglitazone[42] 	Diabetes rate of 4.6% per year during treatment with pioglitazone for 3 years, compared with a rate of 12.1% per year during placebo treatment.[42]
Intensive lifestyle changes[43]	Reduced progression to T2DM by 35% compared with placebo.[43]
Metformin[43]	Reduced progression to T2DM by 40% compared with placebo.[43]
Screening for preeclampsia with blood pressure measurements throughout pregnancy is recommended (U.S. Preventive Services Task Force, B recommendation).[44]	
Regularly taking aspirin[45]	Eliminates increased risk (1.5 times increased likelihood) of CVA among women age <60 years with any prior hypertensive disorders of pregnancy.[45]
Lifestyle interventions (exercise, diet, and smoking cessation)[46] 	Decreases cardiovascular risk by about 10% among women with a preeclampsia history.[46]
Cesarean delivery†	Cesarean delivery was associated with about a 50% lower risk of stress urinary incontinence and overactive bladder and a 70% lower risk of POP compared with spontaneous vaginal delivery.[35]
†*Cesarean delivery is an important risk factor for SMM but does not necessarily explain the increasing trend in SMM.*[47]	
Screening is recommended.[48] 	Research is needed on specific interventions to prevent depression among women who have experienced postpartum depression. 

How Are HHS Agencies Addressing MMM?

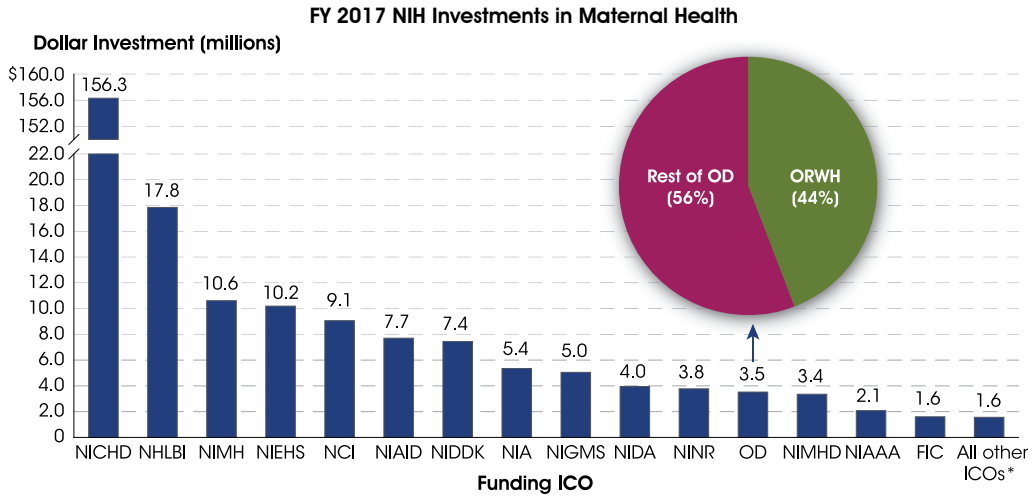
Arena of Collaboration

NIH makes a substantial investment in research to enhance maternal health and identify the causes of MMM. In 2017, NIH expenditures on maternal health research totaled nearly $250 million.

A wide range of NIH Institutes, Centers, and Offices (ICOs) support research activities on various aspects of maternal health within their areas of scientific expertise, including the following:

- Leveraging NIH collaborative research and clinical trials networks.
- Investigating factors underlying SMM and ways to address disparities.
- Addressing chronic conditions that influence MMM (e.g., obesity).
- Conducting basic and preclinical research on the mechanisms underlying pregnancy-related conditions and risk for disease in later life.
- Improving the application of health technology and management of pregnancy-related conditions.

In 2017, NIH created an official reporting category for maternal health. Estimates of NIH funding for maternal health are available to the public via the NIH Research Portfolio Online Reporting Tools. Although the majority (about 63%) of the research was funded by the *Eunice Kennedy Shriver* National Institute of Child Health and Human Development (NICHD), 19 other ICOs funded one or more research projects. NIH research on the health of women and maternal health considers the entire life course of women as an integrated whole rather than compartmentalizing distinct stages or events, and it encompasses everything that affects women—from head to toe, including both body and mind. NIH recognizes that the health of women is affected by the complex intersection of multiple factors at the levels of the individual, family, community, and society. Biological factors intersect with the social and contextual aspects of a woman's life to affect overall health, as well as pregnancy and peripartum periods. To improve the understanding of pregnancy, NICHD initiated a research



NOTE: See page 11 for the list of funding ICOs

project called PregSource®: Crowdsourcing to Understand Pregnancy. This project gathers firsthand information about pregnancy from pregnant women through confidential online questionnaires. More information on NIH's efforts to improve maternal health—and the health of all women—can be found in the Trans-NIH Strategic Plan for Women's Health Research.

What's Next? An NIH Approach to MMM

Representatives from NIH ICOs that support research on maternal health have joined together to develop a plan aimed at identifying needed studies and additional efforts that will address many of the antecedents and consequences of MMM. Such research would aim to do the following:

- Enhance health disparities research to reduce adverse pregnancy-related outcomes.
- Increase understanding of social determinants and risk factors for MMM.
- Improve antepartum, intrapartum, and postpartum care and the management of complications.
- Define environmental risk factors, such as the microbiome, exogenous hormones, and environmental toxins.
- Provide insight into psychosocial exposures, including stress, discrimination, and caregiving.
- Understand coping behaviors in women with SMM and families experiencing a maternal mortality.
- Investigate the potential effects of implicit bias on the health care system regarding pregnancy.

Federal Partners Working to Reduce MMM

The CDC supports states as they track SMM and pregnancy-related deaths, and these data are used to guide care for pregnant women. In the maternal health area, the CDC focuses on epidemiology and surveillance, environmental approaches, health care system interventions, and community programs linked to clinical services. The CDC also works with public health agencies, community organizations, and other partners to improve the health of women before, during, and after pregnancy.[7] For more information on CDC's efforts, please visit the CDC Maternal and Infant Health web page.

The Health Resources and Services Administration (HRSA) is working to reduce SMM and maternal mortality through health promotion, risk prevention, and training the health care workforce to identify and treat early warning signs. HRSA efforts focus on implementing best practices—including through the Alliance for Innovation on Maternal Health and Safety (AIM) initiative, which works with states and hospitals to implement "maternal safety bundles"—partnering with local communities and sparking innovative solutions. The HRSA Health Center Program provides affordable and accessible primary, prenatal, and perinatal care (among other health services) to approximately 7 million women of reproductive age across the country. HRSA also helps train health care providers and supports data collection and research.[49] For more information on HRSA efforts, please see the HRSA Maternal Morbidity & Mortality web page.

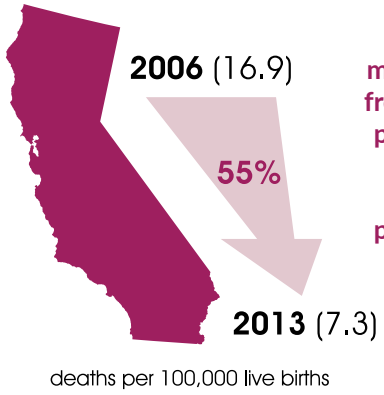
The Food and Drug Administration (FDA) promotes and protects maternal health through numerous programs, initiatives, and collaborations with internal and external stakeholders. The FDA's Office of Women's Health (OWH) funds research pertinent to pregnancy and lactation and also maintains a public website that includes a listing of pregnancy exposure registries, serving as a resource to consumers and health care providers. OWH also provides other consumer-friendly resources to educate pregnant and postpartum women about medicines, foods, and other products. The Division

of Pediatric and Maternal Health (DPMH) in the Center for Drug Evaluation and Research develops clinically relevant, evidence-based prescription product and over-the-counter product labeling and other communications that facilitate informed use of drugs and biologics for pregnant and nursing women. DPMH also develops guidance to help drug developers and researchers, including recently published draft guidance titled "Pregnant Women: Scientific and Ethical Considerations for Inclusion in Clinical Trials." This guidance provides recommendations on how and when to include pregnant women in clinical trials during drug development. In addition, the National Center for Toxicological Research is spearheading the formation of a virtual Center of Excellence that is focused on the perinatal period, as defined to include maternal, premature, and neonatal periods and development throughout childhood. For more information on FDA's efforts, please visit FDA's web page on maternal health.

Conclusion

There are many efforts to address MMM across the country. For example, states are working to improve the quality and safety of perinatal care as part of CDC's National Network of Perinatal Quality Collaboratives. Through the HRSA-supported AIM initiative, the Council on Patient Safety in Women's Health Care has developed "bundles"—toolkits with evidence-driven practices for maternity care—that are endorsed by many multidisciplinary health professional societies.[50] Importantly, there is an AIM patient safety bundle to address racial/ethnic disparities in maternal health. Hospitals can download these patient safety bundles and obtain resources on implementing them. To see what maternal health looks like when such initiatives are implemented, one can look at California. In 2006, California established a public-private partnership to improve maternal health, and by 2013, the state had cut its maternal mortality rate by more than half—to a rate comparable to the average in Western Europe.[51,52] Please visit the California Maternal Quality Care Collaborative website for toolkits and other resources.

These efforts to improve the quality and safety of maternal care are very valuable. But it is also critical to improve the health of women across the life course—including preconception health and treating chronic conditions—and address the social determinants of health to reduce MMM. Passage of the Preventing Maternal Deaths Act of 2018 was a big step toward reducing maternal mortality.[53] This law authorizes Federal funding to bolster maternal mortality review committees (also called MMRCs) in all states, which should help standardize data collection across the country.[53] Awareness of MMM in the United States seems to be increasing, which is also important for mobilizing efforts to address this crucial issue.



California saw maternal mortality decline from 16.9 deaths per 100,000 live births in 2006 to 7.3 deaths per 100,000 live births in 2013.

Source: California Maternal Quality Care Collaborative, 2019.[51]

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ICO Abbreviations

FIC: Fogarty International Center

NCI: National Cancer Institute

NHLBI: National Heart, Lung, and Blood Institute

NIA: National Institute on Aging

NIAAA: National Institute on Alcohol Abuse and Alcoholism

NIAID: National Institute of Allergy and Infectious Diseases

NIAMS: National Institute of Arthritis and Musculoskeletal and Skin Diseases

NIBIB: National Institute of Biomedical Imaging and Bioengineering

NICHD: *Eunice Kennedy Shriver* National Institute of Child Health and Human Development

NIDA: National Institute on Drug Abuse

NIDCD: National Institute on Deafness and Other Communication Disorders

NIDCR: National Institute of Dental and Craniofacial Research

NIDDK: National Institute of Diabetes and Digestive and Kidney Diseases

NIEHS: National Institute of Environmental Health Sciences

NIGMS: National Institute of General Medical Sciences

NIMH: National Institute of Mental Health

NIMHD: National Institute on Minority Health and Health Disparities

NINDS: National Institute of Neurological Disorders and Stroke

NINR: National Institute of Nursing Research

OD: NIH Office of the Director

For more information and resources on maternal morbidity and mortality, visit the ORWH Maternal Morbidity and Mortality Web Portal: http://www.nih.gov/women/maternalhealth

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