Does WIC Work? The Effects of WIC on Pregnancy and Birth Outcomes

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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. © 2005 by the Association for Public Policy Analysis and Management

INTRODUCTION

The Special Supplemental Nutrition Program for Woman, Infants, and Children (WIC) was established in 1972 in order to enhance the nutritional status of these vulnerable groups. WIC provides participants with healthy foods (generally in the form of vouchers) and nutritional counseling. In the quarter century since it was authorized as a permanent program, WIC has grown steadily, from serving fewer than 1 million participants in 1977 to serving approximately 7.6 million participants per month in fiscal year 2003 at a projected annual cost of $4.5 billion (USDA, 2004). These figures imply a cost per month per participant of $49, of which an average $35 went for food costs. While the program is not an entitlement, waiting lists have disappeared in recent years, as appropriations have grown.

Support for WIC is based on the perception that "WIC works." This perception, in turn, is supported by a great deal of research showing that pregnant women who participate in WIC give birth to healthier infants. For example, a series of influential studies by Barbara Devaney and her collaborators (Devaney et al., 1992; Devaney, 1992; Devaney & Schirm, 1993) found that among mothers on

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Medicaid, each dollar spent on WIC saved the state at least $1.77 to $3.13 in health care costs.[1]

However, lately, the consensus in favor of WIC has come under attack. For example, Besharov and Germanis (2001) provide a critical summary of research on WIC which highlights the fact that most WIC studies have failed to account for the possible effects of non-random selection into the program. If those mothers who enroll in WIC are more able or more motivated, healthier, or if they have access to better health care than other mothers, then we may estimate a positive effect of WIC even if the true effect is zero. Moreover, Besharov and Germanis argue that for many women it would be unreasonable to expect anything other than a zero effect because more generous enrollment rules have increasingly drawn in women of higher income. In a household with an income of $35,000 per year, a food package worth $35 per month may not have much impact. Nutritional education could have a far greater impact, but Besharov and Germanis argue that insufficient funds are allocated for this purpose, and that WIC agencies lack the authority to compel people to participate.

A few recent studies have tried to address the selection problem with the standard tools available to economists: instrumental variables and mother-specific fixed effects. Since WIC is administered at the state level, there is variation in program rules which can, in principal, be used as instruments for WIC participation. Brien and Swann (2001) find, using the 1988 National Maternal and Infant Health Survey, that WIC participation among black women varied with whether or not the state required income verification (all states now require it). When they use this instrument, they find that WIC reduced the probability of low birth weight among blacks. They find no evidence of WIC effects among whites. However, their instruments have little explanatory power for whites, and they cannot include state fixed effects in their models, which raises the possibility that these instruments might be capturing other characteristics of states.

Using data from the National Longitudinal Survey of Youth (NLSY), Chatterji et al. (2002) also rely on program characteristics as instruments (as well as fixed effects) and find negative effects of WIC on breastfeeding. Using the NLSY and mother fixed-effect models, Kowaleski-Jones and Duncan (2002) find average increases in birth weight of 9 ounces, when their coefficients are evaluated at sample means. However, these estimates are based on 71 “discordant” sibling pairs (pairs in which one participated and the other did not), and may be biased downwards by measurement error, or by “spill-overs” in the effects of WIC from one sibling to another. On the whole, studies which attempt to take selection into account have produced much less consistent findings in favor of WIC than earlier studies.

This study investigates the effects of WIC on maternal and infant health using rich data from the Pregnancy Risk Assessment Monitoring System (PRAMS). These data combine information from birth certificates with data from a survey of a sample of new mothers in 19 states over the period 1992 to 1999. We use these data to address two questions about selection into WIC. First, how reasonable is it to

[1] These papers use a specially constructed sample of all Medicaid-covered births in five states and compare WIC users to other Medicaid-covered groups. They find that WIC use is associated with higher birth weight and gestational length (Devaney, 1992), reduced Medicaid expenditures on births (Devaney et al., 1992), and reduced infant mortality (Devaney & Schirm, 1993). In a recent paper, Moss and Carver (1998) use the 1988 National Maternal and Infant Health Survey and find that WIC participation is associated with a decrease in the risk of infant mortality. Other studies have found that WIC use is associated with both lower probabilities of being a small-for-gestational-age birth (Ahluwalia et al., 1992) and improved nutrition for infants and young children, along with having other beneficial effects. See Currie (1995) and Currie (2003) for a review of other studies of the effects of WIC.

assume that mothers who participate in WIC are positively selected in terms of their unobservable characteristics? We address this question by comparing the observable characteristics of WIC participants and non-participants in the sample of women whose deliveries were paid for by Medicaid. It is important to note that Medicaid coverage automatically confers eligibility for WIC, even if the woman's income is higher than the 185 percent of poverty cutoff for WIC. Hence, all women who had Medicaid-funded deliveries were eligible for WIC.

Second, we examine the estimated effects of WIC on a wide range of outcomes, including a subset that should not be affected by the length of the pregnancy. It is important to examine variables of this type, since women with longer pregnancies have more time to enroll in WIC, which could lead to a spurious positive association between WIC participation and outcomes such as gestation and birth weight. These models include a full set of interactions between state and year effects, thus controlling for all unobserved time-varying and time-invariant state-level determinants of infant health such as income cutoffs for the Medicaid program, or numbers of maternal and infant child health clinics. We examine the impacts of WIC in a series of more-disadvantaged subsamples to see if the impacts are larger for more disadvantaged women. Finally, we examine the relationship between state-level WIC program characteristics and individual WIC participation with an eye toward assessing the use of program characteristics as instrumental variables for participation.

Our results suggest that mothers who actually participate in WIC are very negatively selected relative to the population of eligibles (all Medicaid mothers), in terms of education, age, marital status, father involvement with the birth, smoking behavior, obesity, use of public assistance last year, having wage income last year, having a bathroom in the household, and having had a previous low birth weight or premature infant (if it is not a first birth). This is also true within racial groups. Within the population of women whose deliveries were paid for by the Medicaid program, WIC mothers appear to be negatively selected in terms of observables.

Despite these negative observables, WIC participation appears to have a positive effect. For example, WIC mothers are 6 to 7 percent more likely to have begun prenatal care in the first trimester, and are 2 percent less likely to bear infants who are below the 25th percentile of weight given gestational age or to bear infants of low birth weight. Furthermore, the impact is larger for more disadvantaged groups such as women who received public assistance last year; single, high school dropouts; and teen mothers. Finally, we find that variation in WIC program regulations may make poor instruments for WIC participation, so that estimates based on them are likely to be unreliable.

The rest of the paper proceeds as follows. The first section provides more details about the WIC program. The second section describes the data set used in the analysis. The third section describes the empirical methods used in the analysis, and the fourth section the results. Finally, the fifth section concludes.

BACKGROUND

The Special Supplemental Nutrition Program for Women, Infants, and Children or WIC program is a federally-funded, state-run program that provides food (either directly or through vouchers) and nutritional advice to pregnant women, postpartum women, infants, and children who are nutritionally-at-risk and low-income.[2] By law,

[2] Program information is drawn from U.S. Department of Agriculture (1995a, 1995b).

the foods provided by WIC must contain protein, calcium, iron, and vitamins A and C. There is a list of approved foods, including milk and cheese. Participants receive nutritional counseling and are encouraged to breastfeed their children, though free infant formula available to WIC mothers provides the opposite incentive.

In order to be eligible, individuals must have incomes less than 185 percent of the federal poverty line or be adjunctively eligible through participation in Medicaid, Food Stamps, or AFDC. Higher income eligibility cutoffs for Medicaid for pregnant women have resulted in many women with incomes of 250 percent of poverty or higher being eligible for WIC. WIC providers also refer mothers to other government services and health care providers such as Medicaid and immunization programs. WIC participants must be certified to be at nutritional risk, though in practice it appears that virtually all would-be participants satisfy at least one of the nutritional risk criteria (Ver Ploeg & Betson, 2003).

WIC is not an entitlement, but in recent years, waiting lists for the program have been eliminated, suggesting that all of those who present themselves to WIC clinics are served (Ver Ploeg & Betson, 2003). There is, however, controversy about the fraction of eligibles who are served and about the extent to which this number depends on state program characteristics such as: whether the state requires women to document income (some states allowed women to self-declare their income level until 2000, when federal regulations requiring proof of income were implemented); whether AFDC/TANF, the free School Lunch or Breakfast program, or SSI automatically confer WIC eligibility; whether the agency requires WIC participants to report monthly in order to receive food vouchers; the hematocrit and hemoglobin cutoffs for the anemia nutritional-risk criteria; the value of the food package; and the extent to which the food packages are tailored to provide low fat or low sugar foods. Information about these and other regulations is summarized in U.S. Department of Agriculture (1992, 1994, 1996, 1998, and 2000).

As discussed above, Brien and Swann (2001) found that whether income verification was required was an important predictor of WIC participation among blacks (at least in the cross section), while Chatterji et al. (2002) find that how food packages are tailored predicts participation. An examination of the values for the instruments within our sample of states shows while there is cross-state variation, there is very little within-state variation in most of these measures, at least over our sample period, from 1992–1999. This implies that it will be quite difficult to distinguish between the effects of these regulations and the effects of other state characteristics.

DATA

The PRAMS data are collected by individual states with support from the Centers for Disease Control (CDC) in order to track maternal behaviors and experiences associated with maternal and infant health outcomes. Like many CDC surveillance data sets, it is produced through a partnership between the CDC and participating states. States contact a stratified sample of new mothers each survey year. Women are contacted between two and six months after giving birth and asked a variety of demographic, infant, and maternal health questions. Questionnaire data are combined with a subset of birth certificate data. Data are made available on request for states having a weighted response rate that exceeds 70 percent (unweighted response rates ranged from 60.7 percent in South Carolina in 1994 to 82 percent in West Virginia in 1993 over the 1992–1998 period, with the vast bulk being in the 70–80 percent range). Different states have implemented different sampling schemes with different strata and sampling rates within strata. We present weighted statistics and all of our regression analyses use PRAMS weights.

Our sample consists of 60,731 observations from 19 states for women whose deliveries were paid for by Medicaid and who also had information about WIC use during pregnancy. We focus on the subset of women whose deliveries were paid for by Medicaid because all of these women are eligible for WIC. Thus, we avoid comparing WIC eligible women with other, higher income women who could not take up the program. Nearly 80 percent of women in our sample who used WIC during their pregnancies had their deliveries paid for by Medicaid.

PRAMS provides both demographic information and information about participation in WIC and Medicaid, which automatically confers WIC eligibility. Moreover, PRAMS data have detailed information on mothers' characteristics and PRAMS is one of the only publicly available data sets with information through 1999 about both detailed birth outcomes and WIC program participation.[4] PRAMS data are well suited for analyzing WIC, both because they are a repeated cross-section spanning all cohorts of women giving birth during recent years and because they contain detailed information about pregnancy, birth, and infant health outcomes and WIC program participation.[5]

Ideally, we would know when the woman first obtained access to WIC. However, since PRAMS only asks if the woman was on WIC during her pregnancy, we are unable to determine exactly when the woman got onto the WIC program. Instead, we match women to the year of their second trimester by using the reported month and year of birth. We do not use any observations for which this match could not be performed. Observations where the birth month and year were missing are also excluded from the analysis. Additionally, we do not use any data where the infant's second trimester was before 1992 because this is the first year when data on WIC program characteristics is continuously available.[6] Finally, while plural births are excluded from the analysis, infants who die after childbirth are not excluded.

One concern with using national survey data to study the WIC program is the degree of under-reporting of WIC in these data. Bitler, Currie, and Scholz (2003) document a serious undercount of the WIC program in the Current Population Survey and the Survey of Income and Program Participation. In contrast, counts

[4] The 1995–2001 Current Population Survey (CPS) Food Security Supplements have information about WIC use and food security at the household level, but they have no information about birth outcomes. Furthermore, there is evidence that under reporting of WIC in the Food Security Supplements is more severe than in the March CPS (see Bitler, Currie, & Scholz, 2003). The National Health and Examination Survey-IV, while also nationally representative, is limited to 1998–2000. The 1993 and 1996 rounds of the Survey of Income and Program Participation (SIPP) have little information about infant health outcomes. The National Longitudinal Survey of Youth 1979 includes the cohort of mothers aged 14–21 in 1979 but has less detailed information than does PRAMS. Few of these other data sets have as large a sample of births as does PRAMS.

[5] Appendix Table 2 (not shown) contains a list of the states and years used in our analysis. All Appendix tables are available at Currie's website (http://www.econ.ucla.edu/people/faculty/currie.html), as is a discussion of missing data, sample selection, and the degree of item non-response.

[6] Information about WIC program characteristics were collected in April of 1988, 1990, 1992, 1994, 1996, 1998, and 2000 by USDA; however, the 1990 data on many of the characteristics are not publicly available. In lieu of assuming values did not change between 1988 and 1992, we restrict our sample to 1992–1999. Values for odd years are assumed to be the same as the values for the previous even year. Restricting the sample to even years resulted in qualitatively similar results.

obtained by aggregating PRAMS data compare relatively well to USDA Food and Nutrition Service counts of participants.[7]

PRAMS data contain information about a variety of health outcomes for the infant and mother, most of which are unavailable in other data sets that contain information about WIC use. Maternal health outcomes available in PRAMS include the mother's weight gain during pregnancy, whether the mother initiated prenatal care during the first trimester (which is indicated on both the birth certificate and the PRAMS questionnaire), and the number of nights in the hospital before and after birth. Pregnancy and infant health outcomes include gestation, birth weight, whether the infant was in an Intensive Care Unit (ICU) after birth, and the number of days the infant spent in the hospital after the delivery.

From the information on gestation and birth weight, we construct measures of whether the birth was premature (gestation $<$ 37 weeks), whether the birth was very premature (gestation $<$ 32 weeks), whether the infant was of low birth weight ($<$ 2,500 grams), whether the infant was of very low birth weight ($<$ 1,500 grams), and whether the infant's weight-for-age was below the 10th or 25th percentiles (using the Hoffman criteria (Hoffman et al., 1974)). The Hoffman measures are particularly useful since they adjust birth weight for gestational age. Thus, they account for the fact that women with longer pregnancies are likely to have better outcomes and also have had longer to enroll in the WIC program. Finally, we examine whether the woman had initiated any breastfeeding by the time the survey was returned. Breastfeeding is an issue among WIC participants because the provision of free infant formula removes a powerful economic incentive to breastfeed.

While the PRAMS states do not provide a random sample of the entire U.S. population, the average values of our outcome measures are reasonably close to averages for the whole country from the National Vital Statistics Report on Births for 2000 (Martin et al., 2002). For example, average weight gain for the PRAMS women was 30.8 pounds compared with a U.S. average of 30.5 for 2000 (not shown). Either 77 percent (according to the questionnaire) or 83 percent (according to the birth certificate) of all women in the PRAMS sample (not shown) received prenatal care during the first trimester compared to 83 percent of all women in 2000. Not surprisingly, our Medicaid mother sample was less likely to receive prenatal care than all women in PRAMS; only 62 percent (questionnaire) or 71 percent (birth certificate) did so.

Sample means are shown in Table 1, for all women whose deliveries were paid for by Medicaid, and separately by whether or not they received WIC during pregnancy. Nearly 82 percent of the final PRAMS sample women whose deliveries were paid for by Medicaid were on the WIC program during pregnancy. We also show means separately for three more disadvantaged subsamples of women: those who received public assistance last year; those who were single, high school dropouts over 18; and those who were teen mothers.

One limitation of PRAMS is that it does not have extensive information about income. Not all states asked about income and those that did used categorical variables (which were not consistent across states). By focusing on the set of women

[7] Because PRAMS data report any WIC use during pregnancy and the FNS data are monthly counts, some adjustment must be made to the FNS numbers to make them comparable to PRAMS counts as not every woman will be on WIC each month of her pregnancy. Using estimates of when women initiated WIC use from the FNS Participant Characteristics 2000 report, aggregated PRAMS totals of WIC participants for 1995–1999 are 112 percent of the adjusted FNS average monthly counts (PRAMS totals of the count of infants are 99 percent of Vital Statistics counts of births for 1995–1999).

Table 1. Means for women whose delivery was paid for by Medicaid, 1992–1999 PRAMS.

	All Women	WIC Women	Aid Last year	Single, Dropout > 18	Teen Mother
WIC while pregnant	0.816	1.000	0.845	0.837	0.863
Medicaid before pregnant	0.306	0.314	0.474	0.428	0.355
Black	0.312	0.326	0.399	0.344	0.363
Mother or child Hispanic	0.104	0.106	0.079	0.156	0.075
No Hispanic indicator	0.298	0.302	0.345	0.272	0.301
Mother high school dropout or under 19	0.373	0.389	0.414	1.000	0.642
Mother high school graduate no college	0.421	0.419	0.413	0.000	0.310
Mother has some college no 4-year degree	0.160	0.152	0.138	0.000	0.036
Mother has 4-year college degree	0.031	0.025	0.019	0.000	0.001
Married	0.408	0.398	0.305	0.000	0.228
Mother's age	23.52	23.37	23.47	23.41	17.66
Teen mother	0.256	0.271	0.253	0.169	1.000
Ever smoked 100 cigarettes	0.441	0.434	0.461	0.527	0.399
Mother obese (BMI >30)	0.135	0.142	0.154	0.132	0.064
Father's information on birth certificate	0.642	0.635	0.535	0.433	0.521
Father high school dropout or under 19	0.200	0.212	0.191	0.231	0.234
Father high school graduate no college	0.319	0.315	0.265	0.173	0.240
Any public assistance last year	0.451	0.466	1.000	0.620	0.446
Any wage income last year	0.713	0.707	0.540	0.519	0.698
No bathroom in household	0.057	0.058	0.053	0.075	0.067
Previous pre-term birth (not first birth)	0.124	0.125	0.132	0.158	0.139
Previous low birth weight infant (not first birth)	0.121	0.122	0.130	0.167	0.127
Weight gain (lbs.)	30.41	30.50	29.67	29.47	32.65
Prenatal care first trimester, questionnaire	0.62	0.64	0.60	0.56	0.54
Prenatal care first trimester, birth certificate	0.71	0.72	0.70	0.66	0.64
Gestation (weeks)	38.90	38.94	38.86	38.81	38.84
Premature (< 37 weeks)	0.09	0.09	0.10	0.10	0.11
Very premature (< 32 weeks)	0.02	0.02	0.02	0.02	0.02
Birth weight (grams)	3271	3277	3243	3208	3200
Low birth weight (< 2,500 grams)	0.081	0.078	0.088	0.091	0.094
Very low birth weight (< 1,500 grams)	0.014	0.012	0.015	0.013	0.017
Weight-for-gestation, < 10th percentile	0.06	0.06	0.07	0.07	0.07
Weight-for-gestation < 25th percentile	0.20	0.20	0.21	0.22	0.23

(continued)

Table 1. *(continued).*

	All Women	WIC Women	Aid Last Year	Single, Dropout > 18	Teen Mother
Nights woman in hospital at delivery	2.53	2.49	2.52	2.49	2.46
Nights infant in hospital	3.60	3.46	3.63	3.62	3.58
Nights woman in hospital pre-delivery	0.39	0.39	0.44	0.40	0.44
Infant in ICU	0.13	0.12	0.13	0.14	0.13
Any breastfeeding	0.26	0.25	0.20	0.20	0.22
N	60,731	49,040	27,734	7,368	17,106

Note: Summary statistics for PRAMS data pooled across all state/years. Row entries are means. Sample in column 1 is all deliveries paid for by Medicaid, in column 2 is all deliveries paid for by Medicaid where the woman was on WIC during the pregnancy, and in columns 3–5 is the set of all deliveries to subgroup members paid for by Medicaid. All means calculated using weights and adjusting for complex nature of sample. Characteristics are those of mother unless otherwise stated.

whose deliveries were paid for by Medicaid, we ensure that we have a subsample of women who are all eligible for WIC. Whether the birth was paid for by Medicaid is a useful indicator of a woman's economic status because hospitals have powerful incentives to make sure that otherwise uninsured women who are eligible for Medicaid have deliveries that are paid for by the program since hospitals are required to serve women in active labor, and many hospitals offer such women enrollment assistance.[8] Although the rate varies across states, 39 percent of births in PRAMS were paid for by Medicaid. Table 1 demonstrates that Medicaid mothers who received WIC during pregnancy are very negatively selected relative to all Medicaid mothers in terms of observables. They are less educated, more likely to be of minority race, less likely to be married, and more likely to be teen mothers. WIC mothers are more likely to be obese (as measured by having body mass index over 30), which suggests that they know less about nutrition than other mothers or that they are less likely to follow nutritional guidelines than other mothers. The increased likelihood that WIC mothers are obese implies that WIC mothers are more susceptible to certain complications of pregnancy.

Finally, they are less likely to report any information about the father on the birth certificate, suggesting that the father is not involved with the mother at the time of the delivery.[9] Even among women who had information about the father on the birth certificate, the WIC mothers' partners are less well-educated. WIC women are more likely to have been on Medicaid before they were pregnant, were more likely to have received public assistance last year, less likely to have any wage income last year, and more likely to live in households without a bathroom; evidence that they

[8] In contrast, it may be quite difficult for an individual to gain Medicaid coverage. Applicants for Medicaid may be required to produce birth certificates and/or citizenship papers, rent receipts and utility bills to prove residency, and pay stubs as proof of income, all within a specified number of days. Applicants are often required to return for several interviews. Up to a quarter of Medicaid applicants are denied because applicants do not fulfill these administrative requirements (U.S. GAO, 1994).

[9] In their work on "fragile families," Carlson and McLanahan (2001) note that many fathers are involved with the mother at the time of the birth, even if they are not married or even cohabiting. Our indicator of whether the father's information appears on the birth certificate is intended to capture this effect.

are less well off economically than other Medicaid mothers. Furthermore, conditional on this not being a first birth, they were more likely to have had a previous premature or low birth weight birth.

It is perhaps surprising then that, on average, infants born to these women have almost the same birth weight and gestation as other infants. The WIC infants are no more likely to be premature and are also slightly less likely to be of low or very low birth weight. Moreover, there is no appreciable difference in the probability of being very premature and no difference in the probability of being of lower birth weight conditional on gestational age. This comparison suggests that WIC may well be having a positive effect on outcomes.[10]

METHODS

We first estimate logistic models of WIC participation. These models control for most of the maternal and infant characteristics shown in Table 1. Specifically, controls for the mother's characteristics include dummy variables for the mother's age being 20–24, 25–34, 35 or older, or missing (the omitted category is teen mothers); dummy variables for the mother being a high school dropout, having attended some college but not having a four-year degree, and having completed a four-year degree (the omitted category is the mother having only a high school diploma); a dummy for the mother's education being missing; a dummy for the mother being black; a dummy for the child or mother being Hispanic on the birth certificate; a dummy for there being no Hispanic indicator; dummies for Asian, American Indian, other non-white/unknown race, or race missing; and dummy variables for the number of previous live births being one, two, three, four, or five or more, or missing (the omitted category is parity zero or a first birth). The regressions also include an indicator for the infant's sex or sex missing and an indicator for the residence being urban or for urban status being unknown.[11]

We also include indicators for whether the mother has smoked more than 100 cigarettes or smoker-status is missing, whether she is obese or BMI is missing, and whether the father's information is listed on the birth certificate. While it may be argued that smoking and maternal weight are endogenous, whether someone has ever smoked a significant amount and obesity are longer-term measures which are unlikely to be immediately affected by pregnancy or WIC participation.

Finally, these models include separate dummies for each state-year combination. The inclusion of these state-year dummies controls for state-level characteristics of the WIC program (even those that change over time) as well as for any other state characteristics or policies that might affect infant health outcomes. In particular, factors such as the income eligibility cutoff for Medicaid, and state-level measures

[10] Despite the fact that the Medicaid mothers on WIC were more likely to be on public assistance and less likely to have a bathroom in the house, one referee expressed concern that they might nonetheless have higher income. Hence, we used data from waves 1–12 of the 1996 Survey of Income and Program Participation (SIPP) and waves 1–6 of the 2001 SIPP to address the issue. We found that among women 15–44 who were on Medicaid and who had an infant less than 12 months old in the household, those on WIC had average family incomes equal to 0.679 of the federal poverty line, while those not on WIC had incomes equal to 0.814 of the federal poverty line.

[11] Unfortunately, Hispanic ethnicity and urban status were not included in the PRAMS questionnaire for a large share of the sample and are unavailable from the Birth Certificate data for the early 1990s. All of the results discussed below are qualitatively similar if the indicators for urban residence, Hispanic ethnicity, and mother's obesity (the variable most frequently missing after Hispanic ethnicity and urban residence) are excluded.

of medical services for pregnant women are controlled for in this design. The inclusion of these variables is a significant improvement over many previous studies, which did not have data rich enough to support this design.

Our second set of estimates is based on models of the same form, except that we use our outcome measures rather than participation as the dependent variables. We estimate logistic regressions for binary variables and least squares for continuous outcomes.

To summarize, we estimate models that attempt to control for selection into the program by including many variables that are correlated with WIC participation and which have not been included in previous studies. If we find positive effects of WIC, it is still at least theoretically possible that this is because of unmeasured characteristics which are positively associated with both infant health outcomes and with WIC participation. Unobserved factors could include such things as nutrition knowledge and the desire to be a good mother. However, in order for this type of bias to account for positive findings, it would have to be the case that WIC participants were negatively selected in terms of all of the observables we examine, yet positively selected in terms of unobservables. In other words, there would have to be a *systematic* negative correlation between observable factors and unobservable factors in terms of their effects on infant health. It seems highly unlikely, for example, that the least educated and/or obese mothers would nevertheless have the best information about nutrition.

Finally, following some of the recent literature, we take a more conventional approach to the problem of selection, and estimate two-stage least squares (2SLS) models using state-level characteristics of WIC programs as instruments. Of course, we cannot include the full set of state-year interactions in these models, so we include state effects and year effects, as well as a series of time-varying state-level controls, including the Medicaid income eligibility level for pregnant women as a share of the federal poverty level, the real maximum AFDC/TANF benefit for a family of four, the AFDC/TANF participation rate, the Food Stamp participation rate, the percentage black and the percentage Hispanic in the state, the percentage of state residents living in an MSA, the percentage of the state population under the poverty level, real median income for a family of four, and the share of births to unmarried mothers. Appendix Table 1 contains summary statistics for these state-level controls.

We estimate first stage regressions, and calculate both the F-statistics for the joint significance of the instruments, and the partial R-squareds. These test statistics are then used to assess the validity of the instruments, as suggested by Bound, Baker, and Jaeger (1995) and Staiger and Stock (1997). These authors show that if the instruments are "weak" in the sense that they yield low F-statistics and partial R-squareds then 2SLS estimates based on them are unreliable.

RESULTS

Each of the main tables reports odds ratios or coefficients only for some of the key right hand side variables of interest. Appendix Table 6 (not shown) reports coefficients for the full specification for WIC participation in the full sample (Table 2, column 1), and Appendix Table 7 (not shown) reports coefficients for the full specification for the impact of WIC on weight gain during pregnancy for the full sample (Table 3, column 1, row 1).

Estimates of the determinants of WIC participation are shown in Table 2. Each column shows odds ratios from a separate regression; odds ratios above one mean

Table 2. Determinants of WIC participation, PRAMS 1992–1999. Specification includes state-by-year fixed effects.

	All	Aid Last Year	Single, Dropout > 18	Teen Mother
Mother is:				
Black	1.492***	1.128***	0.774***	1.527***
	(0.045)	(0.051)	(0.068)	(0.099)
Hispanic	1.556***	1.480***	1.297**	1.230**
	(0.064)	(0.106)	(0.148)	(0.114)
High school dropout	1.629***	1.421***		1.629***
	(0.056)	(0.079)		(0.189)
High school graduate, no college	1.282***	1.336***		1.535***
	(0.039)	(0.069)		(0.182)
4-year college degree	0.549***	0.954		0.368*
	(0.031)	(0.120)		(0.213)
Married	0.965	1.114**		0.901
	(0.026)	(0.050)		(0.059)
20–24 years old	0.865***	1.007	0.983	
	(0.028)	(0.052)	(0.097)	
25–34 years old	0.837***	1.064	1.347**	
	(0.031)	(0.064)	(0.161)	
35 or older	0.687***	0.936	1.062	
	(0.039)	(0.085)	(0.203)	
Obese (BMI > 30)	1.598***	1.502***	1.491***	1.109
	(0.056)	(0.079)	(0.165)	(0.109)
Mother has smoked more than 100 cigarettes	0.981	0.942	0.697***	1.003
	(0.024)	(0.037)	(0.054)	(0.054)
Father's information on birth certificate	1.092***	1.144***	1.184**	1.208***
	(0.031)	(0.047)	(0.086)	(0.068)
N	60731	27733	7363	17102

Note: *** = $p < 0.01$, ** = $p < 0.05$, * $p < 0.10$. Table contains odds ratios from weighted logistic regressions of the determinants of WIC participation. Columns report results from regressions for the subgroup indicated. Each row represents one regression. Regressions include state-by-year fixed effects. Unless subgroup definition does not allow it, all regressions include indicators for the infant being male or sex missing; the mother being a high school dropout, high school graduate, having four or more years of college, or education missing (dropout includes women under 18); the mother being married or marital status missing; the mother being 20–24, 25–34, 35 or older, or age missing; the mother being obese or BMI missing; the mother having smoked at least 100 cigarettes or smoker-status missing; the father's information being on the BC; the mother living in an urban area or that being unavailable; the infant's parity (1, 2, 3, 4, 5 or more, or missing); the mother's race being black/Asian/American Indian/other non-white or race unknown; and the mother or infant being Hispanic or Hispanic ethnicity being unknown.

that participation is more likely if this characteristic holds. The first column shows that in the full sample, mothers who are black or Hispanic are much more likely to participate, conditional on age, education, and marital status. Mothers who are high school dropouts are also much more likely to participate than college graduates, while women over 20 are much less likely to participate than young women. Women who are obese are also much more likely to participate. Finally, mothers who report father's information on the birth certificate are more likely to participate. Thus, these multivariate regressions with a full set of state-year controls are

Table 3. Coefficients or odds ratios on WIC use from regressions explaining various outcomes, PRAMS 1992–1999. Specification includes state-by-year fixed effects.

	All	Aid Last Year	Single, Dropout > 18	Teen Mother
Coefficients, least squares:				
Weight gain (lbs.)	1.058***	1.248***	1.049**	2.180***
	(0.154)	(0.250)	(0.492)	(0.333)
Gestation (weeks)	0.279***	0.384***	0.313***	0.424***
	(0.025)	(0.040)	(0.075)	(0.057)
Birth weight (grams)	63.650***	72.518***	61.160***	77.540***
	(6.194)	(9.764)	(18.343)	(13.087)
Nights woman in hospital	–0.217***	–0.059	0.003	–0.207***
at delivery	(0.038)	(0.057)	(0.098)	(0.059)
Nights infant in hospital	–0.868***	–0.615***	–0.752***	–1.168***
	(0.082)	(0.128)	(0.235)	(0.170)
Nights woman in hospital	0.013	0.025	–0.131***	0.101***
pre-delivery	(0.012)	(0.023)	(0.039)	(0.028)
Odds ratios, logistic regressions:				
Prenatal care, first trimester,	1.485***	1.557***	1.686***	1.573***
questionnaire	(0.033)	(0.055)	(0.115)	(0.075)
Prenatal care, first trimester,	1.441***	1.508***	1.512***	1.620***
birth certificate	(0.035)	(0.055)	(0.106)	(0.078)
Premature (< 37 weeks)	0.708***	0.640***	0.764***	0.646***
	(0.025)	(0.033)	(0.077)	(0.044)
Very premature (< 32 weeks)	0.473***	0.458***	0.459***	0.367***
	(0.033)	(0.047)	(0.098)	(0.048)
Low birth weight	0.726***	0.677***	0.659***	0.633***
(< 2500 grams)	(0.027)	(0.037)	(0.068)	(0.046)
Very low birth weight	0.463***	0.458***	0.456***	0.384***
(< 1500 grams)	(0.036)	(0.054)	(0.110)	(0.056)
Weight-for-gestation	0.870***	0.907	0.880	0.831**
< 10th percentile	(0.038)	(0.060)	(0.110)	(0.072)
Weight-for-gestation	0.885***	0.865***	1.002	0.865***
< 25th percentile	(0.024)	(0.036)	(0.081)	(0.047)
Infant in ICU	0.857***	0.881**	0.680***	0.831***
	(0.028)	(0.044)	(0.061)	(0.056)
Any breastfeeding	0.905***	1.163***	0.919	1.014
	(0.028)	(0.064)	(0.095)	(0.067)

Note: *** = p < 0.01, ** = p < 0.05, * = p < 0.10. Table contains coefficients (SEs) on WIC use in weighted least squares regressions (for continuous variables) or odds ratios (SES) for WIC use in logistic regressions (for indicator variables) predicting the outcome in the row label. Columns report results from regressions for the subgroup indicated. Each row represents one regression. Regressions include state-by-year fixed effects. Unless subgroup definition does not allow it, all regressions include indicators for the infant being male or sex missing; the mother being a high school dropout, high school graduate, having four or more years of college, or education missing (dropout includes women under 18); the mother being married or marital status missing; the mother being 20–24, 25–34, 35 or older, or age missing; the mother being obese or BMI missing; the mother having smoked at least 100 cigarettes or smoker-status missing; the father's information being on the BC; the mother living in an urban area or that being unavailable; the infant's parity (1, 2, 3, 4, 5 or more, or missing); the mother's race being black/Asian/American Indian/other non-white or race unknown; and the mother or infant being Hispanic or Hispanic ethnicity being unknown.

consistent with the means tables in that they suggest that WIC mothers are generally very negatively selected, at least in terms of observables.

Column 2 of Table 2 suggests that the WIC mothers are slightly less negatively selected if we look only at the subset of women who received AFDC/TANF or Food Stamp aid last year. In this sample, for example, high school dropouts are only 1.4 times (rather than 1.6 times) more likely to participate. Differences in participation rates by age are also much less pronounced. The same holds in columns 3 and 4; yet even within these already relatively disadvantaged subgroups, the more disadvantaged are more likely to participate in WIC.

In summary, Table 2 suggests that, among deliveries paid for by Medicaid, WIC mothers are negatively selected on observables relative to the full population of mothers. Hence, it would not be surprising to find zero or even negative "effects" of WIC in this sample if relevant unobservables are positively correlated with observables and/or WIC has little or no true impact. If we find that WIC has significant positive impacts, the negative selection on observables would suggest that WIC has real impacts. WIC mothers are not as negatively selected in the more-disadvantaged subgroups of women on aid last year, single dropout women over 18, or teen mothers; if WIC does have positive effects, they should be more apparent in these subsamples.

Table 3 shows that these predictions are borne out in the data. The first column, which compares the WIC women to other women whose deliveries were paid for by Medicaid, shows favorable effects of WIC. In this subsample, WIC is associated with being 1.4–1.5 times as likely to initiate prenatal care in the first trimester; being only 0.7 times as likely to have a low birth weight infant or premature infant; and only 0.9 times as likely to be in the lowest quartile or decile of birth weight conditional on gestation. WIC participants are only 0.9 times as likely to have the infant admitted to the ICU. There is also a reduction of about one night in the number of nights that the infant spends in the hospital after birth; and WIC is associated with increases in maternal weight gain, gestation, and birth weight. The only negative effect of WIC is to decrease the probability of initiating breastfeeding.

As discussed above, the estimated effects of WIC on some birth outcomes may be biased because women who have longer pregnancies have a longer window of time in which they can enroll in WIC. However, the probability of commencing prenatal care in the first trimester and the measures of birth weight conditional on gestational age are not affected by this potential bias, and they still show positive effects of WIC.

Columns 2 through 4 show coefficients or odds ratios from models estimated separately for the disadvantaged subgroups of women on aid last year, single dropout women over 18, and teen mothers. The coefficients in column 2–4 suggest that the effects of WIC are larger among these more disadvantaged women. We test this hypothesis by estimating least squares regressions that fully interact the right-hand side variables with the subgroup indicators; a positive and significant coefficient on WIC interacted with "aid last year" (when the outcome is a desired one) indicates that the impact of WIC is larger for women who received aid last year (Appendix Table 8). These tests suggest that for women on aid last year, as compared to all women, WIC use had a larger positive impact on gestation and initiation of prenatal care, and a positive impact on the likelihood of breastfeeding, contrary to the impact in the full sample. For these women relative to all women, WIC led to a larger reduction in the probability of being premature and of being low birth weight.

If we compare dropout women over 18 to the full population of Medicaid deliveries, it appears that WIC has a more beneficial impact on the number of nights in the hospital before delivery, early initiation of prenatal care, the probability of having a low birth weight infant, and for the probability that the infant was in the ICU. Finally, impacts of WIC were more beneficial for teen mothers than for all mothers for weight gain during pregnancy, gestation, nights in the hospital for the infant, prenatal care initiation, premature birth, very premature birth, low birth weight, and very low birth weight. Thus, Table 3 suggests that WIC has beneficial effects on a wide range of outcomes, within the population of eligible women, and that these effects are greater in more disadvantaged groups, as we would expect given the negative selection into WIC that we have documented.

Table 4 addresses the issue of whether program characteristics can be used as instruments for WIC participation in 2SLS models of the effects of participation on outcomes. Table 4 shows estimates of "first stage regressions" from models that differ from those in Table 2 both because they include the state-level characteristics and because they do not include the state-year interactions. Table 4 indicates that requiring proof of income has a significant negative effect on participation in the full sample and in the women on aid and teen mother samples. Requiring WIC participants to collect food instruments monthly also has negative effects (as one might expect since it increases transactions costs associated with WIC participation). Tailoring of the food packet has some significant effects, as does the value of the food packet, which is significant in all of the regressions. Finally, there is weak evidence that higher hemoglobin cutoffs (used to determine anemia, a nutritional risk criteria) are associated with lower WIC participation among all Medicaid mothers.

Thus, the WIC policy variables satisfy the first requirement of instruments, which is that they have some predictive power. However, the F-statistics shown at the bottom of Table 4 fall far below the critical value of 10 suggested by Staiger and Stock (1997), suggesting that 2SLS results may well be biased towards OLS estimates. Moreover, the partial R-squareds, which measure the additional explanatory power of the instruments over and above that of the other variables included in the first stage regressions, are uniformly low, suggesting again that the instruments have little power, and that 2SLS results are likely biased towards OLS estimates. The estimated 2SLS effects of WIC are in fact generally negative (these are not shown but are available from the authors). WIC is estimated to reduce the probability that timely prenatal care is received and to increase the probability of low birth weight conditional on gestational age. However, our analysis casts severe doubt on the validity of this method, at least in this sample.

DISCUSSION AND CONCLUSIONS

It is of course possible that the estimated positive effects of WIC are driven by positive selection on unobserved maternal characteristics. In other words, even though WIC mothers have observable characteristics that are predictive of poorer infant health outcomes, they could conceivably have unobserved characteristics that cause them to have better outcomes, with or without WIC. But is this likely? The available evidence suggests that it is not. For example, like us, Burstein et al. (2000) show that WIC children are more likely than eligible nonparticipants to have mothers who are negatively selected; in their data, mothers on WIC were more likely to have smoked or drank during pregnancy, were poorer, and scored lower on tests of coping skills. Bitler, Currie, and Scholz (2003) use data from the SIPP and from the CPS and show that WIC participants are poorer and less educated than eligible non-participants. Bitler (1998) found, using data from the National Longitudinal Survey of

Table 4. Selected coefficients from regressions predicting WIC use, PRAMS 1992–1999. Specification includes state and year fixed effects.

	All	Aid Last Year	Single, Dropout > 18	Teen Mother
Proof of income required for WIC eligibility	–0.083**	–0.138**	–0.129	–0.100**
	(0.033)	(0.055)	(0.081)	(0.042)
AFDC/TANF confer WIC eligibility	0.030*	–0.020	0.068*	0.031
	(0.017)	(0.024)	(0.041)	(0.029)
SSI/School Lunch confer WIC eligibility	0.024**	0.024	0.099***	0.052***
	(0.012)	(0.016)	(0.037)	(0.018)
WIC food instrument is distributed monthly	–0.036***	–0.044***	–0.113***	–0.056**
	(0.013)	(0.015)	(0.040)	(0.022)
Food packets allow tailoring of milk	0.031	0.026	0.142***	0.032
	(0.019)	(0.022)	(0.051)	(0.034)
Food packets allow tailoring of low sugar foods	4.197***	–1.064	8.842***	–2.638**
	(1.572)	(0.765)	(2.876)	(1.191)
Real average cost (97$) of woman's food packet	1.105**	1.615**	3.568**	1.881**
	(0.448)	(0.688)	(1.594)	(0.785)
Hematocrit cutoff, WIC, first trimester pregnancy	–0.002	0.008	–0.084	0.038
	(0.018)	(0.031)	(0.054)	(0.031)
Hemoglobin cutoff, WIC, first trimester pregnancy	–0.095*	–0.055	–0.055	–0.126
	(0.056)	(0.083)	(0.165)	(0.094)
N	60731	27734	7368	17106
F-statistic, WIC program variables	3.3	3.2	4.1	3.4
p-value	0.0007	0.0009	0.0001	0.0005

Note: *** = $p < 0.01$, ** = $p < 0.05$, * = $p < 0.10$. Table contains coefficients from weighted regressions of the determinants of WIC participation. Each column reports coefficients on WIC program variables from regressions for the subgroup indicated. Regressions include state and year fixed effects. Unless the subgroup prevents it, all regressions also include indicators for the infant being male or sex missing; the mother being a high school dropout, high school graduate, having four or more years of college, or maternal education being missing; the mother being married or marital status missing; the mother being 20–24, 25–34, 35 or older or maternal age missing; the mother being obese or BMI missing; her having smoked at least 100 cigarettes or smoker-status missing; the father's information being on the BC; the mother living in an urban area or that being unavailable; the infant's parity (1, 2, 3, 4, 5 or more, or missing); the mother's race being black/Asian/American Indian/other non-white or race unknown; and the mother or infant being Hispanic or Hispanic ethnicity being unknown. State-level variables include the share of population that is urban, black, Hispanic, or in poverty; the share of births to unmarried women in the state; the Food Stamp and AFDC/TANF participation rates; real median income for a family of 4; maximum AFDC/TANF benefits for a family of 4; and the Medicaid eligibility cutoff for pregnant women. Standard errors clustered by state-year.

Youth, that WIC participants have significantly lower scores on a test of ability (the Armed Forces Qualification Test) than other mothers, even conditional on race, ethnicity, and age.

Our results suggest that OLS estimates of the effects of WIC generated using samples of women similar to those likely to use WIC are likely to be more sensible than 2SLS estimates which attempt to correct for selection into the WIC program in a larger sample of all women using characteristics of the programs as instruments. The main problem with the latter is that while program characteristics have some explanatory power, they are very "weak instruments" in the sense of Staiger and Stock (1997).

It is reasonable to note that existing studies of WIC are imperfect if they do not properly account for selection. Much more research on the determinants of participation among pregnant women and also among children is necessary. However, it would be irresponsible to conclude that the existing evidence provides no information about the effects of WIC. While it remains theoretically possible that WIC mothers might be positively selected, all the evidence points in the opposite direction. Hence, the onus should be on critics of the program to describe a specific and plausible way that selection on unobservables could invalidate the positive findings of previous WIC studies.

This study adds to a large body of work suggesting that WIC mothers are negatively selected from the population of eligibles and that the WIC program helps these women to have healthier infants. Moreover, the richness of the PRAMS data enables us to demonstrate that the benefits of WIC use by pregnant women far outweigh the costs of the program benefits. As discussed above, the typical woman receives a food package worth approximately $35 per month. A limitation of PRAMS is that we do not know the month in which a woman began receiving benefits, but a conservative estimate is that the typical woman begins in the second month of pregnancy and continues through the ninth month. Hence, the woman receives $280 in direct program benefits.

Set against these direct costs are an array of benefits in the form of cost savings to the Medicaid program. For example, the average reduction of almost one night's hospital stay per infant, and a quarter of a night's stay in hospital per woman, would be enough to repay the cost of the WIC benefits by itself. But the WIC infants are also 14 percent less likely to end up in an intensive care unit, at a cost of thousands of dollars per day. Thus, Devaney's argument that WIC saves the government money by economizing on the costs of treating mothers and infants under the Medicaid program is borne out by these data.

However, this simple calculation of cost savings is likely to greatly under-estimate the value of the WIC program, since it does not include the social benefit of producing healthier babies. Our estimates suggest that WIC reduces the probability that an infant is low birth weight by 29 percent, and reduces the probability that an infant is very low birth weight by more than half. There is a large volume of research showing that low birth weight increases the risk of death, and is also associated with a range of negative outcomes for surviving infants. For example, Currie and Hyson (1999) show using data from the British cohort studies that compared to infants of normal birth weight, low birth weight infants had less completed education and lower earnings and probabilities of employment at age 33.

In summary, our estimates show that WIC *does* work. This does not mean that it could not be improved, perhaps by improving the nutrition education component as Besharov and Germanis suggest, or by trying to target larger benefits more specifically to the neediest women. But we should be wary of any proposal that would undermine support for this important program serving our most vulnerable children.

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Table A–1. Means and standard errors for state-level controls and WIC program characteristics.

	Mean	Standard Error
Medicaid eligibility threshold as share of federal poverty level	1.708	0.001
Real monthly maximum AFDC/TANF benefits, family of four (97 $1000s)	0.415	0.001
TANF/AFDC participation rate	0.039	0.000
Food Stamp participation rate	0.098	0.000
Percent black	17.21	0.04
Percent Hispanic	6.48	0.04
Percent of population living in metro areas	76.17	0.08
Percent of population under the poverty level	14.55	0.01
Percent of births to unmarried women	33.91	0.02
Proof of income required for WIC eligibility determination	0.197	0.003
AFDC/TANF confers adjunctive WIC eligibility	0.914	0.002
SSI/Free School Lunch or Breakfast programs confer WIC eligibility	0.588	0.003
WIC food instrument distributed monthly	0.378	0.003
Food packets allow tailoring of milk	0.814	0.002
Food packets allow tailoring of low sugar foods	0.150	0.002
Real average cost of woman's food packet (97$)	37.326	0.052
Cost of woman's food packet missing	0.068	0.001
Hematocrit cutoff for WIC eligibility for first trimester pregnancy	35.209	0.010
Hemoglobin cutoff for WIC eligibility for first trimester pregnancy	11.499	0.007
No hemoglobin cutoff listed for state	0.012	0.001

Note: Summary statistics for state controls in final sample, pooled across all state/years. Column 1 contains means and column 2 contains standard errors. All statistics calculated using weights and adjusting for complex nature of sample.