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CHARACTERISTICS AND OUTCOMES OF WIC PARTICIPANTS AND NONPARTICIPANTS: ANALYSIS OF THE 1988 NATIONAL MATERNAL AND INFANT HEALTH SURVEY

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Authors:

Anne Gordon
Lyle Nelson

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U.S. Department of Agriculture
Food and Nutrition Service
Office of Analysis and Evaluation
3101 Park Center Drive, 2nd Floor
Alexandria, VA 22302

Project Officer:
Janet Tognetti Schiller

Submitted by:

Mathematica Policy Research, Inc.
P.O. Box 2393
Princeton, N.J. 08543-2393
(609) 799-3535

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Anne Gordon
Lyle Nelson

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CONTENTS

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The Special Supplemental Food Program for Women, Infants, and Children (WIC) provides supplemental foods, nutrition education, and social service referrals to low-income pregnant, breastfeeding, and postpartum women, to infants, and to children up to 5 years of age. This study examines the background characteristics, pregnancy experiences, and birth and infant outcomes of WIC participants, income-eligible nonparticipants, and higher-income nonparticipants, using data from the 1988 National Maternal and Infant Health Survey (NMIHS). The National Center for Health Statistics (NCHS) sponsored the NMIHS and collected data from a national sample of 9,953 women who experienced a live birth in 1988. The objectives of this study are to (1) examine patterns of WIC participation among pregnant and postpartum women, and infants; (2) conduct a descriptive analysis of the characteristics and experiences of WIC participants, income-eligible nonparticipants, and all other nonparticipants; and (3) estimate the effects of prenatal WIC participation on birth outcomes.

CHARACTERISTICS OF WIC PARTICIPANTS

Approximately 62 percent of pregnant women who were income-eligible for WIC are estimated to have participated in the program in 1988. Among prenatal WIC participants, 51 percent reported enrolling in their first trimester and another 35 percent in their second trimester. About 94 percent of prenatal WIC participants reported having received nutritional advice at the WIC center, 66 percent remembered being advised to get prenatal care, 64 percent reported being advised to breastfeed their infants, and 62 percent reported having been advised to avoid illegal drugs during pregnancy.

In general, the WIC program serves individuals who are disadvantaged on average, even relative to the rest of the income-eligible population:

- Prenatal WIC participants were more likely to be teenagers, less likely to have a high school diploma, more likely to be black or Hispanic, and less likely to be married or living with the baby's father than were income-eligible nonparticipants or higher-income nonparticipants.

- WIC participants were less likely to have been employed in the previous year, and were more likely to depend on Medicaid and to lack private insurance than were nonparticipants.

- Fathers of the WIC participants' babies were younger, less educated, more likely to be black or Hispanic, and less likely to

have been employed than were fathers of the babies of income-eligible nonparticipants and higher-income nonparticipants.

Prenatal WIC participants and income-eligible nonparticipants did not differ significantly in terms of household size or mean household income, but WIC participants were more likely to depend on public assistance income. A larger proportion of prenatal WIC participants had incomes below the poverty level (56 versus 45 percent).

Virtually all prenatal WIC participants had newborns who participated in WIC as infants, and 77 percent were enrolled postpartum. About 30 percent of infant WIC participants and 16 percent of postpartum women participants had not been enrolled prenatally.

PRENATAL CARE AND HEALTH BEHAVIORS

Only slightly more than half of both WIC participants and income-eligible nonparticipants received adequate levels of prenatal care, compared with 82 percent of higher-income nonparticipants. Prenatal WIC participants, however, were less likely than income-eligible nonparticipants to receive inadequate levels of prenatal care in several respects: WIC participants were less likely to receive no prenatal care (1.3 percent for WIC participants versus 4.9 percent for nonparticipants), and WIC participants who received prenatal care were less likely to receive inadequate care, as measured by the Kessner Index for the adequacy of care.

Prenatal WIC participants were more likely than both groups of nonparticipants to have received their prenatal care from county or city health departments, community health centers, or hospital clinics, and were less likely to have used private doctors or HMOs. WIC participants were much more dependent than income-eligible nonparticipants on Medicaid or other government assistance for payment for prenatal care: 51 percent of prenatal WIC participants used Medicaid as compared with 26 percent of nonparticipants. Income-eligible nonparticipants were more likely than prenatal WIC participants to pay for care with their own funds or through private insurance. Prenatal WIC participants were more likely to be hospitalized during pregnancy than income-eligible nonparticipants; 18 percent of participants and 14 percent of income-eligible nonparticipants were hospitalized during pregnancy.

Participants differed little from income-eligible nonparticipants in their reported use of alcohol, cigarettes and illegal drugs. Most WIC participants (86 percent) reported not drinking alcohol during pregnancy, and only 4 percent reported more than 1 drink per week. Although 37

percent of participants smoked before the pregnancy, one-fifth of this group quit during the pregnancy, and most reduced smoking to some extent. About 3 percent of prenatal WIC participants reported using marijuana during the pregnancy, and 1 percent reported using cocaine.

INFANT HEALTH CARE USE AND HEALTH STATUS

In the first six months of life, infant WIC participants visited the doctor 5.9 times on average, with 3.6 visits for well-baby care and 2.5 visits for care for an illness or injury. Income-eligible nonparticipants had similar numbers of physician visits. WIC participants were less likely to receive their well-baby care from a private physician than income-eligible nonparticipants, and more likely to receive care from health departments, community health centers or hospital clinics. Infant WIC participants were also more likely to have their health care paid for by Medicaid, and less likely to have care paid for by private insurance or their family's resources.

Infant WIC participants did not differ from income-eligible nonparticipants in the number of vaccinations received during the first 6 months of life. Both low-income groups, however, were less likely to receive any vaccinations, or to receive the appropriate number of vaccinations, than were higher-income nonparticipants.

Among infant WIC participants, 83 percent received a polio vaccination in the first 6 months, and 61 percent received two or three vaccinations (the recommended number). Similarly, 93 percent of infant WIC participants received a diphtheria/tetanus/pertussis vaccination, and 78 percent received the recommended two or three vaccinations. Since 1988, WIC agencies have stepped up efforts to increase immunization coverage among infant WIC participants.

WIC infants did not differ significantly from income-eligible nonparticipants in the prevalence of hospitalizations after birth, but they were significantly more likely than higher-income nonparticipants to have been hospitalized. Ten percent of infant WIC participants and 8.9 percent of income-eligible nonparticipants were re-hospitalized after birth, but only 5.3 percent of higher-income infants were re-hospitalized after birth.

INFANT FEEDING PRACTICES

The feeding practices used by mothers of infant WIC participants were compared with guidelines for infant feeding from the Committee on Nutrition of the American Academy of Pediatrics (CN-AAP). Although breastfeeding is the preferred method of infant feeding, the CN-AAP guidelines state that either breastfeeding or use of appropriate infant formula is acceptable in the first 6 months, but not cow's milk. Furthermore, the CN-AAP does not recommend introduction of solid foods until the infant is 4 months old; solid foods may be introduced any time between 4 and 6 months of age, depending on the maturity of the infant.

About 85 percent of mothers of WIC participants fed their infants according to the guidelines in the first month, but this proportion fell to 25 percent in the fourth month, since most mothers introduced solid foods before the fifth month. Nearly all mothers of WIC participants were in compliance with the guidelines in months 5 and 6 (95 percent and 91 percent), but small proportions reported feeding their infants cow's milk in these months.

In general, mothers of WIC participants and mothers of income-eligible nonparticipants followed the guidelines to a similar extent. However, mothers of WIC participants were more likely to feed their infants appropriately in months 5 and 6, since mothers of income-eligible nonparticipants were more likely to start feeding their infants cow's milk during these months.

Mothers of infant WIC participants were less likely than mothers of income-eligible nonparticipants to breastfeed their babies, and they stopped breastfeeding sooner, and were more likely to supplement breastfeeding with formula. Only 36 percent of mothers of WIC infants were breastfeeding in their first month, compared with 51 percent of mothers of income-eligible nonparticipants; only 10 percent were breastfeeding in the sixth month after birth, compared with 21 percent of mothers of income-eligible nonparticipants. Provision of infant formula may attract nonbreastfeeding mothers to WIC. Furthermore, these 1988 data predate legislative changes that required WIC agencies to set aside substantial resources for breastfeeding promotion.

The findings concerning infant feeding practices are descriptive and do not control for the more disadvantaged socioeconomic characteristics of WIC participants. Using the NMIHS data, Schwartz et al. (1992) found no significant association between WIC participation and breastfeeding initiation or duration, after controlling for differences in the socioeconomic characteristics of WIC participants and income-eligible nonparticipants.

PRENATAL WIC PARTICIPATION AND BIRTH OUTCOMES

The mean birthweight of newborns of prenatal WIC participants is 3,284 grams (7.23 pounds), and 8.2 percent of newborns born to WIC participants were low birthweight (less than 2,500 grams or 5.5 pounds).

Prenatal WIC participation is associated with higher average newborn birthweight and gestational age. Although the simultaneous relationship between prenatal WIC participation and the duration of pregnancy makes it difficult to estimate the relationship between WIC participation and birth outcomes reliably, it is possible to derive plausible upper and lower bounds on these relationships. Prenatal WIC participation is associated with an increase in average birthweight of between 25 and 68 grams (approximately 1 to 2 percent of average birthweight). This estimate is of a similar magnitude to estimates found in previous studies. Similarly, prenatal WIC participation is associated with an increase in gestational age of between one-fourth and one-half of a week.

Furthermore, prenatal WIC participation significantly reduces the extremes of low birthweight and preterm birth. WIC participation reduces the percentage of low birthweight births by between 1 and 3 percentage points (from a mean of 10.8 percent for income-eligible nonparticipants), and reduces the percentage of preterm births between 2.4 and 3.6 percentage points (from a mean of 14.2 percent for income-eligible nonparticipants). However, prenatal WIC participation is not related to neonatal or infant mortality.

I. INTRODUCTION

Inadequate nutrition and its consequences are a public health concern in the United States. While on average, the diets of most Americans provide sufficient quantities of most nutrients, some subgroups of the population have special nutritional needs that are often not met. In particular, pregnant women, infants, and children require adequate nutrition during critical growth and development periods. To address the need of these subgroups, the Special Supplemental Food Program for Women, Infants, and Children (WIC) provides supplemental foods, nutrition education, and health care and social service referrals to low-income pregnant, breastfeeding, and postpartum women, to infants, and to children up to five years of age who are at nutritional risk. Supplemental foods and nutrition education are intended to improve the nutritional status of low-income pregnant women, which, in turn, is expected to improve pregnancy outcomes. For infants and children, the supplemental foods are expected to reduce the prevalence of anemia and to improve physical and mental growth and development. The WIC Program also aims to promote good health care by referring participants to health care providers.

This report presents results from an analysis of data from the 1988 National Maternal and Infant Health Survey (NMIHS). The NMIHS collected data from a national sample of women who experienced a live birth, fetal death, or infant death in 1988. The objectives of this report are to (1) examine patterns of WIC participation among pregnant women, postpartum women, and infants; (2) conduct a descriptive analysis of the characteristics and experience of WIC participants, income-eligible nonparticipants, and higher-income nonparticipants; and (3) estimate the effects of prenatal WIC participation on birth outcomes.

This report is organized in five chapters. The remainder of this chapter provides background on the WIC Program and discusses in detail the objectives of this study. Chapter II highlights findings from previous research on the effects of WIC participation. Chapter III describes the NMIHS data and our methodology. Chapter IV presents the findings from a descriptive analysis of the patterns of WIC participation and the characteristics of WIC participants, income-eligible nonparticipants, and higher-income (ineligible) nonparticipants. The final chapter presents results from a multivariate analysis of the effects of WIC participation on birth outcomes.

BACKGROUND ON THE WIC PROGRAM

In 1969, the White House Conference on Food, Nutrition, and Health recommended that special attention be given to the nutritional needs of pregnant women and preschool children at nutritional risk. As a result, in September 1972, Congress authorized the WIC Program as a two-year pilot program. The program was designed to provide nutritional screening, food assistance, nutrition education, and health and social service referrals for low-income pregnant and postpartum women, their infants, and children up to age five. Since its inception, the WIC Program has grown dramatically. In fiscal year 1980 (FY80), the program served 1.9 million women and children at a cost of $725 million; in FY91, the program served an estimated 5.2 million women and children at a cost of $2.3 billion.

The WIC Program is administered nationally by the Food and Nutrition Service (FNS) of the U.S. Department of Agriculture (USDA) and at the state level by a designated state agency, usually the state health department. Congress sets funding annually, and the available funds are allocated to the states on the basis of a formula that accounts for the number and percentage of eligible women being served, among other factors. WIC is not an entitlement program, and states may not have sufficient funds to serve all eligible persons who apply for benefits. Federal regulations thus require that the states establish priority systems to ensure that scarce program resources are fairly allocated and reach those most in need. The priority system should be operated statewide and satisfy the broad federal requirements described below:

- ***Priority I.*** Pregnant women, breastfeeding women, and infants at nutritional risk as demonstrated by hematological or anthropometric assessments or by other documented nutritionally related medical conditions

- ***Priority II.*** Infants up to 6 months of age who were born to women who were WIC recipients during pregnancy or who can be documented as at nutritional risk during pregnancy

- ***Priority III.*** Children at nutritional risk as demonstrated by hematological or anthropometric measurements or other documented medical conditions

- ***Priority IV.*** Pregnant women, breastfeeding women, and infants at nutritional risk because of an inadequate dietary pattern

- ***Priority V.*** Children at nutritional risk because of an inadequate dietary pattern

- ***Priority VI.*** Postpartum women, not breastfeeding, at nutritional risk based on either medical or dietary criteria

- ***Priority VII.*** Previously certified participants whose nutritional status might regress without the continued provision of supplemental foods

The state agencies are required to use Priorities I through VI, and, at their option, they can include Priority VII.

Program eligibility depends on categorical eligibility, income level, and evidence of nutritional risk. To be categorically eligible for WIC, the applicant must be (1) a pregnant woman, (2) a breastfeeding woman less than one year postpartum, (3) a nonbreastfeeding woman less than 6 months postpartum, (4) an infant up to 1 year of age, or (5) a child between 1 and 5 years of age. States have the option to set income eligibility between 100 and 185 percent of the federal poverty level, provided that the income level is no lower than the income level for free or reduced-price health services. All states have set income eligibility at 185 percent of the poverty level. Participants must be determined to be at nutritional risk through a medical or nutritional assessment. Risk factors include both medical risks, such as anemia, extremes of leanness or obesity, high or low maternal age, or poor pregnancy history, and dietary risks resulting from poor dietary patterns. Specific risks are defined by the states within broad federal guidelines.

The WIC Program provides three types of benefits: (1) supplemental food, (2) nutrition education, and (3) referrals to health care providers. Supplemental food is usually provided in the form of a "food instrument" (either a voucher or check), which can be exchanged for food in a store. The food instrument lists the quantities of specific foods (including brand names in some cases) that it can be used to purchase. The 1978 amendments to the Child Nutrition Act (PL 95-627) mandated that supplemental foods should contain the nutrients that are lacking in the diets of the populations targeted by WIC--protein, vitamin A, vitamin C, calcium, and iron.

Nutrition education is offered as a means of improving the nutritional status of participants. The local agencies must spend at least one-sixth of WIC administrative funds on nutrition education and counseling. At least two nutrition education sessions must be provided in each 6-month

certification period (or at the rate of once per quarter for infants certified for a period in excess of 6 months). However, participants cannot be denied food supplements if they do not attend the nutrition education sessions.

To qualify as a WIC provider, the local agency must show that accessible health care facilities for low-income women, infants, and children are available. Clients must be advised about the types of health care available, the location of health care facilities, how to receive health care, and why it is useful. Routine health services and/or pediatric care are provided at nearly half of the WIC service sites (Williams et al. 1990). However, WIC funds cannot be used directly to provide health care to participants.

STUDY OBJECTIVES

The objectives of this study are to (1) examine patterns of WIC participation among pregnant and postpartum women, and infants up to 6 months postpartum, (2) compare the characteristics and experience of WIC participants, income-eligible nonparticipants, and higher-income (ineligible) nonparticipants, and (3) estimate the effects of WIC participation on birth outcomes such as birthweight, gestational age, and infant mortality. Specifically, the analysis addresses the following four research questions:

1. How do prenatal WIC participants, income-eligible nonparticipants, and higher-income nonparticipants compare with respect to the following?

    - Demographic and socioeconomic characteristics
    - Behavior and experience before and during the target pregnancy (health behaviors, pregnancy history, experiences in the WIC Program)
    - Outcomes of the target pregnancy
    - Behavior and experience of the prenatal WIC participants and their infants following delivery (infant health status, infant health care utilization, infant feeding, postpartum maternal and infant WIC participation)

2. How do postpartum WIC participants, income-eligible nonparticipants, and higher-income nonparticipants compare

with respect to demographic and socioeconomic characteristics?

3. How do infant WIC participants, income-eligible nonparticipants, and higher-income nonparticipants compare with respect to the following?

   - Demographic and socioeconomic characteristics
   - Infant health status and health care utilization
   - Infant feeding practices

4. What are the effects of prenatal WIC participation on birth outcomes including birthweight; gestational age; and the incidence of low birthweight, very low birthweight, preterm birth, neonatal mortality, and infant mortality through 6 months after birth?

In answering these questions, the analysis uses the 1988 NMIHS. The WIC program has expanded since 1988 and it is possible that the composition of the participant population may have changed since the period covered by the NMIHS. However, the NMIHS remains the best data source currently available to address these questions. The NMIHS is a rich, nationally representaitve database that includes data on maternal and family characteristics, WIC participation, and maternal and infant outcomes. Many variables in the NMIHS are not available in other data sources that distinguish WIC participants. Furthermore, it is the most up-to-date data available.

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II. REVIEW OF PREVIOUS LITERATURE

Since its inception in 1972, the WIC Program has grown immensely in part because, at least on an intuitive level, the provision of food supplements to at-risk pregnant women, infants, and children seems like it should result in improved pregnancy and health outcomes. However, as noted by Kennedy et al. (1982), although the benefit of nutritional supplementation has been demonstrated in underdeveloped countries, its efficacy in industrialized countries is continually questioned. In addition, both the size and growth of the WIC Program have caused policymakers and lawmakers, as well as the scientific community, to focus a great deal of attention on quantifying its benefits in order to determine whether, as a publicly funded intervention, the WIC Program indeed provides a measurable net benefit to society.

Thus, the 1970s and 1980s have witnessed numerous evaluations of the WIC Program that vary in scope and the outcomes examined. Many evaluations have been performed at the state and local level, and some on the national level. Outcomes examined have included birthweight, fetal and neonatal mortality, medical conditions and nutritional status in the mother and infant, and Medicaid cost savings at and around birth for prenatal WIC participants and their newborns. Some evaluations have also sought to determine whether WIC differentially affected particular subgroups of the population (such as nonwhites or those with high-risk conditions or risk behaviors like smoking) or whether the intensity of WIC participation, such as the number of months in the WIC Program or the number of WIC food instruments redeemed, influenced its effectiveness. Each evaluation has been scrutinized and criticized by subsequent investigators. This chapter reviews previous evaluations of the WIC Program that are relevant to topics covered in this report, focusing on studies of the effects of prenatal participation in the WIC Program, but also briefly considering studies of the effects of WIC on health care utilization among infants and children.

STUDIES OF THE EFFECTS OF PRENATAL WIC PARTICIPATION

Studies of the effects of WIC participation during the prenatal period include several major evaluations as well as reviews of these evaluations. Both the evaluations and reviews are discussed below.

Major Evaluations

The methodologies and findings of eight major evaluations of the WIC Program published between 1979 and 1991 are summarized in Table II.1. The following information is restricted to those aspects of the studies concerning the effects of prenatal WIC participation.

TABLE II.1

SUMMARY OF MAJOR WIC EVALUATIONS

Authors (Year Published)	Comparison Group(s)	Selected Outcomes Examined	Summary of Reported Impacts for Outcomes Relevant to Current Study	Data Source
J. Edozien, B. Switzer, and R. Bryan (1979)	WIC participants at enrollment with characteristics of current WIC participant group	Birthweight Infant mortality Growth of children Anemia and other measures of nutritional status	Increased birthweight	More than 50,000 women, infants, and children in 19 WIC projects in 14 states; clinical examinations and laboratory tests carried out between 1973 and 1976
E. Kennedy, S. Gershoff, R. Reed, and J. Austin (1982)	Pregnant WIC applicants not certified because program had no slots or those who applied and were certified postpartum Pregnant women at non-WIC health facilities	Birthweight	Increased birthweight (3,273 vs. 3,136 grams) that also increased with the number of WIC vouchers received	Medical and nutrition records for 1,307 live births (897 to WIC participants, 410 to non-WIC) at 9 sites in Massachusetts between 1973 and 1978
M. Kotelchuck, J. Schwartz, M. Anderka, and K. Finison (1984)	Non-WIC pregnant women matched on demographics to WIC participants	Birthweight Infant mortality Gestational age Use of prenatal care	Decrease in percent low birthweight (6.9 vs. 8.7%) Nonstatistically significant increase in birthweight (3,281 vs. 3,260 grams) Increased WIC participation associated with larger impacts Decreased infant mortality Improvement in use of prenatal care	Birth and death certificates and WIC data for 8,252 WIC and non-WIC births in Massachusetts in 1978
J. Metcoff, P. Costiloe, W. Crosby, S. Dutta, H. Sandstead, D. Milne, C. Bodwell, and S. Majors (1985)	Randomly assigned comparison group	Birthweight Maternal nutritional status	Increase in birthweight (3,254 vs. 3,163 grams)	Clinical data for 824 WIC-eligible pregnant women attending Oklahoma prenatal clinics

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TABLE II.1 *(continued)*

Authors (Year Published)	Comparison Group(s)	Selected Outcomes Examined	Summary of Reported Impacts for Outcomes Relevant to Current Study	Data Source
W. Schramm (1985, 1986, 1989)	Medicaid-covered births to WIC nonparticipants	Medicaid costs within 30 days of birth for 1980 data; within 45 days for 1982 and 1985-86 Birthweight NICU admissions	For 1980 Medicaid births, $.83 reduction in Medicaid costs for each dollar spent on the prenatal WIC program; $.49 and $.79 in 1982 and 1985-86, respectively	7,628 Medicaid births in Missouri in 1980; 9,086 Medicaid births in 1982; and 17,944 Medicaid births in 1985 and 1986.
B. Devaney, L. Bilheimer, and J. Schore (1990, 1991)	Medicaid-covered births to WIC nonparticipants	Medicaid costs from birth to 60 days after birth Newborn birthweight Gestational age	Savings in maternal and newborn Medicaid costs per dollar spent on WIC ranged from $1.77 to $3.13. Increase in birthweight ranged from 51 grams to 117 grams	More than 105,000 Medicaid births in 1987 from 5 states: Florida, Minnesota, North Carolina, South Carolina, and Texas (January-June 1988 in Texas)
J. Stockbauer (1986, 1987)	WIC nonparticipants	Birthweight	In 1980, mixed effects on birthweight (depending on method of comparison), with consistently more favorable outcomes among black WIC participants; 1982 found small but consistently favorable effects Both studies found at least 7 months of participation required to observe improved birthweight	1986 study used 1980 data on 6,732 births to prenatal WIC participants in Missouri and 5,574 to 6,657 non-WIC births; 1987 study used 9,411 WIC and 9,411 non-WIC 1982 births
D. Rush (1986)	Low-income, first-time, non-WIC registrants at prenatal clinics	Birthweight Fetal mortality	No effect on birthweight Nonstatistically significant decrease in fetal deaths	5,205 prenatal WIC participants and 1,358 non-WIC registrants from 174 WIC sites and 55 clinics across the county

- The earliest evaluation cited in Table II.1, Edozien et al. (1979), was a national effort that involved more than 50,000 women, infants and children at 19 WIC projects in 14 states. Outcomes from clinical examinations and laboratory samples collected between 1973 (just a year after the inception of WIC) and 1976 for WIC participants were compared with similar outcomes for new WIC enrollees collected at the time of their enrollment. WIC participation resulted in an increase in birthweight.

- Kennedy et al. (1982) compared medical and nutrition records collected between 1973 and 1978 for the births of 897 WIC participants with those of 410 pregnant women on WIC waiting lists or receiving health services at non-WIC facilities at nine sites in Massachusetts. WIC participants had infants with higher average birthweights than did nonparticipants (3,273 grams and 3,136 grams, respectively).

- Kotelchuck et al. (1984) examined 4,126 pairs of births for WIC participants and nonparticipants matched on maternal age, race, parity, education and marital status. Data for the sample were obtained from 1978 birth and death certificates and WIC Program records in Massachusetts. A small, nonsignificant increase in birthweight (from 3,260 to 3,281 grams) was estimated, as was a statistically significant decrease in the percent of low birthweight babies (from 8.7 to 6.9 percent), a decrease in infant mortality, and an improvement in the use of prenatal care. The estimated WIC impacts increased with the length of WIC participation.

- Metcoff et al. (1985) randomly assigned half of a sample of 824 WIC-eligible pregnant women attending Oklahoma prenatal clinics to a WIC treatment group and to a control group. This was the first use of random assignment in a major evaluation, although the universe of prenatal clinic enrollees used for sampling was intrinsically restricted to women with a commitment to the use of prenatal care. WIC participants had higher average birthweights than controls (3,254 grams versus 3,163 grams).

- Schramm (1985, 1986, and 1989) examined the effect of WIC participation on Medicaid costs after birth in Missouri at three points in time--1980, 1982, and 1985-86. For 1980, Schramm estimated a savings of $.83 in newborn Medicaid reimbursements within 30 days after birth for each dollar spent

on the prenatal component of the WIC Program; in 1982 and 1985-86, the estimated Medicaid savings for services received within 45 days after birth were $.49 and $.79, respectively. Mean birthweight was 6 grams greater for WIC participants than for nonparticipants in 1980, compared with differences of 31 grams and 25 grams in 1982 and 1985-86, respectively.

- Devaney et al. (1990 and 1991) also examined the effects of prenatal WIC participation on Medicaid costs after birth in five states--Florida, Minnesota, North Carolina, South Carolina, and Texas. The study period was 1987 for Florida, Minnesota, North Carolina, and South Carolina; and January through June 1988 for Texas. The estimated savings in Medicaid costs within 60 days after birth for each dollar spent on the prenatal WIC Program ranged from $1.77 to $3.13. Average newborn birthweight was higher for WIC participants than for nonparticipants, ranging from an increase of 51 grams to 117 grams. Prenatal WIC participation was also associated with a lower incidence of low birthweight, longer gestational age, and a lower incidence of a preterm birth.

- Stockbauer (1986 and 1987) compared 1980 and 1982 Missouri birth records for WIC participants with those of women not participating in WIC. The first study compared 6,732 WIC births with three comparison samples of between 5,574 and 6,657 births drawn from non-WIC births in Missouri vital records; although income information was not available, statistical techniques were used to control for other differences in characteristics. The second study compared 9,411 pairs of WIC and non-WIC births matched on key maternal characteristics. The 1980 study estimated mixed overall effects on birthweight depending on the comparison sample used, but it consistently estimated favorable outcomes for black WIC participants. The 1982 study found that prenatal WIC participation was associated with a reduction in the percentage of infants with low birthweight and a reduction in the percentage of women having inadequate prenatal care. Both studies found that at least 7 months of WIC participation were required to observe improved birthweight outcomes.

- Rush (1986) compared longitudinal data on 5,205 prenatal WIC participants and 1,358 non-WIC registrants at prenatal clinics selected from 174 WIC sites and 55 clinics across the country. The primary findings concerning the effects of prenatal WIC participation were no statistically significant

effect on newborn birthweight; increased infant head circumference; increased birthweight and head circumference with better WIC Program quality; lower incidence of fetal death and low birthweight of appreciable but not significant magnitude; and increased intake of protein, iron, calcium, and vitamin C (four of the five targeted WIC nutrients).[1]

These evaluations shared a number of features. Each examined the ability of WIC participation to increase birthweight. There are two primary reasons for looking at birthweight as an outcome. The first is that low birthweight predicts subsequent short- and long-term health problems in newborns, such as respiratory difficulties and developmental disabilities (Institute of Medicine, 1985). The second is that birthweight is a relatively reliable quantitative measure that is routinely available on birth certificates, a major data source for these studies.

Each evaluation also identified a comparison group against which to compare outcomes, such as birthweight, for WIC prenatal participants. Ideally, the goal in selecting a comparison group is to identify a sample of women who are identical to WIC prenatal participants except for their participation in the program in order to see what would have happened to the WIC participants in the absence of the WIC Program. Identifying such a group is difficult. As a result, researchers are confronted with the problem of interpreting differences in outcomes for WIC participants and nonparticipant comparison groups in light of the measured and unmeasured differences that might have existed between the two groups. For example, most of the evaluations reported that prenatal WIC participation favorably affected birthweight, and that the effects varied in size and level of statistical significance. However, a critical question, and one that seems to dominate critiques of these evaluations, is the extent to which a significant increase in birthweight (or conversely, the lack of a significant increase) is an artifact of the comparison group and not a function of program participation.

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[1]The historical study by Rush (1986) used aggregate county-level data for the years 1972-1980 to relate WIC penetration rates (estimates of the proportion of eligible pregnant women enrolled in WIC in the county) to average birth outcomes, fetal death rates, and infant death rates in each county. This study found effects on birth outcomes in the expected direction, but most were not statistically significant. Because this study raises very different methodological issues than other WIC studies, it is not discussed in detail here.

A number of the studies also investigated a so-called "dose-response effect" for WIC participation. The hypothesis of the dose-response effect is that the greater the extent of a woman's participation in the WIC Program, the greater the size of the program's effects. The extent of participation is frequently measured in terms of months of WIC participation or the number of WIC vouchers received or redeemed. A corollary to the dose-response hypothesis is that there is a threshold below which WIC participation can be expected to have no statistically significant effect on birth outcomes. The dose-response issue is of interest to researchers and policymakers for a number of reasons including its implications for targeting WIC outreach efforts according to the gestational age of the fetus. However, as discussed in the following sections, estimation of a dose-response effect for WIC participation is not straightforward.

Evaluation Reviews

WIC evaluations have been scrutinized with unusual care. In response to a request from the chairman of the Senate Committee on Agriculture, Nutrition and Forestry, the General Accounting Office (1984) produced a review of existing evaluations of WIC. The review focused on three claims of previous studies:

1. That WIC participation decreases the rate of miscarriage, stillbirth, and neonatal death, and improves maternal nutrition

2. That WIC participation is related to improved pregnancy outcomes for high-risk mothers and that improved outcomes are directly related to length of participation in the WIC Program

3. That WIC participation results in increased birthweight and reduces the chances for anemia and mental retardation in infants and children

The General Accounting Office (GAO) reviewed the findings of the evaluations as well as the quality of the methodology. GAO summarized its review of the studies by saying, "The information is insufficient for making any general or conclusive judgments about whether the WIC Program is effective or ineffective overall. However, in a limited way, the information indicates the likelihood that WIC has modestly positive effects in some areas" (GAO 1984, p. ii.).

In particular, GAO found that many studies examined the effect of WIC participation on birthweight and judged several of these studies to be of high or medium quality. The studies supported, but did not give conclusive evidence for, the ability of the WIC Program to increase birthweight. The studies cited a decrease in the rate of low birthweight (that is, birthweight below 2,500 grams) from 9.5 percent for nonparticipants to 7.9 percent for WIC participants and an increase in mean birthweight of 30 to 50 grams. GAO found evidence supporting claims that the program produced more favorable effects on birthweight of newborns for teenagers, blacks, and those with several health- and nutrition-related risks. However, GAO found only inconclusive evidence for the claim that longer WIC participation increased its effectiveness regarding birthweight. GAO found substantially less data to support claims of decreased fetal and neonatal deaths than it found for claims related to birthweight. (The former two outcomes are particularly difficult to study because they occur relatively infrequently.)

David Rush has critiqued many of the WIC evaluations in terms of their methodological limitations. In his review (1982) of the study by Edozien et al. he noted three primary limitations: (1) it was performed too early in the life of the WIC Program to judge definitively its effectiveness; (2) the comparison group was not valid because it assumed comparability between those participating at different times in pregnancy or in the life cycle, as well as between those arriving early in the program with those arriving later; and (3) the authors failed to note in their claim of a dose-response effect for WIC participation that duration of prenatal WIC participation was confounded by duration of gestation.

In his review of the Kotelchuck et al. study, Rush (1984) found shortcomings both in the study design and the analysis. He noted that the Kotelchuck study excluded 353 women who were terminated from the WIC Program for any reason; it is possible that this group of 353 included women who had experienced premature delivery, which would potentially bias the study's results by eliminating some women from the WIC group who had low birthweight babies or whose newborns died as a result of prematurity. In addition, Rush noted that the WIC and non-WIC samples were matched on age, race, parity, education, and marital status of the woman (as recorded on birth certificates), but not on income and the additional health and nutritional risk factors that are the eligibility criteria for WIC. As a result, the WIC group could have been at higher risk of poor perinatal outcomes than the comparison group, which would bias the result in the opposite direction to the bias associated with excluding the 353 terminees. Rush also took issue with Kotelchuck's estimates of the dose-response effect of WIC. As he pointed out regarding the Edozien

study, the number of months of WIC participation is confounded with the duration of pregnancy.

Rush (1985) viewed Schramm's 1985 investigation of the effect of WIC on Medicaid costs for newborns as an important contribution to WIC Program evaluation literature. However, he raised issues with some aspects of Schramm's findings. In particular, only 21 percent of the Medicaid births that formed the base of Schramm's sample could be identified with WIC records. Given the fact that most pregnant women on Medicaid are likely to be eligible for WIC as well, one could expect the WIC participation rate to be higher. Rush was concerned that this low match rate was a result of a flaw in the analysis file creation process. However, it is also possible that it reflects shortcomings in WIC outreach efforts to Medicaid recipients, some other problem concerning access to WIC clinics, or perhaps the attitudes of Medicaid recipients in Missouri to the WIC Program.

STUDIES OF THE EFFECTS OF WIC ON INFANTS AND CHILDREN

A large body of literature exists on the impact of WIC on pregnant women and such birth outcomes as birthweight. Many fewer studies have examined the impact of WIC on infants and children, and most of these studies were performed on small samples of children in a local area. Rush (1986) outline four reasons for the lack of such evaluations. First, the impact of WIC may not be evident until a number of years after the child has enrolled in WIC. For example, most tests of psychological development do not have great predictive validity for later cognitive performance until the child is at least 4 years old. Second, it is extremely difficult to find a comparison group that is truly similar to the treatment group and does not differ from the treatment group by unmeasured factors related to participation in WIC. Third, no consensus exists on the correct indicators of the success of the program. For example, each study of the impact of WIC on behavioral and cognitive development uses different measures of development. Fourth, there are few pre-existing data sources on the health status of children.

Effects of WIC on the Utilization of Health Care Services

This study compares health status and health care utilization of WIC infants and nonparticipants. Among previous studies, only Rush (1986) and Paige (1983) examined the impact of WIC participation on the utilization of health care services.

- Paige (1983) collected data on 145 WIC infants in three counties on the Eastern Shore of Maryland who were enrolled

in WIC during the first 3 months after their birth. These data were compared to data on 213 WIC-eligible infants attending public health departments in two contiguous counties that did not serve WIC. Paige examined physical measurements, blood iron content, and the children's immunization records.

- The National WIC Evaluation, Rush (1986), was a large nationwide study of the impact of WIC on pregnant women, infants, and children. One component of the evaluation was the Study of Infants and Children. This study compared cross-sectional data on 1,459 infants and children up to 4 years of age who were either current or past WIC recipients with data on 683 infants and children of the same ages who were neither current nor past WIC recipients. All infants and children in both the treatment and comparison groups were children of women participating in the Longitudinal Study of Pregnant Women, another component of the evaluation. The Study of Infants and Children examined a wide variety of outcomes including physical measurements, psychological development, nutrient intake, and use of health care services.

These studies have some design problems that have limited their ability to determine unambiguously the impact of the WIC Program on infants and children. First, the Paige study used only a small sample of infants and children from one local area. It is therefore difficult to generalize the findings of this study to the impact of a national WIC Program.

Second, both studies used a comparison group approach to assess the impacts of WIC participation. If there were important differences between the unmeasured characteristics of infants and children in the WIC group and infants and children in the non-WIC comparison group, the true impact of the program cannot be distinguished from the impact of the differences in these characteristics.

- Rush (1986) used as their comparison group infants and children who were income-eligible for WIC but who did not participate in WIC. But while all the infants and children in the treatment group must have been determined to be at nutritional risk in order to be WIC-eligible, some children in the comparison group may never have been at nutritional risk. Hence, if the infants and children in the comparison group were on average more healthy than the infants and children in

the treatment group, the results of this comparison could lead to an underestimate of the program impact.

- Paige (1983) used as a comparison group infants who were fully eligible for WIC but lived in a county not served by WIC. However, while the parents of all the infants in the treatment group decided that their infants should participate in WIC, this choice was never available to parents of the infants in the comparison group. Therefore, the infants in the two groups may have differed in a wide variety of ways not measured in the data but related to program participation, such as their access to health care and their parents' attitudes and preferences.

Rush et al. examined the impact of WIC on six measures of the use of health care by infants and children:

1. Whether the child had a regular source of health care. The mother was asked where she usually took the child if he or she was sick. A response of "I don't know" or "the hospital emergency room" was coded as "no regular source of health care."

2. Whether the child had received preventive health care (defined as a regular checkup or immunization) within the past year.

3. Whether the mother had a record of the child's immunization.

4. Whether the child had received a measles vaccination.

5. Whether the child had received a diphtheria/pertussis/tetanus (DPT) vaccination.

6. Whether the child had received a polio vaccination.

Paige examined the impact of WIC participation on the likelihood that a child had received a DPT or a polio vaccination.

Rush et al. found that children who received WIC benefits were significantly more likely to have a regular source of health care than non-WIC children. However, since the Study of Infants and Children collected

cross-sectional data, we cannot determine whether WIC participation increased the use of health care services or whether the use of health care services encouraged participation in WIC. No significant relationship was found between WIC participation and the use of preventive health care by infants or children.[2]

Rush et al. found a positive relationship between WIC participation and the proportion of infants and children who had received some immunizations, but the relationship was only significant for some subsamples of children stratified according to when they first received WIC benefits. Children who received WIC benefits after their first birthday were 11 percent more likely to have an immunization card and 11 percent more likely to have had a measles vaccination than non-WIC children. Children who received WIC benefits were also more likely to have received a DPT vaccination, but this relationship was only significant for infants. Children whose mothers received WIC benefits while pregnant were more likely to have received a polio vaccination.

In contrast, Paige found no significant relationship between WIC participation and polio vaccination, and a *negative* relationship between WIC participation and DPT vaccination. Paige speculated that a higher proportion of WIC infants may have obtained immunizations from other sources; WIC infants also had more missing data.

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[2]In the Longitudinal Study of Pregnant women, Rush et al. also found no relationship between WIC participation and the frequency of prenatal visits by pregnant women. However, in the Historical Study, there was a significant positive association between WIC participation and first trimester registration of prenatal care and a significant negative association between WIC participation and inadequate prenatal care.

III. DATA AND METHODOLOGY

This chapter provides an overview of the data and methodology used in this study. The data are from the 1988 National Maternal and Infant Health Survey (NMIHS), a large, nationally representative survey of mothers who experienced a birth or fetal death in 1988. The NMIHS is the best available data source with which to assess the characteristics of WIC participants and nonparticipants, and the effects of WIC participation on birth and infant outcomes. The analyses of these data in this report include descriptive tabulations and multivariate analyses. For both types of analyses, important methodological issues include the choice of a comparison group, the choice of the sample to be analyzed, and the correct methods for estimation of means, proportions, and standard errors given the stratified sample design.

THE DATA

The 1988 NMIHS was sponsored by the National Center for Health Statistics (NCHS) to provide a database for the analysis of factors associated with pregnancy outcomes, child growth and development, and the use and cost of health care services. The 1988 NMIHS database contains data from three sources: (1) randomly selected nationwide samples of birth, fetal death, and infant death certificates (vital records); (2) mothers identified from these records who responded to questionnaires that were mailed to them or telephone follow-ups (referred to as the maternal survey); and (3) hospitals at which the mothers were admitted for delivery, and individuals and institutions who provided prenatal care to mothers and health care to mothers or infants up to 6 months postpartum (referred to as the provider survey).[1] This study uses data from the vital records and the 1988 maternal survey.

Data from the vital records include the following information. For the live-birth sample, the birth certificate contains the gender, birthweight, and gestational age of the newborn; the age, education, race, and state of residence of the mother; the state in which the delivery occurred; the number of prenatal visits and the month of pregnancy in which prenatal care began; and the number and outcomes of any previous pregnancies. Similar information is available for the fetal-death sample from the report of the fetal death. For the infant-death sample, the death certificate contains demographic characteristics of the infant and parents; and the date, place, and cause of death.

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[1]The 1991 Longitudinal Follow-up reinterviewed the mothers in the NMIHS sample approximately two-and-one-half years after the initial survey was conducted. These data are not yet available.

The maternal survey collected data from the samples of women identified in the vital records: (1) 9,953 mothers who experienced a live birth in 1988, (2) 3,309 mothers who experienced a fetal death of at least 28 weeks gestation in 1988, and (3) 5,332 mothers who experienced an infant death (children up to a year old) in 1988.[2] Infants with low birthweight were oversampled in the live-birth sample, and blacks were oversampled in all three samples. The final NMIHS data are representative of 48 states plus the District of Columbia.[3]

The NMHIS maternal survey provides the most recent nationally representative data on the characteristics and experiences of pregnant women including: the use and source of prenatal care; participation in WIC and other assistance programs; smoking habits, alcohol consumption, and illegal drug use before and during pregnancy; socioeconomic and demographic characteristics; employment before and after delivery; maternal and infant health and use of medical care during the first 6 months postpartum; infant feeding practices; and other pregnancies. The questions about the WIC Program included whether mothers participated in and the duration of participation in WIC during pregnancy, and whether the mother and infant participated in WIC and the duration of participation up to 6 months postpartum. Information on WIC participation was obtained both for the target pregnancy and for other pregnancies.

NCHS contracted with the Bureau of the Census to collect the data. Sampled mothers were mailed a 35-page questionnaire, a brochure describing the objectives and importance of the survey, and a prepaid return envelope. Mothers who did not respond to the initial mailing of the questionnaire received a second mailing, followed by a postcard

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[2]Data were also collected on a supplemental sample of American-Indian women who had a live birth in 1988 and on a supplemental sample of Hispanic women in Texas who had a live birth, fetal death, or infant death in 1988. However, these supplemental samples were not used in the analysis.

[3]The final sample does not include any cases from Montana because state officials refused to allow NCHS access to their vital records. In addition, the sample for South Dakota is incomplete because state officials provided vital records for events (i.e., live births, fetal deaths, and infant deaths) that occurred through July 1988 and then refused to participate further. The sample from South Dakota is therefore not representative of all events that occurred throughout 1988. The sample does not include observations from Puerto Rico or other U.S. territories.

reminder, and if necessary, they were contacted for a telephone or personal interview. The final response rates for the three national samples were 74 percent for mothers with live births, 69 percent for mothers with fetal deaths, and 65 percent for mothers experiencing infant deaths. Mothers completed the survey between 6 months and 30 months after the birth, with a median interval of 16 months. Only about 20 percent of the maternal surveys were completed within a year of the birth.

As discussed in Chapter II, most previous studies of WIC participants have relied on birth certificate data and/or program or clinical records. The NMIHS is unique in that the birth certificate data are supplemented by the rich detail collected in the maternal survey. It is also the only nationally representative database including both WIC participants and nonparticipants.

METHODOLOGICAL ISSUES

The analysis of data from the 1988 NMIHS has two parts: (1) a descriptive analysis that compares the characteristics and outcomes of WIC participants with income-eligible nonparticipants and higher-income nonparticipants, and (2) a multivariate analysis of the effects of WIC participation on birth outcomes. In this section, methodological issues relevant to both parts of the analysis are discussed:

- Selecting a comparison group
- Determining the sample to be employed in the analysis
- Weighting sample observations and computing standard errors under the stratified sample design

Selecting a Comparison Group

An appropriate comparison group is essential to the analysis of the effects of WIC participation on maternal and infant outcomes. However, selecting an appropriate comparison group for an ongoing program like WIC is extremely problematic. Ideally, the comparison group should consist of individuals who, as a group, are identical to WIC participants in all ways except for participation in the WIC Program. Our basic approach in this study is to define the comparison group as income-eligible nonparticipants. It must be recognized, however, that income-eligible nonparticipants may differ from WIC participants in multiple ways that may affect the outcomes of interest. For example, even among pregnant women who are income-eligible for WIC, some nonparticipants may not be at nutritional risk and, therefore, not qualify for the program. Alternatively, some pregnant nonparticipants may be at higher risk than participants for a poor pregnancy outcome because they do not believe in the efficacy of prenatal care and have therefore not applied for WIC benefits, or because access to the program is a problem for them. Similar issues arise in comparing postpartum women and infant participants to income-eligible nonparticipants.

Identifying WIC participants from the 1988 NMIHS data is a straightforward process, since the data reflect each woman's answer to two questions: (1) whether she received WIC food during pregnancy, and (2) whether she and her infant received WIC food during the 6 months following delivery. If a respondent answered "yes" to the first question, she is identified as a prenatal WIC participant; if she answered "yes" to the second question, she or her infant can be identified as a WIC participant after the birth. Additional questions on the number of months receiving WIC for the mother and baby in the postpartum period allow us to distinguish postpartum and infant WIC participants.

Income-eligible nonparticipants are identified from the data by comparing the incomes of nonparticipants to the WIC income-eligibility standard of 185 percent of the federal poverty level. However, some approximations are required in making this comparison, because the only income data collected in the 1988 survey reflect the pretax income of the household during the 12 months prior to delivery. Information was not collected on income received during the 6 months following delivery or on the rate of income receipt. Thus, the survey does not contain an ideal set of income data for determining WIC income-eligibility for nonparticipating women and infants throughout the entire period covered by the survey. Nonparticipants who are income-eligible for WIC are identified, both during pregnancy and during the 6 months following delivery, by using the reported total household income on the file as a proxy for the household

income that would be used in the actual eligibility determination at any given point in the period of observation.

More specifically, WIC nonparticipants are classified as income-eligible for WIC during pregnancy if one or more of the following conditions are satisfied:

- Reported household income for the 12 months prior to delivery was less than or equal to 185 percent of the poverty level.
- The woman reported Medicaid as a source of payment for her prenatal care.
- The household received AFDC or food stamp benefits during the 12 months prior to delivery.

For births that occurred before July 1, 1988, the federal poverty guidelines effective July 1, 1987 through June 30, 1988 are used to determine income-eligibility for WIC. For births that occurred on or after July 1, 1988, the federal poverty guidelines effective July 1, 1988 through June 30, 1989 are used.

Income eligibility for WIC also depends on household size, since this determines the appropriate poverty threshold for the household. The 1988 NMIHS questioned women about the size of their household (1) during most of their pregnancy and (2) at the time of the interview. Household size reported during pregnancy is used to determine income eligibility during the woman's pregnancy, and household size reported at the time of the interview is used to determine income eligibility during the 6 months following delivery.

The descriptive analysis in Chapter IV assesses the similarity of WIC participants, income-eligible nonparticipants, and higher-income nonparticipants in terms of a wide range of characteristics available from the survey and the birth certificate, including demographic and socioeconomic characteristics; use and source of prenatal care; and behavioral risk factors such as smoking, alcohol consumption, and illegal drug use during pregnancy. These comparisons do not show the effects of the WIC Program, but are used to help interpret the differences in observed outcomes.

Multivariate analysis techniques are used in Chapter V to control for differences in the observed characteristics of WIC participants and income-eligible nonparticipants. However, these estimates may not control for differences in unobserved characteristics that affect key outcomes. Attempts to apply statistical methods to control for unobserved differences (selection bias) were not successful, as discussed more fully in Chapter V. Thus, even after controlling for observed differences between participants and income-eligible nonparticipants, differences in outcomes may be due to either the effects of WIC or to unobserved factors associated with WIC participation.

Determining the Analysis Sample

The NMIHS maternal survey consists of three samples: the live-birth sample, the fetal-death sample, and the infant-death sample. All of the analyses in this report use the live-birth sample. Infant mortality is examined using the live-birth sample because infant mortality is defined as the number of infant deaths per 1,000 live births. Because the live birth sample includes a representative sample of infant deaths, it was not necessary to include the supplemental infant death sample. In principle, one could combine the fetal-death and live-birth samples to produce descriptive tables on the entire population of women who experienced a pregnancy in 1988. In reality, however, fetal death is such a rare event that when weighted, the inclusion of the fetal-death sample would have a negligible effect on the descriptive statistics. In addition, combining the two samples would increase the design effect, and thus reduce the power to detect statistically significant differences between WIC participants and income-eligible nonparticipants. Therefore, all estimates in this report are computed for the live-birth sample only.

Weighting Sample Observations and Computing Standard Errors

The stratified sample design of the NMIHS must be considered in an analysis of the data. The live-birth sample was stratified by race, birthweight, and state; and the infant-death and fetal-death samples were stratified by race and state. Blacks were oversampled in all samples, and infants of very low birthweight (less than 1,500 grams) and moderately low birthweight (1,500 to 2,499 grams) were oversampled in the live-birth sample. For the live-birth sample, the sampling rates are as follows:

- Black
  - Less than 1,500 grams: 1/14
  - 1,500 to 2,499 grams: 1/55
  - 2,500 grams and over: 1/113

- White and all other

  - Less than 1,500 grams: 1/29
  - 1,500 to 2,499 grams: 1/160
  - 2,500 grams and over: 1/720

Thus, 1 of every 14 live births among blacks that resulted in a newborn weighing less than 1,500 grams was selected into the sample, while only 1 of every 720 live births among "nonblacks" that resulted in a newborn of at least 2,500 grams was selected into the sample. These sampling rates were applied individually to each state rather than to the national population. Thus, within a given stratum defined by race and birthweight, the percentage distribution across states of the original sample (respondents plus nonrespondents) matches that of the national population.[4]

All analyses for this report use sample weights constructed by NCHS to ensure that (1) statistics generated for the total population or population subgroups are not biased toward the overrepresented strata and (2) standard errors are correctly computed. The NMIHS sample weights designed by NCHS correct for the stratified sample design as well as for unit nonresponse. The sample weights are derived as the product of two factors: (1) a factor to account for the different sampling rates across strata and (2) a factor to account for different rates of unit nonresponse. For each sample member, the first factor is the inverse of the sampling rate for the stratum to which the individual was assigned, and the second factor is the inverse of the response rate for the "response category" to which the individual was assigned. Response categories were defined by classifying women in each stratum on the basis of marital status. Thus, the correction for unit nonresponse allows for variation in response rates by marital status, race, and for the live-birth sample, birthweight.

To account for the stratified sample design, the software program SUDAAN--Professional Software for Survey Data Analysis for Multi-Stage Sample Designs, Release 6.30 (Shah et al. 1991, 1992)--was used to compute weighted means, proportions, and regression coefficients, and to compute standard errors for these statistics. SUDAAN computes standard errors using the Taylor series linearization method. The estimation of the standard errors accounted for the stratification by state as well as by race and birthweight.

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[4]The stratification by state is not mentioned in the documentation for the NMIHS public use tape, but it was discovered through conversations with NMIHS staff.

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IV. CHARACTERISTICS OF WIC PARTICIPANTS AND NONPARTICIPANTS

This chapter presents findings from a descriptive analysis of the characteristics, behavior, and experience of WIC participants, income-eligible nonparticipants, and higher-income nonparticipants. Comparisons of WIC participants and income-eligible nonparticipants are used to delineate who participates in WIC and to highlight differences in outcomes that may be worthy of further analysis. Higher-income nonparticipants--nonparticipants *not* income-eligible for WIC--are included in the analysis to show how low-income women and infants differ from higher-income women and infants. None of the comparisons in this chapter--including comparisons of birth outcomes--should be interpreted as indicative of the effects of the WIC Program because they do not control for other differences in the characteristics of these groups.

The first section of this chapter describes the prevalence of WIC participation among income-eligible pregnant women, infants, and postpartum women, and the program-related experiences of prenatal participants. The second section examines the characteristics and experience of prenatal WIC participants, and compares them with the characteristics and experience of income-eligible pregnant women who did not participate in the WIC Program during pregnancy and with those of higher-income pregnant women. The third section presents descriptive comparisons in which the WIC participant sample is defined on the basis of mothers' and infants' WIC participation during the first six months following delivery. Two sets of comparisons are presented: postpartum WIC participants are compared with postpartum nonparticipants, and infant WIC participants are compared with infant nonparticipants.

Throughout this chapter, the statistical significance of the differences between WIC participants and income-eligible nonparticipants, and between WIC participants and higher-income nonparticipants is presented. For categorical variables, the distributions are compared using a chi-square test, which tests whether the distribution of the variable is independent of WIC participation status. For continuous variables, a two-tailed t-test is used to determine whether the means for the two groups are significantly different. Differences that are statistically significant at the .05 level or better are noted as such in the tables.

PARTICIPATION AND EXPERIENCES IN THE WIC PROGRAM

This section describes the level and duration of participation in WIC by pregnant women, infants, and postpartum women, and the experiences of prenatal participants in the WIC program.

WIC Participation (Table IV.1)

Based on the weighted NMIHS data, about 1,151,000 of the women who gave birth in 1988 were prenatal WIC participants, about 941,000 were postpartum WIC participants, and about 1,348,000 of the infants born in 1988 were infant WIC participants. The proportion of income-eligible persons participating in WIC was highest for infants (70 percent), next highest for pregnant women (62 percent), and lowest for postpartum women (51 percent).[1]

Based on the mother's retrospective reports, prenatal WIC participants participated for an average of 5.5 months during pregnancy. Most prenatal participants (51 percent) entered WIC during the first trimester, 35 percent entered during the second trimester, and 14 percent entered during the third trimester. The mothers were asked in which month of pregnancy they began receiving WIC benefits. The mothers' reports suggest earlier enrollment in WIC than is shown in program data. In particular, the 1988 WIC Participant and Program Characteristics data indicate that only 24 percent of prenatal participants entered during the first trimester, while 48 percent entered during the second trimester, and 28 percent during the third trimester (Williams 1991). It may be that mothers interpret the "first month" as the first month after they learn of the pregnancy, or as the period after they have been pregnant for one month, which is in fact the second month.

Postpartum mothers reported the total number of months that both they and their infants participated in the program. About 12 percent of mothers and 57 percent of infants were still participating in WIC at the time of the maternal survey.[2] (Mothers were surveyed from 6 months to 30 months after the birth, with a median interval of 16 months. Only about 20 percent of the maternal surveys were completed within a year of birth.) Because many were still participating, the mean duration of WIC participation reported in Table IV.1 understates the total duration of

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[1]The estimated participation rates are, of course, sensitive to the method used to estimate income-eligibility. Our definition of income-eligibility is discussed in Chapter III.

[2]For those still participating at the time of the survey, the number of months of participation was not recorded. We assumed these mothers and infants had been participating since the birth, which may lead to some overstatement of durations. Even when the number of months participating was recorded, we do not know if participation started at birth. In most cases, however, it is reasonable to assume participation started with birth, since most infant and postpartum participants also were prenatal participants.

TABLE IV.1

WIC PARTICIPATION AND DURATION OF PARTICIPATION
BY PREGNANT WOMEN, INFANTS, AND POSTPARTUM WOMEN

	Pregnant Women	Infants	Postpartum Women
Number of WIC Participants (Weighted)	1,151,181	1,347,960	941,244
Percent of Income-Eligibles Who Participated in WIC	61.7	70.1	50.9
Mean Duration of Participation (Months)	5.5	12.8 [a]	6.6 [a]
Month of Pregnancy Began Receiving WIC (Percent Distribution)			
First	14.3	n.a.	n.a.
Second	16.3		
Third	20.5		
Fourth	14.8		
Fifth	11.3		
Sixth	8.4		
Seventh	6.8		
Eighth	3.7		
Ninth	3.9		
Duration of Participation after Birth (Percent Distribution)[a]			
1-3 months	n.a.	5.3	27.2
4-6 months		10.3	46.7
7-9 months		9.8	7.3
10-12 months		31.2	9.7
More than 12 months		43.4	9.1
Prenatal Participants Who Also Received WIC Postpartum (for This Pregnancy) (Percent)	77.1	n.a.	n.a.
Prenatal Participants Whose Infants Received WIC (for This Pregnancy) (Percent)	99.3	n.a.	n.a.
Prenatal WIC Participants (Percent)	n.a.	76.0	84.3
Sample Size (Unweighted)	**3,868**	**4,500**	**3,003**

SOURCE: 1988 National Maternal and Infant Health Survey.

NOTE: All means and percent distributions are based on weighted data and are calculated using SUDAAN.

[a]Duration of participation between birth and interview. Duration of participation will be understated for those still participating at the time of the interview. Approximately 57 percent of infants and 12 percent of mothers were still participating at the time of the interview; infants may have been recertified as children and postpartum mothers may have become pregnant again. Interviews occurred from 6 months to 30 months after birth.

n.a. = not applicable.

participation, especially for infants (who may continue to participate as children up to the age of 5) and for those surveyed early. Nonetheless, the data indicate that 84 percent of infant WIC participants were in the program for more than 6 months, and at least 43 percent participated for more than a year. The average duration of participation was slightly more than a year. Thus, participation generally lasted through much of infancy.

Most postpartum mothers (74 percent) participated in WIC for 6 months or less. Only 17 percent participated from 7 to 12 months, and only 9 percent of postpartum WIC participants participated for more than a year after the child's birth. (Although the program serves postpartum mothers for at most 1 year--1 year if breastfeeding, 6 months if not--some of the mothers reporting longer periods of participation may have become pregnant again.) The average duration of participation for postpartum mothers was nearly 7 months.

More than three-quarters of prenatal WIC participants were postpartum participants, and more than 99 percent of their infants were infant WIC participants. Examined from the opposite perspective, roughly three-quarters of infant WIC participants had mothers who were prenatal WIC participants, and 84 percent of postpartum WIC participants had been prenatal WIC participants. Thus, infant WIC participants included essentially all infants of prenatal WIC participants plus other low-income infants. The population of postpartum WIC participants overlapped for the most part the population of prenatal WIC participants, but there were a number of women in each group who were not in the other group.

Program Experiences of Prenatal WIC Participants (Table IV.2)

The NMIHS survey collected especially detailed data on WIC Program experiences for prenatal WIC participants. Prenatal WIC participants usually learned of the WIC Program from friends or relatives (43 percent), doctors or other health care providers (36 percent), or previous experience with WIC (28 percent). While almost all prenatal participants reported receiving advice concerning nutrition, the major focus of the WIC Program, 60 percent or more reported receiving other types of health advice in addition to nutritional advice. Information was usually obtained through individual counseling sessions (71 percent) or through pamphlets (52 percent). Participants less frequently received information through classes or group sessions (37 percent) or through films and videos (32 percent).

Mothers' self-reports concerning information received from the WIC Program are not necessarily accurate portrayals of information that was available from the WIC Program for two reasons: (1) mothers were not

TABLE IV.2

PRENATAL WIC PARTICIPANTS' EXPERIENCE WITH THE WIC PROGRAM

	All Prenatal WIC Participants	Classified By Race	
		White	Black
Mean Number of Months Received WIC during Pregnancy	5.50	5.48	5.48
Trimester of Pregnancy Began Receiving WIC (Percent Distribution)			
First	51.0	49.8	52.4 **
Second	34.6	33.9	36.4
Third	14.3	16.2	11.2
Participants Who Reported Receiving the Following Advice at the WIC Office (Percent)			
Eat proper foods	94.1	94.4	93.5
How to use WIC foods	87.2	87.5	86.3
How much weight to gain	67.3	67.6	66.2
Breastfeed baby	63.7	66.2	56.2 **
Feed infant formula	60.2	57.7	64.7 **
How to buy food	60.9	61.0	60.8
Get prenatal care	65.8	67.3	63.5
Reduce/stop smoking	65.3	67.8	60.6 **
Reduce/stop drinking	59.7	61.2	56.8 *
Avoid illegal drugs	61.7	62.0	61.5
Participants Who Reported Receiving Information at the WIC Office through (Percent)			
Classes or group sessions	36.6	37.2	35.2
Individual sessions	71.2	73.2	68.4 **
Pamphlets	51.7	53.4	48.4 **
Films or videos	32.3	34.2	27.3 **
Participants Who Reported Learning About the WIC Program from (Percent)			
Friend or relative	43.3	46.6	36.7 **
Doctor or other health care provider	36.3	33.4	41.0 **
Social worker	7.3	7.0	8.2
Advertisement or poster	3.9	4.5	2.9
Previous experience with WIC	27.5	25.9	31.9 **
Other	3.7	4.3	2.8
Sample Size[a]	**3,868**	**1,107**	**2,671**

TABLE IV.2 *(continued)*

SOURCE: 1988 National Maternal and Infant Health Survey.

NOTE: All means, percent distributions, and tests of statistical significance are based on weighted data and are calculated using SUDAAN. Tests of statistical significance are based on t-statistics for the difference in means of the continuous variables and chi-square statistics for the difference in the percent distributions of the categorical variables.

[a]A small number of participants (90) are either Asian or Native American. They are included in the total column but not in the columns for white and black.

* (**): The difference between whites and blacks is statistically significant at the .05 (.01) level.

required to participate in nutrition education and related counseling sessions; and (2) even among those who received a particular type of advice or service, those mothers who later followed the advice may be more likely to remember and report it. For example, mothers who later breastfed their babies may be more likely to report receiving advice concerning the benefits of breastfeeding.

Differences in the Experiences of Black and White Prenatal WIC Participants (Table IV.2)

Blacks and whites differed in the timing of their entry into the WIC Program, in the types of advice they reported receiving from the program, and in how they learned of the program.[3] Blacks entered the WIC Program earlier in pregnancy than whites--in particular, blacks were more likely than whites to enter in the first two trimesters, while whites were more likely than blacks to enter in the third trimester.

Whites were more likely to report receiving advice to breastfeed their babies, while blacks were more likely to report receiving advice to give formula. In addition, whites were more likely to report being advised to stop or reduce smoking, and to stop or reduce drinking. However, these differences were not large, and may reflect differences in recall and reporting by the mothers rather than in the advice actually offered by the program.

Black mothers reported receiving information from the WIC Program through fewer sources than white mothers. Black mothers were more likely than white mothers to have learned of the WIC Program through their health care providers or through previous experience with WIC, and less likely to have learned of the program through word-of-mouth.

PRENATAL WIC PARTICIPANTS AND NONPARTICI-PANTS

This section identifies the key characteristics of prenatal WIC participants and compares them with those of income-eligible pregnant nonparticipants and higher-income pregnant nonparticipants. These characteristics include demographic and socioeconomic characteristics, prenatal care, behavioral risk factors (alcohol use, cigarette smoking, and drug use), previous pregnancies, and pregnancy outcomes for the target pregnancy.

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[3]All differences discussed in this section are statistically significant.

Demographic and Socioeconomic Characteristics (Table IV.3)

The WIC Program serves individuals who are disadvantaged on average, even relative to the rest of the income-eligible population. Prenatal WIC participants were more likely to be teenagers, less likely to have a high school diploma, more likely to be black or Hispanic, and less likely to be married or living with the baby's father than were income-eligible nonparticipants or higher-income nonparticipants. In addition, WIC participants were less likely to have been employed in the previous year, and were more likely to depend on Medicaid and to lack private health insurance than were nonparticipants. Nonetheless, fully 54 percent of WIC participants had worked in the 12 months prior to delivery (compared with 62 percent of income-eligible nonparticipants and 79 percent of higher-income pregnant women).

The characteristics of the fathers showed similar patterns: the fathers of the WIC participants' babies were younger, less educated, more likely to be black or Hispanic, and less likely to have been employed than were the fathers of the babies of income-eligible nonparticipants and higher-income nonparticipants.

Prenatal WIC participants and income-eligible nonparticipants did not differ significantly in terms of household size or mean household income, but WIC participants were more likely to depend on public assistance income. In addition, a larger proportion of WIC participants had incomes below the poverty level (56 percent versus 45 percent), although WIC participants were also more likely than income-eligible nonparticipants to have household incomes above 185 percent of the poverty level.[4] WIC participants were less likely than income-eligible nonparticipants to live in metropolitan counties, suggesting that WIC reaches a larger proportion of the income-eligible population in rural areas.

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[4]The latter contrast reflects the definition of income-eligible nonparticipants. By definition, income-eligible nonparticipants either have household incomes below 185 percent of the poverty level or they received AFDC, Medicaid, or food stamps. Higher-income nonparticipants have household incomes above 185 percent of the poverty level. However, WIC participants may have incomes exceeding 185 percent of the poverty level, because the data on income reflect total household income during the 12 months prior to delivery, not total household income at the time of application for WIC.

TABLE IV.3

DEMOGRAPHIC AND SOCIOECONOMIC CHARACTERISTICS OF PRENATAL WIC PARTICIPANTS, INCOME-ELIGIBLE NONPARTICIPANTS, AND HIGHER-INCOME NONPARTICIPANTS

	Prenatal WIC Participants	Income-Eligible Nonparticipants	Higher-Income Nonparticipants
Mother's Characteristics			
Mean Age (Years)	23.4	25.0 **	28.4 **
Age (Percent Distribution)			
Younger than 18	10.8	5.3 **	1.0 **
18 - 19	14.6	12.1	2.1
20 - 24	38.9	33.3	18.8
25 - 29	22.2	27.9	38.5
30 - 34	9.5	15.7	28.5
35 and older	4.0	5.7	11.2
Education (Percent Distribution)			
8 years or less	8.7	7.7 **	0.9 **
9 - 11 years	30.9	19.2	3.8
High school graduate	43.3	45.0	34.8
Some college	14.7	20.6	30.7
College graduate	2.5	7.6	29.8
Race (Percent Distribution)			
White	64.0	73.3 **	88.9 **
Black	31.5	22.1	5.7
Asian or Pacific Islander	2.0	3.3	4.7
Native American	2.5	1.3	0.6
Hispanic (Percent)	20.3	15.7 **	7.7 **
Married (Percent)	48.0	64.3 **	93.0 **
Lived with the Baby's Father during Most of the Pregnancy (Percent)	59.6	73.2 **	95.3 **
Employed at Any Time during 12 Months prior to Delivery (Percent)	54.0	61.9 **	78.8 **
Covered by Medicaid for Prenatal Care and/or Delivery (Percent)	55.1	29.2 **	0.5 **
No Private Health Insurance during Pregnancy (Percent)	60.7	44.3 **	8.6 **

TABLE IV.3 *(continued)*

	Prenatal WIC Participants	Income-Eligible Nonparticipants	Higher-Income Nonparticipants
Father's Characteristics			
Mean Age (Years)	27.9	29.0 **	32.0 **
Age (Percent Distribution)			
Younger than 18	0.4	0.2 **	0.0 **
18 - 19	4.0	3.8	0.4
20 - 24	29.9	22.6	6.5
25 - 29	33.1	31.3	27.4
30 - 34	18.6	23.3	36.3
35 and older	14.1	18.8	29.4
Education (Percent Distribution)			
8 years or less	9.5	8.4 **	0.9 **
9 - 11 years	24.0	16.7	4.6
High school graduate	50.7	46.1	34.2
Some college	12.3	18.7	22.9
College graduate	3.5	10.2	37.4
Race (Percent Distribution)			
White	60.9	72.2 **	89.1 **
Black	33.6	23.0	6.1
Asian or Pacific Islander	2.0	2.9	4.2
Native American	3.5	2.0	0.7
Hispanic (Percent)	21.9	16.1 **	6.7 **
Employed at Any Time during 12 Months prior to Delivery (Percent)	84.3	88.9 **	98.4 **
Household Characteristics			
Mean Household Size	4.0	4.0	3.0 **
Nonmetropolitan County (Percent)	32.6	23.7 **	17.8 **
Currently Receiving AFDC (Percent)	37.0	21.9 **	0.9 **
Currently Receiving Food Stamps (Percent)	45.0	24.2 **	1.0 **
Mean Annual Pretax Income (Dollars)	12,564	13,266	40,029 **

TABLE IV.3 *(continued)*

	Prenatal WIC Participants	Income-Eligible Nonparticipants	Higher-Income Nonparticipants
Mean Annual Pretax Income per Household Member (Dollars)	3,858	3,851	15,015 **
Pretax Income as a Percentage of the Poverty Level (Percent Distribution)			
100 or less	56.2	45.2 **	0.0 [a]
101 - 150	17.2	25.6	0.0 [a]
151 - 185	8.5	21.0	0.0 [a]
186 - 250	8.7	2.8	15.8
More than 250	9.6	5.5	84.2
Any Income or Assistance from the Following Sources during 12 Months prior to Delivery (Percent)			
Wages, salaries, interest, or dividends	74.8	85.4 **	99.7 **
AFDC	34.1	21.4 **	0.0 [a]
Food stamps	38.0	21.8 **	0.0 [a]
Housing assistance or public housing	8.6	5.9 **	0.3 **
Social security or SSI	8.6	7.5	0.8 **
Unemployment insurance	4.8	5.8	2.1 **
Veteran's benefits	1.5	3.0 **	0.5 **
Child support/alimony from absent parent	5.5	6.8	2.0 **
Sample Size (Unweighted)	**3,868**	**2,302**	**3,783**

SOURCE: 1988 National Maternal and Infant Health Survey.

NOTE: All means, percent distributions, and tests of statistical significance are based on weighted data and are calculated using SUDAAN. Tests of statistical significance are based on t-statistics for the difference in means of the continuous variables and chi-square statistics for the difference in the percent distributions of the categorical variables.

[a]By definition, higher-income nonparticipants had incomes exceeding 185 percent of poverty level and did not receive AFDC or food stamps.

*(**): The difference between WIC participants and nonparticipants is statistically significant at the .05 (.01) level.

Prenatal Care (Table IV.4)

While fully 82 percent of higher-income nonparticipants received adequate prenatal care, only slightly more than half of both WIC participants and income-eligible nonparticipants received adequate prenatal care, based on the Kessner Index. The Kessner Index is one of the most commonly used measures of the adequacy of prenatal care. The index combines information on the month in which prenatal care started, the number of prenatal care visits recorded, and pregnancy gestation to define the adequacy of prenatal care (Kessner et al. 1973). For a full-term pregnancy, adequate prenatal care is defined as nine or more visits, with the first visit occurring during the first trimester of pregnancy, and inadequate care is defined as four or fewer visits. Intermediate care for a full-term pregnancy is defined as all levels of prenatal care between adequate and inadequate care. For preterm births (births before 37 weeks gestation), the number of prenatal care visits required for care to be classified as adequate is adjusted downward, based on the shorter length of gestation. It should be kept in mind, however, that the Kessner Index characterizes the utilization of prenatal care, but provides no information on the quality of care received. Furthermore, the index is based on recommended visits in a normal pregnancy; those with high-risk pregnancies may need more visits. And lastly, the Kessner Index tends to overstate the adequacy of care for women with full-term or postterm births (Kotelchuck 1987).

WIC participants were less likely to receive inadequate prenatal care than were income-eligible nonparticipants in several respects: participants were less likely to receive no prenatal care (1.3 percent versus 4.9 percent for nonparticipants), and participants who received prenatal care were less likely than income-eligible nonparticipants to receive inadequate care (as measured by the Kessner Index) and more likely to receive an intermediate level of care. The month in which care began for participants did not differ significantly from the month in which care began for income-eligible nonparticipants.

WIC participants were more likely than both groups of nonparticipants to have received their prenatal care from county or city health departments, community health centers, or hospital clinics, and were less likely to have used private doctors or HMOs. This pattern reflects the fact that the former group of care locations are often local sites for the WIC Program.

More than 90 percent of women in all groups reported receiving advice concerning nutrition during prenatal visits. WIC participants were more likely to report having received advice concerning other behavior--such as advice to breastfeed or warnings to avoid smoking and alcohol--during prenatal visits than were income-eligible nonparticipants. This difference

TABLE IV.4

THE USE AND SOURCE OF PRENATAL CARE
(Percentages)

	Prenatal WIC Participants	Income-Eligible Nonparticipants	Higher-Income Nonparticipants
Women with No Prenatal Care	1.3	4.9 **	0.6
Month of Pregnancy in Which Prenatal Care Began			
First	10.5	13.1	21.5 **
Second	31.2	31.7	50.1
Third	22.7	23.0	20.3
Fourth	13.0	12.7	4.2
Fifth	10.6	9.1	1.9
Sixth	5.7	4.2	0.7
Seventh	3.8	3.0	0.8
Eighth	2.1	2.2	0.4
Ninth	0.4	1.0	0.2
Kessner Index of the Adequacy of Prenatal Care			
Inadequate	6.8	9.7 **	1.5 **
Intermediate	37.3	30.7	13.6
Adequate	51.8	54.4	82.2
Missing[b]	4.0	5.3	2.7
Primary Source of Prenatal Care			
Private doctor's office	40.8	59.9 **	78.8 **
County or city health dept.	18.4	7.0	0.7
Community health center	12.7	7.6	2.8
HMO	1.7	3.8	7.7
Clinic at work or school	0.5	0.4	0.1
Clinic in a hospital	21.7	16.7	6.2
Hospital emergency room	0.3	0.2	0.0
Other	3.9	4.4	3.7
Advice Received during Prenatal Visits			
Vitamin/mineral supplements	96.3	94.9	98.2 **
Proper nutrition	91.9	90.8	94.0 *
Breastfeed baby	57.0	47.2 **	52.3 **
Avoid alcohol	64.6	58.7 **	72.0 **
Avoid smoking	71.7	63.1 **	68.7 *
Avoid illegal drugs	69.3	59.8 **	64.3 **

TABLE IV.4 *(continued)*

	Prenatal WIC Participants	Income-Eligible Nonparticipants	Higher-Income Nonparticipants
Sources of Payment for Prenatal Care			
Own or husband's income	18.6	34.5 **	43.1 **
Parents, other relatives, or boyfriend	3.0	4.5	1.5 **
Private insurance	21.4	42.5 **	84.6 **
Medicaid	50.8	26.2 **	0.0 [a]
Other government assistance	14.0	9.2 **	0.7 **
Women Reporting Difficulty in Obtaining Prenatal Care	22.3	19.9	6.7 **
Problems with money or insurance	11.5	10.8	2.4 **
Problems with appointments, work, or transportation	10.1	7.3 **	2.4 **
Problems with health care providers	7.0	4.3 **	2.5 **
Other problems	3.1	4.5	1.0 **
Women Hospitalized During Pregnancy	18.2	13.6 **	12.0 **
Sample Size (Unweighted)	**3,868**	**2,302**	**3,783**

SOURCE: 1988 National Maternal and Infant Health Survey.

NOTE: All means, percent distributions, and tests of statistical significance are based on weighted data and are calculated using SUDAAN. Tests of statistical significance are based on t-statistics for the difference in means of the continuous variables and chi-square statistics for the difference in the percent distributions of the categorical variables.

[a]By definition, higher-income nonparticipants did not receive Medicaid payments for prenatal care.

[b]The Kessner Index could not be computed for observations with a missing value for gestational age.

*(**): The difference between WIC participants and nonparticipants is statistically significant at the .05 (.01) level.

is likely to reflect efforts of the WIC Program to make health information available to participants. On some issues--breastfeeding, and avoiding smoking and drugs--WIC participants reported receiving advice more often than did higher-income nonparticipants. However, WIC participants reported that they received advice to avoid alcohol less often than higher-income nonparticipants. As noted above, mothers' reports concerning health advice they received may be biased in that they may be more likely to recall advice they later followed; thus, differences in reporting of advice between WIC participants and nonparticipants may not reflect actual differences in advice received.

WIC participants were much more dependent than income-eligible nonparticipants on Medicaid or other government assistance for payment for prenatal care: 51 percent of WIC participants used Medicaid as compared with 26 percent of nonparticipants. Income-eligible nonparticipants were more likely than participants to pay for care with their own funds (35 percent compared to 19 percent, respectively) or through private insurance (43 percent versus 21 percent).[5]

There were few differences between WIC participants and income-eligible nonparticipants in the barriers to obtaining prenatal care, although both groups were more likely than higher-income nonparticipants to face barriers. WIC participants were somewhat more likely to report difficulties with logistics and with their health care providers.

Finally, 18 percent of WIC participants were hospitalized during pregnancy as compared with 14 percent of income-eligible nonparticipants (and 12 percent of higher-income nonparticipants). It is likely that this difference is related to the fact that the WIC Program is targeted at women with high-risk pregnancies among the income-eligible group.

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[5]All nonparticipants covered by Medicaid were classified as income-eligible nonparticipants. Thus, by definition, higher-income nonparticipants paid for care entirely through private sources.

Behavioral Risk Factors--Alcohol Consumption, Cigarette Smoking, and Drug Use (Table IV.5)

The reported prevalence of maternal behaviors that create risk for fetal development--alcohol consumption, cigarette smoking, and drug use--varies somewhat among the subgroups of women. (Because these tabulations are based on mothers' reports, they may understate actual prevalence.) In general, WIC participants did not differ significantly from income-eligible nonparticipants in these behaviors except that they were slightly less likely to report alcohol use before pregnancy. However, both low-income groups were less likely to report alcohol use (especially in moderation) and were more likely to report smoking and drug use, both before and during pregnancy, than were higher-income women. While 31 percent of WIC participants, 38 percent of income-eligible nonparticipants, and 56 percent of higher-income nonparticipants reported using alcohol in the year before the birth, almost all the mothers reported reduced consumption during pregnancy. Fully 86 percent of WIC participants, 82 percent of income-eligible nonparticipants, and 75 percent of higher-income mothers reported that they did not consume alcohol after they knew they were pregnant, and more than 95 percent of all three groups reported less than 1 drink per week. Furthermore, the proportions reporting high levels of alcohol consumption dropped considerably in all three groups after the onset of pregnancy.

Before pregnancy, 37 percent of WIC participants smoked cigarettes, but only 29 percent smoked during pregnancy (implying about one-fifth of smokers had quit). Those who did not quit reduced the number of cigarettes they smoked on average by about a quarter, from 16.4 cigarettes per day to 12.5. Income-eligible nonparticipants were essentially indistinguishable from WIC participants in their tendency to smoke both before and during pregnancy. Higher-income nonparticipants were less likely than WIC participants to smoke before pregnancy (only 24 percent smoked) and were more likely to quit during pregnancy (only 16 percent smoked after learning they were pregnant).

Small numbers of WIC participants reported use of illegal drugs: 7.4 percent reported using marijuana, and 2.1 percent reported using cocaine during the 3 months before learning of the pregnancy; 3.4 percent reported using marijuana, and 1 percent reported using cocaine while pregnant. Reported drug use among income-eligible nonparticipants did not differ significantly from reported drug use among participants, while higher-income nonparticipants were much less likely to report drug use.

TABLE IV.5

ALCOHOL CONSUMPTION, CIGARETTE SMOKING, AND DRUG USE BEFORE AND DURING PREGNANCY

	Prenatal WIC Participants	Income-Eligible Nonparticipants	Higher-Income Nonparticipants
Alcohol Consumption			
Women Who Drank Any Alcoholic Beverage during the 12 Months before Delivery (Percent)	31.0	37.9 **	56.0 **
Reported Frequency of Alcohol Consumption during the 3 Months before the Woman Found Out She Was Pregnant (Percent)			
14 or more drinks per week	1.4	1.2 **	1.1 **
6 - 13 drinks per week	3.3	3.4	3.8
3 - 5 drinks per week	3.8	5.0	7.8
1 - 2 drinks per week	5.6	6.4	11.4
Less than 1 drink per week	16.4	21.6	31.7
Did not drink	69.5	62.4	44.1
Reported Frequency of Alcohol Consumption after the Woman Found Out She Was Pregnant (Percent)			
14 or more drinks per week	0.3	0.4	0.1 **
6 - 13 drinks per week	0.5	0.6	0.2
3 - 5 drinks per week	0.8	1.3	0.7
1 - 2 drinks per week	2.1	1.9	3.1
Less than 1 drink per week	10.3	13.9	21.4
Did not drink	86.0	82.0	74.5
Drinkers Who Reported Reducing Alcohol Consumption during Pregnancy (Percent)	89.5	87.7	93.0 *
Cigarette Smoking			
Women Who Reported Smoking Cigarettes (Percent)			
During 3 months before the woman found out she was pregnant	37.2	35.3	23.9 **
After she found out she was pregnant	29.3	28.8	15.9 **
Cigarettes Smoked Per Day (Mean Number)			
During 3 months before the woman found out she was pregnant	16.4	16.8	15.6
After she found out she was pregnant	12.5	12.4	11.5

TABLE IV.5 *(continued)*

	Prenatal WIC Participants	Income-Eligible Nonparticipants	Higher-Income Nonparticipants
Reported Frequency of Cigarette Smoking during 3 Months before the Woman Found Out She Was Pregnant			
15 or more per day	20.7	20.8	14.0 **
6 - 14 per day	11.2	10.2	5.8
1 - 5 per day	5.3	4.3	4.1
Did not smoke	62.8	64.7	76.1
Reported Frequency of Cigarette Smoking after the Woman Found Out She Was Pregnant			
15 or more per day	10.1	10.3	5.5 **
6 - 14 per day	11.5	10.4	5.4
1 - 5 per day	7.8	8.0	5.1
Did not smoke	70.7	71.2	84.1
Smokers Who Quit Smoking for at Least a Week during Pregnancy (Percent)	48.3	50.8	62.6 **
Drug Use			
Women Who Reported Smoking Marijuana or Hashish			
During the 3 months before the woman found out she was pregnant	7.4	6.1	4.2 **
After she found out she was pregnant	3.4	2.3	1.8 **
Women Who Reported Using Cocaine or Crack			
During the 3 months before the woman found out she was pregnant	2.1	2.7	1.1 **
After she found out she was pregnant	1.0	1.2	0.1 **
Sample Size (Unweighted)	**3,868**	**2,302**	**3,783**

SOURCE: 1988 National Maternal and Infant Health Survey.

NOTE: All means, percent distributions, and tests of statistical significance are based on weighted data and are calculated using SUDAAN. Tests of statistical significance are based on t-statistics for the difference in means of the continuous variables and chi-square statistics for the difference in the percent distributions of the categorical variables.

*(**): The difference between WIC participants and nonparticipants is statistically significant at the .05 (.01) level.

Previous Pregnancies and Previous WIC Participation (Table IV.6)

Data on previous pregnancies were collected both in the maternal survey and from the birth certificate. The maternal survey provides the most detailed information on the history of each previous pregnancy, including previous WIC participation. However, there are many more cases for which data on previous pregnancies are missing in the maternal survey (nearly 30 percent) than on the birth certificate (15 percent).[6] For this reason, we present birth certificate data whenever they are available, and maternal survey data on variables not available from the birth certificate.

a. Number and Timing of Previous Pregnancies and Births

Fewer WIC participants than income-eligible nonparticipants had previous pregnancies (59 percent and 66 percent, respectively) or live births (54 percent and 61 percent, respectively). Among low-income women with previous pregnancies, WIC participants and income-eligible nonparticipants had similar numbers of pregnancies, but there was a shorter interval between the preceding pregnancy and the most recent pregnancy for WIC participants. The median number of past pregnancies was two for both groups, with the mean slightly more than two. Although the difference between the distributions is not statistically significant, WIC participants were more likely than income-eligible nonparticipants to have had their most recent pregnancy in the past 2 years, and they were less likely to have had the pregnancy 4 years ago or more. Furthermore, differences in the percentages of women with very long intervals between pregnancies lead to a statistically significant difference in the mean interval between pregnancies of about 5 months.[7]

WIC participants were about as likely as higher-income nonparticipants to have ever been pregnant or to have ever given birth, but WIC participants with past pregnancies had been pregnant more often on

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[6]In particular, 28 percent of the sample had missing data on the number of previous pregnancies (combining two maternal survey questions), while 8 percent had missing data on the interval since the last live birth (from the birth certificate), and 15 percent had missing data on the interval since the last pregnancy (from the birth certificate). Cases with multiple births (about 2 percent) were treated as missing on birth certificate variables, since in these cases the interval since the last birth or pregnancy was coded as zero months.

[7]Similar results hold for the interval between live births, for low-income mothers with previous live births.

TABLE IV.6

PREVIOUS PREGNANCIES AND PREVIOUS WIC PARTICIPATION

	Prenatal WIC Participants	Income-Eligible Nonparticipants	Higher-Income Nonparticipants
Women with Previous Pregnancy (Percent)[a]	58.8	66.4 **	59.1
Women with Previous Live Birth (Percent)[a]	54.3	61.3 **	52.6
Among Women with Previous Pregnancy			
Previous Pregnancies (Mean Number)[b]	2.3	2.2	1.8 **
Number of Previous Pregnancies (Percent Distribution)[b]			
1	38.7	41.8	51.6 **
2	27.0	29.1	28.6
3	16.0	15.6	12.1
4 or more	18.3	13.5	7.8
Mean Interval since Last Pregnancy (Months)[a]	36.7	41.3 **	40.4 **
Interval since Last Pregnancy (Percent Distribution)[a]			
11 months or less	5.5	4.6	3.7 **
12-23 months	36.7	31.8	27.7
24-35 months	20.9	21.5	25.6
36-47 months	13.5	12.7	15.6
48-71 months	12.2	14.4	14.9
72 months and more	11.3	15.0	12.6
Prior Prenatal WIC Participation (Percent)[a]	66.8	22.5 **	4.8 **

TABLE IV.6 *(continued)*

	Prenatal WIC Participants	Income-Eligible Nonparticipants	Higher-Income Nonparticipants
Among Women with Previous Live Birth			
Mean Interval since Last Live Birth (Months)[a]	41.6	46.7 **	45.1 **
Interval since Last Live Birth (Percent Distribution)[a]			
11 months or less	3.0	2.1	0.5 **
12-23 months	30.9	27.2	21.6
24-35 months	21.9	21.0	27.5
36-47 months	14.7	13.7	18.1
48-71 months	15.1	16.5	17.4
72 months and more	14.3	19.6	15.0
Prior Postpartum WIC Participation (Percent)[b]	59.9	21.3 **	4.2 **
Prior Infant WIC Participation (Percent)	79.9	38.7 **	7.9 **
Sample Size (Unweighted)	**3,868**	**2,302**	**3,783**

SOURCE: 1988 National Maternal and Infant Health Survey.

NOTE: All means, percent distributions, and tests of statistical significance are based on weighted data and are calculated using SUDAAN. Tests of statistical significance are based on t-statistics for the difference in means of the continuous variables and chi-square statistics for the difference in the percent distributions of the categorical variables. Missing data have been excluded from the tabulations.

[a]Birth certificate data. Data on previous pregnancies were missing for about 15 percent of the sample.

[b]Maternal survey data. Data on previous pregnancies were missing for about 30 percent of the sample.

*(**): The difference between WIC participants and nonparticipants is statistically significant at the .05 (.01) level.

average than higher-income nonparticipants. Most higher-income nonparticipants had only one previous pregnancy. The intervals between the last pregnancy (or birth) and the most recent pregnancy (or birth) were shorter on average for WIC participants than for higher-income nonparticipants.

b. Previous WIC Participation

Not surprisingly, current WIC participants were much more likely than nonparticipants to have participated in WIC in the past. For prenatal participants with previous pregnancies and births, two-thirds had been prenatal WIC participants in a previous pregnancy, while 80 percent had had infants who had received WIC, and 60 percent had participated postpartum. These figures suggest substantial continuity in the population served by the program over time. However, nearly one-quarter (23 percent) of income-eligible nonparticipants with previous pregnancies had been prenatal WIC participants in the past. Furthermore, 39 percent of those with previous births had enrolled their infants and 21 percent had been enrolled as postpartum mothers. Small proportions (under 10 percent) of nonparticipants who are not currently income-eligible for WIC had also participated in WIC in the past.[8]

[8]The data on past WIC participation are consistent with the data on current participation in the first section of this chapter in that both sources suggest that the WIC Program serves a higher proportion of income-eligible infants than of income-eligible pregnant or postpartum women.

Pregnancy Outcomes (Table IV.7)

WIC participants exhibited slightly more positive pregnancy outcomes than did income-eligible nonparticipants, although the differences were not always statistically significant. In particular, although WIC participants' newborns did not differ significantly from income-eligible nonparticipants' newborns in mean birthweight, WIC participants were significantly less likely to have a low-birthweight (less than 2,500 grams) or a very low-birthweight baby (less than 1,500 grams). WIC participants' newborns also had a significantly longer mean gestational age although the mean difference was only 0.3 weeks. WIC participants had lower neonatal and infant mortality rates than did income-eligible nonparticipants, but these differences were not statistically significant. It is important to note that because WIC participants and income-eligible nonparticipants differed in respects other than WIC participation, these observed differences in outcome are not necessarily the effects of the WIC Program. The multivariate analysis in Chapter V controls for differences in observed characteristics other than program participation that may affect outcomes.

Higher-income nonparticipants had significantly more positive birth outcomes in most respects than did WIC participants; mean birthweights were higher by 144 grams, and the incidence of low birthweight and of preterm births was roughly half that found for WIC participants. The infant mortality rate during the 6 months after birth was significantly lower for higher-income women, but the difference in neonatal mortality rates, while of similar magnitude, was not statistically significant.

POSTPARTUM AND INFANT WIC PARTICIPANTS AND NONPARTICIPANTS

The preceding section focused on the women served by the WIC Program during pregnancy. As discussed in the first section of this chapter, the WIC Program also provided supplemental food to many of these mothers and their infants after birth and served some mothers and infants who were not served prenatally. This section describes the characteristics and experiences of postpartum and infant WIC participants. We first compare the demographic and socioeconomic characteristics of postpartum WIC participants with the characteristics of nonparticipants. Next, we examine demographic and socioeconomic characteristics of infant WIC participants, nonparticipants, and their parents. We then compare infant WIC participants and nonparticipants in terms of health status and health care utilization in the 6 months after birth. Last, we examine infant feeding practices in the 6 months after birth.

TABLE IV.7

PREGNANCY OUTCOMES FOR PRENATAL WIC PARTICIPANTS, INCOME-ELIGIBLE NONPARTICIPANTS, AND HIGHER-INCOME NONPARTICIPANTS

	Prenatal WIC Participants	Income-Eligible Nonparticipants	Higher-Income Nonparticipants
Mean Birthweight (Grams)	3,284	3,265	3,428 **
Birthweight (Percent Distribution)			
< 1,500 grams	1.3	2.1 **	0.9 **
1,500 - 2,499 grams	6.9	8.2	4.1
≥ 2,500 grams	91.8	89.7	95.0
Mean Gestational Age (Weeks)	39.2	38.9 **	39.5 **
Gestational Age at Delivery < 37 Weeks (Percent)	11.3	12.8	6.2 **
Gestational Age (Percent Distribution)			
Less than 28 weeks	0.8	1.4 *	0.4 **
28 - 30 weeks	1.0	1.0	0.5
31 - 33 weeks	2.0	2.9	1.0
34 - 36 weeks	7.5	7.6	4.2
37 - 39 weeks	39.9	41.4	42.0
40 weeks and more	48.8	45.8	51.8
Number of Infant Deaths within 28 Days of Birth per 1,000 Live Births	5.5	6.6	2.9
Number of Infant Deaths within 6 Months of Birth per 1,000 Live Births	7.7	9.4	4.0 *
Maternal Weight Gain during Pregnancy (Pounds)	33	32	33
Prepregnancy Weight (Pounds)	136	134	135

SOURCE: 1988 National Maternal and Infant Health Survey.

NOTE: All means, percent distributions, and tests of statistical significance are based on weighted data and are calculated using SUDAAN. Tests of statistical significance are based on t-statistics for the difference in means of the continuous variables and chi-square statistics for the difference in the percent distributions of the categorical variables.

*(**): The difference between prenatal WIC participants and nonparticipants is statistically significant at the .05 (.01) level.

It is again important to keep in mind that differences in the characteristics of participants and nonparticipants often are preprogram differences, not differences that reflect the effects of WIC Program participation (both before and after birth). Some of the preexisting differences may reflect the fact that the WIC Program has appropriately targeted infants and mothers most likely to be at nutritional risk.

Demographic and Socioeconomic Characteristics of Postpartum WIC Participants and Nonparticipants (Tables IV.8 and IV.9)

Most postpartum WIC participants (84 percent) were also prenatal WIC participants (refer back to Table IV.1). Thus, tabulations comparing the characteristics of postpartum WIC participants and nonparticipants are very similar to those comparing the characteristics of prenatal WIC participants and nonparticipants.

Postpartum WIC participants were from more disadvantaged backgrounds than were income-eligible nonparticipants, and from much more disadvantaged backgrounds than were higher-income nonparticipants (Table IV.8). Postpartum participants were younger, less educated, more likely to be black, less likely to be married or to have been employed before the birth, more likely to receive Medicaid, and less likely to have private health insurance than were income-eligible nonparticipants, and, to a greater degree, higher-income nonparticipants. Their babies' fathers were similarly younger, less educated, and more likely to be black than were the fathers of nonparticipants' babies. Postpartum WIC participants were also more likely to live in rural areas and to depend on public assistance than were income-eligible nonparticipants.

Average incomes were similar for postpartum WIC participants and income-eligible nonparticipants, but WIC participants were both more likely than income-eligible nonparticipants to have incomes below the poverty level and above 185 percent of the poverty level.[9]

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[9]The measure of income used is from the year before the birth, and is thus somewhat inexact. Families with incomes above 185 percent of the poverty level were classified as income-eligible only if they received AFDC, food stamps, or Medicaid at the time of the interview.

TABLE IV.8

DEMOGRAPHIC AND SOCIOECONOMIC CHARACTERISTICS OF POSTPARTUM WIC PARTICIPANTS, INCOME-ELIGIBLE NONPARTICIPANTS, AND HIGHER-INCOME NONPARTICIPANTS

	Postpartum WIC Participants	Income-Eligible Nonparticipants	Higher-Income Nonparticipants
Mother's Characteristics			
Mean Age (Years)	23.7	24.6 **	28.4 **
Age (Percent Distribution)			
Younger than 18	10.2	6.4 **	0.9 **
18 - 19	13.3	12.4	2.4
20 - 24	39.3	35.0	17.9
25 - 29	22.7	27.4	38.5
30 - 34	10.7	14.0	28.7
35 and older	3.8	4.8	11.7
Education (Percent Distribution)			
8 years or less	8.8	7.7 **	0.7 **
9 - 11 years	28.3	22.4	3.6
High school graduate	44.2	45.5	33.8
Some college	16.0	18.6	30.9
College graduate	2.7	5.8	30.9
Race (Percent Distribution)			
White	66.0	72.5 **	88.9 **
Black	29.3	23.3	5.6
Asian or Pacific Islander	2.1	2.7	4.9
Native American	2.6	1.5	0.6
Hispanic (Percent)	18.7	17.1	7.8 **
Married (Percent)	51.6	62.0 **	92.8 **
Lived with the Baby's Father during Most of the Pregnancy (Percent)	61.6	71.5 **	95.5 **
Employed at Any Time during 12 Months prior to Delivery (Percent)	55.0	61.3 **	78.7 **
Covered by Medicaid for Prenatal Care and/or Delivery (Percent)	51.1	33.3 **	1.0 **
No Private Health Insurance during Pregnancy (Percent)	56.2	47.7 **	8.1 **

TABLE IV.8 *(continued)*

	Postpartum WIC Participants	Income-Eligible Nonparticipants	Higher-Income Nonparticipants
Father's Characteristics			
Mean Age (Years)	28.1	28.7 *	32.1 **
Age (Percent Distribution)			
Younger than 18	0.4	0.2 **	0.0 **
18 - 19	4.0	3.2	0.5
20 - 24	28.8	24.7	6.1
25 - 29	33.5	32.3	26.6
30 - 34	18.6	23.2	36.5
35 and older	14.9	16.5	30.3
Education (Percent Distribution)			
8 years or less	9.6	8.3 **	0.7 **
9 - 11 years	22.8	17.8	4.7
High school graduate	50.2	49.3	33.0
Some college	13.3	16.5	22.9
College graduate	4.0	8.2	38.6
Race (Percent Distribution)			
White	63.9	69.6 **	89.0 **
Black	30.8	24.9	6.1
Asian or Pacific Islander	2.0	2.8	4.2
Native American	3.3	2.4	0.7
Hispanic (Percent)	21.2	16.8 **	6.8 **
Employed at Any Time during 12 Months prior to Delivery (Percent)	85.5	87.9	98.4 **
Household Characteristics			
Mean Household Size	4.3	4.4	3.6 **
Nonmetropolitan County (Percent)	36.2	22.7 **	17.3 **
Currently Receiving AFDC (Percent)	36.2	24.3 **	0.0 [a]
Currently Receiving Food Stamps (Percent)	43.1	28.7 **	0.0 [a]

TABLE IV.8 *(continued)*

	Postpartum WIC Participants	Income-Eligible Nonparticipants	Higher-Income Nonparticipants
Mean Annual Pretax Income (Dollars)	12,893	13,024	40,986 **
Mean Annual Pretax Income per Household Member (Dollars)	3,558	3,238 **	12,611 **
Pretax Income as a Percentage of the Poverty Level (Percent)			
100 or less	59.0	49.8 **	0.0 [a]
101 - 150	15.7	27.6	0.0 [a]
151 - 185	8.3	16.6	0.0 [a]
186 - 250	8.8	1.7	23.1
More than 250	8.3	4.3	76.9
Any Income or Assistance from the Following Sources during 12 Months prior to Delivery (Percent)			
Wages, salaries, interest, or dividends	76.3	84.1 **	99.7 **
AFDC	31.8	21.0 **	1.0 **
Food stamps	36.0	22.3 **	1.0 **
Housing assistance or public housing	8.2	4.6 **	0.9 **
Social security or SSI	7.9	6.0 *	1.6 **
Unemployment insurance	4.7	4.0	2.8 **
Veteran's benefits	1.4	1.2	1.0
Child support/alimony from absent parent	5.4	4.8	2.5 **
Sample Size (Unweighted)	**3,003**	**2,660**	**3,451**

SOURCE: 1988 National Maternal and Infant Health Survey.

NOTE: All means, percent distributions, and tests of statistical significance are based on weighted data and are calculated using SUDAAN. Tests of statistical significance are based on t-statistics for the difference in means of the continuous variables and chi-square statistics for the difference in the percent distributions of the categorical variables.

[a]By definition, higher-income nonparticipants have incomes exceeding 185 percent of the poverty level and were not receiving AFDC or food stamps at the time of the survey.

*(**): The difference between WIC participants and nonparticipants is statistically significant at the .05 (.01) level.

Nonparticipants who were not income-eligible had average incomes roughly three times as high as postpartum WIC participants.

Among postpartum participants, those who were not prenatal participants were generally less disadvantaged than those who were prenatal participants (Table IV.9). In particular, women who only enrolled in WIC postpartum were more educated, more likely to be married, and less often black or Hispanic. These women were also more likely to be employed or to have had an employed spouse during pregnancy, and were less likely to participate in AFDC, food stamps, or Medicaid. Furthermore, "postpartum only" participants reported much higher incomes in the year before the birth; more than one-quarter reported incomes exceeding 185 percent of the poverty level. The reasons for these differences are not clear. "Postpartum only" participants may have had incomes that fell after the birth, they may have had complications after the birth but not have been at nutritional risk during pregnancy, or they may not have been aware of WIC during pregnancy.

Demographic and Socioeconomic Characteristics of Infant WIC Participants and Nonparticipants (Tables IV.10 and IV.11)

a. Characteristics of the Infant at Birth

Infant WIC participants (who include both prenatal participants and infants who entered WIC after birth) had less favorable birth outcomes than infant income-eligible nonparticipants (Table IV.10). Infant WIC participants had significantly lower average birthweights (a difference of 83 grams) than did infant income-eligible nonparticipants, and were more likely to have been low birthweight babies. They also had slightly lower gestational ages.

These findings are somewhat surprising, since infants of prenatal WIC participants had similar or better birth outcomes than infants of income-eligible nonparticipants (refer back to Table IV.7), and most infant WIC participants (76 percent) had mothers who were prenatal WIC participants (refer back to Table IV.1). However, approximately one quarter of all infant WIC participants entered the WIC Program after birth but had not been served prenatally. These infants were more likely to have been preterm or low birthweight and, perhaps, were referred to WIC for that reason (Table IV.11). Because these relatively low birthweight infants moved from the income-eligible group to the WIC participant group after birth, infant WIC participants have lower average birthweights than infant income-eligible nonparticipants. Thus, the less favorable birth outcomes of WIC infants suggest that the WIC Program successfully targets infants who, among all income-eligible infants, are more likely to be at nutritional risk.

TABLE IV.9

DEMOGRAPHIC AND SOCIOECONOMIC CHARACTERISTICS OF POSTPARTUM WIC PARTICIPANTS WHO WERE AND WERE NOT PRENATAL WIC PARTICIPANTS

	Postpartum WIC Participants	
	Prenatal Participants	Not Prenatal Participants
Mother's Characteristics		
Mean Age (Years)	23.6	24.1
Age (Percent Distribution)		
Younger than 18	10.9	6.8
18 - 19	13.1	14.3
20 - 24	39.4	38.6
25 - 29	22.6	23.1
30 - 34	10.0	14.7
35 and older	4.1	2.4
Education (Percent Distribution)		
8 years or less	9.5	4.8 **
9 - 11 years	29.9	19.9
High school graduate	43.3	48.8
Some college	14.8	22.1
College graduate	2.4	4.4
Race (Percent Distribution)		
White	64.5	74.3 **
Black	30.8	21.6
Asian or Pacific Islander	2.0	2.1
Native American	2.7	2.1
Hispanic (Percent)	20.3	9.9 **
Married (Percent)	49.5	63.4 **
Lived with the Baby's Father during Most of the Pregnancy (Percent)	59.7	71.7 **
Employed at Any Time during 12 Months prior to Delivery (Percent)	52.9	66.5 **
Covered by Medicaid for Prenatal Care and/or Delivery (Percent)	55.6	27.1 **
No Private Health Insurance during Pregnancy (Percent)	59.8	37.0 **

TABLE IV.9 *(continued)*

	Postpartum WIC Participants	
	Prenatal Participants	Not Prenatal Participants
Father's Characteristics		
Mean Age (Years)	28.1	28.2
Age (Percent Distribution)		
Younger than 18	0.4	0.7
18 - 19	4.2	2.7
20 - 24	29.3	26.0
25 - 29	32.8	37.0
30 - 34	18.6	18.3
35 and older	14.8	15.3
Education (Percent Distribution)		
8 years or less	10.1	6.8 **
9 - 11 years	24.2	15.7
High school graduate	50.1	51.0
Some college	12.1	19.8
College graduate	3.5	6.7
Race (Percent Distribution)		
White	61.7	75.3 **
Black	32.5	21.4
Asian or Pacific Islander	2.1	1.8
Native American	3.7	1.5
Hispanic (Percent)	22.5	13.8 **
Employed at Any Time during 12 Months prior to Delivery (Percent)	84.6	90.4 **
Household Characteristics		
Mean Household Size	4.3	4.2
Nonmetropolitan County (Percent)	36.0	37.4
Currently Receiving AFDC (Percent)	38.2	25.7 **
Currently Receiving Food Stamps (Percent)	45.9	28.3 **
Mean Annual Pretax Income (Dollars)	12,129	16,986
Mean Annual Pretax Income per Household Member (Dollars)	3,318	4,841

TABLE IV.9 *(continued)*

	Postpartum WIC Participants	
	Prenatal Participants	Not Prenatal Participants
Pretax Income as a Percentage of the Poverty Level (Percent)		
100 or less	63.0	37.1 **
101 - 150	15.0	19.3
151 - 185	6.9	15.7
186 - 250	7.7	14.7
Over 250	7.4	13.2
Any Income or Assistance from the Following Sources during 12 Months prior to Delivery (Percent)		
Wages, salaries, interest, or dividends	74.5	85.7 **
AFDC	34.3	18.1 **
Food stamps	39.0	19.7 **
Housing assistance or public housing	8.7	5.4 *
Social security or SSI	8.1	6.9
Unemployment insurance	4.6	5.1
Veteran's benefits	1.3	2.2
Child support/alimony from absent parent	5.5	4.9
Sample Size (Unweighted)	**2,558**	**445**

SOURCE: 1988 National Maternal and Infant Health Survey.

NOTE: All means, percent distributions, and tests of statistical significance are based on weighted data and are calculated using SUDAAN. Tests of statistical significance are based on t-statistics for the difference in means of the continuous variables and chi-square statistics for the difference in the percent distributions of the categorical variables.

*(**): The difference between postpartum participants who were prenatal WIC participants and those who were prenatal nonparticipants is statistically significant at the .05 (.01) level.

TABLE IV.10

DEMOGRAPHIC AND SOCIOECONOMIC CHARACTERISTICS OF INFANT WIC PARTICIPANTS, INCOME-ELIGIBLE NONPARTICIPANTS, AND HIGHER-INCOME NONPARTICIPANTS

	Infant WIC Participants	Income-Eligible Nonparticipants	Higher-Income Nonparticipants
Infant's Characteristics			
Mean Birthweight (Grams)	3,273	3,356 **	3,449 **
Birthweight (Percent Distribution)			
< 1,500 grams	1.2	0.8 **	0.6 **
1,500 - 2,499 grams	7.6	6.0	3.9
≥ 2,500 grams	91.2	93.2	95.5
Mean Gestational Age (Weeks)	39.2	39.4 *	39.5 **
Gestational Age (Percent Distribution)			
28 - 31 weeks	1.7	1.4	0.7 **
32 - 35 weeks	5.6	4.8	2.9
36 - 39 weeks	44.7	43.8	44.6
40 weeks and more	48.0	50.1	51.9
Mother's Characteristics			
Mean Age (Years)	23.6	25.4 **	28.6 **
Age (Percent Distribution)			
Younger than 18	9.4	5.2 **	0.7 **
18 - 19	14.1	10.5	1.8
20 - 24	39.6	31.2	17.3
25 - 29	22.9	30.6	38.9
30 - 34	10.3	16.6	29.5
35 and older	3.7	5.9	11.9
Education (Percent Distribution)			
8 years or less	8.2	7.5 **	0.7 **
9 - 11 years	28.4	17.7	3.0
High school graduate	45.1	44.9	33.3
Some college	15.4	22.2	31.1
College graduate	3.0	7.7	31.8

TABLE IV.10 *(continued)*

	Infant WIC Participants	Income-Eligible Nonparticipants	Higher-Income Nonparticipants
Race (Percent Distribution)			
White	64.7	79.9 **	89.4 **
Black	30.8	15.7	5.1
Asian or Pacific Islander	1.9	3.3	5.1
Native American	2.6	1.2	0.5
Hispanic (Percent)	18.7	16.7	7.3 **
Married (Percent)	51.0	72.7 **	93.4 **
Employed at Any Time during 12 Months prior to Delivery (Percent)	56.9	63.4 **	78.8 **
Covered by Medicaid for Prenatal Care and/or Delivery (Percent)	49.0	22.7 **	0.7 **
No Private Health Insurance during Pregnancy (Percent)	55.4	39.7 **	7.8 **
Father's Characteristics			
Mean Age (Years)	28.0	29.3 **	32.2 **
Age (Percent Distribution)			
Younger than 18	0.4	0.1 **	0.0 **
18 - 19	4.1	2.7	0.3
20 - 24	28.6	21.6	5.5
25 - 29	32.9	32.6	26.5
30 - 34	19.9	23.9	37.0
35 and older	14.3	19.2	30.7
Education (Percent Distribution)			
8 years or less	9.3	7.4 **	0.7 **
9 - 11 years	22.3	15.9	4.1
High school graduate	51.6	46.5	32.0
Some college	12.9	19.4	23.3
College graduate	4.0	10.8	39.9
Race (Percent Distribution)			
White	61.9	79.0 **	89.6 **
Black	32.6	16.3	5.5
Asian or Pacific Islander	1.9	3.2	4.4
Native American	3.6	1.5	0.5

TABLE IV.10 *(continued)*

	Infant WIC Participants	Income-Eligible Nonparticipants	Higher-Income Nonparticipants
Hispanic (Percent)	20.0	17.0	6.3 **
Employed at Any Time during 12 Months prior to Delivery (Percent)	85.2	91.4 **	98.5 **
Household Characteristics			
Mean Household Size	4.2	4.5 **	3.6 **
Nonmetropolitan County (Percent)	32.9	21.4 **	16.9 **
Baby's Father Present (Percent)	57.2	76.5 **	95.1 **
Currently Receiving AFDC (Percent)	34.5	16.3 **	0.0 [a]
Currently Receiving Food Stamps (Percent)	41.0	19.6 **	0.0 [a]
Mean Pretax Income (Dollars)	13,335	14,360 *	41,370 **
Pretax Income as a Percentage of the Poverty Level (Percent)			
100 or less	56.9	41.7 **	0.0 [a]
101 - 150	16.0	32.1	0.0 [a]
151 - 185	8.3	20.0	0.0 [a]
186 - 250	8.9	1.9	22.2
More than 250	9.8	4.3	77.8
Any Income or Assistance from the Following Sources during 12 Months prior to Delivery (Percent)			
Wages, salaries, interest, or dividends	77.3	89.7 **	99.7 **
AFDC	31.2	12.6 **	0.2 **
Food stamps	34.6	13.3 **	0.9 **
Housing assistance or public housing	7.6	3.3 **	0.9 **
Social security or SSI	7.9	4.7 **	1.4 **
Unemployment insurance	4.5	4.0	2.7 **
Veteran's benefits	1.3	1.7	1.0
Child support/alimony from absent parent	5.3	4.3	2.6 **
Sample Size (Unweighted)	**4,500**	**1,390**	**3,248**

TABLE IV.10 *(continued)*

SOURCE: 1988 National Maternal and Infant Health Survey.

NOTE: All means, percent distributions, and tests of statistical significance are based on weighted data and are calculated using SUDAAN. Tests of statistical significance are based on t-statistics for the difference in means of the continuous variables and chi-square statistics for the difference in the percent distributions of the categorical variables.

[a]By definition, higher-income nonparticipants have incomes exceeding 185 percent of the poverty level and were not receiving AFDC or food stamps at the time of the survey.

*(**): Indicates that the difference between WIC participants and nonparticipants is statistically significant at the .05 (.01) level.

TABLE IV.11

DEMOGRAPHIC AND SOCIOECONOMIC CHARACTERISTICS OF INFANT WIC PARTICIPANTS WHO WERE AND WERE NOT PRENATAL WIC PARTICIPANTS

	Infant WIC Participants	
	Prenatal Participants	Not Prenatal Participants
Infant's Characteristics		
Mean Birthweight (Grams)	3,289	3,224 **
Birthweight (Percent Distribution)		
< 1,500 grams	0.9	1.9 **
1,500 - 2,499 grams	6.9	9.8
≥ 2,500 grams	92.1	88.3
Mean Gestational Age (Weeks)	39.3	38.7 **
Gestational Age (Percent Distribution)		
28 - 31 weeks	1.5	2.1
32 - 35 weeks	5.4	6.4
36 - 39 weeks	43.9	47.2
40 weeks and more	49.2	44.2
Mother's Characteristics		
Mean Age (Years)	23.4	24.1 **
Age (Percent Distribution)		
Younger than 18	10.4	6.2 **
18 - 19	14.4	13.3
20 - 24	39.6	39.6
25 - 29	22.3	24.6
30 - 34	9.4	13.2
35 and older	3.8	3.1
Education (Percent Distribution)		
8 years or less	8.6	6.9 **
9 - 11 years	30.7	21.2
High school graduate	44.1	48.1
Some college	14.2	19.1
College graduate	2.5	4.7

TABLE IV.11 *(continued)*

	Infant WIC Participants	
	Prenatal Participants	Not Prenatal Participants
Race (Percent Distribution)		
White	63.4	68.7
Black	31.9	27.3
Asian or Pacific Islander	1.9	1.7
Native American	2.7	2.2
Hispanic (Percent)	19.9	15.1 *
Married (Percent)	48.6	58.6 **
Employed at Any Time during 12 Months prior to Delivery (Percent)	53.7	66.9 **
Covered by Medicaid for Prenatal Care and/or Delivery (Percent)	55.1	29.9 **
No Private Health Insurance during Pregnancy (Percent)	60.3	39.9 **
Father's Characteristics		
Mean Age (Years)	28.0	28.2
Age (Percent Distribution)		
Younger than 18	0.4	0.4
18 - 19	4.1	4.1
20 - 24	29.4	26.0
25 - 29	33.0	32.5
30 - 34	19.0	22.8
35 and older	14.3	14.2
Education (Percent Distribution)		
8 years or less	9.5	8.6 **
9 - 11 years	23.6	17.9
High school graduate	51.5	51.9
Some college	12.0	15.6
College graduate	3.4	6.1

TABLE IV.11 *(continued)*

	Infant WIC Participants	
	Prenatal Participants	Not Prenatal Participants
Race (Percent Distribution)		
White	60.4	66.7 *
Black	34.0	28.1
Asian or Pacific Islander	1.9	1.9
Native American	3.7	3.4
Hispanic (Percent)	21.5	15.4 **
Employed at Any Time during 12 Months prior to Delivery (Percent)	84.2	88.3 **
Household Characteristics		
Mean Household Size	4.3	4.2
Nonmetropolitan County (Percent)	33.9	29.8
Baby's Father Present (Percent)	56.1	60.5
Currently Receiving AFDC (Percent)	37.1	26.2 **
Currently Receiving Food Stamps (Percent)	44.8	29.1 **
Mean Pretax Income (Dollars)	12,175	17,004 **
Pretax Income as a Percentage of the Poverty Level (Percent)		
100 or Less	62.0	40.7 **
101 - 150	15.7	17.2
151 - 185	6.8	13.0
186 - 250	7.5	13.3
More than 250	8.0	15.7
Any Income or Assistance from the Following Sources during 12 Months prior to Delivery (Percent)		
Wages, salaries, interest, or dividends	74.9	85.0 **
AFDC	34.6	20.5 **
Food stamps	38.8	21.4 **
Housing assistance or public housing	8.6	4.7 **
Social security or SSI	8.5	5.9 *

TABLE IV.11 *(continued)*

	Infant WIC Participants	
	Prenatal Participants	Not Prenatal Participants
Unemployment insurance	4.5	4.6
Veteran's benefits	1.3	1.1
Child support/alimony from absent parent	5.4	5.2
Sample Size (Unweighted)	**3,363**	**1,137**

SOURCE: 1988 National Maternal and Infant Health Survey.

NOTE: All means, percent distributions, and tests of statistical significance are based on weighted data and are calculated using SUDAAN. Tests of statistical significance are based on t-statistics for the difference in means of the continuous variables and chi-square statistics for the difference in the percent distributions of the categorical variables.

*(**): Indicates that the difference between infant WIC participants who were also prenatal WIC participants and those who were prenatal nonparticipants is statistically significant at the .05 (.01) level.

Birth outcomes for WIC infants were much less favorable than outcomes for infants from higher-income families. WIC infants had birthweights that were 176 grams lower on average and lower average gestational ages.In addition, WIC infants were about twice as likely to have birthweights of less than 2,500 grams and gestational ages of less than 36 weeks than were infants from higher-income families.

b. Parental and Family Characteristics

The characteristics of the parents and families of infant WIC participants differ from those of income-eligible nonparticipants and higher-income nonparticipants in essentially the same ways as the other WIC participant groups differ from corresponding nonparticipants (Table IV.10). Families of WIC infants are somewhat more disadvantaged than families of income-eligible nonparticipants despite similar total family incomes. They are much more disadvantaged than families of higher-income nonparticipants.

Characteristics of families of infant WIC participants who were not prenatal WIC participants are in many ways different than those of families who participated both prenatally and for the infant (Table IV.11). Mothers of "infant only" participants were older, more educated, more often married, and less likely to be Hispanic. Parents of "infant only" participants were more often employed, less often receiving public assistance, including Medicaid, and reported higher household incomes in the year before the birth.

Infant Health Care Utilization and Health Status (Table IV.12)

The NMIHS data provide a substantial amount of information on the health status and health care utilization of infants born in 1988, including the number of physician visits, the usual source of well-baby care, the source of payment for babies' medical care, the number and timing of vaccinations, the incidence of various illnesses, and the number of hospitalizations. Differences between infant WIC participants and nonparticipants on these measures may reflect either the effects of the WIC Program or differences in the characteristics of the infants and their parents (some of which are related to eligibility for WIC).[10]

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[10]The health care utilization and health status of *prenatal* WIC participants' infants were also compared with those of nonparticipants' infants. The differences between those groups were very similar to the differences between infant WIC participants and infant nonparticipants, which are presented in this section.

TABLE IV.12

INFANT HEALTH STATUS AND HEALTH CARE UTILIZATION DURING THE SIX MONTHS AFTER BIRTH

	Infant WIC Participants	Income-Eligible Nonparticipants	Higher-Income Nonparticipants
Mean Number of Physician Visits[a]			
Total	5.91	5.62 *	6.26 **
For well-baby care	3.61	3.62	4.17 **
For illness or injury	2.53	2.18 *	2.26 *
Rate of Physician visits per Month[b]			
Total	1.11	1.07	1.17 *
For well-baby care	.71	.72	.81 **
For illness or injury	.59	.55	.56
Usual Source of Well-Baby Care (Percent Distribution)			
Private doctor's office	47.0	65.4 **	80.6 **
County or city health department	18.1	8.1	1.0
Community health center	12.4	7.2	2.6
HMO	2.4	4.7	8.6
Clinic in a hospital	13.3	9.2	4.3
Hospital emergency room	0.4	0.4	0.0
Other	3.0	2.8	2.0
No well-baby care received	3.5	2.4	1.0
Sources of Payment for Infant's Medical Care (Percent)[c]			
Mother's or father's income	27.8	49.6 **	56.3 **
Grandparents, other relatives	3.5	3.4	1.0 **
Private insurance	23.0	40.6 **	76.0 **
Medicaid	42.2	18.3 **	0.0 **
Other government assistance	11.5	4.8 **	0.5 **
Other	5.6	5.6	2.8 **
Infants Receiving a Polio Vaccination (Percent)			
At any time	83.0	84.4	88.9 **
Within medically appropriate time frame[d]	61.2	62.6	70.1 **

TABLE IV.12 *(continued)*

	Infant WIC Participants	Income-Eligible Nonparticipants	Higher-Income Nonparticipants
Infants Receiving a Diphtheria, Tetanus, and/or Pertussis Vaccination (Percent)			
At any time	93.3	93.6	98.0 **
Within medically appropriate time frame[d]	77.6	78.2	86.8 **
Infants with the Following Illnesses or Health Problems (Percent)[c]			
Fever	45.7	40.7 *	44.6
Ear infection	33.3	33.3	36.2
Eye infection	9.3	8.5	10.9
Colic	18.7	19.7	16.5
Fussy or irritable	29.2	30.6	32.0
Runny nose or cold	49.5	46.8	54.2 **
Cough or wheeze	27.2	20.2 **	24.4 *
Pneumonia	3.8	3.8	1.7 **
Listless or droopy appearance	3.1	2.6	2.4
Seizures or convulsions	0.6	0.6	0.3
Vomiting	14.9	11.6 *	10.0 **
Diarrhea	27.5	22.0 **	21.1 **
Injury from fall or accident	2.1	1.2	1.1 **
Number of Times Readmitted to a Hospital after First Coming Home (Percent Distribution)			
None	90.0	91.2	94.7 **
1	7.8	7.1	4.4
2	1.5	0.7	0.6
3 or more times	0.7	1.1	0.3
Sample Size (Unweighted)	**4,500**	**1,390**	**3,248**

SOURCE: 1988 National Maternal and Infant Health Survey.

NOTE: Questions concerning infant health were not asked for infants who lived less than 1 month or who did not come home from the hospital (n=538). Cases that were income-eligible for WIC but had missing data on infant WIC participation were also omitted (n = 277). Cases with missing data on specific variables were omitted from the tabulations of those variables. All means, percent distributions, and tests of statistical significance are based on weighted data and are calculated using SUDAAN. Tests of statistical significance are based on t-statistics for the difference in means of the continuous variables and chi-square statistics for the difference in the percent distributions of the categorical variables.

TABLE IV.12 *(continued)*

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[a]Total visits in the first 6 months, not adjusted for the number of months "at-risk," that is, the number of months in which the baby is alive and at home.

[b]Total visits divided by the number of months with valid data. This ratio adjusts for the number of months "at-risk," as well as for other sources of missing data.

[c]More than one response was possible. Percentages may thus add up to more than 100 percent.

[d]Vaccinations within the medically appropriate time frame are 2 or 3 polio vaccinations and 2 or 3 DPT vaccinations in the first 6 months.

*(**): The difference between WIC participants and nonparticipants is statistically significant at the .05 (.01) level.

a. Physician Visits

Mothers reported the number of physician visits in each of the first six months, provided the baby was alive and living at home during the month. Two measures of physician visits are examined: total physician visits during the first six months and the rate of physician visits per month with valid data, defined as total physician visits divided by the number of months in which data on visits was not missing. The first measure does not adjust for possible differences between participants and nonparticipants in terms of the number of months the infant was alive and at home. The second measure adjusts for these differences and for differences in other sources of missing data.

Using the unadjusted measure, WIC infants had significantly more physician visits for illness or injury and more total visits than income-eligible nonparticipants, but the two groups had the same number of well-baby visits. Using the adjusted measure, the differences between participants and income-eligible nonparticipants were smaller and no longer statistically significant. (This suggests that WIC participants had more months than income-eligible nonparticipants in which data on visits for illness or injury were reported.) The larger number of sick-baby visits for WIC infants may reflect poorer infant health, mothers with greater concerns about their infant's health, or better access to health care.

Using either measure, we found that WIC infants had significantly fewer well-baby visits than did infants who were not income-eligible for WIC. Using the unadjusted measure, we found that WIC infants had significantly more sick-baby visits than did higher-income nonparticipants, but the difference was again not significant using the adjusted measure. The difference in the number of well-baby visits may reflect differences in access to health care or in the mothers' awareness of the importance of these visits.

b. Source of Well-Baby Care

WIC infants were much less likely than income-eligible nonparticipants to receive well-baby care from private doctors or HMOs, but they were more likely to receive well-baby care from local health departments, community health centers, or hospital clinics. These differences are likely to reflect the fact that community health centers, hospital clinics, or local health departments may also be WIC Program sites. WIC infants were more likely than income-eligible nonparticipants to be covered by Medicaid instead of private insurance (see below), which also may have affected their source of health care.

Similar but larger differences in the source of well-baby care are evident when we compare WIC infants and higher-income nonparticipants--fully 89 percent of infants from higher-income families received well-baby care from private doctors or HMOs, while only 49 percent of WIC infants received well-baby care from these sources. It is likely that these differences are related to differences in income and in insurance coverage (see below).

c. Source of Payment for Baby Care

WIC infants were more likely than income-eligible nonparticipant infants to receive Medicaid or other government assistance to pay for their health care, and less likely to have their care paid for by their parents or private insurance. Medicaid was a source of payment for 42 percent of WIC infants but for only 18 percent of income-eligible nonparticipants. In contrast, only 23 percent of WIC infants were covered by private insurance, while 41 percent of income-eligible nonparticipants had private insurance. While parents paid for some medical care for 28 percent of WIC infants, parents paid for some care for 50 percent of income-eligible nonparticipants.

Infants from higher-income families usually had their medical care covered by private insurance (76 percent), but 56 percent had some care paid for by their parents. Out-of-pocket costs for infant health care are common even for families with private insurance because private insurance plans often require co-payments, and some do not cover well-baby visits.

d. Vaccinations

Infant WIC participants did not differ from income-eligible nonparticipants in the number of vaccinations received during the first 6 months of life. Both low-income groups were slightly less likely to receive any vaccinations, or to receive the appropriate number of vaccinations, than were higher-income nonparticipants. Two or three vaccinations each for polio and diphtheria/pertussis/tetanus (DPT) are recommended during the first 6 months. Some infants may have received fewer than the recommended number of vaccinations, however, because of illness or delayed check-ups.[11] Thus, data are also presented on whether any vaccinations were received.

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[11]It is also possible that some mothers do not accurately recall vaccinations received.

Among WIC participants and income-eligible nonparticipants, more than 80 percent of infants had received at least one polio vaccination and more than 60 percent had received two or three vaccinations (the recommended number) according to their mothers' reports. Among higher-income nonparticipant infants, nearly 90 percent had at least one polio vaccination, and 70 percent had received two or three.

The incidence of DPT vaccinations was somewhat higher than that of polio vaccinations. More than 93 percent of WIC infants and income-eligible nonparticipants, and 98 percent of higher-income nonparticipants had received a DPT vaccination. About 78 percent of WIC infants and income-eligible nonparticipants received two or three DPT vaccinations, while fully 87 percent of higher-income nonparticipants received two or three vaccinations.

The differences in the receipt of vaccinations between low-income and higher-income infants, although not large, are in accord with the data presented above on the number of well-baby visits, suggesting that low-income infants receive less adequate well-baby care.

e. Illnesses and Problems

In general, the incidence of common childhood ailments, symptoms, or other health problems during the first 6 months of life, as reported by mothers, was quite similar among infant WIC participants, income-eligible nonparticipants, and higher-income nonparticipants. The significant differences in reported health problems that did exist suggest that infant WIC participants may have had somewhat more health problems on average than infant nonparticipants. However, most differences were not significant, and not all differences indicated more health problems for WIC participants.

According to the mothers' reports, infant WIC participants were significantly more likely to have experienced episodes of vomiting and diarrhea than were infants in the other two groups. Mothers also reported some significant differences in the incidence of respiratory illnesses. Infant WIC participants were significantly more likely to have had fevers and coughs than were income-eligible nonparticipants. WIC participants were less likely to have had colds, but were more likely to have had coughs and pneumonia than were higher-income nonparticipants.

f. Hospitalizations

WIC infants did not differ significantly from income-eligible nonparticipants in the prevalence of hospitalizations after birth, but they were significantly more likely than higher-income nonparticipants to have been hospitalized. Ten percent of WIC infants were hospitalized after birth (2.2 percent more than once), and 8.9 percent of income-eligible nonparticipants were hospitalized (1.8 percent more than once), but only 5.3 percent of higher-income infants were hospitalized (0.9 percent, more than once). This pattern is another indicator that WIC infants may have been somewhat less healthy than infants in higher-income families.

Infant Feeding Practices

The 1988 NMIHS collected retrospective information on infant feeding practices for each of the first 6 months after birth. This section compares the infant feeding practices reported by mothers of infant WIC participants and nonparticipants with guidelines for infant nutrition set forth by the Committee on Nutrition of the American Academy of Pediatrics (CN-AAP). Subsection a. provides an overview of the CN-AAP guidelines. Subsection b. compares the infant feeding practices reported in the NMIHS data with the guidelines. The remaining subsections examine each aspect of infant feeding in more depth--the prevalence of breastfeeding, and the use of infant formula, cow's milk, and solid foods--for infant WIC participants, income-eligible nonparticipants, and higher-income nonparticipants.

Several data issues are noteworthy. Data on infant feeding practices were collected month by month for the 6 months after birth. Values for these variables were not imputed by NCHS, and roughly one-half of cases had some missing data. When data on breastfeeding by month were missing, questions on whether the mother ever breastfed and the age at which breastfeeding stopped were used to impute the monthly information, which eliminated almost all missing data. When data on use of formula, cow's milk, or solid foods were missing because the mother left that part of the grid blank, but valid data were available on feeding of other foods, the missing data were recoded as zeros.[12] Cases with other types of missing data were dropped from the analysis.

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[12]This recode was made on the assumption that mothers who did not offer their child a particular food may have mistakenly assumed they should skip a question on the frequency of feeding that food, even though careful reading of the instructions indicated that they were to enter zeros in the grid.

Another issue is that the mothers' recall of the precise month in which they began feeding specific foods may have been inexact. The data may also reflect the mothers' confusion about the month a question referred to. For example, mothers may have interpreted "the fourth month after birth" as "when baby was 4 months old," which is in fact the fifth month.

a. CN-AAP Recommendations for Infant Feeding During the First 6 Months of Life

An expert panel convened by the CN-AAP has established recommendations for feeding normal infants. The recommendations are based on studies of infant physiology, development, and nutrient needs, and the rationales for the recommendations are set forth in a series of articles in *Pediatrics* (Committee on Nutrition 1980, 1992a, 1992b) and in the *Pediatric Nutrition Handbook* (Committee on Nutrition 1993). These recommendations are accepted and promoted by health practitioners and nutritionists nationwide.

The recommendations relevant to this analysis relate to breastfeeding, infant formula, use of cow's milk in infancy, and introduction of solid foods. This section describes the recommendations for the first 6 months of life as well as the rationale upon which each recommendation is based.

Breastfeeding. Breastfeeding is the preferred method of infant feeding. It provides important benefits for both infant and mother (Worthington-Roberts and Williams 1989). Human milk is best matched to infant nutrient needs and developmental capabilities, and nutrients are provided in their optimal form and concentration. For example, the protein concentration in human milk adequately meets nitrogen needs without causing a high renal solute load, and iron is present in a highly bioavailable form. Breast milk also contains numerous substances with anti-infective properties, as well as substances that may promote the growth and development of the gastrointestinal tract. Finally, breastfeeding promotes close emotional contact between infant and mother.

Infant Formula. When breastfeeding is contraindicated for health reasons, or when mothers choose not to breastfeed, mothers should provide a properly formulated breast-milk substitute during their infants' first 6 months of life. They should also provide formula as necessary to supplement breast-milk feedings.

Infant formula manufacturers have attempted to produce a substance that more closely resembles human milk than it does cow's milk, and is thus

more compatible with infant nutrient needs and developmental capabilities. As a result, most formulas contain food energy, protein, and other nutrients in the concentrations required to meet the needs of growing infants. Furthermore, federal law sets minimum standards for the composition of formula.

Several types of formula recorded in the NMIHS are not considered appropriate for young infants. In particular, "evaporated milk formula," a mixture of canned evaporated cow's milk, water, and corn syrup, is inadequate in iron, vitamin C, and other nutrients. In addition, "follow-on formulas" are intended for babies 6 months old or older and should not be given in the first 6 months. They contain higher concentrations of protein and sodium than does regular infant formula.

Although most pediatricians recommend the use of iron-fortified infant formulas (Fomon 1987a, 1987b), their prevalence was not tabulated for two reasons. First, this recommendation is not generally accepted, since there is a widespread belief that iron-fortified formulas cause gastrointestinal disturbances. Second, it seems likely that mothers would not always report use of an iron-fortified formula.

Cow's Milk. Mothers should not feed cow's milk to infants during the first 12 months of life because it has a number of qualities that make it inappropriate (Committee on Nutrition 1993a).[13] First, the protein concentration and sodium content of whole cow's milk, which is much higher than that of human milk, results in a high renal solute load. This is especially harmful to young infants, whose kidneys are unable to excrete highly concentrated urine. Feeding only cow's milk to young infants may result in dehydration. Second, casein, the major protein in cow's milk, forms a hard, difficult-to-digest curd in the infant's stomach. Third, the iron in cow's milk is poorly absorbed, and some mothers who have fed their infants cow's milk have reported gastrointestinal bleeding in the child. These factors may lead to iron deficiencies. Fourth, cow's milk is high in phosphate, which may lead to hypocalcemia. Finally, cow's milk provides inadequate levels of essentially fatty acids, such as linoleic acid.

Solid Foods. Mothers should introduce solid foods when an infant is able to sit with support and has good neuromuscular control of the head and neck (usually between 4 and 6 months of age). This recommendation is based on the definition of two infant feeding periods.

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[13]The CN-AAP does not recommend feeding low-fat milk to children under 2 years of age (Committee on Nutrition 1992b). The NMIHS data do not distinguish use of whole and low-fat cow's milk.

The nursing period, which usually lasts about 4 to 6 months, is characterized by a liquid diet. The infant's absence of teeth and low saliva production are consistent with a liquid diet. Gastric acid output is low until about 3 months of age, and amylase levels are low relative to adults. Thus, an infant may have trouble digesting foods other than breast milk or appropriate infant formulas. In addition, a young infant has a reduced ability to cope with foreign antigens, either in the form of food proteins or infectious microorganisms. Thus, in the early months, a mother should avoid exposing an infant to a wide variety of foods, which may cause allergic reactions or contain contaminants.

In the transitional period, an infant becomes developmentally mature enough to eat an increasing variety of semisolid and solid foods safely. Mothers should introduce foods one at a time. Although the order of introduction is not critical, mothers often introduce iron-fortified cereals first.

b. Mothers' Compliance with CN-AAP Infant Feeding Recommendations (Table IV.13)

This section compares the feeding practices of mothers of infant WIC participants, income-eligible nonparticipants, and higher-income nonparticipants in terms of their compliance with CN-AAP guidelines for infant feeding during the first 6 months after birth. We apply the criteria set forth in the CN-AAP guidelines as follows:

- For the **first 4 months**, infant feeding practices are in compliance with the CN-AAP guidelines under the following conditions:
  - Breastfeeding or an appropriate formula is used.
  - No cow's milk is used.
  - No solid foods (cereals, fruits, vegetables, or meats) are used.

  If any of the above conditions is not satisfied, the infant is not fed according to the CN-AAP guidelines.
- For the **fifth and sixth months**, infant feeding practices are in compliance with the CN-AAP guidelines under the following conditions:
  - Breastfeeding or an appropriate formula is used.

TABLE IV.13

COMPLIANCE WITH INFANT FEEDING GUIDELINES OF THE COMMITTEE ON NUTRITION OF THE AMERICAN ACADEMY OF PEDIATRICS (CN-AAP)

	Infant WIC Participants	Income-Eligible Nonparticipants	Higher-Income Nonparticipants
Infants Fed According to CN-AAP Guidelines, Months 1-4 (Percent)[a]			
Month 1	84.9	88.7 **	93.9 **
Month 2	69.6	72.3	81.7 **
Month 3	47.9	50.8	61.1 **
Month 4	24.9	26.0	33.6 **
Infants Not Fed According to CN-AAP Guidelines, Months 1-4 (Percent)[b]			
Month 1	15.1	11.3 **	6.1 **
Month 2	30.4	27.7	18.3 **
Month 3	52.1	49.2	38.9 **
Month 4	75.1	74.0	66.5 **
Infants Fed According to CN-AAP Guidelines, Months 5-6 (Percent)[c]			
Month 5	95.1	91.2 **	95.9
Month 6	90.6	83.1 **	89.1
Infants Not Fed According to CN-AAP Guidelines, Months 5-6 (Percent)[d]			
Month 5	4.9	8.8 **	4.1
Month 6	9.4	16.9 **	10.9
Infants Fed According to CN-AAP Guidelines for All 6 Months (Percent)	23.9	23.8	31.7 **
Sample Size	**4,500**	**1,390**	**3,248**

SOURCE: 1988 National Maternal and Infant Health Survey.

NOTE: All percentages are based on weighted data and are calculated using SUDAAN. Tests of statistical significance are based on t-statistics for the difference in percentages. Only cases with nonmissing data were used to calculate the percentages.

* (**): The difference between prenatal WIC participants and nonparticipants is statistically significant at the .05 (.01) level.

[a]Breast milk or appropriate formula only.

[b]Cow's milk; inappropriate formula; or feeding of cereals, fruits, vegetables, or meats.

[c]Breast milk or appropriate formula in combination with other foods.

[d]Cow's milk or inappropriate formula.

- No cow's milk is used.

- Feeding of solid foods (cereal, fruits, vegetables, and meats) is acceptable, but not required.

Among all three groups of mothers, feeding practices accord fairly well with the CN-AAP guidelines in the first month, but are increasingly less consistent in the second through fourth months. In the fourth month, only 25 percent of WIC participants' mothers, 26 percent of income-eligible nonparticipants' mothers, and 34 percent of higher-income infants' mothers fed their infants according to the guidelines. The fall-off in the percentage of those mothers feeding their infants according to the CN-AAP guidelines through the fourth month is largely a result of the fact that many mothers introduced solid foods or cow's milk before the fifth month (as opposed to use of inappropriate formulas). Although compliance was high again (over 80 percent) in the fifth and sixth months, when the guidelines permit solid foods, it was lower in the sixth month than in the fifth month because more mothers had introduced cow's milk.

The mothers of infant WIC participants and income-eligible nonparticipants followed the CN-AAP guidelines to a similar extent during the first 4 months after birth, but mothers of infant WIC participants were somewhat less likely to feed according to the guidelines in the first month (85 percent versus 89 percent among mothers of income-eligible nonparticipants). Some mothers may have been referred to WIC because they were feeding their infants improperly in the first month. Mothers of infant WIC participants were much less likely than mothers of higher-income nonparticipants to feed in compliance with the nutrition guidelines in each of the first 4 months. This is largely because mothers of higher-income nonparticipants were less likely than mothers of infant WIC participants to introduce solid foods before the recommended time.

In contrast, mothers of infant WIC participants were significantly more likely than mothers of income-eligible nonparticipants to follow the CN-AAP guidelines in the fifth and sixth months, because they were less likely to feed their infants cow's milk in these months.

Overall, similar proportions of infant WIC participants' and income-eligible nonparticipants' mothers fed their children according to the guidelines in all 6 months (24 percent both for WIC participants and for income-eligible nonparticipants). Mothers of higher-income nonparticipants were significantly more likely than mothers of WIC participants to feed according to the guidelines in all 6 months (32 percent and 24 percent, respectively).

c. Feeding Practices for WIC Participants versus Nonparticipants (Table IV.14)

Breastfeeding. Mothers of infant WIC participants were significantly less likely than those of both income-eligible nonparticipants and higher-income nonparticipants to breastfeed during the 6 months after birth. In addition, of the women who originally breastfed, a larger proportion of mothers of WIC infants than of infants in the other two groups had stopped breastfeeding by the sixth month. WIC participants' mothers were also more likely to supplement breast milk with formula.

In the first month after birth, 36 percent of mothers of infant WIC participants were breastfeeding either wholly or partially. This proportion declined steadily to only 10 percent in the sixth month after birth (only 28 percent of those originally breastfeeding). Mothers of infant WIC participants who were still breastfeeding were doing so less frequently over time and were increasingly using formula as a supplement. In the first month, 20 percent of mothers of infant WIC participants were breastfeeding exclusively (57 percent of breastfeeding mothers), while 14 percent were breastfeeding and using formula (40 percent of breastfeeding mothers).[14] By the sixth month, only 4.6 percent of mothers of infant WIC participants were breastfeeding exclusively (46 percent of breastfeeding mothers), and 5.2 percent were breastfeeding and supplementing (52 percent of breastfeeding mothers).

In contrast, mothers of income-eligible nonparticipants were significantly more likely than mothers of WIC participants to breastfeed in the 6 months after birth. The proportion who breastfed was 51 percent in the first month after birth and fell to 21 percent in the sixth month (41 percent of those originally breastfeeding). Mothers of income-eligible nonparticipants were also significantly more likely to breastfeed exclusively in each of the 6 months after birth, but roughly as likely to feed a combination of breast milk and formula.

Mothers of higher-income infant nonparticipants were roughly twice as likely as mothers of WIC participants to breastfeed in each month, and were about three times as likely to breastfeed exclusively.

The differences in breastfeeding rates between WIC participants should not be interpreted as effects of the WIC program. These descriptive

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[14]Data on supplemental feeding were missing for 3 percent of breastfeeding mothers.

TABLE IV.14

INFANT FEEDING PRACTICES REPORTED BY MOTHERS OF INFANT WIC PARTICIPANTS, INCOME-ELIGIBLE NONPARTICIPANTS, AND HIGHER-INCOME NONPARTICIPANTS

	Infant WIC Participants	Income-Eligible Nonparticipants	Higher-Income Nonparticipants
Mothers Who Breastfed (Percent)			
Month 1	35.5	50.8 **	65.2 **
Month 2	22.9	38.3 **	51.2 **
Month 3	18.4	30.4 **	42.7 **
Month 4	14.4	25.3 **	35.3 **
Month 5	11.6	22.7 **	30.4 **
Month 6	10.0	20.6 **	26.9 **
Mean Daily Frequency of Breastfeeding for Mothers Who Breastfed (Times per Day)			
Month 1	7.2	7.9 **	8.2 **
Month 2	7.0	7.4	7.5 **
Month 3	6.5	6.7	6.7
Month 4	6.1	6.3	6.0
Month 5	6.0	5.9	5.5 *
Month 6	5.9	5.6	5.2 *
Mothers Who Breastfed Only (Percent)			
Month 1	20.2	35.7 **	49.4 **
Month 2	13.4	27.6 **	36.5 **
Month 3	9.8	20.4 **	27.9 **
Month 4	7.3	17.0 **	21.3 **
Month 5	5.5	14.3 **	18.2 **
Month 6	4.6	11.8 **	15.3 **
Mothers Who Breastfed and Used Breast-Milk Supplements (Percent)			
Month 1	14.2	13.2	13.9
Month 2	9.1	9.9	13.7 **
Month 3	8.2	9.5	13.9 **
Month 4	6.8	8.0	13.1 **
Month 5	5.9	8.1	11.4 **
Month 6	5.2	8.3 **	11.0 **

TABLE IV.14 *(continued)*

	Infant WIC Participants	Income-Eligible Nonparticipants	Higher-Income Nonparticipants
Mothers Who Fed Formula (Percent)			
Month 1	77.6	61.4 **	48.3 **
Month 2	84.2	68.6 **	59.8 **
Month 3	87.8	76.0 **	68.7 **
Month 4	89.9	77.5 **	74.9 **
Month 5	89.9	77.7 **	76.4 **
Month 6	88.7	73.9 **	75.5 **
Primary Type of Infant Formula Used (Percent)			
Enfamil	33.0	34.5 **	30.0 **
ProSobee	5.1	5.2	7.9
Nutramigen	1.2	0.3	0.9
Pregestimil	0.2	0.4	0.2
Similac	39.4	40.6	39.3
Isomil	9.8	8.5	13.7
Advance	0.0	0.0	0.0
SMA	7.9	4.9	3.9
Nursoy	1.9	1.9	1.3
Evaporated Milk Formula	0.2	1.0	0.3
Other	1.1	1.2	1.7
None	0.2	1.5	0.9
Mothers Who Fed Cow's Milk (Percent)			
Month 1	1.8	1.0	0.4 **
Month 2	1.9	1.3	0.6 **
Month 3	1.9	1.8	0.8 **
Month 4	2.6	4.1	1.8
Month 5	4.7	8.0 **	4.0
Month 6	9.1	16.3 **	10.8
Mothers Who Fed Solid Foods (Percent)			
Month 1	13.9	10.6 *	5.5 **
Month 2	28.5	26.0	17.0 **
Month 3	49.8	47.4	36.8 **
Month 4	71.7	71.0	63.0 **
Month 5	80.4	77.9	74.5 **
Month 6	88.6	86.3	87.5
Sample Size	**4,500**	**1,390**	**3,248**

TABLE IV.14 *(continued)*

SOURCE: 1988 National Maternal and Infant Health Survey.

NOTE: All means, percent distributions, and tests of statistical significance are based on weighted data and are calculated using SUDAAN. Tests of statistical significance are based on t-statistics for the difference in means of the continuous variables and chi-square statistics for the difference in the percent distributions of the categorical variables. Only cases with no missing data were used in the tabulations.

*(**): The difference between infant WIC participants and nonparticipants is statistically significant at the .05 (.01) level.

comparisons do not control for the more disadvantaged socioeconomic characteristics of WIC participants, when compared to both income-eligible nonparticipants and higher-income nonparticipants. Using the NMIHS data, Schwartz et al. (1992) found no significant association between WIC participation and breastfeeding initiation or duration, after controlling for differences in the socioeconomic characteristics of WIC participants and income-eligible participants.[15]

Infant Formula. The lower prevalence of breastfeeding among infant WIC participants is reflected in a higher prevalence of the use of infant formula. In each of the first 6 months after birth, mothers of infant WIC participants were significantly more likely to feed infant formula than were mothers of income-eligible nonparticipants or higher-income nonparticipants. The percentage of mothers of infant WIC participants feeding formula started at 78 percent in the first month after birth, compared with 61 percent for mothers of income-eligible nonparticipants and 48 percent for higher-income nonparticipants. By month 6, roughly 9 out of 10 infant WIC participants' mothers were feeding infant formula, compared with about three-fourths of nonparticipants' mothers.[16]

Cow's Milk. Only a small proportion of mothers fed cow's milk during the first 4 months after birth.[17] During months 5 and 6, however, the use of cow's milk increased in all three groups. The percentage of infant WIC participants' mothers feeding cow's milk was significantly lower than the percentage of income-eligible nonparticipants' mothers (in months 5 and 6), and not significantly different from that of higher-income nonparticipants' mothers.

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[15]Schwartz et al. used both descriptive and multivariate analysis to examine the relationship of WIC participation and other characteristics to the initiation and duration of breastfeeding. Their descriptive findings are fully consistent with those reported here.

[16]Trends in the use of infant formula may reflect two offsetting forces: (1) some women may switch from breastfeeding to infant formula, or supplement breastfeeding with formula, causing the percentage using formula to increase, and (2) some women may switch from infant formula to cow's milk, causing the percentage using formula to decline.

[17]Mothers of WIC participants were significantly more likely than mothers of higher-income nonparticipants to use cow's milk in the first 3 months, but the proportions using cow's milk were fairly small (around 2 percent).

Solid Foods (Cereal, Fruits or Vegetables, or Meats). Substantial proportions of mothers, regardless of WIC participation status, fed their infants solid foods (especially cereal) in the first 4 months, although the American Academy of Pediatrics does not recommend introducing solids until the fifth or sixth month. Roughly half of the mothers of infant WIC participants and income-eligible nonparticipants and 38 percent of the mothers of higher-income infants fed solid foods by month 3. More than 60 percent of the mothers in all three groups (more than 70 percent in the low-income groups) fed solid foods by month 4. Mothers of infant WIC participants and income-eligible nonparticipants did not differ significantly in the use of solid foods after the first month, but mothers of infant WIC participants were significantly more likely to feed solid foods than mothers of higher-income nonparticipants through month 5.

d. Feeding Practices for Infants Who Were Not Breastfed (Table IV.15)

Formula versus Cow's Milk. Among mothers who did not breastfeed, almost all mothers fed infant formula in the early months. However, with time, increasing proportions fed their infants cow's milk instead of (or with) formula, and some mothers stopped using formula.

In months 4 to 6, mothers of infant WIC participants who were not breastfeeding were significantly more likely to feed formula than were mothers of income-eligible nonparticipants not breastfeeding. They were also significantly more likely than higher-income nonparticipants' mothers to feed formula in months 5 and 6. In addition, mothers of WIC participants were significantly less likely than mothers of income-eligible nonparticipants to feed cow's milk in months 5 and 6, and less likely to feed cow's milk than mothers of higher-income nonparticipants in month 6. The proportion of mothers of WIC participants who fed their infants cow's milk was 5 percent in month 5 and 10 percent in month 6, while the proportion of mothers of income-eligible nonparticipants who fed cow's milk was 12 percent in month 5 and 20 percent in month 6. The proportion of mothers of other nonparticipants who fed their infants cow's milk was 7 percent in month 5 and 16 percent in month 6.

Solid Foods. Regardless of WIC participation status, a large proportion of mothers who were not breastfeeding fed their children solid foods during the first 4 months after birth. Roughly half of these mothers fed their infants cereal by the third month and fruits and vegetables by the fourth month, but had not introduced meats even in the sixth month.

Although the timing and prevalence of feeding different types of solid foods--cereals, fruits, vegetables, meats--varies with each type of food,

TABLE IV.15

INFANT FEEDING PRACTICES USED BY MOTHERS OF INFANTS WHO WERE NOT BREASTFED

	Infant WIC Participants	Income-Eligible Nonparticipants	Higher-Income Nonparticipants
Mothers Who Fed Infant Formula (Percent)			
Month 1	98.7	98.0	99.5
Month 2	99.0	98.2	99.1
Month 3	98.6	97.3	99.0
Month 4	97.8	94.2 *	97.6
Month 5	95.9	90.1 **	93.7 *
Month 6	93.2	83.6 **	87.4 **
Mothers Who Fed Cow's Milk (Percent)			
Month 1	2.1	1.6	0.4 **
Month 2	2.2	1.6	0.7 **
Month 3	2.2	2.2	1.0 *
Month 4	3.0	5.5	2.6
Month 5	5.2	12.0 **	6.8
Month 6	10.3	20.1 **	16.1 **
Mothers Who Fed Cereals (Percent)			
Month 1	14.0	12.5	9.2 **
Month 2	29.0	32.3	25.2
Month 3	49.9	53.4	49.4
Month 4	68.2	71.8	71.7
Month 5	75.2	75.2	77.4
Month 6	79.9	79.9	84.2 **
Mothers Who Fed Fruits or Vegetables (Percent)			
Month 1	6.8	4.3 *	1.7 **
Month 2	13.4	12.0	8.9 **
Month 3	29.6	29.8	26.2
Month 4	50.9	55.3	51.8
Month 5	66.5	67.0	67.8
Month 6	80.4	81.8	84.6 **
Mothers Who Fed Meats (Percent)			
Month 1	2.6	1.1 **	0.4 **
Month 2	3.1	1.6 *	0.9 **
Month 3	6.6	4.6	3.8 **
Month 4	15.9	16.4	11.6 **

TABLE IV.15 *(continued)*

	Infant WIC Participants	Income-Eligible Nonparticipants	Higher-Income Nonparticipants
Month 5	28.5	31.2	23.8 *
Month 6	49.8	49.3	45.6

SOURCE: 1988 National Maternal and Infant Health Survey.

NOTE: All percentages, percent distributions, and tests of statistical significance are based on weighted data and are calculated using SUDAAN. Tests of statistical significance are based on t-statistics for the difference in means of the continuous variables and chi-square statistics for the difference in the percent distributions of the categorical variables. Only cases with no missing data were used in the tabulations.

*(**): The difference between infant WIC participants and nonparticipants is significant at the .05 (.01) level.

several patterns are consistent among the nonbreastfeeding mothers. Mothers of WIC participants and income-eligible nonparticipants differed only slightly in terms of the feeding of solid foods; mothers of WIC participants were more likely to feed fruits and vegetables and meats in the first 2 months. However, significantly more mothers of WIC participants than mothers of higher-income nonparticipants fed cereals and fruits or vegetables in the early months after birth, when feeding of solid foods is not recommended. Mothers of WIC participants were also more likely to feed meats in the first 4 months after birth. Mothers of WIC participants were less likely than mothers of higher-income nonparticipants to feed cereals and fruits and vegetables in the sixth month, when almost all mothers of higher-income nonparticipants had introduced solids.

e. Feeding Practices of Breastfeeding Mothers (Table IV.16)

Mothers who started out breastfeeding their infants supplemented breast milk increasingly with formula or cow's milk over time (or switched to one of these foods). Forty-three percent of mothers of infant WIC participants who ever breastfed reported supplementing with formula in the first month after birth, and fully 81 percent were using formula by month 6, when most had stopped breastfeeding (see discussion of breastfeeding above). Among mothers of income-eligible nonparticipants who ever breastfed, the use of formula increased from 29 percent in the first month to 65 percent in the sixth month. Mothers of higher-income nonparticipants who ever breastfed were least likely to use formula initially--only 24 percent used formula in the first month--but 70 percent used formula by month 6.

Among those who ever breastfed, mothers of WIC infants were significantly more likely to feed formula than were both mothers of income-eligible nonparticipants and higher-income nonparticipants throughout the 6 months after birth. Infant WIC participants' mothers were significantly less likely to feed cow's milk in month 6 than were income-eligible nonparticipants' mothers (7 percent for infant WIC participants' versus 13 percent for income-eligible nonparticipants' mothers).

Mothers of WIC participants and income-eligible nonparticipants who ever breastfed did not differ significantly in the feeding of solid foods in the first 6 months. In contrast, mothers of WIC participants were significantly more likely than mothers of higher-income nonparticipants to feed solid foods in the early months.

TABLE IV.16

INFANT FEEDING PRACTICES USED BY MOTHERS OF INFANTS WHO WERE EVER BREASTFED

	Infant WIC Participants	Income-Eligible Nonparticipants	Higher-Income Nonparticipants
Mothers Who Fed Infant Formula (Percent)			
Month 1	42.8	28.5 **	23.5 **
Month 2	59.4	41.0 **	40.2 **
Month 3	69.7	56.2 **	53.4 **
Month 4	76.6	61.9 **	63.5 **
Month 5	79.6	66.2 **	67.7 **
Month 6	80.9	64.8 **	69.6 **
Mothers Who Fed Cow's Milk (Percent)			
Month 1	1.3	0.5	0.4
Month 2	1.3	0.9	0.6
Month 3	1.3	1.4	0.7
Month 4	2.1	2.9	1.4
Month 5	3.9	4.3	2.6
Month 6	7.1	12.6 **	8.1
Mothers Who Fed Cereals (Percent)			
Month 1	9.6	7.7	3.4 **
Month 2	21.9	17.1	11.8 **
Month 3	41.1	35.1	29.0 **
Month 4	63.5	61.3	56.2 **
Month 5	72.1	68.6	69.7
Month 6	81.5	78.9	83.7
Mothers Who Fed Fruits or Vegetables (Percent)			
Month 1	4.3	4.2	1.0 **
Month 2	10.2	8.6	4.0 **
Month 3	24.4	20.6	15.3 **
Month 4	48.6	44.4	39.0 **
Month 5	65.3	61.6	58.1 **
Month 6	81.4	78.7	80.1
Mothers Who Fed Meats (Percent)			
Month 1	1.6	0.6	0.3 **
Month 2	1.8	1.0	0.6 *
Month 3	4.4	2.7	2.1 **

TABLE IV.16 *(continued)*

	Infant WIC Participants	Income-Eligible Nonparticipants	Higher-Income Nonparticipants
Month 4	14.7	10.3 *	6.6 **
Month 5	25.6	21.7	17.3 **
Month 6	47.7	44.3	43.3

SOURCE: 1988 National Maternal and Infant Health Survey.

NOTE: All means, percent distributions, and tests of statistical significance are based on weighted data and are calculated using SUDAAN. Tests of statistical significance are based on t-statistics for the difference in means of the continuous variables and chi-square statistics for the difference in the percent distributions of the categorical variables. Only cases with nonmissing data were used in the tabulations.

*(**): The difference between infant WIC participants and nonparticipants is statistically significant at the .05 (.01) level.

f. Summary

Mothers of infant WIC participants and income-eligible nonparticipants did not differ greatly in their compliance with CN-AAP feeding recommendations in the first 4 months after birth. Mothers of infant WIC participants, however, were significantly less likely than mothers of income-eligible nonparticipants to feed according to CN-APP guidelines in month 1 and were significantly more likely than mothers of income-eligible nonparticipants to feed according to the guidelines in months 5 and 6. Mothers of WIC participants and nonparticipants differed significantly in the prevalence of breastfeeding. Although breastfeeding is the preferred method of infant feeding in most circumstances, mothers of infant WIC participants were less likely than both mothers of income-eligible nonparticipants and higher-income nonparticipants to breastfeed throughout the first 6 months and were more likely to provide formula supplements along with breast milk if they breastfed. Mothers of infant WIC participants, however, were significantly less likely than mothers of income-eligible nonparticipants to feed cow's milk in months 5 and 6. Reflecting the lower prevalence of both breastfeeding and the use of cow's milk in months 5 and 6, mothers of infant WIC participants were significantly more likely than either mothers of income-eligible nonparticipants or higher-income nonparticipants to feed infant formula.

Among those who did not breastfeed, mothers of WIC participants were significantly more likely than mothers of income-eligible nonparticipants to feed an appropriate formula in months 4 to 6. WIC participants' mothers were also less likely to switch from formula to cow's milk in months 5 and 6 than were income-eligible nonparticipants' mothers, and in this sense were more likely to feed according to recommended practices.

Mothers of infant WIC participants were less likely to follow recommended infant feeding practices than were mothers of higher-income infant nonparticipants, primarily because WIC participants' mothers tended to introduce solid foods earlier. Infant WIC participants' mothers were about half as likely as higher-income infants' mothers to breastfeed, and they were more likely to feed formula when breastfeeding.

It is important to emphasize that many possible reasons could account for the observed differences in infant feeding practices. These reasons include differences in mothers' background characteristics, differences in infant health status (including feeding problems or other risk factors that may have led to referral to WIC), as well as the effects of the WIC Program. In addition, the effects of the WIC Program may be associated with information provided during prenatal WIC participation or with

infant WIC participation (since infants of prenatal WIC participants are much more likely to participate in WIC than are other infants, as noted in Table IV.1).

Schwartz et al. (1992) analyzed the 1988 NMIHS data to examine the determinants of breastfeeding and the effect of prenatal WIC participation. They found no significant association between WIC participation and breast feeding initiation or duration, after controlling for differences in the socioeconomic characteristics of WIC participants and income-eligible nonparticipants. Their results imply that lower breastfeeding rates among WIC participants are a reflection of their more disadvantaged socioeconomic status, rather than an effect of WIC participation.

V. MULTIVARIATE ANALYSIS OF THE RELATIONSHIP BETWEEN PRENATAL WIC PARTICIPATION AND BIRTH OUTCOMES

OVERVIEW AND SUMMARY

This chapter presents estimates of the relationship between prenatal WIC participation and birth outcomes such as birthweight, gestational age, neonatal mortality, and infant mortality. The birth outcomes of prenatal WIC participants are compared with the birth outcomes of a comparison group of income-eligible nonparticipants (see the discussion in Chapter III). Because WIC participants differ from the comparison group in many characteristics that may also influence birth outcomes, multivariate analysis techniques are used to control for such differences.

The estimates presented here complement results from the WIC-Medicaid Study (Devaney et al. 1990, 1991). However, while the WIC-Medicaid study considered the effects of prenatal WIC participation on birth outcomes for Medicaid beneficiaries in five states, the current study is nationally representative and includes both Medicaid beneficiaries and women not covered by Medicaid. In addition, this study was able to take advantage of the wider range of control variables available in the NMIHS.

Methodological Issues

Several methodological problems make reliable estimation of the relationship between prenatal WIC participation and birth outcomes difficult. First, all estimates of the relationship between WIC participation and outcomes in this chapter control for the adequacy of prenatal care, and other measures of the mother's behavior during pregnancy, and thus may understate the effects of prenatal WIC participation. The descriptive results in Chapter IV show that about 60 percent of prenatal WIC participants received advice from the WIC Program to obtain prenatal care, to reduce or eliminate their use of tobacco products and alcohol, and to avoid illegal drugs. Because these aspects of the mother's behavior are included as control variables, the estimated relationship between WIC participation and outcomes does not include any effects of the WIC Program on birth outcomes through changes in the woman's behavior.[1] The estimates should therefore be interpreted as reflecting the role of the supplemental food provided by the WIC Program, which may be less than the total effect of the program.

Second, although prenatal WIC participation may increase pregnancy duration, longer duration of pregnancy may also increase the likelihood of WIC participation. Because of this simultaneous relationship, estimates of the effects of WIC from models using a simple binary indicator of WIC

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[1]That is, the model provides estimates of the relationship between WIC participation and birth outcomes after controlling for differences in the mothers' behavior during pregnancy.

participation--presented in the first section of this chapter--will tend to *overstate* the effects of WIC. The second section of this chapter presents several alternative approaches to controlling for this simultaneity bias. However, these approaches can be shown to systematically *understate* the effects of WIC on birth outcomes. Thus, both sets of approaches together bound the likely magnitude of the relationship.

Lastly, although the multivariate analyses control for a wide range of maternal characteristics, it remains possible that WIC participants and income-eligible nonparticipants differ in terms of unobserved characteristics that affect birth outcomes. In this case, estimates of the association between WIC participation and birth outcomes would in part reflect the effects of WIC participation and in part reflect the effects of these unobserved characteristics, a problem referred to in the statistical literature as "selection bias."

Because of these methodological problems, references to the "effects" of WIC in this chapter are really a shorthand for the estimated statistical association between prenatal WIC participation and birth outcomes, and do not necessarily estimate the true causal relationship.

Other methodological issues, including the precise definitions of dependent and independent variables, and the methods used to estimated the models, are discussed in Appendix A.

Summary

Keeping all of these caveats in mind, the results in this chapter indicate that prenatal WIC participation is associated with higher average newborn birthweight and gestational age. Prenatal WIC participation is associated with an increase in average birthweight of between 25 and 68 grams. Prenatal WIC participation is associated with an increase in gestational age of between one-fourth and one-half of a week. These estimates are similar to those found in previous studies (see Chapter II).

Furthermore, prenatal WIC participation significantly reduces the extremes of low birthweight and preterm birth. WIC participation is associated with reductions in the percentage of low birthweight births of between 1 and 3 percentage points (from a mean of 10.8 percent for income-eligible nonparticipants), and with reductions in the percentage of preterm births of between 2.4 and 3.6 percentage points (from a mean of 14.2 percent). However, prenatal WIC participation does not have a statistically significant effect on neonatal or infant mortality in any of the specifications estimated.

EMPIRICAL RESULTS FROM THE BASIC MODEL

This section presents estimates of the effect of prenatal WIC participation on birth outcomes using the basic model, in which WIC participation is specified as a binary variable equal to one if the woman participated in WIC at any time during pregnancy and equal to zero otherwise. Estimates are presented for the effect of WIC on birthweight, gestational age, and the incidence of five adverse birth outcomes--low birthweight, very low birthweight, preterm birth, neonatal death, and infant death within 6 months of birth. Separate estimates of the effects of WIC on birthweight for blacks and whites are also presented.

Effects on Birthweight

Estimates from the basic birthweight model indicate that prenatal participation in the WIC Program increases birthweight by about 2 percent (67.9 grams, on average, or about 2.4 ounces) (Table V.1). This effect is statistically significant at the 1 percent level. Control variables included in the model largely have the expected effects. Birthweight is significantly lower for blacks and Asians than for whites. Controlling for other factors, black newborns weigh 260 grams less than white newborns on average, and Asian newborns weigh 215 grams less than white newborns. Married women have newborns weighing about 62 grams more than those of unmarried women.

Receiving inadequate prenatal care, as measured by the Kessner Index, substantially and significantly decreases birthweight (135 grams), but intermediate levels of care do not have a significant effect. Mothers with missing data (because of missing gestational age) for the Kessner Index also have infants with significantly lower birthweights. Reported smoking and cocaine use during pregnancy significantly reduce birthweight--cocaine users have babies who weigh 290 grams less, all other things being equal, and an increase of one per day in the average number of cigarettes smoked reduces birthweight by 8.5 grams. These results may indicate either direct effects of smoking and cocaine use, or effects of other associated health problems. In addition, underreporting may bias estimates of these effects if the likelihood of reporting high-risk behaviors is related to birth outcomes. Alcohol and marijuana use during pregnancy do not have significant effects, although the point estimates of their effects are negative. The lack of significant effects for these variables may reflect underreporting. Hospitalization of the mother during pregnancy (an indicator of pregnancy-related health problems not otherwise measured) is associated with a 147-gram decline in the baby's birthweight.

The estimates from the basic birthweight model indicate that black newborns have lower birthweights on average than whites even after controlling for other factors (see Table V.1). To investigate whether the

TABLE V.1

THE EFFECT OF PRENATAL WIC PARTICIPATION ON BIRTHWEIGHT: BASIC MODEL

Independent Variables	Coefficients (Grams)	Standard Errors
Intercept	2,630.0 **	94.5
Prenatal WIC Participation	67.9 **	19.6
Newborn Characteristics		
Male	123.9 **	18.0
Multiple birth	-933.4 **	55.3
Mother's Characteristics		
Age	5.1	2.7
Years of education	9.7 *	4.8
Black	-260.1 **	20.6
Asian	-215.0 **	62.3
Native American	-150.2	78.2
Hispanic	-21.1	31.7
Married	61.9 **	23.4
Unmarried, father present	8.1	27.3
Kessner index intermediate	-26.4	20.5
Kessner index inadequate	-134.8 **	34.8
Kessner index missing	-192.3 **	45.7
Number of previous live births	20.1 *	9.5
Number of cigarettes smoked per day during pregnancy	-8.5 **	1.6
Alcohol use during pregnancy		
3+ drinks per week	-53.7	55.4
1 - 2 drinks per week	-66.6	61.0
Less than 1 drink per week	-17.5	31.3
Used marijuana during pregnancy	-3.5	55.8
Used cocaine during pregnancy	-289.7 **	62.9
Prepregnancy weight (pounds)	4.0 **	0.3
Hospitalized during pregnancy	-146.6 **	25.2
Father's Characteristics		
Age	-3.7 *	1.8
Years of education	3.3	4.5
Household/Residence Characteristics		
Household size	-3.8	4.6
Per capita income	2.4	2.6
Metropolitan county	4.6	22.1
Northeast region	-17.4	33.0

TABLE V.1 *(continued)*

Independent Variables	Coefficients (Grams)	Standard Errors
Northcentral region	-38.0	31.7
Southern region	-26.8	28.9
R^2	**.175**	
Sample Size	**6,138**	

SOURCE: 1988 National Maternal and Infant Health Survey.

NOTE: Estimates were produced using weighted least squares. The analysis sample includes prenatal WIC participants and income-eligible nonparticipants. Birthweight is measured in grams. Standard errors adjusted to reflect the stratified sample design were calculated using SUDAAN.

*(**): Significant at the .05 (.01) percent level in a two-tailed test.

effect of the WIC Program on birthweight differs for blacks and whites, the model was estimated separately for each group. The findings suggest that the effect of WIC on birthweight does not differ significantly between blacks and whites. The estimated effect of WIC participation on birthweight is an increase of 79.5 grams for blacks and an increase of 59.0 grams for whites (Table V.2). The difference in the effects between the two groups (20.5 grams) is not statistically significant--the standard error of the difference is 32.9 grams. Most control variables have effects in similar directions for blacks and whites, although the magnitude of the effects sometimes differs.

Effects on Gestational Age

Estimates from the basic model of gestational age suggest that prenatal WIC participation increases gestational age by just under half a week (Table V.3). Not surprisingly, many of the factors associated with lower birthweight are also associated with lower gestational age. The estimates in Table V.3 indicate that after controlling for other factors, the gestational ages of black newborns are 1.1 weeks less than those of whites and the gestational ages of Asian newborns are about 0.7 weeks less than those of whites. Cocaine use during pregnancy is associated with a 1-week decline in gestational age, and inadequate prenatal care (as measured by the Kessner Index) is associated with a half-week decline. Mothers with more years of education have significantly longer gestations, although the effect of education on birthweight was not significant.

Effects on the Incidence of Adverse Birth Outcomes

Weighted logit analysis was used to estimate the effects of prenatal WIC participation on the incidence of five adverse birth outcomes:

- Low birthweight (birthweight less than 2,500 grams)
- Very low birthweight (birthweight less than 1,500 grams)
- Preterm birth (gestational age less than 37 weeks)
- Neonatal death (death within 28 days of birth)
- Infant death within 6 months of birth

As with the linear regression models described previously, WIC participation in the basic logit models was measured as a simple binary

TABLE V.2

THE EFFECT OF PRENATAL WIC PARTICIPATION
ON BIRTHWEIGHT BY RACE
(Standard Errors in Parentheses)

Independent Variables	Coefficients (grams)	
	Blacks	Whites
Intercept	2,417.6 **	2,635.5 **
	(102.6)	(130.2)
Prenatal WIC Participation	79.5 **	59.0 *
	(19.0)	(26.9)
Newborn Characteristics		
Male	118.4 **	126.9 **
	(17.3)	(24.9)
Multiple birth	-856.8 **	-1,027.1 **
	(47.1)	(95.7)
Mother's Characteristics		
Age	1.5	7.8 *
	(2.6)	(3.8)
Years of education	9.7	5.8
	(5.5)	(6.2)
Hispanic	113.1	-36.6
	(60.6)	(37.0)
Married	72.0 **	55.1
	(22.0)	(34.3)
Unmarried, father present	-7.6	21.7
	(25.3)	(42.1)
Kessner index intermediate	-44.0 *	-6.4
	(19.4)	(28.5)

TABLE V.2 *(continued)*

Independent Variables	Coefficients (grams)	
	Blacks	Whites
Kessner index inadequate	-183.7 **	-106.7
	(28.2)	(56.2)
Kessner index missing	-251.0 **	-193.5 **
	(45.1)	(63.2)
Number of previous live births	17.6 *	25.9
	(8.0)	(14.8)
Number of cigarettes smoked per day during pregnancy	-10.6 **	-8.4 **
	(1.7)	(1.9)
Alcohol use during pregnancy		
3+ drinks per week	-88.2	-33.5
	(66.4)	(84.4)
1 - 2 drinks per week	-158.2 **	-3.6
	(59.1)	(87.9)
Less than 1 drink per week	-28.1	-7.0
	(33.5)	(38.0)
Used marijuana during pregnancy	-64.5	32.6
	(60.0)	(74.0)
Used cocaine during pregnancy	-186.8 **	-337.2 **
	(64.5)	(113.2)
Prepregnancy weight (pounds)	3.6 **	4.2 **
	(0.3)	(0.5)
Hospitalized during pregnancy	-148.4 **	-149.5 **
	(24.9)	(34.7)
Father's Characteristics		
Age	-3.3	-4.5
	(1.9)	(2.6)
Years of education	4.0	1.9
	(5.6)	(5.7)

TABLE V.2 *(continued)*

Independent Variables	Coefficients (grams)	
	Blacks	Whites
Household/Residence Characteristics		
Household size	2.8	-10.6
	(3.7)	(7.8)
Per capita income	1.8	1.4
	(2.8)	(3.3)
Metropolitan county	30.4	4.0
	(21.7)	(28.9)
Northeast region	59.8	-31.9
	(39.4)	(42.0)
Northcentral region	-33.7	-24.5
	(36.2)	(40.0)
Southern region	2.3	-24.3
	(34.6)	(35.3)
R^2	.147	.153
Sample Size	4,000	1,968

SOURCE: 1988 National Maternal and Infant Health Survey.

NOTE: Estimates were produced using weighted least squares. The analysis sample includes all black or white prenatal WIC participants and income-eligible nonparticipants. Birthweight is measured in grams. Standard errors adjusted to reflect the stratified sample design were calculated using SUDAAN.

*(**): Significant at the .05 (.01) percent level in a two-tailed test.

TABLE V.3

THE EFFECT OF PRENATAL WIC PARTICIPATION ON GESTATIONAL AGE: BASIC MODEL

Independent Variables	Coefficients (Weeks)	Standard Errors
Intercept	38.100 **	0.444
Prenatal WIC Participation	0.470 **	0.100
Newborn Characteristics		
Male	-0.061	0.093
Multiple birth	-3.119 **	0.278
Mother's Characteristics		
Age	-0.011	0.013
Years of education	0.050 *	0.024
Black	-1.069 **	0.112
Asian	-0.701 *	0.296
Native American	-0.280	0.297
Hispanic	-0.281	0.157
Married	-0.005	0.124
Unmarried, father present	0.085	0.154
Kessner index intermediate	0.082	0.102
Kessner index inadequate	-0.438 *	0.216
Number of previous live births	0.041	0.045
Number of cigarettes smoked per day during pregnancy	0.002	0.008
Alcohol use during pregnancy		
3+ drinks per week	-0.840	0.564
1 - 2 drinks per week	0.017	0.329
Less than 1 drink per week	0.132	0.142
Used marijuana during pregnancy	0.034	0.359
Used cocaine during pregnancy	-1.078 **	0.353
Prepregnancy weight (pounds)	0.004 **	0.002
Hospitalized during pregnancy	-0.219	0.131
Father's Characteristics		
Age	0.005	0.011
Years of education	0.019	0.022
Household/Residence Characteristics		
Household size	0.001	0.025
Per capita income	0.018	0.014
Metropolitan county	0.028	0.112
Northeast region	-0.320 *	0.163

TABLE V.3 *(continued)*

Independent Variables	Coefficients (Weeks)	Standard Errors
Northcentral region	-0.212	0.147
Southern region	-0.244	0.142
R^2	0.063	
Sample Size	5,781	

SOURCE: 1988 National Maternal and Infant Health Survey.

NOTE: Estimates were produced using weighted least squares. The analysis sample includes all prenatal WIC participants and income-eligible nonparticipants for whom gestational age is reported. Gestational age is measured in weeks. Standard errors adjusted to reflect the stratified sample design were calculated using SUDAAN.

*(**): Significant at the .05 (.01) percent level in a two-tailed test.

variable equal to one if the woman participated in WIC at any time during pregnancy and equal to zero otherwise.

Unlike parameters in a linear regression model, parameters in a logit model do not have a direct intuitive interpretation. However, the standard errors and signs of the parameters yield information about the independent variables that have significant effects on the outcome, and about the direction of those effects. The estimated logit coefficients are shown in Appendix B. These coefficients were used to calculate the predicted probability of each adverse birth outcome with and without prenatal WIC participation. The results indicate that WIC reduces the incidence of low birthweight, very low birthweight, and preterm birth, but does not significantly affect neonatal or infant death rates (Table V.4). The estimates imply that WIC reduces the incidence of low birthweight by 2.9 percentage points, the incidence of very low birthweight by 1.0 percentage points and the incidence of preterm births by 3.6 percentage points. Each estimated effect is significant at the 1 percent level.

Interpreting the Results from the Basic Model

The estimates of the effects of WIC on birthweight, gestational age and other birth outcomes from the basic model should be interpreted with caution for several reasons.

First, these estimates do not control for the simultaneous relationship between prenatal WIC participation and gestational age. WIC participation and pregnancy duration are likely to be simultaneously related because women with longer pregnancy durations have more opportunity to enroll in WIC. Thus, while WIC participation may increase gestational age, causality may also operate in the opposite direction--in that a longer pregnancy may increase the likelihood of WIC participation. Both effects would lead to a positive correlation between WIC participation and gestational age, controlling for other factors. Both are likely to result in a positive correlation between WIC participation and improvements in other birth outcomes, because of the relationship between gestational age and birthweight. Thus, the results of the basic model are likely to *overstate* the effects of WIC on birthweight and gestational age, and to overstate the reductions in low birthweight births, preterm births, and neonatal and infant mortality associated with WIC participation, because a portion of the estimated positive effect reflects reverse causality. The next section discusses models that partially control for the simultaneous relation between WIC participation and gestational age; these models estimate smaller effects of WIC on birth outcomes than the estimates from the basic model.

TABLE V.4

EFFECTS OF PRENATAL WIC PARTICIPATION ON THE PERCENTAGE OF UNFAVORABLE BIRTH OUTCOMES: BASIC MODEL

	Predicted Percentages		
	With WIC Program	Without WIC Program	Estimated Effect of WIC Participation
Predicted Percentage of Low Birthweight Infants	7.9	10.8	-2.9 **
Predicted Percentage of Very Low Birthweight Infants	1.2	2.2	-1.0 **
Predicted Percentage of Preterm Births	10.6	14.2	-3.6 **
Predicted Percentage of Neonatal Deaths	0.5	0.7	-0.2
Predicted Percentage of Infant Deaths within 6 Months of Birth	0.6	0.8	-0.2

SOURCE: Predicted probabilities computed from weighted logit models estimated on data from the 1988 NMIHS.

NOTE: The analysis sample includes prenatal WIC participants and income-eligible nonparticipants. Standard errors adjusted to reflect the stratified sample design were calculated using SUDAAN.

*(**) Significant at the .05 (.01) level in a two-tailed test.

Second, the estimates from the basic model control for the effects of observed differences between prenatal WIC participants and income-eligible nonparticipants, but do not control for any unobserved differences between the two groups that affect birth outcomes. If such unobserved differences exist, the estimated coefficients would be contaminated by "selection bias." The third section of this chapter discusses the selection bias issue in more detail.

RESULTS FOR MODELS USING ALTERNATIVE MEASURES OF WIC PARTICIPATION

The models presented in this section address two important limitations of the basic model. First, a range of models address the simultaneous relationship between WIC participation and pregnancy duration described above. Second, a model is presented that addresses the issue of whether WIC participation has a dose-response effect; that is, whether longer (earlier) enrollment in WIC leads to greater improvements in birth outcomes than shorter (later) enrollment.

Addressing the Relationship between WIC Enrollment and Pregnancy Duration

This section presents results from three approaches to addressing the relationship between the timing of WIC enrollment and pregnancy duration. The first two approaches, redefining WIC participation by omitting very late WIC entrants, and estimating the effect of WIC on birthweight controlling for gestational age, were developed in previous analyses of the WIC-Medicaid data (Devaney 1991; Devaney et al. 1991). The third approach, which involves defining cohorts with pregnancies of at least certain durations, and looking at the effects of WIC participation prior to the week of pregnancy used to define the cohort, has not been previously used to examine the effects of WIC. These approaches provide estimates that largely avoid simultaneity bias, but that have other limitations that imply they are likely to *understate* the effects of WIC.

Redefining Participation. The first approach to the simultaneity issue is to define WIC participants as women who participated in WIC prior to a specified month of pregnancy. For example, under one specification, prenatal WIC participants are defined as women who participated in WIC during the first 8 months of pregnancy, and nonparticipants include women who enrolled in WIC in the ninth month of pregnancy. This specification assumes that any positive birth outcomes for women who enrolled in WIC in the ninth month of pregnancy are attributable to the length of their pregnancy rather than to the effects of WIC.

This alternative definition of WIC participation reduces the potential for bias in the estimated WIC impact that results from the simultaneous relationship between WIC participation and pregnancy duration, but it

does not eliminate the bias entirely. Women whose pregnancies reach the eighth month still have a longer time in which they can enroll in WIC (and thus be classified as a WIC participant) than women whose pregnancies ended earlier. And women in the former group have better birth outcomes than those in the latter group in part because of the longer duration of their pregnancies.

Therefore, results are also presented for models using two other definitions of WIC participation. The first classifies women as WIC participants only if they participated in WIC during the first 7 months of pregnancy, and the second classifies women as WIC participants only if they participated in WIC during the first 6 months of pregnancy. By successively reducing the number of months that define WIC participation, the strength of the simultaneous relationship between WIC participation and pregnancy duration is reduced, thereby reducing the potential for bias caused by this relationship. The bias is likely to be very small--and may be negligible--for the 6-month definition of WIC participation, since nearly all pregnancies resulting in a live birth reach the sixth month. However, by defining WIC participation in terms of fewer months, the total effect of prenatal WIC participation may be underestimated. The 6-month definition, for example, does not capture the effects of WIC during the third trimester, which may be important.

As expected, the estimated effect of WIC participation declines with the number of months for which participation is defined (Table V.5). Estimates using the 8-month definition suggest that WIC participation during the first 8 months of pregnancy increases birthweight by 53 grams on average. Estimates from the 7-month specification indicate that WIC participation during the first 7 months of pregnancy increases birthweight by 47 grams on average. Both estimates are statistically significant at the 1 percent level. The estimated effect on birthweight using the 6-month definition of WIC participation is much smaller (10 grams) and is not statistically significant. The estimates from all three specifications suggest that WIC participation increases gestational age, with the effects ranging from an increase of a third of a week for the 6-month definition to nearly half a week for the 8-month definition.

Controlling for Gestational Age. A second approach to addressing the simultaneous relationship between WIC participation and pregnancy duration is to include gestational age as an independent variable in the birthweight regression. Results from a regression that controls for gestational age are presented in Table V.6.

The average estimated effect of the WIC program on birthweight for infants *of a given gestational age* is 25 grams, which is not statistically

TABLE V.5

EFFECTS OF PRENATAL WIC PARTICIPATION UNDER ALTERNATIVE DEFINITIONS OF PARTICIPATION
(Standard Errors in Parentheses)

	Estimated Coefficients on WIC Participation Variable	
	Birthweight (Grams)	Gestational Age (Weeks)
Prenatal WIC Participation	67.9 **	0.470 **
	(19.6)	(0.100)
WIC Participation in First 8 Months of Pregnancy	52.7 **	0.447 **
	(19.1)	(0.098)
WIC Participation in First 7 Months of Pregnancy	46.5 *	0.383 **
	(19.0)	(0.098)
WIC Participation in First 6 Months of Pregnancy	9.5	0.328 **
	(18.8)	(0.098)

SOURCE: 1988 National Maternal and Infant Health Survey.

NOTE: Estimates were produced using weighted least squares. The analysis sample includes prenatal WIC participants and income-eligible nonparticipants. Separate models were estimated corresponding to the different definitions of WIC participation. Standard errors adjusted to reflect the stratified sample design were calculated using SUDAAN.

*(**) Significant at the .05 (.01) level in a two-tailed test.

TABLE V.6

EFFECT OF PRENATAL WIC PARTICIPATION ON BIRTHWEIGHT, CONTROLLING FOR GESTATIONAL AGE

Independent Variables	Coefficients (Grams)	Standard Errors
Intercept	-624.4 **	167.7
Prenatal WIC Participation	25.3	19.6
Newborn Characteristics		
Male	132.1 **	18.1
Multiple birth	-663.5 **	47.5
Gestational age (weeks)	85.3 **	3.5
Mother's Characteristics		
Age	6.4 *	2.8
Years of education	5.1	4.9
Black	-171.9 **	20.8
Asian	-175.0 **	60.7
Native American	-141.9 *	66.5
Hispanic	2.9	31.4
Married	57.1 *	23.7
Unmarried, father present	4.7	26.8
Kessner index intermediate	-34.6	19.5
Kessner index inadequate	-101.2 **	34.6
Number of previous live births	14.7	9.5
Number of cigarettes smoked per day during pregnancy	-8.7 **	1.4
Alcohol use during pregnancy		
3+ drinks per week	36.3	69.5
1 - 2 drinks per week	-65.2	60.4
Less than 1 drink per week	-41.5	31.2
Used marijuana during pregnancy	-19.1	51.8
Used cocaine during pregnancy	-177.8 **	59.1
Prepregnancy weight (pounds)	3.6 **	0.4
Hospitalized during pregnancy	-127.2 **	24.3
Father's Characteristics		
Age	-3.8 *	1.9
Years of education	1.6	4.5
Household/Residence Characteristics		
Household size	-4.3	4.7
Per capita income	-0.8	2.9
Metropolitan county	4.4	21.7

TABLE V.6 *(continued)*

Independent Variables	Coefficients (Grams)	Standard Errors
Northeast region	23.4	32.4
Northcentral region	-20.7	31.5
Southern region	-0.7	28.8
R^2	.335	
Sample Size	5,781	

SOURCE: 1988 National Maternal and Infant Health Survey.

NOTE: Estimates were produced using weighted least squares. The analysis sample includes all prenatal WIC participants and income-eligible nonparticipants for whom gestational age is reported. Birthweight is measured in grams. Standard errors adjusted to reflect the stratified sample design were calculated using SUDAAN.

*(**): Significant at the .05 (.01) percent level in a two-tailed test.

significant. However, this approach does not account for any effect of WIC participation on birthweight that works by increasing gestational age.

This estimate is thus likely to understate the overall effects of WIC. Another caveat is that gestational age is missing from the birth certificates of about 6 percent of the sample, and births without gestational age data are frequently cases of low birthweight (see, for example, the coefficient on Kessner Index missing in Table V.1). All observations with missing gestational ages were excluded from this regression.

Defining Gestational Age Cohorts. The third approach to dealing with the simultaneous relationship between WIC participation and pregnancy duration is to define a set of cohorts of women whose pregnancies reached a specified number of weeks, and estimate the effects of WIC participation during the period prior to the week of pregnancy used to define the cohort. A similar approach has been used by Tyson et al. (1990) to estimate the effects of prenatal care. The first cohort consists of women whose pregnancies lasted at least 28 weeks. For this cohort, WIC participants are defined as women who participated in WIC during the first 6 months of pregnancy. Women who enrolled in WIC after the sixth month are treated as nonparticipants. (The sixth month is the last complete month prior to the 28th week of pregnancy.)[2] Thirty-two-week, 36-week, and 40-week cohorts were defined similarly. For each cohort, WIC participants are defined as women who had enrolled in WIC by the month just prior to the week of pregnancy defining the cohort. Thus, for the 32-week cohort, WIC participants are defined as women who enrolled in WIC by the seventh month of pregnancy, and for the 36-week and 40-week cohorts, WIC participants are defined as women who enrolled in WIC by the eighth and ninth month of pregnancy, respectively. To estimate the effects of WIC on birth outcomes, separate models were estimated for each cohort.

The advantage of this approach is that it eliminates the simultaneity between WIC participation (as defined) and pregnancy duration. For example, since all women in the 32-week cohort had pregnancies lasting at least 32 weeks, they all had the potential to enroll in WIC during the first seven months of pregnancy (and thus to be classified as a WIC participant). Estimates generated with this approach should therefore be free of the type of bias that may exist for the basic model.

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[2]On average, there are 4.33 weeks per month. So the 28th week of pregnancy corresponds on average to nearly 6 1/2 months.

However, this approach almost certainly yields conservative estimates of the effect of WIC participation for two reasons: (1) the gestational age distribution in the sample is truncated, and regressions with truncated dependent variables tend to lead to regression coefficients that are biased downward, and (2) all women who enter WIC after the cutoff are counted as nonparticipants, but may benefit from WIC services to some extent. Thus, estimates from these models should be interpreted as *lower bounds* on the effects of WIC participation over the periods defined.[3]

Estimates of the birthweight model for the 32-week cohort indicate that WIC participation during the first 7 months increases birthweight by 28 grams on average (Table V.7). Results for the 36-week and 40-week cohorts indicate that WIC participation during the first 8 months increases birthweight by 27 grams, and WIC participation during the first 9 months increases birthweight by 39 grams. None of these estimates is significant at the 5 percent level but they provide plausible lower bounds on WIC Program effects. Results for the 28-week cohort suggest that WIC participation during the first 6 months does not affect birthweight; the point estimate is negative but close to zero and insignificant. Although neither estimate is significant, the difference in the estimates for the 28-week and 32-week cohorts is puzzling.

The gestational age regressions were also estimated separately for the 28-week, 32-week, and 36-week cohorts (Table V.8). Estimates are not presented for the 40-week cohort, since all pregnancies in this cohort reached full term. The estimates indicate that WIC participation (whether during the first 6, 7, or 8 months of pregnancy) increases gestational age by about a quarter of a week. It is important to emphasize that these estimates do not suffer from the type of bias discussed for the basic model of gestational age because all women in a given cohort had the potential to enroll in WIC during the entire period used to define WIC participation.

To examine further the effects of WIC participation on the incidence of the five adverse birth outcomes defined earlier, weighted logit models were estimated for each cohort. Using the estimated coefficients in the logit models, the predicted probability of each adverse birth outcome was calculated with and without prenatal WIC participation (Table V.9). For each cohort, the predicted probabilities reflect the effect of WIC participation by the month just prior to the week of pregnancy used to

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[3]A second issue is that this approach requires information on gestational age to define the cohorts. Thus, observations with a missing gestational age have been excluded from this analysis.

TABLE V.7

EFFECT OF PRENATAL WIC PARTICIPATION ON BIRTHWEIGHT: FOUR COHORTS DEFINED BY GESTATIONAL AGE THRESHOLDS
(Standard Errors in Parentheses)

Independent Variables	28-Week Cohort	32-Week Cohort	36-Week Cohort	40-Week Cohort
Intercept	2,705.2 **	2,674.3 **	2,704.3 **	2,757.5 **
	(96.0)	(96.2)	(98.5)	(144.4)
WIC Participation	-3.6	28.2	27.0	39.2
	(19.2)	(19.5)	(20.1)	(29.8)
Newborn Characteristics				
Male	130.2 **	135.4 **	143.9 **	168.3 **
	(18.5)	(18.5)	(18.9)	(26.4)
Multiple births	-887.8 **	-822.7 **	-757.1 **	-705.7 **
	(57.7)	(57.0)	(59.5)	(141.8)
Mother's Characteristics				
Age	5.1	6.2 *	6.6 *	10.0 *
	(2.8)	(2.8)	(2.9)	(4.3)
Years of education	8.5	7.9	7.9	15.9 *
	(5.0)	(5.0)	(5.1)	(7.1)
Black	-240.2 **	-233.7 **	-212.0 **	-172.5 **
	(21.2)	(21.3)	(21.8)	(30.5)
Asian	-222.9 **	-213.1 **	-215.1 **	-208.9 *
	(60.2)	(60.3)	(59.3)	(83.7)
Native American	-161.7 *	-148.8	-148.8	-146.6
	(79.4)	(78.4)	(79.1)	(103.1)
Hispanic	-11.6	-11.1	-13.6	6.0
	(32.7)	(32.7)	(33.1)	(42.9)
Married	40.0	40.7	31.3	69.7 *
	(24.4)	(24.2)	(25.0)	(35.4)

TABLE V.7 *(continued)*

Independent Variables	28-Week Cohort	32-Week Cohort	36-Week Cohort	40-Week Cohort
Unmarried, father present	9.5	10.9	5.4	28.7
	(28.2)	(28.1)	(28.9)	(39.0)
Kessner index intermediate	-27.7	-25.3	-18.4	17.0
	(20.5)	(20.6)	(21.0)	(28.4)
Kessner index inadequate	-138.2 **	-123.9 **	-102.9 **	-48.3
	(35.2)	(35.2)	(36.7)	(52.1)
Number of previous live births	18.9	18.6	20.4 *	11.8
	(9.8)	(9.9)	(10.1)	(14.1)
Number of cigarettes smoked per day during pregnancy	-8.4 **	-8.4 **	-8.2 **	-5.8 **
	(1.6)	(1.6)	(1.6)	(1.9)
Alcohol use during pregnancy				
3+ drinks per week	-23.2	-17.0	-6.2	-24.6
	(61.1)	(63.9)	(66.9)	(90.3)
1 - 2 drinks per week	-65.5	-69.6	-27.7	-44.1
	(62.0)	(62.3)	(61.0)	(90.2)
Less than 1 drink per week	-32.9	-37.4	-36.3	-25.0
	(31.7)	(31.8)	(32.7)	(43.2)
Used marijuana during pregnancy	-17.9	-17.8	-37.1	17.3
	(54.2)	(53.6)	(57.0)	(66.3)
Used cocaine during pregnancy	-256.7 **	-239.9 **	-209.6 **	-245.6 **
	(66.9)	(66.4)	(62.8)	(90.7)
Prepregnancy weight (pounds)	4.0 **	3.9 **	3.7 **	3.1 **
	(0.3)	(0.3)	(0.4)	(0.5)
Hospitalized during pregnancy	-133.2 **	-116.5 **	-87.8 **	-34.6
	(25.5)	(25.5)	(26.2)	(36.7)

TABLE V.7 *(continued)*

Independent Variables	28-Week Cohort	32-Week Cohort	36-Week Cohort	40-Week Cohort
Father's Characteristics				
Age	-3.3	-3.4	-3.9 *	-3.4
	(1.9)	(1.9)	(1.9)	(2.7)
Years of education	1.9	2.5	3.8	-2.6
	(4.6)	(4.6)	(4.7)	(6.9)
Household/Residence Characteristics				
Household size	-5.7	-5.7	-7.8	-8.3
	(4.8)	(4.8)	(5.1)	(7.2)
Per capita income	0.9	1.7	1.8	1.1
	(3.0)	(3.0)	(3.1)	(4.2)
Metropolitan county	-0.6	9.6	6.6	-43.8
	(22.7)	(22.7)	(23.1)	(32.2)
Northeast region	10.1	13.4	34.4	20.8
	(34.1)	(34.4)	(34.8)	(47.3)
Northcentral region	-29.8	-32.2	-31.1	-31.1
	(32.5)	(32.6)	(33.4)	(46.0)
Southern region	-13.3	-7.9	-5.7	-37.4
	(29.4)	(29.5)	(30.4)	(42.6)
R^2	.174	.173	.163	.145
Sample Size	5,361	4,955	4,316	2,013

SOURCE: 1988 National Maternal and Infant Health Survey.

NOTE: Cohorts are defined to include all prenatal WIC participants and income-eligible nonparticipants whose pregnancies lasted at least through the week specified. For each cohort, WIC participants are defined as women who participated in the program by the month preceding the week of gestation defining the cohort. Estimates were produced using weighted least squares. Birthweight is measured in grams. Standard errors adjusted to reflect the stratified sample design were calculated using SUDAAN.

*(**): Significant at the .05 (.01) percent level in a two-tailed test.

TABLE V.8

EFFECT OF PRENATAL WIC PARTICIPATION ON GESTATIONAL AGE:
THREE COHORTS DEFINED BY GESTATIONAL AGE THRESHOLDS
(Standard Errors in Parentheses)

Independent Variables	28-Week Cohort	32-Week Cohort	36-Week Cohort
Intercept	38.593 **	38.928 **	39.323 **
	(0.421)	(0.408)	(0.379)
WIC Participation	0.262 **	0.269 **	0.233 **
	(0.092)	(0.088)	(0.082)
Newborn Characteristics			
Male	-0.020	-0.005	0.021
	(0.089)	(0.083)	(0.078)
Multiple births	-2.828 **	-2.268 **	-1.509 **
	(0.267)	(0.229)	(0.199)
Mother's Characteristics			
Age	-0.018	-0.023 *	-0.021
	(0.012)	(0.012)	(0.011)
Years of education	0.035	0.017	0.020
	(0.022)	(0.021)	(0.019)
Black	-0.841 **	-0.799 **	-0.477 **
	(0.107)	(0.100)	(0.093)
Asian	-0.690 *	-0.638 *	-0.584 *
	(0.294)	(0.283)	(0.272)
Native American	-0.288	-0.208	-0.321
	(0.289)	(0.274)	(0.267)
Hispanic	-0.231	-0.226	-0.170
	(0.147)	(0.142)	(0.130)
Married	-0.074	-0.137	-0.113
	(0.119)	(0.112)	(0.106)

TABLE V.8 *(continued)*

Independent Variables	28-Week Cohort	32-Week Cohort	36-Week Cohort
Unmarried, father present	0.038 (0.151)	0.056 (0.136)	0.032 (0.129)
Kessner index intermediate	0.142 (0.097)	0.082 (0.092)	0.124 (0.087)
Kessner index inadequate	-0.291 (0.188)	-0.277 (0.173)	-0.028 (0.170)
Number of previous live births	0.042 (0.043)	0.049 (0.041)	0.036 (0.037)
Number of cigarettes smoked per day during pregnancy	0.003 (0.008)	0.004 (0.007)	0.005 (0.007)
Alcohol use during pregnancy			
3+ drinks per week	-0.449 (0.555)	0.291 (0.324)	0.251 (0.328)
1 - 2 drinks per week	0.065 (0.318)	0.037 (0.308)	0.150 (0.301)
Less than 1 drink per week	0.107 (0.141)	0.086 (0.134)	0.036 (0.126)
Used marijuana during pregnancy	-0.084 (0.355)	-0.174 (0.351)	0.056 (0.294)
Used cocaine during pregnancy	-0.929 ** (0.330)	-0.840 * (0.331)	-0.880 ** (0.294)
Prepregnancy weight (pounds)	0.004 * (0.002)	0.003 * (0.001)	0.002 (0.001)
Hospitalized during pregnancy	-0.170 (0.127)	-0.130 (0.124)	0.015 (0.117)

TABLE V.8 *(continued)*

Independent Variables	28-Week Cohort	32-Week Cohort	36-Week Cohort
Father's Characteristics			
Age	0.007	0.010	0.007
	(0.011)	(0.010)	(0.009)
Years of education	0.021	0.023	0.009
	(0.021)	(0.020)	(0.018)
Household/Residence Characteristics			
Household size	-0.008	-0.021	-0.013
	(0.025)	(0.024)	(0.022)
Per capita income	0.026 *	0.023 *	0.025 *
	(0.012)	(0.012)	(0.011)
Metropolitan county	0.004	0.095	0.064
	(0.107)	(0.102)	(0.096)
Northeast region	-0.258	0.137	0.024
	(0.161)	(0.149)	(0.139)
Northcentral region	-0.185	-0.073	-0.019
	(0.144)	(0.138)	(0.131)
Southern region	-0.163	-0.055	0.000
	(0.136)	(0.131)	(0.123)
R^2	.057	.052	.033
Sample Size	5,361	4,955	4,316

SOURCE: 1988 National Maternal and Infant Health Survey.

NOTE: Cohorts are defined to include all prenatal WIC participants and income-eligible nonparticipants whose pregnancies lasted at least through the week specified. For each cohort, WIC participants are defined as women who participated in the program by the month preceding the week of gestation defining the cohort. Estimates were produced using weighted least squares. Gestational age is measured in weeks. Standard errors adjusted to reflect the stratified sample design were calculated using SUDAAN.

*(**) Significant at the .05 (.01) percent level in a two-tailed test.

TABLE V.9

EFFECTS OF PRENATAL WIC PARTICIPATION ON THE PERCENTAGE OF UNFAVORABLE BIRTH OUTCOMES: FOUR COHORTS DEFINED BY GESTATIONAL AGE THRESHOLDS

	Predicted Percentages		
	With WIC Program	Without WIC Program	Estimated Effect of WIC Participation
28-Week Cohort			
Predicted Percentage of Low Birthweight Infants	7.6	8.5	-0.9
Predicted Percentage of Very Low Birthweight Infants	0.9	0.8	0.1
Predicted Percentage of Preterm Births	9.8	12.3	-2.5 **
Predicted Percentage of Neonatal Deaths	0.3	0.2	0.1
Predicted Percentage of Infant Deaths within 6 Months of Birth	0.4	0.3	0.1
32-Week Cohort			
Predicted Percentage of Low Birthweight Infants	6.6	7.6	-1.0
Predicted Percentage of Very Low Birthweight Infants	0.4	0.4	0.0
Predicted Percentage of Preterm Births	8.4	10.8	-2.4 *
Predicted Percentage of Neonatal Deaths	0.3	0.2	0.1
Predicted Percentage of Infant Deaths within 6 Months of Birth	0.4	0.2	0.2
36-Week Cohort			
Predicted Percentage of Low Birthweight Infants	4.5	5.7	-1.2 *
Predicted Percentage of Very Low Birthweight Infants	0.1	0.2	-0.1
Predicted Percentage of Neonatal Deaths	0.3	0.1	0.2
Predicted Percentage of Infant Deaths within 6 Months of Birth	0.3	0.1	0.2

TABLE V.9 *(continued)*

	Predicted Percentages		
	With WIC Program	Without WIC Program	Estimated Effect of WIC Participation
40-Week Cohort			
Predicted Percentage of Low Birthweight Infants	2.0	3.1	-1.1 *
Predicted Percentage of Very Low Birthweight Infants	0.1	0.1	0.0
Predicted Percentage of Neonatal Deaths	0.2	0.1	0.0
Predicted Percentage of Infant Deaths within 6 Months of Birth	0.2	0.2	0.0

SOURCE: Predicted probabilities computed from weighted logit models estimated on data from the 1988 NMIHS.

NOTE: Cohorts are defined to include all prenatal WIC participants and income-eligible nonparticipants whose pregnancies lasted at least through the week specified. For each cohort, WIC participants are defined as women who participated in the program by the month preceding the week of gestation defining the cohort. Standard errors adjusted to reflect the stratified sample design were calculated using SUDAAN.

*(**) Significant at the .05 (.01) level.

define the cohort. Thus, for example, the results for the 28-week cohort indicate that participation in WIC during the first 6 months of pregnancy reduces the percentage of preterm births by 2.5 percentage points.

Results for the 32-week cohort indicate that participation in WIC during the first 7 months of pregnancy reduces the percentage of preterm births by 2.4 percentage points. Depending on the cohort, the results indicate that prenatal WIC participation reduces the percentage of low-birthweight infants by 0.9 percentage points to 1.2 percentage points, but these estimates are not statistically significant for the 28-week and 32-week cohorts. WIC participation does not have a statistically significant effect on the incidence of other adverse birth outcomes examined.

Addressing the Dose-Response Issue

Determining whether WIC has a dose-response effect is complicated by the fact that women with longer pregnancies have a longer time to participate in WIC. Thus, if the basic birthweight model was modified by including a variable representing the number of months on WIC, the effect of the duration of prenatal WIC participation on birthweight would be confounded with the effect of the duration of pregnancy on birthweight. In other words, women who have longer durations of prenatal WIC participation are likely to have newborns with higher birthweight simply because their pregnancies are longer. It would be incorrect to attribute the effect of the duration of pregnancy on favorable birth outcomes to the duration of WIC participation alone.

One approach to estimating a dose-response effect is to examine the effects of early and late enrollment in the WIC Program. In this approach, the birth outcomes for women who enroll in the WIC Program early during pregnancy (that is, during the first trimester of pregnancy) are compared with the birth outcomes for women who enroll later during pregnancy *and* with the birth outcomes for nonparticipants. If WIC participation had a dose-response effect, birthweights would be higher for early enrollees in the WIC Program relative to later enrollees.

However, this approach to the dose-response issue is problematic in the same way that estimating the relationship between WIC participation and pregnancy duration is problematic. That is, the group of WIC participants who enroll after the first trimester includes some women who enroll late in their pregnancy. Pregnancy outcomes are likely to be more favorable for very late enrollees (for example, after 32 weeks gestation) relative to early enrollees for reasons that are related mostly to longer pregnancy durations rather than to WIC participation.

To investigate whether WIC has a dose-response effect, the cohort analysis described earlier was extended by including in the cohort birthweight regressions a dummy variable equal to one if the woman enrolled in WIC in the first trimester and equal to zero otherwise. Since each cohort consists of women whose pregnancies lasted at least a specified number of weeks, and since WIC participation is defined as enrollment by the month just prior to the week of pregnancy used to define the cohort, one can investigate whether earlier WIC enrollment leads to improved birth outcomes without introducing the type of bias just described. For example, in the 36-week cohort, all women had pregnancies that lasted at least 36 weeks, so late enrollees (that is, women enrolling after the first trimester but by month 8) did not necessarily have longer pregnancies than those who enrolled in the first trimester.

The results from including a dummy variable indicating first trimester WIC enrollment in the cohort birthweight regressions are presented in Table V.10. The first column gives the estimated coefficients on the dummy variable indicating participation in WIC by the month just prior to the week of pregnancy used to define the cohort, and the second column gives the estimated coefficients on the dummy variable representing first trimester enrollment. Thus, the first column gives the estimated effect of WIC for women who enrolled after the first trimester, and the second column gives the estimated additional effect of first trimester enrollment. The results suggest that first trimester enrollment does not increase the effects of WIC--in fact, the parameter estimates are negative, though not statistically significant.[4] However, it is possible that first-trimester enrollees are at higher risk for adverse pregnancy outcomes in ways not controlled for in the regression. It may also be that misreporting of the timing of enrollment has diluted the effects of first trimester enrollment; as noted in Chapter IV, mother's reports in the NMIHS data on timing of enrollment do not accord with program data.

[4]In contrast, the WIC-Medicaid study found the effect of first trimester WIC enrollment to be positive and significant in all five states examined (Devaney et al. 1991).

TABLE V.10

EFFECTS OF PRENATAL WIC PARTICIPATION AND OF FIRST TRIMESTER WIC ENROLLMENT: FOUR COHORTS DEFINED BY GESTATIONAL AGE THRESHOLDS
(Standard Errors in Parentheses)

	Estimated Coefficients (Grams)	
	WIC Participation by Week of Pregnancy Defining the Cohort	First Trimester WIC Enrollment
28-Week Cohort	8.4	-20.6
	(23.7)	(24.5)
32-Week Cohort	49.4 *	-39.6
	(23.4)	(23.9)
36-Week Cohort	43.0	-31.1
	(23.6)	(23.8)
40-Week Cohort	45.9	-13.8
	(33.3)	(32.2)

SOURCE: 1988 National Maternal and Infant Health Survey.

NOTE: Cohorts are defined to include all prenatal WIC participants and income-eligible nonparticipants whose pregnancies lasted at least through the week specified. For each cohort, WIC participants are defined as women who participated in the program by the month preceding the week of gestation defining the cohort. Estimates were produced using weighted least squares. Standard errors adjusted to reflect the stratified sample design were calculated using SUDAAN.

SELECTION BIAS

An important caveat to these findings is that the estimates do not control for any unmeasured differences between WIC participants and nonparticipants that may also influence birth outcomes. WIC participants are a self-selected group of women who may be more likely to participate in the WIC Program because of underlying factors that are also associated with birth outcomes. For example, some pregnant women may not participate in the WIC Program because they lack access to or knowledge of publicly funded programs that provide health care or other services, which may independently affect birth outcomes. Thus, the estimated improvement in birth outcomes may overstate the effect of the Program since, relative to nonparticipants, WIC participants may have better outcomes even in the absence of the WIC Program. Conversely, if the WIC Program is successful at reaching high-risk, low-income pregnant women, WIC participants may be more likely than nonparticipants to have poor birth outcomes in the absence of the program. In this case, the estimated improvement in outcomes would understate the true effect of prenatal WIC participation. In either case, estimates are contaminated by selection bias.

In the absence of an experimental research design in which WIC-eligible pregnant women would be randomly assigned to treatment and control groups, it is extremely difficult to control for the effects of self-selection when estimating the effects of prenatal WIC participation on birth outcomes. Most statistical methods for adjusting for selection bias involve specifying and estimating a joint model of program participation and the outcome of interest. Estimation of such a model relies on specifying at least one variable that affects WIC participation but not birth outcomes.

In this study, selection-bias-adjustment models of birth outcomes were specified and estimated using several alternative identifying variables and estimation methods.[5] Identifying variables tried included state-level WIC food expenditures per capita (a proxy for the availability of WIC services in the mother's state), an indicator of whether the family had income from wages (which may indicate their level of contact with public assistance agencies), and an indicator for WIC participation during previous pregnancies.

None of these models gave plausible estimates of the effects of prenatal WIC participation on birthweight or gestational age. Most of the

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[5]Estimation methods tried included the "Heckit" approach, nonlinear two-stage least squares, and full-information maximum likelihood. See Maddala (1983) and Heckman and Robb (1985) for surveys of estimation methods for selection-bias-adjustment models.

estimates of the effects of WIC on birthweight were large and negative, although it is not credible that WIC participation reduces newborn birthweight. In contrast, most of the models produced positive and significant estimates of the effects of WIC on gestational age, but the estimated impacts were implausibly large. The specific results were very sensitive to the estimator used and the precise identifying variables used. Implausible results were obtained even when selection-bias-adjustment was attempted in the context of the cohort models, which control for the simultaneity between WIC participation and the duration of pregnancy.[6]

A number of other studies have found implausible and even negative impacts of WIC after applying selection-bias-adjustment techniques. In particular, the WIC Child Impact Field Test estimated implausible negative effects of infant WIC participation on length-for-age and head circumference when adjusting for selection bias (Burstein et al. 1991). The WIC-Medicaid study concluded that estimates of the impacts of prenatal WIC on birthweight from a range of selection-bias-adjustment models were very imprecise and unreliable (Devaney et al. 1991).

It is possible that the selection-bias-correction models of the effects of WIC on birth outcomes produce unstable and implausible results because the factors affecting WIC participation and birthweight are very nearly identical, since WIC targets low-income women at risk for poor pregnancy outcomes. In this case, modeling the participation decision is not likely to be a useful approach to controlling for selection bias.

In such a situation, the only possible method for avoiding selection bias is to collect data on variables that affect both participation and outcomes and to control for such variables in the outcome equation. For example, including additional controls for the health status of the mother and her access to health care before and during the pregnancy may lead to better estimates of the effects of WIC. Some variables of this type have been included in the models presented here--for example, measures of prenatal care, smoking, alcohol use, drug use, and hospitalization during pregnancy--and it is possible that differences between WIC participants and income-eligible nonparticipants were effectively controlled for. However, the potential implications of the self-selection issue should be kept in mind when interpreting and generalizing the study findings.

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[6]The sensitivity of the results to outliers in the data and to other methods for coding the dependent variables (such as discrete versus continuous) was also examined. The paradoxical results remained.

AREAS FOR FURTHER RESEARCH

Several results of this investigation remain puzzling, and point to possible areas for further research. In particular, although it seems plausible that early enrollment in WIC is better, the estimates of the effects of WIC participation in the first 6 months of pregnancy were very close to zero, and the estimates of the effects of first trimester enrollment (versus later enrollment) were insignificant but negative. Such results may reflect selection bias, if women with high-risk pregnancies are most likely to enroll early, or they may indicate that the nutritional supplementation provided by WIC is most important late in pregnancy.[7] Further study of the factors affecting WIC enrollment and the timing of WIC enrollment could shed light on these results.[8] In particular, it would be useful to know what factors lead women to seek WIC benefits and how WIC Program sites target outreach efforts. Further data on the prevalence of nutritional risk factors in the income-eligible population would also be useful in controlling for possible selection bias.

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[7]It may be that early WIC enrollment improves outcomes through increased access to health care; since the models used here control for use of prenatal care, this effect is not detectable. Another possibility is that early WIC participation may help prevent miscarriages--since our sample includes only women with live births, this effect is also not detectable.

[8]An analysis of the accuracy of mothers' recall of the timing of WIC enrollment, by cross-checking survey and program data, would also be useful.

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APPENDIX A

MULTIVARIATE ANALYSIS METHODOLOGY

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This appendix describes the methodological approach underlying the estimates presented in Chapter V. The effects of prenatal WIC participation on birth outcomes were assessed by estimating multivariate models of the following general form on the NMIHS sample of prenatal WIC participants and income-eligible nonparticipants:

$$(1) \quad Y_i = X_i\beta + \delta P_i + \epsilon_i,$$

where the subscript i denotes the ***ith*** sample member, Y is an outcome such as birthweight, X is a vector of observed characteristics thought to affect the outcome, P is a dummy variable denoting prenatal participation in the WIC Program (equal to 1 for participants and zero for the comparison group), the vector β and scalar δ are parameters to be estimated, and ϵ is a random error term. The coefficient δ represents the effect of prenatal WIC participation on the outcome variable after controlling for differences between participants and the comparison group in the observed characteristics included in X.

Estimating this model requires specifying the outcome variables, the indicator of WIC participation, and the control variables. In addition, an appropriate estimation method must be used. The remainder of this appendix discusses each of these issues in turn.

Outcome Variables

Seven birth outcomes are examined in this study: five derived from the birth certificates and two from the maternal survey. As described in Chapter III, the analysis used the NMIHS live-birth sample. The outcomes derived from birth certificates are birthweight (in grams), gestational age (in weeks), and three binary variables:

- ***Low birthweight***, which is equal to one if the newborn birthweight was less than 2,500 grams (5.5 pounds) and equal to zero otherwise

- ***Very low birthweight***, which is equal to one if the newborn birthweight was less than 1,500 grams (3.3 pounds) and equal to zero otherwise

- ***Preterm birth***, which is equal to one if gestational age was less than 37 weeks and equal to zero otherwise

Birthweights are generally recorded by hospital staff and are more reliably recorded than is gestational age, which is based on the mother's estimate of the date of her last menstrual period. Birthweight is available for essentially all members of the NMIHS sample, but gestational age is missing for 5.1 percent of prenatal WIC participants and 7.3 percent of income-eligible nonparticipants. (All such percentages in this section are unweighted.) Observations with a reported gestational age of less than 20 weeks were recoded to 20 weeks, and those with a reported value of more than 45 weeks were recoded to 45 weeks.[1] The gestational age was recoded in this manner for 1.4 percent of prenatal WIC participants and 1.6 percent of income-eligible nonparticipants with a reported value for gestational age.

The maternal survey provided infant mortality outcomes based on mothers' responses to the questions, "Is your baby still living?" and "If not, when did your baby die?" The minimum time between delivery and the interview was 6 months, so that is the maximum period over which infant deaths can be followed for the entire sample. The following two outcome variables were created:[2]

- ***Neonatal death***, which is equal to one for infants who died within 28 days after birth and equal to zero otherwise
- ***Infant death***, which is equal to one for infants who died within 6 months after birth (including those who died within 28 days) and equal to zero otherwise

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[1]Setting lower and upper bounds of 20 weeks and 45 weeks, respectively, has been recommended by David (1980), who argues that the vast majority of cases in which the birth certificate reports a value outside this range represent inaccurate data.

[2]To protect the confidentiality of mothers in the sample, NCHS did not include infants' dates of birth or dates of death on the public use data file. For mothers who reported that their infants were no longer living at the time of the interview, NCHS included a variable on the file indicating the infant's age at death (which was derived from the date of birth on the birth certificate and date of death reported by the mother). This variable was used to construct the outcome variables denoting neonatal and infant death.

These variables are missing for 2 percent of the sample of prenatal WIC participants and 3.1 percent of the sample of income-eligible nonparticipants. Observations with missing values include mothers who did not answer the question about whether their infants were still alive, those who reported not knowing whether their infants were still alive, and others for whom valid responses to these questions were not available.

Indicator of WIC Participation

Models that measure WIC participation as a simple binary variable (that equals one if the woman participated in the WIC Program at any time during pregnancy and equals zero otherwise) provide the first set of results presented in Chapter V. Most studies of the effects of prenatal WIC participation use this simple measure of WIC participation (see Chapter II). However, it has some important limitations. First, it is likely that prenatal WIC participation and pregnancy duration are simultaneously related because women with longer pregnancies have a longer time period to enroll in WIC than do women with shorter pregnancies. Thus, while WIC participation may increase gestational age, causality may also operate in the opposite direction--that is, a longer pregnancy may increase the likelihood of WIC participation. Both effects would lead to a positive correlation between WIC participation and gestational age, controlling for other factors. Both are likely to result in a positive correlation between WIC participation and improvements in other birth outcomes because of the positive relationship between gestational age and birthweight. Thus, models that specify WIC participation as a binary indicator of whether women participated in WIC at any time during pregnancy are likely to overstate the effects of WIC on birthweight and gestational age, and to overstate the reductions in low birthweight births, preterm births, and neonatal and infant mortality associated with WIC.

Another important limitation of the simple binary indicator is that it does not provide information on whether WIC participation has a dose-response effect. A dose-response effect exists if enrollment in WIC at an earlier stage in pregnancy or enrollment for a longer duration leads to greater improvements in birth outcomes than would later enrollment or shorter durations. However, determining whether WIC has a dose-response effect is complicated by an issue closely related to the preceding issue--that the effect of duration of prenatal WIC participation on birth outcomes is inevitably confounded with the effect of gestational age.

Because of these limitations, alternative approaches to defining WIC participation are also presented in Chapter V.

Control Variables

The remaining variables in the multivariate models control for measured differences between WIC participants and income-eligible nonparticipants that may affect birth outcomes. From the birth certificate, data were obtained on the characteristics of the infant (sex and plurality), the age of the mother, the number and timing of prenatal care visits, the mother's geographic region, and whether the mother resides in a metropolitan county (Table A.1). NCHS staff advised using the age of the mother on the birth certificate rather than the value reported in the maternal survey because they thought mother's age and date of birth are reliably reported on birth certificates, while the mother's date of birth collected in the survey was illegible on or missing from a small percentage of the returned questionnaires.[3] Again following advice from NCHS, the Kessner Index of the adequacy of prenatal care (defined in Chapter IV) was constructed from information on prenatal care in the birth certificate if such information was available. Otherwise, information on prenatal care collected in the survey was used. A recent study compared the information on prenatal care from birth certificates with information from the NMIHS maternal survey and found high levels of agreement for the proportion receiving first-trimester prenatal care, but low levels of agreement for the number of prenatal care visits and gestational age (Schoendorf et al. 1993). It seems plausible, since the NMIHS questionnaire was completed by the mother anywhere from 6 to 30 months after the birth of the child, that mothers may have had more difficulty recalling details of the number of prenatal care visits at the time of the survey.

Additional variables were constructed from the maternal survey data to control for the characteristics of the mother, the father, and the household. Background characteristics of the mother include education (years of schooling), race and ethnicity (Black, Asian, Native American, and Hispanic), marital status, presence of the father in the household for unmarried mothers, and the number of previous live births. Other control variables include measures of behavioral risk factors (number of cigarettes smoked, and use of marijuana, cocaine, and alcohol), prepregnancy weight, and whether the mother was hospitalized during pregnancy. The latter variable is an indicator of pregnancy complications that may be associated with adverse birth outcomes. Other variables included in the models are the father's age and education, household size, and per capita household income.

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[3]Frequency distributions on the mother's age derived from the two sources are nearly identical. Furthermore, the multivariate results do not depend on which of the two age variables is included in our models.

TABLE A.1

INDEPENDENT VARIABLES FOR MULTIVARIATE ANALYSIS OF THE EFFECTS OF PRENATAL WIC PARTICIPATION ON BIRTH OUTCOMES

Variables	Source
Newborn's Characteristics	
Sex	Birth Certificate
Plurality	Birth Certificate
Mother's Characteristics	
WIC Participation	Maternal Survey
Age	Birth Certificate
Highest Grade Completed	Maternal Survey
Race/Hispanic Ethnicity	Maternal Survey
Marital Status	Maternal Survey
Presence of the Father during Pregnancy	Maternal Survey
Kessner Index of the Adequacy of Prenatal Care	Birth Certificate
Cigarette Smoking during Pregnancy	Maternal Survey
Alcohol Consumption during Pregnancy	Maternal Survey
Marijuana/Hashish Use during Pregnancy	Maternal Survey
Cocaine/Crack Use during Pregnancy	Maternal Survey
Number of Previous Live Births	Maternal Survey
Prepregnancy Weight	Maternal Survey
Hospitalization during Pregnancy	Maternal Survey
Father's Characteristics	
Age	Maternal Survey
Highest Grade Completed	Maternal Survey
Household/Residence Characteristics	
Household Size	Maternal Survey
Per Capita Income	Maternal Survey
Metropolitan County	Birth Certificate
Geographic Region	Birth Certificate

NOTE: The mother's age was taken from the birth certificate for the reasons discussed in the text. The Kessner Index was derived from information on prenatal care in the birth certificate if such information was reported. Otherwise, it was derived from information collected in the maternal survey.

Estimation Methods

Models containing a continuous dependent variable (birthweight or gestational age) were estimated with weighted least squares, using the weights constructed by NCHS. As described in Chapter III, those weights adjust for the different sampling rates across strata and different rates of unit nonresponse. If the sample were stratified on exogenous variables only, least squares would yield unbiased estimates of both regression coefficients and standard errors (if the standard assumptions underlying the linear regression model are satisfied). In this study, however, one of the outcome variables--birthweight--was used as a basis for stratifying the sample. (Low-birthweight infants were oversampled.) Hausman and Wise (1981) have shown that weighted least squares yields consistent parameter estimates in such cases. However, the estimated standard errors generated by the usual weighted least squares algorithms are biased downward. SUDAAN was used to estimate standard errors of the regression coefficients adjusted for the stratified sample design. The estimated standard errors produced using SUDAAN were from 20 to 50 percent larger than estimates based on standard weighted regression algorithms.

When the analysis is extended to examine binary dependent variables--such as the incidence of low birthweight--estimation methods that take into account the discrete nature of the dependent variable were used. When the dependent variables are low birthweight or very low birthweight, standard discrete-choice methods do not generally produce consistent estimates, again because the sample is stratified on the basis of these endogenous variables (referred to as choice-based sampling). However, parameter estimates for logit models are invariant to whether the data are generated from a choice-based sample design. Weighted logit maximum likelihood estimation was used to estimate these models.[4]

Standard errors that adjust for the stratified sample design were again computed using SUDAAN. Given that a consistent estimator is used, a choice-based sample design which oversamples rare outcomes such as low birthweight generates more efficient estimates than a random sample of the same size (Cosslett 1981). Thus, standard errors estimated with SUDAAN for the coefficients in the low birthweight and very low birthweight models (which take the sample design into account) are smaller than standard error estimates not adjusted for the sample design. (Standard errors of the coefficients in the other discrete outcome models are somewhat larger when SUDAAN estimates are used).

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[4]This estimator is consistent but not the most efficient estimator for the choice-based model, but was the only estimator that could be calculated with the available software.

APPENDIX B

ESTIMATED COEFFICIENTS IN LOGIT MODELS OF THE EFFECT OF PRENATAL WIC PARTICIPATION ON THE INCIDENCE OF ADVERSE BIRTH OUTCOMES

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TABLE B.1

ESTIMATED LOGIT COEFFICIENTS IN MODELS OF THE EFFECT OF PRENATAL WIC PARTICIPATION ON THE INCIDENCE OF LOW BIRTHWEIGHT, VERY LOW BIRTHWEIGHT, AND PRETERM BIRTH

Independent Variables	Low Birthweight	Very Low Birthweight	Preterm Birth
Intercept	-0.949 *	-4.119 **	-0.917
	(0.399)	(0.417)	(0.525)
Prenatal WIC Participation	-0.397 **	-0.657 **	-0.360 **
	(0.084)	(0.087)	(0.110)
Newborn Characteristics			
Male	-0.233 **	0.022	0.015
	(0.079)	(0.082)	(0.101)
Multiple Births	3.118 **	2.034 **	2.077 **
	(0.225)	(0.154)	(0.194)
Mother's Characteristics			
Age	0.027 *	0.034 **	-0.018
	(0.011)	(0.012)	(0.015)
Years of Education	-0.054 **	-0.022	-0.059 **
	(0.020)	(0.021)	(0.023)
Black	0.754 **	0.868 **	0.966 **
	(0.084)	(0.094)	(0.128)
Asian	0.626 *	0.394	0.371
	(0.259)	(0.296)	(0.394)
Native American	-0.060	-0.216	-0.141
	(0.509)	(0.446)	(0.563)
Hispanic	-0.065	0.085	0.175
	(0.141)	(0.148)	(0.183)
Married	-0.366 **	-0.383 **	0.001
	(0.107)	(0.113)	(0.128)
Unmarried, Father Present	-0.098	0.011	0.012
	(0.116)	(0.120)	(0.151)

TABLE B.1 *(continued)*

Independent Variables	Low Birthweight	Very Low Birthweight	Preterm Birth
Kessner Index Intermediate	0.164 (0.090)	0.086 (0.097)	0.115 (0.108)
Kessner Index Inadequate	0.624 ** (0.138)	0.766 ** (0.134)	0.681 ** (0.161)
Kessner Index Missing	0.697 ** (0.163)	0.987 ** (0.159)	[a]
Number of Previous Live Births	-0.097 * (0.041)	-0.145 ** (0.045)	-0.015 0.049()
Number of Cigarettes Smoked per Day During Pregnancy	0.029 ** (0.005)	0.014 * (0.005)	-0.001 (0.007)
Alcohol Use During Pregnancy: 3+ drinks per week	0.179 (0.209)	0.393 (0.237)	0.884 * (0.377)
1 - 2 drinks per week	0.642 ** (0.229)	0.036 (0.262)	0.127 (0.250)
Less than 1 drink per week during pregnancy	0.128 (0.136)	-0.122 (0.143)	-0.089 (0.188)
Used Marijuana During Pregnancy	0.103 (0.248)	-0.157 (0.267)	-0.004 * (0.416)
Used Cocaine During Pregnancy	0.568 * (0.279)	0.351 (0.264)	0.228 (0.341)
Prepregnancy Weight (Pounds)	-0.013 ** (0.002)	-0.003 (0.002)	-0.004 (0.002)
Hospitalized During Pregnancy	0.799 ** (0.098)	0.929 ** (0.095)	0.337 ** (0.118)
Father's Characteristics			
Age	0.000 (0.008)	-0.005 (0.008)	0.004 (0.012)
Years of Education	-0.008 (0.019)	-0.031 (0.020)	-0.036 (0.024)

TABLE B.1 *(continued)*

Independent Variables	Low Birthweight	Very Low Birthweight	Preterm Birth
Household/Residence Characteristics			
Household Size	-0.009 (0.020)	-0.019 (0.020)	-0.009 (0.025)
Per Capita Income	-0.006 (0.011)	0.010 (0.011)	0.001 (0.014)
Metropolitan County	0.103 (0.101)	0.073 (0.104)	0.038 (0.127)
Northeast Region	0.076 (0.122)	0.142 (0.119)	0.551 ** (0.199)
Northcentral Region	0.008 (0.117)	0.014 (0.119)	0.478 * (0.190)
Southern Region	0.082 (0.111)	0.081 (0.111)	0.461 ** (0.179)
Sample Size	**6,170**	**6,170**	**5,806**

SOURCE: 1988 National Maternal and Infant Health Survey.

NOTE: Estimates were produced using weighted logit analysis. The analysis sample includes all prenatal WIC participants and income-eligible nonparticipants. Standard errors adjusted to reflect the complex sample design were calculated using SUDAAN.

*(**): Significant at the .05 (.01) percent level in a two-tailed test.

[a]The Kessner index was available for all observations included in the model of preterm birth because observations with a missing value for gestational age were excluded from the model.

TABLE B.2

ESTIMATED LOGIT COEFFICIENTS IN MODELS OF THE EFFECT OF PRENATAL WIC PARTICIPATION ON NEONATAL DEATH AND INFANT DEATH
(Standard Errors in Parentheses)

Independent Variable	Neonatal Death	Infant Death within 6 Months
Intercept	-2.851 *	-2.830 *
	(1.232)	(1.206)
Prenatal WIC Participation	-0.359	-0.325
	(0.334)	(0.302)
Newborn Characteristics		
Male	0.172	0.318
	(0.341)	(0.319)
Multiple Births	1.558 **	1.443 **
	(0.288)	(0.286)
Mother's Characteristics		
Age	-0.040	-0.030
	(0.051)	(0.048)
Years of Education	-0.030	-0.058
	(0.042)	(0.038)
Black	0.396	0.430
	(0.392)	(0.346)
Asian	-0.988	-1.212
	(0.779)	(0.774)
Native American	-1.218	-1.292
	(1.026)	(1.010)
Hispanic	0.294	0.312
	(0.778)	(0.700)
Married	0.030	0.137
	(0.376)	(0.335)
Unmarried, Father Present	0.296	0.199
	(0.487)	(0.483)

TABLE B.2 *(continued)*

Independent Variable	Neonatal Death	Infant Death within 6 Months
Kessner Index Intermediate	-0.493 (0.434)	-0.230 (0.408)
Kessner Index Inadequate	0.197 (0.457)	0.255 (0.439)
Kessner Index Missing	1.068 (0.763)	1.033 (0.718)
Number of Previous Live Births	0.169 (0.133)	0.146 (0.125)
Number of Cigarettes Smoked per Day During Pregnancy	0.016 (0.022)	0.013 (0.020)
Alcohol Use During Pregnancy:		
3+ drinks per week	-0.135 (0.550)	-0.099 (0.511)
1 - 2 drinks per week	-0.442 (0.598)	-0.370 (0.550)
Less than 1 drink per week during pregnancy	-0.375 (0.358)	-0.246 (0.335)
Used Marijuana During Pregnancy	0.914 (0.656)	0.762 (0.656)
Used Cocaine During Pregnancy	-0.409 (0.779)	-0.247 (0.733)
Prepregnancy Weight (Pounds)	0.000 (0.007)	-0.002 (0.006)
Hospitalized During Pregnancy	-0.057 (0.295)	0.176 (0.289)
Father's Characteristics		
Age	-0.041 * (0.019)	-0.051 ** (0.019)
Years of Education	-0.076 (0.067)	-0.041 (0.064)

TABLE B.2 *(continued)*

Independent Variable	Neonatal Death	Infant Death within 6 Months
Household/Residence Characteristics		
Household Size	-0.169 **	-0.147 **
	(0.057)	(0.054)
Per Capita Income	-0.056	-0.050
	(0.046)	(0.040)
Metropolitan County	0.534	0.461
	(0.457)	(0.412)
Northeast Region	1.661 **	1.674 **
	(0.594)	(0.565)
Northcentral Region	0.608	0.778
	(0.432)	(0.401)
Southern Region	1.141 **	1.188 **
	(0.389)	(0.368)
Sample Size	**6,170**	**6,170**

SOURCE: 1988 National Maternal and Infant Health Survey.

NOTE: Estimates were produced using weighted logit analysis. The analysis sample includes all prenatal WIC participants and income-eligible nonparticipants. Standard errors adjusted to reflect the complex sample design were calculated using SUDAAN.

*(**): Significant at the .05 (.01) percent level in a two-tailed test.

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