United States
Department of
Agriculture

Food and
Nutrition
Service

Office of
Analysis and
Evaluation

The Savings in Medicaid Costs for Newborns and Their Mothers From Prenatal Participation in the WIC Program

Volume 2

THE SAVINGS IN MEDICAID COSTS FOR NEWBORNS AND THEIR MOTHERS FROM PRENATAL PARTICIPATION IN THE WIC PROGRAM

VOLUME 2

April 1991

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Submitted to:

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CONTENTS

CONTENTS (continued)

TABLES

TABLES (continued)

FIGURE

THE SAVINGS IN MEDICAID COSTS FOR NEWBORNS AND THEIR MOTHERS RESULTING FROM PRENATAL PARTICIPATION IN THE WIC PROGRAM

VOLUME 2

EXECUTIVE SUMMARY

This report is Volume 2 of a study mandated by the Commodity Distribution Reform Act and WIC Amendments of 1987 (Public Law 100-237) and the Joint Resolution Continuing Appropriation for Fiscal Year 1988 (Public Law 100-202). The primary objective of this study is to determine the savings in Medicaid costs for newborns and their mothers during the first 60 days after birth resulting from participating in the Special Supplemental Food Program for Women, Infants, and Children (WIC) during pregnancy. Volume 1 of this report presents the basic results of the study, and Volume 2 explores the methodological issues and analytical results in more detail.

STUDY DESIGN

The WIC/Medicaid study entailed analyzing the effects of prenatal WIC participation on Medicaid costs and birth outcomes 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. In each of the five study states, the analysis database was constructed from multiple program data files: (1) Medicaid files, which provided Medicaid cost and eligibility data on newborns and their mothers; (2) Vital Records birth files, which provided data on maternal characteristics, birthweight and other newborn characteristics, prenatal care, and infant deaths; and (3) WIC program files, from which the Medicaid mothers were identified as either WIC prenatal participants or nonparticipants and which provided WIC cost data on the participants. These data files were linked to create a database of 1987 Medicaid births (1988 in Texas) that included data on Medicaid costs, WIC participation status and costs, birthweight and other pregnancy outcomes, and some information on maternal characteristics, including age, race, previous live births, education, marital status, and the use of prenatal care. Thus, the WIC/Medicaid database, while including information on a very large number of Medicaid newborns and mothers, provides only limited information on maternal characteristics and perinatal risk factors and is, thus, constrained in its ability to support an in-depth analysis of complex statistical issues.

REVIEW OF MAJOR STUDY FINDINGS

The basic study results indicate that prenatal participation in the WIC program improves birth outcomes and generates savings in Medicaid costs for mothers and newborns. The following specific findings are reported in Volume 1:

- Prenatal participation in the WIC program is associated with substantial savings in Medicaid costs for newborns and their mothers during the first 60 days after birth. Estimated savings in newborn and maternal Medicaid costs due to prenatal WIC participation ranged from $277 in Minnesota to $598 in North Carolina, with intermediate values of $347, $493, and $565 for Florida, Texas, and South Carolina (hospital costs only), respectively.

- When newborn and maternal Medicaid costs were able to be separated, the estimated savings in newborn Medicaid costs associated with prenatal WIC participation were even greater than the estimated savings when newborn and maternal costs are combined; these estimates were $744 in North Carolina and $573 in Texas.

- In all five study states, the benefits of prenatal WIC participation, as measured by the estimated savings in Medicaid costs, exceeded the costs of providing prenatal WIC benefits. For newborns and mothers, the estimated benefit-cost ratios ranged from 1.77 in Florida to 3.13 in North Carolina, with values of 1.83 for Minnesota and 2.44 for both South Carolina and Texas. For newborns only, the benefit-cost estimates were 3.90 in North Carolina and 2.84 in Texas. Thus, for every dollar spent on the prenatal component of the WIC program, the associated savings in Medicaid costs during the first 60 days after birth ranged from $1.77 to $3.13 for newborns and mothers and from $2.84 to $3.90 for newborns only.

- In all five study states, prenatal WIC participation by Medicaid beneficiaries is associated with increased birthweight, longer gestational age, a lower incidence of low birthweight, and a lower incidence of preterm birth.

- In all five study states, receiving inadequate levels of prenatal care is associated with increased Medicaid expenditures during the first 60 days after birth. As with the findings on the effects of prenatal WIC participation, the estimated cost savings associated with receiving adequate versus inadequate levels of prenatal care for newborns alone exceeded the cost savings for newborns and mothers combined.

ANALYTIC ISSUES

The primary results of this study and their interpretation are based on straightforward analytic models in which Medicaid costs and newborn birthweight depend on prenatal WIC participation, newborn characteristics, and maternal characteristics. This model specification was judged to be the most appropriate after several methodological problems and issues were assessed and examined. The most important of these issues are (1) whether to prorate Medicaid claims that span the 60-day postpartum period, (2) the confounding of the timing of enrollment in the WIC program and gestational age, and (3) selection bias. The principal findings from an analysis of these issues are:

- Including the full reimbursements for Medicaid claims that span the 60-day postpartum period increased the estimated Medicaid cost savings from prenatal WIC participation and the associated benefit-cost ratios relative to prorating Medicaid reimbursements for claims that span the 60-day postpartum period.

- Including a control variable for gestational age in the Medicaid cost regressions reduced the estimated savings in Medicaid costs due to prenatal WIC participation, although the results also indicate that Medicaid costs from birth to 60 days after birth were significantly lower for prenatal WIC participants than nonparticipants at each level of gestational age. (The exception to this is Minnesota.)

- Average newborn birthweight was higher for first trimester WIC enrollees. Relative to later WIC enrollees, the estimated increase in newborn birthweight for first trimester WIC enrollees ranged from 29 grams to 73 grams in Florida, with intermediate values of 35 grams in Minnesota, 63 grams in North Carolina, and 71 grams in Texas. Relative to nonparticipants, the estimated increase in newborn birthweight for first trimester WIC enrollees is appreciable in magnitude, even after controlling for gestational age, ranging from 30 grams in Minnesota to 76 grams in South Carolina to 95 grams, 97 grams, and 98 grams in North Carolina, Texas, and Florida, respectively.

- The estimated effects of first trimester WIC enrollment on newborn birthweight were generally consistent with the findings from the analysis of Medicaid costs. That is, first trimester WIC enrollees generally had lower newborn and maternal Medicaid costs during the first sixty days after birth than did later WIC enrollees, which is consistent with higher average newborn birthweight for first trimester WIC enrollees. However, the estimated coefficients of first trimester

WIC enrollment in the Medicaid cost regression equations are not statistically significant at conventional two-tailed levels, in contrast to the highly significant coefficients in the birthweight regression equations. (For Florida and Texas, the estimated coefficients of first trimester WIC enrollment in the Medicaid cost regressions are of considerable magnitude and are significant at conventional one-tailed significance levels.)

I. INTRODUCTION

The Commodity Distribution Reform Act and WIC Amendments of 1987 (Public Law 100-237) and the Joint Resolution Continuing Appropriation for Fiscal Year 1988 (Public Law 100-202) mandated a study to examine the relationship between prenatal participation in the Special Supplemental Food Program for Women, Infants, and Children (WIC) and Medicaid costs for mothers and newborns from birth to 60 days after birth. The first volume of this report presented the basic results of this study, which indicated that prenatal participation in the WIC program improves birth outcomes and lowers Medicaid costs for mothers and their newborns in the first 60 days of life. This second volume explores the methodological issues and analytical results of the study in more detail.

A. A REVIEW OF THE MAJOR STUDY FINDINGS

The WIC/Medicaid study entailed analyzing the effects of prenatal WIC participation on Medicaid costs and birth outcomes in five states: Florida, Minnesota, North Carolina, South Carolina, and Texas. The results of the study indicate that prenatal participation in the WIC program improves birth outcomes and generates savings in Medicaid costs for mothers and newborns. The following specific findings are reported in Volume 1:

- Prenatal participation in the WIC program is associated with substantial savings in Medicaid costs for newborns and their mothers during the first 60 days after birth. Estimated savings in newborn and maternal Medicaid costs due to prenatal WIC participation ranged from $277 in Minnesota to $598 in North Carolina, with intermediate values of $347, $493, and $565 for Florida, Texas, and South Carolina (hospital costs only), respectively.

- When newborn and maternal Medicaid costs were able to be separated, the estimated savings in newborn Medicaid costs associated with prenatal WIC participation were even greater than the estimated savings when newborn and maternal costs were combined; these estimates were $744 in North Carolina and $573 in Texas.

- In all five study states, the benefit-cost estimates were greater than one when the estimated savings in Medicaid costs were combined with data on the costs of the WIC program. Thus, as measured by the estimated Medicaid savings, the benefits of prenatal WIC participation exceeded the costs of providing prenatal WIC benefits. For newborns and mothers, the estimated benefit-cost ratios ranged from 1.77 in Florida to 3.13 in North Carolina, with values of 1.83 for Minnesota and 2.44 for both South Carolina and Texas. For newborns only, the benefit-cost estimates were 3.90 in North Carolina and 2.84 in Texas.

- In all five study states, prenatal WIC participation by Medicaid beneficiaries is associated with increased birthweight, longer gestational age, a lower incidence of low birthweight, and a lower incidence of preterm birth.

B. OBJECTIVES OF THIS REPORT

The study findings reported in Volume 1 and discussed briefly above are based on the model specification judged to be the most preferable after all the methodological issues had been assessed fully. This volume presents the results from analytic models that were rejected, for a number of reasons, in favor of a relatively straightforward model underlying the basic study findings. Many complex analytic issues were considered during the course of the analysis, and the objective of this volume is to discuss these analytic issues and how they interact with the basic study findings as presented in Volume 1. Specifically, important analytic issues considered in this volume include the definition of Medicaid costs, dose-response effects of prenatal WIC participation, the timing of WIC enrollment, and selection bias. However, the data available for this study, while including information on a very large number of Medicaid newborns and mothers, provide only limited information on maternal characteristics and perinatal risk factors and are, thus, not able to support an in-depth analysis of these analytic issues. Thus, the basic study findings represent a compromise between an exhaustive evaluation of the effects of prenatal WIC participation and the types of analysis that could be supported by the database used in this study.

C. OVERVIEW OF THE STUDY DESIGN

The analysis included the following three key components, each of which entailed complex methodological problems:

1. Combining information on Medicaid costs, WIC participation and costs, and birth outcomes for each of the study states

2. Assessing the savings in Medicaid costs by comparing Medicaid costs for WIC participants with the Medicaid costs for nonparticipants, based on statistical analysis to adjust for differences in costs attributable to other factors

3. Interpreting the study findings and assessing their implications for the states not included in the study and for recent changes in the WIC and Medicaid programs and target populations

The first component pertains to the data used in the analysis. In each of the five study states, the database for the analysis was constructed from multiple program data files: (1) Medicaid files, which provided Medicaid cost and eligibility data on newborns and their mothers; (2) Vital Records files on births, deaths, and fetal deaths, which provided data on maternal characteristics, birthweight and other newborn characteristics, prenatal care, and infant and fetal deaths; and (3) WIC program files, from which the Medicaid mothers were identified as either WIC prenatal participants or nonparticipants and which provided WIC cost data on the participants. These data files were linked to create a database of 1987 Medicaid births that included data on Medicaid costs, WIC participation status and costs, birthweight and other pregnancy outcomes, and maternal characteristics, such as age, race, birth parity, education, marital status, prenatal care, and previous obstetrical history.[1] Constructing this database entailed (1) specifying the data extracts required from the WIC, Medicaid, and Vital Records programs in each state, taking into account differences in the programs and databases among the states, (2) linking the program files, without the benefit of unique identifiers, to create a single database for each state, and (3) constructing the variables to be used in the analysis, which, again, had to take into account the important differences in programs and databases across states. These database development issues are discussed in Chapter III and in extensive detail in two separate reports (Burghardt et al., 1989; Schore et al., 1991).

The second analytic component involved developing an accurate measure of the Medicaid costs that WIC participants would have incurred had they not participated in the WIC program. This process was complex for two reasons. First, several different definitions of Medicaid costs and prenatal WIC participation are possible, leading to different analytical results. Second, the characteristics of WIC participants and nonparticipants differ in terms of demographic characteristics and prenatal care utilization, and such differences need to be accounted for when estimating the effects of prenatal WIC participation on Medicaid costs and birth outcomes. Different formulations of the Medicaid cost and birthweight models which incorporate alternative strategies for addressing these issues are described in Chapters IV and V of this report.

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[1]In Texas, the time period used was the first six months of 1988.

The third analytical component entailed drawing inferences about the WIC and the Medicaid programs nationwide from the results of the analysis. The analysis yielded findings on the cost-effectiveness of prenatal WIC participation in four states during 1987 and during the first six months of 1988 for Texas. The findings differed among the study states because of variations in the Medicaid and WIC programs across states and because of the different socioeconomic and demographic composition of the target populations. Even greater variation exists on a nationwide basis than among the five states in the study. Furthermore, significant changes in both the WIC and the Medicaid programs have occurred since the study period. Consequently, generalizing the study results for the nation as a whole in the 1990s is extremely difficult. These issues are discussed in Volume 1 of the report and are not addressed in detail in this volume.

D. ORGANIZATION OF THE REPORT

This volume contains five chapters. Chapter II includes a review of the literature on the effects of prenatal participation in the WIC program. Chapter III introduces the conceptual model of WIC benefits and costs and provides an overview of the WIC/Medicaid database. The empirical analyses of the effects of prenatal WIC participation on Medicaid costs and birth outcomes are presented in Chapters IV and V, respectively.

II. PREVIOUS LITERATURE ON THE EFFECTS OF PRENATAL WIC PARTICIPATION

The WIC program has grown from a $750 million program serving 2 million women and children in 1980 to a $2.1 billion program serving an estimated 4.5 million women and children per month in 1990. Since its inception in 1972 the program has prospered under four separate administrations, in part because, at least on an intuitive level, the provision of food supplements to low-income, at-risk pregnant women, infants, and children seems like it should improve pregnancy and health outcomes. However, as noted by Kennedy et al. (1982), while the benefit of nutritional supplementation for poor pregnant women has been demonstrated in underdeveloped countries its efficacy in industrialized countries--where poor pregnant women are relatively better off--continues to come under scrutiny. In addition, both the size and growth of the WIC program have prompted policy- and lawmakers, as well as the scientific community, to call for efforts to quantify its benefits, in order to determine whether, as a publicly funded intervention, the WIC program indeed provides a measurable net benefit to society.

Thus, as the WIC program has grown in the 1970s and 1980s, it has been subjected to numerous and varied evaluations. Many evaluations have been carried out at the state and local level, but only a few at the national level. The outcomes that have been examined include birthweight, fetal and neonatal mortality, medical conditions and nutritional status in the mother and infant, and, less frequently, Medicaid and indigent care cost savings at and around birth for prenatal WIC participants and their newborns. Furthermore, due to the size and importance of the WIC program, each evaluation has been subjected to detailed scrutiny and criticism by subsequent evaluators. The objective of this chapter is to summarize the existing literature on the effects of prenatal WIC participation and to show how the current study builds on these efforts and adds to their body of findings. The chapter first reviews the relevant studies and then discusses the methodological issues raised by previous evaluations.

A. MAJOR EVALUATIONS

This section discusses the methodologies and findings of seven major evaluations of the WIC program published between 1979 and 1989. The key features of the evaluations of direct relevance to the current WIC/Medicaid study are summarized in Table II.1 and discussed in turn.

- The earliest evaluation, Edozien et al. (1979), was a national study of over 50,000 women, infants, and children at 19 WIC projects in 14 states. Data on the outcomes of clinical examinations and laboratory

TABLE II.1

SUMMARY OF MAJOR WIC EVALUATIONS

Author(s) (Year Published)	Comparison Group(s)	Selected Outcomes Examined	Summary of Reported Impacts on the Outcomes Relevant to WIC/Medicaid Study	Data Source
J. Edozien, B. Switzer, and R. Bryan (1979)	WIC participants at enrollment (compared with the characteristics of a current WIC participant group)	Birthweight Infant mortality Growth of children Anemia and other measures of nutritional status	Increased birthweight	Over 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)	(1) Pregnant WIC applicants not certified because program had no slots, or those who applied and were certified postpartum (2) Pregnant women at non-WIC health facilities Demographics of pregnant non-WIC participants were matched with the demographics of WIC participants	Birthweight	Increased birthweight (3,273 vs. 3,136 grams) that also increased with the number of WIC food instruments	Medical and nutrition records for 1,297 live births (897 to WIC participants, 400 to non-WIC) and 9 sites in Massachusetts between 1973 and 1978
M. Kotelchuck, J. Schwartz, M. Anderka, and K. Finison (1984)	Demographics of pregnant non-WIC participants were matched with the demographics of WIC participants	Birthweight Infant mortality Gestational age Use of prenatal care	Decrease in percent of 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 certificate and WIC data for 8,252 WIC and non-WIC 1978 births in Massachusetts
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) (not significant when woman's midpregnancy weight was controlled for)	Clinical data for 824 WIC-eligible pregnant women attending Oklahoma prenatal clinics

TABLE II.1 (continued)

Author(s) (Year Published)	Comparison Group(s)	Selected Outcomes Examined	Summary of Reported Impacts on the Outcomes Relevant to WIC/Medicaid Study	Data Source
W. Schramm (1985, 1986, 1989)	Medicaid-covered births to WIC nonparticipants	Medicaid costs within 30 days after birth for 1980 data; within 45 days for 1982 and 1985-86 Birthweight NICU admissions	For 1980 Medicaid births, $.83 reduction in Medicaid reimbursements 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.
J. Stockbauer (1986, 1987)	Non-WIC births	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 that at least 7 months of participation were required to observe improved birthweight.	1986 study used 1980 data on 6,732 births to prenatal WIC participants in Missouri and from 5,574 to 6,657 non-WIC births; 1987 study used 1982 data on 9,411 WIC and 9,411 non-WIC births
D. Rush (1987)	Low-income, first time, non-WIC registrants at prenatal clinics	Birthweight Gestational age Fetal mortality Infant length and head circumference Health behavior (smoking and use of alchohol) Maternal dietary intake Weight gain	No effect on birthweight, although increased birthweight is significantly related to better program quality. Decrease in fetal deaths and rate of low birthweight of appreciable but not significant magnitude. Statistically significant increase in infant head circumference. No effect on mean gestational age. Reduction in the rate of preterm delivery although not statistically significant Increased intake of 4 of the 5 nutrients targeted by WIC	5,205 prenatal WIC participants and 1,358 comparisons from 174 WIC sites and 55 prenatal clinics across the country

tests that were collected between 1973 (just a year after the inception of the WIC program) and 1976 for then-current WIC participants were compared with data on similar measures collected for new WIC enrollees at the time of their enrollment. The authors reported that WIC participation led to increased birthweights.

- Kennedy et al. (1982) compared medical and nutritional records collected between 1973 and 1978 on the births of 897 WIC participants with those of 400 pregnant women who were either on WIC waiting lists or were receiving health services at non-WIC facilities at nine sites in Massachusetts. The authors reported an increase in overall mean birthweight (from 3,136 grams to 3,273 grams) for WIC participants, which increased with the degree of WIC participation (namely, the number of WIC food instruments).

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

- Metcoff et al. (1985) examined a sample of 824 WIC-eligible pregnant women who were attending prenatal clinics in Oklahoma; half of the sample was assigned randomly to a WIC treatment group and half to a control group. This study was the first to use random assignment procedures to support a major evaluation of the WIC program, although the universe of prenatal clinic enrollees was intrinsically restricted to women with a demonstrated commitment to using prenatal care. The authors reported an increase in birthweight for WIC participants (from 3,163 to 3,254 grams), based on regression techniques which controlled for selected characteristics of the mother and her pregnancy. However, the increase disappeared when they controlled for mid-pregnancy weight.

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

on WIC; 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.

- Stockbauer (1986 and 1987) compared 1980 and 1982 Missouri birth records for WIC participants with those of women not participating in WIC. In the first study, 6,732 WIC births were compared with three non-WIC comparison samples: (1) a random sample from the remainder of the 1980 Missouri live-born singletons, with analysis of covariance used to control for differences between the WIC and non-WIC groups; (2) 1980 Missouri live births minus the WIC births, with the WIC group serving as a standard population and smoking, education, prepregnancy weight, and race used in a standardization analysis; and (3) a sample of 1980 Missouri non-WIC births matched to the WIC births on the basis of number born this pregnancy, race, education, smoking during pregnancy, and prepregnancy weight. In the second study, 9,411 pairs of WIC and non-WIC births were compared along key maternal characteristics. The 1980 study found that the overall effects on birthweight varied according to the comparison sample used, but that consistently favorable outcomes were experienced by black WIC participants in all three samples. The 1982 study found that the incidence of low birthweight and the incidence of inadequate prenatal care were lower for prenatal WIC participants than for comparison women. Both studies concluded that at least 7 months of WIC participation were required to observe improved birthweight outcomes.

- Rush (1987) 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 are: no statistically significant effect on newborn birthweight; increased infant head circumference; increased birthweight and head circumference with better WIC program quality; no statistically significant effect on gestational age; lower incidences of fetal death and low birthweight of appreciable but not significant magnitude; higher weight gain in later pregnancy that offset lower weight gain in early pregnancy; and increased intake of protein, iron, calcium, and vitamin C (4 of the 5 targeted WIC nutrients) and of food energy, magnesium, phosphorus, thiamin, riboflavin, niacin, vitamin B-6, and vitamin B-12. The final sample used in the Rush analysis of perinatal outcomes was considerably smaller than anticipated, and the power of the study to

detect statistically significant WIC effects of the magnitude reported in previous studies was fairly low (Rush et al., 1988).[1]

These seven evaluations shared two methodological features. First, each examined whether prenatal WIC participation increased birthweight. Birthweight is an important outcome measure, both because it is known to predict subsequent short- and long-term health problems in newborns, such as respiratory and developmental disabilities (Institute of Medicine, 1985), and because it is a relatively reliable quantitative measure routinely available on birth certificates, a major data source for these studies.

The second feature common to these evaluations is that each identified comparison groups whose outcomes, such as birthweight, could be compared with those 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 order to determine what would have happened to the WIC participants in the absence of the WIC program. However, as discussed in more detail in Section II.B, identifying such a group is difficult; thus, researchers must attempt to resolve how differences in outcomes between WIC participants and comparison group members are to be interpreted in light of the measured and unmeasured differences that may exist between the two groups. For example, most of the evaluations reported finding favorable effects for prenatal WIC participants on birthweights. However, a critical question, and one that dominated critiques of these evaluations, is the extent to which a significant increase in birthweight (or, conversely, the lack of an increase) is an artifact of the comparison group chosen for the evaluation.

B. EVALUATION REVIEWS

Due to both the importance and magnitude of the WIC program and its potential for affecting expenditures on health care and support services for women with nutritional or medical risks during pregnancy, WIC

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[1]In addition to the longitudinal study of pregnant women, the Rush analysis included a historical study of pregnancy outcomes using county-level data for 945 counties over 9 years, 1972 through 1980. The results of this historical study show a statistically significant reduction in fetal mortality associated with WIC participation, an appreciable but not significant decrease in the neonatal death rate for prenatal WIC recipients, and no significant change in the postneonatal death rate for WIC participants.

evaluations have come under unusually careful scrutiny. In 1984, in response to a request from the Chairman of the Senate Committee on Agriculture, Nutrition and Forestry, the General Accounting Office (GAO) produced a review of existing evaluations of the WIC program. The GAO investigation focused on three basic claims of earlier studies:

1. That WIC participation reduces the rate of miscarriage, stillbirths, and neonatal deaths and improves maternal nutrition

2. That WIC participation is related to positive pregnancy outcomes for "high-risk" mothers, and that positive outcomes are directly associated with the length of participation in the WIC program

3. That WIC participation increases birthweight and reduces the probability of anemia and mental retardation among infants and children

GAO reviewed both the findings of the evaluations and the quality of their evaluation methodologies. GAO summarized the findings 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."

In particular, GAO concluded that a sufficient number of studies had examined the effect of WIC participation on birthweight and that several of those studies were of high or medium quality. The studies gave support for, but not conclusive evidence of, the ability of prenatal WIC participation to increase birthweight. The studies cited a reduction in the rate of low birthweights from 9.5 percent for nonparticipants to 7.9 percent for WIC participants and an increase of mean birthweights of 30 to 50 grams (around an average of 3,200 grams for both groups). Claims of more favorable effects on birthweight among teenagers, blacks, and those with several health- and nutrition-related risks were upheld. However, the GAO also found only inconclusive evidence to support the claim that longer WIC participation increased its effectiveness for birthweight, and substantially less data to support claims that WIC participation during pregnancy reduced fetal and neonatal deaths (although the relative infrequency of those outcomes makes studying them difficult).

David Rush has critiqued many of the WIC evaluations for their methodological limitations. In his review of the study by Edozien et al.

(1979), he noted three primary limitations: (1) it was performed too early in the life of the WIC program to develop a strong judgment about its effectiveness; (2) the comparison group used was not valid because it assumed comparability among those participating at different times in pregnancy or in the life cycle, as well as between those arriving early in the program and those arriving later; and (3) the authors failed to note in their claim of a "dose-response" effect for WIC participation that the duration of WIC benefits was confounded by the duration of gestation (Rush 1982).

In his review of the Kotelchuck et al. study, Rush (1984) commented on both 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, possibly including those whose deliveries were premature; thus, the results of the study may have been biased because the WIC group may not have included some women who had low-birthweight newborns or whose newborns had died from prematurity. In addition, Rush noted that, although the WIC and non-WIC samples were matched along the age, race, parity, education, and marital status of the woman (as recorded on birth certificates), they were not matched according to the income and additional health and nutritional risk factors that serve as the eligibility criteria for the WIC program. Thus, the WIC group may have been at greater risk of poor perinatal outcomes than the comparison group, biasing the results in a direction opposite from the one due to the exclusion of the 353 terminees. Rush also discussed the limitations of Kotelchuck's estimates of the dose-response effect of WIC participation due to the confounding effects of the duration of pregnancy and the number of months of WIC participation.

Rush (1982, 1985) concluded that Schramm's 1985 investigation of the effect of prenatal WIC participation on Medicaid costs for newborns was an important contribution to WIC program evaluation literature. However, he had several comments on Schramm's findings. First, Schramm's 1989 estimate of an $.83 savings in Medicaid costs for newborns for every dollar spent on prenatal WIC participation may have been too high, since the only control variable used to compare WIC participants and nonparticipants was whether the mother lived in an urban or nonurban area. Rush suggested that in the nonurban areas in which many of the WIC participants lived hospitals were likely to be less expensive (and infants less likely to be admitted to neonatal intensive care units), and that these differences required further investigation. Second, only 21 percent of the Medicaid births that formed the base for Schramm's 1980 analysis were linked with WIC records. Given the fact that most pregnant women on Medicaid are likely also to be eligible for the WIC program, one would expect that the WIC participation rate would be higher. Rush

was concerned that this low match rate was due to a flaw in the process used to construct the analysis files. However, the low match rate may also reflect shortcomings in WIC outreach efforts to Medicaid beneficiaries, other problems associated with access to WIC clinics, or perhaps the attitudes of Missouri Medicaid beneficiaries about the WIC program. Prenatal WIC participation rates among Medicaid beneficiaries in Missouri were 36 percent in 1982 and 54.5 percent in 1985-86.

C. METHODOLOGICAL ISSUES RAISED BY PREVIOUS EVALUATIONS

As discussed in Section B, the reviewers of WIC program evaluations have pointed out a variety of issues associated with the design of the studies and their methodological techniques that have limited their ability to determine unambiguously whether prenatal participation in the WIC program improves birth outcomes and saves money in the long run. Both the evaluations and their critiques have underscored a number of key issues for future WIC program evaluation efforts. Two of the most important issues are (1) choosing an appropriate comparison group and (2) estimating a "dose-response" effect.

Choosing a Comparison Sample

Each of the studies discussed in Section A relied on a comparison sample. However, selecting or constructing an appropriate comparison sample for an ongoing program like WIC is extremely difficult. Most researchers would agree that the ideal comparison group is one whose members are identical to WIC participants in all ways except for their WIC participation. One way to develop such a group is to screen women for WIC eligibility and then assign half of them randomly to a WIC treatment group and half to a control group that does not receive WIC services. Random assignment minimizes the chances that differences in the propensity of women to enroll in the WIC program are correlated with such outcome measures as birthweight or Medicaid costs. However, random assignment is not usually feasible for an ongoing initiative like the WIC program, due to the ethical problems involved in purposefully withholding an established benefit from an otherwise qualified recipient.

In contrast, selecting a comparison group from a universe of non-WIC births (Kennedy et al.), WIC nonparticipants in prenatal clinics (Kotelchuck et al.), or women on WIC waiting lists (who are likely to be at lower risk than WIC participants) raises questions about the actual similarity between the comparison group women and women who must meet income and health and nutritional-risk criteria to be eligible for the WIC program and then choose to participate. In general, do WIC

nonparticipants have (1) a lower risk of a poor perinatal outcome because they are healthier and better off financially and thus do not qualify for the WIC program or (2) a higher risk of a poor perinatal outcome because they do not believe sufficiently in the efficacy of prenatal care to apply for WIC benefits or because they lack access to the WIC program?

The difficulty of accounting statistically for individual decisions by eligible women to participate in the WIC program is that a wide range of both measurable and unmeasurable factors-- personal preferences, attitudes, habits, and biases, as well as accessibility to and a knowledge of WIC services--influence a woman's decision to participate in the WIC program. These factors are also likely to affect her willingness to engage in other health-promoting activities during pregnancy. That is, relative to nonparticipating WIC-eligible individuals, women who choose to participate in the WIC program may also be more likely to engage in other activities beneficial to their pregnancies, such as reducing or eliminating alcohol, drug consumption, or nicotine intake or by receiving adequate prenatal care. Conversely, WIC programs that aggressively target the highest-risk pregnant women in their communities may have a sample of participants who are less likely to engage in other beneficial activities. Measuring these risk factors, such as the intake of alcohol, drug, or nicotine, is difficult at best and frequently impossible. It is even more difficult to determine whether improved (or diminished) perinatal outcomes are due to the receipt of WIC benefits or to the use (or nonuse) of other types of prenatal care for women who use both. Thus, research efforts must use various statistical means and rigorous data collection methods to address the problems associated with interpreting estimates based on nonrandomly assigned comparison groups.

Estimating a Dose-Response Effect

Determining whether WIC participation has a dose-response effect, and if so, whether WIC participation has some critical threshold of use below which it is usually ineffective, is important for improving targeting and outreach efforts in light of the limited resources available to serve eligible women. For example, some studies have presented evidence that fewer than three months of WIC participation can be expected to have no effect on birth outcomes. If this evidence could be proven conclusively, focusing outreach efforts on newly pregnant women and reducing the priority given to women who are more than six months pregnant might be an effective way to allocate services when resources are limited. However, as pointed out by Rush and others, isolating a dose-response effect is difficult because the intensity of WIC participation is so highly correlated with the length of gestation. That is, women with fewer months of WIC participation may also consist of those who have had premature births.

D. THE CURRENT WIC/MEDICAID STUDY

The current WIC/Medicaid study has built upon the experiences and goals of earlier evaluations in a number of ways:

- The study restricts both its sample to Medicaid beneficiaries and its primary outcome of interest to Medicaid costs for mothers and newborns during the first 60 days after birth. Outcomes such as birthweight and gestational age are examined for their ability to explain Medicaid costs and to shed light on the effects of WIC participation on birth outcomes. By restricting the study sample to Medicaid beneficiaries, the comparison sample of Medicaid-covered women who did not participate in the WIC program is known to be essentially income-eligible for the WIC program, and thus more likely to have been similar to WIC participants than would be, for example, a comparison group of prenatal clinic enrollees.

- The study sample includes all Medicaid-covered births in five states, rather than a subsample taken within several states or the full sample of all births in a single state. It will thus build on the work of Schramm whose study of the effect of prenatal WIC participation on Medicaid costs was restricted to a single state (Missouri). Examining five state programs will enhance the generalizability of the findings to the national WIC program. However, the peculiarities of these particular states (for example, four of the five are in the South) necessitates using extreme caution in generalizing the effects of the WIC program for the entire country.

- Data collection and file matching procedures were developed to minimize the exclusion of cases from the analysis sample.

- Statistical analysis techniques were used to isolate the effects of prenatal WIC participation from other factors on birth outcomes and Medicaid costs.

III. THE CONCEPTUAL MODEL AND A DESCRIPTION OF THE WIC/MEDICAID DATABASE

The primary goal of this study is to estimate the effect of prenatal participation in the WIC program on Medicaid costs for mothers and newborns during the first 60 days after birth. This chapter describes both a conceptual model that compares the costs of the Medicaid and WIC programs and the process of constructing the database for each of the five study states to estimate the effects of prenatal WIC participation. The first section presents the conceptual model used in the study to examine the costs and benefits of participation in the WIC program by pregnant women. The second and third sections describe the database used for the empirical application of the conceptual model. The fourth section presents the results of the database construction process.

A. THE CONCEPTUAL MODEL OF WIC BENEFITS AND COSTS

The underlying premise that motivates this study is that, to some extent, participation in the WIC program during pregnancy by Medicaid recipients is an investment whereby improved pregnancy outcomes may lead to reduced Medicaid costs for newborns at birth and over some period after birth. Associated with this investment--the provision of WIC benefits--are its costs. They include the cost of the WIC benefits (food instruments and nutrition education) and the costs of administering the program. In addition, WIC participation may increase health care costs insofar as WIC participation leads to earlier and more adequate prenatal care for women, which also may increase Medicaid costs.[1]

The benefits of prenatal participation in the WIC program may be seen as occurring over the lifetime of newborns and their mothers. That is, the enormous social and economic costs of the developmental abnormalities, congenital malformations, and neurologic disorders that can be associated with prematurity and low birthweight suggest that any WIC-induced reduction in the incidence of negative pregnancy outcomes is likely to have benefits that extend over the entire lifetime of the newborn and its family.

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[1]Not all the benefits of prenatal participation in WIC lead to reduced Medicaid costs. One potential benefit of the WIC program that may drive up health care costs is a reduction in infant mortality. That is, very low birthweight babies who survive the neonatal period because their mothers received WIC benefits, while arguably the paramount benefit of the WIC program, will incur higher medical costs than had they died in childbirth.

Figure III.1 illustrates a general conceptual framework for assessing the costs and benefits of prenatal participation in the WIC program. In this figure, W1 denotes prenatal WIC costs; M1, M2, and M3 are Medicaid costs for WIC participants before birth, birth to 60 days, and after the 60-day postpartum period, respectively; and M4, M5, and M6 are the Medicaid costs for the same time intervals in the absence of the WIC program.[2]

A comprehensive evaluation of the cost-effectiveness of prenatal participation in the WIC program would determine whether the total savings in Medicaid costs are greater or less than the costs of the WIC program. That is, if--

$$(M4 - M1) + (M5 - M2) + (M6 - M3) \begin{matrix} ? \\ > \\ < \end{matrix} W1.$$

A priori, we might expect that the prenatal savings in Medicaid costs (M4 - M1) would be negative if prenatal participation in the WIC program leads to improved prenatal care, which involves costs over and above the WIC costs. On the other hand, the cost savings after the 60-day postpartum period may be considerable (that is, M6 - M3 may be positive and potentially large) if prenatal WIC participation reduces the incidence of negative pregnancy outcomes that would otherwise require intensive medical services during the first year of life and thereafter.

Although Figure III.1 illustrates a conceptual framework in which the full range of costs and benefits of prenatal participation in the WIC program can be assessed, the Congressional mandate for this study focuses more narrowly on a comparison of the prenatal WIC costs with the savings in Medicaid costs from birth to 60 days after birth. That is, this study examines whether--

$$(M5 - M2) \begin{matrix} ? \\ > \\ < \end{matrix} W1 \quad \text{or if} \quad \frac{(M5 - M2)}{W1} \begin{matrix} ? \\ > \\ < \end{matrix} 1.$$

[2]This figure is a conceptual benefit/cost model of the prenatal component of the WIC program, and thus does not include WIC costs after birth.

FIGURE III.1

CONCEPTUAL MODEL OF WIC BENEFITS AND COSTS

	WIC Program Costs	Medicaid Costs	
		With WIC Program	Without WIC Program
Conception	W1	M1	M4
Birth		M2	M5
60 Days After Birth		M3	M6

NOTE: This figure is a conceptual cost/benefit model of the prenatal component of the WIC program, which is why WIC costs after birth are not applicable.

B. OVERVIEW OF THE WIC/MEDICAID DATABASE

The empirical application of the conceptual model entails estimating the savings in Medicaid costs from birth to 60 days after birth that are attributable to prenatal WIC participation. This section summarizes the construction of the database used in the empirical estimation of the savings in Medicaid costs due to prenatal participation in the WIC program. Two additional reports from this study--a data feasibility report (Burghardt et al., 1989) and a file linkage handbook (Schore et al., 1991)--contain more detailed descriptions of the design and construction of the database.

The database for this study served four major purposes: (1) to identify newborns born to mothers who were Medicaid recipients and mothers who had Medicaid claims for labor and delivery in a specified year, (2) to provide information on Medicaid costs at birth through 60 days after birth, (3) to determine whether the mother participated in the WIC program while she was pregnant, and the cost of her WIC benefits, and (4) to provide explanatory variables for the empirical application of the conceptual model.

Table III.1 presents an overview of the specific data items used as input to the database, by source. The data sources include Medicaid paid claims and eligibility files, WIC participant and reconciliation files, and Vital Records files. The discussion that follows summarizes the Medicaid, WIC, and Vital Records data used to construct the analysis database for this study.

Medicaid Data

Medicaid eligibility and paid claims files served two purposes: (1) to identify the sample of Medicaid-covered births, and (2) to provide data on Medicaid costs for use as outcome variables in the analysis. The analysis sample included all Medicaid-covered births in 1987 in Florida, Minnesota, North Carolina, and South Carolina, and all Medicaid-covered births in the first six months of 1988 in Texas. Mothers for the sample were identified from an inpatient, birthing center, or practitioner claim for labor and delivery (as designated by codes for diagnoses, procedures, revenue centers, or other similar fields). Newborns were identified from any type of claim with a date of birth in 1987 (January through June 1988 in Texas) and a start date of service within the 60-day postpartum period. In addition, the sample included all newborns and mothers with Medicaid claims, not just those for whom Medicaid was the first payor.

TABLE III.1

REQUIRED DATA ITEMS AND THEIR SOURCES

	Data Items Needed for:			
	Sample/File Linkage	Medicaid Costs and Intervening Outcomes	WIC Participation and Costs	Explanatory Variables
Medicaid Eligibility and Paid Claims File				
Newborn name	X			
Newborn Medicaid number	X			
Newborn date of birth	X			
Newborn sex	X			
Newborn county of residence	X			
Newborn race	X			
Mother name	X			
Mother Medicaid number	X			
Mother date of birth	X			
Mother county of residence	X			
Mother race	X			
Claims information:				
Dates of service	X	X		
Type of provider	X	X		
Provider ID	X	X		
Diagnosis code(s)	X	X		
Procedure code(s)	X	X		
Amount billed		X		
Amount paid by Medicaid		X		
Amount third-party liability		X		
WIC Participant and Reconciliation Files				
Mother: Name	X			
Date of birth	X			
WIC ID	X			
WIC project	X			
Action code	X		X	
Certification date	X		X	
Date of birth	X			
Race/ethnicity	X			
Migrant status	X			
County of residence	X			
Actual date of delivery	X			
Outcome of pregnancy	X			
Prenatal food instrument data (date of issuance, date of redemption, redeemed value)	X		X	

TABLE III.1 (continued)

		Data Items Needed for:			
		Sample/File Linkage	Medicaid Costs and Intervening Outcomes	WIC Participation and Costs	Explanatory Variables
Newborn:	Participant's name	X			
	Date of birth	X			
	Race/ethnicity	X			
	Sex	X			
	County of residence	X			
	Food card recipient's name	X			
	WIC ID	X			
	WIC project	X			
	Cross-reference number	X			
Vital Records Data File					
Newborn:	Name	X			
	Sex	X			X
	Race/ethnicity	X			X
	Date of birth	X			
	Birthweight		X		
	Weeks of gestation		X		X
	Apgar score		X		
	Hospital of birth	X			
	County of residence	X			
	Date of death	X	X		
	Multiple birth	X			X
Mother:	Name	X			
	Race/ethnicity	X			X
	Education				X
	Age	X			X
	Marital status				X
	County of residence	X			X
	Month prenatal care began				X
	Number of prenatal visits				X
	Number of previous pregnancies				X
	Number of previous live births				X
Father:	Name	X			

Women and newborns who participated in health maintenance organizations (HMOs) were not included in the analysis sample. Medicaid pays a flat monthly capitation fee to HMOs that covers all acute-care services for enrollees, rather than a fee based on individual services rendered. Thus, WIC participation--while possibly influencing the cost of providing birth-related care to an HMO enrollee--will not have any short-term effect on the cost of such care to Medicaid. Furthermore, data on individual visits or services received are not consistently available for HMO enrollees.

The choice of 1987 as the study period represents a balance between (1) selecting the most recent year possible in order to observe a period when at least some of the recently enacted Medicaid expansions were in effect, and (2) selecting a period of time for which all Medicaid claims for the study subjects were fully processed and finalized. Given that the database construction was started in early to mid-1989, 1987 was selected as the most recent year for which finalized Medicaid cost data would be available on the state files. A decision was made to allow a year between the last date of service of interest to the study (60 days following the end of 1987, or February 29, 1988) and the timing of the data extraction from state files (early 1989), because the maximum expected lag time for virtually all claims is one year between the date of service for a Medicaid claim and its appearance as a paid claim on a state's Medicaid Management Information System (MMIS).[3]

Texas is the sole exception to adopting calendar year 1987 as the analysis period. In Texas, the study was based on Medicaid births that occurred from January 1988 through June 1988, since the data necessary to identify WIC prenatal participants were not available for earlier births. The risk of missing Medicaid claims that were not finalized by early 1989, the date the Medicaid extract was created, increases somewhat with this choice. However, Texas Medicaid appeared to process most claims relatively promptly and paid for just 30 days of inpatient services per year. Thus, the risk of missing long-term hospitalizations (a major component of Medicaid costs) by using the later analysis period is much lower in Texas than it would be in states without such a limit on inpatient services.

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[3]One year was also thought to be sufficient for a death certificate to appear in the Vital Records system and for birth and infant death records to be linked for states that link birth and death data on an ongoing basis.

WIC Data

Analyzing the effects of prenatal participation in the WIC program on Medicaid costs requires constructing a variable that indicates WIC participation status. Data from the states' WIC data systems were used to determine whether a mother identified by the Medicaid data was receiving WIC benefits while she was pregnant and, if so, the cost to WIC of her redeemed food instruments. Because most states do not maintain historical data on the nutritional risk factors on their participant files, data on the medical and dietary risk factors for the prenatal WIC participants could not be used in the analysis.

Most states have two related WIC data systems that are relevant to this study: (1) a participant file, which includes certification information for WIC participants, and (2) a reconciliation file, which is a log of redeemed food instruments. The ability to match redeemed food instruments from the reconciliation file to prenatal WIC participants varied considerably across states and affected how individual-level WIC costs were estimated. Specifically, Florida, Minnesota, and North Carolina were able to match redemption data to individual participants, while South Carolina could match only issued food instruments to participants, and Texas had data only on the certification date for the WIC program. Measuring the total costs of WIC for an individual participant required using a state-level ratio of administrative and nutrition education costs to food costs to inflate individual-level food instrument redemption estimates.

Vital Records

Vital Records furnished the bulk of the explanatory variables used in the empirical application of the WIC/Medicaid conceptual model, and served as a linkage hub for Medicaid and WIC data. Vital Records data are maintained at the state level by Bureaus of Vital Statistics. Several Vital Records data files were used in this study. Most importantly, the birth files provided information on all births occurring within the state for each calendar year. In general, data available from birth records included the following:

- Newborn data on name, sex, hospital of birth, gestational age, and birthweight
- Maternal data on maiden name, age, race, education, and marital status
- Obstetrical history data on the number of previous live births, the number of previous pregnancies, and use of prenatal care

Infant and fetal death records were also added to the database, although using them posed complicated analytic problems. While the effect of prenatal WIC participation on infant death rates is important, infant deaths are relatively rare events, and have thus been included in the analysis only for descriptive purposes. State fetal death files, providing information on the deaths of fetuses of at least 20 weeks gestation, were also available for all states but Texas. However, the registration of fetal deaths is believed to be incomplete (see, for example, Greb et al., 1987), and the reliability of fetal death files varies by state. However, as with infant deaths, fetal deaths are important outcomes and also explain why some women with Medicaid-covered birth-related claims do not link to Medicaid-covered newborns.

C. THE DATABASE CONSTRUCTION PROCESS

Constructing the database for the five states in the WIC/Medicaid study entailed linking data extracts from the three state data systems into an analysis file that contained a single record for each Medicaid-covered birth. Conceptually, for each Medicaid birth in the study period, the linked database from the Medicaid, Vital Records, and WIC data extracts consisted of single multi-segment records with the following general structure:

1	2	3	4	5
Newborn Medicaid Costs	Mother Medicaid Costs	Newborn Birth Data	Mother Demographic/ Prenatal Care Data	Mother Prenatal WIC Participation

As discussed earlier, Medicaid costs, segments 1 and 2, came from the Medicaid claims files. Segment 3, which includes such factors as birthweight and the gestational age of the newborn, came from the newborn's birth certificate. Segment 4 contains demographic data and information on the extent of prenatal care and previous pregnancies for the mother, and also came from the newborn's birth certificate. Information on prenatal participation in the WIC program, segment 5, came from the WIC data files.

The process of creating a database of multi-segment birth-event records from Medicaid, WIC, and Vital Records files entailed four basic linkage steps:

1. Internal Medicaid Linkage. Mothers with delivery-related Medicaid claims were matched to their respective newborns with Medicaid claims during the first 60 days after birth.

2. Medicaid to Vital Records Linkage. Medicaid-covered birth events were matched to the birth certificate of the newborn in order to capture demographic and prenatal care data, birth history, and birth outcome data.

3. Internal WIC Linkage. Pregnant WIC participants were matched to newborns participating in the WIC program in order to obtain additional identifying information for merging WIC data with a combined Medicaid/Vital Records file.

4. Medicaid/Vital Records to WIC Linkage. Medicaid-covered birth events were matched to data on the mother's prenatal WIC participation, if such participation occurred.

The internal Medicaid linkage matches mothers and their respective newborns both previously identified from Medicaid claims files as having been part of a Medicaid-covered birth in 1987. This link is crucial, since costs incurred both for mothers and their newborns were identified, and for some states combined, for the primary outcome measure of the study. The ability to link these costs was important because for some types of claims (such as Medicaid inpatient claims for labor and delivery that include newborn care) the costs for the two were not separable. Thus, it was not possible to consider only the costs incurred by the mother or only the costs incurred for newborns as dependent variables for the models to be estimated in the study, and data for both were made available to combine costs for mothers and newborns when necessary.

In the Medicaid to Vital Records linkage, Medicaid records were linked with the Vital Records birth file. The input to this link was either matched mother/newborn Medicaid records or separate Medicaid mother and newborn files. This linkage was based primarily on the county of residence, hospital of birth, and the newborn's last name, date of birth, and sex. Given that the Vital Records files contained all births in the state for the study period (not just births to women with Medicaid coverage), the match criteria had to be very strict in order to avoid false matching. Linking the Medicaid mothers with Vital Records who were not already matched to Medicaid newborns was difficult, since the mothers' Medicaid records contained only an approximation of the birth date of the newborn--the service dates from the mother's claim for labor and delivery. Matching Medicaid newborn records that had not already

been linked with a Medicaid mother record was also difficult because birth certificates frequently did not include the first name of the newborn; rather, on the birth certificate the first name was blank, "baby," "boy," or "girl."

The result of the Medicaid-to-Medicaid and Medicaid-to-Vital Records links was a base file that contained all Medicaid records. This file included Medicaid mothers linked with Medicaid newborns, unlinked Medicaid mothers, and unlinked Medicaid newborns. Each of these records contained Vital Records information if it had been linked successfully with the Vital Records file.

The internal WIC linkage entailed matching WIC data for pregnant women to WIC data for their newborns, if the newborns were WIC participants. The primary purpose of the internal WIC link was to add the newborn's name and date of birth to the mother's record of prenatal WIC participation in order to improve the Medicaid/Vital Records to WIC link. Naturally, if the newborn was not a WIC participant, this match could not be performed, and the mother's estimated date of delivery was used to approximate the date of birth in subsequent linking programs.

In the Medicaid/Vital Records to WIC linkage, matched Medicaid-Vital Records births were linked with the WIC file. The output file from this linkage consisted of matched Medicaid-Vital Records-WIC births (WIC participants) and Medicaid-Vital Records births that were not matched to a WIC record (nonparticipants).

This linkage is an interesting one, in that the a priori expectation is that WIC nonparticipants on the Medicaid/Vital Records file will not match the WIC file. Consequently, any Medicaid births that could not be linked with the WIC files were assumed to be nonparticipants, as opposed to nonmatches. In reality, it is likely that some Medicaid-identified births could not be linked with WIC files because either the data or linking algorithms were inadequate, and some WIC participants may have erroneously been called nonparticipants.

Because the exact percentage of Medicaid beneficiaries enrolled in WIC is unknown, assessing the quality of the Medicaid/Vital Records to WIC linkage is difficult. Thus, a subsample of all WIC participants was drawn and compared with the Vital Records files, regardless of whether or not the WIC enrollees were eligible for Medicaid. Because all pregnant WIC participants should match to the birth or fetal death files (except for those whose pregnancy terminated less than 20 weeks after conception), the percentage of WIC records that did not match the Vital Records files

provided some indication of the success of the Medicaid/Vital Records to WIC link. A high percentage of WIC participants who could not be linked to the Vital Records file would have suggested that some of the WIC nonparticipants from the file linkage process might in fact have been WIC participants. Fewer than 10 percent of WIC records for women certified as pregnant in the first three months of 1987 failed to match Vital Records. Since some of the prenatal WIC participants may have experienced fetal deaths that were not recorded, out-of-state births, or births outside the study period, the 90 percent match rate was judged to be adequate. Thus, the designation of WIC participant status based on file linkage results was reasonably reliable.

Even with the addition of Vital Records as a linking hub for the Medicaid and WIC files, the data available to match records were not fully consistent across data sources for each birth included in the study. In particular, files did not share unambiguous numeric identifiers, such as Social Security numbers or Medicaid identifiers. Thus, multiple matching criteria were used for each link step. The first criterion to be implemented was the most stringent, with successive criteria weakened slightly in order to make as many correct matches as possible. For example, the most stringent criterion for matching Medicaid-covered newborn data with birth certificates was an exact match on county of residence, hospital of birth, date of birth, sex, and newborn first and last name. The next criterion included all of these variables with the exception of sex; and so on.

Constructing Analytical Variables

After the file linkage process was completed, variables were constructed for estimating the conceptual model described in Section A of this chapter. This section describes the important features of the variables used to describe Medicaid costs for mothers and newborns during the 60 days after birth and WIC prenatal participation and costs.[4] The variables constructed for each state are described further in Chapter IV.

Medicaid Cost Variables. Medicaid cost variables were defined in terms of Medicaid reimbursement for all types of services. While Medicaid reimbursement does not necessarily reflect the cost to the provider of providing a service, it does reflect the cost of the service to Medicaid. All services were included in the cost variables, because distinguishing

[4]The construction of variables from Vital Records files was relatively more straightforward and is described in Schore et al. (1991).

between services that were and were not strictly pregnancy or birth-related would have been too time-consuming, very expensive, and frequently impossible.

Ideally, separate cost variables would have been constructed for the prenatal period and the birth to 60-day postpartum period. An unambiguous demarcation between the end of the prenatal period and the start of the postpartum period would have enabled the study to address the explicit objective of estimating Medicaid costs in the 60-day postpartum period. However, distinguishing these two periods was not possible because all five study states allowed global billing procedures by physicians. Under global billing, a physician may submit to Medicaid a single claim covering prenatal care, labor and delivery services, and routine postpartum checkups. These claims include services that occur both in the prenatal and 60-day postpartum periods, without an accurate allocation of parts of the total reimbursement to each period. Thus, for this study, physician claims for prenatal care and labor and delivery, whether submitted individually or with a global bill, were allocated to the prenatal period. More specifically, all physician claims that occurred between seven and a half months prior to the birth of the newborn and up to and including the date of birth were allocated to the prenatal period. Seven and a half months prior to birth was chosen as the start date of the prenatal period under the assumption that a woman would not begin prenatal care before she was at least six weeks pregnant (assuming that the pregnancy terminated in a full-term birth). The date of birth was chosen for the end of the prenatal period for physician services because global bills tend to be submitted with the date of birth as the service date. By contrast, hospital claims and claims from all other providers were allocated to the prenatal period if they occurred between seven and a half months prior to birth and up to but not including the start date of the birth claim.[5] In this way, hospital reimbursement for labor and delivery could be allocated appropriately to the postpartum period.

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[5]The birth claim was defined as the claim that identified the woman for the study sample: a hospital claim with a diagnosis, revenue center, or DRG code related to labor and delivery; or, failing that, a claim from a physician, nurse midwife, or birthing center for labor and delivery. Most of the birth claims for the study were hospital claims. In the minority of cases with other types of birth claims, the day before the date of birth, rather than the start date of the birth claim, was used as the end of the prenatal period.

The postpartum period began the day after the end of the prenatal period. By definition, all newborn claims were allocated to the postpartum period. Two types of postpartum cost variables were constructed. For "Type 1" postpartum Medicaid costs, claims whose service dates spanned the beginning or end of an analysis period were prorated according to the proportion of the service period that occurred within the 60-day postpartum period. For example, if the dates of service on a claim started three days before the end of the 60-day postpartum period and ended three days after, one-half of the Medicaid reimbursements were included in the Medicaid cost variable. "Type 2" postpartum Medicaid cost variables included reimbursements for any claim in its entirety if its start date was in the postpartum period regardless of the end date of service. This second set of postpartum variables was meant to capture the full cost of ongoing services for serious medical problems that began in the postpartum period but continued past 60 days after birth.[6]

North Carolina and Texas were the only two study states in which newborns automatically received their own Medicaid identifier, and in which claims for all newborns appeared under their own number. In the other states, claims for normal healthy newborns often appeared under the claims for the mother, and it was not possible to distinguish the newborn's Medicaid costs from the mother's Medicaid costs. Thus, in North Carolina and Texas, Medicaid cost variables were constructed for both newborns only and newborns and mothers combined, while the Medicaid cost variables in the other states were for mothers and newborns combined. In addition, in South Carolina, it was not possible to separate physician claims for the prenatal period from claims for the 60-day postpartum period. Thus, only hospital costs from birth through 60 days were included in the Medicaid cost variable for South Carolina.

WIC Participation and Costs. Women were deemed to be prenatal WIC participants if they met two conditions: (1) they were issued or had redeemed at least one food instrument during the nine months prior to birth, or (2) for Texas, which did not provide any food instrument data, if the WIC certification dates were sometime during the nine months prior to birth.

[6]The results presented in Volume 1 are based on the Type 1 postpartum cost variables, and the results for both sets of variables are presented in the following chapter of this volume.

For this study, Florida, Minnesota, and North Carolina provided data on the value of food instruments redeemed during pregnancy for each of the prenatal WIC participants. South Carolina provided data only on the number of months WIC food instruments were issued during pregnancy, and, as noted, Texas had data only on the month of enrollment in the WIC program. Thus, estimates of the cost of the WIC program in Florida, Minnesota, and North Carolina were based on the actual amount of redeemed food instruments during the nine months prior to birth; estimates of the amount of redeemed food instruments in South Carolina and Texas were derived from instruments issued and the number of months enrolled in the WIC program, respectively.

Estimating the total WIC costs per prenatal WIC participant entailed adding an adjustment for administrative expenses and the costs of the nutrition education component of WIC to the costs of the WIC food supplements. This adjustment, which was based on state data on total WIC food costs and total administrative and nutrition education costs, was calculated by multiplying the ratio of administrative and nutrition education expenses to total WIC food costs by the average food supplement cost per prenatal participant. The total WIC costs per prenatal WIC participant were the sum of the food package costs and administrative and nutrition education expenses.

Creating the Birth-Based Analysis File. After the analytical variables were constructed, the records for individuals with duplicate Medicaid identifiers were eliminated and consolidated. It was particularly important that data which appeared under multiple Medicaid identifiers for the same person be maintained on the file throughout the variable construction process. In this way, complete cost variables could be constructed for each individual in the sample even if that individual changed Medicaid identifiers over time.

At the conclusion of the variable construction process, the WIC/Medicaid study database contained raw data from state extracts, state data that had been recoded to a uniform coding scheme for the study, and the more complicated constructed variables described in the previous sections. The unit of observation on the database at this point was the newborn. However, the unit of observation for the analysis of the effect of prenatal WIC participation on Medicaid costs was the Medicaid-covered birth. For singleton births, these units were identical. For multiple births, cost data for all newborns involved in the birth had to be aggregated. Thus, a second, birth-based file was created by summing costs for all newborns in a birth, from which analysis files for statistical cost estimates were subsequently extracted. In general, birth outcomes were not transferred

to the birth-based file, because multiple sets of birth outcome data for individual births would not have been useful.[7] Rather, the newborn-based file was retained as the source of analysis files for drawing statistical estimates of the effect of prenatal WIC participation on birth outcomes.

D. THE RESULTS OF THE FILE LINKAGE PROCESS

The database for the WIC/Medicaid study contained 111,958 Medicaid-covered births, ranging from just over 12,000 from Minnesota to just under 38,000 from Florida (see Table III.2). As noted previously, because the analysis relied heavily on Vital Records data, only those Medicaid births that were linked to the Vital Records birth certificates were included in the final analysis sample. With the exception of South Carolina, over 93 percent of all Medicaid births identified in each state were linked with Vital Records and were thus retained for analysis. In South Carolina, 86 percent of Medicaid-covered births were linked with Vital Records. The percentage in South Carolina was lower than in other states for two reasons: (1) birth certificates for South Carolina residents who gave birth in other states were not available, so that Medicaid births to residents giving birth in other states could not be matched to a birth record; and (2) less identifying information from the Medicaid files was available in South Carolina than in the other four states. In all states, descriptive analyses of the cases deleted from the study database indicated that deleted cases did not differ systematically from cases that were retained.

[7]However, when a multiple birth occurred, the sex of the newborn on the birth-based file indicated whether any of the newborns were male, since male newborns tend to have more medical complications and higher medical costs.

TABLE III.2

LINKAGE RESULTS BY LINKAGE TYPE AND STATE

Number of Records by Linkage Type	Florida	Minnesota	North Carolina	South Carolina	Texas
Total	37,587	12,110	21,973	13,542	26,746
Link to Vital Records					
Mother/newborn/Vital Records	21,530	8,874	16,137	10,071	22,823
Mother/Vital Records	10,395	1,576	2,357	391	711
Newborn/Vital Records	3,993	1,142	1,947	1,179	1,975
No Link to Vital Records					
Mother/newborn	284	54	47	719	369
Mother	883	338	1,173	489	572
Newborn	502	126	312	693	296
Percentage of Total Linked to Vital Records	95.6 %	95.7 %	93.0 %	86.0 %	95.4 %

SOURCE: WIC/Medicaid database for Florida, Minnesota, North Carolina, South Carolina, and Texas.

NOTE: The unit of observation for records is the Medicaid-covered unit. Fetal deaths are excluded.