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Effects of the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC): A Review of Recent Research

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I. INTRODUCTION

The Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) provides nutritious food supplementation, nutrition education, and screening and referral to health and social services to pregnant, breastfeeding, and non-breastfeeding postpartum women, and infants and children up to 5 years of age. WIC also supports the initiation and continuation of breastfeeding among postpartum women who choose to breastfeed. The objective of the program is to improve fetal growth and development, improve the health and development of infants and young children, and increase access to needed services. The WIC program has greatly expanded since its inception as a pilot program in 1972. The average monthly participation in the program increased from approximately 88,000 in 1974 to more than 9.2 million in fiscal year 2010. The annual expenditure for the program for fiscal year 2010 was $6.8 billion, making it the third-largest nutrition assistance program in the United States (Oliveira 2011).

The existing body of research on the WIC program is large in size and scope. With respect to impacts on birth-, nutrition- and health-related outcomes, WIC is the most widely studied of the food and nutrition assistance programs at the U.S. Department of Agriculture (USDA). In 2004, USDA published the most comprehensive review of WIC impact studies completed to date (Fox et al. 2004). That report catalogued the effects of WIC on pregnant women's health, birth outcomes, and breastfeeding practices; participants' dietary intakes; and infant and child health outcomes. In addition, the report discussed research findings on health care service utilization and the Medicaid costs (and cost-savings) associated with WIC participation. By discussing the strengths and weaknesses of available data sources and previous methodological approaches, the authors also helped identify several important gaps in the existing research and pathways for future study.

In recent years, the WIC program has continued to be the subject of much research. Researchers have produced more-refined methodological approaches and attempted to measure WIC's impact on previously unmeasured outcomes. The present report is intended to update the literature review completed by Fox et al. (2004) by comprehensively reviewing all published research on WIC program impacts between 2002 and 2010 as well as "gray" or unpublished research completed between 1999 and 2010. Studies released during this interval include all currently available research that was not reviewed by Fox and her colleagues.

This report begins with an overview of the WIC program, including its administrative structure and benefits, and a detailed description of the literature search protocol used to identify the studies included. The research overview begins with a discussion of selection issues related to WIC evaluations, and follows with a detailed discussion of the evidence on the association between WIC and specific health outcomes that have been grouped into seven categories: (1) pregnancy and birth outcomes; (2) infant feeding practices; (3) infant and child dietary intake, food security, and related outcomes; (4) infant and child growth; (5) child immunization; (6) health care utilization and associated costs; and (7) child health and socioemotional and cognitive development.[1] Each outcome section discusses the approaches used to deal with selection bias, other methodological challenges (if applicable), an overview of the key findings, and a discussion of the strengths and weaknesses of the individual studies.

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[1] None of the studies identified through the literature search focused on the health outcomes of postpartum or breastfeeding women.

A. Program Overview

WIC is a federally funded program administered by the Food and Nutrition Service (FNS) of USDA. However, WIC is not implemented uniformly nationwide. There are 90 WIC State Agencies (WSAs), including the 50 states, the District of Columbia, Puerto Rico, four territories (American Samoa, Guam, Northern Mariana Islands, and U.S. Virgin Islands), and 34 Indian Tribal Organizations (ITOs). Each WSA is separately responsible for assigning food packages consistent with the WIC participant's eligibility category and for issuing WIC food instruments, such as vouchers or EBT cards, to participants for redemption at authorized retailers. Items included in the state food list must satisfy federal regulations; however, state lists may also reflect more stringent selection criteria established by the WSA. As a result, each WSA has the discretion to establish its own list of authorized foods based on factors that include the availability of certain foods within the state, the cost of individual foods and brands, the nutrient value of available foods, and (with FNS approval) variations in cultural eating patterns.

To participate in WIC, applicants must meet three eligibility criteria. First, they must be members of one of five groups: (1) pregnant women up to six weeks after delivery, (2) breastfeeding women up to one year after delivery, (3) non-breastfeeding women up to six months after delivery, (4) infants, or (5) children up to age 5. In 2008, half of all WIC participants were children aged 1 to 4, 25 percent were infants, 11 percent were pregnant women, and the rest were postpartum breastfeeding or non-breastfeeding women (Connor et al. 2010). The distribution of women, infants, and children in the program has remained relatively stable since 2002 (Fox et al. 2004).

Second, applicants must show, through the assessment of a health professional, that they are at nutritional risk according to federal guidelines. Such risk can be based on biochemical or anthropometric measurements, a nutrition-related medical condition, dietary deficiencies, unhealthy behavior such as alcohol or drug abuse, or conditions that can lead to risk, such as homelessness.

Third, participants must be either income eligible (household income at or below 185 percent of the federal poverty level [FPL]) or adjunctively eligible through participation in other means-tested programs. Persons who participate in Medicaid, Temporary Assistance for Needy Families (TANF; formerly Aid to Families with Dependent Children [AFDC]), the Supplemental Nutrition Assistance Program (SNAP, formerly the Food Stamp Program), or other programs with income guidelines at or below that specified for WIC are automatically income eligible and need not provide proof of income (Connor et al. 2010). Applicants are also adjunctively income eligible if they are a member of a family that is certified as eligible to receive assistance under TANF or if they are a member of a family in which a pregnant woman or an infant is certified as eligible to receive assistance under Medicaid (7 CFR 246.7). In 2008, 62 percent of WIC participants reported receiving Medicaid, 22.6 percent reported receiving SNAP benefits, and 6.5 percent reported receiving TANF at the time of certification, with about 30 percent of WIC participants who did not participate in other programs (Connor et al. 2010). The 30 percent of WIC participants who are not adjunctively eligible tend to have higher incomes relative to the rest of the WIC population. Overall, WIC has been successful in enrolling the most economically disadvantaged population. In 2008, 68 percent of WIC participants lived in households with incomes below 100 percent of FPL, compared to 12.5 percent among the general U.S. population (Connor et al. 2010).

WIC is not an entitlement program, and enrollment depends on availability of funds, which is determined by annual appropriations. To ensure that the population at the greatest nutritional risk is served, WIC has developed a priority system that takes effect once a local agency reaches its maximum enrollment under the current budget and is applied to the applicants on the local agency's waiting list. In recent years, funding appropriations have been sufficient to provide benefits to all applicants seeking to participate, and as a result the waiting list provisions have not come into effect (Oliveira 2009). The program has achieved broad levels of national coverage. In 2006, nearly 30 percent of all pregnant women, almost half of all infants, and about a quarter of children aged 1 to 4 in the United States had participated in WIC (Oliveira 2009). Nevertheless, a substantial proportion of eligible women do not enroll. According to the latest estimates, WIC enrolled 59 percent of the total eligible population in 2007 (Harper et al. 2009).

The WIC program is designed to address the negative impacts of poverty on prenatal, infant, and early childhood health by providing supplemental foods, nutrition counseling, and referral to a wide range of complementary health and social services. Although each state has some discretion in determining its preferred method for distributing supplemental foods, most State agencies provide coupons for food purchases at retail vendors. The quantities and types of allowed foods are federally regulated. All beneficiaries are assigned to one of seven benefit packages based on pregnancy status, breastfeeding practices, dietary needs, and child age. The available supplemental foods include a wide range of food categories, and the quantities of allowed foods vary for each package type. Prior to 2009, the available food categories were infant formula, infant cereal, juice, cereal, milk, eggs, cheese, dried beans and/or peanut butter, tuna fish, and carrots.

In 2009, comprehensive revisions to the WIC food packages went into effect.[2] The new packages align with the 2005 Dietary Guidelines for Americans and infant feeding practices supported by the American Academy of Pediatrics. The food packages were intended to better support the establishment of successful, long-term breastfeeding; provide WIC participants with a wider variety of foods, including fruits, vegetables, and whole grains; and allow State agencies greater flexibility in prescribing packages that accommodate the cultural preferences of WIC participants. Although these program revisions are likely to affect the relationship between WIC participation and a broad range of maternal and child outcomes, none of the studies included in this review incorporated participant samples observed after State agencies implemented the new Interim Rule.

In recent years, the WIC program has also strongly emphasized breastfeeding promotion. Prenatal WIC participants are encouraged, through educational materials and counseling, to initiate breastfeeding once the baby is born, and the program continues to promote breastfeeding to postpartum women, through both nutrition education and an enhanced food package for breastfeeding women and breastfed infants 6 to 12 months of age. However, the WIC program also offers food packages that provide a supplemental amount of infant formula. Because infant formula is expensive, the total market value of the food package provided to breastfeeding women is lower than that of the package tailored to formula-feeding women. This has led some observers to suggest that WIC program "incentivizes" formula use and discourages breastfeeding. With the goal of reducing such incentives and promoting breastfeeding, recent changes to the food packages significantly reduced the difference between the market value of food packages for fully breastfeeding and partially breastfeeding or non-breastfeeding women.

[2] All state agencies were required to implement the revised program regulations by October 1, 2009. The full, revised Interim Rule was released as 72 Federal Register 68965-69032.

B. Scope of Review and Search Methods

The current report focuses on peer-reviewed studies published since 2002 and unpublished studies completed in 1999 or later. The search protocol used in this review corresponds closely to the one used in Fox et al. (2004), with a specific focus on the literature relating to WIC rather than to all nutrition-related programs, as in the previous review. The protocol involved three components: (1) a comprehensive electronic database search focused on published studies and dissertations; (2) a public call for studies; and (3) a customized internet search focused on unpublished research.

1. Electronic Database Search Protocol

The main component of the literature identification process was a comprehensive computerized search of bibliographic databases, with the goal of ensuring that the results included all potentially relevant studies. This approach is likely to produce many irrelevant citations in an initial search, but it is unlikely to exclude studies with relevant research findings. As a result, the search protocol was highly inclusive and permitted a wide variety of possible keyword combinations. The selection of searchable databases and keywords was carefully considered, as discussed below. The actual database search was implemented by a professional research librarian with experience supporting comprehensive literature reviews and social science research.

Selecting Searchable Databases

The first step in selecting the list of searchable databases was to review and update the list of bibliographic resources searched by Fox et al. (2004). Several of the databases used in the earlier report have been consolidated into searchable platforms (EBSCOhost, FirstSearch, and OvidSP), which permits a single search query to return results from a much broader set of resources. A few databases from the earlier report had ceased operations and were therefore excluded. The present search also included a small number of newly available online electronic resources, such as the Health Policy Reference Center, which added significant breadth to the included body of searched literature. As shown in Table I.1, the online search used a total of 18 databases.

Defining Search Parameters

Because the search included such a broad range of databases, it was necessary to repeat the same query across multiple online platforms. The queries used identical search terms in all the searched bibliographic databases. Each query had three required components: (1) a WIC program identifier, (2) an impact study identifier, and (3) an outcome identifier. To be included in the search results, studies had to include at least one term from each of the three search components. The search terms used by Fox et al. (2004) provided the starting point for developing the list of keywords included under each of the three components. Because the earlier literature review included programs other than WIC, the search terms were adjusted to remove identifiers of non-WIC programs. The current search also included several additional WIC-specific outcome keywords. Each search included all the terms in tables I.2 and I.3 and was limited to studies published between 2002 and 2010.

Table I.1. Searchable Databases Used in Comprehensive Literature Search

Database	Platform	Database Producer	Subject Category
Ageline	EBSCOhost	American Association of Retired Persons	Social services and public welfare
Agricultural Online Access (AGRICOLA)	Online	U.S. National Agricultural Research Library	Agricultural research; economics; policy
Combined Health Information Database	Online	National Institutes of Health	Child health
Dissertation Abstracts Online	FirstSearch	University Microfilms, Inc.	General
Economic Literature Index (EconLit)	EBSCOhost	American Economic Association	Health economics
Education Research Information Center (ERIC)	EBSCOhost	U.S. Department of Education	Education research
E-Journals	EBSCOhost	EBSCO Industries, Inc.	General
Federal Research in Progress (FEDRIP)	Online	U.S. National Technical Information Service	General
GPO Monthly Catalogue	Online	U.S. Government Printing Office	General
Health Policy Reference Center	EBSCOhost	EBSCO Industries, Inc.	Health economics
HealthStar	OVID	U.S. National Library of Medicine	Health economics
Inside Conferences	FirstSearch	British Library	General
MEDLINE	OVID	U.S. National Library of Medicine	Medicine and health; nutrition
Nursing and Allied Health Database	EBSCOhost	Cinahl Information Systems	Nursing and allied health; medicine and health; nutrition
Nutrition Evidence Library	Online	U.S. Department of Agriculture	Nutrition
PsycInfo	Online	American Psychological Association	Social science research
Social Sciences Index	EBSCOhost	H.W. Wilson Company	Social science research
Sociological Abstracts	EBSCOhost	H.W. Wilson Company	Social services and public welfare

Table I.2. WIC Impact Study Identifiers Used in Querying Searchable Databases

WIC Program Identifiers (one match required)	Impact Study Identifiers (one match required)
Special Supplemental Nutrition Program for Women, Infants, and Children	Association
Special Supplemental Food Program for Women, Infants, and Children	Relationship between
Special Supplemental Program for Women, Infants, and Children	Effect
Women, Infants, and Children Program	Affect
Farmers' Market Nutrition Program	Evaluation
WIC	Impact

Table I.3. Outcome Keywords Used in Querying Searchable Databases

Terms Used in Fox et al. (2004)			New Terms
Nutrition			
Anemia	Folacin	Iron-deficiency	Added Sugar
Anemic	Folic acid	Iron deficient	Carbohydrates
Breakfast consumption	Food availability	Iron-deficient	Cholesterol
Diet	Food choices	Iron status	Fat
Dietary adequacy	Food costs	Malnutrition	Fiber
Dietary effects	Food expenditures	Nutrient availability	Food energy
Dietary impacts	Food insecurity	Nutrient content	Grains
Dietary intake	Food intake	Nutrient consumption	Mineral
Dietary outcomes	Food purchases	Nutrient intake	Protein
Dietary patterns	Food security	Nutrition	Sodium
Dietary practices	Food selections	Nutritional adequacy	Vitamin
Dietary quality	Food use	Nutritional intake	
Dietary trends	Healthy Eating Index	Nutritional status	
Dietary variety	Hemoglobin	Overnutrition	
Eating behaviors	Hunger	Undernutrition	
Eating practices	Iron deficiency		
Health-Related Behaviors			
Alcohol use	Drug abuse	Prenatal care	Alcohol consumption
Cigarette (tobacco) use	Drug use	Smoking	Breast feed
	Immunizations		Breastfeed
	Infant feeding practices		Formula-feed
	Perinatal care		Infant formula
Pregnancy and Birth Outcomes			
Birth weight	Intrauterine growth	Neural tube defects	Apgar score
Birthweight	Length of gestation	Perinatal morbidity	Birth-weight
Fetal growth	Light-for-date infants	Pregnancy	Cesarean delivery
Fetal outcomes	Maternal morbidity	Pregnancy outcome(s)	Fetal death
Gestational age	Maternal mortality	Prematurity	Gestational
Head circumference	Maternal weight gain	Preterm delivery	Gestational diabetes
Infant morbidity	Neonatal morbidity	Preterm infants	Hypertension
Infant mortality	Neonatal mortality		Infant death
			Large-for-gestational age
			Premature birth
			Preterm birth
			Pregnancy weight
			Small-for-gestational age
Other Relevant Mother, Infant or Child Outcomes			
Body Mass Index (BMI)	Health status	Skinfold(s)	Childhood illness
Body measurements	Height	Stature	EPSDT
Body weight	Hematocrit	Underweight	Hemoglobin
Bone density	Length	Weight	Postneonatal death
Growth	Morbidity	Weight gain	Postneonatal mortality
Growth rate	Mortality		Well-child exam
Growth velocity	Obesity		Well-child visit
Health	Overweight		
Health outcome(s)	Postnatal growth		
Child Development			
Behavioral development	School attendance		Abuse
Cognitive development	School performance		Neglect
Cognitive performance			
Health Care Utilization and Costs			
Healthcare (access, utilization, needs, cost)			Dental
Medicaid			Emergency room visit
Medical (care, cost, need)			Healthcare expenditure
Medicare			Hospitalization
			Medical expenditure
			Saving

In addition to the search of electronic databases, the study team used two strategies to search the "gray" literature, which includes reports and policy briefs published by the Federal or State governments or private research organizations, working papers, and dissertations. The study team conducted a Google-based custom search of selected website domains and issued a public call for WIC-related research that was completed between 1999 and 2010 but was not published in peer-reviewed journals. The domain names for the Google-based search included a broad range of Federal agencies, State governments, all State WIC agencies, academic and private research institutions, advocacy organizations, and WIC-related associations. The study team reviewed all documents and web pages that were returned by the Google search and that met search criteria. The public call for studies was posted on the website of the Food Research and Action Center and was distributed to Directors of State WIC agencies through the National WIC Association.

2. Identifying Relevant Studies

All the references the search protocol captured were compiled into a single list using reference-management software. This list provided title, author, and (when provided) abstract information for all the collected articles, without incurring the cost of acquiring full texts. An electronic matching protocol identified and removed exact citation duplicates returned from separate databases.

The study team manually reviewed the collected article titles and abstracts and identified all citations potentially relevant to the review. Any study that claimed to analyze effects of WIC participation was selected for inclusion, and all citations that did not provide enough information to make a screening determination were marked for potential inclusion. Full texts were acquired for all the potentially relevant studies, and a final round of screening was conducted using the full texts of obtained articles to determine if the studies included estimates of WIC participation impacts.

Because the initial search protocol was designed to be very inclusive, the search results returned a large number of irrelevant citations that were eventually excluded from this review. Citations that were excluded tended to fall into one of the following categories:

- General program descriptions
- WIC program materials, brochures, and training manuals
- Descriptions of WIC participation levels and participant characteristics
- Descriptive research on WIC implementation, operations, and program costs
- Descriptive analyses that did not attempt to adjust for differences between WIC participants and nonparticipants
- Studies related to outcomes of interest that did not estimate effects of WIC participation
- Studies evaluating an intervention that is not a standard component of the WIC program (such as a newly designed antismoking or breastfeeding-promotion initiative) using a sample of WIC participants only

In addition to the comprehensive electronic search, the study team conducted a manual cross-check of the final citation list against a sample of WIC literature reviews and the bibliographies of highly cited WIC articles. Omissions were unusual, but occasionally the cross-check did identify relevant research that was subsequently added to the list of studies included in this review. Additional citations provided by these reviewers were incorporated into this report.

The full texts of articles were obtained from online downloads, Mathematica Policy Research's in-house library, university libraries, interlibrary loan services, and, when necessary, from primary authors. All full-text articles were reviewed by the study team, who used the screening criteria described above and reviewed the articles' research designs and methodological considerations to determine whether each article provided empirical information on the effect of WIC participation on relevant nutrition, health, and program cost-effectiveness outcomes. These final documents included on the basis of this review process constitute the main body of evidence discussed in the literature review.

C. Selection Issues in WIC Evaluations

In the absence of a randomized experiment, a major concern in any program evaluation is whether the participants differ from nonparticipants in ways that are not observable by the researcher but that affect the outcomes. For instance, it may be that women who enroll in WIC are more motivated, more health conscious, and more concerned about good nutrition than women who are eligible for but do not enroll. If this is the case, WIC enrollees are likely to have better health outcomes or health-related behaviors than nonparticipants irrespective of the program. Conversely, if WIC is successful at reaching out to the population at the highest risk for adverse health outcomes, WIC participants may have poorer health outcomes than nonparticipants irrespective of the program. These unobserved factors that affect enrollment in WIC can lead to biased estimates of the effect of WIC (or selection bias).

Because of the ethical concerns involved with any randomized evaluation of a widely available program with potential health benefits, researchers must rely on nonexperimental methods to understand the gains from participation in the WIC program. Researchers have employed several statistical approaches in an attempt to reduce selection bias from estimates of WIC impacts. The most widely applied method is to limit the sample to WIC-eligible women or children and apply a multivariate regression analysis to control for differences between WIC participants and nonparticipants. Unbiased estimates through multivariate regression, however, can be achieved only if all relevant covariates are controlled for, thereby eliminating omitted variable bias.

Increasingly, researchers have used propensity score matching in an attempt to create more comparable treatment and comparison groups. Some suggest that the advantage of this method over multivariate regression analysis is that it produces treatment and comparison groups that are closer in terms of observed characteristics. It further eliminates the need for statistical adjustment once a balance in terms of covariates between the treatment and comparison groups is achieved. Estimates from multivariate regression models, on the other hand, are dependent on the correct specification of the relationship between the covariates and the outcome (the functional form). Another benefit of propensity score methods is that the specification of the propensity function, and therefore the selection of the treatment and comparison group, is independent of the outcome, and therefore the modeling is more objective. However, as is the case for multivariate regression analysis, propensity score methods are subject to omitted variable bias. A recent comparison of the two methods demonstrated the sensitivity of the propensity score methods to the richness of the covariates used to predict the propensity score, and identified no clear advantage of propensity score methods over multivariate regression analysis in terms of reducing bias (Shadish et al. 2008).

Numerous studies have tried using instrumental variables as a way of reducing selection bias, but attempts to find reliable and valid instruments for WIC participation have been largely unsuccessful. The challenge has been to find a variable that is a strong predictor of WIC enrollment but that affects health outcomes only through its impact on WIC participation. Researchers have used changes in federal policy, differences in state rules, and various measures of local access to WIC services as instruments to predict WIC participation. Generally, because of questions about the exogeneity of the employed instruments or as a result of low predictive power, attempts to reduce selection bias through this method have been largely ineffective.

A handful of studies controlled for unobservable differences between WIC participants and nonparticipants through the use of family (or mother) fixed-effects on samples of siblings whose mother was enrolled in WIC during pregnancy or postpartum for one of the siblings but not the other or, in the case of child-WIC participation, one sibling was enrolled in WIC while the other was not. This design improves on more traditional multiple regression methods by controlling for the influence of time-invariant unobservable family characteristics; however, it does not eliminate bias from unobserved factors that change between the two pregnancies. Those changes in family circumstances may be driving both the mother's decision to enroll in WIC and the differences in health outcomes between the siblings. Furthermore, studies using sibling fixed-effects models typically rely on survey data. Given the small number of discordant siblings that are eligible for this type of analysis, studies using a family fixed-effects model are limited by small sample sizes.

Given the inherent problem of selection bias in evaluations not based on a random experiment, and the limitations of nonexperimental statistical methods in terms of addressing such bias, nonrandom evaluations can provide only suggestive evidence of program impacts. Therefore, caution and objectivity in interpreting the findings from existing WIC evaluations are warranted.

D. Other Considerations

WIC has undergone considerable changes over time in terms of the socioeconomic characteristics of participants and the level of program penetration. For example, between 1980 and 2006, the proportion of pregnant women enrolled in WIC increased from 8.6 to 30 percent, and the proportion of infants enrolled increased from 14 to 51 percent (Besharov and Call 2009). This substantial increase in the WIC caseload has contributed to changes in the characteristics of WIC participants over time. These differences have likely influenced the impact of the program on participants' outcomes, and might also have altered the direction of selection bias based on unobserved characteristics in estimates of program impacts based on nonexperimental methods. Although this report focuses on studies published since 2002, many of the studies reviewed are based on data collected in the late 1980s or early 1990s. Readers should be cautious in comparing findings from studies that use data from different time periods.

The studies reviewed in this report also vary widely in terms of geographic coverage, which has important implications for interpretation of study findings. Some studies use nationally representative samples; but many are based on convenience samples and use data collected in selected hospitals, medical centers, cities, counties or states. For the evaluation of certain health outcomes, nationally representative data appropriate for studying the effect of WIC are simply not available. Studies based on convenience samples that cover a small geographic area still provide useful information about the effectiveness of WIC as implemented in the particular area. However, such findings are not likely to generalize to the WIC population as a whole. The characteristics of the populations included in convenience samples are not likely to represent the characteristics of the national WIC population. In addition, local WIC offices have considerable discretion in how they operate the nutrition education, breastfeeding promotion, and referral components of the WIC program. Both these issues are likely to influence the relationship between WIC participation and a particular outcome.

In interpreting the research findings reported in this review, readers should avoid merely counting the number of studies that fall on one side of a question, as this will not necessarily lead to valid conclusions. Rather, readers should consider the merits of each individual study, taking into account the advantages and disadvantages of the research design, the time period covered by the data, and the geographic coverage of the study sample.

II. IMPACTS ON PREGNANCY AND BIRTH OUTCOMES

The literature search uncovered 15 studies that evaluated the association between WIC participation and birth- and pregnancy-related outcomes. The most commonly evaluated birth outcomes in the identified studies are measures of birth weight (such as mean birth weight, the rate of low (< 2,500 g) or very low (< 1,500 g) birth weight), measures of gestational age (such as length of gestation in weeks or rate of preterm [< 37 weeks] delivery), and measures of fetal growth restriction (such as small-for-gestational-age or term low birth weight). Less common outcomes include the incidence of fetal death and whether the infant was placed in neonatal intensive care after delivery. Fourteen studies evaluated one or more of these birth outcomes. Three evaluated pregnancy-related mediating factors such as the mother's weight gain during pregnancy or modifiable risk behaviors, such as smoking during pregnancy. Table II.1 presents a summary of the data sources, measures of WIC participation, statistical methods used, and a summary of findings for all 15 studies.

A. Approaches to Dealing with Selection Bias

Studies examining the effect of prenatal WIC participation on pregnancy and birth outcomes employed several design and analysis strategies to address selection bias. Six studies used a multivariate regression analysis controlling for a detailed set of personal characteristics such as demographic characteristics of the mother, family socioeconomic factors, and health-related risks and behaviors (Bitler and Currie 2005; Joyce et al. 2005; Brodsky et al. 2009; Reichman et al. 2003; El-Bastawissi et al. 2007; Cox 2009). Many of these restricted their analysis to a subsample of women who were more homogeneous in terms of important observed characteristics, a strategy that may have reduced the differences between prenatal WIC participants and nonparticipants in terms of unobserved characteristics as well. Joyce et al. (2005), for example, argued that the timing of the first prenatal visit is likely correlated with the mother's motivation for a healthy pregnancy, and therefore limited their sample to women who initiated prenatal care in the first trimester. Another common strategy is to stratify the sample by maternal characteristics associated with adverse birth outcomes such as age or prepregnancy BMI, with the expectation that the effects of participation should be greater among those at the highest risk for adverse birth outcomes (Bitler and Currie 2005).

Four studies used propensity score methods to adjust for differences between WIC participants and the comparison group (Lazariu-Bauer et al. 2004; Rivera 2008; Gueorguieva et al. 2009; Foster et al. 2010). Lazariu-Bauer et al. (2004), for example, used a propensity score analysis to evaluate the effect of *early* enrollment in WIC using WIC participants who enrolled *late,* and therefore for a shorter period of time as the comparison group. The authors found that the unadjusted estimates were not statistically different from the estimates produced by the propensity score analyses. In a more recent evaluation, Gueorguieva et al. (2009) used both multiple regression analysis and a propensity function method with a rich set of covariates on mother's demographic characteristics, adverse medical history, prior pregnancy experience, high-risk behavior such as smoking, and income. The estimates from the two models were virtually identical, which suggests that the two methods performed equally well in terms of reducing bias from observed factors. Bias from unobserved factors in both sets of estimates may still be present.

Two studies employed a family (or mother) fixed-effects model on samples of siblings whose mother was enrolled in WIC during pregnancy for one of the siblings but not the other (Kowaleski-Jones and Duncan 2002; Foster et al. 2010). As noted earlier, this design improves on traditional multiple regression methods by controlling for the influence of time-invariant unobservable family characteristics; however, it does not eliminate bias from unobserved factors that change between the two pregnancies. For example, a pregnant woman with a prior adverse birth outcome (such as a low-birth-weight infant) may be more likely to engage in health behavior that would reduce her risk of a subsequent adverse birth outcome, one of which may be enrollment in WIC during a subsequent pregnancy. Furthermore, because of the complexity of linking sibling pairs in administrative records such as birth certificates, Medicaid files, and WIC records, studies using sibling fixed-effects models typically rely on survey data. Given the small number of discordant siblings that are eligible for this type of analysis, studies using a family fixed-effects model are limited by small sample sizes. The number of discordant sibling pairs was 71 and 245 in Kowaleski-Jones and Duncan (2002) and Foster et al. (2010), respectively.

Most recently, Figlio et al. (2009) employed an instrumental variable approach in an attempt to reduce selection bias. The authors used a change in a federal policy regulating the income documentation requirement that had the effect of increasing the burden of application for those who are not adjunctively eligible in Florida. The policy's differential impact on the two populations served as the instrument to predict WIC participation. However, the change in the policy is likely to lead to compositional changes in the WIC population, since the relative ease and burden of application for the different populations will affect the "type" of women who apply for WIC. This concern over the validity of the study's instrument suggests caution in interpreting the findings.

Some researchers have used a "dose-response" design that compares the outcomes of WIC participants with varying length of participation (Lazariu-Bauer et al. 2004; Joyce et al. 2008; Gueorguieva et al. 2009; Yunzal-Butler et al. 2010). The advantage of this design is that all members in the study sample were eligible for WIC and made the decision to enroll at some point during pregnancy. However, confounding from unobserved factors that are related to both the timing of enrollment and birth outcomes is likely present.

B. Other Methodological Considerations

Gestational age bias. Arguably the most important source of bias in the evaluation of prenatal WIC participation is gestational age bias. In brief, women whose pregnancies last longer are less likely to experience an adverse birth outcome, and the longer a pregnancy goes, the greater the opportunity for a woman to enroll in WIC. Put differently, women who enroll in WIC late in pregnancy are more likely to have positive birth outcomes simply because of longer gestation, not because of WIC. For example, a large proportion of infants delivered prematurely (before the 37th week of pregnancy) have low birth weight. As a result, women who enroll in WIC in their third trimester tend to have better birth outcomes simply because their pregnancy lasted longer, not because they participated in WIC.

This source of bias is best illustrated in Joyce et al. (2008), who presented a simple plot of the rate of low-birth-weight and preterm delivery by the week of pregnancy women enrolled in WIC, using data from the Pregnancy Nutrition Surveillance System (PNSS). As demonstrated by the authors, the rate of low birth weight varied little by week of enrollment in WIC between the 5th and the 23rd week of pregnancy, and began to decline continuously in the later months. The presence of this bias is likely to create a positive correlation between WIC participation and gestational age and birth weight, irrespective of the effectiveness of WIC. Failure to adjust for this anomaly will produce estimates that likely overstate the true impact of WIC.

Existing studies have attempted to correct for gestational age bias in several ways. One approach is to include length of gestation as a covariate in models of birth weight. Another is to evaluate the effect of WIC on fetal growth. A common measure of fetal growth restriction applied in this literature is the incidence of small-for-gestational-age infants, generally defined as the proportion of infants with a birth weight below the 10th percentile for a given gestational age. Alternatively, researchers have stratified their sample based on length of gestation and evaluated the association between WIC and measures of birth weight within each stratum. Common categorizations of gestational length are full term (≥37 weeks), preterm (<37 weeks), moderately preterm (34-36 weeks), and extremely preterm (<34 weeks) births.

The inclusion of gestational age as a covariate in models of birth weight greatly diminishes the magnitude of the impact estimates and in some cases reduces or even eliminates the statistical significance of the findings. Furthermore, the association between WIC participation and fetal growth is generally weaker than its association with birth weight unadjusted for gestational age and length of gestation (Joyce et al. 2005; Gueorguieva et al. 2009; Joyce et al. 2008). Some interpreted this finding to mean that WIC was associated with prolonged gestation as well as increased birth weight, and hence by controlling for gestational age in models of birth outcomes, we underestimate the effect of WIC (Bitler and Currie 2005). Others argued that the threat of bias in the estimates of WIC's effectiveness from the spurious correlation between gestational age and WIC enrollment is a larger concern, and therefore stressed the importance of eliminating this source of bias from impact estimates (Joyce et al. 2005; Joyce et al. 2008). Citing the evidence from clinical trials that provide little support to the claim that nutritional supplementation can reduce the incidence of preterm delivery, some researchers stressed the importance of focusing on measures of fetal growth rather than improvements in birth weight that result from a reduction in preterm deliveries.

Mediating factors. Increasingly, researchers are putting more emphasis on evaluating the possible mechanisms through which WIC affects birth outcomes. As noted previously, nutritional supplementation is the main service provided under the WIC program; however, services such as nutritional education and referral to health and social services, including referral to substance abuse counseling and treatment, may all be important factors that contribute to improvements in birth outcomes. Establishing a link between WIC participation and intermediate outcomes such as appropriate weight gain and the prevalence of smoking during pregnancy, both of which are important predictors of birth weight, could provide support for a causal relationship.

Two studies in this review looked at the relationship between prenatal WIC participation and weight gain during pregnancy (Bitler and Currie 2005; Joyce et al. 2008). Both used average weight gain in pounds as the outcome measure. One potential concern with this measure, however, is that the Institute of Medicine pregnancy weight gain guidelines recommend a higher weight gain for women who are underweight prior to pregnancy and a lower gain for obese women, a difference that is not captured by looking only at the average gain in weight. Only one of the studies evaluated this outcome among women who were underweight prior to pregnancy (Joyce et al. 2008). For this subgroup, a higher increase associated with WIC can be interpreted as a positive outcome. Three studies evaluated the effect of WIC on smoking either during or after pregnancy (Joyce et al. 2008; Yunzal-Butler et al. 2010; Brodsky et al. 2009). The challenge of using smoking as an outcome is that it is generally not well reported in vital statistics data, which are the primary source for WIC evaluations and often do not contain enough detail to evaluate the timing of WIC enrollment and smoking behavior.

Some researchers consider prenatal care an important mediating factor, recognizing that WIC encourages care and potentially provides a link to such care; they argue that including prenatal care as a covariate will understate the true impact of WIC. Others argue that prenatal care and WIC are chosen simultaneously, and therefore prenatal care is a potential confounding factor (for example, if women who seek prenatal care early also enroll in WIC early, we cannot separate the influences of the two.) A few studies in this review evaluated WIC's effect on the timing of first prenatal visit or the adequacy of prenatal care, but given the issues of simultaneity and the difficulty of determining the timing of care relative to the timing of WIC enrollment in the available data sources, we do not discuss the findings on the association between WIC and prenatal care.

Lack of focus on magnitude of impacts. One major limitation of the literature on the impact of prenatal WIC participation is the focus on statistically significant findings, without consideration for whether the magnitude of the impacts is clinically meaningful or plausible (Yunzal-Butler et al. 2010). Most of the recent WIC evaluations are based on administrative data from birth and WIC records from individual or multiple states. The large sample sizes and the multiple hypothesis testing across different outcomes or subgroups are likely to produce statistically significant findings. Therefore, the interpretation of the findings in the context of the clinical literature is important.

C. Summary of Key Findings

As was the case in the earlier generation of WIC evaluations, recent studies of the effect of prenatal WIC participation have consistently found a positive association with gestational age and mean birth weight and a negative one with the incidence of low and very low birth weight when the estimates are not adjusted for gestational age bias. These findings are typically consistent across studies regardless of study methods and data source. Estimates for mean birth weight unadjusted for gestational age are typically moderate. Estimates for the incidence of low and very low birth weight unadjusted for gestational age generally suggest substantial improvements associated with WIC. For example, Bitler and Currie (2005) found a nearly 30 percent reduction in the rate of low birth weight and a 54 percent reduction in the rate of very low birth weight. Given that the majority of low-birth-weight infants are born premature, the estimates for measures of gestational age, such as the incidence of preterm delivery, are generally in line with the estimates of the rate of low and very low birth weight. In contrast, the evidence on the association between prenatal WIC participation and measures of fetal growth is less consistent. Generally, the magnitude of the impacts is substantially smaller than the estimates for unadjusted measures of birth weight. A few studies found a weak or no association (Joyce et al. 2005; Foster et al. 2010; Rivera 2008), and a few found sizable effects (Bitler and Currie 2005; Figlio 2009).

Outcomes related to birth weight and gestational age have largely been the focus of prenatal WIC evaluations. Relatively few studies examined other pregnancy-related outcomes. The evidence on the association between prenatal WIC participation and mediating factors such as weight gain during pregnancy and smoking is therefore limited. Two studies suggested that WIC may reduce the likelihood of smoking during pregnancy (Brodsky et al. 2009; Yunzal et al. 2010). However, as Yunzal et al. (2010) noted, there is some evidence to suggest that women who enroll in WIC are also more likely to quit smoking prior to enrollment. Therefore, the association between smoking cessation and WIC may be spurious and should be interpreted with caution. The findings from Brodsky et al. (2009) are mixed, with no clear evidence of a positive WIC effect. Recent research has provided no clear evidence of an association between WIC and adequate weight gain during pregnancy. Findings from the only study that evaluated the average weight gain among underweight women found mixed results: a positive association with first-trimester enrollment in WIC and a negative association with third-trimester enrollment.

D. Research Results

Birth outcomes

Using data on discordant sibling pairs from the National Longitudinal Survey of Youth (NLSY), Kowaleski-Jones and Duncan (2002) were the first to apply a mother fixed-effects model to estimate the impact of prenatal WIC participation on birth weight. The authors advanced the literature by introducing the potential utility of using maternal fixed-effects. As discussed above, this model eliminates selection bias from time-invariant characteristics of the mother but not from time-variant unobserved characteristics that can affect both enrollment in WIC and birth outcomes. To reduce this source of bias, the authors included maternal smoking and drinking during each pregnancy, prenatal Food Stamp participation, and family income in the year prior to each birth as additional controls in the model.

Findings from the fixed-effects model suggest a marginally significant ($p<0.1$) positive impact on (logged) birth weight. The magnitude of the impact is large compared to previous estimates: an increase of 185 g in birth weight associated with prenatal WIC participation; the authors' inability to control for gestational age bias is likely a contributing factor. As the authors note, mothers' report of gestational age in the NLSY is unreliable and therefore of little value for addressing this source of bias. As discussed earlier, the small sample of discordant sibling pairs in national surveys that can be used for WIC evaluations significantly limits the sample size available for analysis. This is true for the sample employed in Kowaleski-Jones and Duncan (2002), who relied on a sample of 71 discordant siblings for the estimation of the fixed-effects model, which raises questions about the generalizability of the findings.

The authors also evaluated the association between WIC and birth weight by applying ordinary least squares (OLS) to the full NLSY sample. This analysis produced unexpected results. The mean family income of WIC participants in the sample was about $20,000 but was over $50,000 in the full sample, which indicates a large disparity between WIC participants and nonparticipants in the full sample. Yet in regressions adjusted only for the child's race and order of birth, prenatal WIC participation was positively associated with mean birth weight, a striking result given clearly adverse selection into WIC in their full sample.

Reichman and Teitler (2003) used data collected from women enrolled in New Jersey's HealthStart program between 1988 and 1996 to evaluate the effect of a wide range of prenatal care services, including WIC, on birth weight and the likelihood of low birth weight. The authors employed multivariate regression analysis to control for a rich set of behavioral and psychosocial risk factors. They found a positive association between WIC participation and birth weight and a negative association between WIC and the odds of low birth weight. The sample consisted of relatively high-risk women: 81 percent of the sample participated in WIC prenatally. Secondary analysis on the 21 percent of the sample who were identified as having inadequate nutrition and were therefore referred to nutritional education services as well as WIC produced similar results, with a somewhat higher impact on mean birth weight. After addressing gestational age bias by repeating the analysis on a subsample of women who initiated care in the first or second trimester, the authors concluded that their estimates remained unchanged. This strategy is effective in reducing gestational age bias only if the timing of the first prenatal visit and enrollment in WIC are closely related. If a substantial number of women who enrolled in WIC late in the pregnancy initiated care in the first or second trimester, this strategy will not eliminate gestational age bias.

Two issues need to be considered when interpreting the study findings. First, the sample used in this study consisted of pregnant women who enrolled in New Jersey's HealthStart program, the goal of which is to provide comprehensive prenatal care services with an individualized plan based on assessment of medical, nutritional, and psychosocial risks. Therefore, participation in other services, such as nutrition-related education, substance abuse treatment, smoking cessation, and home visitation, was also very high in the sample (for example, 98 percent participated in basic nutrition-related education services). While the authors control for all the complementary services the pregnant women received, the high rates of participation in related services raise issues of multicollinearity and about the interpretation of the WIC coefficient. In other words, the coefficient on WIC may reflect only the WIC services that are not also covered by the other programs, which seems to be food supplementation. Second, the coefficients on some of the services, such as substance abuse treatment and professional home visitation, indicate that those treatments are associated with an increase in the rate of low birth weight, even when controlling for psychosocial and behavioral risk factors such as smoking and drug and alcohol use during pregnancy. As the authors pointed out, it is unlikely that these services were the *cause* of the adverse birth outcome. Rather, the association between these services and birth weight reflects the bias from selection on unobserved factors.

Lazariu-Bauer et al. (2004) used data from New York State vital statistics and WIC administrative records to study the link between the length of prenatal WIC participation and fetal growth. One of the strengths of this study is the unique data that enabled the authors to construct a measure of WIC participation based on the timing of WIC enrollment and the length of participation as determined from the WIC check redemption files. In addition, they used propensity score matching to create a sample of *early* and *late* WIC enrollees who were similar in terms of observed characteristics available from birth certificate data and WIC records. The study found a positive link between length of WIC participation and birth weight among both full-term and preterm infants. The impacts are greater for blacks and Hispanics compared to whites, and greater for women with inadequate prenatal care compared to women with intermediate or adequate care (based on Kotelchuck's Adequacy of Prenatal Care Utilization index).

The estimates based on the propensity score analysis were similar to the unadjusted differences in the birth weight between *early* and *late* enrollees. The authors suggested that this could be an indication that selection bias is not an issue if researchers compare outcomes between early and late WIC enrollees with similar gestational length. An alternative interpretation would be that the observable characteristics are not capturing the unobserved differences between the two groups of women—factors that motivate some women to enroll early during pregnancy while leaving others to delay enrollment until later, and that are likely correlated with birth outcomes.

Bitler and Currie (2005) used data from the Pregnancy Risk Assessment Monitoring System (PRAMS) from 1992 to 1999 to evaluate the relationship between prenatal WIC participation and a range of birth and pregnancy outcomes. Using data on a sample of women whose delivery was paid for by Medicaid, the authors employed a multiple regression analysis using detailed person-level covariates as well as dichotomous indicators of all state-year combinations to control for state characteristics and policies that may have affected birth outcomes. The authors demonstrated that among the income-eligible women (as determined by Medicaid participation), WIC participants were negatively selected based on a number of observable characteristics such as race, education, age, and obesity. Still, the authors found that WIC participation is associated with (1) substantial and statistically significant improvements in birth weight and gestational age (including measures of low and very low birth weight and rate of premature and very premature delivery), (2) a reduction in the number of days the infant or mother spent in the hospital, and (3) a reduction in the likelihood that an infant was held in an intensive care unit after birth. These findings hold true for the full sample of women as well as for the three subgroups evaluated by the authors: (1) women who received aid in the previous year, (2) single women over age 18 who are high school dropouts, and (3) teens.

The significance of this study is the more detailed data on maternal characteristics and outcomes in PRAMS than had been available from the linkage of birth certificates and administrative data prior to this study. However, the estimates do not take into account gestational age bias and therefore likely overstate the true impact of WIC. In addition, secondary analysis by the authors revealed little support for the argument that estimated WIC effects should be larger for women who are seemingly less negatively selected. Among the three subgroups evaluated by the authors, single high school dropouts over age 18 seem to be the least negatively selected based on observed characteristics. Among this group, African American women and heavy smokers were less likely to enroll in WIC. Having the father's information on the birth certificate was positively associated with WIC enrollment. On the other hand, obese women were more likely to enroll (compared to those who were not obese). Secondary analysis by the authors revealed no differential WIC effect for five of the six measures of birth weight and gestational age for this subgroup (single high school dropouts over 18). The effect of WIC on one of the measures (the likelihood of low birth weight), is greater for this subgroup, though this finding is only marginally significant ($p<0.1$).

Bitler and Currie (2005) evaluated WIC's effectiveness on two measures of fetal growth that are free of gestational age bias: (1) having a birth weight below the 10th percentile for a given gestational age, and (2) having a birth weight below the 25th percentile for a given gestational age. Their findings for both measures are statistically significant, although the magnitude of the impacts is substantially smaller compared to the estimates for the likelihood of low and very low birth weight. Secondary analysis provided no evidence of a differential impact for the three subgroups of women. The estimate for one of the measures of fetal growth (weight-for-gestation < 10th percentile) suggests that WIC had less of an effect among single dropouts; however, this finding is only marginally significant.

Joyce et al. (2005) used data from New York City birth certificates to estimate the changing association between WIC and measures of birth weight and fetal growth over a 14-year span (1988-2001) during which prenatal WIC participation grew dramatically as a response to the Medicaid eligibility expansions. The authors limited their sample to women whose delivery was paid for by Medicaid and applied multiple regression analysis controlling for all relevant covariates available on the birth certificates. To further address the issue of selection bias, the authors performed separate analyses on subgroups of women who were more homogeneous in terms of their observed characteristics, such as those who initiated prenatal care early (in the first trimester) and who had had no previous live births. The authors' motivation for the subgroup analyses was the assumption that women who are similar in their observed health-related behaviors (such as initiation of prenatal care) are also similar in terms of unobserved characteristics that affect the birth outcomes of their infants. Furthermore, limiting the sample to first births reduces the bias from prior experiences with WIC or history of adverse birth outcomes. A disadvantage of limiting the sample to women who initiate prenatal care early is that it excludes from the sample the subset of WIC population who initiate care late and who are arguably at higher risk of adverse birth outcomes and have the most to gain from participating in WIC. Therefore, the findings based on a sample limited to women with early prenatal care may not generalize to the broader WIC population.

Based on the analysis of women with singleton births, the estimates for birth outcomes unadjusted for gestational age (mean birth weight, rate of low and very low birth weight, gestational age, and rate of preterm delivery) suggest that WIC is associated with statistically significant, but small, improvements in all outcomes between 1988 and 1992. The effects dissipate over time, though some remain statistically significant. Citing the lack of clinical evidence to support the relationship between the services provided through WIC and length of gestation, and the presence of gestational age bias in the above estimates, the authors took a conservative approach and cautioned against attributing these findings to WIC. Instead, they focused attention on measures of fetal growth, such as birth weight adjusted for gestation, the likelihood of small-for-gestational-age infant, and the rate of term low birth weight. The findings for all three measures provide little evidence of WIC's effectiveness among singleton births. There is some suggestive evidence that WIC improves fetal growth among twin deliveries, which have a higher risk of adverse birth outcomes. The improvements are limited to infants of African American women born in the United States. An important caveat to these modest effects is that the indicator for WIC participation is self-reported, with no information on the length or intensity of enrollment. Nondifferential misclassification bias would attenuate an association.

Similar to the findings in Bitler and Currie (2005), among the full sample of Medicaid-financed births in Joyce et al. (2005) there was seemingly negative selection into WIC on observable characteristics. Racial and ethnic minorities, women with low levels of education, teens, and unmarried women were more likely to participate in WIC and were also more likely to have adverse birth outcomes. The lack of protective WIC effect could be attributed to the negative selection of women into WIC. However, the observed negative selection remained stable throughout the study period, yet the estimated effects of WIC participation on birth outcomes diminished over time. A plot of unadjusted rate of low birth weight over time reveals that while both WIC participants and eligible nonparticipants experienced an improvement in this outcome between 1988 and 2001, the rate of low birth weight decreased faster among nonparticipants. Thus, the seemingly diminishing impact of WIC from the regression models is due to the relatively greater improvement in birth outcomes among nonparticipants. Given the relatively stable observed characteristics of WIC and non-WIC participants over time, and the changing association between WIC and birth outcomes, it is likely that the relationship between observed and unobserved characteristics is more complex than Bitler and Currie (2005) suggest. Changes in the composition of both groups in terms of unobserved characteristics may be responsible for the changing association between WIC and birth outcomes over time.[3]

Analyzing data on Florida births linked with WIC and public school records, Figlio et al. (2009) employed an instrumental variable approach to study the effect of prenatal WIC participation on birth weight and rate of low birth weight. They exploited a 1999 change in the income-reporting requirements that affected applicants not adjunctively eligible for WIC. The authors used information on the older sibling's participation in the National School Lunch Program (NSLP) in

[3] For a discussion of the conflicting findings in Joyce et al. (2005) and Bitler and Currie (2005), see Ludwig and Miller (2005).

the year before, during, and after the mother was pregnant with the index child to classify women as marginally eligible or ineligible for WIC. Specifically, women whose school-aged children received free or reduced-price lunches through the NSLP in the year the mothers were pregnant but not in the adjacent years were characterized as marginally eligible. Mothers whose school-age children received free or reduced-price lunches in either the year before or after (or both before and after) their pregnancy but not during, were characterized as marginally ineligible for WIC. The instrument employed by the authors is the interaction of the policy change and the eligibility indicator.

The OLS estimates employed by the authors found no association between WIC and birth weight conditional on gestational age but found a small positive association with gestational age in weeks. The estimates changed dramatically when the authors used the instrumental variable approach. The findings from this model suggest a statistically significant 12.9 percent reduction in the incidence of low birth weight conditional on gestational age, which represents a 120 percent decline given the mean of 10.7 percent among the marginally eligible. Findings from the instrumental variable model found no association with average birth weight, gestational age in weeks, or rate of preterm delivery.

The study demonstrated the challenges of applying instrumental variables to prenatal WIC participation, a finding consistent with previous literature. It is not clear how accurately the year-to-year status of an older sibling's participation in NSLP captures income eligibility for WIC. Furthermore, the authors limited their sample to newborns with school-aged siblings with matched school records who had a specific pattern of participation in the NSLP around the time of the mother's pregnancy with the index child. Their analysis sample was thus restricted to less than 1 percent of the total births in Florida, which limits the generalizability of even robust findings.

Foster et al. (2010) analyzed data from the Panel Study of Income Dynamics Child Development Supplement to study the relationship between prenatal WIC participation and birth weight, gestational age, and fetal growth. The authors used two methods in an attempt to address the issue of selection into WIC: propensity score matching and mother fixed-effects. The estimates based on the propensity-score-matched sample suggest no significant impacts on any of the outcomes based on the full sample or the sample restricted to Medicaid participants. In an attempt to reduce recall bias for reported WIC participation during pregnancy, the authors also analyzed a subsample of matched children younger than 7. For this subsample, the estimates suggested a 7-percentage-point *increase* in the probability of a small-for-gestational-age infant associated with WIC.

Estimates based on the fixed-effect model suggest a positive association between WIC and birth weight and a negative association between WIC and the incidence of low birth weight and preterm delivery. None of these estimates are adjusted for gestational age bias. The association between small-for-gestational-age infants and WIC is negative based on the fixed-effects model, but not statistically significant. Foster et al. (2010) estimated their fixed-effects model using OLS regression on a sample of 1,742 matched sibling pairs; however, only 245 sibling pairs in their sample varied in terms of mother's prenatal WIC participation. It is not clear how the inclusion of the nondiscordant sibling pairs affects the sign, magnitude, and precision of the estimated coefficients.

In another study based on data from Florida, Gueorguieva et al. (2009) evaluated the dose-response relationship between prenatal WIC participation and fetal growth, using the incidence of small-for-gestational-age infants as the outcome measure. Using data from birth certificates linked with Medicaid eligibility files and WIC administrative records, the authors restricted their sample to singleton births between 1996 and 2004 to women whose prenatal care or delivery was paid for by Medicaid and who participated in WIC prenatally. Unlike in most WIC evaluations that used a dichotomous measure of WIC participation, Gueorguieva and colleagues evaluated the effect of the relative length of WIC participation, which they defined as the percentage of pregnancy enrolled in WIC. They estimated propensity scores for WIC participation using a rich set of demographic characteristics and health risk factors as covariates and divided the sample into five approximately equal-sized groups based on the range of propensity scores. They estimated program impacts within each group and for the overall sample using the weighted average of the estimates based on the five strata. The study found that longer WIC participation is associated with a reduction in the risk of small-for-gestational-age infants among full-term, preterm, and very preterm births, but not among extremely preterm (23-28 weeks) deliveries. While the findings are statistically significant, the reduction in the incidence of fetal growth restriction is modest. Results from multiple regression analyses produced estimates very similar to those based on the propensity function method.

Joyce et al. (2008) also evaluated the dose-response effect of prenatal WIC participation; however, unlike Gueorguieva et al. (2009), they used as the comparison women who enrolled in WIC for the first time postpartum. Using data from the PNSS from nine states, the authors evaluated the differential impact of WIC among women who enrolled during their first, second, or third trimester. The authors attempted to address selection into WIC by employing a multiple regression analysis and by evaluating program impacts among three groups of women who were at high risk for adverse birth outcomes and had a potentially greater need for WIC services. These included women who were underweight prior to pregnancy, women who smoked prior to pregnancy, and women with multiple gestations. The goal was to lessen heterogeneity among WIC participants and to focus on groups for whom nutritional supplementation is likely to be most helpful.

Results based on the full sample revealed that prenatal participants had better birth outcomes than postpartum participants, regardless of when in the pregnancy they enrolled in WIC. However, for all outcomes (mean birth weight, rate of low and very low birth weight, and rate of preterm delivery) the effects are larger among third-trimester enrollees than among women who enrolled in the first trimester. The authors attributed such counterintuitive findings to gestational age bias, as none of their estimates were adjusted for gestational age. As noted previously, the authors demonstrated this source of bias in a simple plot of the rate of low birth weight and preterm delivery by the week of pregnancy in which women enrolled in WIC. The authors therefore focused the attention on measures of fetal growth, such as birth weight adjusted for gestational age, the incidence of small-for-gestational-age infant, and the incidence of term low birth weight infant. The findings suggest statistically significant but modest improvements associated with prenatal WIC participation in all measures. Furthermore, the improvements were greater among women who enrolled in WIC in their first trimester than among those who enrolled in their second trimester. The findings for the subgroups of high-risk women were very similar to the findings among the full sample. In addition to birth outcomes, Joyce et al. 2008 evaluated whether early enrollment in WIC is associated with smoking cessation (as assessed during a postpartum interview) among women who reported smoking three months before pregnancy. They found no meaningful association.

Hoynes et al. (2009) used data on birth weight aggregated on the county level and employed a difference-in-differences analysis that exploited the variation in the timing of the opening of WIC offices across the counties in the United States between 1972 and 1979. The idea was to exploit the "rollout" of WIC as an exogenous source of variation in exposure. To the extent that WIC was randomly assigned to counties in the early 1970s, the "reduced-form" regression of county-level birth outcomes on the presence of a WIC program provides an unbiased estimate of exposure to WIC. The authors found that the introduction of WIC is associated with an increase in mean birth weight of approximately 2 grams. They then inflated the 2 grams by a 1980 estimate of county-level participation in WIC of about 8 percent. Thus, they estimated that the increase in mean birth weight associated with WIC was around 29 grams (2.3 grams/0.08).

An important contribution of Hoynes et al. (2009) is the use of the introduction of WIC as a plausibly exogenous change in availability. This relatively "clean" identification strategy has been difficult to achieve in WIC evaluations. However, there are two difficulties with this approach. First, if on average only 10 percent of women in a county participate in WIC, the reduced-form estimates will be small, and researchers must assert that they have isolated the county-level change in birth outcomes attributable to the introduction of WIC from spurious changes in birth outcomes of the other 90 percent of women who are unaffected by the introduction of WIC. Second, the authors' estimate of county-level WIC participation came from a 1980 survey that is about 10 years after introduction of WIC and is not obtained from an exogenous change in WIC availability. Ideally, an estimate of the effect of treatment on the treated would have come from the ratio of two reduced-form regressions: (1) birth outcomes on the availability of WIC, and (2) WIC participation on the availability of WIC. However, the authors could not estimate the latter because they lacked data on WIC participation at the county level during the rollout period.

El-Bastawissi et al. (2007) used vital statistics data on births and fetal deaths from Washington State linked to WIC administrative data and evaluated the association between WIC prenatal participation and fetal death as well as measures of preterm delivery and birth weight. Their analysis began with a fully specified model that included a measure of WIC participation interacted with a large number of covariates such as race, age, education, marital status, history of prior births and abortions, prenatal care adequacy, and obstetric risk factors. The authors evaluated the significance of each interaction term using the likelihood ratio test and only retained the ones that produced a p-value less than 0.05. The final models for each outcome therefore contained a different set of interaction terms. For example, in the case of two measures of preterm delivery and a measure of normal preterm birth weight, the authors provided estimates of WIC's impact on eight subgroups defined based on history of abortion and adequacy of prenatal care ranging from "no abortion, adequate care" to "abortion, inadequate care." Most of the point estimates suggest implausibly large effects (for example, 80 percent reduction in fetal deaths among women with less than high school education and 70 percent reduction among women with some college education).

Cox (2009) used data from PRAMS in eight states from 1996 to 2003 to associate the adequacy of prenatal care, the site of prenatal care, and infant outcomes for prenatal WIC participants and women who were eligible for WIC but did not participate. The motivation was to address the comment by Bitler and Currie (2005) that WIC is more than nutritional supplementation because it offers participants advice on health and nutrition and may increase the utilization of prenatal care. The author created an index of optimal prenatal medical care by combining measures of prenatal care utilization, health promotion advice received, and enrollment in WIC. Women were categorized as receiving optimal care during pregnancy if their prenatal care was at least adequate as measured by Kotelchuck's Adequacy of Prenatal Care Utilization index; if they reported that they had received advice on 8 of 10 behaviors such as smoking, drinking, breastfeeding, seat belt use, and HIV testing; and they were enrolled in WIC some time during pregnancy. With this index, Cox created four categories of care: (1) optimal (adequate care and adequate advice); (2) underutilized (inadequate care, adequate advice); (3) underinformed (adequate care, inadequate advice); and (4) deficient (inadequate care and advice). She then compared each category of care for WIC and non-

WIC women. In general, women not on WIC had higher odds of adverse birth outcomes (low birth weight and preterm birth) than women on WIC. Among women on WIC, those with deficient care had no greater risk of low or very low birth weight than women with optimal care. Thus, the most important differences in birth outcomes occurred between WIC and non-WIC women, and Cox's findings are essentially similar to those of Bitler and Currie (2005), which is not surprising given that they both used PRAMS with substantial overlap in states and years.

Cox advanced the literature by trying to distinguish the effects of prenatal care and health advice from those of nutritional supplementation. However, the author's data are too crude to identify causal pathways. PRAMS does not contain information about the timing of WIC enrollment, and therefore it cannot be determined whether women initiate prenatal care and then enroll in WIC or whether enrollment in WIC induces women to obtain more prenatal care. Furthermore, the index of advice employed in the study did not distinguish between types of advice. The advice regarding breastfeeding and seat belt use, for instance, would not be expected to affect birth outcomes, whereas advice about smoking or nutritional supplementation could have an impact. A finer classification of the type of advice would have been more useful.

Rivera (2008) evaluated the association between prenatal WIC participation and birth outcomes using data from the Early Childhood Longitudinal Study Birth Cohort (ECLS-B). To minimize observed differences between WIC participants and the comparison group, Rivera employed propensity score matching and limited the analysis to a subsample of children with propensity scores in the top two quartiles. For children with scores in the bottom two quartiles, the matching procedure did not achieve a balance in the covariates between WIC participants and nonparticipants. Findings based on the sample of 1,919 children in the top quartile (with a propensity score $\geq$0.8275) parallel the findings reported for most studies reviewed in this report: an increase in mean birth weight and a reduction in the rate of very low birth weight unadjusted for length of gestation, and no significant association between WIC and measures of fetal growth (small-for-gestational age).

Other Pregnancy Related Outcomes

Yunzal-Butler et al. (2010) used data from the PNSS from eight states to evaluate the association between maternal smoking behavior and the timing of WIC enrollment. A major advantage of the PNSS data is the detailed information on smoking before, during, and after pregnancy combined with administrative data on the timing of WIC enrollment. Studies that have linked birth certificates to administrative data have lacked such detailed information on smoking. Nevertheless, the screen for smoking in the PNSS is based on maternal self-reports. Thus, the authors presented evidence that the quality of the screen for smoking compares favorably to estimates from more controlled studies. Specifically, they showed that prenatal smoking is associated with a decrease in birth weight of between 100 and 240 grams, depending on the intensity of exposure to tobacco. These estimates conform to findings from clinical studies.

Using multiple regression analysis, the authors found that among women who smoked at the time of WIC enrollment, those who enrolled in WIC in the first trimester were more likely to quit smoking three months before delivery or postpartum than women who enrolled in the third trimester. However, among whites, first-trimester enrollees who quit smoking prior to delivery were also more likely to relapse postpartum. Although the findings are statistically significant, the increases in the quit and relapse rates are modest (between 2 and 5 percentage points).

The authors acknowledged that they lacked a credible instrument with which to address such unobserved selection bias. However, they attempted to flag estimates that may have been compromised by self-selection. Specifically, they noted that 30 to 40 percent of women who smoke before pregnancy quit when they realize that they are pregnant. Such spontaneous quitting should be unrelated to WIC, since the quitting precedes exposure to WIC. As a falsification test, the authors evaluated the association between WIC and spontaneous quitting using the same methodology as employed in the analysis of quit rate three months prior to delivery or postpartum. The findings suggest a positive association between WIC and spontaneous quitting among non-Hispanic black women. As the authors noted, this positive association suggests that their earlier findings between the timing of WIC enrollment and smoking cessation might have been spurious, at least for this group of women.

Brodsky et al. (2009) also evaluated the association between timing of WIC enrollment and patterns of maternal smoking, using administrative WIC records from Rhode Island on prenatal WIC participants who smoked during pregnancy. They estimated the adjusted odds of decreasing smoking between the prepregnancy period and the final WIC visit, and the adjusted odds of increasing smoking between the same periods. The authors evaluated WIC's impact among women who enrolled in WIC during the first trimester of pregnancy, using women enrolling in the second and third trimesters as a comparison. The findings for the odds of increased maternal smoking adjusted for timing of prenatal care, race, poverty status of city of residence, and primary language suggest that early WIC enrollment is associated with a reduction in the likelihood of increased maternal smoking. Their findings for the odds of decreased smoking are less straightforward. Their estimates suggest that among women who initiated prenatal care early, first-trimester WIC enrollees are more likely to decrease smoking than second- and third-trimester enrollees. Among women who initiated care late, the estimates suggest the opposite conclusion: a reduced likelihood of decreasing smoking among first-trimester WIC enrollees. Although this latter finding is not statistically significant, the magnitude is large (OR=0.46). The authors dismissed this finding as unreliable because of a small sample size.

The authors' estimates also suggest that early initiation of prenatal care significantly increases the odds that a woman increases the level of smoking during pregnancy. While the authors' methods could not rule out that the results for both WIC participation and prenatal care are driven by selection bias, this counterintuitive finding further diminishes the support for a causal interpretation of the WIC estimates. It also raises the issue of multicollinearity between WIC participation and prenatal care, and its possible impact on the estimates.

Bitler and Currie (2005) and Joyce et al. (2008) evaluated the association between WIC and weight gain during pregnancy. Both studies used a measure of average weight gain in pounds. As discussed previously, given that a significant proportion of WIC participants are obese, this measure may not appropriately capture the adequacy of weight gain for this population. Joyce and colleagues, however, provided separate estimates for women who were underweight prior to pregnancy. For this subgroup, a higher weight gain is likely beneficial. This review focused on the estimates adjusted for gestational age, as women with longer gestation are expected to gain more weight. The findings vary by the timing of enrollment in WIC and suggest that first-trimester enrollees gained about a half pound more and third-trimester enrollees about a half pound less than postpartum enrollees.

Table II.1. Studies Examining the Effect of Prenatal WIC Participation on Pregnancy and Birth Outcomes

Study	Data and Sample	Design and Methods	Findings	
Bitler and Currie 2005	**Data:** Pregnancy Risk Assessment Monitoring System (PRAMS) 1992-1999 **Sample:** Medicaid births in 19 states (N=60,731)	**Treatment group:** Enrolled anytime during pregnancy **Comparison group:** Did not enroll during pregnancy **Methods:** Multivariate regression	Pregnancy weight gain Gestational age Birth weight Nights spent in hospital by women at delivery Nights spent in hospital by women pre-delivery Nights spent in hospital by infant Rate of preterm delivery Rate of very preterm delivery (<32 weeks) Rate of low birth weight Rate of very low birth weight Weight for gestation <10th percentile Weight-for-gestation <25th percentile Infant in ICU	+++ +++ +++ --- NS --- --- --- --- --- --- --- ---
Brodsky et al. 2009	**Data:** Rhode Island WIC records from 2001-2005 **Sample:** Women enrolled in WIC during pregnancy who reported smoking during pregnancy (N=4,497)	**Treatment group:** Enrolled during the first trimester of pregnancy **Comparison group:** Enrolled during the second or third trimester of pregnancy **Methods:** Multivariate regression	Increased smoking during pregnancy Decreased smoking during pregnancy – among women with early prenatal care Decreased smoking during pregnancy – among women with late prenatal care	-- ++ NS
Cox 2009	**Data:** Pregnancy Risk Assessment and Monitoring System (PRAMS) survey data from 8 states (1996-2003), merged with birth certificate data **Sample:** New mothers ≤200% of FPL who received prenatal care (N=45,227)	**Treatment group:** Enrolled anytime during pregnancy, and received an adequate number of prenatal care visits and adequate health promotion advice **Comparison group:** Did not enroll during pregnancy, and received an adequate number of prenatal care visits and adequate health promotion advice **Method:** Multivariate regression	Very low birth weight (<1,500 grams): Low birth weight (<2,500 grams): Preterm birth (<37 weeks):	-- -- --
El-Bastawissi et al. 2007	**Data:** Washington State WIC records matched with birth/fetal death certificates **Sample:** 1999-2001, births to mothers receiving Medicaid, AFDC, or First Steps services (N=39,608)	**Treatment group:** Enrolled anytime during pregnancy **Comparison group:** Did not enroll during pregnancy **Methods:** Multivariate regression	Rate of fetal death – among women with <15 years of education Rate of preterm delivery – among women with a history of abortion and women with no history of abortion who had less than adequate prenatal care Rate of moderate preterm delivery (34-36 weeks) – among women with a history of abortion and women with no history of abortion who had inadequate prenatal care Rate of very preterm delivery (<34 weeks) – among women with a history of abortion and women with no history of abortion who had inadequate prenatal care Rate of low birth weight Rate of moderate birth weight	-- -- -- -- -- --

Table II.1 *(continued)*

Study	Data and Sample	Design and Methods	Findings	
El-Bastawissi et al. 2007 (continued)			Rate of very low birth weight Rate of preterm normal birth weight – among women with a history of abortion and women with no history of abortion who had inadequate prenatal care Rate of full-term low birth weight Rate of preterm low birth weight	-- ++ NS --
Figlio et al. 2009	**Data:** Florida birth certificates merged with Florida WIC records and the public school records of older siblings **Sample:** 1997-2001 births to families enrolled in the National School Lunch Program (N=4,190)	**Treatment group:** Enrolled anytime during pregnancy **Comparison group:** Did not enroll during pregnancy **Methods:** Instrumental variable estimation	Birth weight (adjusted) Rate of low birth weight (adjusted) Gestational age Rate of preterm delivery	NS --- NS NS
Foster et al. 2010	**Data:** Panel Study of Income Dynamics, Child Development Supplement, 1997 and 2002 **Sample:** Children who lived with their biological mother (N=3,181)	**Treatment group:** Enrolled anytime during pregnancy **Comparison group:** Did not enroll during pregnancy **Methods:** Propensity score matching; multivariate regression with maternal fixed effects	Propensity score model: Mother's rating of child's health at birth Birth weight Rate of low birth weight Small for gestational age Rate of preterm delivery Child in NICU (neonatal intensive-care unit) Fixed-effects model: Mother's rating of child's health at birth Birth weight Rate of low birth weight Small-for-gestational age Rate of preterm delivery Child in NICU	 NS NS NS NS NS NS NS +++ --- NS -- NS
Gueorguieva et al. 2009	**Data:** Florida birth certificates linked to Medicaid files and WIC records **Sample:** Medicaid births to WIC participants, 1996-2004 (N=369,535)	**Measure of WIC participation:** A continuous measure defined as percentage of days on WIC during pregnancy **Methods:** Multivariate regression, stratified by propensity scores for WIC participation	Small-for-gestational age: 37- to 42-week births 34- to 36-week births 29- to 33-week births 23- to 28-week births	 -- -- -- NS
Hoynes et al. 2009	**Data:** Administrative data on WIC implementation from directories and congressional filings; birth outcomes from vital statistics records; population data from CANCER-SEER; demographic and economic data from 1970 IPUMS; income and government transfer data from the Bureau of Economic Analysis, Regional Economic Information System **Sample:** Counties that had an established WIC agency by 1979 (N=2,059)	**Treatment group:** Counties with WIC program implemented **Comparison group:** Counties without WIC program implemented **Method:** Multivariate regression with county, state, and year fixed effects	Average birth weight: Full sample Less than HS education HS education More than HS Highest poverty quartile Lowest poverty quartile % births low birth weight (all subsamples)	 + +++ NS NS +++ NS NS
Joyce et al. 2005	**Data:** New York City birth certificates **Sample:** Medicaid births to women with no previous births, who initiated prenatal care	**Treatment group:** Enrolled anytime during pregnancy **Comparison group:** Did not enroll during	Women of all races – singleton births: Birth weight Low birth weight	 +++ ---

Table II.1 *(continued)*

Study	Data and Sample	Design and Methods	Findings	
Joyce et al. 2005 (continued)	in the first four months of pregnancy; 1988-2001 (N=197,656)	pregnancy **Methods:** Multivariate regression	Very low birth weight	---
			Gestational age	+++
			Rate of preterm delivery	---
			Birth weight (adjusted for gestation)	---
			Small for gestational age	NS
			Term low birth weight	NS
			Women of all races – twin births:	
			Birth weight	NS
			Low birth weight	NS
			Very low birth weight	NS
			Gestational age	NS
			Rate of preterm delivery	NS
			Birth weight (adjusted for gestation)	NS
			Small for gestational age	---
			Term low birth weight	NS
Joyce et al. 2008	**Data:** Pregnancy Nutritional Surveillance System (PNSS) from nine states (1995-2004) **Sample:** Women enrolled in WIC during pregnancy or postpartum (N=1,712,216)	**Treatment group:** Enrolled anytime during pregnancy and did not recertify after delivery **Comparison group:** Enrolled postpartum and did not participate during pregnancy **Methods**: Dose-response effect of WIC using multivariate regression	Differences in WIC impacts between 1st-trimester and 2nd-trimester enrollees (1st-trimester — 2nd-trimester):	
			Birth weight	NS
			Low birth weight	--
			Very low birth weight	NS
			Preterm delivery	+++
			Birth weight (adjusted for gestation)	+++
			Small for gestational age	--
			Term low birth weight	---
			Quit smoking postpartum	-
			Pregnancy weight gain (among underweight women)	+++
			Differences in WIC impacts between 1st-trimester and 3nd-trimester enrollees (1st-trimester — 3nd-trimester):	
			Birth weight	---
			Low birth weight	+++
			Very low birth weight	+++
			Preterm delivery	+++
			Birth weight (adjusted for gestation)	+++
			Small for gestational age	---
			Term low birth weight	NS
			Pregnancy weight gain (among underweight women)	+++
Kowaleski-Jones and Duncan 2002	**Data:** National Longitudinal Survey of Youth (NLSY) **Sample:** Births between 1990 and 1996 with known WIC status during pregnancy (N=1,355)	**Treatment group:** Enrolled anytime during pregnancy **Comparison group:** Did not enroll during pregnancy **Methods**: Multivariate regression with maternal fixed effects	Multivariate regression:	
			Birth weight	+++
			With maternal fixed effects:	
			Birth weight	+

Table II.1 *(continued)*

Study	Data and Sample	Design and Methods	Findings	
Lazariu-Bauer et al. 2004	**Data:** New York State WIC records linked to birth certificates **Sample:** Women with singleton births in 1995 who were enrolled in WIC during pregnancy as determined by WIC check redemption (N=77.601)	**Treatment group:** Enrolled early during pregnancy and participated at least 6 or 7 months for preterm and full-term births, respectively **Comparison group:** Enrolled late during pregnancy and participated less than 4 or 3 months for full-term and preterm births, respectively **Methods:** Propensity score matching, stratified by length of gestation	Birth weight – among full-term infants Birth weight – among preterm infants	++ ++
Reichman et al. 2003	**Data:** Standardized data on pregnant women on Medicaid who enrolled in the New Jersey HealthStart program between 1988 and 1996 **Sample:** Women with a live singleton birth (N=90,117)	**Treatment group:** Enrolled anytime during pregnancy **Comparison group:** Did not enroll during pregnancy **Methods:** Multivariate regression	Full Sample: Birth weight Rate of low birth weight Women at nutritional risk initiating prenatal care before the third trimester: Birth weight Rate of low birth weight	 +++ --- +++ ---
Rivera 2008	**Data:** Early Childhood Longitudinal Study, Birth Cohort (ECLS-B) (2001-2003) **Sample:** Children from 46 states and Washington, DC, who were born in 2001, and whose biological mother was the respondent (N=1,919)	**Treatment group:** Enrolled during pregnancy regardless of postnatal participation **Comparison group:** Did not enroll during pregnancy, regardless of postnatal participation **Methods:** Propensity score matching	Highest quartile of propensity scores: Month started prenatal care Number of prenatal visits Birth weight Rate of low birth weight Rate of very low birth weight Gestational age Rate of preterm delivery Rate of very preterm delivery (<32 weeks) Intrauterine growth Small for gestational age Large for gestational age	 ++ +++ ++ NS - +++ - -- NS NS NS
Yunzal-Butler et al. 2010	**Data:** Pregnancy Nutritional Surveillance System (PNSS) from eight states (1995-2004) **Sample:** Women with singleton birth who enrolled in WIC during pregnancy (N=1,768,970)	**Treatment group:** Enrolled during the first and second trimester of pregnancy **Comparison group:** Enrolled during the third trimester of pregnancy **Methods**: Multivariate regression	Smoking cessation 3 months before delivery: First-trimester enrollees Second-trimester enrollees Smoking cessation postpartum: First-trimester enrollees Second-trimester enrollees Smoking relapse (quit before enrollment, smoked postpartum): First-trimester enrollees Second-trimester enrollees	 +++ +++ +++ +++ +++ NS

Notes: "+++", "++", and "+" indicate a statistically significant positive association between WIC and the specific outcome at p<0.01, p<0.05, and p<0.1, respectively; "---", "--", and "-" indicate a statistically significant negative association between WIC and the specific outcome at p<0.01, p<0.05, and p<0.1, respectively; "NS" indicates a nonsignificant finding.

III. IMPACTS ON INFANT FEEDING PRACTICES

The literature search identified 13 studies that evaluated the association between WIC participation and infant feeding practices. Five evaluations focused on prenatal participation, and 8 evaluated the impacts of postpartum, child, or any WIC participation. The most common outcome measures of infant feeding practices included initiation and duration of breastfeeding, exclusive breastfeeding, and introduction of infant formula. Less frequently, authors evaluated the timing of the introduction of cow's milk or solid foods. Table III.1 presents a summary of the data sources, measures of WIC participation, statistical methods used, and a summary of findings for all 13 studies.

A. Selection Issues Specific to Evaluations of Infant Feeding Practices

There are several ways in which the WIC program can influence infant feeding practices. Promoting breastfeeding is an explicit goal of the program, and prenatal WIC participants are encouraged to initiate breastfeeding through educational materials and counseling. The program continues to promote breastfeeding after birth, possibly affecting breastfeeding duration. On the other hand, the provision of free formula to non-breastfeeding mothers provides a strong incentive for formula use and may discourage breastfeeding.

Given the high cost of infant formula, disadvantaged women who choose to formula feed have a strong incentive to enroll in WIC, relative to women who choose to breastfeed, and this can lead to a negative association between WIC participation and breastfeeding. The interpretation of this negative association will depend on whether WIC induces women to formula feed by making the option more affordable, or simply provides formula at a lower cost to women who would have formula fed even in the absence of WIC. A negative association between WIC and breastfeeding under the first alternative would suggest that WIC indeed reduces the incentives to breastfeed, while a negative association under the latter alternative would imply that the differences in the rates between WIC participants and nonparticipants are spurious and result from selection bias. In other words, even in the absence of access to free formula, women on WIC would have had lower breastfeeding rates compared to nonparticipants. This selection issue makes it very difficult to isolate the true effect of WIC participation on breastfeeding.

B. Approaches to Dealing with Selection Bias

Of the 13 reviewed studies, 3 evaluations attempted to address these issues by employing multivariate regression analysis controlling for observed demographic characteristics of the mother, family socioeconomic factors, and health-related risks and behaviors (Hendricks et al. 2006; Ryan and Zhou 2006; Ziol-Guest and Hernandez 2010). Eight studies limited their sample of nonparticipants to women or children who were income eligible for WIC in addition to controlling for certain covariates (Bitler and Currie 2005; Jacknowitz et al. 2007; Khoury et al. 2005; Racine et al. 2009; Flower et al. 2008; Bunik et al. 2009; Chatterji and Brooks-Gunn 2004; Wojcicki et al. 2010).

Jiang et al. (2009) attempted to reduce selection bias by employing both a propensity score method and a mother fixed-effects model. Estimates based on the matched sample produced nearly identical breastfeeding rates for WIC participants and matched nonparticipants. The authors' estimate from the fixed-effects model is not statistically significant; however, the coefficient suggests a higher breastfeeding rate among WIC participants. As noted earlier, reasons for changing participation are likely unobserved and therefore may be confounding the estimates even in the fixed-effects model. Furthermore, analyses of discordant sibling pairs in the WIC literature generally suffer from small sample sizes. Because of the relative scarcity of families with discordant WIC participation among siblings, it is often difficult to locate a sufficiently large sample. In this study, the authors identified only 140 multichild mothers for analysis, which limits statistical power.

Park et al. (2003) attempted to address bias by limiting the sample to prenatal WIC participants and evaluating the effect of first-trimester enrollment in WIC using second- and third-trimester enrollees as comparison groups. The advantage of this design is that all members in the study sample were eligible for WIC and made the decision to enroll in WIC at some point during pregnancy. However, unobserved traits that are related to both the timing of enrollment during pregnancy and breastfeeding practices remain as potential confounding factors.

C. Other Methodological Considerations

For evaluations of postpartum WIC participation, it is important to employ a measure of WIC participation that clearly identifies whether enrollment in WIC occurred prior to the observed health outcomes. In the case of infant feeding practices, measures of WIC participation should be limited to prenatal participation or participation during infancy. This condition is necessary (but alone not sufficient) to avoid finding a spurious association between WIC and infant feeding practices. Five of the 13 studies that evaluated various measures related to breastfeeding, formula feeding, or introduction of other foods focused on prenatal WIC participation. One study looked at the effect of combined prenatal and postpartum participation, and four evaluated WIC participation during infancy (prior to 12 months of age). Three studies employed measures of WIC participation that did not clearly identify whether enrollment in WIC occurred during infancy or later in childhood. Chatterji and Brooks-Gunn (2004), for example, classified as WIC participants children with reported WIC participation since birth, as evaluated 12-15 months postpartum. Hendricks et al. (2006) used a measure based on any child-WIC participation as reported at the time of the survey when children were between the ages of 4 and 24 months. Ryan and Zhou (2006) defined WIC participation as any or current participation among a sample of infants up to age 12 months. Since the probability that a child is enrolled in WIC decreases with age, WIC participation at a later age is likely a good proxy for participation during infancy. Nevertheless, the ambiguity of these measures relative to initiation and duration of breastfeeding warrants caution in interpreting the studies' findings.

D. Summary of Key Findings

Overall, research suggests lower rates of breastfeeding among WIC participants compared to nonparticipants, but from the available studies it cannot be determined whether this is due to WIC or to underlying differences between WIC participants and nonparticipants. Of the 13 studies reviewed in this section, one found a positive association between prenatal participation in the WIC program and initiation of breastfeeding (Park et al. 2003). Results from Park et al. (2003) suggest that WIC is associated with an increase in the likelihood of breastfeeding initiation among women who enrolled during the first trimester of pregnancy as compared to women who enrolled during the second trimester, but that no such association exists when first-trimester enrollees are compared to third-trimester enrollees. Eleven studies found either negative or no association with breastfeeding and participation in WIC (Jiang et al. 2009; Bunik et al. 2009; Wojcicky et al. 2010; Ziol-Guest and Hernandez 2010; Khoury et al. 2005; Bitler and Currie 2005; Jacknowitz et al. 2007; Racine et al. 2009; Flower et al. 2008; Ryan and Zhou 2006; Hendricks et al. 2006). Evidence from one study suggests that women who enrolled in WIC postpartum were more likely than women who did not enroll after birth to initiate breastfeeding (Chatterji and Brooks-Gunn 2004). However, the study found no difference between the two groups in terms of breastfeeding duration. There is some evidence to suggest that providing infant formula through WIC delays the introduction of cow's milk in infants' diets (Jacknowitz et al. 2007; Ziol-Guest and Hernandez 2010).

E. Research Results

Five studies evaluated the effect of prenatal (as opposed to postpartum) WIC participation on infant feeding practices. Two of the studies estimated a dose-response effect of WIC participation (Park et al. 2003; Ziol-Guest and Hernandez 2010), and three evaluated the effect of WIC participation at any point during pregnancy (Bitler and Currie 2005; Jiang et al. 2010; Wojcicki et al. 2010). Most recently, Ziol-Guest and Hernandez (2010) evaluated the association between first-, second-, and third-trimester enrollment in WIC and six measures of infant feeding practices, using women not enrolled in WIC at any time during pregnancy as the comparison. The authors used a nationwide sample of 4,450 mothers from the 2001 Early Child Longitudinal Survey (ECLS) Birth Cohort and limited their analysis to WIC-eligible births, as determined either based on household income or Medicaid participation during pregnancy. After adjusting for maternal sociodemographic characteristics, infant demographic characteristics and birth outcomes, and household composition, the authors found that compared to nonparticipants, first- and second-trimester enrollees were significantly less likely to initiate breastfeeding and to introduce cow's milk in infants' diet before age 9 months. For all prenatal enrollees, the authors reported a significant increase in the likelihood of formula feeding. The findings further suggest lower rates of exclusive breastfeeding and higher rates of early introduction of solid foods among prenatal participants compared to nonparticipants. However, none of the findings for these two outcomes are statistically significant.

Park et al. (2003) also evaluated the dose-response effect of prenatal WIC participation on initiation of breastfeeding, using a sample of teenage mothers enrolled in WIC during pregnancy from the Michigan PNSS. The authors used a multivariate regression analysis, controlling for maternal demographics and health behaviors. Their study is one of the few that found some positive association between WIC participation and breastfeeding; however, the findings are not consistent across the different comparison groups. Their estimates suggest that first-trimester enrollees were more likely than second-trimester enrollees to initiate breastfeeding, but also that initiation rates among first-trimester enrollees were not significantly different from those of third-trimester enrollees.

Using data from PRAMS, Bitler and Currie (2005) analyzed more than 60,000 births to women on Medicaid between 1992 and 1999 in 19 states. The authors controlled for a detailed set of maternal demographic, education, employment, and health indicators (see the *Impacts on Pregnancy and Birth Outcomes* section for a more detailed discussion of the methods used in this study). Across the full sample, the study identified a relatively small, but significant, negative impact on breastfeeding. The authors reported that women who enrolled in WIC during pregnancy were 10 percent less likely to have engaged in any breastfeeding between two and six months after giving birth compared to women who did not enroll during pregnancy. Among a subgroup of women who received public assistance from AFDC/TANF or the Food Stamp Program[4] in the previous year, the authors found a 16 percent increase in the likelihood of any breastfeeding.

Jiang et al. (2010) used the Panel Study of Income Dynamics Child Development Supplement to evaluate the effect of prenatal WIC participation on breastfeeding practices. The authors used two distinct methods to address selection bias. First, they used propensity score matching to identify a comparison group of WIC nonparticipants who shared the same likelihood of enrolling as the WIC participants in the sample. Second, they removed bias from unobserved, time-invariant maternal characteristics by employing mother fixed-effects on a sample of multichild households in which the mother had enrolled in WIC during the pregnancy of one sibling but not the other. The sample size for the fixed-effects model was relatively small, however, because only 140 multichild mothers met this criterion. The estimates based on the propensity-score-matched sample suggest almost identical breastfeeding initiation rates for prenatal WIC participants and nonparticipants. Using the mother fixed-effects model, the authors estimated a higher rate of breastfeeding initiation for prenatal WIC participants relative to nonparticipants, but the difference was not statistically significant (63.6 versus 50.9 percent). For both the propensity score and fixed-effects models, the duration of breastfeeding was estimated to be slightly shorter for WIC participants, but the differences were not statistically significant.

Finally, Wojcicki et al. (2010) surveyed a convenience sample of 363 mothers, recruited from two hospitals in San Francisco, who were between one and four days postpartum. About 49 percent of the full sample were deemed eligible for WIC based on income, and 43 percent had a college degree or some postgraduate education. These figures suggest that the nonparticipant comparison group in the full sample was likely more advantaged than WIC participants. After adjusting for demographic and some socioeconomic characteristics, the authors found no significant relationship between WIC participation and the likelihood of formula or mixed feeding. However, the adjusted odds ratio suggests a higher likelihood of formula or mixed feeding among WIC participants.

Jacknowitz et al. (2007) evaluated the association between WIC participation during pregnancy or postpartum and adherence to the recommendations of the American Academy of Pediatrics regarding exclusive breastfeeding and the introduction of formula, cow's milk, and solid foods in infants' diets. The authors used a sample of infants between the ages of 8 and 17 months from the 2001 ECLS Birth Cohort, and restricted their analysis to infants of WIC-eligible mothers (N=5,276) as determined by income or participation in the Food Stamp Program, welfare, or Medicaid programs. They defined WIC participation as participation during pregnancy or within six months postpartum, or receiving vouchers for food or infant formula during the 30 days prior to the survey. The authors reported that 83 percent of WIC participants were enrolled prenatally. This, however, leaves 17 percent of the WIC sample that was identified either based on participation within six months postpartum, or during the last 30 days before the survey. While the former definition is acceptable for evaluations of infant feeding practices, the latter raises issues about the timing of WIC enrollment relative to the observed outcomes, as the sample includes children up to age 17 months. The ambiguity of WIC enrollment relative to the timing of the outcome measures in less than 17 percent of the sample should be considered when interpreting the findings.

[4] On October 1, 2008, the Food Stamp Program was renamed the Supplemental Nutrition Assistance Program. In this report, the term *Food Stamp Program* will be used when discussing research conducted prior to the name change.

Estimates from multivariate analysis controlling for maternal sociodemographic characteristics, household composition, and region suggest that compared to nonparticipants, WIC participants were (1) less likely to breastfeed exclusively for at least six months, (2) more likely to use infant formula during the first six months after birth, (3) more likely to introduce solid foods before four months, and (4) less likely to introduce cow's milk before eight months. The difference in the introduction of solid foods during the first six months between WIC participants and nonparticipants based on the multivariate model is not statistically significant. While the findings suggest that WIC is associated with lower rates of breastfeeding, the delay in the introduction of cow's milk in infants' diets associated with WIC suggests that the provision of infant formula may help delay the introduction of less healthful (and less expensive) alternatives to breastfeeding.

Seven studies evaluated the effect of postpartum WIC participation on infant feeding practices (Khoury et al. 2005; Racine et al. 2009; Flower et al. 2008; Bunik et al. 2009; Ryan and Zhou 2006; Hendricks et al. 2006; Chatterji and Brooks-Gunn 2004). Chatterji and Brooks-Gunn (2004) identified a sample of 2,136 unmarried, low-income mothers from the Fragile Families and Child Wellbeing study, all of whom were likely WIC-eligible. After controlling for a large set of maternal characteristics, the authors found that postpartum WIC participants were 7 percentage points more likely than nonparticipants to initiate breastfeeding. The authors did not identify a significant relationship between WIC participation and breastfeeding duration.

Ryan and Zhou (2006) evaluated the association between postpartum WIC participation and initiation and duration of breastfeeding among a sample of 5,685 mothers from the 2003 Ross Laboratories Mothers Survey, an annual (since 1978) nationwide survey of infant feeding practices. After controlling for maternal education, maternal employment, region, and birth weight, the authors found that WIC participants were about half as likely as nonparticipants to initiate breastfeeding or to continue it for six months. However, because the authors did not limit their sample to the WIC-eligible population, their estimates of the association between WIC and initiation and duration of breastfeeding are likely biased downward (finding a larger-than-true negative association).

Using data from the 2002 Feeding Infants and Toddlers on children aged 4-24 months, Hendricks et al. (2006) found a negative association between postpartum enrollment in WIC and breastfeeding at 6 months of age, and no significant impacts on breastfeeding initiation or breastfeeding at 12 months of age. The authors controlled for a wide range of maternal demographic and income-related characteristics; however, as was the case in Ryan and Zhou (2006), Hendricks and colleagues did not limit the analysis sample to WIC-eligible children.

Khoury et al. (2005) surveyed a sample of 733 Medicaid beneficiaries in Mississippi when they were 1-4 months postpartum. WIC participants were defined as women who were enrolled in WIC at the time of the survey. Using multivariate regression analysis, the authors found that current WIC participants were about half as likely as nonparticipants to report breastfeeding at the time of hospital discharge. The multivariate model the authors used controlled for sociodemographic characteristics and for respondents' attitudes about breastfeeding, their perceived support for breastfeeding from family and the health care system, and their perceptions about social barriers to breastfeeding. Because changes in knowledge about the importance of breastfeeding and changes in attitudes toward breastfeeding may be important mechanisms through which WIC influences breastfeeding rates, controlling for such attitudes may not be appropriate, as it likely biases the estimated effect of WIC downward (toward not finding a positive impact).

Using data on 1,287 births from low-income rural families collected through the Family Life Project, Flower et al. (2008) evaluated the association between WIC participation by the mother or any other member of the household at any time since the child's birth and two measures related to breastfeeding practices: initiation and continuation at 6 months. While the sample consisted of low-income families, the income range of the families in the sample is not clear. About two-thirds of the sample were children from households (1) that had income less than 200 percent of the FPL or participated in WIC, TANF or other means-tested programs; or (2) in which the head of the household had less than a high school education. The income, and therefore the WIC eligibility of the remaining 34 percent who were included in the nonparticipant comparison group, cannot be determined from the authors' discussion. Based on a multivariate regression model controlling for maternal demographic and socioeconomic characteristics, health status, health-related behaviors, employment status, and infant health indicators, the authors found a negative association between WIC participation and initiation of breastfeeding. Discontinuation of breastfeeding by age 6 months based on a Cox proportional-hazard model indicated a higher risk of discontinuation associated with WIC participation. However, since this estimate is based on the full sample and therefore includes children who were never breastfed, it is not clear to what degree the lower initiation rate among WIC participants is contributing to the finding of higher discontinuation rate at 6 months.

Bunik et al. (2009) evaluated the association between WIC participation at the time infants were 6 months old and the likelihood of any breastfeeding at 6 months, using a sample of low-income women who participated in the Nurse Family Partnership Program between 2000 and 2005. The authors limited their multivariate analysis to a subsample of women-infant pairs who ever reported breastfeeding and found that after adjusting for sociodemographic characteristics, maternal BMI, and child's gestational age, WIC participation at 6 months is associated with a marginally significant ($p<0.1$) 20 percent decline in the odds of any breastfeeding at 6 months.

Using a sample of 1,595 low-income (below 185 percent of FPL) mothers participating in the Healthy Steps for Young Children National Evaluation, Racine et al. (2009) evaluated the association between WIC participation and breastfeeding cessation. After controlling for maternal education, demographics, and Medicaid participation, the authors found that participating in WIC when an infant was between 2 and 4 months of age was associated with a 50 percent increase in the likelihood of stopping breastfeeding in the first 12 months postpartum. As was the case in Bunik et al. (2009), Racine and colleagues limited their sample to women who initiated breastfeeding.

Table III.1. Studies Examining the Effect of WIC Participation on Infant Feeding Practices

Study	Data and Sample	Design and Methods	Findings	
Bitler and Currie 2005	**Data:** Pregnancy Risk Assessment Monitoring System (PRAMS) 1992-1999 **Sample:** Medicaid births in 19 states (N=60,731)	**Treatment group:** Enrolled anytime during pregnancy **Comparison group:** Did not enroll during pregnancy **Methods:** Multivariate regression	Breastfeeding initiation	---
Bunik et al. 2009	**Data:** Nurse Family Partnership Program **Sample**: Nationally representative group of high-risk, NFP mothers observed between 2000 and 2005 (N=3,570)	**Treatment group:** High-risk mothers enrolled in WIC when infant was 6 months old or 12 months old **Comparison group:** High-risk mothers who did not enroll in WIC when infant was 6 months old or 12 months old **Methods:** Multivariate regression	Breastfeeding at 6 months	NS
Chatterji and Brooks-Gunn 2004	**Data:** Fragile Families and Child Wellbeing Study baseline survey **Sample:** 1999-2000 survey of unmarried, low-income urban mothers in 20 cities nationwide (N=2,136)	**Treatment group:** Enrolled at any time after birth **Comparison group:** Likely WIC-eligible mothers who did not enroll at any time after birth **Methods:** Multivariate regression	Breastfeeding initiation Breastfeeding duration	++ NS
Flower et al. 2008	**Data:** Family Life Project longitudinal cohort study **Sample:** 2003-2004 births to low-income rural families in eastern North Carolina and central Pennsylvania (N=1,287)	**Treatment group:** Enrolled at any time after birth **Comparison group:** Did not enroll after birth **Methods**: Multivariate regression	Breastfeeding initiation Continuous breastfeeding to 6 months	-- --
Hendricks et al. 2006	**Data:** 2002 Feeding Infants and Toddlers Study **Sample:** National random sample of mothers with toddlers aged 4-24 months (N=2,515)	**Treatment group:** Enrolled at time of survey **Comparison group:** Not enrolled at time of survey **Methods:** Multivariate regression	Breastfeeding initiation Breastfeeding at 6 months Breastfeeding at 12 months Use of iron-fortified formula (among formula users) Introduction of cow's milk before 12 months Introduction of solid foods before 4 months	NS -- NS +++ NS NS
Jacknowitz et al. 2007	**Data:** Early Childhood Longitudinal Study-Birth Cohort **Sample:** Nationally representative sample of 2001 births, restricted to WIC-eligible mothers (N=5,276)	**Treatment group:** Enrolled at any time during pregnancy or after birth **Comparison group:** Eligible mothers who never enrolled **Methods:** Multivariate regression	Exclusive breastfeeding ≥4 months Exclusive breastfeeding ≥6 months Introduction of infant formula before 6 months Introduction of cow's milk before 8 months Introduction of solid foods before 4 months Introduction of solid foods before 6 months	--- -- +++ --- +++ NS
Jiang et al. 2010	**Data:** Panel Study of Income Dynamics, Child Development Supplement (1997) **Sample:** Nationally representative sample of children (N=3,276)	**Treatment group:** Enrolled anytime during pregnancy **Comparison group:** Did not enroll during pregnancy	Ever breastfeeding Months of breastfeeding	NS NS

Table III.1 *(continued)*

Study	Data and Sample	Design and Methods	Findings	
Jiang et al. 2010 (continued)		**Methods:** Propensity score matching; multivariate regression with maternal fixed effects		
Khoury et al. 2005	**Data:** Survey of postpartum mothers in Mississippi **Sample:** Medicaid beneficiaries with spring 2000 births (N=733)	**Treatment group:** Enrolled at the time of survey **Comparison group:** Not enrolled at the time of survey **Methods:** Multivariate regression	Breastfeeding at hospital discharge	---
Park et al. 2003	**Data:** Michigan Pregnancy Nutrition Surveillance System **Sample:** 1995 births to mothers between the ages of 12 and 19 who enrolled in WIC during pregnancy (N=3,534)	**Treatment group:** Enrolled in first trimester **Comparison group:** Enrolled in the second or third trimester **Methods:** Multivariate regression	Breastfeeding initiation (compared to second-trimester enrollees) Breastfeeding initiation (compared to third-trimester enrollees)	++ NS
Racine et al. 2009	**Data:** Healthy Steps for Young Children National Evaluation (1996-1998) **Sample:** Low-income families from 24 nationwide sites followed from birth through age 33 months (N=1,595)	**Treatment group:** Enrolled when infant was 2-4 months old **Comparison group:** Did not enroll when infant was 2-4 months old **Methods:** Multivariate regression	Continuous breastfeeding to 12 months	---
Ryan and Zhou 2006	**Data:** Ross Laboratories Mothers Survey **Sample:** 1978-2003, annually administered nationwide sample of mothers (in 2003, N=5,685)	**Treatment group:** Enrollment anytime after birth **Comparison group:** Did not enroll after birth **Methods**: Multivariate regression	Breastfeeding initiation Continuous breastfeeding to 6 months	-- --
Wojcicki et al. 2010	**Data:** Survey of postpartum mothers in San Francisco **Sample:** Convenience sample of mothers less than 5 days postpartum between 2003 and 2005 (N=324)	**Treatment group:** Enrolled at any time during pregnancy **Comparison group:** Did not enroll during pregnancy **Methods:** Multivariate regression	Exclusively breastfeeding during early postpartum period	NS

Table III.1 *(continued)*

Study	Data and Sample	Design and Methods	Findings	
Ziol-Guest and Hernandez 2010	**Data:** Early Childhood Longitudinal Survey-Birth Cohort **Sample:** Nationally representative sample of 2001 births (N=4,450)	**Treatment group:** Enrolled in WIC in first, second, or third pregnancy trimester **Comparison group:** Did not enroll at any time during pregnancy **Methods:** Multivariate regression	Breastfeeding initiation	
			1st-trimester enrollees	---
			2nd-trimester enrollees	--
			3rd-trimester enrollees	NS
			Breastfeeding for at least 4 months	
			1st-trimester enrollees	---
			2nd-trimester enrollees	NS
			3rd-trimester enrollees	NS
			Exclusive breastfeeding for at least 4 months (all trimesters)	NS
			Formula use before 9 months	
			1st-trimester enrollees	+++
			2nd-trimester enrollees	++
			3rd-trimester enrollees	++
			Introduce cow's milk before 9 months	
			1st-trimester enrollees	--
			2nd-trimester enrollees	--
			3rd-trimester enrollees	NS
			Introduce solid food before 4 months (all trimesters)	NS

Notes: "+++", "++", and "+" indicate a statistically significant positive association between WIC and the specific outcome at p<0.01, p<0.05, and p<0.1, respectively; "---", "--", and "-" indicate a statistically significant negative association between WIC and the specific outcome at p<0.01, p<0.05, and p<0.1, respectively; "NS" indicates a nonsignificant finding.

IV. IMPACTS ON INFANT AND CHILD DIETARY INTAKE, FOOD SECURITY, AND RELATED OUTCOMES

The literature search identified 16 studies that estimated the effects of WIC participation on the dietary intake of infants and children, household food security, summary measures of diet quality, knowledge about infant feeding practices, and food labeling behaviors. Table IV.1 presents a summary of the data sources, measures of WIC participation, statistical methods used, and a summary of findings for all 16 studies.

A. Approaches to Dealing with Selection Bias

All the studies that examined the effect of WIC participation on dietary intakes, food security, and related outcomes used multivariate regressions to control for observed household characteristics. The strongest of these studies also included additional covariates that are likely to influence these outcomes. For example, Bhargava and Amailchuk (2007) controlled for several indices of dietary and shopping behavior, which could have important effects on intakes of added sugars. Similarly, Siega-Riz et al. (2004) used controls for other factors that might influence children's diets, including Food Stamp participation, supplement use, dietary restrictions, television watching, and child care attendance.

Several studies limited their samples to households with WIC-eligible incomes, which resulted in comparison groups of nonparticipants that are more similar to WIC participants than a broader group of low-income nonparticipants would be. For those studies in which the comparison group included both eligible and ineligible nonparticipants, ineligibility resulted from inclusion either of individuals with higher income levels or of individuals not categorically eligible for WIC. In a further refinement to their sample design, Black et al. (2004) limited their comparison group to WIC-eligible mothers who reported that their nonparticipation in WIC was due to their lack of access to the program. The authors provided descriptive evidence that their comparison group shares similar characteristics with enrollees.

Ishdorj et al. (2007) used an instrumental variable design, using state variation in WIC eligibility rules and reported household assets to predict WIC enrollment. The inclusion of household assets as a component of the authors' instrument may have been problematic, however, because it is possible that wealth and savings have an exogenous relationship to dietary intake and related outcomes. If, for example, WIC participants with lower household savings have poorer diets than higher-savings households (for reasons other than the WIC program itself), this instrumental variable approach may have underestimated the WIC effects.

In studies of dietary intake, sometimes no impacts can be considered a positive effect. In particular, given concerns about increasing obesity, a finding that WIC participation does not lead to increased energy intake can be interpreted as a positive outcome.

B. Summary of Key Findings

Overall, recent research suggests that WIC participation is associated with improved diets. One study found that WIC participation increases the iron density of preschoolers' diets, reduces the intake of fat as a percentage of food energy, increases the intake of carbohydrates as a percentage of food energy, and increases the number of servings of fruits and vegetables (Siega-Riz et al. 2004); three studies found that WIC participants consume fewer added sugars than nonparticipants

(Bhargava and Amailchuk 2007; Kranz and Siega-Riz 2002; Siega-Riz et al. 2004); and one study found that zinc intake of children is positively related to WIC participation (Arsenault and Brown 2003). Evidence is inconsistent on the association between WIC participation and energy intake. Two studies compared the energy intake of children on WIC to that of ineligible nonparticipants (Mendoza et al. 2006; Oliveira and Chandran 2005); one found that WIC participants consumed significantly more calories than ineligible nonparticipants, and the other found no significant relationship. Oliveira and Chandran (2005) also compared the energy intakes of WIC participants and income-eligible nonparticipants; they found no significant relationship. Two studies examined dietary variety, and both reported a positive relationship between WIC participation and the variety of foods consumed (Knol et al. 2004; Ver Ploeg 2009).

Evidence is either mixed or lacking on the effects of WIC on other outcome measures related to dietary intakes. Two studies evaluated food security status; one found no relationship to WIC participation (Black et al. 2004), and the second found a positive relationship (Oberholzer and Tuttle 2004). Two studies reported a negative association of WIC participation with nutrition-related knowledge and behaviors (Ollberding 2009; Wojcicki et al. 2009). However, both these studies failed to control adequately for other factors that influence these outcomes. Although fewer studies examined WIC impacts on intakes of other vitamins and minerals, two studies found no significant relationship of WIC participation and calcium intakes (Siega-Riz et al. 2004; Ishdorj et al. 2007), and one found a positive relationship between WIC participation and calcium available from household food supplies (Bhargava and Amialchuk 2006). One study evaluated the consumption of WIC-approved foods and found that children on WIC have higher energy intake from approved foods relative to both income eligible and ineligible nonparticipants (Oliveira and Chandran 2005).

C. Research Results

Iron Intake

One reviewed study evaluated the effect of WIC participation on the iron density of diets, defined as iron intake in milligrams per 1,000 kilocalories. Siega-Riz et al. (2004) used the data from the 1994-1996 and 1998 Continuing Survey of Food Intakes by Individuals (CSFII) to evaluate the dietary intakes of children aged 2 to 5 who were eligible for WIC based on household income. Dietary intakes were assessed with two 24-hour recalls. The authors stratified their analysis by income level (less than 130 percent of FPL and 130 to 185 percent of FPL), and found a significant increase in iron density associated with WIC participation for both income groups, after controlling for a wide range of sociodemographic characteristics.

Using data from the National Food Stamp Program Survey (NFSPS), which includes information on the nutrient content of foods used from household food supplies over a seven-day period, Bhargava and Amailchuk (2007) found that iron intake measured in milligrams per week was higher in households participating in WIC compared to households that did not include WIC participants. Their analysis adjusted for differences in income, education, and race.

Calcium Intake

Among reviewed studies, the strongest study design pertaining to calcium intake comes from Ishdorj et al. (2007), who controlled for selection bias with an instrumental variable design. Using the 1994-1996 CSFII dataset, they exploited variation in state eligibility laws and a measure of household savings to predict WIC enrollment. The authors found that WIC participants acquire less calcium from milk than do nonparticipants. The study did not measure total calcium intake, so it is not clear whether WIC participants compensate by obtaining higher levels of calcium from other foods (such as cheese).

Two reviewed studies assessed WIC's effect on total calcium intake. Siega-Riz et al. (2004) controlled for demographic characteristics and participation in the Food Stamp Program. The authors found no statistically significant differences in calcium intakes between WIC participants and nonparticipants. On the other hand, Bhargava and Amailchuk (2007) found that foods used by households that included WIC participants provided significantly higher levels of calcium than foods used by non-WIC households.

Other Vitamins and Minerals

A small number of studies examined the impact of WIC participation on children's intakes of other vitamins and minerals. Analyzing the CSFII data set, Arsenault and Brown (2003) found that WIC participation had a positive impact on total zinc intakes for non-breastfeeding children. Although they find that very few children studied (less than 1 percent) had inadequate zinc intake, they estimated that non-breastfeeding WIC children consume more zinc overall, as well as more zinc from infant formula, beef, and poultry, than non-breastfeeding nonparticipants. There are important concerns about the study's design, however: the authors did not restrict the sample to WIC-eligible children, and the only sociodemographic covariate included was a set of three income-level indicators that do not align with the WIC eligibility cutoff. As a result, they compared WIC participants to others who were not from the same income group and not WIC-eligible, and who therefore may have differed in unobservable ways.

Bhargava and Amailchuk (2007) examined the impact of WIC participation on the beta-carotene, folic acid, potassium, and vitamin A, C, E, B_6, and B_{12} content of foods used from household food supplies. After applying extensive controls for sociodemographic characteristics and nutritional behavior, they found no significant impact of WIC participation on any of these vitamins or minerals.

Other Dietary Components

Several other dietary components, including added sugars, fiber, cholesterol, sodium, and specific foods and beverages, have also been examined in the reviewed WIC literature. Three studies examined the impact of WIC participation on added sugar intake (Bhargava and Amailchuk 2007; Kranz and Siega-Riz 2002; Siega-Riz et al. 2004). All three used national survey samples and found that WIC participants received a significantly smaller percentage of their total energy intake from added sugars. Both Siega-Riz et al. (2004) and Kranz and Siega-Riz (2002) stratified their analysis by income level to better control for Food Stamp eligibility, finding larger impacts for higher-income WIC children than for those below 130 percent of FPL. Bhargava and Amailchuk (2007) report a similar negative relationship between WIC participation and added sugar from household foods, both overall and as a percentage of total energy intake.

Three reviewed studies examined fiber intake, using relatively strong multivariate approaches. Bhargava and Amailchuk (2007) did not find a significant relationship between WIC participation and fiber as a percentage of total energy from household foods. Siega-Riz et al. (2004) found a small, significant positive WIC impact on total fiber intake among lower-income participants, but no significant impact for the higher-income group. Similarly, using CSFII data, Kranz (2006) found that lower-income (below 130 percent of FPL) WIC participants were more likely than their nonparticipant peers to meet their dietary reference intakes for fiber (although they found an insignificant relationship for higher-income WIC participants).

Correlations between WIC participation and cholesterol and sodium intake were examined in one study (Ver Ploeg 2009) that analyzed an unrestricted sample of 1988-1994 NHANES data. After controlling for sociodemographic characteristics and Food Stamp participation, the author reported that children in WIC households had significantly higher Healthy Eating Index (HEI) scores for cholesterol and lower scores for sodium. These correlations were not statistically significant for the subgroup of households with more than one WIC-enrolled child.

Four reviewed studies also provide evidence regarding the impact of WIC participation on fruits and vegetable consumption. Siega-Riz et al. (2004) found that both higher- and lower-income WIC participants consumed more servings of fruits and vegetables than nonparticipants. Ver Ploeg (2009) also found that WIC participants consumed more fruit than nonparticipants, and the effect was stronger in families with more than one participant. She found no significant differences in vegetable consumption.

In addition, one study examined fruit consumption using the Feeding Infants and Toddlers Survey data set. Hendricks et al. (2006), in a multivariate regression controlling for a small set of maternal characteristics, found that WIC participation was not significantly correlated with fruit consumption (defined as the likelihood of "no fruit consumption"). The study also reports no significant correlations between WIC participation and the likelihood that children consume any salty snacks, sweetened beverages, or desserts or candy. Less weight should be given to the findings regarding WIC impacts from this study, however, because the study was not restricted to the sample of WIC-eligible children.

Other Measures of Diet Quality

The Dietary Guidelines for Americans include a recommendation to consume a variety of nutrient-dense foods and beverages. As a result, one dietary outcome often examined is variety. Two studies examined WIC impacts on the variety of food intakes. Knol et al. (2004) found that both young (2-3 years) and older (4-8 years) children in households where any member participated in WIC were more likely to consume a variety of foods, as measured by the HEI. Ver Ploeg (2009) also found a positive impact of WIC on HEI food variety scores for children in families with more than one participant (although there was no significant difference in families with one WIC participant). In a separate analysis, she found that variety is significantly higher in households with older WIC participants compared to those with only an infant participant. This suggests that the impact on food variety may be due to WIC food sharing among household members, since infant foods cannot be shared among older children.

In a small study of low-income households in rural Pennsylvania, Daponte et al. (2004) examined the impact of WIC benefits on whether households attain the resources to acquire the Thrifty Food Plan (TFP), a national standard for a low-cost diet that meets the nutritional needs of its household members. The authors found positive impacts of WIC on households' ability to acquire the necessary resources for the TFP, after controlling for Food Stamp participation and a variety of other characteristics. However, this study estimates a model that is essentially tautological. The outcome variable, called total food acquisitions, is calculated as the sum of the value of Food Stamp benefits, the value of food received from a food pantry, the value of WIC vouchers, and any out-of-pocket food expenditures. Since the value of WIC benefits is one component of the definition of total food acquisitions, it is not surprising that WIC participation has a positive effect on the outcome variable.

Food Security

Only two of the identified studies examined the relationship between WIC participation and food security. Black et al. (2004), analyzing survey data from six urban hospitals and clinics collected through the Children's Sentinel Nutritional Assessment Program, found no significant relationship between WIC participation and food security after controlling for sociodemographic characteristics and participation in the Food Stamp Program. The study design compared WIC participants with low-income (WIC-eligible) infants whose mothers reported that they chose not to receive WIC benefits for their child because of a lack of access to the program (as opposed to those who did not participate because they did not perceive a need for WIC). Descriptive analyses of WIC participants, nonparticipants who lacked access, and nonparticipants who did not perceive a need for WIC showed that nonparticipants who lacked access were more comparable to WIC participants than nonparticipants who did not perceive a need for WIC in terms of mother's age, race, marital status, participation in other programs, and infant's birth weight. This group is probably also a better match in terms of unobserved characteristics, assuming that whatever limited access to WIC did not also have an independent effect on food security.

Oberholzer and Tuttle (2004) administered the Food Security Module by telephone to a random sample of Food Stamp participants in Maryland. They found no significant relationship between WIC participation and food security. The study's sample size was small, however (N=245), which may have made it difficult to detect an effect. Moreover, the comparison group of low-income households not receiving WIC included some households that were ineligible for categorical reasons; that is, some nonparticipating households did not have a pregnant, breastfeeding, or postpartum woman, infant, or child up to age 5.

Nutrition-Related Knowledge and Food Label Behaviors

Two studies examined the relationship between WIC participation and nutrition-related knowledge and behavior (Ollberding 2009; Wojcicki et al. 2009). Both used a comparison group comprising of both income-eligible and -ineligible nonparticipants. Wojcicki and colleagues selected a convenience sample of 363 new mothers at two San Francisco hospitals and interviewed them about their knowledge of recommended infant feeding practices and whether they read nutrition labels. Higher nutrition knowledge, defined as answering four questions correctly about infant feeding practices, was negatively associated with WIC participation after controlling for income and education. WIC participants were also less likely than nonparticipants to report that they frequently read nutritional labels. It is difficult to interpret these findings as causal, however, given the large and significant differences between WIC participants and nonparticipants. Compared with WIC participants in the sample, the nonparticipant comparison group was significantly older and more likely to be white, to be married, to have higher educational attainment, and to be employed full- or part-time.

Federally mandated food labels on packaged food items is one approach to help inform consumers about what they are buying and eating. Ollberding (2009) examined the frequency of food label use in a nationally representative sample of U.S. adults based on the 2005-2006 NHANES data. Respondents reported whether they used food labels—the nutrition facts panel, the list of ingredients, serving size information, or health claims—when deciding whether to buy a product. The author found that WIC participants were less likely than nonparticipants to use nutritional labels in making food-purchasing decisions, after controlling for participation in the Food Stamp Program, health status, and other health behaviors. Moreover, WIC participants were less likely than Food Stamp Program participants to use food labels when buying products. The comparison group of nonparticipants in this study, however, included both income-eligible and -ineligible nonparticipants, which limits the causal interpretation of the findings.

Food Energy, Macronutrients, and Consumption of WIC-Approved Foods

Reviewed studies provide only limited evidence regarding food energy and macronutrient outcomes. The recent studies identified in this area produce mixed findings regarding the relationship between WIC participation and intake of fats and carbohydrates, and no evidence of a program effect on protein intake or energy density.

Siega-Riz et al. (2004) examined the impact of WIC on dietary intake of fat and carbohydrates, applying a multivariate model to the 1994-1996 and 1998 CSFII. The authors limited the study to households with WIC-eligible incomes and further stratified their impact findings by income eligibility for food stamps (food stamp participation was also controlled for as a covariate). This study found mixed program impacts on fat and carbohydrate intake as a percentage of food energy among 2- to 5-year-olds. While WIC participants in the lower-income group (less than 130 percent of FPL) consumed significantly less fat and more carbohydrates than nonparticipants, the opposite was true for the higher-income group (130 to 185 percent of FPL). The estimates in the higher-income group were only weakly significant (at the 10 percent level), and no significant differences were found in saturated fat intake in either income group.

A second study, Ver Ploeg (2009), also found that WIC participation reduced fat and saturated fat intake, as measured by the HEI. The models used to estimate the WIC impact controlled for a range of sociodemographic characteristics, as well as Food Stamp Program participation. Analyzing the NHANES data set, Ver Ploeg found that children in families with more than one WIC participant consumed significantly less fat and saturated fat (as indicated by higher HEI scores on these components). The reported effect was not significant for children in families with only one WIC participant, however.

Only one study identified in our search examines the impact of WIC on protein in foods used from household food supplies (Bhargava and Amailchuk 2007). Using the NFSPS, the authors found very small and insignificant differences in the availability of protein from the household food supplies—both in amount and as a percentage of total energy—between WIC participants and WIC-eligible nonparticipants receiving food stamps. In addition to limiting the study to Food Stamp participants, the authors controlled for a large number of sociodemographic and behavioral covariates, representing a reasonably strong multivariate design.

One study analyzed *dietary energy density,* defined as energy intake in kilocalories divided by amount of food and beverages consumed in grams (Mendoza et al. 2006). The authors used the 1994-1996 and 1998 CSFII, a national survey data set used in several other studies reviewed here, but it did not restrict the sample to WIC-eligible individuals. Although the multivariate analyses controlled for income, Food Stamp enrollment, and food insecurity, there may be other unobserved differences that were unaccounted for in this model because WIC-ineligible people were included.

The authors reported that WIC participation was not significantly correlated with dietary energy density.

Supplemental food packages are a major component of the WIC program. In order to link WIC participation to any health benefits, it is important to show that WIC food packages are, in fact, consumed by the intended beneficiaries. Surprisingly, there is very little research that focuses on this question. The literature search identified only one study, by Oliveira and Chandran (2005), that examined the association between WIC participation and consumption of WIC-approved foods. The authors analyzed the consumption patterns of a sample of 5,519 children aged 1-4 from the CSFII 1994-1996, 1998. Using multivariate regression analysis, they compared consumption of WIC-approved milk, cereal, eggs, cheese, juice, peanut butter, and beans or peas by WIC participants and three groups of nonparticipants: (1) children from income-eligible households with at least one WIC participant, (2) children from income-eligible households with no WIC participants, and (3) children from ineligible households. Findings suggest that WIC participants consumed more WIC-approved juice and less of other beverages relative to all three comparison groups. WIC participants also consumed more WIC-approved cereal than eligible nonparticipants in non-WIC households and ineligible nonparticipants.

Oliveira and Chandran (2005) also evaluated whether participation in WIC led to greater overall energy intake and found no clear association. In general, children on WIC consumed more calories from WIC-approved foods and fewer from other foods relative to nonparticipants. Overall calorie intake was significantly higher among WIC participants relative to ineligible children, but not relative to the two groups of income-eligible nonparticipants. One concern with the study design is that the multivariate regression models control only for average differences between WIC participants and all three groups of nonparticipants combined, as all three comparison groups are included in the models for each outcome measure. Yet there seem to be relatively large differences in the observed characteristics among the three comparison groups. For example, about 38 percent of WIC participants were white non-Hispanic, compared to 50 percent of eligible nonparticipants in non-WIC households, 28 percent of eligible nonparticipants in WIC households, and close to 79 percent of ineligible children. The authors' multivariate regression models, therefore, may not adequately adjust for observed differences between WIC participants and the separate groups of nonparticipants.

An important caveat should be noted in interpreting the association between WIC participation and outcomes such as consumption of WIC-approved foods or total energy intake. The consumption of WIC foods is considered an important moderator through which the WIC program seeks to improve child health, with the assumption that it improves children's diet. However, the fact that children on WIC consume more WIC-approved foods does not necessarily mean that children on WIC have a better quality diet than children not participating in the program, as the counterfactual may not be clearly defined. For example, showing that children on WIC eat more peanut butter relative to eligible nonparticipating children cannot be clearly interpreted as a positive outcome. The interpretation depends on what food products (if any) are replaced in children's diet as a result of the increased consumption of peanut butter. If peanut butter replaces fruits and vegetables, such substitution is unlikely to be interpreted as a positive outcome. On the other hand, if it replaces less nutritious foods such as candy, the substitution would more clearly be seen as beneficial.

A similar argument can be made for total energy intake. Comparing the total number of calories consumed by WIC participants and nonparticipants does not convey information about the outcome that is really of interest—whether WIC participants are more likely than nonparticipants to consume the appropriate amount of calories for their age, gender, and activity level. Again, the interpretation of findings depends on the definition of the counterfactual. For example, if the eligible population of children was generally underweight, then an increase in caloric intake for WIC participants would be considered a positive outcome. On the other hand, if obesity is a problem in the population targeted by WIC, finding no association may be interpreted as a positive outcome, as it would suggest that WIC does not contribute to childhood obesity. However, it would not likely be interpreted as WIC's contributing to a more appropriate calorie intake.

Table IV.1. Studies Examining the Effect of WIC Participation on Infant and Child Nutrition

Study	Data and Sample	Design and Methods	Findings	
Arsenault and Brown 2003	**Data:** Continuing Survey of Food Intakes by Individuals (CSFII),1994-1996 and 1998 **Sample:** Nationally representative sample of children <6 years old and not breastfeeding (N=7,474)	**Treatment group:** Individuals participating in WIC program **Comparison group:** Individuals not participating in WIC program **Method:** Multivariate regression	Zinc intake (from all foods) From infant formula From beef From poultry	+++ +++ +++ ++
Bhargava and Amialchuk 2007	**Data:** National Food Stamp Program Survey (1996-1997) **Sample:** National sample of food stamp recipient households (N=937)	**Treatment group:** Households participating in WIC **Comparison group:** Households not participating in WIC **Method:** Multivariate regression	Consumption over 1 week: Energy from added sugar Protein use Calcium use Iron use B-Carotene/energy Vitamin A/energy Vitamin C/energy Fiber/energy Vitamin E use Potassium use Folic acid/energy Vitamin B-6 use Vitamin B-12/energy	 -- NS ++ ++ NS NS NS NS NS NS NS NS NS
Black et al. 2004	**Data:** Third National Health and Nutrition Examination Survey (NHANES III) administered at urban medical centers in 5 states and Washington, DC (1998-2001) **Sample:** Caregivers of infants ≤12 months of age without private health insurance (N=5,923)	**Treatment group:** Individuals who received WIC assistance for their child **Comparison group:** Individuals who did not receive WIC assistance for their child because of lack of access (individuals who did not receive WIC assistance for their child because of no perceived need were also compared – results not reported in table) **Method:** Multivariate regression	Household food insecurity	NS
Daponte et al. 2004	**Data:** Food Distribution Research project survey (1993) **Sample:** Households with incomes ≤185% of FPL living in Allegheny County, Pennsylvania (N=405)	**Treatment group:** Households participating in WIC **Comparison group:** Households eligible for WIC but not participating **Method:** Multivariate regression	% difference between household food acquisition and ETFP Probability of exceeding ETFP	++ ++
Hendricks et al. 2006	**Data:** 2002 Feeding Infants and Toddlers Study **Sample:** National random sample of mothers with toddlers aged 4-24 months (N=2,515)	**Treatment group:** Enrolled at time of survey **Comparison group:** Not enrolled at time of survey **Methods:** Multivariate regression	Fruit consumption Salty Snacks Sweetened beverages Desserts or candy Child considered a picky eater	NS NS NS NS ++
Ishdorj et al. 2007	**Data:** Continuing Survey of Food Intakes by Individuals (CSFII) (1994-1996) **Sample:** Nationally representative sample of WIC-eligible households (N=2,374)	**Treatment group:** Target and non-target individuals living in households participating in WIC **Comparison group:** Target and non-target individuals living in WIC-eligible households but not participating in WIC **Method:** Instrumental variable model	Calcium intake through milk	---

Table IV.1 *(continued)*

Study	Data and Sample	Design and Methods	Findings	
Knol et al. 2004	**Data:** Continuing Survey of Food Intakes by Individuals (CSFII), 1994-1996 and 1998 surveys **Sample:** Nationally representative sample of children aged 2-3 (N=1,242) and aged 4-8 (N=1,506)	**Treatment group:** Children receiving in WIC benefits **Comparison group:** Children not receiving WIC benefits **Methods:** Multivariate regression	Among children aged 2-3: Food variety index Among children aged 4-8: Food variety index	 +++ +
Kranz 2006	**Data:** Continuing Survey of Food Intakes by Individuals (CSFII), 1994-1996 **Sample:** Nationally representative sample of 2- to 5-year-old children in WIC-eligible households (N=5,437)	**Treatment group:** Children in households participating in WIC **Comparison group:** Children in WIC-eligible households that are not participating in WIC **Method:** Multivariate regression	Meeting Dietary Reference Intakes for fiber: <130% of poverty ≤185% of poverty	 +++ NS
Kranz and Siega-Riz 2002	**Data:** Continuing Survey of Food Intakes by Individuals (CSFII), 1994-1996 and 1998 **Sample:** Nationally representative sample of 2- to 5-year-olds (N=5,652)	**Treatment group:** Individuals participating in WIC **Comparison group:** Individuals not participating in WIC with household income <130% of poverty (FS- and WIC-eligible); Individuals not participating in WIC with household income ≤185% of poverty (WIC-eligible) **Method:** Multivariate regression	Added sugar intake: <130% of poverty ≤185% of poverty	 -- --
Mendoza et al. 2006	**Data:** Continuing Survey of Food Intakes by Individuals (CSFII), 1994-1996 and 1998 **Sample:** Nationally representative sample of children ≤19 years old (N=11,284)	**Treatment group:** Children in households participating in WIC **Comparison group:** Children in households not participating in WIC **Method:** Multivariate regression	Dietary energy density (all age groups)	NS
Oberholser and Tuttle 2004	**Data:** Telephone survey using a modified version of the U.S. Food Security Survey Module (2001) **Sample:** Random sample of Maryland food stamp recipients (N=245)	**Treatment group:** Food stamp recipients participating in WIC **Comparison group:** Food stamp recipients not participating in WIC **Method:** Multivariate regression	Food insecurity	NS
Oliveira and Chandran 2005	**Data:** Continuing Survey of Food Intakes by Individuals (CSFII), 1994-1996 and 1998 **Sample:** Nationally representative sample of children aged 1-4 years (N=5,519)	**Treatment group:** Children participating in WIC at time of survey **Comparison group:** Eligible nonparticipating children in households with no WIC participants; eligible nonparticipating children in households with a WIC participant; non-eligible children **Method:** Multivariate regression	Compared to eligible nonparticipants in non-WIC households: Consumption of WIC-approved and other foods: WIC-approved cereal Other cereal WIC-approved juice Other beverages WIC-approved milk WIC-approved eggs WIC-approved cheese WIC-approved peanut butter WIC-approved beans or peas Energy intake: WIC-approved foods Non-WIC foods Total	 +++ --- +++ --- NS -- NS NS NS +++ - NS

Table IV.1 *(continued)*

Study	Data and Sample	Design and Methods	Findings	
Oliveira and Chandran 2005 (continued)			Compared to eligible nonparticipants in WIC households:	
			Consumption of WIC-approved and other foods:	
			WIC-approved cereal	NS
			Other cereal	NS
			WIC-approved juice	+
			Other beverages	--
			WIC-approved milk	+
			WIC-approved eggs	NS
			WIC-approved cheese	NS
			WIC-approved peanut butter	NS
			WIC-approved beans or peas	NS
			Energy intake:	
			WIC-approved foods	++
			Non-WIC foods	--
			Total	NS
			Compared to non-eligible nonparticipants:	
			Consumption of WIC-approved and other foods:	
			WIC-approved cereal	+++
			Other cereal	NS
			WIC-approved juice	+++
			Other beverages	--
			WIC-approved milk	NS
			WIC-approved eggs	NS
			WIC-approved cheese	NS
			WIC-approved peanut butter	NS
			WIC-approved beans or peas	++
			Energy intake:	
			WIC-approved foods	++
			Non-WIC foods	NS
			Total	+
Ollberding 2009	**Data:** National Health and Nutrition Examination Survey (NHANES) (2005-2006) **Sample:** Adults who completed Diet Behavior and Nutrition survey questions (N=5,502)	**Treatment group:** Individuals participating in WIC **Comparison group:** Individuals not participating in WIC **Method:** Multivariate regression	Serving size food label use	--
			Health claims food label use	--

Table IV.1 *(continued)*

Study	Data and Sample	Design and Methods	Findings	
Siega-Riz et al. 2004	**Data:** Continuing Survey of Food Intakes by Individuals (CSFII), 1994-1996 and 1998 **Sample:** Nationally representative sample of children aged 2-5 in households below 130% of FPL (N=2,461)	**Treatment group**: Children receiving in WIC benefits **Comparison group:** Children not receiving WIC benefits **Methods:** Multivariate regression	Children in households <130% of poverty, from all meals:	
			Energy	NS
			% Energy from fat	--
			% Energy from saturated fat	NS
			% Energy from carbohydrates	++
			% Energy from added sugar	---
			Iron	+++
			Calcium	NS
			Fiber	+
			Servings of fruits	++
			Servings of fruits and vegetables	+++
			Children in households 130% to 185% of poverty, from all meals:	
			Energy	+
			% Energy from fat	+
			% Energy from saturated fat	NS
			% Energy from carbohydrates	-
			% Energy from added sugar	---
			Iron	+++
			Calcium	NS
			Fiber	NS
			Servings of fruits	++
			Servings of fruits and vegetables	+++

Table IV.1 *(continued)*

Study	Data and Sample	Design and Methods	Findings	
Ver Ploeg 2009	**Data:** National Health and Nutrition Examination Survey (1988-1994) **Sample:** Nationally representative sample of 5- to 17-year-olds who are not categorically eligible to receive WIC (N=5,310)	**Treatment group:** Children in households with one or more WIC participant **Comparison group:** Children in a non-WIC participating household **Method:** Multivariate regression	Children in households with 1 WIC participant:	
			Total HEI score	+++
			Dairy score	NS
			Meat score	NS
			Grain score	++
			Fruit score	+++
			Vegetables score	NS
			Fat score	NS
			Saturated fat score	NS
			Cholesterol score	+++
			Sodium score	---
			Variety score	NS
			Children in households with 2 or more WIC participants:	
			Total HEI score	+++
			Dairy score	+++
			Meat score	NS
			Grain score	+++
			Fruit score	++
			Vegetables score	NS
			Fat score	+++
			Saturated fat score	+++
			Cholesterol score	NS
			Sodium score	NS
			Variety score	+++
Wojcicki et al. 2009	**Data:** Local survey conducted at two California hospitals (2003-2006) **Sample:** Convenience sample of women within 4 days of giving birth (N=307)	**Treatment group:** Women participating in WIC during pregnancy **Comparison group:** Women not participating in WIC during pregnancy **Method:** Multivariate regression	Know appropriate time to start feeding child low-fat products	--
			Know appropriate first complimentary food to feed child	--
			Know when to start feeding child complementary foods	NS
			Know when to start feeding child cow's milk	NS
			Answer all nutrition questions correctly	++
			Read nutritional labels	--

Notes: "+++", "++", and "+" indicate a statistically significant positive association between WIC and the specific outcome at p<0.01, p<0.05, and p<0.1, respectively; "---", "--", and "-" indicate a statistically significant negative association between WIC and the specific outcome at p<0.01, p<0.05, and p<0.1, respectively; "NS" indicates a nonsignificant finding.

V. IMPACTS ON INFANT AND CHILD GROWTH OUTCOMES

The literature search identified seven studies that examined the relationship between WIC participation and infant and child growth. The most commonly evaluated outcomes in the seven studies were the likelihood of being overweight (BMI ≥95th percentile) and being at risk of overweight (BMI ≥85th percentile).[5] However, one study examined the same outcomes calculated based on weight-for-length (WFL) measurements rather than BMI. Other outcomes evaluated were the likelihood of being underweight (WFL<2SD) and diagnoses of failure to thrive. Table V.1 presents a summary of the data sources, measures of WIC participation, statistical methods used, and a summary of findings for all seven studies.

A. Approaches to Dealing with Selection Bias

Four of the reviewed studies used a multivariate regression approach (Black et al. 2004; Melgar-Quinonez and Kaiser 2004; Rose et al. 2006; Ver Ploeg et al. 2008). Three studies utilizing this approach compared the outcomes of WIC participants to those of either a group defined as eligible or low-income nonparticipants (Black et al. 2004; Melgar-Quinonez and Kaiser 2004; Ver Ploeg et al. 2008). The analysis by Black et al. (2004) was unique in that the authors limited the comparison group to women who reported wanting to participate in WIC but could not participate due to perceived access problems. Close to half the women reporting access problems in the authors' sample stated that they were on a waiting list to receive WIC. This reason for not participating is arguably uncorrelated with unobserved factors related to child health outcomes such as mothers' motivation to enroll, and therefore is likely a more appropriate comparison group for estimating WIC effects. However, other examples of reasons for not participating reported by mothers were missing an appointment, not having time to pick up vouchers, or living in a shelter. It is not clear whether defining the comparison group based on these specific reasons reduces the selection bias from the WIC estimates.

Rivera (2008) used propensity score matching to address bias from observed factors. In this case, the matching procedure did not produce a well-balanced treatment and comparison group. To address this issue, the author limited the study findings to the quartile of participants and nonparticipants with the highest likelihood of enrolling in the WIC program. While this quartile of the sample shared similar characteristics, the analyzed sample may not accurately represent WIC enrollees as a whole.

Lee et al. (2006) employed a multivariate regression analysis, an instrumental variable approach, a mother fixed-effects model, and a multilevel hazard model and compared the estimates across the different methods in an attempt to better understand the selection issues related to WIC participation. The instrument used by the authors is the distance from children's residence to the nearest WIC office. However, because the predictive power of this variable is weak, the authors favored the findings from the fixed-effects model and focused on the comparison between estimates from a multivariate regression and mother fixed effects. The latter can remove bias from

[5] Based on the new terminology, *overweight* among children is defined as a BMI at or above the 85th percentile and lower than the 95th percentile, while *obesity* is defined as a BMI at or above the 95th percentile for children of the same age and sex. The terminology used in the report reflects the definitions of overweight (BMI ≥95 percentile) and the risk of being overweight (BMI ≥85 percentile) applied by the study authors (unless noted otherwise in the text).

unobserved time variant characteristics of the mother by estimating the within-family difference between WIC participants and nonparticipants. It cannot, however remove unobserved factors that differ between the siblings. The authors suggested that the similarity between the two sets of estimates points to evidence of no bias present in the multivariate model. However, as discussed in more detail below, a direct comparison from the two models may not be appropriate, as they are not based on the same sample of children.

Bitler and Currie (2004) attempted to reduce selection bias by using expansions in the income eligibility for Medicaid in a child's state of residence as an instrumental variable to predict WIC participation. As mentioned previously, women and children participating in Medicaid are deemed income-eligible for WIC even if the income cutoff in their state is greater than 185 percent of FPL (the threshold for WIC eligibility). Therefore, it is likely that expansions in Medicaid eligibility would also increase participation in WIC, as more families become income-eligible through their enrollment in Medicaid. The OLS results provided by the authors indicate no significant relationship between WIC participation and children's weight or height, while the estimates from the instrumental variable model suggest substantial reductions in weight, BMI, and overweight status associated with WIC. The authors interpret the findings as an indication of a negative selection into the WIC program, and argue that correcting for this selection bias using an instrumental variable reveals the protective effect of WIC against childhood obesity. Given the considerable differences in the estimates from the two models, and the large magnitude of the instrumental variable estimates relative to the sample means for each outcome, caution in drawing causal inferences is warranted.

B. Other Methodological Considerations

Contemporaneous WIC participation is likely not an appropriate measure for evaluating the potential benefits of WIC participation on infants' and children's growth outcomes, as these tend to be more long-term outcomes that develop over time. However, if current WIC participation is a good proxy for past participation, then it may be adequate for studying the relationship between WIC and children's growth. Four of the seven studies reviewed in this section applied a measure of WIC participation that reflects current participation in the program (Melgar-Quinonez and Kaiser 2004; Black et al. 2004; Ver Ploeg et al. 2008); one study evaluated the association between past WIC participation—defined as participation anytime during childhood—and children's weight status at age 5-6 years, when they are no longer eligible (Rose et al. 2006); one study looked at the effect of prenatal WIC participation on outcomes at age 2 years (Rivera 2008); and one categorized children as WIC participants only if enrollment in WIC preceded the observed outcome (diagnosis of failure to thrive) but did not consider the time between enrollment and diagnosis (Lee et al. 2006).

C. Summary of Key Findings

Overall, the evidence on the association between WIC participation and infant growth outcomes is mixed. Findings from the only study evaluating growth outcomes among infants suggest that compared to WIC participants, nonparticipants with access problem tend to be lighter and shorter (Black et al. 2004). Among the six studies that evaluated overweight status among children older than 12 months (up to age 6 in some cases), two suggest a significant reduction in the risk of overweight among WIC participants relative to nonparticipants (Melgar-Quinonez and Kaiser 2004; Bitler and Currie 2004); one suggests that WIC is associated with a greater likelihood of being overweight among white children but not among blacks or Hispanics (Rose et al. 2006); and three show either no significant relationship or no consistent evidence of either a positive or a negative relationship (Black et al. 2004, Ver Ploeg et al. 2008; Rivera 2008). A study evaluating the incidence of failure to thrive by age 5 found a lower rate among both WIC participants and joint WIC and Food Stamp Program participants compared to children not enrolled in either program (Lee et al. 2006).

D. Research Results

Analyzing survey data collected in six cities through the Children's Sentinel Nutritional Assessment Program, Black et al. (2004) examined the association between WIC participation and infants' height and weight. The authors limit their sample to WIC-eligible children aged 12 months or less, using the lack of private insurance as a proxy for income eligibility. Among the income-eligible sample (N=5,923), 91 percent reported currently receiving WIC benefits, 6 percent reported not receiving benefits because of various access problems, and 3 percent reported not receiving benefits and indicated no perceived need for WIC services.

Using multivariate regression analysis and adjusting for socioeconomic and demographic characteristics, city, birth outcomes, mothers' breastfeeding practices, and receipt of TANF benefits or food stamps, the authors found that compared to current WIC participants, infants with reported access problems were shorter and lighter, while infants from families reporting no need for WIC services were taller and no different in terms of weight. There was no statistically significant difference in the likelihood of being overweight among the groups, although the adjusted odds ratios suggest a lower rate among both groups of nonparticipants relative to current participants.

As discussed earlier, a novel aspect of the study is the use of a comparison group that reported nonparticipation in WIC due to perceived access problems. Women and their children who intended to enroll in WIC but were unable to gain access may be similar to those who enrolled in terms of unobserved characteristics, and therefore constituted a more appropriate comparison group. This assumption, however, holds only if the barriers to access are not related to the health outcomes being evaluated. As the authors note, women provided various reasons for not participating: 45 percent reported being on a waiting list, and 24 percent reported missing an appointment, not having time to pick up vouchers, or needing to reapply for WIC. Being on a waiting list likely reflects the lack of sufficient funding at the particular local areas to meet the demand for WIC services, and is likely an exogenous determinant of WIC participation for women living in the same area. On the other hand, reasons such as missing appointments, not having time to pick up vouchers, or lacking transportation may reflect the mother's motivation to enroll. Exploring the sensitivity of the estimates to the different comparisons based on reported barriers to access would have been instructive; however, the authors were limited by the relatively few nonparticipants in their sample.

Bitler and Currie (2004) used data from the 1996 and 2001 panels of the Survey of Income and Program Participation (SIPP) and evaluated the association between WIC participation and children's weight status at age 4 among families with income below 350 percent of FPL. The authors employed an instrumental variable approach using the Medicaid income cutoff at the time a child was an infant as an instrument to predict WIC participation at age 4. As noted earlier, since most children enroll in WIC during infancy rather than later in childhood, children who participate at age 4 are likely to be enrolled since infancy. Therefore, Medicaid eligibility during infancy is likely correlated with WIC participation not only during infancy, but also at a later age.

The authors show that the Medicaid income eligibility threshold when a child is an infant is indeed a statistically significant predictor of WIC participation at age 4. This result, however, is based on the full sample of children that meet the study's inclusion criteria (N=7,310). The estimates for WIC's effectiveness, on the other hand, are based on a subsample of children with reported anthropometric measures, which is about half the sample. An indication of the predictive power of the instrument for this subsample would have been instructive.

Findings from the OLS regression model reveal no statistically significant difference between WIC participants and nonparticipants in terms of weight, height, and BMI. However, the results from the instrumental variable model are considerably different from those from the OLS model, and suggest that WIC significantly reduces children's average weight, BMI, and likelihood of being overweight. The estimates for height and the likelihood of being underweight from the instrumental variable model are positive and substantially larger than those based on the OLS model, but are not statistically significant.

Bitler and Currie (2004) point out that their estimates are confounded by co-enrollment in Medicaid and WIC and therefore likely reflect the association between joint Medicaid and WIC participation and children's weight status. Such confounding might bias their estimates of WIC participation upward (toward finding a protective effect). However, as the authors suggest, the findings are more likely to indicate the effect of WIC rather than of the Medicaid program, as WIC is focused specifically on improving the nutritional health of children. Another factor that needs to be considered when interpreting the findings is that the data from SIPP provide only self-reported measures of height and weight, which tend to be less accurate than direct measurement and tend to vary based on individual characteristics (Gorber et al. 2007).

The confounding factor and the large impact estimates for children's BMI and weight based on the instrumental variable model suggest caution in attributing the findings to WIC. Based on the average weight and BMI of the children in the authors' sample (45 pounds and 18, respectively), a reduction in weight of close to 20 pounds and an 8-unit reduction in BMI associated with WIC is quite large. A discussion of how these estimates compare to the impacts of other programs that target childhood obesity would have been instructive.

Using data from the Early Childhood Longitudinal Study, Rose et al. (2006) evaluated the association between WIC participation by the child anytime during childhood and overweight status at age 5-6 years. The authors employed a multivariate regression adjusting for socioeconomic characteristics such as education, household income, and food insecurity; behavioral factors such as activity level and watching TV; and health risk factors such low or high birth weight. The findings suggest no significant association between WIC and overweight status among black and Latino children, but an increased rate of overweight status among white children.

The sample utilized in Rose et al. (2006) is not limited to WIC-eligible children, and it is not clear from the authors' discussion how the WIC participants and nonparticipants compare in terms of observed characteristics. Furthermore, one of the covariates included in the authors' model is an indicator of food security. Since changes in food security status could be one of the mechanisms through which WIC affects the overweight status of children, a discussion of the sensitivity of their estimate to the inclusion of this variable would have been instructive.

Melgar-Quinonez and Kaiser (2004) analyzed the association between WIC participation and the likelihood of being overweight and the risk of overweight among a sample of 204 children from low-income Mexican-American families from three counties in California. Adjusted estimates from multivariate regression models suggest a lower rate of overweight and a lower risk of being overweight among WIC participants compared to nonparticipants. The sample used in the study includes children aged 3-5 years, with a mean age of 4.4 years (SD of 0.8). Since the authors' measure of WIC participation is defined as current participation in the program, it is not clear how the inclusion of 5-year-old children, who were not eligible to receive WIC, affects the estimates. As in Rose et al. (2006), Melgar-Quinonez and Kaiser (2004) adjusted for factors that are likely to be influenced by WIC, such as food security and child feeding practices. A discussion of the sensitivity of the estimates to the inclusion of these mediating factors would have been useful.

Ver Ploeg et al. (2008) examine the relationship between WIC participation and household income and (1) children's BMI and (2) overweight status, using a sample of children aged 2-4 years from NHANES. The authors evaluate the differences in outcomes between WIC participants and three groups of nonparticipants: (1) those eligible for WIC based on income, (2) those from households with income between 185 and 300 percent of FPL, and (3) those from households with income over 300 percent of FPL. Like Melgar-Quinonez and Kaiser (2004), Ver Ploeg et al. (2008) utilized a WIC measure that reflects current participation only. Findings from regression models adjusted for race and age suggest no significant differences in BMI or the risk of being overweight between WIC participants and eligible nonparticipants among either boys or girls. Comparisons between WIC participants and nonparticipants in the higher income categories are also largely insignificant (3 of the 16 estimates show a statistically significant impact, 1 positive and 2 negative).

Two issues must be considered when interpreting the findings from Ver Ploeg et al. (2008). Of the three categories of nonparticipants defined by the authors, the most appropriate comparison group for estimating a WIC effect is children eligible for but not enrolled in WIC. For each outcome, the authors employed a model that included indicators for the three groups of nonparticipants, using WIC participants as the reference category. Given this model specification, it is unlikely that the model adequately adjusted for differences between WIC participants and eligible nonparticipants even for the limited covariates included in the model (age and race). Furthermore, since the authors focused on rates of overweight, they excluded from their sample all children who were underweight. If the proportion of children who were underweight differed between WIC participants and nonparticipants, this would bias the authors' estimates for the association between WIC and the risk of being overweight. For example, if nonparticipants are more likely to be underweight than WIC participants, excluding underweight children from the analysis would bias the authors' estimates downward.

Using propensity score matching, Rivera (2008) evaluated the association between prenatal WIC participation and child weight status among a sample of 24-month-old children from the Early Childhood Longitudinal Study, Birth Cohort (ECLS-B). The author constructed indicators of being underweight, overweight, and at risk of overweight, and of having low middle upper arm circumference (MUAC) using WHO-recommended guidelines based on sex-specific WFL measures. Among children with propensity scores in the highest two quartiles, the findings generally do not support a significant association between WIC and any of the weight outcomes. The only statistically significant finding (of the eight estimates) points to a higher risk of being overweight among WIC participants compared to nonparticipants among children with propensity scores in the highest quartile. While the estimates for the likelihood of being underweight suggest a lower risk among WIC participants, the findings are not statistically significant. The results for MUAC, while also not significant, point to a lower risk among WIC participants (as compared to nonparticipants) among children with propensity scores in the second-highest quartile, and a greater risk among WIC participants in the highest quartile.

Lee et al. (2006) used various methods to evaluate the association between child WIC and (1) Food Stamp participation, and (2) failure-to-thrive diagnosis by age 5. A unique feature of the study is the ability to employ a mother fixed-effects model based on a large sample of sibling pairs (15,882) using data from the Integrated Database on Children's Services in Illinois. The authors limited their analysis to children who enrolled in Medicaid within a month after birth, and adjusted their estimates for demographic characteristics of the child and the mother, as well as for socioeconomic characteristics such as education and work experience and census tract-level covariates related to race, birth outcomes, and poverty. Estimates from the multivariate regression model indicate a significantly lower likelihood of having a failure-to-thrive diagnosis among WIC participants and among joint Food Stamp and WIC participants relative to children who participated in neither WIC nor the Food Stamp Program (nonparticipants). Results based on the fixed-effects model also suggest a negative relationship between the likelihood of a failure-to-thrive diagnosis and WIC or Food Stamp participation, although the estimate for WIC-only participation is substantially smaller in the fixed-effect model (about half the estimate from the multivariate regression model).

The authors compared the outcomes between nonparticipants and three groups of program participants—WIC-only, Food Stamp only, and joint participants—in a single multivariate regression model. Simple descriptive statistics provided by the authors suggest that joint participants as well as WIC-only participants were different in observed characteristics from nonparticipants. Furthermore, the selection based on these observed factors was generally not in the same direction. For example, 43 percent of the mothers in the nonparticipant sample were married, as opposed to 51 percent in the WIC-only sample and 27 percent in the joint-participant sample. In other words, WIC-only participants were less likely to be married, while joint participants were more likely to be married compared to nonparticipants. The authors make inferences based on the comparison of nonparticipants to each group of program participants. However, the multivariate regression model controls only for average differences between nonparticipants and all three groups of participants combined, and as a result may not adjust adequately for observed differences between the nonparticipant comparison group and the separate groups of program participants.

A positive feature of Lee et al. (2006) is the implementation of various methods and the comparison of the estimates based on different model specifications. In particular, the authors compared the estimates from the OLS and fixed-effects models and concluded that they are generally close. While such comparison is instructive, to be able to attribute the differences in the estimates to the different statistical approaches, it is important that both models be based on the same sample of children. The OLS model implemented by the authors included a sample of close to 300,000 children, while the fixed-effects model included only the subsample of about 16,000 discordant siblings. It is therefore not clear whether the two samples are comparable.

Table V.1. Studies Examining the Effect of WIC Participation on Infant and Child Growth

Study	Data and Sample	Design and Methods	Findings	
Bitler and Currie 2004	**Data:** Survey of Income and Program Participation (SIPP) (1996 and 2001) **Sample:** Nationally representative sample of 4-year-old children with family income <350% of FPL (N=7,310)	**Treatment group:** Children participating in WIC at age 4 **Comparison group:** Children in households at <350% of poverty but not participating in WIC at age 4 **Method:** Instrumental variable model	Body Mass Index (BMI) Weight Height Underweight (BMI <5th percentile) Overweight (BMI >85th percentile)	-- -- NS NS --
Black et al. 2004	**Data:** Third National Health and Nutrition Examination Survey (NHANES III) administered at urban medical centers in 5 states and Washington, DC (1998-2001) **Sample:** Caregivers of infants ≤12 months of age without private health insurance (N=5,923)	**Treatment group:** Individuals who received WIC assistance for their child **Comparison group:** Individuals who did not receive WIC assistance for their child due to perceived access problems **Method:** Multivariate regression	Weight-for-age z score Length-for-age z score Overweight (weight-for-length ≥95th percentile)	+++ +++ NS
Lee et al. 2006	**Data:** Administrative data from the Integrated Database on Children's Services in Illinois (IDB), merged with U.S. Census and vital statistics data **Sample:** Illinois Medicaid births between 1990 and 2000 (N=36,277)	**Treatment group:** Children participating in WIC before the occurrence of a relevant health event **Comparison group:** Children not participating in WIC or FSP **Method:** Multivariate regression; maternal fixed effects	Multivariate regression model: Failure to thrive Maternal fixed-effects model: Failure to thrive	 --- ---
Melgar-Quinonez and Kaiser 2004	**Data:** Local survey with anthropometric measurements (1998) **Sample:** Convenience sample of Mexican-American parents in California with at least one child 3-5 years old, recruited through Head Start, Healthy Start, WIC, county day care centers, and migrant education programs (N=204)	**Treatment group:** Families currently participating in WIC **Comparison group:** Families not currently participating in WIC (was not restricted to WIC-eligible families, but 80% of sample earned less than $1,500/month) **Method:** Multivariate regression	At risk of overweight (BMI ≥85th percentile) Overweight (BMI ≥95th percentile)	-- --
Rivera 2008	**Data:** Early Childhood Longitudinal Study, Birth Cohort (ECLS-B), 2001-2003 **Sample:** Children from 46 states and Washington, DC, who were born in 2001 whose biological mother was the respondent (N=9,685)	**Treatment group:** Enrolled during pregnancy regardless of postnatal participation **Comparison group:** Did not enroll during pregnancy, regardless of postnatal participation **Methods:** Propensity score matching	Highest quartile of propensity scores: Low weight for length at 24 mos. (weight-for-length <2SD) Risk of overweight at 24 mos. (weight-for-length ≥1SD) Overweight at 24 mos. (weight-for-length ≥2SD) Low middle upper arm circumference at 24 mos. (<2SD)	 NS ++ NS NS
Rose et al. 2006	**Data:** Early Childhood Longitudinal Study (1996) **Sample:** Kindergarten cohort of the study (N>15,000)	**Treatment group:** Children who had participated in WIC **Comparison group:** Children who had not participated in WIC **Methods:** Multivariate regression	Overweight (BMI ≥95th percentile) Among African Americans Among Latinos Among Whites	 NS NS ++

Table V.1 *(continued)*

Study	Data and Sample	Design and Methods	Findings	
Ver Ploeg et al. 2008	**Data:** Three waves of National Health and Nutrition Examination Survey (NHANES) (1976-1980, 1988-1994, 1999-2002) **Sample:** Nationally representative sample of WIC-eligible children aged 2 to 4 (N=21,056)	**Treatment group:** Children aged 2-4 participating in WIC **Comparison group:** Children aged 2-4 not participating in WIC but ≤185% of poverty **Methods:** Multivariate regression	BMI At risk of overweight (BMI ≥85th percentile) Overweight (BMI ≥95th percentile)	NS NS NS

Notes: "+++", "++", and "+" indicate a statistically significant positive association between WIC and the specific outcome at $p<0.01$, $p<0.05$, and $p<0.1$, respectively; "---", "--", and "-" indicate a statistically significant negative association between WIC and the specific outcome at $p<0.01$, $p<0.05$, and $p<0.1$, respectively; "NS" indicates a nonsignificant finding.

VI. IMPACTS ON CHILD IMMUNIZATION

The literature search identified three studies that evaluated the association between children's WIC participation and their immunization status. Outcomes analyzed in the three studies include the up-to-date (UTD) immunization status among children aged 19 to 35 months as defined by the recommended childhood immunization schedule, and rates of hepatitis A vaccination by age 2 years. Table VI.1 presents a summary of the data sources, measures of WIC participation, statistical methods used, and a summary of findings in all three studies.

A. Approaches to Dealing with Selection Bias

All studies reviewed in this section applied a multivariate regression analysis adjusting for differences in demographic and socioeconomic characteristics between children who enroll in WIC and the comparison group (Santoli et al. 2004; Luman et al. 2003; Weston and Enger 2010). Santoli et al. (2004) used the full sample of children who participated in both the National Immunization Survey (NIS) and the National Survey of Early Childhood Health (NSECH) (and who had available provider-verified data on vaccination), and included indicators of household poverty status and insurance status (private, public, or other) among their covariates. Given the composition of their sample, the nonparticipant comparison group likely included children from more advantaged families. Because of the large differences in immunization rates between low- and high-income households, it is not clear whether the authors' adjustments adequately accounted for the underlying differences between the two groups. Furthermore, it is not apparent how the exclusion of children without provider-reported immunization records from the analysis affected their estimates.

Luman et al. (2003) used reported household income and participation in WIC to identify children that are (1) current WIC participants, (2) eligible for WIC with past (but not current) participation, (3) eligible for WIC but never participated, or (4) ineligible for WIC. The authors estimated a model that included indicators for the different groups of children and adjusted for a similar (but less extensive) set of covariates as Santoli et al. (2004). The authors compared the outcomes of current WIC participants to the outcomes of each group of nonparticipants in a single multivariate regression model. Given that differences in the observed characteristics between WIC participants and each group of nonparticipants likely vary, the model employed in the study may not have adequately controlled for observed differences between WIC participants and either group of nonparticipants (including those eligible for WIC).

The main comparison in Weston and Enger (2010) was between the vaccination rate of children who received neither Medicaid nor WIC services and the rates of three groups of children: (1) those enrolled in WIC only, (2) those on Medicaid only, and (3) those enrolled in both programs. The authors lacked information on income or education that could have been used to adjust for differences in the socioeconomic characteristics between the groups. Based on the authors' categorization, the most appropriate comparison to identify a WIC effect is likely between WIC-only and Medicaid-only participants. However, it is not clear how children on WIC who are not enrolled in Medicaid compare to those on Medicaid in the authors' sample.

B. Other Methodological Considerations

A limitation of the literature on the association between WIC and child immunization is the lack of focus on the timing of WIC enrollment relative to the timing of vaccinations. Two of the reviewed studies use the NIS for their analysis. The questions related to child WIC participation in this survey vary over time. For certain years, the public use data files contain information about whether the child was enrolled in WIC continuously since birth, was ever enrolled, is currently on WIC, or ever had a spell of more than six months with no WIC benefits. In other years, the questions are limited to whether the child ever participated in WIC or is currently enrolled. Except for the case of continuous WIC participation since birth, the information provided in NIS is too crude to determine whether enrollment in WIC occurred prior to immunization, which is necessary (but not sufficient) in order to attribute the findings to participation in WIC. One of the two studies that used NIS categorized children as WIC participants if they ever participated during their lifetime, using children who never participated as the comparison group (Santoli et al. 2004). The other study distinguished among children who were current participants, participated in the past, or never participated (Luman et al. 2003). Weston and Enger (2010) analyzed rates of hepatitis A vaccination using data from the Michigan Care Improvement Registry; theirs is the only study that measured WIC participation before the child was vaccinated. The authors evaluated the rate of hepatitis A vaccination by age 2 and measured WIC participation at age 1, which is when children first become eligible to be vaccinated.

C. Summary of Key Findings

The evidence on WIC's effectiveness in improving children's immunization rates is limited and inconclusive. Santoli et al. (2004) found no significant association between children's WIC participation and their UTD status for routine vaccinations. Luman et al. (2003) found that children with current WIC participation (as reported in the NIS) are more likely to be UTD on their routine vaccinations than children who (1) are eligible but never participated, (2) participated in the past but are not currently participating, or (3) are ineligible for WIC. As noted previously, both studies employed a measure of WIC participation that could not assert whether enrollment in WIC preceded vaccination. The findings in Weston and Enger (2010), the only study reviewed that used a more appropriate measure of WIC participation, did not provide a straightforward interpretation of the association between WIC participation and hepatitis A vaccination. Their estimates, adjusted for a limited number of demographic characteristics, suggest that compared to children who receive neither Medicaid nor WIC at age 1, those who receive both Medicaid and WIC have a higher vaccination rate, but those who receive WIC only do not differ in this outcome. Since the comparison group most likely included children from families with higher incomes who did not qualify for either WIC or Medicaid, the lack of difference in hepatitis A vaccination between this group and children who receive WIC only may be encouraging.

D. Research Results

Santoli et al. (2004) analyzed the relationship between insurance status and vaccination coverage among U.S. preschool children aged 19 to 35 months using a sample of 735 children whose parents participated in both the NIS and the NSECH. Along with insurance status, the authors evaluated the association between participation in the WIC program and child immunization, controlling for demographic and socioeconomic characteristics. The measure of WIC participation was defined based on any participation by the child during his/her lifetime. The estimates based on univariate analysis indicate that children who participated in WIC at any point during their lifetime are significantly less likely to be UTD for routine vaccinations compared to children who never participated. This result is not surprising, as the children in the comparison group were not limited to WIC-eligible nonparticipants. Only 20 percent of the sample used in the study was covered through public health insurance (most through Medicaid or the State Children's Health Insurance Program), and more than half the sample was covered through private insurance. Thus, their comparison group likely included children from more-advantaged families, who generally have higher immunization rates. After adjusting for observed differences, the association between WIC and immunization status remains negative, but is no longer significant.

Luman et al. (2003) analyzed a sample of 21,212 children aged 19 to 35 months from the 2000 NIS. Using multivariate regression analysis, the authors estimated the adjusted odds of being UTD on routine vaccinations for three groups of children: (1) those who were eligible for WIC (as determined by reported income) but never participated; (2) those who were eligible and participated in the past, but were not currently enrolled; and (3) those who were not eligible; they used children who were current WIC participants at the time of the interview as the comparison group. Estimates adjusted for demographic and socioeconomic characteristics suggest that all three groups had significantly lower odds of being UTD relative to current WIC participants. The largest difference was between current participants and eligible children who never enrolled in WIC. These findings are in stark contrast to those of Santoli et al. (2004), who also used a sample from the NIS survey (albeit a subsample) and a similar but more extensive set of covariates, and indicate higher rates of immunization among nonparticipants than among WIC participants. As in Santoli et al. (2004), the measure of WIC participation used in Luman et al. (2003) could not establish whether enrollment in WIC preceded the vaccinations.

Weston and Enger (2010) used multivariate regression analysis to assess factors associated with hepatitis A vaccination among a sample of 134,226 1-year-olds, using data from the Michigan Care Improvement Registry. The primary outcome variable was receipt of at least one dose of hepatitis A vaccination by the time the child turned 2. As noted earlier, the advantage of this study is that WIC participation is measured prior to the child's being vaccinated. The authors compared the rate of hepatitis A vaccination between children who received neither WIC nor Medicaid at age 1 and three groups defined as Medicaid-only, WIC-only, and dual participants. While the data came from a population-based registry with a high estimated provider participation, they contained limited information on important demographic and socioeconomic variables that could be used in multivariate analysis. The adjusted odds of hepatitis A vaccination reported by the authors suggest that, relative to children who received neither Medicaid nor WIC benefits, those enrolled in Medicaid only or in both Medicaid and WIC were more likely to be vaccinated. Furthermore, the magnitude of the estimates is greater among dual participants than among Medicaid-only participants. The authors found no association between participation in WIC only and hepatitis A vaccination. The association between Medicaid and WIC participation (either dual or separate) was generally stronger among racial/ethnic minorities compared to whites. The interpretation of the authors' findings is not straightforward. Since children who participate in neither Medicaid nor WIC (about half the sample) are likely to be from households with higher incomes, the higher rates of vaccination among Medicaid participants and dual participants are surprising. Furthermore, given the lack of association between WIC-only participation and vaccination rates, it is not clear whether the positive association among the dual participants is due to the joint WIC-Medicaid effect or simply to Medicaid.

Table VI.1. Studies Examining the Effect of WIC Participation on Immunization

Study	Data and Sample	Design and Methods	Findings	
Luman et al. 2003	**Data:** National Immunization Survey (2000-2001) **Sample:** Nationally representative sample of children 19-35 months old (N=21,212)	**Treatment group:** Children whose mothers are participating in WIC **Comparison group:** Children whose mothers are WIC-eligible and never participated in WIC; children whose mothers are WIC-eligible and participated in WIC in the past; children whose mothers are not WIC-eligible **Method:** Multivariate regression	Completion of recommended childhood vaccines (excluding varicella vaccine)	++
Santoli et al. 2004	**Data:** Linked telephone survey samples from the 2000 National Immunization Survey and the National Survey of Early Childhood Health **Sample:** National sample of children, aged 19-35 months, surveyed in 2000 (N=735)	**Treatment group:** Children who ever enrolled in WIC **Comparison group:** Nonparticipants **Methods:** Multivariate regression	Up-to-date immunization status	NS
Weston and Enger 2010	**Data:** Michigan Care Improvement Registry **Sample:** All children born in Michigan between May 2006 and April 2007 (N=134,226)	**Treatment group:** Enrolled when infant was 12 months old (with and without Medicaid) **Comparison group:** Did not enroll when infant was 12 months old **Methods:** Multivariate regression	Hepatitis A vaccine (all sampled children)	NS

Notes: "+++", "++", and "+" indicate a statistically significant positive association between WIC and the specific outcome at $p<0.01$, $p<0.05$, and $p<0.1$, respectively; "---", "--", and "-" indicate a statistically significant negative association between WIC and the specific outcome at $p<0.01$, $p<0.05$, and $p<0.1$, respectively; "NS" indicates a nonsignificant finding.

VII. IMPACTS ON INFANT AND CHILD UTILIZATION OF HEALTH CARE SERVICES AND RELATED COSTS

The literature search uncovered six studies that evaluated the association between WIC participation and utilization of health care among infants or children and associated Medicaid costs. Three studies evaluated the association between WIC and the use of preventive care, such as receipt of well-child visits or Early Periodic Screening and Diagnosis and Treatment Program (EPSDT) services. One study evaluated the likelihood of diagnosis of common childhood illnesses. Two focus on utilization of dental care, both preventive and restorative. Only two evaluated the Medicaid expenditures and possible cost savings related to child WIC participation. Table VII.1 presents a summary of the data sources, measures of WIC participation, statistical methods used, and a summary of findings in all six studies.

A. Approaches to Dealing with Selection Bias

Two of the studies in this section attempted to reduce selection bias by limiting the sample to income-eligible children, as determined by their participation in Medicaid, and by applying a multivariate regression analysis to control for observed characteristics. Buescher et al. (2003) applied covariates based on information available from birth certificates, such as mothers' demographic characteristics and education, as well other risk factors, such as low birth weight and smoking during pregnancy. Lee et al. (2004b) used mothers' demographic characteristics, as well as income and the availability of dental services in the county, and also controlled for characteristics of the child (including age and low birth weight) and mother (including race, education, living arrangements, and household income). Chatterji and Brooks-Gunn (2004) also applied a multivariate regression and used a more extensive list of covariates. However, their approximation of WIC eligibility was to limit the sample to mothers who were unmarried and living at or below 250 percent of FPL, rather than those enrolled in Medicaid.

Three studies attempted to control for selection bias by employing an instrumental variable approach or a mother fixed-effects model. Lee et al. (2004a) used the total number of WIC offices, the number of WIC staff, and the hours of operation of the WIC offices on the county level as instruments to predict WIC participation. Lee et al. (2005) applied a very similar set of instruments: the number of full-time WIC clinics, multiple sites, and hours open per month in a county. Questions about the validity of these instruments suggest caution in interpreting the study findings. For example, a distribution of the clinics across counties is likely a function of the demand for WIC services and may be associated with unobserved characteristics that are also related to the outcome measures. Since the available test for assessing the validity of instruments is weak, a conceptual justification for their use is important (Angrist et al. 1996).

Lee et al. (2006)[6] employed three methods in an attempt to better understand issues related to selection into the WIC program. They first used a multivariate regression analysis and compared the estimates to those from instrumental variables and mother fixed-effects models. Their instrument for WIC participation was the distance from the child's residence to the nearest WIC office. As in Lee et al. (2004a and 2005), the authors did not provide a compelling reason for why they considered the location of the WIC offices exogenous. However, since the distance to the nearest

[6] The authors in Lee et al. 2004a, 2004b, and 2005 are different from the authors in Lee et al. 2006.

office was not a strong predictor of WIC participation in their sample, the authors discounted the findings from this analysis and emphasized the results from the fixed-effects model. This is the only study that used a fixed-effects model to evaluate the association between WIC and health care utilization. As noted previously, this method eliminates bias from unobserved time-variant characteristics; bias from time-variant unobserved factors that might influence both the mother's motivation for a certain level of health care utilization and enrollment in WIC may still be present.

B. Other Methodological Considerations

A complicating factor for evaluations of health care utilization and Medicaid expenditures is that if WIC participants are more likely to use health care services, they will also have higher medical expenditures, at least in the short run. These expenditures might not be limited to costs of preventive care services, but could also be for curative services, as children with higher health care utilization are more likely to be diagnosed with childhood illnesses (Buescher et al. 2003). For these reasons, an association between WIC participation and Medicaid expenditures may simply reflect the underutilization of care among nonparticipants and might even suggest that non-WIC children are more likely to go undiagnosed and untreated for their illnesses (Buescher et al. 2003). However, increased Medicaid expenditures in the first four years of life among WIC participants may still lead to cost savings in the long run, if the underutilization of care in early childhood by non-WIC participants leads to more health problems later.

C. Summary of Key Findings

Overall, the reviewed studies suggest that children who participate in WIC or whose mothers are on WIC have a greater utilization of both preventive and curative health care services than nonparticipants. Findings from Buescher et al. (2003), the most widely cited study in this literature, suggest that children on Medicaid who are also on WIC are more likely to receive EPSDT services and well-child visits, to be hospitalized, to use the emergency room, and to be diagnosed with common childhood illnesses. As a result, Medicaid costs associated with health care utilization are also higher among WIC participants. Further, their findings suggest that children with the longest enrollment in WIC have the highest levels of utilization as well as Medicaid expenditures. As Buescher et al. (2003) suggested, this could indicate that one of the benefits of WIC participation is that children are better connected to the health care system and thus more likely to be diagnosed and treated for childhood illnesses. However, an alternative explanation—that children who are more connected to the health care system in general are also more likely to enroll in WIC—cannot be ruled out.

Findings by Chatterji and Brooks-Gunn (2004), who analyzed mothers' participation in WIC, confirmed the positive association between WIC enrollment and receipt of well-child visits found by Buescher et al. (2003). The findings from Lee et al. (2006) suggest an inverse relationship between WIC and utilization of EPSDT based on multivariate analysis, and no association based on the mother-fixed effects model. As the authors noted, the negative relationship from the multilevel models may be due to the fact that children on WIC receive EPSDT services prior to enrollment. To avoid spurious association due to inverse causality, the authors considered the occurrence of EPSDT visits prior to WIC enrollment as a non-WIC-associated event.

Findings on the association between WIC participation and the use of dental care services are very similar to those on the utilization of primary care, and suggest that children on WIC are more likely to use both preventive and restorative care (Lee et al. 2004a). However, unlike the findings from Buescher et al. (2003), those from Lee et al. (2004a) suggest that children on WIC are less likely to use emergency rooms and hospitals for dental care. This difference seems to have important implications for Medicaid expenditures for dental services. As Lee et al. (2004b) suggested, children on WIC are more likely to have any Medicaid expenditures related to dental care. Among younger children (aged 1-2) with any expenditures, the expenditures are lower among WIC participants. While the authors concluded that the combined effect leads to lower total Medicaid expenditures among children aged 1-2 on WIC, since the statistical significance of these findings is not reported, it is not clear whether the inferred relationship is due to chance. The conclusions of Lee et al. (2004b) are in stark contrast to the findings of Buescher et al. (2003), who reported that high levels of WIC participation are associated with higher dental-related Medicaid costs for children aged 1-4.

While the finding of a higher rate of health care utilization among WIC participants relative to nonparticipants is fairly consistent across the six reviewed studies, it should nevertheless be interpreted with caution. Four of the six studies are based on administrative data from North Carolina; one study is based on data from Illinois. It is not clear whether a higher rate of health care utilization is characteristic of the WIC population in other states and nationwide. Furthermore, the analysis sample in studies based on data from North Carolina and Illinois is limited to Medicaid enrollees, who make up about 60 percent of WIC participants (Connor et al. 2010). Higher utilization of health care services may not apply to the 40 percent of the WIC population not enrolled in Medicaid. Findings from Chatterji and Brooks-Gunn (2004) provide some evidence of greater health care utilization associated with WIC among a sample not restricted to Medicaid enrollees. However, the findings are based on only one outcome, and the sample is limited to unmarried low-income women from 20 U.S. cities.

D. Research Results

Buescher et al. (2003) examined the use of health care services and associated Medicaid costs among a sample of children on Medicaid, using linked birth certificate, Medicaid, and WIC records from North Carolina. They used multivariate regression analysis to evaluate the relationship between levels of WIC participation and health care utilization, using nonparticipants as the comparison. The three levels of WIC participation were defined as high, medium, and low, based on the percentage of months from age 1 through the particular year of age in which food vouchers were redeemed. Along with variables on demographic characteristics and risk factors available from birth certificates, the authors controlled for whether the EPSDT visit was received in public health departments. By doing so, the authors reduced confounding due to the close proximity of many WIC clinics to other clinical services. They also controlled for prenatal WIC participation to isolate the effect of child WIC participation.

Findings from Buescher et al. (2003) suggest that WIC participants at all ages (1-4) are more likely than nonparticipants to have received any well-child visit and to have had the recommended number of EPSDT visits. In addition, the magnitude of the estimates suggests a positive association between levels of WIC participation and both outcomes. It is thus not surprising that the authors also found that Medicaid expenditures for well-child care and EPSDT visits among WIC participants are higher, and that increased levels of WIC participation are associated with higher Medicaid expenditures.

The higher utilization of health care services among WIC participants was not limited to preventive care; participants were also more likely than nonparticipants to have emergency room visits, to be hospitalized, and to be diagnosed with common childhood illnesses, though the association between WIC and hospitalization was weak and applied only to certain age groups. The total annual Medicaid expenditure per child was also higher among WIC participants relative to nonparticipants, with the high-level WIC participants having the largest such expenditures. High WIC participation had annual Medicaid expenditures that were \$163 higher for 1-year-olds, \$197 higher for 2-year-olds, \$204 higher for 3-year-olds, and \$345 higher for 4-year-olds compared to nonparticipants of the same ages. These are substantial differences, since the total annual Medicaid expenditure per child for ages 1-4 is about \$825.

Buescher et al. (2003) interpreted their findings as indicators of the child's connection with the health care system. As the authors discussed, these findings can be explained three different ways, and no explanation can be confirmed given the data and study methodology: (1) children who use more services may also be more likely to enroll in WIC and thus also more likely to be diagnosed with illnesses (positive selection); (2) children who are more sickly and have higher health care needs are more likely to enroll in WIC (negative selection); and (3) WIC had a positive impact in that it increased children's connection with the health care system and thus the likelihood that they would be diagnosed and receive treatment for their illnesses.

Chatterji and Brooks-Gunn (2004) also analyzed the use of preventive care services, using data from the Fragile Families and Child Wellbeing Study. Using a multivariate regression analysis, the authors evaluated the association between WIC participation by the mother and the likelihood that the child received at least four well-child visits during the first year of life. Like Buescher et al. (2003), the authors found a positive association between WIC participation and the receipt of well-child visits. However, while Buescher et al. (2003) limited their sample to children on Medicaid and therefore to WIC-eligible children, Chatterji and Brooks-Gunn (2004) approximated WIC eligibility by limiting the analysis to unmarried mothers at or below 250 percent of FPL. Given the available information on income and Medicaid participation in the survey, it would have been instructive to test whether the estimates are sensitive to the definition of WIC eligibility for their analysis sample (such as Medicaid participants only, or women living below 185 percent of FPL).

Using data from linked North Carolina birth, Medicaid, and WIC files, Lee et al. (2004a) evaluated the association between child WIC participation and the use of dental care services among children enrolled in Medicaid. Using a two-stage instrumental variable approach, the authors found that children's WIC participation is associated with an increase in the use of oral health services. Compared to nonparticipants, WIC participants are more likely to have a preventive and restorative dental visit and less likely to have an emergency room visit. Using the same data, outcomes, and methods and comparable instruments, Lee et al. (2005) came to similar conclusions regarding the association between WIC participation and the use of dental care services. As noted earlier, the number of WIC clinics per county, full-time WIC workers per county, and WIC hours of operation per county—examples of instruments used by the authors—are unlikely to be randomly distributed across counties. For example, WIC offices are likely to locate where there is a greater need or demand for WIC services. Therefore, counties with greater WIC availability may be different from counties with relatively few offices in ways that are not observed by the authors but are correlated with the outcome.

Lee et al. (2004b) is one of the two studies that estimated the possible Medicaid cost savings related to child WIC participation. Using the same North Carolina data analyzed by Lee et al. (2004a and 2005), Lee et al. (2004b) estimated the association between WIC and the likelihood of having any dental-related Medicaid expenditures, as well as the amount of the expenditures among children aged 1-4 enrolled in Medicaid. The authors used a two-part model, where the first part estimated the effect of WIC participation on the probability of having a Medicaid-reimbursed dental expenditure, and the second part estimated the effect of WIC participation on the amount spent among those with any expenditure. Both regressions controlled for mother's race, age, marital status, income, and education, as well as the number of months the child was enrolled in Medicaid, the child's age, and the number of dentists per 10,000 persons in the county of residence.

The authors found that WIC participation increases the likelihood of any dental spending among infants and children aged 1-2 but reduces the average dental expenditures among those with positive expenditures for infants and 1-year-olds. Taking into account both effects, the authors concluded that WIC reduced total dental-related Medicaid spending among the younger age groups, and interpreted this as evidence that WIC's promotion of better home oral care and more frequent dental visits reduces the prevalence and severity of dental disease.

The authors focused on the savings among children aged 1-2. The results seem to indicate that WIC reduces Medicaid dental spending by less and less as the children age, and even increases it for children aged 3-4. If the difference between WIC and non-WIC children reflects better counseling, then one would expect the opposite pattern: an increase in WIC's effect rather than a decrease. As noted earlier, the authors did not provide the standard errors for their estimates of the effect of WIC on total dental spending. Therefore, the reader cannot determine whether the differences are due simply to chance.

Most recently, Lee et al. (2006) used data from the Integrated Database on Children's Services in Illinois to evaluate the relationship between participation in the WIC, Food Stamp, or both programs and the timing and utilization of EPSDT services among a sample of children who enrolled in Medicaid within their first month of life. The authors employed an instrumental variable approach as well as mother fixed-effects in an attempt to control for selection bias. However, since the instrument used by the authors—the distance between a child's residence and the nearest WIC office—was not a strong predictor of WIC participation, the authors emphasized their findings from the fixed-effects model.

One of the main strengths of the study is its ability to apply the fixed-effects model to a large sample of children: the authors identified 15,882 discordant sibling groups. Previous WIC evaluations using this method were severely limited in their sample size. The findings based on this method suggest no association between enrollment in WIC-only and EPSDT services, and a strong negative association between joint enrollment in WIC and the Food Stamp Program and EPSDT. The pattern of the coefficients suggests that this negative association for the dual participation is driven by the Food Stamp Program rather than by WIC.

Since there is no theoretical reason to believe that joint participation in WIC and the Food Stamp Program should *cause* a lower utilization of EPSDT services, the negative association provided by the fixed-effects model is more likely to be a reflection of the limitations of this method in reducing bias from time-variant unobservable factors or simply the result of the authors' definition of WIC participation. Lee et al. (2006) are among the few who considered the timing of WIC enrollment in relation to the occurrence of the outcome. As the authors noted, this is a necessary step for inferring a "causal" relationship. However, as they also noted, the correction applied to eliminate the reverse causality may have biased their estimates of the effects of WIC on utilization of EPSDT downward, since WIC participants who received EPSDT services prior to enrollment were categorized as nonparticipants at the time of the event (the EPSDT visit). This classification could increase the rate of EPSDT among nonparticipants relative to WIC participants.

Table VII.1. Studies Examining the Effect of WIC Participation on Infant and Child Health Care Utilization and Associated Costs

Study	Data and Sample	Design and Methods	Findings	
Buescher et al. 2003	**Data:** North Carolina birth certificates merged with Medicaid participation and cost data **Sample:** 1992 births with Medicaid enrollment at any time before 60 months (N=49,795)	**Treatment group:** Children with high (>66% of eligible months), medium (34%-66%), or low (<34%) levels of WIC participation during the first 60 months of life **Comparison group:** Nonparticipants during first 60 months of life **Methods:** Multivariate regression	Well-child care visits Early and Periodic Screening, Diagnosis, and Treatment (EPSDT) visits Emergency room visits Hospitalizations Diagnosis and treatment for: Allergy Asthma Gastroenteritis Iron deficiency anemia Otitis media Respiratory infection Medicaid preventive child care costs Medicaid curative child care costs (Compared to nonparticipants, children with high WIC participation had annual Medicaid expenditures that were $163 higher for 1-year-olds, $197 higher for 2-year-olds, $204 higher for 3-year-olds, and $345 higher for 4-year-olds)	+++ +++ +++ +++ +++ +++ +++ +++ +++ +++ +++ +++
Chatterji and Brooks-Gunn 2004	**Data:** Fragile Families and Child Wellbeing Study baseline survey **Sample:** 1999-2000 survey of unmarried, low-income urban mothers in 20 cities nationwide (N=2,136)	**Treatment group:** Enrolled at any time after birth of child **Comparison group:** Likely WIC-eligible mothers who did not enroll at any time after birth of child **Methods:** Multivariate regression	Well-child care visits	+++
Lee et al. 2004a	**Data:** Linked North Carolina administrative data (composite birth records, Medicaid eligibility enrollment files, Medicaid dental enrollment files, WIC files); 4-year panel data set **Sample:** Children born in North Carolina in calendar year 1992 who were enrolled in Medicaid (N=49,795)	**Treatment group:** Children who participated in WIC, as measured by number of months when any WIC voucher was redeemed during each year of life **Comparison group:** Children who did not participate in WIC **Method:** Instrumental variable model	Preventive care visit Restorative care visit Emergency care visit	+++ +++ -

Table VII.1 *(continued)*

Study	Data and Sample	Design and Methods	Findings	
Lee et al. 2004b	**Data:** Linked North Carolina administrative data sets including composite birth records, Medicaid enrollment files, Medicaid dental claims, WIC files, and Area Resource file **Sample:** Children born in North Carolina in calendar year 1992 who were enrolled in the Medicaid program between birth and age 3 years (N=49,795)	**Treatment group:** Children participating in WIC for each year of life (infant, age 1 year, age 2 years, and age 3 years. Children were considered WIC participants for any year if the household redeemed any WIC food vouchers for that particular year of life **Comparison group:** Children not participating in WIC **Method:** Multivariate regression	Infant WIC Any dentally related expenditures Amount of dentally related expenditures Age 1 WIC Any dentally related expenditures Amount of dentally related expenditures Age 2 WIC Any dentally related expenditures Amount of dentally related expenditures Age 3 WIC Any dentally related expenditures Amount of dentally related expenditures	 +++ --- +++ --- ++ NS NS NS
Lee et al. 2005	**Data:** Linked North Carolina administrative data sets including composite birth records, Medicaid enrollment files, Medicaid dental claims, WIC files, and Area Resource file **Sample:** Children born in North Carolina in calendar year 1992 who were enrolled in the Medicaid program (N=49,795)	**Treatment group:** Children who participated in WIC, as measured by number of months when any WIC voucher was redeemed during each year of life **Comparison group:** Children who did not participate in WIC **Method:** Instrumental variable model	Dental services use	+++
Lee et al. 2006	**Data:** Administrative data from the Integrated Database on Children's Services in Illinois (IDB), merged with U.S. Census and vital statistics data **Sample:** Illinois Medicaid births between 1990 and 2000 (N=36,277)	**Treatment group:** Children participating in WIC before the occurrence of a relevant health event (e.g., diagnosis of anemia) **Comparison group:** Children not participating in WIC or Food Stamps **Method:** Multivariate regression; maternal fixed effects	Multivariate regression model: EPSDT visits Maternal fixed-effects model: EPSDT visits	 --- NS

Notes: "+++", "++", and "+" indicate a statistically significant positive association between WIC and the specific outcome at p<0.01, p<0.05, and p<0.1, respectively; "---", "--", and "-" indicate a statistically significant negative association between WIC and the specific outcome at p<0.01, p<0.05, and p<0.1, respectively; "NS" indicates a nonsignificant finding.

VIII. IMPACTS ON CHILD HEALTH AND SOCIOEMOTIONAL AND COGNITIVE DEVELOPMENT

The literature search uncovered eight studies that analyzed the association between WIC participation and various measures of child health and development. Two evaluated the prevalence of childhood morbidity as measured by diagnosis of illnesses such as asthma, a respiratory illness, a severe gastrointestinal illness, ear infection, or other common childhood illnesses. Four evaluated a general health rating of the child, based on either the caregiver's report or a physician's assessment. One study evaluated children's cognitive, motor, and socioemotional abilities. Table VIII.1 presents a summary of the data sources, measures of WIC participation, statistical methods used, and a summary of findings in all seven studies.

A. Approaches to Dealing with Selection Bias

Three of the studies discussed in this section used multivariate analysis (Buescher et al. 2003; Black et al. 2004; Carlson and Senauer 2003). All studies limited their sample to WIC participants and eligible nonparticipants as determined either by participation in Medicaid, household income, or both. Carlson and Senauer (2003) further employed a Hausman test to evaluate the endogeneity of WIC participation. Since the results of the test indicated that the estimates from the multivariate and instrumental variable models were not statistically different, the authors concluded that WIC participation is exogenous and therefore used the multivariate regression model for their analysis.

As Carlson and Senauer (2003) pointed out, the reliability of this test depends heavily on the quality of the instruments used to predict WIC participation. The instruments the authors used included employment, urbanization, whether the mother was younger than 18 when the child was born, language spoken in the household, U.S.-born status of the parents, time spent living at the current address, and phase of the National Health and Nutrition Examination Survey (NHANES) survey. While the authors stated that these variables had a low t-statistic when predicting child health in their sample, this test is not sufficient to establish exogeneity. There is extensive literature indicating a correlation between most of these measures and health. As with all applications of instrumental variables, the authors need to make a case for the validity of the instruments.

As noted in the Research Results section of Chapter IV (Impacts on Infant and Child Dietary Intake, Food Security and Related Outcomes), the analysis by Black et al. (2004) is unique in that the authors stratified WIC-eligible nonparticipants into two groups: (1) children of mothers with reported access problems, and (2) children of mothers with no perceived need for WIC benefits. About half the nonparticipant sample with reported access problems was on a waiting list to receive WIC, a reason for nonparticipation that is likely uncorrelated with child health outcomes. Other reported access problems, however, such as not having time to pick up vouchers and living in a shelter, are potentially negatively correlated with child health outcomes.

Sparks (2010) and Rivera (2008) used a propensity-score-matching method to minimize differences between WIC participants and the comparison group. Rivera (2009) could not achieve a balance on covariates for the full matched sample and therefore limited the analysis to the children in the two highest quartiles based on their estimated probability to participate in WIC (the propensity score). However, differences in certain characteristics remained even for these two subgroups of children. WIC participants in the highest quartile were significantly less likely than matched nonparticipants to live in urban areas. WIC participants and matched nonparticipants in the second-highest quartile differed in terms of poverty, Medicaid receipt, and foreign-born status.

While Sparks (2010) was able to reduce differences in most covariates between WIC participants and nonparticipants, some differences remained in this study as well.

Lee et al. (2006) compared three analytic approaches to estimating WIC impacts: multivariate regression, fixed-effects models, and an instrumental variable approach that used distance to WIC clinics as the predictor of WIC enrollment. Distance to a WIC clinic turned out to be only weakly associated with WIC enrollment, and as a result the instrumental variables results are given less emphasis than results from multivariate regression and fix-effects models. Comparing the multivariate regression results to maternal fixed-effects results, the authors found that both models produced similar findings. Lee et al. (2006) interpreted this as evidence that time-invariant unobserved factors are not major sources of bias for WIC studies. Other considerations—such as the complication from factors that change over time that likely contribute to both changes in WIC participation and child health outcomes—are not discussed.

B. Other Methodological Considerations

Outcomes such as a physician's diagnosis of illnesses depend on a visit to a health care provider. Differences in the utilization of health care services between WIC participants and nonparticipants are likely a confounding factor for these outcomes if they are based on parents' reports rather than physicians' assessments of all children in a particular survey. As suggested by Buescher et al. (2003), children on WIC have a higher utilization of health care services relative to eligible nonparticipants, which likely leads to higher rates of diagnosis of illnesses among children enrolled in WIC. The association between WIC and health care utilization may not be causal; nevertheless, it has important consequences for the interpretation of the findings for parent-reported diagnoses of childhood illnesses.

C. Summary of Key Findings

The literature on the association between WIC and child health outcomes provides no clear evidence of either a positive or a negative association. Carlson and Senauer (2003) found a positive relationship between WIC and physicians' assessments of children's health among a sample of WIC-eligible children, as well as based on a larger sample that included children from more advantaged families. Among infants 12 months or younger, Black et al. (2004) found that, compared to children in families who because of perceived access problems did not receive WIC benefits, children receiving WIC benefits were less likely to be in fair or poor health, as reported by the caregiver. Rivera (2008) found a marginally significant negative association between WIC and mother's report of child's health status at age 24 months for a subgroup of children (as defined by their estimated propensity to participate in WIC), but no significant impacts for health at 9 months. Findings from Sparks (2010) suggest no association between WIC and ratings of children's general health or physician's diagnosis of illnesses as reported by the mother. Buescher et al. (2003) found a higher incidence of diagnosis of common childhood illnesses among WIC participants compared to nonparticipants, which they attributed to the higher utilization of health care services among WIC participants. Estimates from Rivera (2008) suggest no consistent association between prenatal WIC participation and children's cognitive, motor, and socioemotional abilities. The estimates vary somewhat based on the subgroups of children classified by the probability of WIC participation (as determined by the propensity score). Of the 14 estimates, 2 suggest a significant positive and 2 a significant negative association with WIC.

The evidence on the relationship between WIC participation and iron status is complicated. Two studies examined the prevalence of iron deficiency (ID) or iron deficiency anemia (IDA) based on blood samples for the entire sample and found that WIC participation reduced the prevalence of ID and IDA (Schneider et al. 2008; Park et al. 2009). Two other studies examined the relationship between WIC participation and the likelihood of being diagnosed with anemia and other measures of nutritional deficiency. Of these two studies, one found that child WIC participation was associated with an increased prevalence of being diagnosed with anemia and all measures of nutritional deficiency (Buescher et al. 2003), while the other found the exact opposite (Lee et al. 2006). It is difficult to determine whether the differences in these results are due to differences between the studies in (1) the study population (North Carolina versus Illinois Medicaid enrollees), (2) methods used to estimate the models, (3) definition of WIC participation, or (4) other factors.

D. Research Results

Sparks (2010) evaluated the association between WIC participation and diagnosis of childhood morbidities by age 9 months, using a nationally representative sample of children from the Early Childhood Longitudinal Study, Birth Cohort (ECLS-B), Longitudinal Nine-Month-Preschool Restricted-Use Data File. The author limited the sample to WIC participants and eligible nonparticipants defined as children from families with incomes at or below 185 percent of FPL, or from families with a household member enrolled in Medicaid, TANF, or the Food Stamp Program. Using propensity score methods to minimize observable differences between WIC participants and nonparticipants, the authors compared the average treatment effect based on the matched sample to the estimates based on the unmatched sample. The findings suggest that WIC participants differ from eligible nonparticipants in terms of both demographic and socioeconomic characteristics, and that WIC participants are generally negatively selected based on these observable factors. The estimates based on the unmatched sample suggest that WIC participants are significantly more likely to be diagnosed with all illnesses evaluated by the authors—asthma, respiratory illness, a severe gastrointestinal illness, and ear infection—and are more likely to be rated in poor health by their mother. On the other hand, the estimates based on the matched sample indicate smaller differences, and the differences are no longer significant for any of the outcomes.

Measures of physicians' diagnoses of illnesses employed by Sparks (2010) are based on mothers' reports. As noted earlier, a diagnosis by a physician is naturally conditional on a visit to the physician. Since previous research suggests that health care utilization is higher among WIC participants than among eligible nonparticipants (Buescher et al. 2003; Lee et al. 2004a), a discussion about how differences in utilization might affect the study's estimates would have been instructive. (See the "Impacts on Health Care Utilization and Related Costs" chapter for a more detailed discussion, based on findings from Buescher et al. 2003, about the relationship between WIC and (1) health care utilization, and (2) diagnosis of illnesses).

Carlson and Senauer (2003) used data from NHANES III on children aged 24 to 60 months to analyze the association between WIC participation by anyone in the household and physicians' overall evaluation of children's health. Similar to Sparks (2010), Carlson and Senauer (2003) limited their sample to WIC participants and eligible nonparticipants, defined as children from households that either had income below the WIC threshold or included someone who qualified for Medicaid. The authors used an ordered probit to evaluate the association between WIC and a four-point scale rating of the child's health (excellent, very good, good, fair/poor), controlling for individual, household, and geographic characteristics. The findings based on the WIC-eligible sample suggest that children from households that participated in WIC were more likely than nonparticipants to be in excellent health. As noted earlier, the authors chose a multivariate regression model over an instrumental variable approach, citing results from a Hausman test indicating no difference between the estimates from the two models; and the validity of the instruments employed by the authors to perform the test are questionable.

Rivera (2008) also used the ECLS-B and analyzed the association between prenatal WIC participation and infants' cognitive, motor, socioemotional abilities, and health status at ages 9 and 24 months, as reported by the parents. The author employed a propensity-score-adjusted multivariate regression model. Because the matching procedure improved equivalence only in the sample with propensity scores in the two highest quartiles, Rivera focused on the estimates based on this subsample. The simple multivariate analyses based on this subgroup suggest that WIC is associated with an improvement in motor skills at 9 months. The propensity-score-adjusted estimates based on the sample of children with the highest probability of WIC participation indicate (1) a significant positive association between WIC and motor skills at 9 months, and (2) a marginally significant positive association with socioemotional ability at 9 months, but (3) a marginally significant negative association with socioemotional ability at 24 months. The only significant finding based on the sample with the second-highest probability of WIC participation is a negative association between WIC and socioemotional ability at 24 months. Their findings for children's health status at 9 and 24 months indicate no association. One of their four estimates related to this outcome is negative and marginally significant. The variation in the results provides no clear understanding of the association between WIC and children's cognitive, motor, and socioemotional abilities, or their health status.

Using data from the Children's Sentinel Nutritional Assessment Program, Black et al. (2004) evaluated the association between WIC participation and caregivers' rating of infants' overall health status. As described earlier, the authors used lack of private health insurance as a proxy for WIC eligibility and constructed two comparison groups based on reported reasons for nonparticipation. Both the unadjusted and the regression-adjusted estimates suggest that infants on WIC are less likely to be in fair or poor health compared to infants in households that, as a result of reported access problems, are not currently receiving WIC benefits. On the other hand, children in households with no perceived need for WIC benefits have better health status than children on WIC; however, the differences for this comparison are not statistically significant. The reason for the nonsignificant findings may be lack of statistical power, as the magnitude of the estimates is smaller, and the sample size for the comparison group with no perceived need for WIC (188) is only about half the size of the sample that because of access problems is not on WIC (340).

Iron Deficiency/Iron Deficiency Anemia and Other Nutritional Deficiencies

Lee et al. (2006) used linked Medicaid and WIC data for a sample of children born between 1990 and 2000 in Illinois who entered Medicaid within a month after birth. As noted previously, the study employed a multivariate regression analysis, a mother-fixed-effects model, and an instrumental variable approach to mitigate selection bias. However, since their instrument (proximity to a WIC clinic) is not a strong predictor of WIC participation, the authors focused on the estimates from the multivariate regression and mother-fixed-effects models. Both models produced similar results, which suggests that children enrolled in WIC are at significantly lower risk of being diagnosed with anemia and other nutrition-related health problems, such as malnutrition and vitamin deficiencies.

Schneider et al. (2008) and Park et al. (2009) also examined the association between WIC participation and ID. Schneider et al. (2008) used data from a convenience sample of 498 children of women attending WIC clinics in two counties in California. Study participants were recruited from WIC waiting rooms between August 2000 and June 2002. The authors evaluated the association between several measures of WIC participation and IDA among children aged 1-3. They found a significant reduction in anemia among children who were current WIC participants (compared to children who were not currently enrolled but whose mothers were applying for WIC benefits) and among children whose mothers participated in WIC prenatally. It is very difficult to determine the appropriateness of the comparison group of nonparticipants used in this study. Since the nonparticipants had not previously been WIC participants as infants, it would have been useful to know several factors about the child nonparticipants, especially the sample sizes and whether they were more likely to be breastfed.

As part of the Children's Sentinel Nutrition Assessment Project (C-SNAP), which included the administration of the Food Security Survey Module, Park et al. (2009) examined the relationship between (1) food security and ID/IDA, and (2) child WIC participation and ID/IDA. The authors found that children aged 0-3 who participated in WIC were significantly less likely than nonparticipants to have ID. There was no significant difference between WIC participants and nonparticipants in the prevalence of IDA. However, since one of the objectives of the study was to evaluate the relationship between household food security and ID, measures of very low food security and low food security were included among the covariates. If improved food security from WIC participation is partly responsible for reducing the incidence of ID, then the authors' estimates of WIC effects are biased downward.

Table VIII.1. Studies Examining the Effect of WIC Participation on Child Health and Socioemotional and Cognitive Development

Study	Data and Sample	Design and Methods	Findings	
Black et al. 2004	**Data:** Third National Health and Nutrition Examination Survey (NHANES III) administered at urban medical centers in 5 states and Washington, DC (1998-2001) **Sample:** Caregivers of infants ≤12 months of age without private health insurance (N=5,923)	**Treatment group:** Individuals who received WIC assistance for their child **Comparison group:** (1) Eligible individuals who did not receive WIC assistance for their child because of reported access problems; (2) eligible individuals who did not receive WIC assistance for their child because of no perceived need **Method:** Multivariate regression	Compared to eligible nonparticipants with reported access problems: Caregiver perception of infant health poor/fair Compared to eligible nonparticipants with no perceived need: Caregiver perception of infant health poor/fair	 +++ NS
Buescher et al. 2003	**Data:** North Carolina birth certificates merged with Medicaid participation and cost data **Sample:** 1992 births with Medicaid enrollment at any time before 60 months (N=49,795)	**Treatment group**: Children with high (>66% of eligible months), medium (34%-66%), or low (<34%) levels of WIC participation during the first 60 months of life **Comparison group:** Nonparticipants during first 60 months of life **Methods:** Multivariate regression	Diagnosis and treatment for: Allergy Asthma Gastroenteritis Iron deficiency anemia Otitis media Respiratory infection	 +++ +++ +++ +++ +++ +++
Carlson and Senauer 2003	**Data:** Third National Health and Nutrition Examination Survey (NHANES III) (1988-1994) **Sample:** Nationally representative sample of 2- to 5-year olds in WIC-eligible households (N=1,816)	**Treatment group:** Children in households where any family member participated in WIC in the past month **Comparison group:** Children in households without any family members participating in WIC in the past month **Methods:** Multivariate regression	Child health observed in medical examination (0=excellent, 1=very good, 2=good, 3=fair/poor)	+++
Lee et al. 2006	**Data:** Administrative data from the Integrated Database on Children's Services in Illinois (IDB), merged with U.S. Census and vital statistics data **Sample:** Illinois Medicaid births between 1990 and 2000 (N=36,277)	**Treatment group:** Children participating in WIC before the occurrence of a relevant health event (e.g., diagnosis of anemia) **Comparison group:** Children not participating in WIC or Food Stamps **Method:** Multivariate regression; maternal fixed effects	Multivariate regression model: Anemia Nutritional deficiency Maternal fixed-effects model: Anemia Nutritional deficiency	 --- --- --- ---
Park et al. 2009	**Data:** U.S. Food Security Survey Module and chart review of medical records (1998-2003) **Sample:** Low-income children <36 months old who received care at a large medical center in Minneapolis, Minnesota (N=2,853)	**Treatment group:** Individuals participating in WIC **Comparison group:** Individuals who are low-income but not participating in WIC **Method:** Multivariate regression	Iron deficiency Iron-deficiency anemia	-- NS

Table VIII.1 *(continued)*

Study	Data and Sample	Design and Methods	Findings	
Rivera 2008	**Data:** Early Childhood Longitudinal Study, Birth Cohort (ECLS-B) (2001-2006) **Sample:** Children from 46 states and Washington, DC, whose biological mother was the respondent (N=9,685)	**Treatment group:** Enrolled during pregnancy regardless of postnatal participation **Comparison group:** Did not enroll during pregnancy, regardless of postnatal participation **Methods:** Propensity score matching	Highest quartile of propensity scores: Child health status at 9 mos. Mental ability, 9 mos. Motor skills, 9 mos. Socioemotional ability, 9 mos. Child health status at 24 mos. Mental ability, 24 mos. Motor skills, 24 mos. Socioemotional ability, 24 mos.	 NS ++ NS + NS NS NS -
Schneider et al. 2008	**Data:** Questionnaire and blood samples collected in WIC clinic laboratories in two California counties (2000-2002) **Sample:** Convenience sample of 12- to 36-month-old children recruited in WIC clinics (N=498)	**Treatment group:** (1) Children enrolled in WIC; (2) children of mothers who participated in WIC during pregnancy **Comparison group:** (1) Children whose families are applying for WIC; (2) children of mothers who did not participate in WIC during pregnancy, but who are currently participating or are applying to enroll **Method:** Multivariate regression	Child WIC participation: Anemia Prenatal WIC participation Iron deficiency	 -- ---
Sparks 2010	**Data:** Early Childhood Longitudinal Study – Birth Cohort (ECLS-B) **Sample:** Nationally representative sample of children born between January and December 2001, limited to families with incomes below 185% of poverty or families receiving Medicaid, food stamps, or TANF assistance since the birth of the child (N=6,100).	**Treatment group:** Children in WIC-participating households who used WIC benefits in the last 30 days before the interview **Comparison group:** Children in a household that was eligible for WIC but not participating **Method:** Propensity score matching	Asthma Gastrointestinal illnesses Respiratory illnesses Ear infection Mother poor child health rating	NS NS NS NS NS

Notes: "+++", "++", and "+" indicate a statistically significant positive association between WIC and the specific outcome at p<0.01, p<0.05, and p<0.1, respectively; "---", "--", and "-" indicate a statistically significant negative association between WIC and the specific outcome at p<0.01, p<0.05, and p<0.1, respectively; "NS" indicates a nonsignificant finding.

IX. RESEARCH OVERVIEW

WIC continues to have an extensive research record. Increasingly, researchers are more concerned about the limitations of quasi-experimental methods in estimating a *causal* WIC effect and attempt to reduce selection bias through a careful assessment of the robustness of the estimates or through the application of more sophisticated methods, such as propensity score matching or mother fixed-effects. Despite the efforts to eliminate the issue of selection, it remains the most important consideration in interpreting study results.

The pattern of findings from studies evaluating the association between WIC and birth outcomes, children's diets or infant feeding practices is generally consistent across the different studies. Recent research continues to find a positive association between birth weight and prenatal WIC participation. However, estimates adjusted for gestational age bias, such as measures of fetal growth, indicate a weaker association with WIC. Overall, research suggests that WIC is associated with improved diets among children, as measured by the intake of fats, carbohydrates, added sugars and variety of foods consumed. As with earlier WIC evaluations, the most common finding in recent research is a lower likelihood of breastfeeding and a higher likelihood of formula feeding among WIC participants relative to nonparticipants.

Research on the association between WIC and health care utilization generally indicates a higher utilization of preventive and curative health care services for both primary health care and dental care. Only two studies evaluate the consequences of higher health care utilization among WIC participants for Medicaid costs. One suggests a higher overall cost associated with WIC participation for both primary and dental care services, while the other suggests a reduction in dental care services among children aged 1-2, but not among older children.

The findings for other infant and child health outcomes are generally inconclusive and in some cases are based on a limited number of studies. Research provides no consistent evidence on the association between WIC and children's weight, height, or BMI. Evidence on whether WIC is associated with higher immunization rates is limited and inconclusive. Findings for children's health status suggest a higher likelihood of diagnoses of common childhood illnesses among WIC participants based on data from Medicaid claims, but no clear evidence on the association between WIC and general health status as reported by a physician or the mother. ID and IDA tend to be lower among WIC participants when based on blood tests for the entire sample.

The findings from this review generally parallel the findings based on a review of earlier research completed by Fox et al. (2004). As in the earlier review, the current report finds that research is most extensive in the area of prenatal WIC participation and birth outcomes. However, studies published since 2002 tend to be more conservative in dealing with issues of selection and gestational age bias, and more innovative in their approaches to addressing these issues. Few new studies have explored the utilization of health care and costs associated with WIC, and the ones that have been published in this area rely on data from the 1990s or early 2000s. Thus, our main findings regarding health care utilization and costs are based on studies published between 2003 and 2004 that were also covered by Fox et al. (2004). New research using current data and wider geographic coverage is needed to assess whether the often-cited positive relationship between WIC participation and health care utilization applies to the existing WIC population. In light of the comprehensive revisions in the WIC food packages introduced in 2009, an important objective of future research should be to evaluate the extent to which the improved food packages promote healthier diets, higher rates of breastfeeding among postpartum women, and better health outcomes.

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Wojcicki, Janet M., Roberto Gugig, Cam Tran, Suganya Kathiravan, Katherine Holbrook, and Melvin B. Heyman. "Early Exclusive Breastfeeding and Maternal Attitudes Towards Infant Feeding in a Population of New Mothers in San Francisco, California." *Breastfeeding Medicine,* vol. 5, no. 1, 2010, pp. 9–15.

Yunzal-Butler, Cristina, Ted Joyce, and Andrew D. Racine. "Maternal Smoking and the Timing of WIC Enrollment." *Maternal & Child Health Journal,* vol. 14, no. 3, 2010, pp. 318–331.

Ziol-Guest, K. M., and D. C. Hernandez. "First- and Second-Trimester WIC Participation Is Associated with Lower Rates of Breastfeeding and Early Introduction of Cow's Milk During Infancy." *Journal of the American Dietetic Association,* vol. 110, no. 5, 2010, pp. 702–709.

APPENDIX A

STUDY ABSTRACTS

Arsenault, J. E. and K. H. Brown. “Zinc Intake of US Preschool Children Exceeds New Dietary Reference Intakes.” *American Journal of Clinical Nutrition,* vol. 78, no. 5, 2003, pp. 1011–1017.

ABSTRACT

Background: The recent dietary reference intakes publication provides updated information on the physiologic and dietary requirements for zinc and proposes new tolerable upper intake levels. **Objective:** We analyzed dietary intake data of US preschool children to determine the prevalence of inadequate and excessive intakes of zinc. **Design:** Diets of 7474 nonbreastfeeding preschool children in the Continuing Survey of Food Intakes by Individuals (1994-1996 and 1998) were analyzed for the intakes of zinc and other dietary components, and factors associated with zinc intake were examined. **Results:** The mean intakes of zinc by children aged < 1 y, 1-3 y, and 4-5 y were 6.6, 7.6, and 9.1 mg/d, respectively. Less than 1% of children had usual zinc intakes below the adequate intake or estimated average requirement. The percentages of children with intakes exceeding the tolerable upper intake level were 92% (0-6 mo), 86% (7-12 mo), 51% (1-3 y), and 3% (4-5 y). Controlling for age and energy intake, zinc intake was greater in 1998 than in 1994 ($P < 0.0001$) and was positively associated with participation in the Women, Infants, and Children Program ($P < 0.001$) and with the lowest income category ($P < 0.001$). **Conclusions:** Preschool children in the United States have dietary zinc intakes that exceed the new dietary reference intakes. Zinc intakes increased during the 4 y of the study. The present level of intake does not seem to pose a health problem, but if zinc intake continues to increase because of the greater availability of zinc-fortified foods in the US food supply, the amount of zinc consumed by children may become excessive.

Bhargava, Alok, and Aliaksandr Amialchuk. "Added Sugars Displaced the Use of Vital Nutrients in the National Food Stamp Program Survey." *Journal of Nutrition,* vol. 137, no. 2, 2007, pp. 453–460.

ABSTRACT

Recent increases in consumption of added sugars in the US can reduce intake of vital nutrients and increase the overall energy intakes. A comprehensive framework is necessary for addressing the controversy surrounding the effects of added sugars on nutrient intakes while controlling for dietary knowledge, behavioral factors, and total energy intakes, especially among low-income households. This paper analyzed the proximate determinants of 1-wk availability or use of added sugars by 913 households participating in the National Food Stamp Program Survey conducted in 1996-97. In addition, households' use of protein; fiber; calcium; iron; β-carotene; vitamins A, C, E, B-6, and B-12; folic acid; and potassium were explained by socioeconomic and behavioral factors and by added sugars use. Linear programming analyses were conducted for assessing the effects of food prices on added sugars use. Participation in Supplemental Food Program for Women, Infants and Children program, food stamp benefits, and consumption of low-fat diets were associated ($P < 0.051$ with lower added sugars use. Furthermore, greater use of added sugars significantly lowered households' uses of protein; iron; vitamins A, C, B-6, and B-12; and potassium. Behavioral and socioeconomic variables such as adopting a low-fat diet, consuming fruits and vegetables, saving money at grocery stores, frequency of shopping trips, skipping meals, and food insecurity were often important predictors of nutrient use. Overall, the results indicated that added sugars should be discouraged in dietary guidelines, because their adverse effects on diet quality were evident in this low-income population.

Bitler, Marianne P., and Janet Currie. "Does WIC Work? The Effects of WIC on Pregnancy and Birth Outcomes." *Journal of Policy Analysis and Management,* vol. 24, no. 1, 2005, pp. 73–91.

ABSTRACT

Support for WIC, the Special Supplemental Nutrition Program for Women, Infants, and Children, is based on the belief that "WIC works." This consensus has lately been questioned by researchers who point out that most WIC research fails to properly control for selection into the program. This paper evaluates the selection problem using rich data from the national Pregnancy Risk Assessment Monitoring System. We show that relative to Medicaid mothers, all of whom are eligible for WIC, WIC participants are negatively selected on a wide array of observable dimensions, and yet WIC participation is associated with improved birth outcomes, even after controlling for observables and for a full set of state-year interactions intended to capture unobservables that vary at the state-year level. The positive impacts of WIC are larger among subsets of even more disadvantaged women, such as those who received public assistance last year, single high school dropouts, and teen mothers.

Bitler, Marianne P., and Janet Currie. "Medicaid at Birth, WIC Take Up, and Children's Outcomes." Santa Monica, CA: RAND Corporation, WR-172, 2004. As of October 2, 2011: http://www.rand.org/pubs/working_papers/WR172

ABSTRACT

The Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) provides food and nutritional advice to low-income women, and infants and children, who are income eligible and are nutritionally-at-risk. The effects of WIC on infants have been extensively studied, but children one to four are the most rapidly growing part of the WIC caseload, and little information is available about the effects of WIC on this group. Using data from the 1996 and 2001 panels of the Survey of Income and Program Participation (SIPP), we show that Medicaid policies that affected take up among infants had long term effects on participation in the WIC program. By contrast, increases in the generosity of Medicaid towards older children increased WIC eligibility without having much impact on participation. Hence increases in WIC participation among children have not been driven by higher income families made eligible as a result of SCHIP, as some critics have argued. Our most striking finding is that WIC participation at age four has large and significant effects on the probability that a child is at risk of overweight (i.e. had BMI greater than the 85th percentile for sex and age). This suggests that either the nutrition education or the actual provision of healthy food is helping to prevent obesity among young children. This is an important measure of the success of the WIC program because of the importance of obesity as a public health threat, and because of the importance of establishing healthy eating habits early in life.

Black, Maureen M., Diana B. Cutts, Deborah A. Frank, Joni Geppert, Anne Skalicky, Suzette Levenson, Patrick H. Casey, Carol Berkowitz, Nieves Zaldivar, John T. Cook, Alan F. Meyers, and Tim Herren. "Special Supplemental Nutrition Program for Women, Infants, and Children Participation and Infants' Growth and Health: A Multisite Surveillance Study." *Pediatrics,* vol. 114, no. 1, 2004, pp. 169–176.

ABSTRACT

Context: The Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) is the largest food supplement program in the United States, serving almost 7 500 000 participants in 2002. Because the program is a grant program, rather than an entitlement program, Congress is not mandated to allocate funds to serve all eligible participants. Little is known about the effects of WIC on infant growth, health, and food security. **Objective:** To examine associations between WIC participation and indicators of underweight, overweight, length, caregiver-perceived health, and household food security among infants ≤12 months of age, at 6 urban hospitals and clinics. **Design and Setting:** A multisite study with cross-sectional surveys administered at urban medical centers in 5 states and Washington, D.C., from August 1998 through December 2001. **Participants:** A total of 5,923 WIC-eligible caregivers of infants ≤ 12 months of age were interviewed at hospital clinics and emergency departments. **Main Outcome Measures:** Weight-for-age, length-for-age, weight-for-length, caregiver's perception of infant's health, and household food security. **Results:** Ninety-one percent of WIC-eligible families were receiving WIC assistance. Of the eligible families not receiving WIC assistance, 64% reported access problems and 36% denied a need for WIC. The weight and length of WIC assistance recipients, adjusted for age and gender, were consistent with national normative values. With control for potential confounding family variables (site, housing subsidy, employment status, education, and receipt of food stamps or Temporary Assistance for Needy Families) and infant variables (race/ethnicity, birth weight, months breastfed, and age), infants who did not receive WIC assistance because of access problems were more likely to be underweight (weight-for-age z score = -0.23 vs 0.009), short (length-for-age z score = -0.23 vs -0.02), and perceived as having fair or poor health (adjusted odds ratio: 1.92; 95% confidence interval: 1.29–2.87), compared with WIC assistance recipients. Rates of overweight, based on weight-for-length of >95th percentile, varied from 7% to 9% and did not differ among the 3 groups but were higher than the 5% expected from national growth charts. Rates of food insecurity were consistent with national data for minority households with children. Families that did not receive WIC assistance because of access problems had higher rates of food insecurity (28%) than did WIC participants (23%), although differences were not significant after covariate control. Caregivers who did not perceive a need for WIC services had more economic and personal resources than did WIC participants and were less likely to be food-insecure, but there were no differences in infants' weight-for-age, perceived health, or overweight between families that did not perceive a need for WIC services and those that received WIC assistance. **Conclusions**. Infants ≤12 months of age benefit from WIC participation. Health care providers should promote WIC utilization for eligible families and advocate that WIC receive support to reduce waiting lists and eliminate barriers that interfere with access.

Brodsky, Jennifer L., Samara Viner-Brown, and Arden S. Handler. "Changes in Maternal Cigarette Smoking Among Pregnant WIC Participants in Rhode Island." *Maternal & Child Health Journal,* vol. 13, no. 6, 2009, pp. 822–831.

ABSTRACT

Objectives: To describe the relationship between the timing of entry into the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) among pregnant women in Rhode Island (RI) and changes in maternal cigarette smoking (MCS) during pregnancy. **Methods:** MCS data gathered by WIC were analyzed for pregnant women who self-identified as smokers at the onset of pregnancy between the years 2001–2005. Bivariate and multivariate analyses were performed to examine the relationship between timing of WIC entry and both increased and decreased/quit MCS during pregnancy. **Results:** Self-reports from smokers indicated that 9.5% quit smoking, 24.6% decreased MCS, 26.8% experienced no change, 33.5% increased MCS, and 5.6% attempted to quit MCS but failed during pregnancy. The adjusted odds ratio for smokers with 1st trimester WIC entry and increased MCS was 0.64 (95% CI 0.52, 0.79). Among smokers with 1st trimester PNC entry, the adjusted odds ratio for smokers with 1st trimester WIC entry and decreased/quit MCS was 1.51 (95% CI 1.17, 1.96). **Conclusions:** Early WIC entry appears to be associated with improvements in MCS. Participants who entered WIC in the first trimester of pregnancy were less likely to increase smoking during pregnancy, and if they also had first trimester prenatal care, were more likely to decrease/quit smoking compared to those who entered WIC later. Programs that increase the rates of first trimester WIC entry may contribute to lower rates of MCS in the WIC population.

Buescher, Paul A., Stephanie J. Horton, Barbara L. Devaney, Sarah J. Roholt, Alice J. Lenihan, J. T. Whitmire, and Jonathan B. Kotch. "Child Participation in WIC: Medicaid Costs and Use of Health Care Services." *American Journal of Public Health,* vol. 93, no. 1, 2003, pp. 145–150.

ABSTRACT

We used data from birth certificates, Medicaid, and the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) to examine the relationship of child participation in WIC to Medicaid costs and use of health care services in North Carolina. We linked Medicaid enrollment, Medicaid paid claims, and WIC participation files to birth certificates for children born in North Carolina in 1992. We used multiple regression analysis to estimate the effects of WIC participation on the use of health care services and Medicaid costs. Medicaid-enrolled children participating in the WIC program showed greater use of all types of health care services compared with Medicaid-enrolled children who were not WIC participants. The health care needs of low-income children who participate in WIC may be better met than those of low-income children not participating in WIC.

Bunik, Maya, Nancy F. Krebs, Brenda Beaty, Maureen McClatchey, and David L. Olds. "Breastfeeding and WIC Enrollment in the Nurse Family Partnership Program." *Breastfeeding Medicine,* vol. 4, no. 3, 2009, pp. 145–149.

ABSTRACT

Objective: Recent studies have raised the issue of lower breastfeeding rates for mothers enrolled in the Special Supplemental Nutrition Program for Women, Infants and Children (WIC). We wanted to explore this association of WIC and lower breastfeeding in Nurse Family Partnership Program (NFP), a national representative group of mother–baby pairs on which extensive background data are available. Our aim was to compare breastfeeding rates at 6 and 12 months in NFP high-risk mothers who were enrolled in WIC to those who were not enrolled in WIC. **Methods:** We conducted a retrospective secondary analysis in mothers and infants from this cohort for 2000–2005 (n = 3,570). **Results:** We found that at 6 months of age, 87.8% of mothers who were not breastfeeding were enrolled in WIC as compared to 82.6% of mothers who were breastfeeding ($p < 0.001$). However, in the multivariate analysis, WIC was no longer a significant predictor of breastfeeding. **Conclusions:** Prospective evaluation of this issue is warranted particularly with the implementation of changes in the WIC Food Package and Breastfeeding Promotion.

Carlson, Andrea, and Ben Senauer. "The Impact of the Special Supplemental Nutrition Program for Women, Infants, and Children on Child Health." *American Journal of Agricultural Economics,* vol. 85, no. 2, 2003, pp. 479–491.

ABSTRACT

Data from the third National Health and Nutrition Examination Survey are used to analyze the effect of the Women, Infants, and Children (WIC) Program and other factors on the health of U.S. preschool children. Ordered probit equations are estimated for the physician's overall evaluation of the child's health. The WIC Program has a significant positive impact on the overall health of children. In particular, children in households participating in WIC are significantly more likely to be in excellent health. Increased household income also improves their health.

Chatterji, Pinka, and Jeanne Brooks-Gunn. "WIC Participation, Breastfeeding Practices, and Well-Child Care Among Unmarried, Low-Income Mothers." *American Journal of Public Health,* vol. 94, no. 8, 2004, pp. 1324–1327.

ABSTRACT

We estimated the effect of Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) participation in 1999 to 2000 on breastfeeding initiation and duration and well-child care. We applied multivariate regression to a sample of 2,136 unmarried, low-income, urban mothers from the Fragile Families and Child Wellbeing Study. WIC participation was associated with small increases in the probabilities of initiating breastfeeding and having had at least 4 well-child visits since birth--behaviors that benefit infants beyond the newborn period--but not with breastfeeding duration.

Cox, Suzanne M. "Prenatal Care Experience and Infant Health Outcomes Among Low-Income Women in Eight States, 1996–2003." Ph.D. dissertation, University of Illinois at Chicago, 2009.

ABSTRACT

A study of the relationship between low-income mothers' prenatal care (PNC) site, and associated factors, and their infants' outcomes was carried out using a sample of women from eight states. The sample of 45,277 women was derived from the Pregnancy Assessment Monitoring System, which includes information from a random sample of birth certificates and linked postpartum follow-back survey data. Characteristics of the sample, where they received PNC, and their PNC experiences were summarized for the time period, 1996 to 2003. The unique methodological contribution of this study is the development of a Prenatal Care Experience Index, which is a composite variable that allows for the simultaneous measurement of receipt of health promotion advice and PNC utilization, stratified by participation in the Special Supplementary Nutrition Program for Women, Infants, and Children (WIC), resulting in an eight-category variable. Overall, there was not an increased risk for adverse outcomes among low-income women receiving care at either public or private PNC sites; although infants of women that received PNC at hospital clinics had a slightly increased risk of adverse outcomes, including very low birth weight (<1500 grams), low birth weight (<2500 grams), and very preterm birth (<32 weeks gestational age). Insufficient prenatal care delivery including inadequate communication of health promotion advice and/or failure to participate in WIC was significantly associated with adverse outcomes among infants including: very low birth weight, low birth weight, very preterm birth, and preterm birth (<37 weeks gestational age). Women who received PNC at publicly funded sites were more likely to report receiving adequate health promotion advice and were more likely to participate in WIC than women at other PNC sites. Women who received care at privately funded sites were more likely to start their PNC early and get the recommended number of visits compared to other PNC sites. However, adequate care utilization was not significantly protective against adverse outcomes. The findings support policy and funding decisions which ensure that regardless of site of care, the content of care for low-income women includes adequate health promotion as well as referral to the WIC program.

Daponte, Beth O., Amelia Haviland, and Joseph B. Kadane. "To What Degree Does Food Assistance Help Poor Households Acquire Enough Food? A Joint Examination of Public and Private Sources of Food Assistance." *Journal of Poverty,* vol. 8, no. 2, 2004, pp. 63–87.

ABSTRACT

We study the efficacy of public and private food assistance in alleviating food shortages among poor households by jointly considering the effects of all major forms of domestic food assistance—the Food Stamp Program, WIC, and food pantries. The analyses are based on detailed data collected in 1993 from 398 low-income households in Allegheny County, Pennsylvania. We examine the effect each of the widely available forms of food assistance has on helping poor households acquire enough resources potentially to meet basic nutritional requirements. Research findings suggest that compared with other forms of food assistance, the receipt of a significant amount in food stamps has a much greater impact on whether a household attains at least the Thrifty Food Plan than the receipt of food from a food pantry or through the WIC program.

El-Bastawissi, Amira, Riley Peters, Kristin Sasseen, Tom Bell, and Rebecca Manolopoulos. "Effect of the Washington Special Supplemental Nutrition Program for Women, Infants and Children (WIC) on Pregnancy Outcomes." *Maternal and Child Health Journal,* vol. 11, no. 6, 2007, pp. 611–621.

ABSTRACT

Objectives: We determined the effect of the Washington State Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) on adverse pregnancy outcomes. **Methods:** We used a record-linkage retrospective cohort design. We matched records of eligible women who enrolled in Washington WIC from 9/1/1999-12/31/2000 to records of their subsequent birth/fetal death from the Washington State Department of Health to determine their pregnancy outcome between 9/1/1999-10/15/2001 (N = 42,495). We selected comparison women from birth/fetal death records who were WIC-eligible but not on WIC (N = 30,751). We used unconditional logistic regression for analysis. **Results:** WIC was protective for preterm delivery depending on history of abortion and adequacy of prenatal care, being most protective for women with abortion and inadequate prenatal care (Odds ratio (OR) = 0.4; 95% confidence interval (CI) = 0.3-0.5). WIC was protective for low birth weight depending on women's cervical health, with most protection conferred to those with incompetent cervix (OR = 0.2; 95% CI = 0.1-0.6). WIC was protective for fetal death depending on women's education, being most protective to those with <12 years of education (OR = 0.2; 95% CI = 0.1-0.3). **Conclusions:** WIC is protective for adverse pregnancy outcomes especially for high risk women.

Figlio, David, Sarah Hamersma, and Jeffrey Roth. “Does Prenatal WIC Participation Improve Birth Outcomes? New Evidence from Florida.” *Journal of Public Economics,* vol. 93, no. 1-2, 2009, pp. 235–245.

ABSTRACT

We study the effects of prenatal receipt of nutritional and educational services provided by the Supplemental Nutrition Program for Women, Infants, and Children (WIC) on birth outcomes. Our identification strategy consists of two elements: (1) identifying families in a very tight income range surrounding the WIC eligibility threshold and (2) exploiting a policy change that differentially influenced the WIC take-up rates of the families on each side of the eligibility threshold. We conduct this analysis by merging three large statewide administrative data sets from Florida concerning all births during the period 1997–2001. We match the birth records of infants and the school records of their older siblings in order to relatively precisely identify “marginally eligible” and “marginally ineligible” families that are very similar in their observable characteristics. We find that WIC participation has no effect on mean birth weight and gestational age, but substantially reduces the likelihood of adverse birth outcomes, e.g. birth weights below 2,500 g.

Flower, Kori B., Michael Willoughby, R. J. Cadigan, Eliana M. Perrin, Greg Randolph, and Family Life Project Investigative Team. "Understanding Breastfeeding Initiation and Continuation in Rural Communities: A Combined Qualitative/Quantitative Approach." *Maternal and Child Health Journal,* vol. 12, no. 3, 2008, pp. 402–414.

ABSTRACT

Objective: To determine factors associated with breastfeeding in rural communities. **Methods:** We combined qualitative and quantitative data from the Family Life Project, consisting of (1) a longitudinal cohort study (N = 1,292) of infants born September 2003-2004; and (2) a parallel ethnographic study (N = 30 families). Demographic characteristics, maternal and infant health factors, and health services were used to predict breastfeeding initiation and discontinuation using logistic and Cox regression models, respectively. Ethnographic interviews identified additional reasons for not initiating or continuing breastfeeding. **Results:** Fifty-five percent of women initiated breastfeeding and 18% continued for at least 6 months. Maternal employment at 2 months and receiving WIC were associated with decreased breastfeeding initiation and continuation. Ethnographic data suggested that many women had never even considered breastfeeding and often discontinued breastfeeding due to discomfort, embarrassment, and lack of assistance. **Conclusions:** Breastfeeding rates in these rural communities lag behind national averages. Opportunities for increasing breastfeeding in rural communities include enhancing workplace support, maximizing the role of WIC, increasing hospital breastfeeding assistance, and creating a social environment in which breastfeeding is normative.

Foster, E. M., Miao Jiang, and Christina Gibson-Davis. "The Effect of the WIC Program on the Health of Newborns." *Health Services Research,* vol. 45, no. 4, 2010, pp. 1083–1104.

ABSTRACT

Objective: To determine the effect of the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) on birth outcomes. **Data Source:** The Child Development Supplement (CDS) of the Panel Study of Income Dynamics (PSID). The PSID provides extensive data on the income and well-being of a representative sample of U.S. families from 1968 to present. The CDS collects information on the children in PSID families ranging from cognitive, behavioral, and health status to their family and neighborhood environment. The first two waves of the CDS were conducted in 1997 and 2002, respectively. We use information on 3,181 children and their mothers. **Study Design:** We use propensity score matching with multiple imputations to examine whether WIC program influences birth outcomes: birth weight, prematurity, maternal report of the infant's health, small for gestational age, and placement in the neonatal intensive care unit. Furthermore, we use a fixed-effects model to examine the above outcomes controlling for mother-specific unobservables. **Principal Findings:** After using propensity scores to adjust for confounding factors, WIC shows no statistically significant effects for any of six outcomes. Fixed-effects models, however, reveal some effects that are statistically significant and fairly substantial in size. These involve preterm birth and birth weight. **Conclusions:** Overall, the WIC program had moderate effects, but findings were sensitive to the estimation method used.

Gueorguieva, Ralitza, Steven B. Morse, and Jeffrey Roth. "Length of Prenatal Participation in WIC and Risk of Delivering a Small for Gestational Age Infant: Florida, 1996–2004." *Maternal and Child Health Journal,* vol. 13, no. 4, 2009, pp. 479–488.

ABSTRACT

Objective: To assess the association between length of prenatal participation in WIC and a marker of infant morbidity. By focusing on small for gestational age, we consider one of the possible pathways through which prenatal nutrition affects fetal growth. **Design/Methods:** The study sample consists of 369,535 matched mother-infant pairs drawn from all singleton live births in Florida hospitals from 1996 to 2004. All subjects received WIC and Medicaid-funded prenatal services during pregnancy. We controlled for selection bias on observed variables using a generalized propensity scoring approach and performed separate analyses by gestational age category to control for simultaneity bias. **Results:** Ten percent increase in the percent of time in WIC was associated with 2.5% decrease (95% CI: 2.1–3.0%) in the risk of a full-term an SGA infant. The risk was also significantly decreased for very preterm and late preterm infants (29-33 and 34-36 weeks gestation) but not for extremely preterm infants (23- 28 weeks gestation). **Conclusions:** The observed small negative dose response relationship between percent of pregnancy spent in WIC and fetal growth restriction implies that longer participation in the program confers a small measure of protection against delivering an SGA infant.

Hendricks, Kristy, Ronette Briefel, Timothy Novak, and Paula Ziegler. "Maternal and Child Characteristics Associated with Infant and Toddler Feeding Practices" *Journal of the American Dietetic Association,* 2006, vol. 106, no. 1, 2006, pp. 135–148.

ABSTRACT

Objective: To describe maternal/child characteristics associated with important practices of feeding U.S. infants and toddlers aged 4 to 24 months. **Design:** Cross-sectional analysis of data collected in the 2002 Feeding Infants and Toddlers Study. Maternal/child characteristics associated with compliance to American Academy of Pediatrics feeding guidelines, and maternal/child characteristics associated with specific feeding patterns were assessed. **Subjects:** A national random sample of mothers (n = 2,515) whose infants and toddlers aged 4 to 24 months made up the Feeding Infants and Toddlers Study cohort. **Statistical Analysis:** Student t tests were used to compare the means and standard errors and were considered significant if $P<.05$. To predict if the mother/child met a particular recommendation, logistic regression was used to calculate odds ratios (ORs) and 95% confidence intervals. **Results:** Having a college education was the maternal characteristic associated with the largest number of positive child feeding behaviors. Mothers with a college education were significantly more likely than mothers without a college education to initiate breastfeeding and breastfeed the child to age 6 and 12 months (OR 2.8, 3.2, and 3.9, respectively). College-educated mothers were significantly more likely to comply with the American Academy of Pediatrics juice and complementary feeding recommendations (OR 1.4 and 2.0). In addition, infants and toddlers whose mother had a college education were more likely to consume fruit and less likely to consume sweetened beverages and desserts or candy. Ever breastfeeding the sample child, living in the western region of the United States, and being married and older were also associated with multiple positive practices. The child being in day care was associated with decreased duration of breastfeeding at age 6 and 12 months as well as with consumption of salty snacks. **Conclusions:** Initiatives to improve infant and toddler feeding practices should focus on assisting mothers who have less than a college education, who are unmarried, whose child is in day care, or who are enrolled in the Special Supplemental Nutrition Program for Women, Infants, and Children.

Hoynes, Hilary W., Marianne E. Page, and Ann H. Stevens. "Is a WIC Start a Better Start? Evaluating WIC's Impact on Infant Health Using Program Introduction." Cambridge, MA: National Bureau of Economic Research, NBER Working Paper No. 15589, 2009.

ABSTRACT

The goal of federal food and nutrition programs in the United States is to improve the nutritional well-being and health of low-income families. A large body of literature evaluates the extent to which the Supplemental Program for Women Infants and Children (WIC) has accomplished this goal, but most studies have been based on research designs that compare program participants to non-participants. If selection into these programs is non-random then such comparisons will lead to biased estimates of the program's true effects. In this study we use the rollout of the WIC program across counties to estimate the impact of the program on infant health. We find that the implementation of WIC lead to an increase in average birth weight and a decrease in the fraction of births that are classified as low birth weight. We find no evidence that these estimates are driven by changes in fertility. Back-of-the-envelope calculations suggest that the initiation of WIC lead to a ten percent increase in the birth weight of infants born to participating mothers.

Ishdorj, Ariun, Helen H. Jensen, and Justin Tobias. "Intra-Household Allocation and Consumption of WIC-Approved Foods: A Bayesian Approach." Center for Agricultural and Rural Development (CARD) Publications 07-wp452, Center for Agricultural and Rural Development (CARD) at Iowa State University, 2007.

ABSTRACT

WIC, the Special Supplemental Nutrition Program for Women, Infants, and Children, is a widely studied public food assistance program that aims to provide foods, nutrition education, and other services to at-risk, low-income children and pregnant, breastfeeding, and postpartum women. From a policy perspective, it is of interest to assess the efficacy of the WIC program - how much, if at all, does the program improve the nutritional outcomes of WIC families? In this paper we address two important issues related to the WIC program that have not been extensively addressed in the past. First, although the WIC program is primarily devised with the intent of improving the nutrition of "target" children and mothers, it is possible that WIC may also change the consumption of foods by non-targeted individuals within the household. Second, although WIC eligibility status is predetermined, participation in the program is voluntary and therefore potentially endogenous. We make use of a triangular treatment-response model in which the dependent variable is the requirement-adjusted calcium intake from milk consumption and the endogenous variable is WIC participation, and estimate it using Bayesian methods. Using data from the CSFII 1994-1996, we find that the correlation between the errors of our two equations is strong and positive, suggesting that families participating in WIC have an unobserved propensity for high calcium consumption. The direct "structural" WIC parameters, however, do not support the idea that WIC participation leads to increased levels of calcium consumption from milk.

Jacknowitz, Alison, Daniel Novillo, and Laura Tiehen. "Special Supplemental Nutrition Program for Women, Infants, and Children and Infant Feeding Practices." *Pediatrics,* vol. 119, no. 2, 2007, pp. 281–289.

ABSTRACT

Objective: This study examined the association between participation in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) and adherence to 4 American Academy of Pediatrics recommendations on infant feeding. **Methods:** We used data from the Early Childhood Longitudinal Study-Birth Cohort, which is nationally representative of children born in 2001. We estimated regression models to assess relationships between program participation and adherence to American Academy of Pediatrics recommendations on exclusive breastfeeding and the introduction of infant formula, cow's milk, and solid foods. **Results:** Regression results indicated that WIC participation was associated with a 5.9 percentage point decrease in the likelihood of exclusive breastfeeding for ≥4 months and a 1.9-percentage point decrease in the likelihood of exclusive breastfeeding for ≥6 months. Program mothers were 8.5 percentage points less likely than nonparticipants to adhere to the American Academy of Pediatrics recommendation to delay introduction of infant formula until month 6. Program mothers were 2.5 percentage points more likely than nonparticipants to delay the introduction of cow's milk until month 8. Program participants were 4.5 percentage points less likely than nonparticipants to delay the introduction of solid foods for ≥4 months. However, the difference between participants and nonparticipants disappeared by month 6. **Conclusions:** Results suggest that, although program participants are less likely to breastfeed exclusively than eligible nonparticipants, program-provided infant formula is an important option for mothers who do not breastfeed exclusively. The program faces the challenge to encourage breastfeeding without undermining incentives to follow other recommended infant feeding practices. Recent changes proposed to the food packages by the U.S. Department of Agriculture Food and Nutrition Service are consistent with the goal of increasing adherence to recommended infant feeding practices among participants.

Jiang, Miao, E. M. Foster, and Christina Gibson-Davis. "The Effect of WIC on Breastfeeding: A New Look at an Established Relationship." *Children & Youth Services Review,* vol. 32, no. 2, 2010, pp. 264–273.

ABSTRACT

Although the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) has been credited with increasing birth weights and improving child health, the program has been criticized for reducing breastfeeding through the provision of free formula. Yet WIC recipients are socio-economically disadvantaged as compared to non-participants. As a result, whether lower breastfeeding rates reflect the effect of the program or the types of women who participate is unknown. Using data from the Panel Study of Income Dynamics—Child Development Supplement, this study uses propensity scores and fixed-effects estimation to determine the effect of WIC on breastfeeding initiation and duration. Our study is the first to use a method other than Ordinary Least Squares to analyze the association between WIC and breastfeeding behaviors. Results indicate that the negative association is likely spurious, arising from the poor socio-demographic profile of participants.

Joyce, Ted, Diane Gibson, and Silvie Colman. "The Changing Association between Prenatal Participation in WIC and Birth Outcomes in New York City." *Journal of Policy Analysis and Management,* vol. 24, no. 4, 2005, pp. 661–685.

ABSTRACT

We analyze the relationship between prenatal WIC participation and birth outcomes in New York City from 1988—2001. The analysis is unique for several reasons. First, we have over 800,000 births to women on Medicaid, the largest sample ever used to analyze prenatal participation in WIC. Second, we focus on measures of fetal growth distinct from preterm birth, since there is little clinical support for a link between nutritional supplementation and premature delivery. Third, we restrict the primary analysis to women on Medicaid who have no previous live births and who initiate prenatal care within the first four months of pregnancy. Our goal is to lessen heterogeneity between WIC and non‐WIC participants by limiting the sample to highly motivated women who have no experience with WIC from a previous pregnancy. Fourth, we analyze a large sub‐sample of twin deliveries. Multifetal pregnancies increase the risk of anemia and fetal growth retardation and thus may benefit more than singletons from nutritional supplementation. We find no relationship between prenatal WIC participation and measures of fetal growth among singletons. We find a modest pattern of association between WIC and fetal growth among U.S.‐born Black twins. Our findings suggest that prenatal participation in WIC has had a minimal effect on adverse birth outcomes in New York City.

Joyce, Ted, Andrew Racine, and Cristina Yunzal-Butler. "Reassessing the WIC Effect: Evidence from the Pregnancy Nutrition Surveillance System." *Journal of Policy Analysis and Management,* vol. 27, no. 2, 2008, pp. 277–303.

ABSTRACT

Recent analyses differ on how effective the Special Supplemental Nutrition Program for Women, Infants and Children (WIC) is at improving infant health. We use data from nine states that participate in the Pregnancy Nutrition Surveillance System to address limitations in previous work. With information on the mother's timing of WIC enrollment, we test whether greater exposure to WIC is associated with less smoking, improved weight gain during pregnancy, better birth outcomes, and greater likelihood of breastfeeding. Our results suggest that much of the often reported association between WIC and lower rates of preterm birth is likely spurious, the result of gestational age bias. We find modest effects of WIC on fetal growth, inconsistent associations between WIC and smoking, limited associations with gestational weight gain, and some relationship with breastfeeding. A WIC effect exists, but on fewer margins and with less impact than has been claimed by policy analysts and advocates.

Khoury, A. J., S. W. Moazzem, C. M. Jarjoura, C. Carothers, and A. Hinton. "Breast-Feeding Initiation in Low-Income Women: Role of Attitudes, Support, and Perceived Control." *Women's Health Issues: Official Publication of the Jacobs Institute of Women's Health,* vol. 15, no. 2, 2005, pp. 64–72.

ABSTRACT

Despite the documented health and emotional benefits of breast-feeding to women and children, breast-feeding rates are low among subgroups of women. In this study, we examine factors associated with breast-feeding initiation in low-income women, including Theory of Planned Behavior measures of attitude, support, and perceived control, as well as sociodemographic characteristics. A mail survey, with telephone follow-up, of 733 postpartum Medicaid beneficiaries in Mississippi was conducted in 2000. The breast-feeding initiation rate in this population was 38%. Women who were older, white, non-Hispanic, college-educated, married, not certified for the Supplemental Nutrition Program for Women, Infants, and Children, and not working full-time were more likely to breast-feed than formula-feed at hospital discharge. Attitudes regarding benefits and barriers to breast-feeding, as well as health care system and social support, were associated with breast-feeding initiation at the multivariate level. Adding the health care system support variables to the regression model, and specifically support from lactation specialists and hospital nurses, explained the association between breast-feeding initiation and women's perceived control over the time and social constraints barriers to breast-feeding. The findings support the need for health care system interventions, family interventions, and public health education campaigns to promote breast-feeding in low-income women.

Knol, Linda L., Betsy Haughton, and Eugene C. Fitzhugh. "Food Insufficiency Is Not Related to the Overall Variety of Foods Consumed by Young Children in Low-Income Families." *Journal of the American Dietetic Association,* vol. 104, no. 4, 2004, pp. 640–644.

ABSTRACT

This study explored the relationship between food sufficiency status and redundancy of food choices, or dietary variety, among children in low-income families using the Variety Score from the Healthy Eating Index. Two samples of children ages 2 to 3 (n = 1,242) and 4 to 8 years (n = 1,506) were selected from the Continuing Survey of Food Intakes by Individuals 1994–1996, 1998 and then classified as either food sufficient, food sufficient with limitations, or food insufficient. Mean variety scores were low for all children, but did not differ by food sufficiency status for either age group. However, they did differ by Special Supplemental Nutrition Program for Women, Infants, and Children participation and region of the country for the younger and older children, respectively. Results suggest the importance of nutrition education and food assistance programs that enhance dietary variety. Further research should explore how food assistance program participation is related to dietary variety and the degree to which variety within food groups is related to food security.

Kowaleski-Jones, Lori, and Greg J. Duncan. "Effects of Participation in the WIC Program on Birthweight: Evidence from the National Longitudinal Survey of Youth." *American Journal of Public Health,* vol. 92, no. 5, 2002, pp. 799–804.

ABSTRACT

Objectives: This study sought to estimate the impact on birthweight of maternal participation in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC). **Methods:** WIC estimates were based on sibling models incorporating data on children born between 1990 and 1996 to women taking part in the National Longitudinal Survey of Youth. **Results:** Fixed-effects estimates indicated that prenatal WIC participation was associated with a 0.075 unit difference (95% confidence interval [CI] = -0.007, 0.157) in siblings' logged birthweight. At the 88-oz. (2,464g) low-birthweight cutoff, this difference translated into an estimated impact of 6.6 oz. (184.8g). **Conslusion:** Earlier WIC impact estimates may have been biased by unmeasured characteristics affecting both program participation and birth outcomes. Our approach controlled for such biases and revealed a significant positive association between WIC participation and birthweight.

Kranz, Sibylle. "Meeting the Dietary Reference Intakes for Fiber: Sociodemographic Characteristics of Preschoolers with High Fiber Intakes." *American Journal of Public Health,* vol. 96, no. 9, 2006, pp. 1538–1541.

ABSTRACT

To better understand the public health impact of the National Academy of Sciences' Dietary Reference Intakes (DRIs) for fiber in preschoolers, I analyzed data from the United States Department of Agriculture Continuing Survey of Food Intake in Individuals for 5437 preschoolers and examined socio-demographic predictors of meeting the DRIs. Overall, only 12% of the children met the DRIs. Older children (age 4 and 5 years) were less likely than younger children, girls were less likely than boys, and children from medium-income families (those earning 186% to 350% of the poverty guidelines, with poverty set at 100%) were least likely to meet the DRIs. Low-income children participating in the Special Supplemental Nutrition Program for Women, Infants, and Children were twice as likely as nonparticipants to meet the DRIs. The public should be educated about the importance of increasing fiber density in the diet.

Kranz, Sibylle, and Anna Siega-Riz. "Sociodemographic Determinants of Added Sugar Intake in Preschoolers 2 to 5 Years Old." *The Journal of Pediatrics,* vol. 140, no. 6, 2002, pp. 667–672.

ABSTRACT

Objectives: To determine sociodemographic predictors of added sugar intake from a national representative sample of 2- to 5-year-old children. **Study design:** Cross-sectional study that used dietary intake data of the U.S. Department of Agriculture Continuing Survey of Food Intake in Individuals 1994 to 1996 and 1998 (n = 5652). Amount of added sugar intake in teaspoons per day, teaspoons per 100 kcal, and percent of total energy was calculated by selected sociodemographic variables, accounting for sample design and weighted to permit inferences applicable to the total population. Multivariate linear regression analysis was used to predict added sugar intake. **Results:** Average added sugar consumption was 15.4 tsp/d (15.7% of total energy). Significant differences were observed by several socio-demographic characteristics. Multivariate models predicting energy-adjusted intake indicated strong associations with age, ethnicity, income, day care/school attendance, Supplemental Program for Women, Infants, and Children (WIC) participation, region of residence, and female head of household's educational level. **Conclusions:** The identified sociodemographic predictors of high added sugar intake might help target public health messages to improve children's diet quality and prevent future chronic diseases

Lazariu-Bauer, Victoria, Howard Stratton, Robert Pruzek, and Mary L. Woelfel. "A Comparative Analysis of Effects of Early Versus Late Prenatal WIC Participation on Birth Weight: NYS, 1995." *Maternal & Child Health Journal,* vol. 8, no. 2, 2004, pp. 77–86.

ABSTRACT

Objectives: This study examined the effects of prenatal participation in the NYS WIC Program on birth weight through enhanced control of selection bias and gestational age bias. Program effects were assessed separately for White, Black, and Hispanic women and subpopulations defined by values of Kotelchuck index of adequacy of prenatal care utilization. **Methods:** 1995 New York State Vital Statistics records were linked to WIC certifications, administrative and check redemption files, and to the 1990 federal census of NY county level data. The final data set contained 77,601 records. Birth weight among WIC participants who enrolled early and participated longer were compared to those who enrolled late and participated a shorter time. Selection bias was addressed using classification tree methods as part of a propensity score analysis. Gestational age bias was addressed by analyzing preterm and full-term pregnancies separately. **Results:** Adjusted estimates showed a significant positive effect of longer prenatal WIC participation on birth outcomes for all groups studied. Infants born to WIC participants who enrolled early were heavier than those who enrolled late by, on average, 70 g for full-term and 129 grams for preterm. Black and Hispanic full-term infants experienced larger WIC effects than Whites (79, 75, 43 g, respectively). Looking at full-term pregnancies using Kotelchuck's index indicated that effects of longer prenatal WIC participation were greatest for the inadequate prenatal care group (83 g). **Conclusion:** Longer prenatal WIC participation was associated with an increase in birth weight overall and for all groups studied. The effect on birth weight of longer participation in WIC was greatest in Black and Hispanic, inadequate and no prenatal care groups.

Lee, Bong J., and Lucy Mackey-Bilaver. "Effects of WIC and Food Stamp Program Participation on Child Outcomes." Contractor and Cooperator Report No. 27. Washington, DC: USDA, ERS, December 2006.

ABSTRACT

This study examines the relationship between WIC and Food Stamp Program participation and young children's health and maltreatment outcomes, utilizing a unique individual-level longitudinal database linking administrative data sets on WIC and Food Stamp Program (FSP) participation, Medicaid enrollment and claims, and child abuse and neglect reports in Illinois. Using Ordinary Least Square (OLS) methods, the data show that any of the three program participation types (joint WIC and FSP, WIC only, and FSP only) is associated with a lower risk of abuse and neglect reports, and of diagnosis of several nutrition related health problems such as anemia, failure to thrive, and nutritional deficiency. When we control for the possible selection bias using sibling fixed-effects models, the results were essentially unchanged suggesting no evidence of selection bias in the OLS results. The findings are significant indicators of the benefits of WIC and FSP participation among low-income young children. Furthermore, the findings about the lower risk of abuse and neglect is significant because it offers some evidence that participation in programs such as WIC and FSP that offer family supports not directly aimed at preventing child abuse and neglect may protect children.

Lee, J. Y., R. G. Rozier, E. C. Norton, and W. F. Vann, Jr. "Addressing Selection Bias in Dental Health Services Research." *Journal of Dental Research,* vol. 84, no. 10, 2005, pp. 942–946.

ABSTRACT

When randomization is not possible, researchers must control for non-random assignment to experimental groups. One technique for statistical adjustment for non-random assignment is through the use of a two-stage analytical technique. The purpose of this study was to demonstrate the use of this technique to control for selection bias in examining the effects of the The Supplemental Program for Women, Infants, and Children's (WIC) on dental visits. From 5 data sources, an analysis file was constructed for 49,512 children ages 1-5 years. The two-stage technique was used to control for selection bias in WIC participation, the potentially endogenous variable. Specification tests showed that WIC participation was not random and that selection bias was present. The effects of the WIC on dental use differed by 36% after adjustment for selection bias by means of the two-stage technique. This technique can be used to control for potential selection bias in dental research when randomization is not possible.

Lee, Jessica Y., R. G. Rozier, Edward C. Norton, Jonathan B. Kotch, and William F. Vann, Jr. "Effects of WIC Participation on Children's use of Oral Health Services." *American Journal of Public Health,* vol. 94, no. 5, 2004, pp. 772–777.

ABSTRACT

Objectives: We estimated the effects of the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) on dental services use by Medicaid children in North Carolina. **Methods:** We used linked Medicaid claims and enrollment files, WIC files, and the area resource file to compare dental services use for children enrolled in WIC with those not enrolled. We used multivariate models that controlled for child clustering and employed 2-step methodology to control for selection bias. **Results:** Children who participated in WIC had an increased probability of having a dental visit, were more likely to use preventive and restorative services, and were less likely to use emergency services. **Conclusions:** Children's WIC participation improved access to dental care services that should lead to improved oral health.

Lee, Jessica Y., R. G. Rozier, Edward C. Norton, Jonathan B. Kotch, and William F. Vann, Jr.. "The Effects of the Women, Infants, and Children's Supplemental Food Program on Dentally Related Medicaid Expenditures." *Journal of Public Health Dentistry,* vol. 64, no. 2, 2004, pp. 76–81.

ABSTRACT

Objective: This study estimates the effects of the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) on dentally related Medicaid expenditures for young children. **Methods:** We used a five-year cohort study design to compare dentally related Medicaid expenditures for children enrolled in WIC versus those not enrolled for each year of life up to age 5 years. There were 49,795 children born in North Carolina in 1992 who met the inclusion criteria for the study. Their birth records were linked to Medicaid enrollment and claims files, WIC master files, and the Area Resource File. Our analysis strategy included a logit and OLS two-part model with CPI dollar adjustments. **Results:** Children who participated in WIC at ages 1 and 2 years had significantly less dentally related expenditures than those who did not participate. WIC participation at age 3 years did not have a significant effect. Fewer WIC children received dental care under general anesthesia than non-WIC children. **Conclusions:** The WIC program has the potential for decreasing dentally related costs to the Medicaid program, while increasing use of dental services.

Luman, Elizabeth T., Mary M. McCauley, Abigail Shefer, and Susan Y. Chu. "Maternal Characteristics Associated with Vaccination of Young Children." *Pediatrics,* vol. 111, no. 5, 2003, pp. 1215–1218.

ABSTRACT

Objective: Mothers can be instrumental in gaining access to vaccination services for their children. This study examines maternal characteristics associated with vaccination in U.S. preschool children. **Methods:** We analyzed data from 21,212 children aged 19 to 35 months in the National Immunization Survey. Bivariate and multivariate analyses were used to identify maternal characteristics associated with completion of all recommended vaccinations in these children. **Results**: Factors most strongly associated with under-vaccination included having mothers who were black; had less than a high school education; were divorced, separated, or widowed; had multiple children; were eligible for the Special Supplemental Nutrition Program for Women, Infants and Children (WIC) but not participating; or had incomes below 50% of the federal poverty level. **Conclusion**: Because most mothers play an important role in their children's vaccination, it is important to address maternal concerns and barriers when developing public health interventions for promoting childhood vaccinations. Encouraging eligible women and their children to participate in the WIC program and providing support and encouragement for immunization to mothers with multiple children may improve early childhood vaccination coverage.

Melgar-Quiñonez, Hugo R., and Lucia L. Kaiser. "Relationship of Child-Feeding Practices to Overweight in Low-Income Mexican-American Preschool-Aged Children." *Journal of the American Dietetic Association,* vol. 104, no. 7, 2004, pp. 1110–1119.

ABSTRACT

Objective: The purpose of this research was to examine the relationship of child-feeding practices and other factors to overweight in low-income Mexican-American preschool-aged children. **Design:** Cross-sectional survey with anthropometric measurements of mothers and target children. Trained bilingual staff interviewed the parents to collect data on child-feeding strategies, food patterns, child's health history, parental acculturation level, food insecurity, and other household characteristics. **Subjects and setting:** Complete data were available from 204 low-income Mexican American parents residing in California with at least one child aged 3 to 5 years. **Outcomes measured:** Risk of overweight was defined as body mass index (BMI) (measured as weight [in kilograms]/height [in meters]2) ≥85th percentile and overweight was defined as BMI ≥95th percentile. The Student t test, χ2 test, and logistic regression were used. **Results:** Three variables were positively related to risk of overweight: birth weight (odds ratio [OR], 2.31; 95% confidence interval [CI], 1.11 to 4.82), mother's BMI ≥30 (OR, 2.05; 95% CI, 1.11 to 3.79), and juice intake (OR, 2.33; 95% CI, 1.09 to 4.98). Being enrolled in the Special Supplemental Nutrition Program for Women, Infants, and Children was negatively related to risk of overweight (OR, 0.40; 95% CI, 0.21 to 0.75). Additional variables related to overweight were monthly income >$1,500 (OR, 2.33; 95% CI, 1.00 to 5.42) and child takes food from the refrigerator between meals (OR, 0.32; 95% CI, 0.13 to 0.76).**Conclusions:** The results of this study suggest that biological and socioeconomic factors are more associated with overweight in Mexican-American preschool-aged children than most of the self-reported child-feeding strategies.

Mendoza, Jason A., Adam Drewnowski, Allen Cheadle, and Dimitri A. Christakis. "Dietary Energy Density Is Associated with Selected Predictors of Obesity in U.S Children." *Journal of Nutrition,* vol. 136, no. 5, 2006, pp. 1318–1322.

ABSTRACT

Increasing rates of childhood overweight have been linked to the rising energy density of the diet. We sought to provide temporal profiles of dietary energy density (DED) in a nationally representative sample of U.S. children and adolescents ≤ 19 y old and to describe associations between DED and predictors of overweight. We used a subset of data from the 1994–1996, 1998 Continuing Survey of Food Intake for Individuals (CSFII) and a multivariate regression model to determine independent associations between DED and socioeconomic and demographic variables after controlling for covariates. In this cross-sectional data set, DED was positively associated with total energy intakes and varied with both age and gender. DED increased from birth, peaked at 7–8 y of age, and then declined. Boys consumed more energy-dense diets than girls. Among children ≤ 4 y old, higher DED was associated in the regression model with lower household incomes and with enrollment in the food stamp program. Among adolescents 12–19 y old, higher DED was associated with being African-American. In contrast, lower DED among children ≤ 11 y old was associated with being Asian or Hispanic and with total daily consumption of fluid milk. The quality of the diet for young children, as indexed by high DED, may be adversely affected by limited household economic resources. Although food insecurity and WIC enrollment were not associated with DED in this study sample, milk consumption in children ≤ 4 y old was associated with lower DED.

Oberholser, Cheryl A., and Cynthia R. Tuttle. "Assessment of Household Food Security Among Food Stamp Recipient Families in Maryland." *American Journal of Public Health,* vol. 94, no. 5, 2004, pp. 790–796.

ABSTRACT

Objectives: We assessed the relationship between food security status and various sociodemographic characteristics among households that include children and that receive food stamps. **Methods:** A modified version of the U.S. Food Security Survey Module was implemented by telephone survey with Maryland food stamp recipients. **Results:** Of the 245 households, 66% experienced food insecurity. Food security status was associated with participation in the Special Supplemental Food Program for Women, Infants, and Children, the summer food program, and a food bank. Food security status was not associated with the number of months households received food stamps. There was no difference between the food security status of households living in urban and rural counties. **Conclusion:** A gap exists between the food stamp support provided and some households' nutritional and economic needs.

Oliveira, Victor, and Ram Chandran. "Children's Consumption of WIC-Approved Foods." Food Assistance and Nutrition Research Report No. 44. Washington, DC: USDA, ERS, February 2005.

ABSTRACT

The WIC program offers supplemental foods to low-income women, infants, and children. This study compared consumption patterns of WIC children with those of three different comparison groups: eligible nonparticipating children living in non-WIC households, eligible nonparticipating children living in WIC households, and children living in households whose income is too high to be eligible for WIC. The study provides strong evidence that participation in the WIC program increases consumption of at least some types of WIC-approved foods. Although WIC-participating children consumed significantly more calories from WIC-approved foods than children in the two comparison groups of eligible nonparticipants, there was no significant difference in total calories consumed. The results suggest that WIC foods replace non-WIC foods in the diets of children participating in WIC rather than adding to their food consumption. This is the first study to examine in detail children's consumption of WIC-approved foods by WIC status. Understanding WIC's effect on the consumption of foods contained in the WIC food packages can help inform decisions on possible changes to the packages.

Ollberding, Nicholas J. "Food Label Use and its Relation to Dietary Intake Among U.S. Adults: Results from the 2005–2006 NHANES." Ph. D. dissertation, Columbia University, 2009.

ABSTRACT

Recent rises in rates of obesity and diet-related disease are warranting the reexamination of public health approaches that may assist in combating these disorders. The federally mandated food label on packaged foods items is one approach designed for this purpose. This study examined frequency of food label use in a nationally representative sample of U.S. adults by demographic, health, and weight characteristics and the association between food label use and nutrient intake. The cross-sectional investigation was conducted using data collected during the 2005-2006 National Health and Nutrition Examination Survey (NHANES) that obtained information on food label use (nutrition facts panel, list of ingredients, serving size, health claims), nutrient intake (two 24-hour recalls), and participant characteristics on survey participants over 18 years of age. Findings were that 61.55% of participants reported using the nutrition facts panel, 51.58% list of ingredients, 47.15% serving size, and 43.75% health claims. The percent of food label users was found to differ ($p < .05$) on the majority of characteristics examined. Multivariate logistic regression revealed an increased likelihood of using at least one aspect of the food label among participants who were older, female, possessed greater education, had a higher poverty income ratio, were non-Hispanic White, resided in the U.S. for >20 years if foreign born, lived alone, were married, participated in WIC, had a history of diabetes or hypertension, attempted weight loss in the past year, or saw a dietitian/nutritionist in the past year for weight loss. Increased use of the various components of the food label was associated with changes in nutrient intake for all nutrients examined. Despite explaining only a small proportion of variation in nutrient intake mean differences between label users and non-users may be of potential public health significance. Overall these findings suggest that there is much room for improvement in respect to label use among U.S. adults. Modification of the food label is likely to be needed to increase rates of use and impact dietary intake. However, food label use alone is not expected to be sufficient in modifying behavior ultimately leading to improved health outcomes.

Park, Kyong, Margaret Kersey, Joni Geppert, Mary Story, Diana Cutts, and John H. Himes. "Household Food Insecurity Is a Risk Factor for Iron-Deficiency Anaemia in a Multi-Ethnic, Low-Income Sample of Infants and Toddlers." *Public Health Nutrition,* vol. 12, no. 11, 2009, pp. 2120–2128.

ABSTRACT

Objective: The present study examines the relationships of household food security status with Fe deficiency (ID) and Fe-deficiency anaemia (IDA) among children less than 3 years of age, and associated factors that contribute to ID and IDA. **Design:** Cross-sectional study and chart review. The US Food Security Survey Module was administered to adult caregivers as part of the Children's Sentinel Nutrition Assessment Project (C-SNAP). Haematological data were obtained from medical records. **Setting:** A large metropolitan medical centre in Minneapolis, Minnesota, USA. Subjects: A multi-ethnic sample of 2853 low-income children aged, 36 months who received care at the medical centre. **Results:** Among the caregivers, 23.3% reported low household food security and 11.6% reported very low household food security (VLFS). After controlling for background factors, children from households with VLFS were almost twice as likely to have IDA than were children from households with high or marginal food security (OR=1.98, 95% CI 1.11, 3.53); the corresponding associations for ID were not statistically significant. **Conclusions:** The prevalence of IDA in early childhood is significantly larger in low-income infants and toddlers living in VLFS households. Asian, Hispanic and African-American children have elevated prevalences of ID and IDA. Breastfeeding may be associated with elevated ID and IDA, while participation in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) may be protective for ID.

Park, Y. K., E. R. Meier, and W. O. Song. "Characteristics of Teenage Mothers and Predictors of Breastfeeding Initiation in the Michigan WIC Program in 1995. Women, Infants, and Children." *Journal of Human Lactation,* vol. 19, no. 1, 2003, pp. 50–56.

ABSTRACT

Although breast milk is recommended as the optimal source of infant nutrition, breastfeeding initiation is below recommended levels, especially among teenage mothers. Breastfeeding initiation rates among Michigan (U.S.) teenage mothers (12-19 y) were compared by demographics and health behaviors. Multivariate analyses determined which factors were significant independent predictors of breastfeeding initiation among teenage mothers enrolled prenatally in the Michigan Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) program in 1995. Significant predictors independently associated with breastfeeding initiation were race/ethnicity, education, marital status, postpartum anemia status, parity, prenatal trimester of WIC enrollment, and smoking. The strongest predictor of breastfeeding initiation differed for white mothers (positive predictor: education beyond high school [OR = 3.13]) and black mothers (negative predictor: multiparous [OR = 0.25]). Initiation rates for this population of teenage mothers fall below the national average for mothers of all ages and the US Healthy People 2010 goals. Research is needed concerning how breastfeeding support and education can be improved to reach the U.S. national health goals.

Racine, Elizabeth, Kevin Frick, Joanne Guthrie, and Donna Strobino. "Individual Net-Benefit Maximization: A Model for Understanding Breastfeeding Cessation among Low-Income Women." *Maternal & Child Health Journal,* vol. 13, no. 2, 2009, pp. 241–249.

ABSTRACT

Objectives: We use economic theory of individual net benefit maximization to motivate a comprehensive look at 32 social, economic, and psychological disincentives that potentially influence breastfeeding cessation. **Methods:** The sample consists of 1,595 low-income families participating in the Healthy Steps for Young Children National Evaluation. Participants were recruited from 24 pediatric sites across the United States. Infants were enrolled at birth and followed through age 30–33 months. Survival analysis was used to assess the relation of social, economic and psychosocial factors with duration of breastfeeding. **Results:** Disincentives significantly associated with cessation in multivariate hazard analysis were WIC participation at 2–4 months (HR = 1.50; 95% CI: 1.29, 1.74), mother's returning to work for 20–40 h per week (HR = 1.47; 95% CI: 1.26, 1.71); mother's not attending a postpartum doctor's visit (HR = 1.39; 95% CI: 1.18, 1.63); father's not being in the home (HR = 1.38; 95% CI: 1.21, 1.57); a smoker in the household (HR = 1.34; 95% CI: 1.17, 1.52); no receipt of breastfeeding instruction at the pediatric office (HR = 1.20; 95% CI:1.06, 1.37); the doctor's not encouraging breastfeeding (HR = 1.19; 95% CI: 1.01, 1.39); and the mother experiencing depressive symptoms (HR = 1.16; 95% CI: 1.02, 1.33). **Conclusions:** The decision to stop breastfeeding is often complex. Research on breastfeeding cessation has been limited with regard to the social and economic issues that may influence the behavior of low-income women. The results support the need to develop interventions and policies to minimize disincentives associated with breastfeeding cessation.

Reichman, Nancy, and Julien Teitier. "Effects of Psychosocial Risk Factors and Prenatal Interventions on Birth Weight: Evidence from New Jersey's HealthStart Program." *Perspectives on Sexual and Reproductive Health,* vol. 35, no. 3, 2003, pp. 130–137.

ABSTRACT

Context: Many states developed and implemented multifaceted Medicaid prenatal care programs in the late 1980s in response to expansions in Medicaid eligibility. Although these new programs were based on the presumed relationships between psychosocial risk (actors, early prenatal care, prenatal interventions and birth outcomes), research has not verified all of these linkages. **Methods:** Data were collected on 90,117 women who took plan in New Jersey's comprehensive prenatal care program, HealthStart, between 1988 and 1996. The impact of psychosocial risk factors and prenatal interventions on mean birth weight and the odds of low birth weight (less than 2, Soog) was assessed using ordinary least-squares regression and logistic regression, respectively. **Results:** After controls were introduced for social and demographic. psychosocial and behavioral factors, as well as the woman's county of residence and the year of her baby's birth, smoking, drinking, and using hard drugs (but not marijuana) during pregnancy were independently associated with reductions in mean birth weight (of 123 g, 299and 137g, respectively) and with increases in the odds of low birth weight (odds ratios, 1.4, 1.2and 1.7, respectively). However, according to the fully adjusted model, which also controlled for medical risk factors and prenatal services, the interventions designed to reduce those behaviors had no favorable effects on birth weight - In contrast, the receipt of services in the Special Supplemental Nutrition Program for Women, Infants and Children (WIC) was associated with an increase in mean birth weight of 229 (and of 489 among inadequately nourished women only), and with a reduction in the risk of low birth weight (odds ratio, 0.87). **Conclusion:** Referrals to WIC services should be a key feature of prenatal care programs for poor women.

Rivera, Ann C. "Impact and Process Evaluation of Prenatal WIC on Maternal and Infant Outcomes." Ph.D. dissertation, New York University, 2008.

ABSTRACT

The Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) is among the most evaluated programs in the federal social safety net, but most of the research is hindered by insufficient attention to selection bias and to factors that determine who takes-up the program. Few studies have examined potential program effects beyond birth. No studies have investigated processes that might transmit the program's effects. Study 1 investigates the effects of maternal participation in WIC prenatally on prenatal care, birthweight, gestational age, child health status, low weight-for-length, overweight, and middle-upper-arm-circumference through 24 months using the Early Childhood Longitudinal Study Birth Cohort (ECLS-B). This study compares treatment effects estimated using standard OLS regression and regression after matching and stratifying on propensity scores. Propensity scores substantially reduced selection bias in the two quartiles most likely to take up WIC. In these groups, prenatal WIC improved timing of initiation and adequacy of prenatal care, increased birthweight and gestational age, and reduced the likelihood of very preterm birth. Mediational analyses suggest that increased use of prenatal care transmits prenatal WIC's effects on birthweight and gestational age. Study 2 investigates the effects of prenatal WIC participation on infant cognitive, motor, and socioemotional abilities through 24 months using the ECLS-B. Propensity-score-adjusted estimates indicate that prenatal WIC contributes to improved cognitive ability at 9 months of age in the quartile most likely to take up WIC. Mediational analyses suggest that higher birthweight and greater cognitive stimulation transmit prenatal WIC's effects on cognitive ability. Study 3 features analysis of longitudinal qualitative data (i.e., interview transcripts and extensive field notes) and complementary survey data to examine the determinants of participation in WIC and Food Stamp Program (FSP) among a New York City sample of low-income, immigrant, and ethnically diverse families with infants. Qualitative data uncovered more reasons for take-up of WIC than FSP, including the non-monetary benefits of WIC, suggesting meaningful differences in families' views of these programs. Both survey and qualitative data provide evidence that WIC's associations with health and direct benefit to children contribute to a greater willingness across ethnic and immigrant/native-born groups to use WIC versus FSP.

Rose, Donald, J. N. Bodor, and Mariana Chilton. "Has the WIC Incentive to Formula-Feed Led to an Increase in Overweight Children?" *Journal of Nutrition,* vol. 136, no. 4, 2006, pp. 1086–1090.

ABSTRACT

We explored the relationship between the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) and overweight status in children, with a focus on WIC's provision of infant formula, through secondary analyses and review of existing literature. Because of the complexity involved and the lack of previous research on the combined link between WIC, breast-feeding, and overweight status, we considered evidence for each of these relations separately. Using food-cost data from the WIC's 1996 Participant and Program Characteristics Survey, we found that the state-level average for 1 y of program benefits for women who formula-fed was over twice the value of program benefits for those who breast-fed (BF). This difference in benefit levels, or formula incentive, was negatively associated with both the in-hospital and 6-mo BF rates instate-level multiple regression models. Despite WIC's efforts to promote BF, other large-scale studies have found a negative association of program participation with BF rates. An inverse association of BF on subsequent overweight in children also has been shown in a number of studies. Despite this accumulating evidence for the protective effect of BF, it has not been seen in African American or Latino populations. In sum, there is reason to be concerned that WIC's incentive to formula-feed may have led to an increase in overweight children; yet there is too much uncertainty about the issue to conclude that this is so. Further research is needed to understand this relationship, as is the development of applied interventions to increase BF rates.

Ryan, Alan, and Wenjun Zhou. "Lower Breastfeeding Rates Persist Among the Special Supplemental Nutrition Program for Women, Infants, and Children Participants, 1978–2003." *Pediatrics,* vol. 117, 2006, pp. 1136–1146.

ABSTRACT

Objective: We set out to compare rates of breastfeeding between women who participated in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) with those of non-WIC mothers from 1978 to 2003. **Methods:** The Ross Laboratories Mothers Survey is a national survey designed to determine patterns of milk feeding during infancy. Mothers were asked to recall the type of milk fed to their infant in the hospital and during each month of age. Rates of breastfeeding in the hospital and at 6 months of age were evaluated. Logistic regression analyses identified significant predictors of breastfeeding in 2003. **Results:** From 1978 through 2003, rates for the initiation of breastfeeding among WIC participants lagged behind those of non-WIC mothers by an average of 23.6 ± 4.4 percentage points. At 6 months of age, the gap between WIC participants and non-WIC mothers (mean: 16.3 ± 3.1 percentage points) steadily increased from 1978 through 2003 and exceeded 20% by 1999. Demographic factors that were significant and positive predictors of breastfeeding initiation in 2003 included some college education, living in the western region of the United States, not participating in the WIC program, having an infant of normal birth weight, primarily, and not working outside the home. For mothers of infants 6 months of age, WIC status was the strongest determinant of breastfeeding: mothers who were not enrolled in the WIC program were more than twice as likely to breastfeed at 6 months of age than mothers who participated in the WIC program. **Conclusions:** Breastfeeding rates among WIC participants have lagged behind those of non-WIC mothers for the last 25 years. The *Healthy People 2010* goals for breastfeeding will not be reached without intervention. Food package and programmatic changes are needed to make the incentives for breastfeeding greater for WIC participants.

Santoli, Jeanne, Natalie Huet, Philip Smith, Lawrence Barker, Lance Rodewald, Moira Inkelas, Lynn Olson, and Neal Halfon. "Insurance Status and Vaccination Coverage Among US Preschool Children." *Pediatrics,* vol. 113, 2004, pp.1959–1964

ABSTRACT

Background: Insurance status has been shown to have an impact on children's use of preventive and acute health services. The objective of this study was to determine the relationship between insurance status and vaccination coverage among U.S. preschool children aged 19 to 35 months. **Methods:** We linked data from 2 national telephone surveys, the National Immunization Survey and the National Survey of Early Childhood Health, conducted during the first half of 2000. Children were considered up to date (UTD) when they had received at least 4 diphtheria-tetanus- acellular pertussis/diphtheria-tetanus-pertussis vaccines, 3 poliovirus vaccines, 1 MMR vaccine, 3 Haemophilus influenza vaccines, and 3 hepatitis B vaccines at the time the interview was conducted. **Results:** Among the 735 children in our study sample, 72% were UTD. The vast majority (94%) reported some type of health insurance at the time of the survey. Children with private insurance were more likely to be UTD (80%) than those with public insurance (56%) or no insurance (64%). In a multivariate analysis that controlled for child's race/ethnicity; household income; maternal age/marital status/educational level; location of usual care; and Special Supplemental Nutrition Program for Women, Infants, and Children participation, insurance was no longer an independent predictor of vaccination. **Conclusions:** The disparity in vaccination coverage among publicly, privately, and uninsured children is dramatic, underscoring its importance as a marker for underimmunization, despite the multivariate findings. The Vaccines for Children Program, a partnership between public health and vaccination providers who serve uninsured children and those enrolled in Medicaid, is well suited to target and improve vaccination coverage among these vulnerable children.

Schneider, J. M., M. L. Fujii, C. L. Lamp, B. Lönnerdal, K. G. Dewey, and S. Zidenberg-Cherr. "The Use of Multiple Logistic Regression to Identify Risk Factors Associated with Anemia and Iron Deficiency in a Convenience Sample of 12-36-Mo-Old Children from Low-Income Families." *American Journal of Clinical Nutrition,* vol. 87, no. 3, 2008, pp. 614–620.

ABSTRACT

Background: The prevalence of iron deficiency (ID) anemia among preschool-age children remains relatively high in some areas across the United States. Determination of risk factors associated with ID is needed to allow children with identifiable risk factors to receive appropriate education, testing, and follow-up. **Objective:** We aimed to evaluate risk factors associated with anemia and ID in a sample of children participating in or applying for the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC). Design: The study was a cross-sectional study of a convenience sample of 12–36-mo-old children recruited from WIC clinics in 2 California counties (n = 498). **Results:** Current WIC participation by the child and a greater rate of weight gain were negatively associated, and current maternal pregnancy was positively associated with anemia (hemoglobin < 110 g/L at 12–<24 mo or < 111 g/L at 24–36 mo) after control for age, sex, and ethnicity. Maternal WIC participation during pregnancy, child age, and the intake of ≥125 mL orange or tomato juice/d were negatively associated, and being male and living in an urban location were positively associated with ID (≥2 of the following abnormal values: ferritin ≤ 8.7 μg/L, transferrin receptors ≥ 8.4 μg/mL, and transferrin saturation ≤ 13.2%). **Conclusions:** Current WIC participation by the child and maternal WIC participation during pregnancy were negatively associated with anemia and ID, respectively. It is anticipated that the risk factors identified in this study will be included in the development of an educational intervention focused on reducing the risk factors for ID and ID anemia in young children.

Siega-Riz, A. M., S. Kranz, D. Blanchette, P. S. Haines, D. K. Guilkey, and B. M. Popkin. "The Effect of Participation in the WIC Program on Preschoolers' Diets." Journal of Pediatrics, vol. 144, no. 2, 2004, pp. 229–234.

ABSTRACT

Objective: To evaluate nutrient, food intake, and snacking behavior by participation in the WIC (Special Supplemental Nutrition Program for Women, Infants, and Children) program. **Study design:** Secondary data analysis of a nationally representative cross-sectional survey conducted by USDA in 1994 to 1996 and 1998. **Methods:** Statistical analysis was performed correcting for sample design effects and weighting for children in two income groups (<130%, n = 1772 and 130% to 185% of poverty, n = 689). **Results:** Among WIC participants, the prevalence of snacking was significantly lower (68%) compared with nonparticipants (72%) ($v2$ = 5.9, P = .01). For those <130% of poverty, WIC had a beneficial effect on the intake of fat, carbohydrates, added sugar, and fruit from the total diet as well as on added sugar from snacks. These were independent of food stamp participation. For those with higher incomes, the beneficial effects were limited to added sugar, iron density, and fruit intake for the total diet. A similar significant effect of decreased added sugar intake from snacks was also seen. **Conclusions:** Our results are in line with previous research showing beneficial effects of WIC participation among preschoolers, primarily for nutrients targeted by the program. This study shows that the effect can reach beyond those targeted nutrients.

Sparks, P. J. "Childhood Morbidities among Income- and Categorically-Eligible WIC Program Participants and Non-Participants." *Journal of Children and Poverty,* vol. 16, no. 1, 2010, pp. 47–66.

ABSTRACT

The Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) is the largest supplemental food assistance program in the United States. WIC benefits include food and infant formula, nutrition counseling, health screenings, and health-care referrals to low-income, nutritionally at-risk pregnant and postpartum women, infants, and children up to age five. This research explored the associations between childhood morbidities among income- and categorically-eligible WIC participant and non-participant groups in a diverse, nationally representative sample of children. Results indicate significant differences in the maternal sociodemographic profiles of eligible child WIC participants and non-participants. After propensity score-matching methods were used to create more appropriate comparison groups among child WIC participants and non-participants, complete covariate balance was obtained for all sociodemographic characteristics. Further, no significant differences in child asthma, respiratory illness, severe gastrointestinal illness, or ear infection diagnosis, or with mothers rating their health as poor, were noted between child WIC participants and non-participants, once the matched pairs were compared. Government regulators formulating future policies around WIC would benefit from understanding the characteristics of eligible non-participants in order to offer appropriate food, health, and educational assistance beneficial to child health.

Ver Ploeg, Michele, Lisa Mancino, BiingHwan Lin, and Joanne Guthrie. "US Food Assistance Programs and Trends in Children's Weight." *International Journal of Pediatric Obesity,* vol. 3, no. 1, 2008, pp. 22–30.

ABSTRACT

Objectives: High rates of overweight and obesity among low-income children have led some to question whether participation in U.S. domestic food assistance programs contributes to this health problem. We use multiple years of data to examine trends in children's body weight and participation in the Food Stamp Program (FSP) or Special Supplemental Nutrition Program for Women, Infants, and Children (WIC). Specifically, we assess whether a consistent relationship between program participation and body weight exists over time. **Methods:** Data from multiple waves of the National Health and Nutrition Examination Surveys (NHANES) are used to examine the relationship between children's body weight and food assistance programs between 1976 and 2002. Linear regression models are used to estimate BMI and logit models are used to predict the probabilities of at-risk of overweight and overweight. Food assistance program participants (either FSP or WIC participants depending on age) are compared with income eligible non-participants and higher income children. **Results:** Results show no systematic relationship over time between FSP participation and weight status for school-aged children (age 5-17). For children aged 2-4, no differences in weight status between WIC participants and eligible nonparticipants were found. However, recent data show some differences between WIC participants and higher income children. **Conclusions:** Our analysis does not find evidence of a consistent relationship between childhood obesity and participation in the FSP or WIC programs.

Ver Ploeg, Michele. "Do Benefits of U.S. Food Assistance Programs for Children Spillover to Older Children in the Same Household?" *Journal of Family and Economic Issues,* vol. 30, no. 4, 2009, pp. 412–427.

ABSTRACT

The Women, Infants and Children (WIC) program targets low-income individuals in nutritionally vulnerable groups in the U.S. The food benefits individuals receive could be shared with other family members or may free a portion of the family budget. National Health and Nutrition Examination Survey data are used to examine whether children who are age-ineligible for WIC (age 5-17), that live in WIC-participating families have healthier diets than similar children in nonparticipating families. Results show children in WIC-participating families score higher on the Healthy Eating Index than children in non participating families. This association is stronger for children in families with two or more WIC participants compared with children living with only one or no WIC participants.

Weston, Andrea L., and Kyle S. Enger. "Factors Associated with Hepatitis A Vaccination Receipt in One-Year-Olds in the State of Michigan." *Journal of Biomedicine and Biotechnology,* vol. 2010, no. 1, 2010.

ABSTRACT

The objectives of this study were to determine factors associated with hepatitis A vaccination and to assess overall hepatitis A vaccination coverage levels among one-year-olds in Michigan. The study population was the first hepatitis A vaccination-eligible birth cohort (n = 134,226) enrolled in the Michigan Care Improvement Registry (MCIR) after 2006 recommendations were made to routinely vaccinate all one-year-olds. All children whose first birthday occurred on or between May 1, 2006, and April 31, 2007, were included in the study population. Racial/ethnic minorities had increased odds of receiving the hepatitis A vaccination in Michigan, and Medicaid and WIC status modified this relationship. Fully understanding these relationships will be useful in targeting vaccination outreach and education programs.

Wojcicki, Janet M., Roberto Gugig, Suganya Kathiravan, Kate Holbrook, and Melvin B. Heyman. "Maternal Knowledge of Infant Feeding Guidelines and Label Reading Behaviours in a Population of New Mothers in San Francisco, California." *Maternal and Child Nutrition,* vol. 5, no. 3, 2009, pp. 223–233.

ABSTRACT

The objective of this study was to evaluate the relationship between maternal nutrition knowledge and maternal socio-demographics, including participation in the Special Supplemental Women, Infants and Children's (WIC) Program. A cross-sectional study of new mothers at two San Francisco hospitals was conducted using some of the American Academy of Pediatrics' guidelines in a structured questionnaire to assess maternal nutritional knowledge. Maternal nutritional attitudes towards product nutrient labels were also assessed in a questionnaire format. Logistic regression models were used to evaluate the odds of having high maternal nutrition knowledge and of infrequently reading nutrition labels. In multivariate logistic regression models, higher maternal nutrition knowledge (defined as answering all four nutrition questions correctly) was associated with higher income levels defined as \$25,000/year, odds ratio (OR) 10.03 95% confidence interval (CI) (1.51-66.74), and in linear models, higher nutritional knowledge was associated with having more children ($P<0.01$), a higher income ($P<0.01$) and not being a WIC participant ($P<0.01$). Mothers with higher incomes were also more likely to read product nutritional labels OR 4.24, 95% CI (1.24-14.51), compared with mothers with lower incomes as were mothers with higher education levels OR 3.32, 95% CI (1.28-8.63). In San Francisco, lower income mothers are at greatest risk for low maternal nutrition knowledge and not reading product nutritional labels. Higher household income was independently associated with increased maternal nutrition knowledge and likelihood of reading nutritional labels. More comprehensive interventions need to target low-income mothers including current WIC participants to help close the nutritional advantages gap conferred by income and education.

Wojcicki, Janet M., Roberto Gugig, Cam Tran, Suganya Kathiravan, Katherine Holbrook, and Melvin B. Heyman. "Early Exclusive Breastfeeding and Maternal Attitudes Towards Infant Feeding in a Population of New Mothers in San Francisco, California." *Breastfeeding Medicine,* vol. 5, no. 1, 2010, pp. 9–15.

ABSTRACT

Background: Positive parental attitudes towards infant feeding are an important component in child nutritional health. Previous studies have found that participants in the Special Supplemental Women, Infants, and Children (WIC) Program have lower breastfeeding rates and attitudes that do not contribute towards healthy infant feeding in spite of breastfeeding and nutrition education programs targeting WIC participants. The objective of this study was to assess the frequency of exclusive breastfeeding in the early postpartum period and maternal attitudes towards breastfeeding in a population of mothers at two San Francisco hospitals and in relation to WIC participation status. **Methods:** We interviewed women who had recently delivered a healthy newborn using a structured interview. **Results:** A high percentage (79.8%) of our sample was exclusively breastfeeding at 1-4 days postpartum. We did not find any significant differences in rates of formula or mixed feeding by WIC participant status. Independent risk factors for mixed or formula feeding at 1-3 days postpartum included Asian/Pacific Islander ethnicity (odds ratio [OR] 2.90, 95% confidence interval [CI]1.17-7.19). Being a college graduate was associated with a decreased risk of formula/mixed feeding (OR 0.28, 95% CI 0.10-0.79). We also found that thinking breastfeeding was physically painful and uncomfortable was independently associated with not breastfeeding (OR 1.41, 95% CI 1.06-1.89). **Conclusions:** Future studies should be conducted with Asian-Americans and Pacific Islanders to better understand the lower rates of exclusive breastfeeding in this population and should address negative attitudes towards breastfeeding such as the idea that breastfeeding is painful or uncomfortable.

Yunzal-Butler, Cristina, Ted Joyce, and Andrew D. Racine. "Maternal Smoking and the Timing of WIC Enrollment." *Maternal & Child Health Journal,* vol. 14, no. 3, 2010, pp. 318–331.

ABSTRACT

Objective: To investigate the association between the timing of enrollment in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) and smoking among prenatal WIC participants. **Methods:** We use WIC data from eight states participating in the Pregnancy Nutrition Surveillance System (PNSS). We adjust the association between the timing of WIC participation and smoking behavior with a rich set of maternal characteristics. **Results:** Women who enroll in WIC in the first trimester of pregnancy are 2.7% points more likely to be smoking at intake than women who enroll in the third trimester. Among participants who smoked before pregnancy and at prenatal WIC enrollment, those who enrolled in the first trimester are 4.5% points more likely to quit smoking 3 months before delivery and 3.4% points more likely to quit by postpartum registration, compared with women who do not enroll in WIC until the third trimester. However, among pregravid smokers who report quitting by the first prenatal WIC visit, first-trimester enrollment is associated with a 2% point increase in relapse by postpartum registration. These results differ by race/ethnicity; white women who enroll early are 3.6% points more likely to relapse, while black women are 2.5% points less likely to relapse. **Conclusions:** Early WIC enrollment is associated with higher quit rates, although changes are modest when compared to the results from smoking cessation interventions for pregnant women. Given the prevalence of prenatal smoking among WIC participants, efforts to intensify WIC's role in smoking cessation through more frequent, and more focused counseling should be encouraged.

Ziol-Guest, K. M., and D. C. Hernandez. "First- and Second-Trimester WIC Participation Is Associated with Lower Rates of Breastfeeding and Early Introduction of Cow's Milk During Infancy." *Journal of the American Dietetic Association,* vol. 110, no. 5, 2010, pp. 702–709.

ABSTRACT

Background: Existing literature suggests prenatal participation in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) may reduce breastfeeding among low-income mothers. However, little is known about whether the timing of WIC entrance during pregnancy influences infant feeding decisions. **Objective:** This study assesses the association between the timing of prenatal participation in WIC and various infant feeding practices, including breastfeeding initiation, breastfeeding for at least 4 months, exclusive breast feeding, formula feeding, and early introduction of cow's milk and solid food. **Design:** Cross-sectional survey matching of birth certificate data to mothers' interviews 9 months after the child's birth. Mothers provided information on participation in the WIC program, infant feeding practices, and sociodemographic characteristics. **Subjects:** A nationally representative sample of 4,450 births in 2001 from the Early Childhood Longitudinal Survey-Birth Cohort. Analyses Multivariate logistic regression techniques (using STATA 9.0 SE, Stata Company, College Station, TX) estimated the relationship between the timing of prenatal WIC participation and infant feeding practices. **Results:** Entry into the WIC program during the first or second trimester of pregnancy is associated with reduced likelihood of initiation of breastfeeding and early cow's milk introduction; and entry during the first trimester is associated with reduced duration of breastfeeding. WIC participation at any trimester is positively related to formula feeding. **Conclusions:** Prenatal WIC participation is associated with a greater likelihood of providing babies infant formula rather than breast milk after birth. Findings also indicate that there are critical prenatal periods for educating women about the health risks of early cow's milk introduction. Given the health implications of feeding infants cow's milk too early, WIC may be successful in educating women on the health risks of introducing complementary foods early, even if direct counseling on cow's milk is not provided.