

resent a diverse genetic pool that allows for adaptation and evolutionary change. Further insight into how these adaptations occur may enhance our ability to predict the emergence of new, more capable bacterial pathogens, the development of more predictive animal models, and the potential identification of critical pathways that might serve as therapeutic targets.

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Are We Making Progress in Maternal Mortality?

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The number of women who die during pregnancy or childbirth has decreased by more than a third globally since 1990, according to new estimates from the United Nations¹ — from nearly 550,000 deaths in that year to roughly 350,000 in 2008. Yet progress has been uneven: while some countries have seen significant improvements, others have seen marked increases in maternal mortality. Furthermore, the overall downward trend is insufficient to achieve the Millennium Development Goal (MDG) of a 75% reduction in maternal mortality between 1990 and 2015 (see table). In the United States, where women's chances of surviving pregnancy and childbirth are far greater than in other parts of the world (see map, and interactive map, available with the full text of this article at NEJM.org) — the lifetime risk of pregnancy-related death for a U.S. woman is 1 in 2100, as compared with 1 in 31 for a woman in sub-Saharan Africa — maternal mortality actually increased during this period, according to United Nations estimates. Despite spending more money on health

care than any other country, the United States has higher maternal mortality than many other developed countries. How do we interpret these data and conflicting impressions of progress and decline?

First, we must recognize that the main complications that lead to death during pregnancy or childbirth are fairly common among all women, regardless of where they live. The women who die from these complications are generally those who lack access to treatment. Globally, the leading cause of death (responsible for 35% of all maternal deaths, according to the World Health Organization [WHO]) is hemorrhage, usually occurring immediately after delivery. But hemorrhage doesn't occur only in countries with high maternal mortality: in 2000, it was the second most frequently seen pregnancy-related complication among U.S. women,² yet the vast majority of these women were promptly treated and not in danger of dying. In developing countries, by contrast, women may give birth at home, unattended or attended by someone unskilled, or in a

poorly equipped health center or hospital where they can't be treated quickly and effectively. The second-leading cause of maternal death globally (according to the WHO) is hypertensive disorders, another common medical problem during pregnancy that, again, leads to death primarily if there is no access to treatment.

Countries with high maternal mortality also have a large burden of pregnancy-related complications, the most devastating of which is obstetrical fistula. In this sense, maternal death is just the tip of the iceberg in terms of the impact of poor availability and quality of obstetrical services. It is estimated that for every woman who dies from a pregnancy-related cause, about 20 more — roughly 7 million women yearly — experience injury, infection, disease, or disability.³

These facts suggest that a key common factor in the trends in maternal mortality, both globally and in the United States, is access to good obstetrical care. As the table shows, the greatest decrease in maternal mortality has occurred in the East Asia and Pacific region, and much of that decrease

Trends in Maternal Mortality Ratios, 1990–2008.*							
UNICEF Region	Estimated Maternal Mortality Ratio (No. of Maternal Deaths per 100,000 Live Births)					Percent Change between 1990 and 2008	Annual Percent Change between 1990 and 2008
	1990	1995	2000	2005	2008		
Sub-Saharan Africa	870	850	790	710	640	-26	-1.7
Eastern and Southern Africa	750	760	720	630	550	-26	-1.7
West and Central Africa	980	940	870	780	720	-27	-1.7
Middle East and North Africa	270	230	200	180	170	-37	-2.6
South Asia	610	510	430	330	290	-53	-4.2
East Asia and Pacific	200	160	130	100	88	-56	-4.5
Latin America and the Caribbean	140	130	110	91	85	-41	-2.9
Central Eastern Europe/Commonwealth of Independent States	69	60	48	36	34	-52	-4.0
Industrialized Countries	12	10	11	14	14	16	0.8
Developing countries	440	410	370	320	290	-34	-2.3
Least developed countries	900	840	750	650	590	-35	-2.4
World	400	370	340	290	260	-34	-2.3

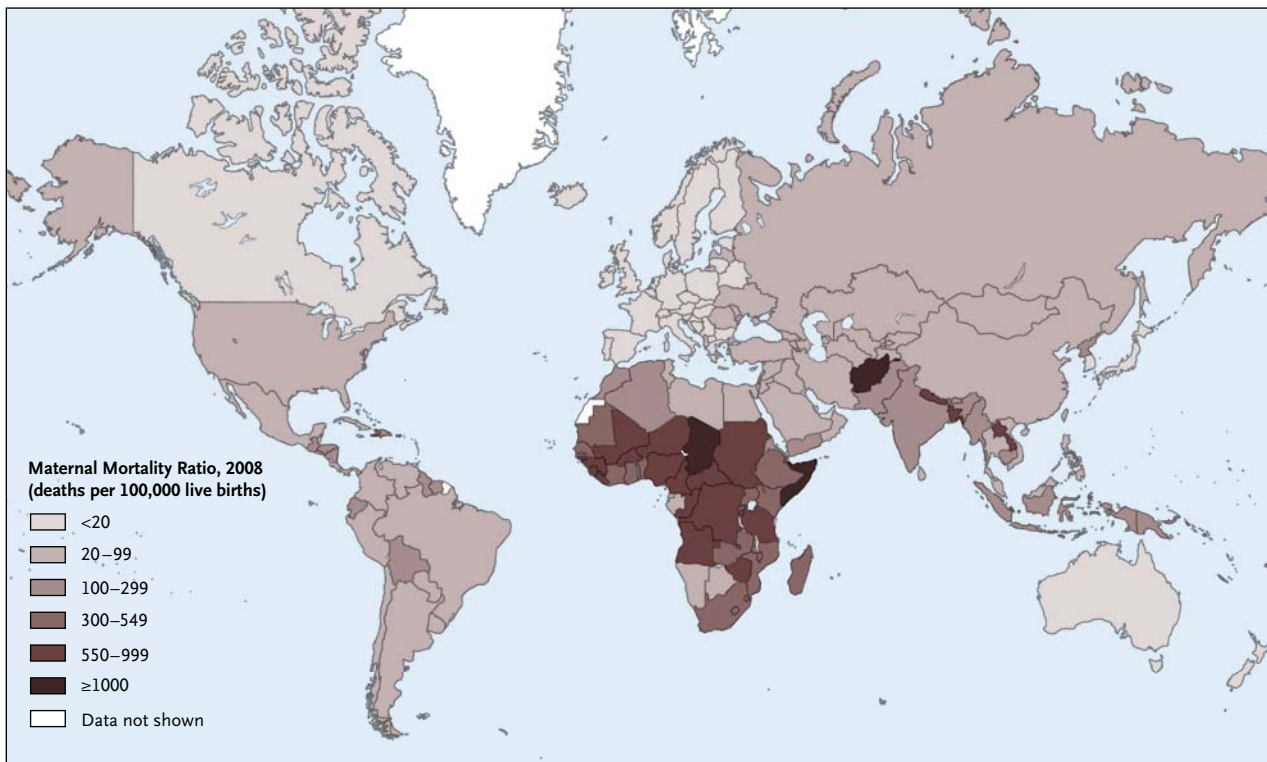
* Data are United Nations interagency estimates. Maternal mortality ratios have been rounded as follows: less than 100, no rounding; 100 to 999, rounded to nearest 10; and greater than 1000, rounded to nearest 100. Negative values for percent changes indicate decreases in maternal mortality; positive values indicate increases. Since the uncertainty intervals are wide for some countries, the data should be interpreted cautiously.

is due to improvements in care in China, the region's most highly populated country. China reports dramatic decreases in maternal mortality, from 110 per 100,000 live births in 1990 to 38 per 100,000 live births in 2008, a 65% decrease. During this period, China saw an increase in the proportion of women giving birth assisted by a skilled provider, as well as an increase in the proportion of births taking place in hospitals or other health care institutions from 51% in 1990 to 92% in 2007, according to UNICEF. Bangladesh, another Asian country with a huge population, also made significant progress in reducing maternal mortality, as have many other countries in South and Southeast Asia — a notable exception being war-torn Afghanistan, which saw almost no decrease in its remarkably high ma-

ternal mortality ratio. Many other parts of the world — Latin America, Central Eastern Europe, North Africa, and the Middle East — have seen gradual, steady decreases in deaths during pregnancy, childbirth, and the postnatal period, reflecting improvements in the quality of and access to obstetrical care as well as decreases in fertility rates. In fact, 90 countries had decreases in maternal mortality of 40% or more.


Sub-Saharan Africa has the greatest burden of maternal mortality. Yet there, too, the story is not uniform. Most countries in the region have seen small but promising decreases in maternal mortality, with notable and stark exceptions. The countries with substantial increases tend to fall into two categories: countries whose health systems have been decimated by war or internal con-

flict, such as Congo and Somalia (other conflict-ridden countries with extremely high maternal mortality, such as Chad, Liberia, and Guinea Bissau, showed only very small improvements), and countries with extremely high rates of infection with human immunodeficiency virus (HIV), such as South Africa, Botswana, Swaziland, Lesotho, Kenya, Zimbabwe (which has also experienced internal strife), and Zambia. The HIV epidemic affects maternal mortality both directly — since HIV-positive women are more likely than HIV-negative women to die from opportunistic infections, postpartum sepsis, and hemorrhage⁴ — and indirectly, through stresses on the health system and loss of physicians and nurses to death and migration. Care for HIV-positive pregnant women has focused primarily on



Maternal Mortality Ratios, 2008.

Data are the numbers of maternal deaths per 100,000 live births. Data are from the WHO, UNICEF, the United Nations Population Fund, and the World Bank. The boundaries used do not imply official endorsement or acceptance by the United Nations. An interactive map showing changes in maternal mortality ratios over time is available with the full text of this article at NEJM.org.

 **An interactive map showing changes in maternal mortality ratios is available at NEJM.org**

preventing transmission of the virus to the child; the finding that maternal mortality is high among HIV-positive

women suggests that more attention should be paid to treating the women themselves.

Within countries, higher rates of death are found among more economically disadvantaged women. In the United States, for example, black women are three times as likely as white women to die during pregnancy or childbirth.⁵ Although data on maternal mortality broken down according to economic status are not generally available, data analyzed by UNICEF show that in all regions of the world, women from the wealthiest 20% of households are more likely than those

from the poorest 20% to deliver their babies with the assistance of skilled health personnel — a proxy for pregnant women's access to care. In South Asia, the wealthiest women are nearly five times as likely as the poorest women to give birth with a skilled attendant present; poorer women tend to deliver at home with the help of a family member or poorly trained attendant. In China, where detailed data are available, the maternal mortality ratio in rural areas in 2004 was approximately three times that in urban areas. In sub-Saharan Africa, poor women living in rural areas are particularly vulnerable to dying during pregnancy or childbirth because they lack access to obstetrical services — for example, surgery for cesarean delivery,

an essential lifesaving intervention for women with prolonged, obstructed labor.

Where does all this leave us? Should we celebrate the global improvements in maternal mortality or hide ourselves for not being on target to meet the MDGs for maternal health? The overall picture is one of gradual but steady reduction in maternal deaths in most areas of the world — a global public health improvement that calls for cautious optimism. The attention that has been paid to the plight of women at risk of dying during pregnancy or childbirth and increased investments in health care systems, especially in basic and comprehensive emergency obstetrical care, have paid off. The dramatic improvements in China and gains

in other Asian countries, which are associated with economic improvement, decreasing fertility rates, and strengthening of health systems, contrast with sharp increases in countries experiencing the chaos and destruction of war and HIV epidemics. The overall rate of decline in global maternal mortality, 2.3%, is lower than the 5.5% MDG target but is heartening nonetheless. We believe that continued focus on national and district-level planning to make pregnancy and delivery safer and to improve treatment

of obstetrical complications, with particular attention to disadvantaged women, including those with HIV, will accelerate progress over the next decade.

The views expressed in this article are those of the authors and do not necessarily reflect those of UNICEF or the United Nations.

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