Nutrition in Pregnancy and Lactation

SIXTH EDITION

Bonnie S. Worthington-Roberts
Sue Rodwell Williams

NUTRITION IN PREGNANCY AND LACTATION

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Preface

Nutritional support of the reproductive process and the role of nutrition in successful breastfeeding continue to be topics of major interest to clinicians and researchers. Ongoing research on these topics has led to changes in clinical practice over the years. The last several years have been particularly exciting, because of increased investigative efforts. These new findings are presented in the sixth edition of *Nutrition in Pregnancy and Lactation,* along with the fundamental information needed for a clear understanding of the subject.

AUDIENCE

Nutrition in Pregnancy and Lactation is written for health professionals in a variety of disciplines that relate to expectant families and to those who will eventually enter reproductive life. Students preparing for careers in maternal and child health will also find this text particularly helpful.

ORGANIZATION

The table of contents has been reorganized in response to users' suggestions. Chapter 1 reviews the status of maternal and child health, both in the United States and abroad. Chapter 2 examines the relation of nutrition and fertility, including the present focus on preconceptional care and counseling. The physiology of pregnancy is covered in Chapter 3, including a detailed discussion of the placenta and its vital nutritional and nonnutritional functions. This is followed, in Chapter 4, by a survey of the development of knowledge about the effect of diet on fetal development.

Chapters 5 and 6 explore, respectively, known and suspected energy and vitamin needs and mineral needs during pregnancy, including (in Chapter 5) expanded coverage of folic acid deficiency and neural tube defects. Chapter 7 discusses other dietary lifestyle components such as drug and alcohol use, which are believed (rightly or wrongly) to adversely affect pregnancy course and outcome.

After the principles of nutritional assessment are established (Chapter 8), the next two chapters cover, respectively, conditions and complications of pregnancy that may require special nutrition counseling, such as phenylketonuria (Chapter 9), and the nutritional challenges facing the pregnant adolescent (Chapter 10).

A key element in these chapters devoted to pregnancy is that they offer suggestions for the skillful application of an understanding of the relationship be-

tween nutrition and pregnancy. Considerable detail is included because the text is intended to provide practical information to be used in a clinical setting.

Moving from pregnancy to lactation, the next three chapters summarize the physiologic basis of lactation as well as economic issues relating to formula vs. human milk feedings (Chapter 11); the composition of human milk and its unique properties (Chapter 12); and practical issues related to the counseling and support of the lactating mother (Chapter 13).

The final chapter, Chapter 14, on nutrition education emphasizes the preparation of today's youth for conception before it occurs. Recommendations are given as to how, when, and where nutrition education efforts should be conducted and the impact those efforts can and do have on maternal and child health in the United States.

CHANGES IN THIS EDITION

Although the changes in the table of contents result in two additional chapters, the total length of the text has not increased appreciably. Instead, material has been reorganized into chapters of similar length, which should make reading assignments easier for the student.

This revision draws attention to recent developments in the area of nutrition and reproduction, and practical recommendations for counseling have been updated to reflect these developments.

Notable aspects of this edition include:

- Case studies, including questions in appropriate chapters that give the student practice in handling day-to-day situations in clinical settings.
- Updated vital statistics, both national and international.
- Evaluation of current weight-gain guidelines for pregnancy, as well as observations about postpartum weight loss.
- Discussion of the debate over the augmentation of nutritional needs associated with adolescent pregnancy.
- Updated management strategies for handling diabetic pregnancies
- Summary of new data on human milk composition.
- Current practical tips on lactation counseling.

ACKNOWLEDGMENTS

We are grateful to the many people who gave us their personal opinions about the book and its features. We hope that they will find this new edition a satisfactory reference or text for either professional or academic use.

The following reviewers provided many worthwhile ideas, which are reflected in the sixth edition of *Nutrition in Pregnancy and Lactation:* Joyce P. Barnett, University of Texas; Bahram Faraji, California State University/Los Angeles; Kristy Hendricks, Boston University; and Charlotte Pratt, Eastern Michigan State University.

Bonnie S. Worthington-Roberts
Sue Rodwell Williams

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CHAPTER

1

Promotion of Maternal and Infant Health

Bonnie S. Worthington-Roberts

After completing this chapter, the student will be able to:

- ✓ *Define major indices of maternal and infant health.*
- ✓ *Describe the factors that increase risk of low birth weight.*
- ✓ *Discuss characteristics that increase a mother's risk of poor pregnancy outcome.*
- ✓ *List appropriate goals for the improvement in maternal and infant health in both developed and developing countries.*

Introduction

Of all periods in the life cycle, pregnancy is one of the most critical and is unique. When a woman becomes pregnant, all the experiences of her past join with those of the present to lay the foundations of a new life whose potential, in turn, will influence the welfare of generations to come. The critical place that pregnancy occupies in the chain of life has health and social importance for individuals, families, and society as a whole.

The unique nature of pregnancy lies in the fact that at no other time does the well-being of one individual so directly depend on the well-being of another. During the gestational period the mother and child have an intimate and inseparable relationship. The physical and mental health of the mother before and during her pregnancy has profound effects on the status of her infant in utero and at birth. It is only through efforts directed at the mother that advantages can be provided to ensure that her infant will be born well.

The vulnerability and dependence of the infant and the intergenerational significance of pregnancy in the life cycle have led all societies throughout history to recognize the special needs of pregnant women and to make provisions for their care. In a modern world the goal is no longer simply to produce a living infant from a living mother. As society struggles with problems of overpopulation and scarce resources, we are increasingly faced with the moral and social responsibility to make sure that every

woman who chooses to conceive has the opportunity for a safe and successful pregnancy and the ability to deliver and care for an infant whose maximum physical and mental potential is not impaired.

Births[1]

The number of births in the United States has declined each year since 1990. A peak was reached in this year following a gradual rise since 1975. The number of births reached an all-time high in 1961, at the height of the "baby boom."

Year	Number of births
1961	4,268,326
1990	4,158,212
1992	4,065,014
1993	4,039,000 (provisional)

In 1993, the *birth rate* (number of live births per 1,000 population) decreased to 15.7 and the *fertility rate* (number of live births per 1,000 women between the ages of 15 and 44 years) declined to 68.3. Both of these rates are still higher than those that prevailed throughout most of the 1980s.

The decline in births appears to be a result of a combination of a fall in the fertility rate and a declining number of women in childbearing years. A further decrease in the number of births is expected, since it is estimated that there should be a slight decline in the number of women in their childbearing years during the mid-1990s.

Geographic differences are seen in birth rate. Consistent with the national picture, the number of births declined in 38 states and Washington, D.C. but increased in 12 states. Birth rates declined in 44 states and Washington, D.C. and rose in five states, remaining unchanged in one. The highest rates were Utah (19.6), the perennial leader, followed by California (18.9), Texas (18.3), and Arizona (18.0). Lowest were Maine (12.1), West Virginia (12.1), and Vermont (12.6).

Regarding age of the mother, a turning point was reached in 1992 for teenage pregnancies (Table 1-1). From 1986 to 1991, birth rates for women age 15 to 17 increased by 27% but declined 2% in 1992. However, the 1991 and 1992 rates were still higher than in any year since 1973.

TABLE 1-1 Birth Rates for Young Mothers (Age 15-19), Selected Years, by Race, 1992

Group	Birth Rate
All races	
1970	68.3
1980	53.0
1985	51.0
1990	59.9
1992	60.7
Race, 1992	
White	51.8
Black	112.4
American Indian	84.4
Asian/Pacific Islander	26.6
Hispanic origin - 1992	
All Hispanic	107.11
Mexican	108.8
Puerto Rican	110.4
Cuban	26.3
Other Hispanic	112.1
Non-Hispanic White	41.7
Non-Hispanic Black	116.0

From National Center for Health Statistics: *Vital statistics of the United States, 1992*, Hyattsville, Md, 1994, US Department of Health and Human Services.

The decline was more marked among black mothers than white; the rates for blacks continue to be substantially higher than for whites.

The leveling off of the sharp rate of increase in teenage childbearing during the 1980s may reflect a similar leveling off since 1988 in the proportion of teenagers who are sexually active, especially among the younger teenagers. In addition, other data suggest that sexually active teenagers are more likely to be using some contraception regularly. Also, according to recently published data, it appears that abortions among teenagers have also declined in recent years. Thus the decline in teenage birth rates in 1992 would indicate that the teenage pregnancy rate has declined as well, following increases from the mid-to-late 1980s.

Births to the very young are always a matter of concern. In 1992, seven "women" younger than age 15, five white, one black, and one American Indian, had their fourth child.

At the upper end of the age spectrum, rates have continued to increase, but somewhat slower than in the past decade. Related to this is the observation that in 1992, one in every five women was childless, a sharp rise from the levels of the 1970s, when the childless proportion was one in nine. In 1992, 49% of women age 30 to 49 who were having a first child were college graduates; of women in this age group in the general population, only 24% were college graduates.

There is considerable variation by race and Hispanic origin (i.e., may be of any race). The fertility rate for black mothers was higher than that for white mothers. In general, those of Hispanic origin had higher birth and fertility rates than any non-Hispanic category. Of Hispanics, the highest rates were among those of Mexican origin and the lowest among those of Cuban origin.

Births to unmarried mothers have not increased in recent years. There is a racial difference, however, with an increase among white unmarried women and further decrease among black. In 1980 the birth rate to unmarried black women was 4.5 times the rate of whites; in 1992 it was 2.5 times.

INDEXES OF MATERNAL AND INFANT HEALTH

The goal of prenatal care is so important that the extent to which it is achieved is often used as a measure of social and economic development among nations throughout the world. International comparisons of maternal and infant health statistics reveal that promoting the health of mothers and infants requires solutions to problems that still affect a sizable proportion of the population. Much of this book focuses on the contribution that nutrition can make toward solving these problems. The importance of nutrition to the course and outcome of pregnancy can be better appreciated when the incidence of reproductive casualties and factors associated with them are understood (see box above)

WHAT INFANT MORTALITY TELLS US

"Infant mortality is the most sensitive index we possess of social welfare and sanitary administration."

A. Newsholme, 1910

To what extent and through what mediating channels do social and economic conditions (as reflected by parental education, income, housing, occupation) affect infant and perinatal mortality? How much of this effect is related to the type and quality of care received, its availability and accessibility and the ability to utilize it? How much of the effect is an outcome of the mother's earlier growth experience in an underprivileged environment, manifested at conception as a reduced capacity to bear healthy children?

From Yankauer A: What infant mortality tells us, *Am J Public Health* 80:653, 1990.

Maternal Mortality and Morbidity

At the turn of the century childbearing was one of the leading causes of mortality among women in all countries of the world. It is still a major cause of death in developing countries[32] (Table 1-2 and Table 1-3), and statistics show that, even in places like the United States, an unacceptable number of women continue to have problems.[10,20,31,32,37]

In 1992, 318 women in the United States were reported to have died of maternal causes (Table 1-2). This number does not include all deaths occurring to pregnant women; rather, it includes those deaths assigned to complications of pregnancy, childbirth, and the puerperium (90 days following birth). The maternal mortality rate for 1992 was 7.8 deaths per 100,000 live births.

Black women have a higher rate of maternal death than white women. In 1992 the maternal mortality rate for black women was 20.8, 4.2 times the rate of 5.0 for white women (Table 1-2). However, this is an improvement over previous years (Fig. 1-1).

TABLE 1-2 ***Maternal Mortality in Selected Areas of the World***

Area	Year(s)	Maternal Mortality/ 100,000 Live Births
Africa	1985-1987	640
Asia	1985-1987	420
Latin America	1985-1987	270
Northern and Middle Europe	1985-1987	10
United States (All races)	1992	7.8
White		5.0
All other		18.2
Black		20.8

From Report on confidential enquiries into maternal deaths in the United Kingdom, 1985-1987; and Centers for Disease Control and Prevention: Monthly vital statistics report. Report on final mortality statistics, 1992, March 22, 1995: Public Health Service.

Poverty is known to be directly related to both maternal and infant mortality. The poverty rate for whites was 11.7% in 1994; for blacks and Hispanics, it was 30.6% in the same year. This racial difference is reflected in poverty rates by state; the highest poverty rate was recorded in Louisiana (25.7%); other states with high rates of poverty are Washington, D.C. (21.2%), New Mexico (21.1%), Texas (19.1%) and West Virginia (18.6%). The lowest rate of poverty was reported in Vermont (7.6%).[26]

Maternal deaths are most often a result of complications of the puerperium, other direct obstetric causes, pregnancy with abortive outcome, **ectopic pregnancy** and **preeclampsia/eclampsia** (Table 1-4). Most health authorities believe that at least some of these deaths are from preventable conditions whose incidence can be reduced through early and high-quality prenatal care.

The characteristics of women dying from maternal causes differ from those of women dying from nonmaternal causes. Overall, women dying

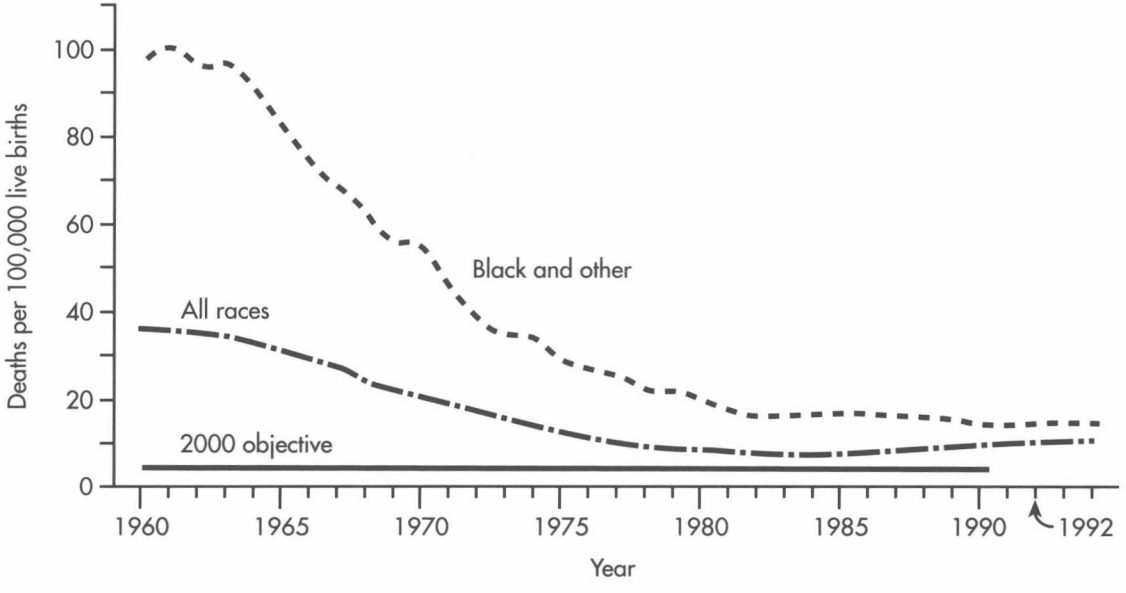

FIG. 1-1 Maternal mortality rates, by race, United States, 1960-1992.

From Centers for Disease Control: Maternal mortality; pilot surveillance in seven states, *JAMA* 255:184, 1986, and National Center for Health Statistics: *Vital statistics of the United States 1992,* Hyattsville, Md, 1995, Department of Health and Human Services.

TABLE 1-3 Causes of Maternal Mortality in Selected Parts of the World

Location	Year of Report	Data Source	Findings
Addis Ababa, Ethiopia	1986	Community survey	45 pregnancy-related deaths over 2 years among 9,315 pregnancies (rate: 566 per 100,000 live births); 54% of deaths from illegal abortion complications
Lagos, Nigeria	1977	Hospitals	51% of maternal deaths from abortion complications
60 developing countries	1980	Survey	Approximately 207 induced abortions per 1,000 live births; estimated total of 70,000 to 100,000 maternal deaths per year from abortion-related complications
Harare, Zimbabwe	1985	Harare Maternity Hospital	15% of all pregnancies end in incomplete or induced abortion
Lusaka, Zambia	1983	University teaching hospital	26% of 27 maternal deaths from induced abortion and ectopic pregnancy; 12,096 patients admitted with diagnosis of "spontaneous" abortion
Nairobi, Kenya	1982	Kenyatta National Hospital	Abortion-related complications accounted for 60% of acute gynecologic beds; 50 to 60 patients with induced abortions admitted daily in 1988 (about 20,000 per year in 1988 compared with 2,000 to 3,000 in mid-1970s)
Durban, South Africa	1984	King Edward III Hospital	19% of all maternal deaths from abortion
Bangladesh	1981	63 hospitals, 732 non-hospital facilities	1933 pregnancy-related deaths in 1978-1979, 26% abortion-related; overall estimate 500 to 600 deaths/100,000 live births resulting in estimate of 21,600 maternal deaths annually
Gambia	1987	Rural study	2,000 maternal deaths per 100,000 live births noted; postpartum hemorrhage and infection are leading causes
Zaria, Nigeria	1985	Urban hospital	219 maternal deaths among 7,654 women seen first time in labor vs. 19 deaths among 15,000 who had prenatal care

From Rosenfield A: Maternal mortality in developing countries, *JAMA* 262:376, 1989.

from maternal causes are older, more likely to be black, and more likely to be married than those dying from nonmaternal causes. The impact of maternal age and race on maternal mortality is illustrated in Fig. 1-2. Data from the Maternal Mortality Collaborative Study indicated that maternal mortality increased with age.[23] The maternal mortality ratio for women over 30 was 2.5 times greater than that for younger women.[31] Women are waiting longer to begin their reproductive experience (Table 1-5), therefore this observation is some cause for concern.

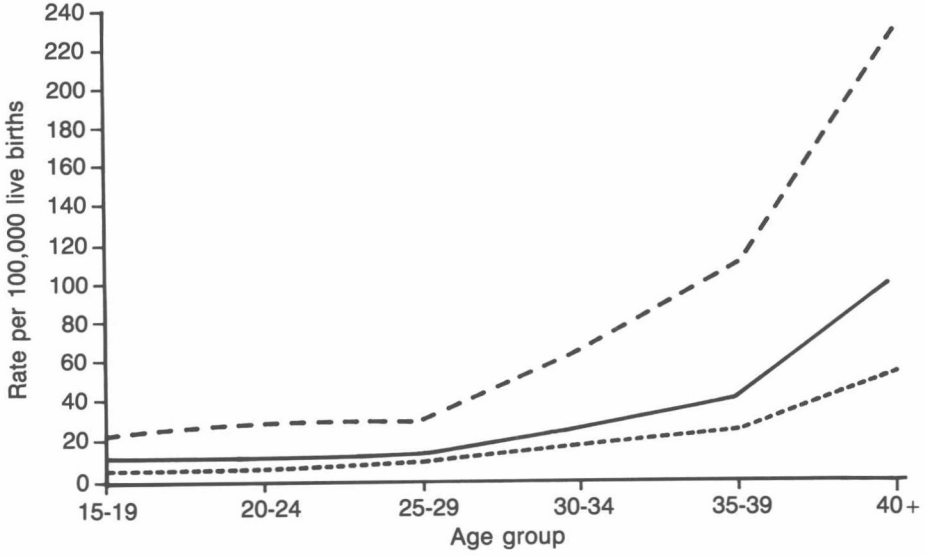

FIG. 1-2 Maternal mortality rates by age and race, Maternal Mortality Collaborative, United States, 1980-1985. Dashed line = black and other; solid line = total; dotted line = white.
From Rochat RW et al: Maternal mortality in the United States, *Obstet Gynecol* 72:91, 1988.

TABLE 1-4 Maternal Mortality Rates by Selected Causes, United States, 1992

Causes of Death	Rate/100,000 Live Births	Causes of Death	Rate/100,000 Live Births
Pregnancy with abortive outcome	1.3	Preeclampsia/eclampsia	2.3
Direct obstetric causes	6.1	Obstructed labor	—
Hemorrhage of pregnancy and childbirth	1.0	Complications of the puerperium	2.3
		Other direct obstetric causes	2.5

From National Center for Health Statistics. *Vital statistics of the United States, 1992,* Hyattsville, Md, 1995, US Department of Health and Human Services.

Also relevant is a report of maternal mortality in the state of Massachusetts.[33] To identify ways in which the safety of childbirth might be increased, the causes of death among 886 women who died during pregnancy or within 90 days **postpartum** were evaluated from records available from 1954 through 1985. The maternal mortality rate declined from 50 per 100,000 live births in the early 1950s to the rate of 7 per 100,000 live births in 1984 and 1985. Between one third and one half of the maternal deaths were considered to be preventable. The leading causes of maternal death from 1954 through 1957 were infection, cardiac disease, pregnancy-associated hypertension, and hemorrhage. In contrast, from 1982 through 1988 the leading causes of death were trauma (suicide, homicide, and motor vehicle accidents) and pulmonary **embolus.**

An important observation in the Massachusetts study[33] was the rapid increase in the frequency of death among women who received