

NUTRITION

in pregnancy and lactation

SECOND EDITION



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NUTRITION

in pregnancy and lactation

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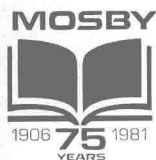


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3. Nutrition - in pregnancy
4. Prenatal care

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SECOND EDITION

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Preface

The purpose of this book is to provide in concise format basic information on nutritional considerations as they relate to pregnancy, lactation, and the periods before and between development of these special physiological conditions. It is our intention to direct this presentation to health professionals in a variety of disciplines who relate in their clinical activities to expectant families and to children of all ages who eventually will enter reproductive life. Because it is our wish to provide information that is practical for application in a variety of clinical settings, an effort has been made to approach all topics with the major goal of providing useful information accompanied by *essential* supportive research data. Consequently, detailed literature reviews have been replaced by concise summaries of major research findings in significant areas.

The topics selected for discussion in this book are presented in what we believe is the most logical sequence. After preliminary review of the status of maternal health in the United States, the subject of nutrition and pregnancy is discussed in a series of chapters. The role of nutrition in determining pregnancy outcome is first reviewed, and this is followed by a careful consideration of the physiology of pregnancy as it relates specifically to nutritional requirements and diet. The subsequent chapter attempts to provide practical recommendations about how our knowledge of the relationship between nutri-

tion and pregnancy can be applied skillfully and sensibly in the clinical setting. Considerable detail is included in this area, since the focus of this text is to provide *applicable* information for exemplary clinical work. The remaining two chapters related to pregnancy include explanations of the special conditions of pregnancy that elicit concern and may require special nutritional counseling. Included in these discussions are the problems of anemia, toxemia, diabetes mellitus, heart disease, pulmonary disease, maternal phenylketonuria, and adolescent pregnancy.

The remaining topics considered in this book include lactation, family planning, and a generalized discussion of nutrition education as it relates to the preparation of today's youth for the experience of reproductive life. Lactation is considered in two parts, with the first summarizing the physiological basis of the process and the nutritional support required to maintain milk production and maternal health. The second part considers in depth the practical issues of concern during lactation and specifies for the health professional how greatest assistance and support can be provided to lactating mothers. The chapter on family planning attempts to define the interrelationships between nutrition and family planning in underdeveloped as well as in developed societies; the known effects of oral contraceptives on nutritional status are also discussed at this time. The final chapter presents a strong case for preparing today's

youth for the reproductive experience long before pregnancy is ever considered. Recommendations are provided as to how, when, and where this should be done and what the ultimate benefits to maternal and child health in the United States might be.

This second edition contains a number of revisions, particularly in relation to lactation, family planning, and nutrition education. The vast amount of research and interest in breast-feeding that has developed during the past 5 years is reflected in a number of new publications, the data of which are summarized in the lactation chapters. New information about nutrition and oral contraceptives is also included along with revised comments about other nutrition issues in the family planning area. Finally, extensive reworking of the final chapter has resulted in a systematic treatment of the issues in nutrition education that are vital to maternal and

child health clinicians and educators. The added tables and figures should assist professionals in defining priorities, goals, and methods of managing challenges in this field.

In summary, then, a sincere effort has been made to construct for the health professional a useful textbook related to nutritional support of women during pregnancy and lactation. Consideration of the interconceptional period is also provided, and emphasis is placed on the importance of "quality" nutrition education in preparing for the reproductive period. It is hoped this book provides under one cover all significant nutrition information pertinent to health professionals involved in clinical management of "mamas" and "babies."

Bonnie S. Worthington-Roberts
Joyce Vermeersch
Sue Rodwell Williams

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Promotion of maternal and infant health

Joyce Vermeersch

GOAL OF PRENATAL CARE

Of all periods in the life cycle, pregnancy is one of the most critical and 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 is the well-being of one individual so directly dependent 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 have profound effects on the status of her infant in utero and at birth. It is only through efforts directed at the mother herself that advantages can be provided to assure that her infant will be well born.

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.

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 will focus 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.

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, and the statistics show that, even in places like the United States, an unacceptable number of women continue to have problems.

The maternal mortality rate expresses the number of all women who die of conditions related to pregnancy during the gestational period, labor and birth, and the puerperium (i.e., 90 days following birth) in a given year over the number of infants born alive in that same year. In spite of a dramatic drop in maternal mortality since 1900, the rate in the United States was still 12.3 per 100,000 live births in 1976.

Maternal deaths are most frequently a result of the toxemias of pregnancy, abortion, hemorrhage, and infection. Most health authorities believe that these are preventable conditions whose incidence can be reduced through early and continued high quality prenatal care.

Fetal and infant death and disability

For purposes of presenting vital statistics, prenatal and infant life are usually divided

into developmental stages. These help to identify the periods when the developing child is particularly at risk. The stages are diagrammed in Fig. 1-1.

The 40 weeks of gestation from conception to birth are separated into two 20-week parts. These are termed the early fetal period and the late fetal period, respectively.

Infancy includes the time from birth to 1 year of age. The first 28 days of infant life are called the neonatal period. The postneonatal period extends from 28 days of age to the infant's first birthday.

Recently another period has been adopted to recognize that fetal and infant life are parts of an inseparable continuum. This is the perinatal period, which includes the two periods—late fetal and neonatal—that immediately surround birth.

Deaths in the early fetal period are difficult to estimate because loss may occur before the mother realizes that she is pregnant. Consequently, the statistic most often reported is for deaths in the late fetal period. This is called the fetal death ratio or sometimes the stillbirth ratio. In 1976 fetal deaths in the United States were 10.5 per 1000 live births.

Compared with other developed countries, the United States occupies an inferior position with respect to the number of babies

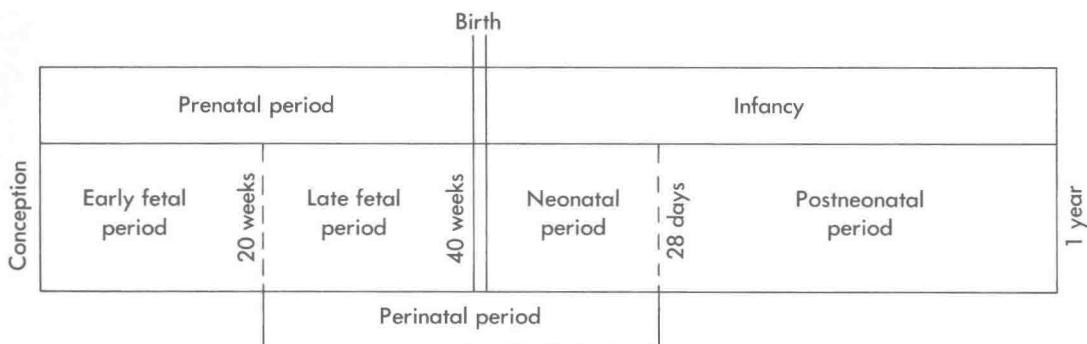


Fig. 1-1. Periods of prenatal and infant life. (Modified from Wilner, D. M., Walkley, R. P., and Goerke, L. S.: Introduction to public health, ed. 6, New York, 1973, The Macmillan Co.)

who die in their first year of life. Although the infant mortality rate has been steadily declining and is presently at an all-time low, 15.2 deaths per 1000 live births occurred in 1976. This is approximately the rate that Sweden had 15 years ago. Furthermore, over the past 25 years, several countries have experienced more rapid declines in infant mortality than the United States and have overtaken it in international rankings. In 1950 the United States had the sixth lowest infant mortality rate in the world; by 1972 it ranked at the bottom of a list of 16 countries with

vital records of sufficient quality to allow international comparisons to be made. Thus, in spite of its wealth and sophisticated systems of health care, the United States has yet to discover the means of assuring the survival of its youngest citizens. It has been suggested that if the United States had an infant mortality rate similar to that of Sweden in 1967, nearly 40,000 infant deaths could have been prevented in that year alone.⁵

Some clues to the problem are gained by looking more closely at when and how these infants die. By far, the largest number die

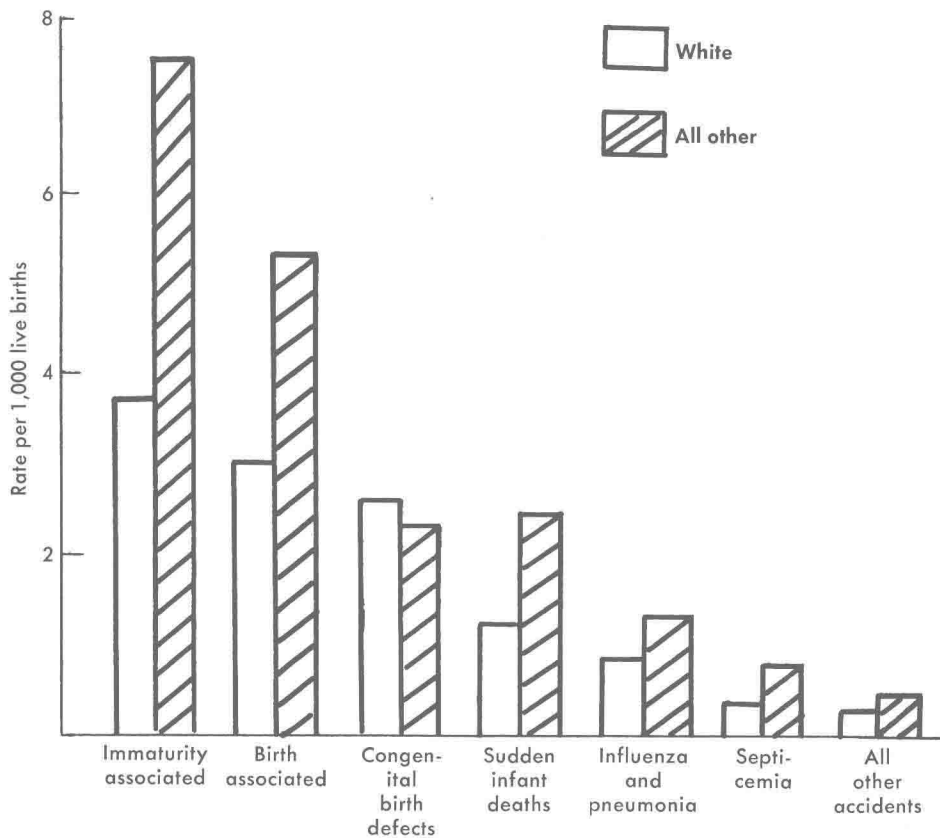


Fig. 1-2. Major causes of infant mortality: United States, 1976. (From *Healthy people*, the Surgeon General's report on health promotion and disease prevention, DHEW Pub. No. [PHS] 79-55071. Washington, D.C., 1979, U.S. Government Printing Office.)

4 Nutrition in pregnancy and lactation

within the first 28 days of life. Neonatal deaths in the United States were 10.9 per 1000 live births in 1976 compared with 4.3 in the postneonatal period.

Postneonatal deaths are related to conditions in the infant's *immediate environment*. Rates are particularly high in poor countries without safe and hygienic conditions in the hospital and in the home. Neonatal deaths are more often associated with *prenatal* factors. The relatively high infant mortality rate in the United States can therefore be traced to conditions that influence or are concurrent with the mother's state during pregnancy. To emphasize this point, it has been noted that of all infant deaths in the United States in a given year about 65% occur in the first 5 days of life, before most infants even leave the hospital and in spite of the intensive care which modern hospitals are able to provide.⁶ The greatest proportion of infant deaths is caused by conditions associated with immaturity. Other causes include birth injuries, congenital defects, accidents, and infection. The conditions most often responsible are shown in Fig. 1-2.

High rate of early infant death is the worst possible outcome of pregnancy, but the casualties of reproduction also include the thousands of children who are impaired but do not die. These children suffer from the same conditions that cause death in their most severe forms, as well as disorders such as cerebral palsy, epilepsy, and mental retardation. Still more have physical handicaps and developmental disabilities that may be prenatal in origin but may not be detected until later in life.

RISKS OF LOW BIRTH WEIGHT

Infants who weigh less than 2500 gm (5½ lb) represent about 7% of all live births in the United States each year. Although the word *premature* is sometimes used to describe these infants, the term is confusing be-

cause low birth weight infants are really of two different types. There are those who are born too small because they are born too soon, and there are those who are born on time but are too small for their gestational age. To avoid confusion, the word *preterm* is used for infants born under 37 weeks' gestation; full-term but underweight infants are called *growth retarded* or *small-for-date*.

The risks for preterm and growth-retarded infants are so well documented that low birth weight itself is considered an unfavorable outcome of pregnancy. For example, deaths of low birth weight infants in the neonatal period are 30 times more frequent than deaths of newborns of normal weight.

Bergner and Susser² examined the records of infants born in New York City between 1958 and 1961 and found that perinatal mortality varied to a much greater extent with birth weight than with the length of gestation. It is now widely held that if the birth weight distribution could be improved, this alone would produce a substantial reduction in infant mortality.

A number of studies have also shown an increased incidence of handicapping conditions among infants who have the misfortune of being born too small. Low birth weight is a known etiological factor in cerebral palsy,^{10,15} and it has been implicated in epilepsy and various forms of mental retardation as well.^{9,18,25} There is also evidence that, as a group, children who were extremely undersized at birth have more frequent hospitalizations for illness,¹³ more visual and hearing disabilities,^{13,19} more behavioral disorders,^{21,27} and more learning problems when they enter school.^{7,8}

EPIDEMIOLOGICAL FACTORS

If progress is to be made in the prevention of death and disability associated with reproduction, specific factors that place women and their infants at risk must be determined.

Much has been learned about predisposing conditions by studying the distribution of reproductive casualties among population groups. Epidemiological investigations of this type have revealed the influences of age, parity, past obstetrical performance, race, and social class on the course and outcome of pregnancy.

Age

It has become axiomatic that the age of the mother is a determinant of her reproductive efficiency. Very young mothers do not have the physiological maturity to withstand the additional stresses of pregnancy. At the other end of the spectrum, older women are beginning to show the effects of the aging process. Consequently, the pattern of reproductive loss by age is a U-shaped curve, with mortality elevated in those below 15 and over 35 years of age. Mothers who are between 20 and 29 years of age have the best performance and outcome of pregnancy.

Age of the mother is also related to age-specific death rates and causes of death in the offspring. Young mothers have the highest number of infants who die in the neonatal period, and more deaths are caused by infection, parasitic disease, and unqualified immaturity or low birth weight. Older mothers experience a greater incidence of fetal loss. Their babies more frequently die of congenital malformations, birth injuries, and hemolytic disease.

Parity

Women frequently experience difficulty with their first pregnancies. First pregnancies are more often complicated by toxemia and by problems of labor and delivery. First-born infants also show higher rates of mortality and morbidity, but in the opinion of some investigators this may be a result of sociological rather than physiological factors. A national study of infant mortality con-

ducted by the United States Center for Health Statistics found the *lowest* mortality among first-born infants. Infants who ranked sixth or more in birth order had the highest mortality, and no consistent trend was observed for birth orders two through five. The investigators speculate that their data may differ from previous studies because their sample contained only infants of married mothers. Infants born to unwed mothers are known to have high mortality, and they are usually disproportionately represented among the first-born infants.¹⁶

Some of these effects may also result from associations between age of the mother and the incidence of low birth weight. By studying the distribution of low birth weights in the United States from 1969 to 1975, Querec and Spratley²² found the highest rate of low birth weight for first-born infants of mothers over 35 years of age. For these mothers, the rate of low birth weights decreased through their fourth pregnancies. Mothers between 15 and 25 years of age exhibited just the opposite trend. The lowest rate of low birth weights at this age span occurred among the first born. Regardless of maternal age, however, the risk of low birth weight increased with five pregnancies or more. This is evidence that birth order itself exerts an independent effect on reproductive performance.

These risks of high parity are further increased when the pregnancies are closely spaced. Perinatal mortality and morbidity are both greater among high birth order infants of mothers whose pregnancies have come in rapid succession.

Past obstetrical performance

Poor performance in a prior pregnancy increases the chance of problems in subsequent ones. As long ago as 1939, Gardiner and Yerushalmy¹² noted a tendency for women who experienced specific reproductive losses to repeat them.

More recently, data from the National Infant Mortality Survey (1964-1966) and the National Natality Survey (1965) showed that 5.4% of mothers of single, live-born infants reported previous infant deaths. Infant mortality is two and one-half times greater among the infants of mothers who had a previous infant death than among mothers whose earlier pregnancies all had favorable outcomes. The same tendencies were noted for mothers who had experienced previous fetal loss.¹⁶

The chance of having a low birth weight infant is also greater when past pregnancy performance is poor. Querec and Spratley²² report that the proportion of low birth weight infants is about one-third greater among women whose previous pregnancies ended in fetal deaths. This proportion increased when the low birth weight infant followed the fetal death by less than 1 year.

These and other studies imply that reproductive casualties are not merely chance occurrences. History *does* repeat itself, suggesting that there are underlying circumstances that place some women at the continual risk of developing problems each time they are pregnant.

Race

Maternal and perinatal mortality and morbidity rates are two to three times higher among nonwhites compared with whites in the United States. Fig. 1-3 shows the difference in infant mortality between whites and nonwhites that has persisted over the last 50 years.

It is difficult to determine how much of the difference in mortality and morbidity is truly racial in origin or the result of socioeconomic circumstances. As a group, racial minorities in the United States have always had the least favored position with respect to income, education, and occupation. They also traditionally have been denied access to general

medical and prenatal care. In addition, non-white women are overrepresented in some of the categories that impose pregnancy risk. More nonwhite women have babies at an early age, and more continue to have their sixth, seventh, or eighth child after they are 35 years old.

There is also a distinct birth weight variation according to race. Compared with the 7% incidence for the United States as a whole, the rate of low birth weight for black infants is 12%; the rate for whites is about 5% while that for other nonwhites is approximately 6.5%. Although some researchers have failed to find significant socioeconomic explanations, there is evidence that lower birth weights among nonwhite infants may not be a totally genetic phenomenon.

Williams has recently studied intrauterine growth curves among four major ethnic groups in California. Intrauterine growth curves express the relationship between median birth weights and the stage of gestation. Their construction is based on the assumption that the weights of babies born at each stage of gestation are representative of all babies both in and out of the uterus. Williams' analysis of over 1.5 million births in California from 1966 to 1970 showed that at 26 weeks' gestation black and white-Spanish infants are actually heavier than non-Spanish whites and Orientals. Beginning at about 35 or 36 weeks' gestation, however, their growth slows so that by term they have lost their initial advantage and weigh considerably less than non-Spanish whites.²⁸

Bergner and Susser¹ found essentially the same pattern for black infants in New York City—that is, they are born heavier than whites up to 28 to 30 weeks' gestation and are born lighter thereafter.

These studies lead to the speculation that genetic potential is not responsible for the higher incidence of low birth weight among certain ethnic groups. Instead, it is possible

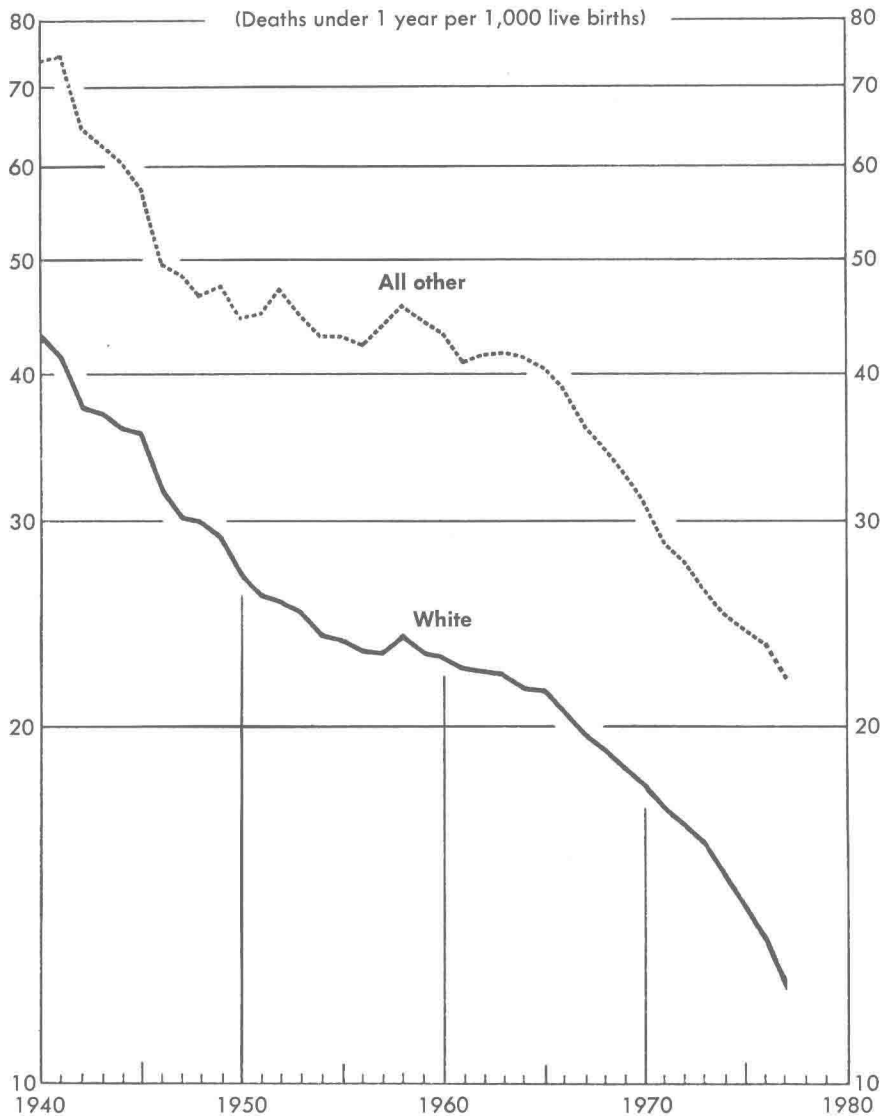


Fig. 1-3. Infant mortality rates by color: United States, 1940-1977. (From National Center for Health Statistics, Monthly Vital Statistics Report.)

that the variations that are observed may be at least partly due to fetal growth retardation in the last trimester of pregnancy. If this retardation could be modified, perinatal loss among nonwhite infants might be substantially reduced.

Social class

Social class in Western countries is usually determined by income, occupation, and education. According to government estimates, 750,000 infants in the United States are born each year to families whose incomes fall be-

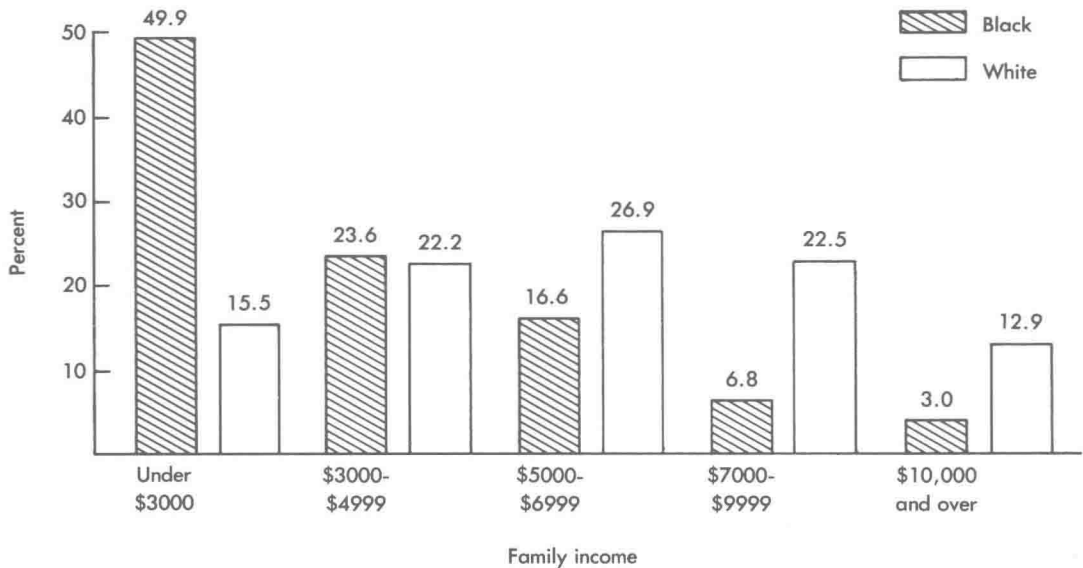


Fig. 1-4. Percent of legitimate live births by family income and race, United States National Natality and Infant Mortality Surveys, 1964-1966. (From MacMahon, B., Kovar, M. G., and Feldman, J. J.: *Infant mortality rates: socio-economic factors*, DHEW Pub. No. [HSM] 72-1045. March, 1972, Rockville, Md., National Center for Health Statistics.)

low the poverty line. As shown in Fig. 1-4, nonwhite infants have a much greater chance of being born poor. The National Natality and Infant Mortality Surveys found that whereas only one sixth of the white births in their sample were in the lowest income category, nearly one half of the black babies were born to families with incomes of \$3000 or less. The same difference, although less marked, was found for parental education.¹⁷

Since social class is so confounded by race, attempts to isolate the effects of socioeconomic variables on reproductive performance must look at variations within racial groups. A number of studies from around the world have confirmed a distinct socioeconomic gradient in the course and outcome of pregnancy.

Some of the most striking data come from Great Britain—a country that is relatively homogeneous as far as race and ethnic background are concerned. The British Perinatal

Mortality Survey (1958)⁴ and the British Births Survey (1970)³ found that death rates for babies from the fifth month of gestation through the first week of life increased consistently as families moved down the social ladder. The lowest mortality rates were observed among the professional classes, whereas the highest rates were found among the unskilled labor class. Furthermore, mortality rates were associated with the social mobility of the mother. Those women who had married men from a higher social class than their own had better obstetrical outcomes than women who married men from a lower social class.

The statistics in the United States exhibit similar trends. Table 1-1 presents data from the National Natality and Infant Mortality surveys on family income and parental education for blacks and whites. In both racial groups, infant mortality rates are substantially higher among the lowest socioeconomic

Table 1-1. Estimated number of infant deaths per 1000 live births by race, education of father, and family income, United States, 1964-1966*

Family income	Education of father				
	8 years or less	9-11 years	12 years	13-15 years	16 or more years
White					
Under \$3000	34.0	25.6	25.1	23.3	†
\$3000-4999	30.0	24.2	18.4	18.1	15.3
\$5000-6999	25.9	23.3	15.6	14.6	13.0
\$7000-9999	24.8	22.1	16.8	22.9	17.4
\$10,000 and over	†	23.1	15.3	19.2	19.8
Black					
Under \$3000	40.5	52.1	35.0	†	†
\$3000-4999	†	51.6	40.3	†	†
\$5000-6999	†	†	15.0	†	†
\$7000-9999	†	†	†	†	†
\$10,000 and over	†	†	†	†	†

*From MacMahon, B., Kovar, M. G., and Feldman, J. J.: Infant mortality rates: socio-economic factors, U.S. Department of Health, Education and Welfare Pub. No. (HSM) 72-1045, Rockville, Md., March, 1972. National Center for Health Statistics.

†Too few in sample to calculate rates.

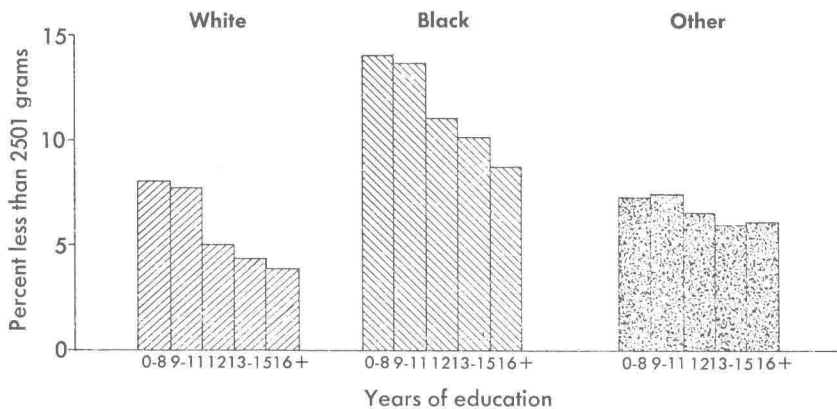


Fig. 1-5. Percent of births less than 2501 gm by mother's education and race for single live births: United States, 1974. (From Selected natality characteristics for single live births, United States, 1974, DHEW Pub. No. [HSA] 79-5744. Public Health Service, Bureau of Community Health Services, Rockville, Md., 1979.)

classes. Where the statistics are sufficient to calculate rates it appears that education of the parent has a greater effect on infant mortality than family income per se.

Birth weight has also been shown to vary with social class. This was found in the Brit-

ish study and has been confirmed in the United States and in other countries. The percent of low birth weight infants born in 1974 according to education and race of the mother is shown in Fig. 1-5. There is a difference between white and nonwhite births in