

## Maternal and Perinatal Health

Julia A. Walsh, Chris M. Feifer, Anthony R. Measham, and Paul J. Gertler

More than 20 percent of the population in developing countries are women in their reproductive years (United Nations 1988). During a woman's life, one of the greatest risks to her health is childbearing. Pregnancy brings high risks of sickness, complications of delivery, disability, and death. Moreover, when pregnant women have complications, the infants these women bear are at increased risk of low birth weight, illness resulting from the complications of delivery, disability, and perinatal mortality. This chapter treats maternal and perinatal health problems together because they are inseparably linked: the main risk factors for disease and death among mothers and their newborns are the same. Not surprisingly, many of the interventions simultaneously improve both maternal and fetal health.

Maternal and perinatal mortality rates are indicators of the health of women of reproductive age and an indirect measure of the quality of the health care system. In many places health care during pregnancy is the only contact with modern medicine that a woman seeks. Obstetric services, therefore, represent a link to the general health care system and thus have an effect on present and future pregnancies and on the well-being of the entire family. High-quality supportive health services reinforce the family's use of preventive and promotive services in the future.

In table 17-1 we detail the risk factors for maternal and perinatal health problems. The main ones include illiteracy, poverty, poor nutrition, and low weight prior to pregnancy, minimal weight gain during pregnancy, first pregnancy or higher than fourth pregnancy (grand multipara), maternal age younger than twenty or older than thirty-four years, poor outcome of prior pregnancies, infections and illnesses during pregnancy, smoking, and inadequate health care during pregnancy and delivery. This complex web of social and medical factors suggests that health service solutions will be inadequate without concurrent attention to the other areas mentioned.

The health problems discussed in this chapter are more complex than many of the others covered in this collection. In the first place, they result from pregnancy, which is not a disease but is often a sought-after and highly desirable condition. Further, the lives of two people, mother and infant, are involved. Finally, events early in the life of the mother, years

before pregnancy was ever contemplated, will result in complications many years later. The factors that affect the mother and newborn can be divided into three: those that occur prior to conception, so that a woman enters into the pregnancy in a precarious state of health; those during pregnancy (prenatal care may eliminate these); and those during delivery. Good health care will decrease these hazards. To reiterate, illness in the mother puts the newborn at greater risk.

Unfortunately, prevention is relatively difficult: the lengthy list of causes of disease and social conditions associated with problems makes this evident. Obviously, no single, highly effective control measure, such as a vaccine, drug, or vector control method, exists. Attention to women's general health care needs and readily available prenatal and obstetric care, however, can prevent the preponderance of perinatal and maternal morbidity and mortality.

### Public Health Significance

The size of the problem of maternal death and disability has been underestimated and poorly recognized. Data on deaths and complications of mothers have not been collected, nor have data on the consequences for family and child health.

### Current Levels and Trends in the Developing World

Maternal deaths and illnesses, low birth weight, and perinatal deaths are underreported in most countries. The best figures for the developing world are merely estimates pieced together from multiple sources of varying degrees of reliability. Little information exists which would allow quantification of the severity and duration of disability.

**MATERNAL MORTALITY AND MORBIDITY.** The World Health Organization (WHO) estimates that 500,000 women annually die of complications of pregnancy and delivery. Ninety-nine percent of these deaths occur in the developing world. Maternal mortality is usually defined as death occurring while the woman is pregnant or within forty-two days of termination of pregnancy. The "maternal mortality ratio," the number of maternal deaths per 100,000 live births, ranges from 25 to

**Table 17-1. Risk Factors for Maternal Morbidity and Mortality, Low Birth Weight, and Perinatal Mortality**

Risk factor	Adverse Outcome			
	Maternal morbidity and mortality	Low birth weight	Perinatal mortality	Preventive or treatment measures available
<i>Prepregnancy—Demographic risk factors</i>				
Age (less than twenty; more than thirty-four) <sup>a</sup>	Yes	Yes	Yes	No
Race <sup>b</sup>	No	Yes	No	No
Low socioeconomic status <sup>a,b</sup>	Yes	Yes	Yes	No
Unmarried <sup>b</sup>	Yes	Yes	No	No
Low level of education <sup>b</sup>	No	No	Yes	No
<i>Medical risk factors</i>				
Number of children (none or more than four) <sup>a</sup>	Yes	Yes	Yes	Yes
Low maternal weight-for-height (poor nutritional status) <sup>a</sup>	Yes	Yes	Yes	Yes
Short paternal height	No	Yes	No	No
Diseases such as diabetes and chronic hypertension	Yes	No	Yes	Yes
Poor obstetric history <sup>a,c</sup>	Yes	Yes	Yes	No
Gynecologic abnormalities <sup>d</sup>	Yes	Yes	No	No
Maternal genetic and related factors <sup>e</sup>	No	Yes	No	No
<i>Conception</i>				
Male fetus <sup>a</sup>	No	Yes	Yes	No
<i>Pregnancy—Medical risk factors</i>				
Multiple pregnancy <sup>a</sup>	No	Yes	Yes	No
Poor weight gain (maternal and fetal) <sup>a</sup>	Yes	Yes	Yes	Yes
Anemia/abnormal hemoglobin	Yes	Yes	Yes	Yes
Malaria <sup>a</sup>	Yes	Yes	Yes	Yes
Streptococcus (group B) infection <sup>a</sup>	Yes	Yes	Yes	Yes
Sexually transmitted diseases <sup>a</sup>	Yes	Yes	Yes	Yes
Urinary tract infection	No	Yes	No	Yes
Rubella, cytomegalovirus	No	Yes	Yes	No
Respiratory and diarrheal disease	No	Yes	Yes	Yes
Short interpregnancy interval	Unknown	Yes	Yes	Yes
Induced abortion (especially illegal) <sup>a</sup>	Yes	No	No	Yes
Ectopic pregnancy <sup>a</sup>	Yes	No	No	Yes
Hypotension	No	Yes	No	No
Hypertension/pre-eclampsia/toxemia <sup>a</sup>	Yes	Yes	Yes	Yes
Low blood volume	No	Yes	No	No
First or second trimester bleeding	No	Yes	No	No
Placental abnormalities <sup>a,f</sup>	Yes	Yes	Yes	No
Hyperemesis	No	Yes	No	No
Oligohydramnios/polyhydramnios	No	Yes	Yes	No
Inadequate health care	Yes	Yes	Yes	Yes
Isoimmunization	No	Yes	Yes	No
Fetal anomalies	No	Yes	Yes	No
Incompetent cervix <sup>a</sup>	No	Yes	Yes	Yes
Spontaneous premature rupture of membranes <sup>a</sup>	No	Yes	Yes	Yes
<i>Behavioral and environmental risk factors</i>				
Unwanted pregnancy <sup>a</sup>	Yes	Yes	Yes	Yes
Smoking/tobacco use <sup>a</sup>	Unknown	Yes	Yes	Yes
Alcohol and other substance abuse <sup>a</sup>	No	Yes	Yes	Yes
Diethylstilbestrol (DES) and other toxic exposures <sup>g</sup>	No	Yes	Yes	No
High altitude	No	Yes	Yes	No
Absent or inadequate prenatal care <sup>a,h</sup>	Yes	Yes	Yes	Yes
<i>Delivery</i>				
Inadequate obstetrical care <sup>a</sup>	Yes	Yes	Yes	Yes
Iatrogenic prematurity <sup>a</sup>	No	Yes	Yes	Yes

Risk factor	Adverse Outcome			Preventive or treatment measures available
	Maternal morbidity and mortality	Low birth weight	Perinatal mortality	
Postpartum/neonatal period				
Inadequate care for mother <sup>a</sup>	Yes	No	No	Yes
Inadequate care for infant <sup>a</sup>	No	No	Yes	Yes

a. High relative risk and/or very common. Reflects the relative risk and the proportion of the population with the risk factor.

b. Closely associated factors with increased risk in different studies. The independent contribution of each factor is difficult to disaggregate.

c. Previous low-birth-weight-infant, maternal morbidity, perinatal morbidity, multiple spontaneous abortions, infertility treatment.

d. Small pelvis, female circumcision, uterine disease, tubal scarring secondary to sexually transmitted diseases and potentially leading to ectopic pregnancy, and similar problems.

e. For example, low maternal weight associated with own birth.

f. Such as placenta previa and abruptio placentae.

g. Including occupational hazards.

h. Prenatal care appears to decrease maternal and infant disease. However, it may have less effect than expected from comparisons of the outcome of pregnancy between women who attend prenatal care and those who do not. Those women who voluntarily choose prenatal care usually are healthier and have fewer risk factors.

Source: Authors.

1,660 in studies from developing countries, and averages 10 in industrial ones.<sup>1</sup> As reported in table 17-2, the highest overall ratio occurs in Africa (640); the ratios are lower in Asia (420) and in Latin America (270). Differences between countries, and between urban and rural areas, are blurred by the regional statistics, however. A recent study of the rural areas of the Gambia found a maternal mortality ratio of 2,200 (Greenwood and others 1987). The maternal mortality ratio measures the obstetric risk in a given pregnancy.

**Table 17-2. Estimated Maternal Mortality, by Region**

Region	Live births (millions)	Maternal deaths (thousands)	Maternal mortality rate (per 100,000 live births)
Africa	23.4	150	640
North	4.8	24	500
West	7.6	54	700
East	7.0	46	660
Middle	2.6	18	690
Southern	1.4	8	570
Asia	73.9	308	420
West	4.1	14	340
South	35.6	230	650
Southeast	12.4	52	420
East	21.8	12	55
Latin America	12.6	34	270
Middle	3.7	9	240
Caribbean	0.9	2	220
Tropical south	7.1	22	310
Temperate south	0.9	1	110
Oceania	0.2	2	100
Developing countries	110.1	494	450
Industrial countries	18.2	6	30
World	128.3	500	390

Note: Estimates for 1980-85 from UN demographic indicators of countries.  
Source: WHO 1985.

The "maternal mortality rate" is the number of maternal deaths in one year per 100,000 women of reproductive age, usually age fifteen through forty-nine. This rate combines the fertility rate (births per thousand women of reproductive age) and the maternal mortality ratio defined above, so it is influenced both by the likelihood of becoming pregnant and by the risk of dying from that pregnancy. Improvements in both family planning and obstetric services affect the maternal mortality rate (Fortney 1987).

The lifetime risk of maternal mortality is many times greater than the ratio indicates because the ratio ignores the effect of repeated pregnancies. Each pregnancy adds to the total lifetime risk. In the developing world (excluding China) an average woman faces a lifetime risk of one chance in thirty-three that a pregnancy will result in her death. For those with serious risk factors or for those living in areas with inadequate health services and high fertility rates, the lifetime risk escalates greatly. The difference between industrial and developing nations is much larger for maternal mortality than it is for infant mortality: the risk of infant death is about 9 times greater in the least industrialized countries, but for maternal mortality the risk can be more than 100 times as great (WHO 1986).

Three-quarters of all maternal deaths can be attributed to one of three causes—hemorrhage, sepsis, or eclampsia (convulsions resulting from hypertensive disease during pregnancy)—though the route to these ends can vary. Most countries list five main causes of maternal mortality: hemorrhage, sepsis, eclampsia, abortion, and obstructed labor. Obstructed labor and abortion, however, usually lead to death from sepsis or hemorrhage. Moreover, differences in reporting can obscure underlying events. For example, Reich suggests that about one-quarter of all pregnancies worldwide end in induced abortions and result in up to 200,000 deaths (Reich 1987); however, these deaths may be coded as hemorrhage or sepsis. In table 17-3 we summarize the leading causes of death in several countries.

Death from hemorrhage can occur in less than an hour. Women far from health services are exposed to the greatest danger because they may not reach a hospital in time for

**Table 17-3. Major Causes of Maternal Deaths, 1980–85**  
(percent)

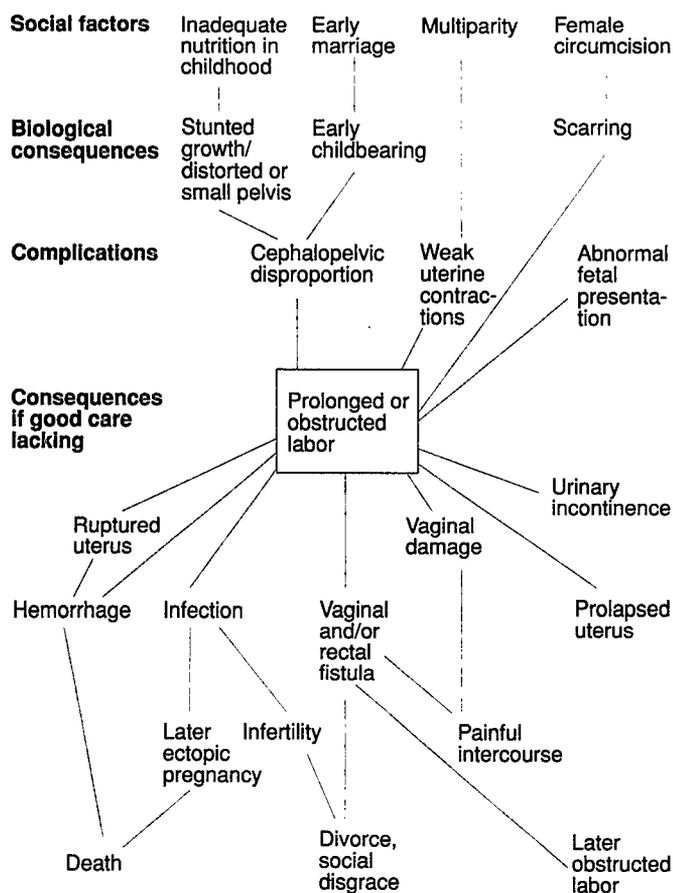
Region	Hemorrhage	Sepsis	Eclampsia	Abortion	Obstructed labor/ruptured uterus	Other
United States	10	8	17	6	3	56
Cuba	6	19	12	15	..	48
Jamaica	23	9	30	10	3	25
Zambia (Lusaka)	17	15	20	17	..	31
Egypt (Menoufia)	29	11	5	4	..	51
Tanzania (four regions)	18	15	3	17	6	41
Ethiopia (Addis Ababa)	6	2	6	25	4	57
Bangladesh	22	3	19	31	9	16
Indonesia	46	10	5	7	..	32
India	18	14	16	14	3	35

.. Negligible.

Source: Calculated from Herz and Measham 1987.

transfusion or surgery. A study in China found, for example, that 60 percent of the maternal deaths in rural areas were from hemorrhage, in contrast to 25 percent in the urban areas (Zhang and Ding 1988).

**Figure 17-1. Major Causes and Consequences of Prolonged or Obstructed Labor**



Source: Lettenmeier and others 1988.

The remaining one-quarter of maternal deaths include complications of illness that existed prior to pregnancy, such as hypertension, diabetes, and heart disease. Hepatitis, for example, causes hemorrhage or liver failure in pregnant women and is a significant cause of maternal death in many countries (China [Chen 1985]; Ethiopia [Kwast and Stevens 1987]; India [Rao 1985; Bhatia 1985]; Nigeria [Ojo and Savage 1974];) and in refugee camps in Somalia and Sudan (CDC 1987). Anemia impedes a woman's ability to resist infection or survive hemorrhage and may increase the likelihood of her dying in childbirth by a factor of four (Llewellyn-Jones 1965; Chi and others 1981). Additionally, latent infections, such as tuberculosis, malaria, and sexually transmitted and other genital infections, can become active during pregnancy and severely threaten the health of mother and baby.

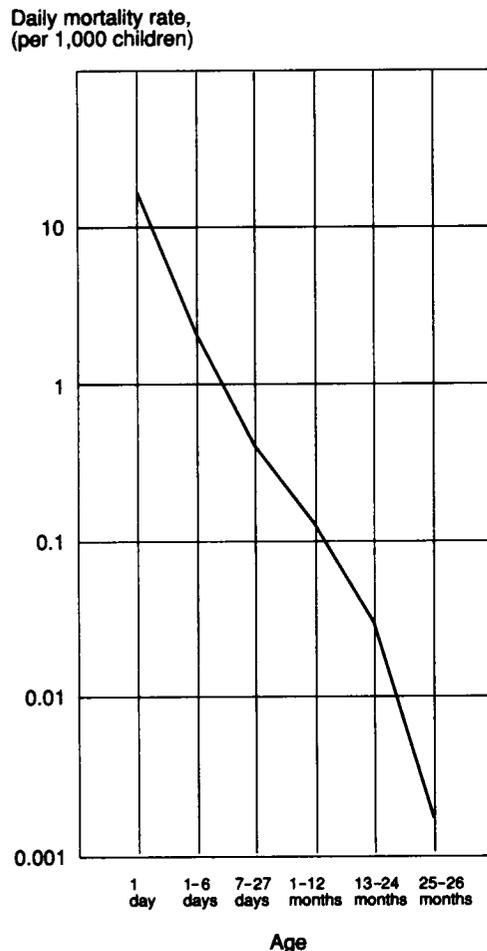
The same complications which cause death can lead to chronic disability when they are less severe. The complications of obstructed or prolonged labor, postabortal or puerperal sepsis, and hemorrhage, for example, include fistulae (tears in the vaginal wall), stenosis (narrowing of the vagina), and uterine scarring or prolapse (Howard 1987). Fistulae (rectal, urethral, and vaginal) can cause foul-smelling discharge and social ostracism. Uterine scarring and prolapse can cause infertility. In figure 17-1 the antecedents and consequences of obstructed labor are presented, clearly illustrating the interconnectedness of reproductive complications. Other chronic disabilities include hypertension, chronic renal failure, and urinary incontinence. Some of these illnesses can cripple a woman, both physically and socially, for the rest of her life.

The incidence of pregnancy-related complications is poorly defined. The authors of the most-quoted study, that of a small village in India, found sixteen illnesses for every death (Datta and others 1973). If the incidence is similar elsewhere, then 3 to 12 percent of all pregnancies result in episodes of serious ill health in women. Other studies, from Zaria, Nigeria, and from China and Egypt, present widely differing results, ranging from 1 to 37 percent, depending on the population and survey methods (Li and others 1982; Mekhemar and others 1984; Harrison 1985).

Thus, complications of pregnancy and delivery cause an enormous burden of illness. Most of this burden can be averted, however, by perinatal and obstetric care. Maternal mortality has declined substantially with increasing use of hospitals for delivery. In Latin America and the Caribbean region, it has fallen by half since 1960 (Walker and others 1986). Despite these declines, deaths from illegal abortion represent a larger percentage here than in other regions (Royston and Lopez 1987). Trends in Asia and Sub-Saharan Africa are not known. About 25 percent of the deaths of women between the ages of twenty and thirty-four years result from maternity-related causes.

**PERINATAL HEALTH PROBLEMS.** At no other age is life so tenuous and the risk of death so great as in the perinatal period. Figure 17-2 illustrates the daily risk of death throughout infancy and childhood, from the perinatal period, which extends from delivery through the first week of life, until five years of age. Perinatal health reflects both the health of the woman and

**Figure 17-2. Daily Mortality Rate for Infants and Children in Chaco Province, Argentina**



Source: Puffer and Serrano 1973.

the quality of care during pregnancy, delivery, and the neonatal period. It is a key determinant of health and well-being for the rest of an individual's life. Compare the prospects of an infant of low weight born after a prolonged, difficult delivery (with substantial risk of hypoxic brain damage, or limb weakness from birth trauma, or pneumonia acquired from amniotic fluid infection) with those of a normal infant. In developing countries very little is known about the incidence of these perinatal disabilities and their consequences for the future well-being of both the child and family.

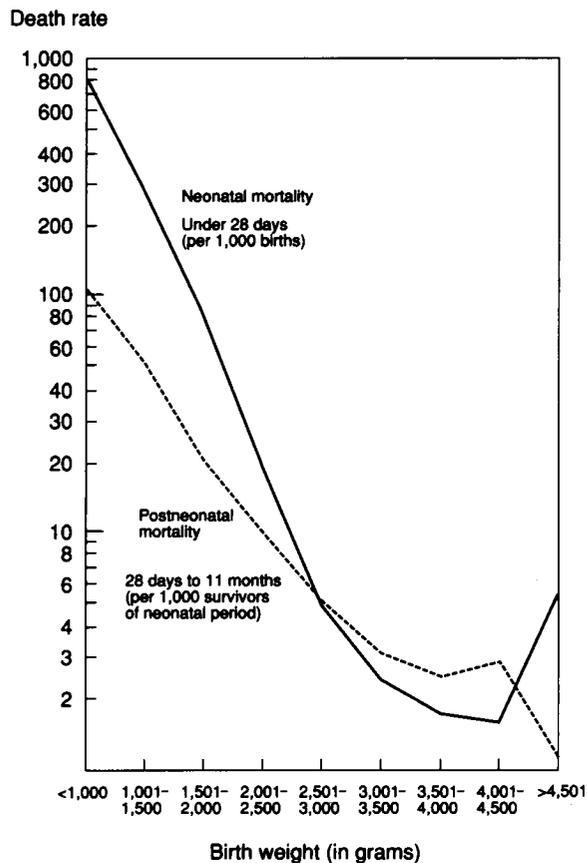
Seven million perinatal deaths occur annually—almost all in developing countries (Lopez 1990). These perinatal deaths include stillbirths (also called late fetal deaths) and deaths in the first week of life.<sup>2</sup> The perinatal mortality rate includes all births (stillbirths and live births) in its denominator. In most developing countries, it ranges between 40 and 60 per 1,000. High rates of 80 to 100 are found in the least industrialized and most disadvantaged countries. In industrial countries, rates range from 6 to 10 (Belsey and Royston 1987, quoting from WHO data banks). Perinatal deaths, particularly stillbirths delivered at home, are frequently underreported. As infant mortality declines, postneonatal deaths (up to twenty-eight days postpartum) decline more rapidly and perinatal deaths thus comprise a larger proportion of infant deaths. For example, the infant mortality rate in Mauritius declined from 70 in 1967 to 29 in 1982; the perinatal mortality rate declined from 67 to 34; however, perinatal deaths as a percentage of all late fetal deaths and infant deaths increased from 61 to 70 percent during the same period. In general, in developing countries, the perinatal mortality rate is almost the same as the infant mortality rate. Neonatal deaths, shared by both the perinatal and infant mortality statistics, approximate 50 to 60 percent of each of these statistics (Edouard 1985).

Perinatal mortality is largely determined by delivery care and the maturity of the fetus, as reflected by birth weight and gestational age. Studies of the relative effects of birth weight and gestational age on mortality suggest that birth weight is the predominant factor (McCormick 1985). Figure 17-3 demonstrates the dramatic rise in perinatal mortality among infants with a birth weight of less than 2,500 grams and more than 4,000 grams. These infants at the ends of the curve usually had gestational ages of less than twenty-eight weeks or more than forty-two weeks.

The main causes of perinatal mortality are infection of the amniotic fluid, congenital syphilis, abruptio placentae, fetal hypoxia of unknown cause, compression of the umbilical cord, premature rupture of membranes, obstructed labor, birth trauma, and congenital malformations. Up to 30 percent of deaths are due to "other" causes (Naeye 1980; Lucas and others 1983; Oyedeji and others 1983; McCormack and others 1987). Virtually all these deaths occur within the first year of life, primarily during the first few days of life.

Morbidity resulting from perinatal problems is difficult to quantify. The long-term consequences of low birth weight, one of the most severe perinatal health problems, are discussed below. Even less is known about the disabling effects of (a) lack of oxygen during labor and delivery that may cause cerebral

**Figure 17-3. Neonatal and Postneonatal Deaths by Birth Weight**



Note: Deaths of single infants alive at birth, 1974-75, based on data from eight areas of the United States.  
Source: Shapiro and others 1980.

palsy, mental retardation, or learning disabilities; (b) pulmonary dysfunction from scarring, respiratory infections, and prematurity; (c) congenital syphilis causing multiple organ and brain damage; (d) birth trauma injuring limbs, nerves, and internal organs; and (e) amniotic fluid infections which result in pulmonary, ocular, brain, and other organ damage. These acute and chronic disabilities have large social costs in health service use, family disruption, lost earnings, and long-term care.

Many infant deaths are potentially preventable by provision of prenatal and obstetric care to women. A clinico-pathological study of 702 perinatal deaths in Nairobi revealed that one-third were potentially preventable with better obstetric care (pregnant woman coming to the hospital earlier in the delivery process), because 38 percent of these were fresh stillbirths. More than 40 percent of deaths resulted from problems avoidable by early cesarean section or assisted delivery: birth trauma, ruptured uterus, cord prolapse, obstructed and prolonged labor, placenta previa, placental abruption, and eclampsia. In addition to these deaths, nearly 10 percent of the neonates died of infection acquired intrapartum, potentially avoidable with early treatment and prompt delivery following

rupture of membranes (Lucas and others 1983). Many of these same problems also cause maternal disease and death; improved obstetric care can prevent both maternal and perinatal morbidity and mortality.

Only a few researchers have examined the incidence of morbidity among neonates, but they have demonstrated its high frequency. In a Madras maternity hospital, with efficient obstetric and pediatric care, 20 percent of all babies suffered some illness and 4 percent died neonatally. The most common conditions were low birth weight (below 2,000 grams in 7.5 percent) and infections (in 8.3 percent). Obstetrical injuries and asphyxia affected only a few (2 percent) as a result of the quality of obstetric and pediatric care (Thirugnanasambandham and others 1986).

Reproductive tract infections from both sexually transmitted diseases and other genital infections are common and result in a substantial amount of perinatal as well as maternal disease (Kundsin and others 1988). In parts of Africa, more than 10 percent of pregnant women are seropositive for syphilis, but few are treated prior to delivery (Brunham and others 1984). In a study done in the 1940s prior to the availability of penicillin, syphilitic mothers experienced over 10 percent stillbirths and 20 percent infant deaths; more than 20 percent of the infants who survived had evidence of congenital syphilis, and only a third of the pregnancies resulted in a healthy child (Brunham and others 1984). Gonorrhea, chlamydia, and mycoplasma cause stillbirths, preterm delivery, and intrauterine growth retardation. Group B streptococci and bacterial vaginosis are associated with neonatal sepsis and low birth weight (Brunham, Holmes, and Eschenbach 1984; Berman and others 1981; Investigators of the Johns Hopkins Study of Cervicitis and Adverse Pregnancy Outcome 1989; Walsh and Hutchinson 1989; Wasserheit 1989). Most of these infections can easily be identified and treated before and during pregnancy to prevent these consequences.

As infant mortality has declined and prenatal and obstetric care have improved, the perinatal mortality rate also has declined but to a smaller extent. Among all infant deaths, however, the proportion from perinatal deaths has increased. As more women obtain skilled prenatal and delivery care, perinatal morbidity and mortality should continue to decline.

**LOW BIRTH WEIGHT.** The World Health Organization defines low birth weight as a birth weight less than 2,500 grams, because below this value birth weight-specific infant mortality begins to rise rapidly. Two main processes determine birth weight: duration of gestation and intrauterine growth rate, and both affect fetal, neonatal, postneonatal, and child mortality. When gestation lasts less than thirty-seven weeks, the infant is considered preterm. Intrauterine growth retardation (IUGR) is also called "small-for-gestational-age" or "small-for-dates" but has no standard definition. Commonly used definitions include: birth weight less than the tenth (or fifth) percentile for gestational age; birth weight less than 2,500 grams and gestational age greater than or equal to thirty-seven weeks; and birth weight less than two standard deviations below the mean value for gestational age.<sup>3</sup>

Unfortunately, most studies from developing countries do not distinguish IUGR from preterm infants (and even fewer disaggregate types of IUGR). Analysis of a small number of studies suggests that more than half of the cases of low birth weight in developing countries probably result from IUGR, whereas in industrial countries most of such cases result from preterm delivery. In 1982, of the 127 million infants born, 16 percent (20 million) weighed less than 2,500 grams and more than 90 percent of these infants were born in developing countries (see table 17-4 for reported mean birth weight and prevalence of low birth weight in selected countries). Western European countries have the lowest proportion (5 percent) of infants of low birth weight (Kramer 1987).

The lowest infant mortality rate occurs among infants weighing 3,000 to 3,500 grams (see figure 17-3) but rises dramatically among those below this weight and only slightly above this. In industrial countries the prevalence of neurodevelopmental handicaps among low-birth-weight infants is three times that for those of normal birth weight. The risk for infants of very low birth weight (1,500 grams or less) is ten times that for normal weight infants. Eight to 19 percent of infants of very low birth weight may be severely affected despite the availability of neonatal intensive care. Low birth weight strongly predicts school failure, but the household setting modifies the effect (which is less pronounced in advantaged households) (McCormick 1985). Comparable statistics are not available for developing countries.

Infants of low birth weight have twice the risk of congenital anomalies than those of normal weight, and infants of very low birth weight have three times the risk. Congenital anomalies and neurodevelopmental handicaps are not mutually exclusive. The proportion of infants affected with one or both ranges from 19 percent in infants of normal birth weight to 42 percent in those of very low birth weight; the proportion of infants severely affected is 2 to 14 percent (McCormick 1985). Low-birth-weight infants also suffer more pulmonary disease, use health services extensively (for neonatal care and subsequent physician visits), increase family health costs, and disrupt the normal functioning of the family.

Though the cause of the majority of low-weight births occurring in both developing and industrial countries remains unexplained, there are many important risk factors (see table 17-1). They are believed to include infant gender, race, ethnic origin, socioeconomic status, maternal height, prepregnancy weight, paternal weight and height, maternal birth weight, parity, history of prior low-birth-weight infants, gestational weight gain and caloric intake, general morbidity and episodic illness during pregnancy, reproductive tract infections (including sexually transmitted diseases), malaria, cigarette smoking (and tobacco chewing to a lesser extent), alcohol consumption, and in utero exposure to diethylstilbestrol.

From 1979 to 1982, the proportion of low-birth-weight infants appeared to decline globally from 16.8 to 16 percent. In developing countries it was reported to have declined from 18.4 to 17.6 percent, whereas in industrial nations it dropped from 7.4 to 6.9 percent. These are minimal declines and probably represent only improved data collection. Data from

**Table 17-4. Mean Birth Weight and Prevalence of Low Birth Weight, Selected Countries**

Country	Mean birth weight (g)	Low birth weight (percent)
<i>Africa</i>		
Egypt	3,200–3,240	7.0
Kenya	3,143	12.8
Nigeria	2,880–3,117	18.0
Tunisia	3,210–3,376	7.3
Tanzania	2,900–3,151	14.4
Zaire	3,163	15.9
<i>Asia</i>		
China	3,215–3,285	6.0
India	2,493–2,970	30.0
Indonesia	2,760–3,027	14.0
Iran, Islamic Rep. of	3,012–3,250	14.0
Iraq	3,540	6.1
Japan	3,200–3,208	5.2
Malaysia	3,027–3,065	10.6
Pakistan	2,770	27.0
<i>Latin America</i>		
Brazil	3,170–3,298	9.0
Chile	3,340	9.0
Colombia	3,912–3,115	10.0
Guatemala	3,050	17.9
Mexico	3,019–3,025	11.7
<i>North America</i>		
Canada	3,327	6.0
United States	3,299	6.9
<i>Europe</i>		
Czechoslovakia	3,327	6.2
France	3,240–3,335	5.6
Hungary	3,144–3,162	11.8
Norway	3,500	3.8
Sweden	3,490	4.0
United Kingdom	3,310	7.0

Source: Kramer 1987.

developing countries prior to 1979 are fragmentary; few neonates were weighed except in urban referral hospitals, and only a small proportion of births was under surveillance. National averages cannot be accurately estimated from these figures, and in any event, few of these statistics have been compiled.

### **Maternal and Perinatal Morbidity and Mortality in 2000**

Future patterns of maternal and perinatal morbidity and mortality probably depend more on the number and proportion of women of childbearing age in the population and fertility rates than on specific factors such as hospital access. The World Health Organization made a series of projections assuming (a) no change in fertility and maternal mortality, (b) a reduction in fertility of 25 percent, and (c) halving of the maternal mortality ratios. In the first case, 600,000 maternal deaths would occur in the year 2000. If fertility were reduced by 25 percent, the number of deaths would drop to 450,000. By halving the mortality ratio, deaths would decrease to 300,000.

If fertility declined by 25 percent and the mortality ratio by half, then maternal deaths would shrink to 225,000 in the year 2000, fewer than half the deaths experienced in 1985.

The World Health Organization estimates continued declines in rates of low birth weight without citing the reasons for the expected decrease. Reduced fertility would result in fewer perinatal deaths and the decline in rate of low birth weight would reduce the perinatal mortality rate. By 2015 the perinatal mortality rate should decline from the 1985 level of 98 for males and 75 for females to 42 and 31 in developing countries (Lopez, chapter 2, this collection). This decline depends on an increase in skilled delivery services along with the decline in low birth weight.

### **Indirect Economic Costs**

There is a dearth of information both on treatments used for maternal and infant morbidity occurring during pregnancy and delivery and on the effects this morbidity has on the women and infants, their families, the community, and health services. Though chronic morbidity may be more expensive than a quick death, mortality is complicated in that the death of the mother is usually accompanied by the death of the infant from that pregnancy. Ninety-five percent of the infants born to mothers who died in childbirth also died, according to a small study in Bangladesh (Chen and others 1974). A disabled mother confined to bed for severe anemia or renal failure might drain the family resources and compromise the health of family members, particularly the very young children, but there would also be long-range effects on the well-being of the entire family from the mother's death.

Although their efforts are often undervalued, women support families through their productive labor: cash crop labor, subsistence farming, and other remunerative work. Poorer women are more likely to be solely responsible for their families. Many regions experience high male outmigration for jobs, in effect leaving the women alone as the sole parent. The loss of the mother through death or disability then means the loss of the nurturer, provider, and de facto household head.

Treatment of low-birth-weight infants and neonatal illness can also drain the resources of the family and health service, particularly when neonatal intensive care is required. Indeed, when health resources are limited, health planners should weigh the cost of neonatal intensive care, which may benefit only a few infants, against the cost of improved preventive care for maternal and perinatal health, which would confer wider benefits. Even where neonatal intensive care units are absent, the increased health needs of sick and disabled infants are costly and time consuming.

### **Summary**

Maternal and perinatal health (including low birth weight) are closely linked, and efforts to improve the health of either pregnant women or the newborn will have synergistic effects

on the health of the other. Death and sickness among these population groups are common, and the effects of this ill health are pervasive and costly to society.

### **Risk Reduction prior to Conception**

Reduction of risk prior to pregnancy is the most feasible way to improve maternal health.

### **Elements of Prevention Strategies**

In order completely to eradicate reproductive risk, pregnancy would have to be eliminated. Because families and society obviously value and desire children, however, the goal should be to avoid unwanted pregnancies and to lower the risks when pregnancy occurs. Many steps can be taken to do this even before conception.

**BETTER GENERAL HEALTH FOR WOMEN.** In general, when women are healthier they are better equipped to handle pregnancy and their infants will be healthier. Good health for all women requires an integrated set of actions, including health services, community development, and education for female children.

Women need better services throughout their life. Nutrition is important at all ages so that a woman enters childbearing age with normal height, weight, pelvic size, and nutritional status. Nutrition programs can include a variety of components, for example, nutrition and health education, anemia screening and prevention (including iron and folate supplements), iodine supplementation, food supplementation, promotion of community and household gardens, and income supplements (Lettenmeier and others 1988). The choice of intervention depends on the most important nutritional deficiencies experienced in an area and the availability of resources.

It is also important to pay attention to those conditions affecting girls early in life that make pregnancy more risky. Rheumatic fever, for example, causes heart disease which can complicate childbirth. In Menoufia, Egypt, 16 percent of maternal deaths were due to cardiovascular disease; one-half of them involved a history of rheumatic fever (Fortney and others 1988). Infections of the reproductive tract and sexually transmitted diseases (STDs) also must be diagnosed and treated. These can cause scarring of the fallopian tubes that may result in infertility or ectopic pregnancy (an important cause of maternal death from hemorrhage) when conception occurs. These infections are also responsible for much morbidity as discussed earlier. Women are often uninformed about the symptoms, risks, and means to prevent STD infection.

The delay of reproduction until a woman is fully grown is very important and may be achieved by raising age at marriage, reducing the need for women to prove their fertility early, and giving more attention to male and female responsibilities in avoiding adolescent pregnancies. Economic and social devel-

opment also makes it easier for people to obtain the resources required for good health and to maintain hygienic conditions to safeguard it. Careful attention to development policy choices can increase the probability that women will have lighter workloads and better food, both of which are extremely important in reducing the wear and tear on health, which is most felt during pregnancy and childbirth.

The status of women in society directly affects their health in many ways. For example, in some societies women are the last to get food in the family and the least likely to use health services. Education can be an important means to improve status. Most important, increasing the education of women indirectly increases the motivation and the means to attain improved health status and instills in each woman an awareness of her own health needs and the methods by which she may handle them. Educated women tend to marry later and are more likely to use family planning, prenatal, and obstetric services and to avoid dangerous traditional health practices (Harrison 1980; Kwast and others 1984; London and others 1985; and Monteith and others 1987). Maternal education substantially affects infant mortality rates (figure 17-4); one might expect similar results for maternal health, but this is not well documented.

**FAMILY PLANNING.** Family planning acts on maternal health through several mechanisms. First and most important, with fewer unwanted pregnancies, fewer women resort to illicit abortion. Second, a birth interval of more than two years has no proven effect on maternal morbidity and mortality, but it does improve the health of the infant. Still, longer birth intervals usually result in fewer total pregnancies for a woman and, therefore, fewer grand multiparas (more than five pregnancies). Third, targeted family planning can play a significant role by reducing the number of pregnancies in women most at risk of pregnancy complications, especially those under eighteen or over thirty-four years of age. Family planning includes education and access to a variety of contraceptive methods such as pills, condoms, intrauterine devices, and so on, plus availability of safe abortion. Because approximately 25 percent of maternal deaths result from unsafe abortion, the provision of safe abortion services to back up other contraceptive services is a highly effective and low-cost way to reduce maternal mortality (Blacker 1987).

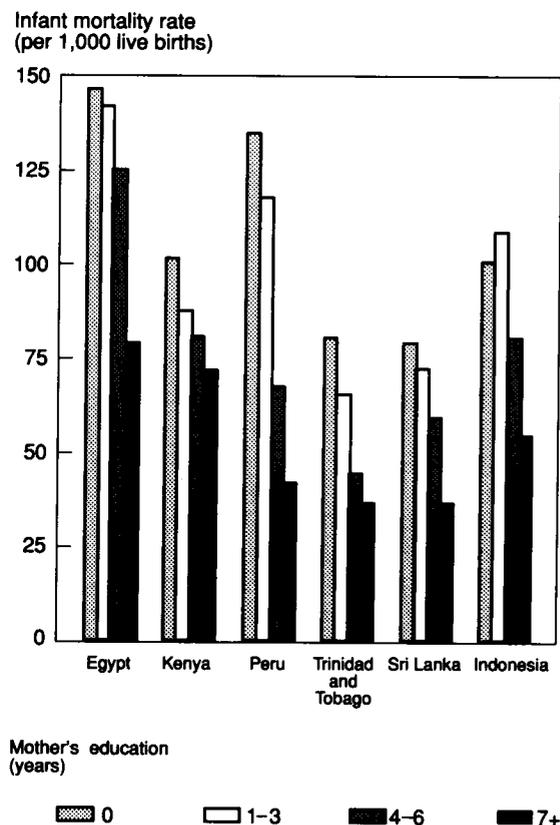
The effect of family planning on maternal mortality depends on a country's stage in the demographic transition (Fortney 1987). If the number of unwanted pregnancies and the need for abortion are reduced, potential declines in maternal mortality range from 5 percent in Côte d'Ivoire to 62 percent in Bangladesh (Lettenmeier and others 1988). A general rule of thumb is that in countries in which fertility is already low, increased use of contraception will have relatively little effect on fertility and maternal mortality. These countries should focus maternal and perinatal health care strategies on obstetric improvements. It is also useful to look at both the maternal mortality ratio and rate; where the rate is high and the ratio is

low, family planning is likely to have more effect on maternal deaths, especially if deaths due to abortion are high (Fortney 1987). Family planning is somewhat less effective and more costly, however, in societies in which women want large families.

As the total fertility rate declines, the proportion of grand multiparas declines, but the proportion of primiparas increases. These two trends have opposite effects on maternal mortality in industrial and developing countries. In industrial countries, a slight increase in maternal mortality results; however, in developing countries, the improvement in maternal health from the decline in grand multiparas outweighs the negative effect of the increase in primiparas.

Wider birth spacing has been recommended for improving maternal morbidity and mortality. Too many births too closely spaced seem to cause a general decline in the health and nutritional status of some women; this decline is called the maternal depletion syndrome. Whether this syndrome actually exists has been questioned (Winikoff and Castle 1987). Nonetheless, the freedom to plan the timing of offspring, and the education required to help a woman make this choice, are undeniably appropriate goals for any maternal health program.

**Figure 17-4. Infant Mortality by Mother's Education, Selected Countries**



Source: Starrs 1987.

Targeted family planning can help avoid pregnancies among women who are too young (less than eighteen), too old (over thirty-four), have already had many births (more than four), have an obstetric or medical history which places them at higher risk, or who do not want another pregnancy (Lettenmeier and others 1988). Locating such women and providing them with contraception will substantially reduce maternal mortality rates. Estimates for this reduction range from 25 to 50 percent of all maternal deaths (Maine 1981; Rinehart and others 1984; Blacker 1987; Maine and others 1987; Winikoff and Sullivan 1987).

### **Good Practice vs. Actual Practice—Where Are the Gaps?**

Many developing countries have made remarkable progress in reducing maternal mortality. Their experiences provide clues to the most effective actions to take. Lettenmeier and others (1988) report that "Sri Lanka, through nearly universal education, raised the average age at marriage and increased the use of family planning, thereby reducing the number of risky pregnancies in adolescents and in older women with many children (Henry and Piotrow 1979). At the same time health care improved. The Sri Lankan maternal mortality ratio dropped from 555/100,000 in 1950 to 95 in 1980 (Royston and Lopez 1987)." Lettenmeier and others (1988) also report that "China lowered maternal mortality by substantially lowering birth rates, raising the age at marriage, and improving health care for pregnant women (Chen and Kols 1982). The maternal mortality ratio, at 25, now rivals that of industrial countries (WHO 1986)." These two success stories demonstrate the potential of multifaceted efforts to reduce maternal mortality and morbidity.

Despite recent gains in a few countries or among women of certain classes, most women in developing countries face social constraints in status and decisionmaking power which limit their ability to safeguard their own health (PCC 1988). Women in developing countries still lag behind men in educational attainment and literacy, as is evident in table 17-5, in which are also shown the regions of the world where women marry at young ages and have large families. Africa scores lowest for educating its women and age of marriage, and it has the highest fertility; maternal mortality is also highest in Africa. The Indian subcontinent (Middle South Asia) scores the next lowest and has maternal mortality rates nearly as high as Africa.

Poor nutrition is still a widespread problem among women despite recent efforts to provide food supplements and nutrition education. A survey of eighty developing countries in the early 1980s showed that between 20 and 45 percent of the women age fifteen through forty-four consumed insufficient calories daily (Hamilton and others 1984). Anemia incidence is even higher; up to 80 percent of the women of reproductive age in developing countries may be anemic (Royston 1982). Food supplementation programs have proved expensive and difficult to manage logistically. Furthermore, they have not generated data on their contribution to the reduction of maternal mortality or morbidity (Weston 1986). To compound

matters, nutritional deficiencies are passed from generation to generation. The poorly nourished woman is more likely to give birth to an infant of low birth weight who in turn may never reach fully normal stature. When this infant becomes an adult, she may give birth to other low-birth-weight children or have obstructed labor from small pelvic size. Contrary to expectations, there has not yet been any evidence of change in the incidence of low birth weight in developing countries as a result of the large-scale food supplementation programs for girls and women prior to conception.

In table 17-6 we summarize possible actions of a maternal and child health program before conception occurs. The priorities for services include family planning, including contraception and safe abortion; integration of family planning into health services which can screen for and treat anemia, infections of the reproductive tract, sexually transmitted diseases, malaria, and other illnesses common in the particular locale; and health education through health centers and other avenues for the prevalent illnesses and for health risks such as poor nutrition and tobacco and alcohol use. Many of these screening, treatment, and education services obviously are needed during pregnancy as well. Wherever possible, all these priority services should be integrated into pregnancy care. Another alternative is to provide family planning and treatment for reproductive tract infections and STDs together and pregnancy care separately.

### **Pregnancy, Delivery, and the Neonatal Period**

The strategy for maximizing good health during pregnancy requires access to health care.

#### **Case Management of Pregnancy and Complications**

The ability of the health system to decrease the effect of pregnancy complications depends upon the capacity to identify high-risk women, prevent complications or treat them, and refer for skilled obstetric care. When a complication presents itself in spite of prenatal care, back-up obstetrical referral facilities are required. It is difficult to identify all women who will have complications; for example, in a group of women with no risk factors receiving prenatal care in Canada, 10 percent of the women had obstetric complications and 19 percent of the neonates had complications (Moutquin and others 1987).

A maternity care program in rural Bangladesh which posted trained midwives at village health posts and referred complicated deliveries to a central maternity clinic reduced maternal mortality by 60 percent (Fauveau and others 1991). Even though the maternal mortality ratio remained high in the program area (1.4 per 1,000), the reduction suggests that midwives can improve maternal survival when given proper facilities, supervision, and referral facilities. The program was undertaken in an area with an already existing high-quality primary health care system, probably a key element in its effectiveness. The effect on perinatal mortality and costs must still be determined.

Table 17-5. Selected Sociologic Indicators, by Region

Region	Literate adults		Married women age 15-19 (percent)	Total fertility rate <sup>a</sup>
	Male (percent)	Female (percent)		
Africa	33	15	44	6.2
North	—	18	34	5.1
West	20	6	70	6.9
East	29	14	32	6.9
Central	35	9	49	6.2
Southern	55	56	2	4.7
Asia	56	34	42	3.5
Southwest	58	31	25	5.1
Middle south	44	17	54	4.7
Southeast	75	53	24	3.7
East	97	92	2	2.4
Latin America	76	70	16	3.6
Central	75	67	21	3.9
Caribbean	67	66	19	3.0
Tropical south	74	67	15	
Temperate south	93	91	10	3.5
Oceania	90	88	10	2.5
North America	99	99	11	1.8
Europe	96	93	7	1.7
Former U.S.S.R.	100	100	10	2.4
World	67	54	30	3.5
Industrial countries	98	97	8	1.9
Developing countries	52	32	39	3.9

a. Number of children per woman.

Source: Starrs 1987; United Nations various years.

The generally accepted strategy for dealing with the complications of pregnancy and childbirth involves a regional network of community risk assessment through prenatal care and use of facilities at the first-referral level, usually a district hospital, for the management of high-risk cases and treatment of obstetrical emergencies. Due to the nature of transportation in the developing world, maternal health programs must address the need for emergency transfer. In some cases, maternity waiting homes for those with expected complications are proposed; in others, innovative methods for providing transportation are involved. Herz and Measham (1987) advocate stronger community-based prenatal, delivery, and family planning services (incorporating the preventive strategies described earlier), stronger referral facilities, and an alarm and transport system.

**PRENATAL CARE.** Prenatal care is cost-effective because it reduces the number of women requiring skilled obstetrical care by screening and treating women at risk of complications and referring them to other facilities if necessary. Prenatal care can also substantially reduce the proportion of low-birth-weight infants and the incidence of perinatal disease. These reductions depend, however, on identifying high-risk women early

in pregnancy and providing them with special care: for example, encouraging an appropriate diet, treating infections and other illnesses, and arranging skilled delivery for those requiring it. A study in Indonesia found that women who received no prenatal care were more than five times as likely to die than those who attended a prenatal clinic (Chi and others 1981). It is estimated that in the United States each dollar invested in equitable access to comprehensive prenatal care results in a savings of \$3.38 in subsequent expenditure for the care of low-birth-weight infants (IOM 1985). Low birth weight and perinatal problems are less common among women who have prenatal care (Chi and others 1981; Donaldson and Billy, 1984; Brown 1985; Harrison 1985; IOM 1985; Trivedi and Mavalankar 1986; Winikoff 1988). Nevertheless, it has not been possible to identify the specific components of prenatal care which reduce these problems (IOM 1985; Winikoff 1988). Women who avail themselves of prenatal care tend to be better educated and in better general health beforehand, so any comparison of women who take advantage of prenatal care with those who do not will show that the former group is better off. Where general health care is not available to prevent or treat risk factors before conception, prenatal care becomes even more important.

**Table 17-6. Preconception Services to Improve Maternal and Perinatal Health**

<i>Intervention</i>	<i>Effectiveness</i>	<i>Major drawbacks</i>	<i>Program feasibility</i>
<i>Nutrition</i>			
Food supplementation	Benefit to mother has not been evaluated. Supplementation increases birth weight 30 to 200 g. Most effective in malnourished women.	Difficult to ensure that pregnant woman does not share the supplement with others or substitute it for usual diet.	High cost. Generally too expensive for large continuing programs. Works best with locally available, inexpensive foods and when combined with nutrition education. Having women eat supplement at local distribution site most effective.
Iron/folate supplementation before and during pregnancy	Highly effective if tablets taken regularly. Malaria and parasite treatment needed in endemic areas.	Gastrointestinal side effects and need to take tablets several times a day make compliance a problem. Hard to motivate asymptomatic women to take tablets.	Low cost. Easy to add to existing antenatal care or other health care that reaches women. No special storage facilities needed.
Iodized oil injections	One injection prevents iodine deficiency for three to five years, shrinks existing goiter.	To benefit infant, injections must be given before pregnancy.	Low cost. Easy to add to existing antenatal care.
<i>Family Planning</i>			
Change maternal age Allow for birth spacing Limit family size Avoid high-risk pregnancy Avoid unwanted pregnancies	All major methods highly effective if used regularly and correctly.	Long-term consistent use and continuity of supplies needed for some methods. Rumors and concerns about potential side effects may deter use. Specialized training needed to perform sterilizations and insert IUDs and implants. Cultural restrictions against use of family planning in some areas.	Moderate cost. Variety of methods allows delivery through many medical and nonmedical delivery systems. Users have choice of methods. Some methods can be distributed by briefly trained workers. Elaborate storage system not needed.
<i>Health services</i>			
Primary health care for STDs, reproductive tract infections, hypertension	Highly effective depending on content and use. Prevents tubal scarring, which can lead to infertility and ectopic pregnancy.	Services depend on local resources and endemic illnesses. Specialized training, diagnostic tests, and treatments required locally.	Moderate cost systems often in place due to Alma Ata conference and "Health for All" programs.
<i>Health education</i>			
Reproductive tract infections and STDs Poor health habits (tobacco, alcohol) Nutrition Signs of premature labor	Effect on maternal and perinatal health depends on content and use.	Community participation in education and adequate training of health educators.	Moderate cost systems often in place due to Alma Ata conference and "Health for All" programs.

Source: Lettenmeier and others 1988.

To some degree, the content of prenatal care must be adjusted according to local technologies, economics, and population needs. The prevailing health problems must be identified and care must be targeted to those at risk so that they are identified and treated. Prenatal programs in poor countries cannot hope to be as comprehensive as those recommended in industrial countries; managers of such programs must select carefully the components they will include for maximum efficiency and benefit. In table 17-7 we list the important components of prenatal care for developing countries and the lowest

levels of the health care system at which this care can occur. At the community level, health workers can educate pregnant women about good nutrition, dangerous habits (tobacco and alcohol use), STDs, and about signs of premature labor and other complications so that women can get to the referral centers quickly (Iam 1989). At the primary level, health workers should be trained and resources available for health and nutrition education and for screening and monitoring for a variety of conditions. The choice of diseases to screen for depends upon the local disease burden. For example, in parts of Africa

**Table 17-7. Prenatal Interventions for Preventing Maternal Morbidity and Mortality, Low Birth Weight, and Perinatal Mortality in Developing Countries**

Level of care	Activity	Areas covered
Community	Educate	Nutrition; tobacco and alcohol use; signs of premature labor and other serious complications; self-referral for care
Primary	Monitor and treat or refer for skilled care	Uterine growth; weight gain; bleeding; presentation; hypertension; edema
Primary	Screen and treat or refer for skilled care	Reproductive tract infections; sexually transmitted diseases; diabetes; urinary tract infections; cardiac disease
Primary	Treat intercurrent illness	Diarrhea, respiratory infections, malaria, and other diseases
Primary	Provide preventive and nutritional care	Malaria prophylaxis in endemic areas; tetanus immunization; iron and folate supplements for anemia; nutritional supplements for malnourished women
Referral	Detect and treat	Premature labor; rupture of membranes
Referral	Skilled delivery	Small pelvic size; poor obstetric history; open cervix; other risk factors (such as age, parity)
Referral	Treat	Complications of spontaneous and induced abortions; ectopic pregnancies; hemorrhage

Source: Authors.

where STDs and malaria are prevalent, these problems must be addressed. Inexpensive diagnostic tests are available for many diseases: syphilis, gonorrhea, malaria, and anemia, among others. Unfortunately, for sexually transmitted diseases, even these diagnostic tests may be too expensive for widespread use. More operational research on diagnosis and treatment of STDs is urgently needed. All prenatal clinics should have the capacity to screen for high-risk pregnancy, perform pelvic examinations, immunize against tetanus, monitor uterine growth, provide iron and folate, and provide malaria prophylaxis. Depending on resources, other interventions, such as more comprehensive health education, should be provided. Trained birth attendants, not just family members or untrained traditional midwives, should assist all deliveries so that incipient complications can be treated or the woman rapidly transported to a referral center.

Most countries have an inadequate number of facilities and trained personnel for prenatal care, normal deliveries, transport to referral centers, and care of complications. The cost and effectiveness of investments in training and facilities expands when they can be used for other priority programs such as STD screening and treatment, family planning, and maternal and child health care.

**REGIONALIZED CARE AND REFERRALS.** Careful consideration of which health care personnel will deal with what level of complications is critical. Table 17-8 is an outline of a proposed system for regionalized care and referral for prevention of maternal mortality. A similar system can be used to prevent low birth weight and perinatal mortality by adding screening for a small number of other fetal risk factors (for example, tobacco and alcohol use, need for malaria prophylaxis, reproductive tract infections, and sexually transmitted diseases). Health care workers should be adequately trained to assess and handle any complication they may encounter. If referral is necessary, they must know how to stabilize and find transportation for the patient. Those in charge of programs may decide to allow traditional birth attendants (TBAs) to dispense drugs

(for example, oral ergometrine for hemorrhage), or have nurse midwives do surgical procedures (for example, cesareans) when emergency transportation is a practical impossibility or likely to be slow enough that local emergency treatment is a necessity.

The World Health Organization recommends that referral centers provide the following eight essential obstetrical services (Starrs 1987; Lettenmeier and others 1988):

- Surgical procedures: cesarean sections, draining abscesses, repairing high vaginal and cervical tears, removing ectopic pregnancies, emptying the uterus following incomplete abortion, symphysiotomies, and, in case of severe complications, rupturing the amniotic membrane to induce or quicken labor.
- Anesthesia: general, spinal, and local.
- Medical treatment: providing fluids and medications intravenously, treating shock, infection, preeclampsia and eclamptic seizures, and inducing labor.
- Blood replacement: transfusions of blood or other fluids for hemorrhage or surgery.
- Manual procedures for diagnosis and treatment: removing placentas manually, delivering by vacuum extraction or forceps, and using partographs to monitor labor.
- Family planning: tubal ligations, vasectomies, implanting and removing intrauterine devices and Norplant, other family planning methods.
- Special care for newborn babies: resuscitation, keeping warm, preventing low blood sugar, treating infections.
- Managing high-risk women: providing waiting homes close by. (This depends on prenatal screening for success.)

Better care during pregnancy, labor, and delivery potentially could reduce maternal mortality rates anywhere from 50 to 80 percent (Kwast and others 1984; Walker and others 1986; Lettenmeier and others 1988) and perinatal mortality rates by 30 to 40 percent (Lucas and others 1983; Kaumitz and others 1984). Most of the improvement would result from additional

**Table 17-8. Selected Interventions at Primary and First-Referral Levels for Prevention of Maternal Morbidity and Mortality**

Problem	Intervention	Health system level <sup>a</sup>
All causes of maternal mortality and morbidity	Family planning	Primary, first referral
	Prenatal care	Primary
	Supervised delivery	Primary
Hemorrhage	Risk screening, referral	Primary
	Other prenatal care, including treatment of anemia	Primary
	Oxytocics when placenta delivered <sup>b</sup>	Primary
	Intravenous fluids	Primary
	Transport to first-referral level	Primary
	Manual removal of placenta	Primary
	Blood typing of donors	First referral
	Blood transfusion	First referral
Infection	Risk screening, referral	Primary
	Tetanus immunization	Primary
	Clean delivery	Primary
	Antibiotics when membranes ruptured, if not delivered within twelve hours	Primary
	Transport to first referral level	Primary
	Hysterectomy	First referral
Toxemia	Monitor symptoms, blood pressure, and urine for protein	Primary
	Bed rest, sedatives	Primary
	Transport to first-referral level	Primary
	Induction or cesarean section	First referral
Complications of abortion	Antibiotics <sup>b</sup>	Primary
	Transport	Primary
	Oxytocics	Primary
	Evacuation	First referral
	Hysterectomy	First referral
Obstructed labor and ruptured uterus	Risk screening, referral	Primary
	Partograph	Primary
	Transport to first-referral level	Primary
	Symphiotomy	First referral
	Cesarean section	First referral

a. Primary level includes outreach programs and health dispensaries, posts, or centers. First-referral level usually is a district or cottage hospital with twenty or more beds and the capability of giving blood transfusions and performing cesarean sections.

b. Recommended experimental approach at the community level.

Source: Herz and Measham 1987.

training for those who attend most births and by organizing emergency systems for unexpected complications.

Recently, experts have suggested the use of three indicators for assessing the effectiveness of prenatal and delivery care: the ratio of fresh stillbirths to macerated stillbirths, the percentage of cesarean sections, and the ratio of scheduled deliveries (women identified as high risk during pregnancy and hospital delivery arranged) to emergency deliveries (Mark Belsey, personal communication, June 1991). The ratio of fresh stillbirths may indicate potentially avoidable deaths; a low rate of cesarean sections may suggest that additional maternal and perinatal disease and death may be preventable; and a low proportion of scheduled deliveries suggests that prenatal care and referral should be improved to identify better the women at risk and arrange for hospital deliveries prior to onset of complications. In European countries where the perinatal mortality ratio is

about 10 per 1,000 births, the ratio of fresh-to-macerated stillbirths is one to five. In contrast, in developing countries like Kenya, the ratio is one to three (Belsey and Royston 1987). Other countries, such as Mexico, suffer from excess cesarean sections with poor quality perinatal care and have high perinatal mortality (Bobodilla 1988).

The quality of postpartum and neonatal care is another concern. Women should be treated for infections and checked for hemorrhage, the health needs of the infant should be monitored, and counseling should begin to address future health needs to guarantee less risky deliveries the next time. Counseling should cover family planning, nutrition, need for rest, child care, and breastfeeding. This attention during postpartum visits of women to hospitals or health centers is especially important in those areas where women use clinic services only for maternal health needs. In table 17-9 the feasibility of

the proposed services for a maternal and child health program is assessed. Neonatal intensive care is extremely expensive and therefore limited to highly specialized referral centers which can provide high-quality care. At the local level, birth attendants should know about clearing respiratory passages, early breastfeeding, sterile cutting and care of the umbilicus, and hydration of the infant when needed.

**TRAINING OF TRADITIONAL BIRTH ATTENDANTS.** About 70 percent of all babies in developing countries are delivered by traditional birth attendants (TBAs) or relatives (Lettenmeier and others 1988). Many women prefer TBAs even when modern health care facilities are available. Health workers need to work with TBAs to improve the quality of maternal care delivered and to increase the number of women obtaining prenatal care. With appropriate training and supportive supervision, TBAs can provide the basic care required by women who have normal deliveries. They must learn to use hygienic techniques, avoid harmful practices (for example, excessive force on the woman's belly or pulling the umbilical cord to withdraw the placenta), and make the woman comfortable while encouraging her to adopt practices such as breastfeeding immediately after delivery, keeping clean, and watching for signs of postpuerperal infection or hemorrhage.

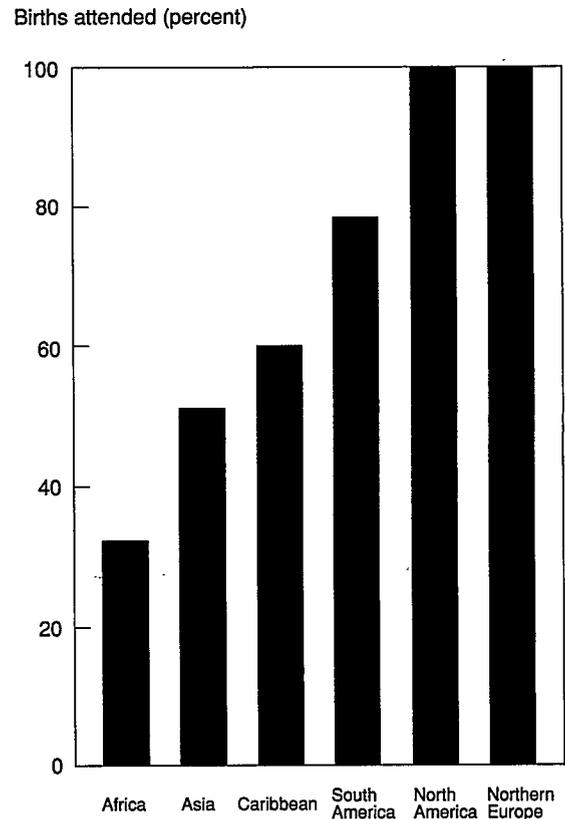
Traditional birth attendants also need instruction in emergency care. The attendants must recognize warning signs, know how to stabilize the woman's condition, and be able to transfer her to the next level of care. The proportion of births, by region, attended by trained personnel is shown in figure 17-5. Africa uses trained personnel the least and has the highest maternal mortality rates.

### **Good Practice vs. Actual Practice—Where Are the Gaps?**

Existing reproductive care for women falls far short of needs and lags far behind what we know is feasible (Ratnam and Prasad 1984). Access to high-quality family planning and abortion services remains limited. Few women in developing countries receive prenatal care. Worse still, the women who receive late or no prenatal care are most often young, primiparous, poor, of a racial or ethnic minority, and undernourished, and they are more likely to smoke or drink (Kramer 1987), all of which puts them at higher risk than average and more in need of care. Of the women who do receive prenatal care, most make only one visit to a health care center and that one relatively late in pregnancy (Williams and others 1985). Rural women are much less likely to receive prenatal care than urban women (table 17-10). In places where walking distance is short, more use has been made of clinics. The best results have been where women are within three kilometers of the clinic (Williams and others 1985).

In many places, clinics are available but women do not attend for various reasons. Because the regional referral networks rely on contact during pregnancy, low prenatal participation rates undermine the entire effort. Cultural barriers to services range from distrust of male clinicians to fears of turning

**Figure 17-5. Births Attended by Trained Personnel, by Region**



Note: Reflects experience about 1982.  
Source: Starrs 1987.

control over to insensitive clinic staff. Some women may consider hospitals or clinics places to die and so refuse to use them for preventive or routine health care; they resort to prenatal care only if they develop complications (Lettenmeier and others 1988; see also Bamisaiye, Ransome-Kuti, and Famurewa 1986; Leslie and Gupta 1989).

Systems to identify high-risk pregnant women in industrial countries have had poor sensitivity and specificity (IOM 1985). Even though most of the adverse pregnancy outcomes occur in women who have several of the risk factors mentioned in table 17-1, many maternal and fetal diseases occur in women with no easily identifiable risk factor. Because of this phenomenon, the sensitivity and specificity of systems based upon history and physical examination average about 60 percent (IOM 1985). These systems identify only about half of the women who eventually have low-birth-weight infants. A reasonably reliable system for classifying women who will have poor pregnancy outcome is needed to contain the cost of services so that those at high risk can receive special, and more expensive, care. An excess of women incorrectly identified as high risk means that scarce resources are used for the care of those who will not benefit from the service and may experience

**Table 17-9. Maternal and Child Health Services for Management of Pregnancy**

<i>Intervention</i>	<i>Effectiveness</i>	<i>Major drawbacks</i>	<i>Program feasibility</i>
<i>Antenatal<sup>a</sup></i>			
Antenatal care; screening and referral; monitoring of height, weight, blood pressure; checking for anemia, swelling, protein, presentation, and bleeding.	Women who receive antenatal care are three to five times less likely to die and also less likely to lose their child than women who do not get care. Low birth weight and perinatal complications also decline.	Appropriate screening criteria difficult to select. Village health care providers may have no formal training. Existing services underutilized.	High cost. Feasible if there are central referral hospitals. Special training may be needed. Community must be educated and involved so women will come for antenatal care.
Antenatal education: warning signs, nutrition, health habits	Difficult to assess. Studies of nutrition education found success in avoiding toxemia.	Scheduling education into busy clinic hours; getting women to attend.	Low cost. Can be done as home visits, through neighborhood organizations, TBAs.
Antenatal treatment of anemia, hypertension, infection, STDs, concurrent disease, complications of spontaneous abortion, ectopic pregnancies	Better to prevent these conditions or detect them early. Without this level of service, women will die.	Cost of diagnosis, medication, and training; getting services to appropriate levels.	Women already demand these services; they can be used as point of entry for general prenatal care. Some services can be done at primary level, others at referral level.
Antimalaria education and prophylaxis to endemic areas	Highly effective if taken regularly. Reduces low birth weight, anemia.	Weekly or monthly regimen for taking tablets throughout pregnancy makes compliance a problem. Only chloroquine is approved for pregnant women; best drug for areas with chloroquine-resistant malaria is controversial.	Low cost. Easy to add to existing antenatal care or other health care that reaches women. No special storage facilities needed. Women more likely to take medicine if assured it will not harm the baby or cause abortion.
Tetanus immunization	Eliminates most deaths from neonatal tetanus. Woman immunized as well.	Pregnant women need two injections at least four weeks apart, the second, at least two weeks before delivery. Toxoid must be kept cold. Some personnel may need special training to give immunizations.	Low cost. Coverage generally lags behind other childhood immunizations. Wider coverage possible if women could be immunized at all health centers.
Food supplementation	Benefit to mother has not been evaluated; benefits of supplementing women during pregnancy only have been evaluated. Increases birth weight 30 to 300 g. Most effective in malnourished women.	Difficult to ensure that pregnant woman does not share the supplement with others or substitute it for usual diet.	High cost. Generally too expensive for large, continuing programs. Works best when locally available, inexpensive foods used and when combined with nutrition education. Having women eat supplement at local distribution site most effective.
Iron/folate supplementation before and during pregnancy	Highly effective if tablets taken regularly.	Gastrointestinal side effects and need to take tablets several times a day make compliance a problem. Hard to motivate asymptomatic women to take tablets.	Low cost. Easy to add to existing antenatal care or other health care that reaches women. No special storage facilities needed.
<i>Referral</i>			
Mothers/ waiting homes	Reduced hospital maternal mortality rates in Nigeria and Cuba; other programs not evaluated.	Women may have to stay several weeks before delivery. Lack of transport to homes. Women more likely to come if they can bring their children. Need to maintain or possibly build homes.	Low cost. Done in at least ten countries. Requires good coordination between community programs and hospital. Food, bedding, and cooking utensils supplied by women's families.

<i>Intervention</i>	<i>Effectiveness</i>	<i>Major drawbacks</i>	<i>Program feasibility</i>
Transportation to hospital for obstetric emergencies	Many deaths from complications may be prevented by getting women to hospitals quickly.	Need to buy and maintain vehicles. Needs constant supply of parts, gasoline, drivers. Road building not planned to meet maternal health needs. Woman may need husband's permission to leave home.	High cost. In many places adequate roads will not be built for years. Innovative communication and transport systems possible where roads are not available.
<i>Delivery</i>			
Regionalization; coordinate TBA, local health center, and specialized facilities <sup>b</sup>	Cost effective	Getting appropriate level of care, especially when unforeseen complications.	Cost depends on existing level of infrastructure. Can be added to any system.
Neonatal care	Detects and treats problems	None	High cost, depending on technology level.
Postpartum care	Most effective way to detect and treat postpartum infections and prevent secondary infertility.	Criteria for referral must be selected. Traditional practices may keep women at home for several weeks after birth. Existing services underutilized.	Low cost. Easy to add to existing antenatal care. Good opportunity to offer family planning. Best when home visits are a real possibility.
<i>Training</i>			
Training TBAs to provide antenatal care, screening, safe delivery	TBA performance improves or remains the same. Effect on maternal complication rates has not been evaluated.	Trainers need special skills and preparation. Supervision and refresher courses needed for TBAs. Delivery kits underutilized.	Moderate cost. Done in many countries. Most effective if community and formally trained health care providers are involved.
Training doctors, nurses, and others	Maternal health outcomes have not been evaluated.	Supervision and refresher courses needed. Degree of training needed that prepares personnel for rural posts. In-service training needs to be offered widely.	Moderate cost. In some countries nurses and nurse-midwives have been trained to perform obstetric surgery.

a. There is insufficient evidence to rate individual components of antenatal care.

b. Herz and Measham plan.

Source: Lettenmeier and others 1988.

complications from unnecessary diagnostic and therapeutic procedures. A misclassification as low risk, however, denies at-risk women access to beneficial services. Some of the systems evaluated classified more than half the women as high risk when the incidence of poor pregnancy outcome was less than 10 percent. These systems for classifying obstetrical risk were evaluated in populations where the average percentage of low-birth-weight infants is 6 percent.

The proportion of false positives and false negatives should decrease in developing countries where the incidence of the adverse outcome increases. For example, in developing countries where the incidence of low birth weight may be two to five times greater than in industrial countries, the predictive value of the screening systems should increase. Conversely, because maternal mortality occurs much less frequently than low birth weight and perinatal mortality, a risk assessment system set up solely to prevent maternal complications will misclassify (false positives and false negatives) a large proportion of women.<sup>4</sup> In order to have a successful maternal and

perinatal health system, based on risk assessment and referral care, improved screening criteria are needed.

Delivery and postpartum care suffer from lack of use for reasons similar to those causing women to ignore prenatal care services. Delivery costs are a special barrier to formal services, which are also often competing against cultural norms favoring home delivery. Postnatal care is by far the least-used service; in 1982 only 5 percent of mothers in Costa Rica made one postpartum visit to a health care center, although nearly 97 percent delivered in hospitals (Lettenmeier and others 1988). In Jamaica only 37 percent of new mothers received postpartum care in 1981 despite the fact that the government there provides it free and locally through mobile clinics (WHO 1985). Various cultural factors cause the lack of demand for postpartum services, not the least of which is the widespread belief that new mothers must stay at home (Lettenmeier and others 1988).

There have also been many problems with programs for training TBAs. For example, the traditional compensation may

be thought inadequate by the newly trained TBA, villagers may believe the attendant is paid through the health care system and not compensate her in the traditional way, and the training may be of limited use without an additional investment in supervision. For best results, the training must be part of a serious attempt to use available resources, not a potentially cheap solution for remote areas.

Emergency care suffers in many places from the lack of roads, reliable vehicles, restrictions on the use of gasoline, and lack of public transportation which would integrate a referral system. Some programs have developed innovative solutions to this problem: one community in rural Somalia has a flag on the road used to signal passersby when a woman needs a ride to the hospital (Lettenmeier and others 1988); Malawi developed bicycle-pulled stretchers; and Zambia gave women expecting complications free tickets for bus transportation (Favin and others 1984). The issue always is whether an emergency, if one arises, can be dealt with quickly enough.

Many prenatal care and delivery interventions have been recommended depending upon local problems and resources. The actual health effect of an intervention, however, depends on several factors: (a) rates of effectiveness, or the ability of an intervention to prevent or treat the problem; (b) accuracy of the diagnostic tests to identify those who would benefit from the intervention; (c) quality of care; (d) patient compliance; (e) coverage—in this case, the proportion of women using the service; and (f) frequency of the health problem. All these factors plus cost and feasibility should be considered by countries planning a system for improving maternal and perinatal health.

### Strategies for Two Standardized Populations

In this section we use two hypothetical populations of one million persons to illustrate maternal and perinatal program strategies and priorities. The populations include a low-mortality country and a high-mortality country. Because of the close interrelationship of resource allocation for fertility control and the management of pregnancy, we present the prevention and case management illustrations in a unified separate section.

#### Low-Mortality Example

The first population, referred to here as Lomort (for low mortality), has already passed through much of the demographic transition. The fertility rate is 2.8, the infant mortality rate is 51 per 1,000 births, the perinatal mortality rate is 35.7 per 1,000 births (because about half of perinatal mortality occurs in the first week of life, about 35 percent of all infant deaths occur in the perinatal period), and life expectancy at birth is 64.4 years. We assume the maternal mortality ratio is about 200 deaths per 100,000 live births (inferred from WHO 1986) and that about 65 percent of women of reproductive age use contraceptives.

**Table 17-10. Women Reporting at Least One Prenatal Visit during Most Recent Pregnancy, Selected Countries**  
(percent)

Country	Urban	Rural	Total
Sri Lanka	97	97	97
Dominican Republic	—	—	95
Liberia	91	77	83
Burundi	96	78	79
Thailand	94	74	77
Brazil	86	51	74
Ecuador	82	58	70
Colombia	83	59	69
Senegal	95	46	63
Guatemala <sup>a</sup>	56	26	34
Morocco	48	13	25

— Data not available.

Note: Based on demographic and health surveys in 1986 and 1987. Covers only pregnancies within five years preceding the survey. Interviewers asked women: "When you were last pregnant, did you see anyone for a check on that pregnancy?" Only those respondents checked by trained health care providers are indicated.

a. Only women checked by a doctor or nurse.

Source: Lettenmeier and others 1988.

Lomort has a reasonably well developed health system, a large proportion of women receive prenatal and delivery care from trained birth attendants, and the average standard of living is moderate. The effect of increasing contraceptive prevalence on maternal mortality in Lomort would be low. Increasing the use of contraception beyond the current level would be prohibitively expensive and the gains are unclear. Therefore, we consider other avenues in Lomort.

In order to bring the maternal mortality ratio down, perhaps to 25 per 100,000 live births, as in urban China, more investment is needed in obstetrical care and perhaps some important social reforms are required as well. China has achieved large reductions in adverse maternal events through its radical one-child policy for population control, higher age at marriage, and better health care for pregnant women. The China example underlines the importance of political will for health achievements at this level of development. China has widely available family planning services and a strong political commitment to maternal health, and it offers continuing education and motivational campaigns using different forms of persuasion (Chen and Kols 1982). Lomort could make substantial gains in maternal health with relative cost efficiency by improving the quality of existing services, focusing on use of the services, and coordinating with other sectors to implement social reforms which promote women's health.

Social reforms in particular can have a large effect on maternal health. Such reforms include legalizing abortion, raising the age of marriage, requiring universal education, and providing welfare to the worst-off, highest-risk groups. Latin American countries have maternal mortality ratios similar to Lomort's, and their revision of abortion policies could poten-

tially save both lives and costs. In the early 1970s in Chile, 3,250 hospital-induced abortions cost \$30,000 during a brief period when abortions were legalized. Researchers calculated a savings of more than \$200,000 above earlier costs for emergency treatment of illegal abortion complications (Weston 1986). Cultural changes are equally important: researchers find that low use of maternal health services is often due to cultural perceptions of women's roles, which block the woman's ability to get care for herself (Leslie and Gupta 1989). There may also be traditional practices which are dangerous, female circumcision, for example, and women's health advocates are calling for national educational campaigns to discourage them.

Lomort's health sector might implement a ten-year, limited effort, safe motherhood program that emphasized health and nutrition education, hiring additional staff to extend community outreach and screening and to improve existing services and increase their use. The program would offer additional training for personnel; provide health and nutrition education campaigns; and examine facilities, emergency systems, and referral networks and renovate them as necessary. The cost estimates for this kind of effort are listed in table 17-11.

On the basis of experience in countries which have implemented similar efforts, we estimate that the program's effect on adverse events could be as much as a 65 percent reduction in maternal mortality and morbidity, a 20 to 25 percent reduction in the number of low-birth-weight babies, and a 35 percent reduction in perinatal mortality over the ten-year period. Table 17-12 contains before-and-after scenarios that use more conservative estimates of the progress which can be achieved. The table provides two sets of calculations for the achievements of a limited effort, in part because current gaps in knowledge keep us from knowing just what can be accomplished. For the lower estimate, we assume that the maternal mortality rate will be reduced by 25 percent, low birth weight will drop in incidence from 8 to 7.5 percent, and the perinatal mortality rate will be reduced by 12.5 percent; for the more optimistic scenario, we assume that maternal mortality will be reduced by 50 percent, the incidence of low birth weight will drop to 7 percent, and the perinatal mortality rate will be reduced by 25 percent. The total cost of the program for a population of one million would be about \$480,000 annually, or about \$0.48 per capita. The estimated cost per death averted (maternal and infant) ranges from \$3,967 to \$1,975, and the estimated cost per adverse event averted ranges from \$1,103 to \$550. Adverse events include deaths, episodes of maternal morbidity, and low-birth-weight babies.

The fertility rate and number of births have been held constant in table 17-12 in order to isolate the effect of improvements in prenatal and obstetric care alone. In reality, one would expect a further decline in fertility if services and community outreach were extended. The number of infant deaths and low-birth-weight babies avoided is much greater than the number of adverse maternal events in spite of the greater percentage of reduction in rates for women. This high-

**Table 17-11. Additional Annual Operating and Capital Costs for Maternal Health and Family Planning in Lomort, a Standardized Population of One Million, in Safe Motherhood Initiative: Limited-Effort Model**  
(U.S. dollars)

Expenditures	Cost
<i>Annual operating costs</i>	
Staff	50,000
Transport	100,000
In-service training and supervision	75,000
Equipment and supplies	75,000
Health education, cultural campaigns	100,000
Monitoring and evaluation	20,000
Contingencies	30,000
<b>Total</b>	<b>450,000</b>
Cost per capita	0.45
<i>Capital costs</i>	
Training	200,000
Construction and upgrading	240,000
Vehicles	160,000
<b>Total</b>	<b>600,000</b>
Capital costs attributable to maternal health <sup>a</sup>	300,000
Annualized capital cost <sup>b</sup>	30,000
Annualized cost per capita	0.03
<i>Total costs<sup>c</sup></i>	
Gross	480,000
Per capita <sup>a</sup>	0.48

a. Assumes half of total capital costs attributable to maternal health.

b. Assumes ten-year depreciation.

c. Annual operating costs plus annualized capital costs.

Source: Herz and Measham 1987.

lights the fact that safe motherhood programs benefit both women and their infants.

### High-Mortality Example

Our second standardized population, Himort (for high mortality), can benefit substantially from relatively small investments in women's health. The ideal maternal and child health program would provide family planning services (including safe abortions, prenatal care, and training of traditional birth attendants and health personnel) and regional referral and emergency transportation systems. As mentioned earlier, efforts to increase female enrollment in schools and improve female nutrition would also contribute to better maternal and perinatal health.

Himort is at an early stage of development. A large area is desert and people are scattered in villages and nomadic settlements. Agriculture is limited and transportation is sparse. Another area is forested and has high humidity and seasonal

**Table 17-12. Current Indicators of Maternal and Child Health in Lomort, a Standardized Population of One Million, in a Limited-Effort Safe Motherhood Program**

Indicator	Before program	With limited-effort program	
		Conservative estimate	Moderate estimate
<i>Demographics</i>			
Population	1,000,000	1,000,000	1,000,000
Contraceptive prevalence (percent) <sup>a</sup>	65	65	65
Fertility rate	2.8	2.8	2.8
Crude birth rate	24.5	24.5	24.5
Births (number)	24,500	24,500	24,500
<i>Morbidity and mortality</i>			
Maternal mortality ratio (deaths per live 100,000 births) <sup>b</sup>	200	150	100
Perinatal mortality rate (deaths per 1,000 births)	35.7	31.2	26.8
Maternal deaths (number)	49	37	25
Maternal morbidity (number) <sup>c</sup>	784	592	400
Perinatal infant deaths (number) <sup>d</sup>	875	766	656
Low-birth-weight babies (number) <sup>e</sup>	1,960	1,838	1,715
<i>Program effectiveness</i>			
Births averted (number)	n.a.	0	0
Maternal deaths averted (number)	n.a.	12	24
Maternal morbidity averted (number)	n.a.	192	384
Perinatal infant deaths averted (number)	n.a.	109	219
Low birth weight averted (number)	n.a.	122	245
<i>Costs (in U.S. dollars)</i>			
Program cost	n.a.	480,000	480,000
Cost per capita	n.a.	0.48	0.48
Cost per death averted	n.a.	3,967	1,975
Cost per event averted	n.a.	1,103	550

n.a. Not applicable.

a. Among females age fifteen to forty-four.

b. Assumes that improved obstetric services result in 25 percent and 50 percent reductions in conservative and moderate estimates, respectively.

c. Number of maternal deaths multiplied by 16. Estimated ratio from Datta and others 1973.

d. Assumes that improved obstetric services result in 12.5 percent and 25 percent reductions in conservative and moderate estimates, respectively.

e. Predicted from regression (see appendix 17A). Assumes a 0.5 percent and 1 percent drop in low-birth-weight incidence in conservative and moderate estimates, respectively, resulting in 6.2 percent and 12.5 percent reductions in the number of low-birth-weight babies.

Source: Herz and Measham 1987.

floods. People crowd together on meager farming plots; communities are often isolated from each other by washed-out roads and unnavigable waterways. Some areas are more favored: conditions there are less harsh, people live in larger communities, health facilities are better developed, and roads are adequate.

Health services are scarce in Himort, with a few exceptions, constrained by inadequate staffing, supervision, and supplies. Family planning is virtually unknown, so there are very few modern contraceptive users except in the capital. Unsafe abortions are relatively common. Most women, about 90 percent, deliver at home; about 70 percent of births are attended by untrained traditional midwives or family members. The few better-off places are served by health centers and a district hospital, but maternal health is not given priority.

Life expectancy at birth is fifty-one years, the infant mortality rate is 129 deaths per 1,000 births and perinatal mortality is 51.6 deaths per 1,000 births (note that the ratio of perinatal mortality to all infant mortality is 0.4, lower than in Lomort because of the higher prevalence of infectious disease and

consequent infant deaths during the first year. This is an extremely conservative estimate of perinatal mortality [Edouard 1985]). Maternal mortality is believed to range from 800 to 1,400 per 100,000 live births in the various regions; health officials estimate a national average of 1,000 deaths. The total fertility rate is 6.9 and the crude birth rate is 49.5 (see table 17-13 for a summary of statistics). Use of modern contraception is low.

The problem facing Himort is how to improve maternal and perinatal health with severe limitations on resources, inadequate facilities, and inadequate transportation. Discussing a hypothetical situation similar to Himort, Herz and Measham (1987) proposed that the choice between "providing a little to many" and "providing more to a few" inadequately represents the dilemma. Little progress can be made in a situation like this without additional investment in community-level care, referral facilities, and transportation. Each region must individually assess its restrictions and needs and may need to plan an appropriate program which differs from those of other regions.

**Table 17-13. Current Indicators of Maternal and Child Health in Himort, a Standardized Population of One Million**

Indicator	Value
<i>Demographics</i>	
Population	1,000,000
Contraceptive prevalence (percent) <sup>a</sup>	0
Fertility rate	6.9
Crude birth rate	49.5
Births (number)	49,500
<i>Morbidity and Mortality</i>	
Maternal mortality ratio (deaths per 1,000 live births)	1,000
Perinatal mortality rate (deaths per 1,000 births)	51.6
Maternal deaths (number)	495
Maternal morbidity (number) <sup>b</sup>	7,920
Perinatal infant deaths (number)	2,554
Low-birth-weight babies (number) <sup>c</sup>	7,425

a. Among females age fifteen to forty-four.

b. Number of maternal deaths multiplied by 16. Estimated ratio from Datta and others 1973.

c. Predicted from regression (see appendix 17A). Represents 15 percent.  
Source: Authors.

Among the options available to Himort are preventive activities as described earlier. In contrast to Lomort, family planning is the most cost-effective preventive activity that could be provided. Addition of some other cost-effective strategies discussed in earlier sections would improve cost-effectiveness, for example, STD screening and treatment. A second option would strengthen prenatal care and train birth attendants for pregnancy management. We begin by illustrating the likely costs and benefits of family planning alone and then discuss the implications of a broader maternal health program.

**FAMILY PLANNING ALONE.** If Himort did nothing to strengthen prenatal and delivery care but did offer family planning services, substantial improvements in maternal and infant health outcomes could result. There are a number of methods of providing family planning services, though social marketing, community-based distribution, postpartum projects, and voluntary sterilization services appear to be among the most cost-effective. Studies show costs in 1980 ranging from \$1 per couple-year of protection for social marketing in Colombia to \$90 for some clinic programs (Sherris and others 1985). A community-based delivery system, using traditional birth attendants and local health personnel, might be a good method for Himort. Such a program in rural Cheju Province in the Republic of Korea between 1976 and 1979, which also included free sterilization, resulted in a 20 percent increase in women who accepted contraceptives and a decline in the total fertility rate of more than 1.5 births in a period of five years, from 1975 to 1980. This program cost \$0.47 annually per capita and \$9.35 per couple-year of protection (Chen and Worth 1982; Park and others 1982).

In table 17-14 we present demographic data and health statistics for three scenarios: increases in the prevalence rate for contraception to 20 percent, 40 percent, and 60 percent, respectively. Through the increase in contraceptive users, fertility rates decline and the number of births is reduced, thereby reducing exposure to pregnancy risk. The maternal mortality ratio is held constant throughout table 17-14, however, emphasizing that unlike the maternal mortality rate, it is unaffected by overall changes in fertility. In spite of the constant maternal mortality ratio, maternal deaths and morbidity drop remarkably. Using the new fertility rates, calculated on the basis of the contraceptive prevalence rates, we have also derived revised rates of low birth weight. Perinatal infant death rates are assumed to drop 5 percent for every 20 percent increase in contraceptive prevalence. The number of low-birth-weight infants and infant deaths declines with reductions in fertility for the following reasons. First, with fewer births there is a smaller risk pool; second, in order to provide family planning services, health personnel increase their contacts with the community, which improves health outcomes; third, part of the demand for family planning results from social improvements, which also improve health.

The success of family planning efforts depends on program quality and acceptability, a strong demand-generation effort, method effectiveness, and consistent availability of supplies. Demand is increased by such changes as increasing the age at marriage, increasing female education, and employment patterns which decrease the value or necessity of children. The demographic changes presented in table 17-14 may occur over several decades. The fertility rate in Thailand fell by almost 40 percent in twenty-five years—one of the most rapid reductions recorded. The crude birth rate was about 44 in the early 1960s (Sherris and others 1985) and fell to 24.5 in 1985 (WHO 1986). The drop in birth rate predicted in the model, from 49.5 to 28.4, is consistent with experience in Thailand but could take many more years, depending on the setting. The assumption for the costs discussed in table 17-14 is that expenses increase exponentially as population coverage goals increase, but ignored in these estimates are adjustment costs, which could occur over long periods and which may be necessary for significant increases in contraceptive use to take place. The data in table 17-14 do show that the cost efficiency of family planning for improving maternal and perinatal health decreases as contraceptive prevalence increases. The cost per death averted ranges from \$806 to \$1,338 to \$2,962 as contraceptive prevalence reaches 20 percent, 40 percent, and 60 percent of couples at risk.<sup>5</sup> Costs per adverse event averted range from \$139 to \$229 to \$505. Adverse events include deaths, episodes of maternal morbidity, and low-birth-weight babies.

**COMPREHENSIVE MATERNAL HEALTH PROGRAM.** In this section two plans are proposed for Himort which go beyond family planning by including various maternal care and structural improvements to the health system. They assume that Himort has adopted the goal of a family planning prevalence rate of 20 percent and that it also undertakes additional reforms in the

**Table 17-14. Effects on Maternal and Child Health of Three Scenarios Based on Contraceptive Prevalence Rates**

Indicator	20 percent prevalence rate	40 percent prevalence rate	60 percent prevalence rate
<i>Demographics</i>			
Fertility rate <sup>a</sup>	5.3	4.3	2.6
Births (number)	41,170	34,183	28,381
<i>Morbidity and mortality</i>			
Maternal mortality ratio (deaths per 100,000 live births)	1,000	1,000	1,000
Perinatal mortality rate (deaths per 1,000 births)	49	46.4	43.9
Maternal deaths (number)	412	342	284
Maternal morbidity (number) <sup>c</sup>	6,592	5,472	4,544
Perinatal infant deaths (number)	2,017	1,586	1,246
Low-birth-weight babies (number) <sup>a,d</sup>	5,764	4,444	3,406
<i>Program effectiveness</i>			
Births averted (number)	8,330	15,317	21,119
Maternal deaths averted (number)	83	153	211
Maternal morbidity averted (number)	1,328	2,448	3,376
Perinatal infant deaths averted (number)	537	968	1,308
Low birth weight averted (number)	1,661	2,981	4,019
<i>Costs (in U.S. dollars)</i>			
Program <sup>e</sup>	500,000	1,500,000	4,500,000
Cost per capita	0.50	1.50	4.50
Cost per death averted	806	1,338	2,962
Cost per event averted	139	229	505

Note: Prevalence rate is percent of women fifteen to forty-four using contraceptives.

a. Predicted from regression (see appendix 17A).

b. Assumes decreases in perinatal mortality rate from the original high of 51.6 through contraceptive prevalence rates of 20 percent, 40 percent, and 60 percent, are 5 percent, 10 percent, and 15 percent, respectively.

c. Maternal deaths times 16. Estimated ratio from Datta and others 1973.

d. Assumes incidence of low birth weight decreases for each 20 percent increase in contraceptive prevalence. With decreases in numbers of births, the result is total decreases in number of low-birth-weight babies of 22 percent, 40 percent, and 54 percent, respectively, for the 20 percent, 40 percent, and 60 percent contraceptive prevalence rates.

e. Longer time periods are needed to achieve higher rates of contraceptive prevalence and are likely to involve costs not included here.

Source: Authors.

area of maternal health care. The limited goal of a 20 percent prevalence rate for contraception was chosen because it is a reasonable accomplishment for a ten-year plan; higher goals would demand a longer time horizon and more resources and would involve much greater uncertainty.

The goals for a comprehensive maternal health program in Himort would differ according to the existing infrastructure, socioeconomy, and ecology of particular subareas. The first effort, a limited one, is most appropriate for the very poor, isolated desert and rain forest areas that make up the bulk of the country. The plan includes resources necessary for a limited prenatal care and birth attendant training program; this effort would be carried out in addition to the family planning effort, aiming for 20 percent prevalence. The second, moderate effort would best be applied in areas that are not as poor, are densely populated, have existing health facilities, including a hospital, and where women use health services more. The moderate plan includes the resources necessary for a moderate prenatal care and birth attendant training program; this is again in addition to the previously mentioned family planning effort. The goals of each effort are described below. We have adapted the program design and cost estimates, developed by Herz and

Measham (1987), who provide a more detailed discussion of these items.

The goals of the limited effort are to reduce the maternal mortality ratio by 20 percent through prenatal and delivery care and trained birth attendants. In addition, we expect the plan to reduce the incidence of low-birth-weight babies to 13 percent (dropping from 14 percent with family planning alone) and perinatal infant mortality by an additional 12.5 percent. These decreases would be the result of reducing the number of high-risk pregnancies and of providing better care to those who become pregnant. The limited plan would include the following elements:

- Upgrading of existing facilities to ensure the availability of maternal health care and the establishment of four more centers (two with cesarean section and surgical family planning capacity)
- Investment in an emergency transportation system, one four-wheel drive vehicle for each new center, so that more women can reach the existing service areas
- Introduction of risk screening and development of plans for at-risk women to deliver in health facilities;

three mobile units equipped with radios and staffed by three health care workers; and maternity villages where those referred to facilities for delivery can await the start of labor

- Strengthening of all community-based services by training all traditional birth attendants and providing them with basic medications, compensation for family planning activities, and radios, so that prenatal and uncomplicated delivery care is readily available
- Coordination of outreach so that facilities and trained personnel are efficiently used
- Conduct of research activities to identify the most effective strategies
- Depending on the community or region, other potential components include training nurse-midwives to enlarge the pool of health workers able to provide blood transfusions, surgical family planning, and cesarean sections; strengthening health services management and giving higher priority to maternal health; and encouraging community groups to become involved in women's health and safe motherhood.

The total cost of the program for a population of one million, including family planning program costs, would be about \$980,000 annually, or about \$0.98 per capita (see table 17-15 for breakdown of costs for the maternal health component alone). The cost per death averted (maternal and infant) is about \$1,303, and the cost per adverse event averted is about \$179.<sup>6</sup> Adverse events include deaths, maternal morbidity, and low-birth-weight babies.

The goals of the moderate effort are to reduce the maternal mortality ratio by 40 percent through prenatal and delivery care, facility development, and training of birth attendants. In addition, we expect the plan to reduce the incidence of low-birth-weight babies to 12 percent (dropping from 14 percent from family planning alone) and perinatal infant mortality by an additional 25 percent. These reductions are more conservative than most cited in the literature. The plan would include the following elements:

- Establishment of a community outreach system for prenatal care, which would provide nutrition advice and pregnancy risk screening, make appropriate referrals, and encourage use of health facilities
- An increase in the number of health posts to one for every 10,000 population, built with community assistance, and the training of all TBAs in outreach and routine care activities
- An increase in the number of health centers by the construction of five new ones in five years, to be used as referral centers for pregnancy complications
- Addition of ten maternity beds to the district hospital and an operating room with the capacity to handle high-risk deliveries, cesarean sections, and surgical contraception
- Training of additional health personnel at each level so that a regional network of services exists with increasingly

**Table 17-15. Additional Annual Operating and Capital Costs for Maternal Health in Himort Safe Motherhood Initiative: Limited-Effort Model**  
(U.S. dollars)

Expenditure	Cost
<i>Annual operating costs</i>	
Staff	150,000
Transport	100,000
In-service training and supervision	50,000
Equipment and supplies	75,000
Health education	25,000
Monitoring and evaluation	20,000
Contingencies	30,000
Total	450,000
Cost per capita <sup>a</sup>	0.45
<i>Capital costs</i>	
Training	100,000
Construction and upgrading	340,000
Vehicles	160,000
Total	600,000
Capital costs attributable to maternal health <sup>b</sup>	300,000
Annualized capital cost <sup>c</sup>	30,000
Annualized cost per capita <sup>a</sup>	0.03
<i>Total costs<sup>d</sup></i>	
Gross	480,000
Per capita <sup>a</sup>	0.48

*Note:*

a. Assumes population of 1 million.

b. Assumes half of total capital costs attributable to maternal health.

c. Assumes ten-year depreciation.

d. Annual operating costs plus annualized capital costs.

Source: Herz and Measham 1987.

complex services offered at health posts, health centers, and the hospital, respectively

- Development of an emergency transport system and training of all personnel for appropriate referrals.

The total cost of the program for a population of one million, including the cost of the family planning program, would be about \$2 million annually, or about \$2 per capita (see table 17-16 for breakdown of costs of maternal health components alone). The cost per death averted (maternal and infant) is about \$1,554, and the cost per adverse event averted is about \$258.<sup>7</sup> In table 17-17 we summarize the effect of and cost information for the family planning effort alone and the family planning effort plus limited and moderate obstetrics programs.

For the limited and moderate obstetrics programs, we assume some community contributions, and both programs are based on assumed correlations between improved prenatal care and birth outcomes. The call for emergency transport systems and care is in recognition of the fallibility of current risk-screening methods and the likelihood that some women will continue to use health services only when there is a problem.

**Table 17-16. Additional Annual Operating and Capital Costs for Maternal Health in Himort Safe Motherhood Initiative: Moderate-Effort Model**  
(U.S. dollars)

Expenditure	Cost
<i>Annual operating costs</i>	
Staff	575,000
Transport	125,000
In-service training and supervision	150,000
Equipment and supplies	300,000
Health education	50,000
Monitoring and evaluation	50,000
Total	1,250,000
Cost per capita <sup>a</sup>	1.25
<i>Capital costs</i>	
Training	800,000
Construction and upgrading	3,600,000
Vehicles	600,000
Total	5,000,000
Capital costs attributable to maternal health <sup>b</sup>	500,000
Annualized capital cost <sup>c</sup>	25,000
Annualized cost per capita <sup>a</sup>	0.25
<i>Total costs<sup>d</sup></i>	
Gross	1,500,000
Per capita <sup>a</sup>	1.50

a. Assumes population of 1 million.

b. Assumes half of capital costs attributable to maternal health.

c. Assumes ten-year depreciation.

d. Annual operating costs plus annualized capital costs.

Source: Herz and Measham 1987.

### Summary of Hypothetical Examples

As the examples illustrate, efforts to improve maternal and perinatal health should involve appropriate combinations of family planning, prenatal care, and obstetric improvements. Health services should also give priority to screening and referral networks and emergency transportation systems. Screening for potential complications is used to direct high-risk women away from home delivery and into adequately staffed and equipped delivery facilities. Emergency transportation systems are also needed for cases in which screening was absent or produced a false negative.

In countries with high fertility, significant reductions in maternal and infant deaths result both from reductions in the number of pregnancies through family planning and from improved maternal care. Where fertility is already low, reductions result almost entirely from improved maternal and perinatal care. Altogether, the investments required for safer motherhood and healthier starts to life are relatively low, and the potential gains are great. Still, the health system must have the capacity to make services available to people in all parts of the country. Extending service coverage is especially critical for those countries whose current budget is allocated largely to the urban centers.

Finally, a word of caution is in order. The calculations presented here depend on heroic assumptions, because reliable data are lacking. We have found virtually no data on the effect of maternal health programs on maternal health, infant mortality, or low birth weight, nor were we able to separate perinatal from neonatal or general infant mortality. There is no clear scientific evidence that a particular component contributes to a specified decline in adverse events. We proposed goals for the hypothetical populations and presented program components without clear evidence of the magnitude of the effect of these measures. In sum, the declines in adverse outcomes that we have suggested are no more than best estimates of the likely effect of the measures proposed based on the limited evidence available from the literature.

### Priorities

Finally, we recommend priorities for resource allocation, and for research.

#### Priorities for Resource Allocation

Maternal mortality, perinatal mortality, high fertility, and low birth weight are all high-priority problems. Technically feasible and affordable methods exist which can significantly reduce the incidence of perinatal and maternal disease and death and increase the prevalence of contraceptive use. Furthermore, investments in family planning and maternal and perinatal health compare favorably with other health investments, such as curative care, that are more costly but have a more limited effect on the population. Indeed, because maternal and perinatal health problems have long been neglected, they should be at the top of the priority list in most countries—especially those in which maternal mortality, neonatal mortality, and low birth weight are high (that is, South Asia and Sub-Saharan Africa).

As the examples set forth in the last section illustrate, the priorities for particular programs that target maternal and perinatal health depend on the demographic situation, particularly the fertility rate and level of contraceptive use, and on ecological and economic factors. When countries are deciding on the balance between maternal health and other health programs, they will find it worth considering that maternal health affects the health of infants, children, and the dependent elderly. The loss of a mother threatens family survival. The choice need not be between maternal health services and other programs; creative health administrators are able to incorporate the needs of women into primary or other health care programs.

The focus in this chapter has been on mortality and morbidity; the other side of the equation, the magnitude and quality of health, has largely been ignored. When safe motherhood programs are implemented, the priority should be to promote good health, not merely to avoid death. Countries should look at the quality of life for newborn children and the quality of life for women both during and after the reproductive period. These priorities will require intersectoral collaboration, strong

**Table 17-17. Estimated Effect of Comprehensive Maternal Health Plan Alone and for Family Planning with Limited and Moderate Obstetrics Program in Himort**

Indicator	Before program	Family planning only	Family planning and limited obstetrics program	Family planning and moderate obstetrics program
<i>Demographics</i>				
Population	1,000,000	1,000,000	1,000,000	1,000,000
Contraceptive prevalence (percent) <sup>a</sup>	0	20	20	20
Fertility rate	6.9	5.3	5.3	5.3
Crude birth rate	49.5	41.17	41.17	41.17
Births (number)	49,500	41,170	41,170	41,170
<i>Morbidity and Mortality</i>				
Maternal mortality ratio (deaths per 100,000 live births)	1,000	1,000	800 <sup>b</sup>	600 <sup>b</sup>
Perinatal mortality rate (deaths per 1,000 births)	51.6	49	47.8 <sup>c</sup>	36.8 <sup>c</sup>
Maternal deaths (number)	495	412	329	247
Maternal morbidity (number)	7,920	6,592	5,264	3,952
Perinatal infant deaths (number)	5,643	2,017	1,968	1,515
Low-birth-weight babies (number)	7,425	5,764	5,352	4,940
<i>Program effectiveness</i>				
Births averted (number)	n.a.	8,330	8,330	8,330
Maternal deaths averted (number)	n.a.	83	166	248
Maternal morbidity averted (number)	n.a.	1,328	2,656	3,968
Perinatal infant deaths averted (number)	n.a.	537	586	1,039
Low birth weight averted (number)	n.a.	1,661	2,073	2,485
<i>Costs (in U.S. dollars)</i>				
Program cost	n.a.	500,000	980,000	2,000,000
Cost per capita	n.a.	0.50	0.98	2.00
Cost per death averted	n.a.	806	1,303	1,554
Cost per event averted	n.a.	139	179	258

n.a. Not applicable.

a. Among females age fifteen to forty-four.

b. Assumes additional decreases of 20 percent and 40 percent for limited and moderate efforts, respectively, over the decreases achieved by family planning alone.

c. Assumes additional decreases of 12.5 percent for limited and moderate efforts, respectively, over the decreases achieved by family planning alone.

Source: Authors' calculations.

political will, and a willingness to recognize the importance and value of women.

Family planning and access to safe abortion as a backup are clearly a priority. Successful family planning programs require a demand for spacing children and limiting family size. Health improvements must be accompanied, therefore, by concomitant efforts to improve female education and women's economic opportunities. Declines in fertility will then make reproductive health care services more affordable.

Access to prenatal and competent obstetric care also merit high priority. The content of these services, their quality, and their use certainly influence their effectiveness. Indeed, merely improving the quality of existing care and increasing the use of existing services could have a substantial effect in many countries. A study in Jamaica concluded that 68 percent of maternal mortality could be prevented through improvements in the quality of care (Walker and others 1986).

Some suggested priorities for prenatal and delivery care follow: screening for high-risk women; tetanus toxoid immunization; iron and folate supplements; malaria prophylaxis in endemic areas; nutrition education and supplements for the most malnourished mothers; testing and treatment for repro-

ductive tract infection and STDs in high-incidence areas; referral of women developing complications during pregnancy to facilities able to provide higher-level care; and encouraging higher-risk women to deliver in hospital. Somewhat lower priorities for prenatal care are education aimed at decreasing alcohol and tobacco abuse; monitoring weight and blood pressure of women during pregnancy; educating for signs of premature labor; screening all women for sexually transmitted diseases and treating identified cases; and performing pelvic examinations to check gynecological anatomy in all women. High priorities for delivery care are providing hygienic delivery kits to birth attendants; training TBAs for delivery emergencies (includes use of oxytocics) and neonatal resuscitation; arranging regional referral systems for skilled obstetrical care and neonatal intensive care. In all countries, health personnel should locate favorable traditional practices and build on these for health promotion.

#### **Priorities for Operational Research**

Maternal and perinatal health are areas that have been severely neglected by researchers. The focus of programs which

have affected the health of women (such as nutrition supplementation) has more often been on infant mortality. We have little evidence of the factors causing mortality rate declines, no measures of the economic effect of death or disability, nor any firm idea of the prevalence or duration of maternal and perinatal illness. There is insufficient information to relate different service components directly with effectiveness and cost. It goes without saying that more field research is needed in this area, and more programs should include an evaluation component.

### Appendix 17A. Regression Equations Used in the Construction of Tables 17-11 through 17-17

Data from *World Development Indicators (1988)* were used to estimate the regressions used for tables 17-11 through 17-17. All equations include gross national product (GNP) to control for societal effects like education, nutrition, and general health status. The fertility rates, rather than crude birth rates, were used as independent variables because they are a better indicator of risks for adverse maternal events. By multiplying the fertility rate and the maternal mortality ratio, one can also derive a maternal mortality rate.

$$\ln(\text{birthrate}) = 4.92 - 0.009 (\% \text{ contraceptive prevalence}) - 0.17 \ln(\text{GNP})$$

(22.84) (4.97) (4.37)

$$\ln(\text{fertility rate}) = 3.63 - 0.0035 (\% \text{ contraceptive prevalence}) - 0.32 \ln(\text{GNP})$$

(21.65) (3.45) (13.24)

$$\ln(\% \text{ low birth wt}) = 3.24 + 0.26 \ln(\text{fertility rate}) - 0.19 \ln(\text{GNP})$$

(4.75) (1.53) (2.71)

### Notes

1. The World Health Organization uses the ratio but calls it a rate.
2. The number of fetal deaths included depends upon the lower limit set for fetal viability. Recently, the World Health Organization has recommended that perinatal statistics for international comparisons be restricted to fetuses and newborn infants with a birth weight of at least 1,000 grams (or, when the birth weight is not available, the gestational age of twenty-eight weeks or crown-to-heel body length of 35 centimeters) for both numerator and denominator for the perinatal mortality rate (Edouard 1985; *Lancet* 1991).
3. Intrauterine growth retardation can be subdivided into "disproportional" or "wasted" IUGR infants, whose length and head circumference are relatively normal for their gestational age but who are thin, with low weight-for-length and skinfold measurements; and "proportional" or "stunted" IUGR infants with proportional reductions in weight, length, and head circumference. The distinction seems to relate to an earlier and more persistent impairment in growth in the stunted group. "Wasted" infants seem to grow faster postnatally, catch up to normal size more rapidly, and have fewer severe cognitive deficits than the "stunted" ones. Unfortunately, large studies comparing the relative incidence of these two forms of IUGR have not been published.
4. The highest maternal mortality ratios are about 8 per 1,000, the highest perinatal mortality is about 100 per 1,000, and the maximum incidence of low birth weight is up to 500 per 1,000.

5. This calculation is very sensitive to the estimated perinatal mortality. If a higher initial estimate for perinatal mortality is used, then the costs per death averted would decrease almost 50 percent.

6. See note 6.

7. See note 6.

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