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MMWR

Weekly

October 01, 1999 / 48(38);849-858

Achievements in Public Health, 1900-1999: Healthier Mothers and Babies

At the beginning of the 20th century, for every 1000 live births, six to nine women in the United States died of pregnancy-related complications, and approximately 100 infants died before age 1 year (1,2). From 1915 through 1997, the infant mortality rate declined greater than 90% to 7.2 per 1000 live births, and from 1900 through 1997, the maternal mortality rate declined almost 99% to less than 0.1 reported death per 1000 live births (7.7 deaths per 100,000 live births in 1997) (3) (Figure 1 and Figure 2). Environmental interventions, improvements in nutrition, advances in clinical medicine, improvements in access to health care, improvements in surveillance and monitoring of disease, increases in education levels, and improvements in standards of living contributed to this remarkable decline (1). Despite these improvements in maternal and infant mortality rates, significant disparities by race and ethnicity persist. This report summarizes trends in reducing infant and maternal mortality in the United States, factors contributing to these trends, challenges in reducing infant and maternal mortality, and provides suggestions for public health action for the 21st century.

Infant Mortality

The decline in infant mortality is unparalleled by other mortality reduction this century. If turn-of-the-century infant death rates had continued, then an estimated 500,000 live-born infants during 1997 would have died before age 1 year; instead, 28,045 infants died (3).

In 1900 in some U.S. cities, up to 30% of infants died before reaching their first birthday (1). Efforts to reduce infant mortality focused on improving environmental and living conditions in urban areas (1). Urban environmental interventions (e.g., sewage and refuse disposal and safe drinking water) played key roles in reducing infant mortality. Rising standards of living, including improvements in economic and education levels of families, helped to promote health. Declining fertility rates also contributed to reductions in infant mortality through longer spacing of children, smaller family size, and better nutritional status of mothers and infants (1). Milk pasteurization, first adopted in Chicago in 1908, contributed to the control of milkborne diseases (e.g., gastrointestinal infections) from contaminated milk supplies.

During the first three decades of the century, public health, social welfare, and clinical medicine (pediatrics and obstetrics) collaborated to combat infant mortality (1). This partnership began with milk hygiene but later included other public health issues. In 1912, the Children's Bureau was formed and became the primary government agency to work toward improving maternal and infant welfare until 1946, when its role in maternal and child health diminished; the bureau was eliminated in 1969 (1). A proponent of the Children's Bureau was Martha May Eliot (see box, page 851). The Children's Bureau defined the problem of infant mortality and shaped the debate over programs to ameliorate the problem. The bureau also advocated comprehensive maternal and infant welfare services, including prenatal, natal, and postpartum home visits by health-care providers. By the 1920s, the integration of these services changed the approach to infant mortality from one that addressed infant health problems to an approach that included infant and mother and prenatal-care programs to educate, monitor, and care for pregnant women.

The discovery and widespread use of antimicrobial agents (e.g., sulfonamide in 1937 and penicillin in the 1940s) and the development of fluid and electrolyte replacement therapy and safe blood transfusions accelerated the declines in infant mortality; from 1930 through 1949, mortality rates declined 52% (4). The percentage decline in postneonatal (age 28-364 days) mortality (66%) was greater than the decline in neonatal (age 0-27 days) mortality (40%). From 1950 through 1964, infant mortality declined more slowly (1). An increasing proportion of infant deaths were attributed to perinatal causes and occurred among high-risk neonates, especially low birth weight (LBW) and preterm babies. Although no reliable data exist, the rapid decline in infant mortality during earlier decades probably was not influenced by decreases in LBW rates because the decrease in mortality was primarily in postneonatal deaths that are less influenced by birthweight. Inadequate programs during the 1950s-1960s to reduce deaths among high-risk neonates led to renewed efforts to improve access to prenatal care, especially for the poor, and to a concentrated effort to establish neonatal intensive-care units and to promote research in maternal and infant health, including research into technologies to improve the survival of LBW and preterm babies.

During the late 1960s, after Medicaid and other federal programs were implemented, infant mortality (primarily postneonatal mortality) declined substantially (5). From 1970 to 1979, neonatal mortality plummeted 41% (Table 1) because of technologic advances in neonatal medicine and in the regionalization of perinatal services; postneonatal mortality declined 14%. During the early to mid-1980s, the downward trend in U.S. infant mortality slowed (6). However, during 1989-1991, infant mortality declined slightly faster, probably because of the use of artificial pulmonary surfactant to prevent and treat respiratory distress syndrome in premature infants (7). During 1991-1997, infant mortality continued to decline primarily because of decreases in sudden infant death syndrome (SIDS) and other causes.

Although improvements in medical care were the main force for declines in infant mortality during the second half of the century, public health actions played a role. During the 1990s, a greater than 50% decline in SIDS rates (attributed to the recommendation that infants be placed to sleep on their backs) has helped to reduce the overall infant mortality rate (8). The reduction in vaccine-preventable diseases (e.g., diphtheria, tetanus, measles, poliomyelitis, and *Haemophilus influenzae* type b meningitis) has reduced infant morbidity and has had a modest effect on infant mortality (9). Advances in prenatal diagnosis of severe central nervous system defects, selective termination of affected pregnancies, and improved surgical treatment and management of other structural anomalies have helped reduce infant mortality attributed to these birth defects (10,11). National efforts to encourage reproductive-aged

women to consume foods or supplements containing folic acid could reduce the incidence of neural tube defects by half (12).

Maternal Mortality

Maternal mortality rates were highest in this century during 1900-1930 (2). Poor obstetric education and delivery practices were mainly responsible for the high numbers of maternal deaths, most of which were preventable (2). Obstetrics as a speciality was shunned by many physicians, and obstetric care was provided by poorly trained or untrained medical practitioners. Most births occurred at home with the assistance of midwives or general practitioners. Inappropriate and excessive surgical and obstetric interventions (e.g., induction of labor, use of forceps, episiotomy, and cesarean deliveries) were common and increased during the 1920s. Deliveries, including some surgical interventions, were performed without following the principles of asepsis. As a result, 40% of maternal deaths were caused by sepsis (half following delivery and half associated with illegally induced abortion) with the remaining deaths primarily attributed to hemorrhage and toxemia (2).

The 1933 White House Conference on Child Health Protection, Fetal, Newborn, and Maternal Mortality and Morbidity report (13) demonstrated the link between poor aseptic practice, excessive operative deliveries, and high maternal mortality. This and earlier reports focused attention on the state of maternal health and led to calls for action by state medical associations (13). During the 1930s-1940s, hospital and state maternal mortality review committees were established. During the ensuing years, institutional practice guidelines and guidelines defining physician qualifications needed for hospital delivery privileges were developed. At the same time, a shift from home to hospital deliveries was occurring throughout the country; during 1938-1948, the proportion of infants born in hospitals increased from 55% to 90% (14). However, this shift was slow in rural areas and southern states. Safer deliveries in hospitals under aseptic conditions and improved provision of maternal care for the poor by states or voluntary organizations led to decreases in maternal mortality after 1930. Medical advances (including the use of antibiotics, oxytocin to induce labor, and safe blood transfusion and better management of hypertensive conditions during pregnancy) accelerated declines in maternal mortality. During 1939-1948, maternal mortality decreased by 71% (14). The legalization of induced abortion beginning in the 1960s contributed to an 89% decline in deaths from septic illegal abortions (15) during 1950-1973.

Since 1982, maternal mortality has not declined (16). However, more than half of maternal deaths can be prevented with existing interventions (17). In 1997, 327 maternal deaths were reported based on information on death certificates; however, death certificate data underestimate these deaths, and the actual numbers are two to three times greater. The leading causes of maternal death are hemorrhage, including hemorrhage associated with ectopic pregnancy, pregnancy-induced hypertension (toxemia), and embolism (17).

Challenges for the 21st Century

Despite the dramatic decline in infant and maternal mortality during the 20th century, challenges remain. Perhaps the greatest is the persistent difference in maternal and infant health among various racial/ethnic groups, particularly between black and white women and infants. Although overall rates have plummeted, black infants are more than twice as likely to die as white infants; this ratio has increased in recent decades. The higher risk for infant mortality among blacks compared with whites is attributed to higher LBW incidence and preterm births and to a higher risk for death among normal

birthweight infants (greater than or equal to 5 lbs, 8 oz [greater than or equal to 2500 g]) (18). American Indian/ Alaska Native infants have higher death rates than white infants because of higher SIDS rates. Hispanics of Puerto Rican origin have higher death rates than white infants because of higher LBW rates (19). The gap in maternal mortality between black and white women has increased since the early 1900s. During the first decades of the 20th century, black women were twice as likely to die of pregnancy-related complications as white women. Today, black women are more than three times as likely to die as white women.

During the last few decades, the key reason for the decline in neonatal mortality has been the improved rates of survival among LBW babies, not the reduction in the incidence of LBW. The long-term effects of LBW include neurologic disorders, learning disabilities, and delayed development (20). During the 1990s, the increased use of assisted reproductive technology has led to an increase in multiple gestations and a concomitant increase in the preterm delivery and LBW rates (21). Therefore, in the coming decades, public health programs will need to address the two leading causes of infant mortality: deaths related to LBW and preterm births and congenital anomalies. Additional substantial decline in neonatal mortality will require effective strategies to reduce LBW and preterm births. This will be especially important in reducing racial/ethnic disparities in the health of infants.

Approximately half of all pregnancies in the United States are unintended, including approximately three quarters among women aged less than 20 years. Unintended pregnancy is associated with increased morbidity and mortality for the mother and infant. Lifestyle factors (e.g., smoking, drinking alcohol, unsafe sex practices, and poor nutrition) and inadequate intake of foods containing folic acid pose serious health hazards to the mother and fetus and are more common among women with unintended pregnancies. In addition, one fifth of all pregnant women and approximately half of women with unintended pregnancies do not start prenatal care during the first trimester. Effective strategies to reduce unintended pregnancy, to eliminate exposure to unhealthy lifestyle factors, and to ensure that all women begin prenatal care early are important challenges for the next century.

Compared with the 1970s, the 1980s and 1990s have seen a lack of decline in maternal mortality and a slower rate of decline in infant mortality. Some experts consider that the United States may be approaching an irreducible minimum in these areas. However, three factors indicate that this is unlikely. First, scientists have believed that infant and maternal mortality was as low as possible at other times during the century, when the rates were much higher than they are now. Second, the United States has higher maternal and infant mortality rates than other developed countries; it ranks 25th in infant mortality (22) and 21st in maternal mortality (23). Third, most of the U.S. population has infant and maternal mortality rates substantially lower than some racial/ethnic subgroups, and no definable biologic reason has been found to indicate that a minimum has been reached.

To develop effective strategies for the 21st century, studies of the underlying factors that contribute to morbidity and mortality should be conducted. These studies should include efforts to understand not only the biologic factors but also the social, economic, psychological, and environmental factors that contribute to maternal and infant deaths. Researchers are examining "fetal programming"--the effect of uterine environment (e.g., maternal stress, nutrition, and infection) on fetal development and its effect on health from childhood to adulthood. Because reproductive tract infections (e.g., bacterial vaginosis) are associated with preterm birth, development of effective screening and treatment strategies may reduce preterm births. Case reviews or audits are being used increasingly to investigate fetal, infant, and maternal deaths; they focus on identifying preventable deaths such as those resulting from health-care system failures and gaps in quality of care and in access to care. Another strategy is to study cases

of severe morbidity in which the woman or infant did not die. More clinically focused than reviews or audits, such "near miss" studies may explain why one woman or infant with a serious problem died while another survived.

A thorough review of the quality of health care and access to care for all women and infants is needed to avoid preventable mortality and morbidity and to develop public health programs that can eliminate racial/ethnic disparities in health. Preconception health services for all women of childbearing age, including healthy women who intend to become pregnant, and quality care during pregnancy, delivery, and the postpartum period are critical elements needed to improve maternal and infant outcomes (see box, page 856).

Reported by: Division of Reproductive Health, National Center for Chronic Disease Prevention and Health Promotion, CDC.

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Table 1

Note: To print large tables and graphs users may have to change their printer settings to landscape and use a small font size.

TABLE 1. Percentage reduction in infant, neonatal, and postneonatal mortality, by year -- United States, 1915-1997*

	Percentage reduction in mortality		
Year	**Infant (aged 0-364 days)**	**Neonatal (aged 0-27 days)**	**Postneonatal (aged 28-364 days)**
1915-1919	13%	7%	19%
1920-1929	21%	11%	31%
1930-1939	26%	18%	35%
1940-1949	33%	26%	46%
1950-1959	10%	7%	15%
1960-1969	20%	17%	27%
1970-1979	35%	41%	14%
1980-1989	22%	27%	12%
1990-1997	22%	17%	29%
1915-1997	93%	89%	96%

* Percentage reduction is calculated as the reduction from the first year of the time period to the last year of the time period.

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Figure 1

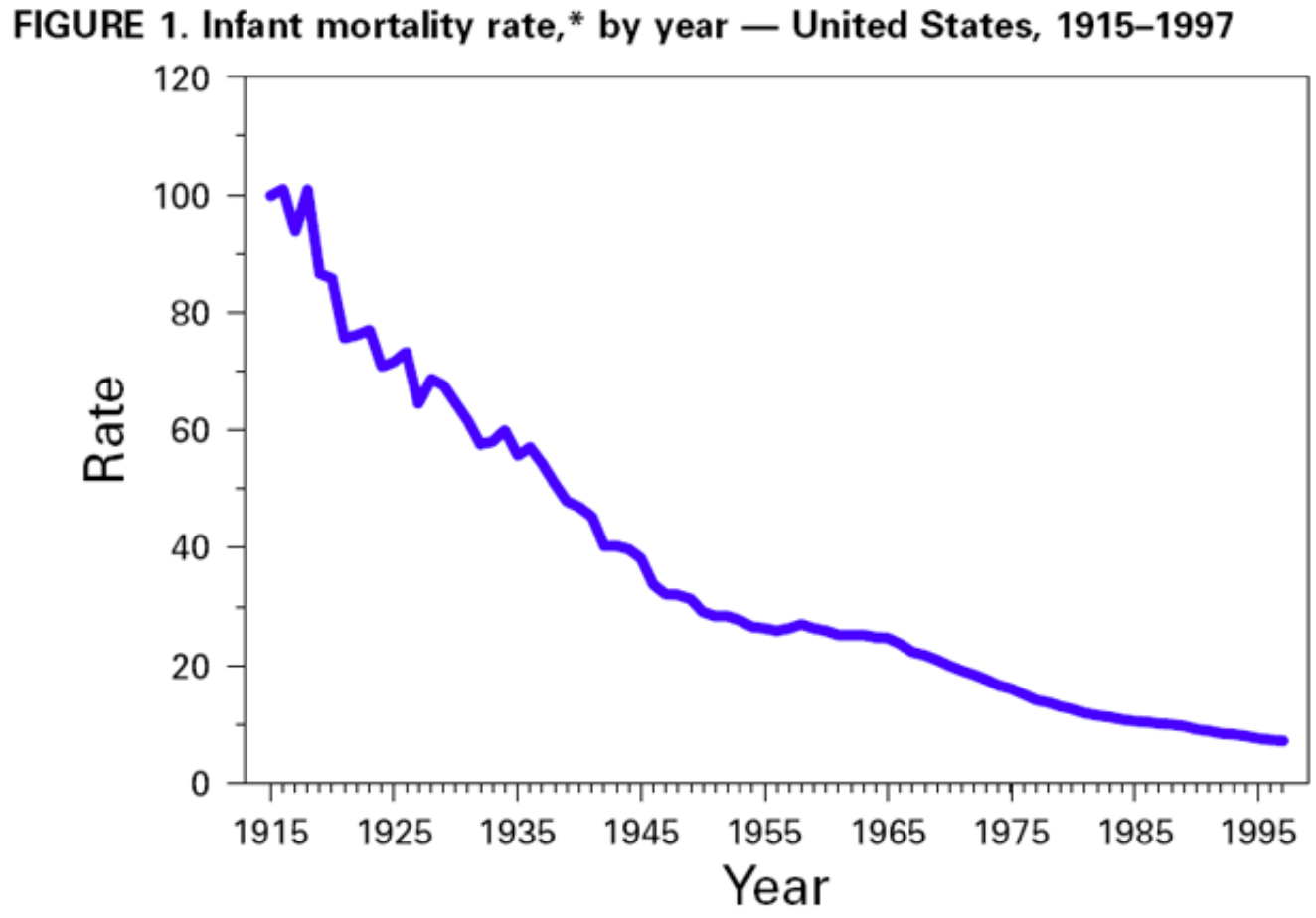

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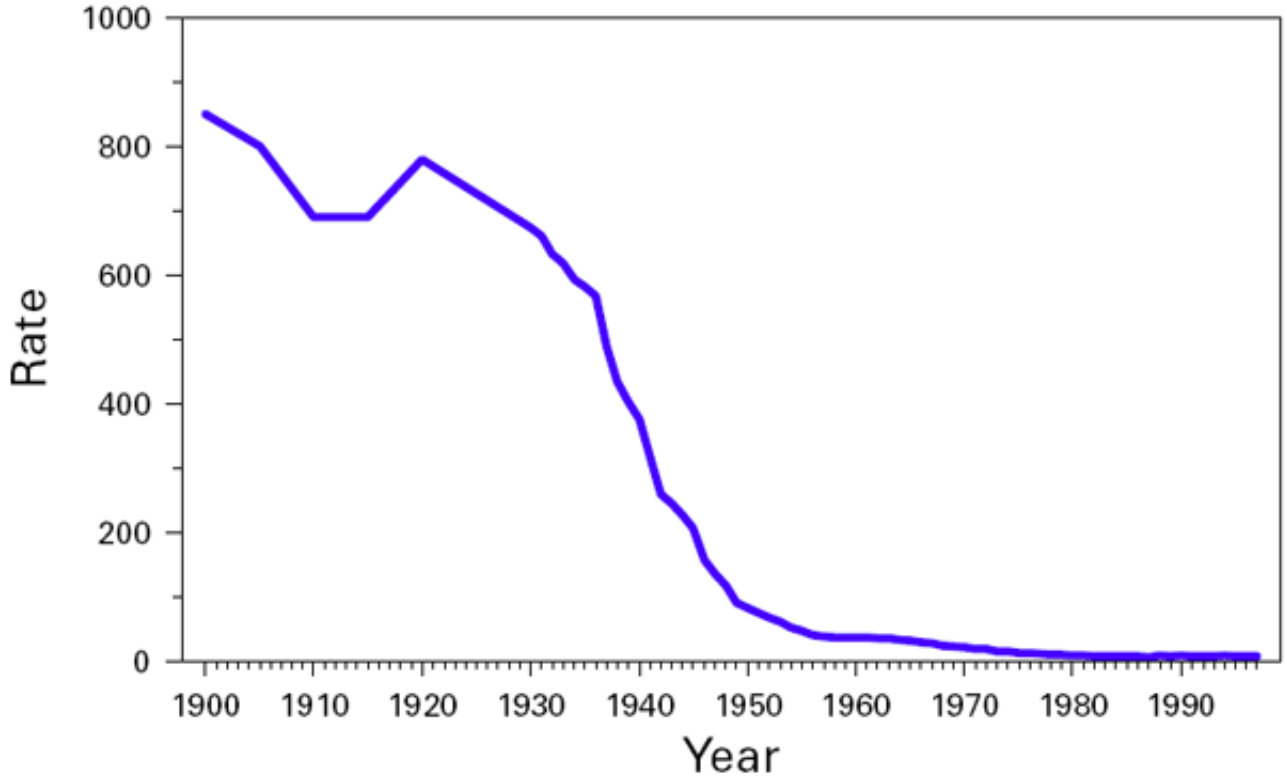
Figure 2

FIGURE 2. Maternal mortality rate,* by year — United States, 1900–1997



*Per 100,000 live births.

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Page converted: 9/30/1999

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This page last reviewed 5/2/01