The Changing Association between Prenatal Participation in WIC and Birth Outcomes in New York City

Ted Joyce
Baruch College, City University of New York
And National Bureau of Economics Research
E-mail: ted_joyce@baruch.cuny.edu

Diane Gibson
Baruch College, City University of New York

Silvie Colman
Graduate Center, City University of New York

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Abstract

We analyze the relationship between prenatal WIC participation and birth outcomes in New York City from 1988 to 2001. The analysis is unique for several reasons. First, we have information on 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 subsample 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.

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INTRODUCTION

Over seven million women, infants, and children participated in the Special Supplemental

Nutrition Program for Women, Infants, and Children (WIC) in 1999, up from 4.1 million in 1989. Over the

same period expenditures in 1999 dollars grew from 2.6 to 4.0 billion dollars (U.S. House of

Representatives, 2000). A large number of studies suggest that prenatal participation in WIC increases birth

weight, prolongs gestation, and lessens the incidence of low and very low birth weight births. Based on the

results from these studies, the General Accounting Office (GAO) concluded that every federal dollar spent

on prenatal WIC participants returned an estimated $3.50 in savings in primarily reduced health care costs

(General Accounting Office, 1992).

Since the release of the GAO report in 1992, the general conclusion among policymakers has been

that "WIC works." The Web site of the United States Department of Agriculture's (USDA) Food and

Nutrition Service (FNS) touts WIC as a highly cost-effective program for the improvement in birth

outcomes.[1] Many states with Web sites for the WIC program make similar claims.[2] At one state Web site

the headline reads, "WIC Works Wonders" (April 25, 2005, from

http://www.fha.state.md.us/wic/html/benefits.html).

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[1]April 25, 2005, from http://www.fns.usda.gov/wic/aboutwic/howwichelps.htm#birth%20outcomes.

[2]The following sites were obtained from a search with Google™. At each site, the benefits of WIC included
heavier babies, fewer preterm births, and cost savings to the state from lower newborn expenditures for women on
Medicaid.

  April 25, 2005, from http://www.nutritionnc.com/wic/wicworks.htm.
  April 25, 2005, from http://dchealth.dc.gov/services/wic/svc_benefits.shtm.
  April 25, 2005, from http://www.health.state.mn.us/divs/fh/wic/aboutwic/wichealth.html.
  April 25, 2005, from http://www.dhfs.state.wi.us/WIC/benefits.htm.
  April 25, 2005, from http://www.doh.wa.gov/cfh/WIC/health_effects.htm.
  April 25, 2005, from http://www.dhs.state.or.us/publichealth/wic/about.cfm#benefit

Yet, in a recent review of previous research, Douglas Besharov and Peter Germanis (2001) challenge the efficacy of the WIC program. They contend that research on the association between WIC participation and improved birth outcomes suffers from outdated estimates and poor designs. Moreover, they point out that there is little evidence in the clinical literature to suggest that supplemental nutrition for pregnant women in developed countries like the United States has an important effect on birth outcomes (Goldenberg and Rouse, 1998; Kramer et al., 2000).

Why, then, is the medical literature at such odds with conclusions reached by public policy analysts as to the effectiveness of WIC? One explanation is the greater use of clinical trials in medicine to more rigorously test hypotheses. Randomized experiments are less common in the social sciences and contamination from selection bias is an important threat to external validity in observational studies. Moreover, it is difficult to challenge popular programs without rigorous studies that provide more definitive conclusions. The one clinical trial of WIC found that participation had no effect on birth weight except among the subgroup of women who smoked (Metcoff et al., 1985). The study has had limited impact since the sample was small, pertained to one clinic, and was conducted over 20 years ago.

However, even without clinical trials to inform policy, many studies of WIC have not used the medical literature to guide interpretation of the data. The highly influential GAO report, based on 17 studies, concluded that prenatal WIC participation lowered the rate of low birth weight (LBW < 2,500 grams [5.5 lbs]) by 25 percent and the rate of very low birth weight (< 1500 grams or 3.3 lbs) by 44 percent. The improvements in very low birth weight births are primarily responsible for the GAO's conclusion that a dollar invested in WIC saved $2.89 in the first year of life. In a recent paper, researchers obtained equally dramatic results (Bitler and Currie, 2005). They find that WIC is associated with a 54-percent decrease in the odds of a very low birth weight birth and a 53-percent decrease in the odds of very premature infants (<

32 weeks gestation).[3] Such results appear implausible. There is little evidence in the clinical literature to suggest that prenatal supplementation could reduce by almost half the incidence of preterm birth.[4] In fact, the determinants of preterm birth remain elusive. An editorial in the *New England Journal of Medicine* summarizes clinicians' frustration**:**

> Trials measuring the effect on the prematurity rate of eliminating a single risk factor are numerous; uterine contractions have been suppressed, cervixes have been sewn shut, microorganisms have been eliminated, and social support, better nutrition, and prenatal care have been provided. When these factors have been studied in isolation, not one has resulted in a decline in preterm birth (Iams, 1998, p. 54).

In this study we take a first step toward reconciling the belief among policy analysts that "WIC works" with the doubt among medical researchers that nutritional supplementation in developed countries like the United States is a meaningful determinant of birth outcomes. We use New York City birth certificates from 1988 to 2001 to address several of the concerns raised above. First, we focus on measures of fetal growth as outcomes by which to assess the effectiveness of WIC. We take the clinical perspective that supplemental nutrition and nutritional counseling are unlikely to prevent preterm birth. We consider associations between WIC and preterm birth as suspect and suggestive of omitted variable bias.

Second, we test whether the association between WIC and birth outcomes has changed over time, and if so, whether the changing composition of participants can explain the difference (Besharov and Germanis, 2001). The growth in WIC coincides with the expansion in Medicaid eligibility thresholds that occurred in the late 1980s and early 1990s. Women on Medicaid are automatically eligible for WIC, even if the income thresholds for Medicaid exceed those for WIC (Lewis and Ellwood, 2000). As a result, the growth in WIC among pregnant women is likely to include proportionately fewer women at risk for adverse

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[3]Ninety-five percent of all very low birth weight births are born preterm (Martin et al., 2003).

[4]This is not to say that social scientists have little to contribute in the evaluation of programs that affect health. However, the "theory" that guides the interpretation of treatment effects is often medicine and not social science. In such analyses, social scientists would be advised to use clinical findings to understand and perhaps challenge their results.

birth outcomes. With 14 years of data and over 800,000 births to women on Medicaid in New York City, we examine the composition of women on Medicaid and WIC from the period before the Medicaid eligibility expansions through the most recent expansions for pregnant women under the State Children's Health Insurance Program (SCHIP).

Third, many studies report that improvements in birth outcomes associated with WIC are greater among women at medical risk, such as smokers, teenagers, and those with a previous premature delivery. Such results are interpreted as evidence that WIC is more beneficial for women in need of nutritional assistance. However, these risk factors tend to be correlated with other hard-to-measure determinants of birth outcomes, such as substance abuse, sexually transmitted disease, and stressful home environments. Thus, effects associated with WIC among a sample of women that smoke, for instance, may reflect greater unobserved heterogeneity between WIC and non-WIC participants than is found among such lower-risk groups as nonsmokers. As a plausibly less-contaminated test of whether the association between WIC and birth outcomes is greater among women at nutritional risk, we compare outcomes between WIC and non-WIC participants who deliver twins. Multiple gestations represent a random health shock that increases the risk of anemia, inadequate weight gain, and adverse birth outcomes, but should be orthogonal to other risky behaviors.[5]

Finally, a universal concern among analysts of WIC has been selection bias. Do women that participate in WIC differ from nonparticipants in ways that are hard to measure but that are also correlated with the outcomes of interest? As with almost all previous studies, we lack a truly exogenous instrument or quasi-experimental design by which to address selection bias directly. However, we allow effects of WIC on fetal growth to vary over time and within relatively homogeneous groups of women. Therefore,

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[5]An exception would be multiple gestations that resulted from assisted reproductive technology (ART). However, 89 percent of women that receive ART are 30 years of age or older and 77 percent have no previous live births (Schieve et al., 2002). Women that receive such treatment are likely to be older, better-educated, and of zero or low parity—a group with a low probability of WIC participation.

treatment effects that are clinically implausible and differ substantially over time and across groups should be interpreted cautiously and viewed as possible evidence of selection bias.

LITERATURE REVIEW

Appropriate Outcomes

Five of the 17 studies reviewed by the GAO (1992) were based on the influential analysis conducted by researchers at Mathematica Policy Research, Inc. In that study, researchers linked birth certificates to WIC administrative files in 1987 and 1988 in five states: Florida, Minnesota, North Carolina, South Carolina, and Texas (Devaney, Bilheimer, and Schore, 1992). Researchers reported that mean birth weight was 87 grams greater and the incidence of low birth weight was 3.8 percentage points less among WIC relative to non-WIC participants. Similar results based on equivalent methods were obtained from a national sample of births in 1988 from the National Maternal and Infant Health Survey (NMIHS). The NMIHS is a national sample drawn from natality files with more extensive information on maternal characteristics and behaviors than was available from state-specific linkages of administrative data to birth certificates (Gordon and Nelson, 1995). The national sample increased the generalizability of the findings and the additional covariates lessened the potential of omitted variable bias.

An important consideration when evaluating the findings of the previous research on WIC is whether there is a plausible mechanism for the relationship between WIC and the outcome of interest. Most studies have emphasized the association between WIC and the probability of a low-birth-weight birth. However, low birth weight can be broadly divided between preterm births—those that occur before the 37th week of gestation—and those that are small for gestational age (SGA). The latter is an indication of fetal growth retardation. As noted above, the causes of preterm birth are largely unknown and few interventions,

if any, appear effective.[6] A stronger case can be made for an association between fetal growth retardation and prenatal supplementation, since the latter is more closely linked to nutritional intake and maternal weight gain (Institute of Medicine, 1990; Kramer, 1987).

There is little doubt, for instance, that extreme nutritional deprivation in the prenatal period affects fetal growth. The Dutch Famine of 1944–45, for example, was associated with a 300-gram decrease in mean birth weight (Stein and Susser, 1975). However, the association between nutritional supplementation and birth weight in developed countries is less clear. In a randomized trial of poor women in New York City, there was some evidence that prenatal supplementation increased maternal weight gain, but supplementation was unrelated to birth weight (Rush, Stein, and Susser, 1980). Similarly, in the National WIC Evaluation, researchers found no association between WIC participation and birth weight, despite significant increases in the intakes of four out of the five nutrients that were analyzed (Rush et al., 1988). And in the only randomized trial of WIC participation, researchers found no effect of WIC participation on birth weight except among a subset of maternal smokers (Metcoff et al., 1985).

Importantly, studies that show an association between WIC and low birth weight or mean birth weight report statistically insignificant associations or small effects of WIC on proxies for fetal growth. In the Mathematica study, differences in mean birth weight fall from 87 grams averaged across the five states to 25 grams when gestational age is included in the birth weight specification (Devaney et al., 1992). The same is true in a detailed assessment of WIC based on the NMIHS. A statistically significant mean difference in birth weight of 68 grams falls to a statistically insignificant difference of 25 grams when adjusted for gestational age (Gordon and Nelson 1995). Kotelchuck et al. (1984) find that participation in WIC in Massachusetts is associated with a 1.8-percentage-point decline in the rate of low birth weight, but WIC is not associated with infants that are SGA, a standard indicator of fetal growth retardation.

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[6]Indeed, in the Dutch Famine study, severe nutritional deprivation had a major effect on birth weight but was unassociated with gestational age.

Stockbauer (1987) and Buescher and Horton (2000) obtain similar results in Missouri and North Carolina respectively. Bitler and Currie (2005) find that WIC is associated with more than a 50 percent decline in preterm birth but only a 13 percent decline in the odds that a newborn is SGA; moreover, the coefficient is statistically insignificant in two of the three high-risk subgroups that they analyze separately.

In none of these analyses, however, do the authors interpret the lack of a substantive association between WIC and fetal growth as inconsistent with the inference that WIC improves infant health. Instead, researchers conclude that WIC has a strong indirect effect on birth weight or low birth weight through prolonged gestation. But as noted previously, the determinants of preterm birth remain elusive and the link between enhanced nutrition and preterm birth is highly questionable (Collaborative Group on Preterm Birth Prevention, 1993; Dyson et al., 1998; Goldenberg and Andrews, 1996; Goldenberg and Rouse, 1998; Joseph et al., 1998). Thus, a more conservative interpretation of the literature is that WIC may have a modest effect on fetal growth, but that the association between WIC and preterm birth is questionable.

One study based on linked WIC administrative data and birth certificates in Michigan focused exclusively on fetal growth (Ahluwalia et al., 1998). Women in WIC were less likely to deliver a term, low-birth-weight infant relative to women who were eligible for WIC but were not enrolled. However, non-WIC women differed significantly from WIC participants with respect to receipt of prenatal care. For instance, 87 percent of women who enrolled in WIC early in pregnancy had adequate prenatal care as compared to 53 percent of non-WIC women. These are large differences in prenatal care and they raise concern about selection bias, a key issue to which we now turn.

Selection Bias

An additional concern with previous research on WIC is that estimates of the effect of WIC are subject to selection bias. A number of approaches such as the use of statistical controls, matched samples, or instrumental variables have been used to attempt to minimize this bias, but none of them are ideal. Selection bias occurs, for example, if women who participate in WIC are more motivated to deliver a healthy baby or

more risk averse than their counterparts who choose not to participate. If motivation or risk aversion is negatively correlated with other hard-to-measure factors that increase the risk of preterm delivery or fetal growth retardation (that is, the intensity of smoking, illegal drug use, vaginal infection), then omitted variable bias will cause the estimated effect of WIC to be overstated. There has been only one randomized trial involving WIC, and as mentioned earlier, its results were equivocal (Metcoff et al., 1985).

In most observational studies, researchers use statistical controls or matched samples to lessen contamination from selection bias. The set of covariates from administrative data and birth certificates is limited, but even studies with much more detailed information on maternal behavior and socioeconomic status have obtained similar findings to studies with many fewer covariates (Bitler and Currie, 2005; Devaney et al., 1992; Gordon and Nelson, 1995; Kotelchuck et al., 1984; Schramm, 1985, 1986; Stockbauer, 1986, 1987).

Studies that match pregnant women on WIC to eligible pregnant women on waiting lists for WIC or to women in counties without WIC programs have reported mixed results (Kennedy et al., 1982). An alternative matching strategy has been to use two births to the same woman, in which during one pregnancy the mother participated in WIC and in the other she did not (Kowaleski-Jones and Duncan, 2002). The advantage of models with "individual fixed effects" is that they remove confounding from time-invariant characteristics of the mother. However, sample sizes tend to be small and arguably unrepresentative. In the study by Kowaleski-Jones and Duncan (2002), the estimated effects of WIC on birth weight, unadjusted for gestational age, are very large, but are based on the experience of only 71 women whose experience with WIC varied between pregnancies. Econometric approaches to selection bias have yielded highly unstable results due to the lack of a credible identification strategy (Brien and Swann, 1999; Fraker, Gordon, and Devaney, 1995).

In summary, there are many concerns with the previous research on WIC. There is little clinical evidence that nutritional supplementation during pregnancy affects preterm birth. Thus, associations between WIC and birth weight that reflect prolonged gestation are suspect. Second, the majority of studies

pertain to women who gave birth in the 1970s and 1980s, but a doubling of WIC enrollment over the past 12 years undermines the relevance of these earlier studies. Finally, selection bias remains a threat to the validity of received work, and the conclusion that WIC is more effective among women at elevated risk of an adverse birth outcome may be a further manifestation of omitted variables bias. We address each of these concerns in the following ways. First, we focus on fetal growth as an outcome and use preterm birth as a specification check on our model. Second, we allow effects of WIC on fetal growth to vary over time and within relatively homogeneous groups of women. Treatment effects that differ substantially over time and across groups should be interpreted cautiously. Finally, we use twinning as an exogenous risk factor for anemia, inadequate weight gain, and intrauterine growth retardation: outcomes that are plausibly amendable by WIC and that may be more detectable among multifetal as compared to single gestations.

DATA

We analyze the relationship between prenatal WIC participation and birth outcomes in New York City from 1988 to 2001 for women on Medicaid as recorded on birth certificates. New York City is a separate vital registration area. Its birth certificate is arguably the most detailed in the country. Since 1988 it has included the method of finance (Medicaid, other third party, HMO, and self-pay) and whether the mother was enrolled in WIC during pregnancy. There are also indicators of smoking and illicit drug use as well as the standard set of sociodemographic characteristics of the mother available from all birth certificates.

The indication of WIC participation is a dichotomous variable. Thus, we lack information on how long the mother has been enrolled or when she enrolled during pregnancy. We are also concerned about accuracy of the indicator given that it is largely self-reported. To investigate the quality of the data, we compared the proportion of women on WIC in New York City as obtained from birth certificates to other

sources with similar information, and the proportions were very similar.[7] It is also important to note that WIC is not an entitlement program. If demand for WIC exceeds the allocated funds, then eligible candidates may not receive benefits. Pregnant women, however, are among the eligible groups with the highest priority for WIC services, and the prenatal WIC program was fully funded in New York State over the study period.[8]

Outcomes

We present results for birth weight (in grams) and gestational age (in weeks). We also use dichotomous indicators of low birth weight (< 2500 grams), very low birth weight (< 1500 grams), and preterm birth (< 37 weeks gestation). We analyze three measures of fetal growth. The first is birth weight adjusted for gestational age.[9] The second measure is a dichotomous indicator of infants below the 10th percentile in weight for gestation within gender, based on all singleton births to U.S. residents in 1995 (Alexander et al., 1998). They are referred to as small for gestational age (SGA). Our final measure of fetal growth is an indicator of infants that are term, low birth weight (> 36 weeks gestation and < 2500 grams).

Separate analyses of birth weight and gestational age outcomes serve several purposes. First, they enable us to compare our estimates with previous work. Second, we can directly test for an association between WIC and gestational age or preterm birth. Our argument is that WIC should not be related to prolonged gestation. Similarly, associations between WIC and low birth weight that operate through

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[7]See Joyce, Gibson, and Colman (2004).

[8]Personal communication: Roberta Hayward, Division of Nutrition, Bureau of Supplemental Food Programs, New York State Department of Health. It is more difficult to determine whether nutritional counseling has changed over time. Moreover, the only change in New York State in the availability of food that we were able to establish was the 1989 Farmers' Market Nutrition Program (FMNP). The program provided coupons for fresh fruits and vegetables to WIC participants.

[9]In other words, we include gestational age as a right-hand side determinant in a birth weight regression.

preterm birth are also implausible and thus provide evidence of omitted variable bias. If WIC does improve

birth outcomes, then the most credible association should be between WIC and fetal growth.

Analysis of Twins

A novel aspect of this study is a subset of analyses based on the outcomes of multifetal pregnancies

that result in twins. There were over 40,000 deliveries of twins in New York City between 1988 and 2001,

of which approximately 11,000 were to women on Medicaid. Thus, we analyze the association between

WIC participation and birth outcomes to women on Medicaid who delivered twins over the study period.

Twin deliveries represent 3 percent of all live births in 2001, and thus are a small proportion of the WIC

caseload. Nevertheless, the rate of low birth weight is over 50 percent among twins and they account for

21.6 percent of all low-birth-weight births. [10] By contrast, the rate of low birth weight among smokers was

11.9 percent and 18.6 percent of low-birth-weight births were to women who smoke. Women pregnant with

twins have 2.4 times the risk of anemia, and the American College of Obstetrics and Gynecology (ACOG)

recommends that women carrying twins consume 300 Kcal per day above that recommended for singletons

(Gall, 1996; American College of Obstetrics and Gynecology, 1999). WIC programs in all 51 states

consider multifetal gestations a marker for women at nutritional risk (Institute of Medicine, 1996).

EMPIRICAL METHODS

Analysis of Singleton Births

The composition of women that gave birth in New York City changed significantly over the 14

years of our study period. In 1988, for example, 39.0 percent of all births in the City were financed by

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[10]April 25, 2005, from http://www.cdc.gov/nchs/data/nvsr/nvsr51/nvsr51_02.pdf.

Medicaid as compared to 55.8 percent in 2001. Similarly, the percentage of births to foreign-born women

increased from 40.1 in 1988 to 53.0 percent in 2001.[11] To adjust for such shifts in the distribution of births

by maternal characteristics, we estimate regressions of the form:

$$(1) \qquad G_{it} = \alpha_0 + \alpha_1 WIC_{it} + \mathbf{x'_{it}}\,\boldsymbol{\beta} + \sum \delta_t Yr_t + e_{it}$$

Let G_{it} be the fetal growth in grams adjusted for gestational age of infant i in year t, let WIC_{it} be one

if the mother participated in WIC during pregnancy in year t, let $\mathbf{x}_{it}$ be a vector of maternal characteristics,

and let Yr_t be an indicator of the year. The coefficient on WIC, α_1, estimates the average treatment effect of

WIC on fetal growth under two assumptions: First, that the decision to participate in WIC, conditional on **X,**

is uncorrelated with fetal growth in the absence of participation; and second, that the expected gains to

participation are constant across individuals (Heckman, 1997; Wooldridge, 2002).[12] Both assumptions are

clearly strong. To illustrate, Figures 1 and 2 show the rate of low-birth-weight births and mean birth weight,

respectively, for singleton births to women on Medicaid by participation in WIC in New York City from

1988 to 2001. In 1988, the difference in the rate of low birth weight between WIC and non-WIC

participants was 3.5 percentage points and the difference in mean birth weight was 75 grams. Both

estimates are consistent with much of the literature of the 1980s. As is apparent in both figures, however,

mean differences diminish over time. There are also large differences by race, ethnicity, and nativity, as we

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[11]New York State expanded income eligibility thresholds for pregnant women in January 1990. Thresholds rose from 100 to 185 percent of the federal poverty level. Women on Medicaid are automatically eligible for WIC. The rise in the proportion of births to women on WIC correlates strongly with the Medicaid eligibility expansion (see Joyce et al., 2004). We only include women on Medicaid and thus only women who are eligible for WIC.

[12]The term "average treatment effects" connotes estimates from a randomized trial. However, as noted by Wooldridge (2002), " Broadly, most estimators of ATEs [*average treatment effects*] fit into two categories. The first set exploits assumptions concerning ignorablility of the treatment conditional on a set of covariates…and in some cases reduces to an OLS regression with many controls" (p. 603). We use average treatment effects in this manner. Note also that stratification by race, ethnicity, nativity, parity, and prenatal care is equivalent to a pooled model with a large set of interactions between these characteristics and each of the variables in **X** of equation (1).

Figure 1
Proportion of Singleton Births with Weight Less than 2500 grams to Women
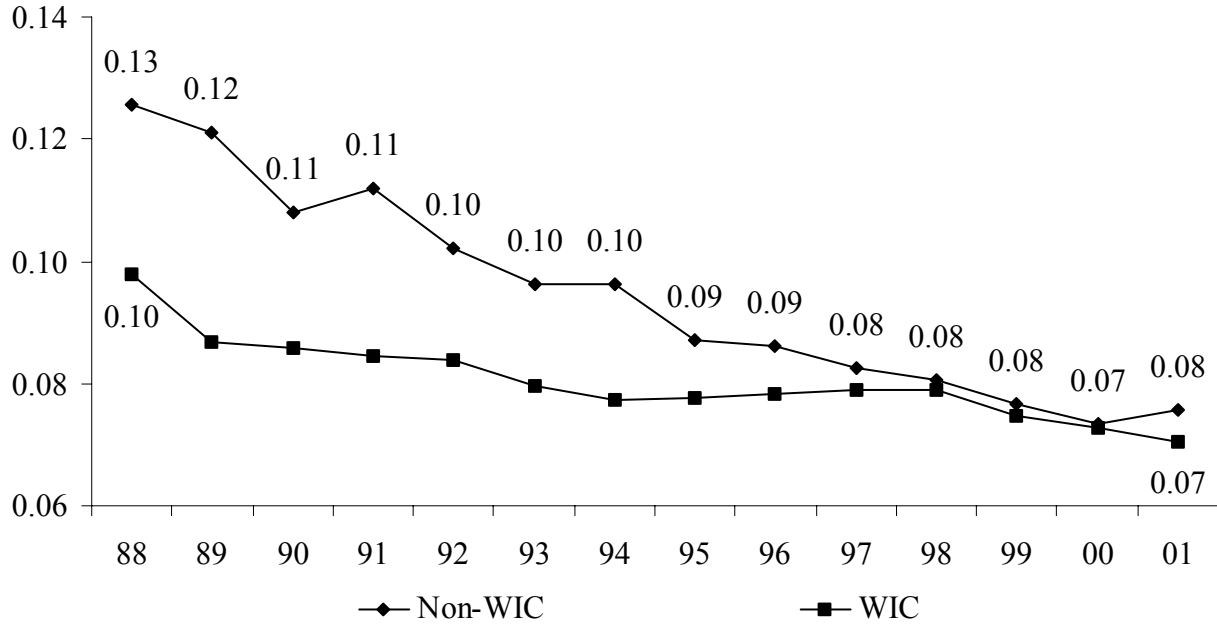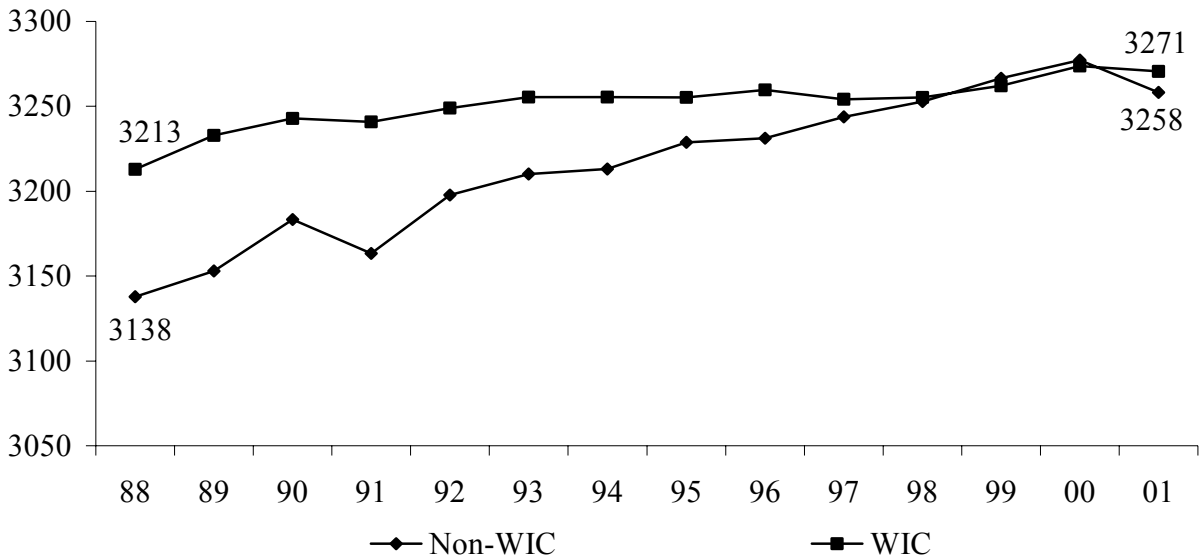**on Medicaid by Participation in WIC, NYC 1988-2001**

Figure 2
Mean Birth Weight (in grams) of Singleton Births to Women on
Medicaid by Participation in WIC, NYC 1988-2001

show below. Consequently, we interact WIC with the year dummies and we estimate separate models by race, ethnicity, and nativity. With these specifications, the assumption of constant average treatment effects may be less problematic, since it pertains to more homogeneous groups at a specific point in time.

The other key assumption is that WIC participation is uncorrelated with fetal growth in the absence of participation. In other words, we assume that women do not select into WIC because they have strong preferences for health (favorable selection) or the opposite: that they have underlying health problems that are not observed by researchers (adverse selection). As with previous research on WIC, we lack credible instruments and eschew an econometric correction of selection bias. Instead, we use our large sample size to stratify analyses so as to enhance the comparability of WIC and non-WIC participants. For instance, we estimate models that are limited to women of zero parity and who initiate prenatal care in the first four months of pregnancy, a standard definition of early prenatal care (Kotelchuck, 1994). Our goal is to compare outcomes among a sample of women whose preferences, motivation, and experience with pregnancy are similar. Data from the NMIHS indicate that in 1988, 67 percent of prenatal WIC participants who had at least one previous live birth had been enrolled in WIC during a preceding pregnancy (Gordon and Nelson, 1995). Women previously enrolled in WIC may be more likely to register for early prenatal care. They may be better informed about nutrition and other risk factors and have stronger preferences for healthy behavior.[13] By restricting the sample to women with no previous live births, we lessen the possibility of differential experience with WIC between current participants and nonparticipants. Early prenatal care may be another marker for favorable selection, since the first prenatal care visit is initiated by the woman. Subsequent visits may be in response to the prenatal protocol. Thus, the timing of the first visit

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[13]Higher order births introduce other forms of selection. For instance, women who had a difficult first birth or pregnancy may enroll in WIC or prenatal care earlier in an effort to improve the subsequent pregnancy or birth outcome, a potentially important form of adverse selection (Rosenzweig and Schultz, 1983).

as opposed to an index of prenatal care may better reflect a mother's attitude toward and access to prenatal care.

An important limitation of our identification strategy is that our results will only generalize to women having first births and who initiate prenatal care early.[14] We consider this an acceptable tradeoff, since it allows us to construct a sample with a lower likelihood of omitted variable bias.

One concern is that if observable characteristics of WIC and non-WIC participants are changing over the study period, then the same may be true of unobserved characteristics. As we show below, the proportion of non-WIC participants with 12 years of completed schooling or more increased more among non-WIC than WIC participants between 1988 and 2001. Thus, in another attempt to reduce omitted variable bias, we also present estimates for the subsample of women 20 years of age or older with less than a high school degree.

Analysis of Twins

As noted above, researchers often estimate Equation 1 separately for groups at greater "nutritional" risk, such as smokers and teens. The objective is to allow for interactions between need and participation in WIC. However, such strategies can exacerbate problems of omitted variable bias if the risk factors are correlated with other hard-to-measure characteristics that vary substantially between WIC and non-WIC participants. We use twinning as an exogenously assigned risk that should be orthogonal to unhealthy behaviors or other hard-to-measure characteristics of the mother. Thus, a comparison of outcomes between

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[14]Our data are also limited to one city, albeit the most populous in the country with an extremely large WIC caseload. Nationally, 81 percent of all U.S.-born blacks and 80 percent of all foreign-born Hispanics initiated prenatal care within the first four months of pregnancy in 1995. For the same year, the comparative percentages for New York City are 77 percent for U.S.-born blacks and 76 percent for foreign-born Hispanics. Moreover, as we show below, our estimates of the association between WIC and adverse birth outcomes in the late 1980s are consistent with previous studies that use data from different states from the late 1980s (Devaney et al., 1992; Gordon and Nelson, 1995).

WIC and non-WIC participants, all of whom delivered twins, may provide a potentially less-contaminated estimate as to whether women at nutritional risk benefit from WIC.[15]

One concern is that the exogeneity of twinning will be compromised if multifetal conceptions result from assisted reproductive technologies (ART). Women who use ART are likely to be highly motivated about achieving a healthy birth outcome and may self-select into WIC. Age and year of birth, however, are important correlates of ART and twinning (Ventura et al., 1999). Eighty-nine percent of women who received ART in 1996–1997 were 30 years of age or older, and the number of infertility clinics and the use of ART have also grown rapidly over time (Jain, Missmer and Hornstein, 2004; Schieve et al., 2002). To lessen the potential bias from women who use ART, we re-estimate the models for twins and limit the sample to women younger than 30. We also allow the effect of WIC to vary by year, since the impact of ART should be less in the late 1980s and early 1990s.

RESULTS

Descriptive Characteristics

Summary statistics for WIC and non-WIC participants are displayed in Table 1 at three points in time: 1988-1992, the period roughly prior to the Medicaid expansion in New York State, 1993–1997, the years prior to welfare reform, and then 1998–2001. Our sample in Table 1 includes only singleton first births to women on Medicaid who initiated prenatal care in the first four months of pregnancy. Differences

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[15]As with singletons, we limit the sample to women who begin care early. We do not stratify initially by parity because of possible recording errors among twin deliveries. The birth certificate indicates which twin is the first. If a woman had no previous live births, then parity of the first twin delivered should be zero and the parity of the second twin delivered should be one. This appears correct for approximately 80 percent of twin deliveries, except in 1994 and 1995. In these years 80 percent of twins were incorrectly assigned the same parity. In our sensitivity analysis we do the following: we assume all twins with the same parity of zero, regardless of which twin was delivered first, are parity zero. We then combine these with the consistent indications of parity zero and re-estimate the models for twins whose mothers initiate care early and who have no previous live births.

Table 1

Characteristics of Singleton Births on WIC and/or Medicaid for Women with No Previous Live Births, Who Initiated Prenatal Care in the First Four Months of Pregnancy, New York City 1988–2001

	1988–1992			1993–1997			1998–2001		
	Non-WIC	WIC	Diff.	Non-WIC	WIC	Diff.	Non-WIC	WIC	Diff.
N	25,897	30,105		23,474	53,524		17,627	47,029	
Measure of Birth Weight:									
Mean (g)	3192.27	3213.55	21.281***	3223.73	3215.11	-8.625*	3231.80	3213.82	-17.980***
% LBW (<2500g)	0.095	0.085	-0.010***	0.079	0.080	0.001	0.075	0.080	0.005**
% VLBW (<1500g)	0.016	0.013	-0.002**	0.014	0.014	0.000	0.015	0.014	-0.001
Weeks of Gestation:									
Mean	38.945	39.043	0.098***	38.971	38.988	0.017	38.907	38.928	0.020
Premature	0.094	0.084	-0.010***	0.086	0.080	-0.006***	0.079	0.081	0.002
Measure of Fetal Growth:									
LBW, >36wks gestation	0.042	0.038	-0.004**	0.030	0.034	0.004***	0.030	0.032	0.002
Small-for-GA	0.164	0.157	-0.007**	0.141	0.145	0.004	0.128	0.142	0.014***
Mother's Weight-Gain:									
Mean (lbs)	29.966	30.867	0.901***	31.527	32.019	0.493***	32.623	32.983	0.360***
% Unknown	0.645	0.269	-0.376***	0.276	0.182	-0.094***	0.098	0.076	-0.022***
Net weight	22.894	23.773	0.878***	24.389	24.919	0.530***	25.487	25.891	0.404***
Mother's Education:									
<12 years	0.382	0.416	0.034***	0.313	0.379	0.066***	0.309	0.385	0.075***
12 years	0.432	0.393	-0.038***	0.414	0.389	-0.024***	0.387	0.378	-0.009**
13–16 years	0.145	0.163	0.018***	0.213	0.190	-0.023***	0.241	0.203	-0.038***
³17 years	0.012	0.011	-0.002*	0.028	0.018	-0.010***	0.039	0.022	-0.017***
Unknown	0.029	0.017	-0.013***	0.033	0.024	-0.009***	0.024	0.013	-0.011***
Mother's Age:									
10–19	0.266	0.315	0.049***	0.234	0.297	0.064***	0.203	0.283	0.080***
20–34	0.685	0.651	-0.034***	0.711	0.666	-0.045***	0.740	0.678	-0.062***
35–50	0.047	0.032	-0.015***	0.055	0.037	-0.018***	0.057	0.039	-0.018***
Unknown	0.002	0.001	-0.001**	0.001	0.001	0.000	0.000	0.000	0.000**

(table continues)

Table 1, continued

	1988–1992			1993–1997			1998–2001		
	Non-WIC	WIC	Diff.	Non-WIC	WIC	Diff.	Non-WIC	WIC	Diff.
Mother's Race:									
Puerto Rican	0.198	0.215	0.017***	0.129	0.158	0.029***	0.104	0.124	0.020***
Other Hispanic	0.238	0.290	0.052***	0.259	0.352	0.094***	0.257	0.384	0.127***
Asian	0.051	0.024	-0.027***	0.171	0.055	-0.116***	0.253	0.087	-0.166***
White Non-Hispanic	0.127	0.069	-0.058***	0.171	0.081	-0.090***	0.156	0.070	-0.087***
Black Non-Hispanic	0.377	0.399	0.022***	0.258	0.343	0.085***	0.225	0.330	0.104***
Other	0.000	0.000	0.000	0.006	0.005	-0.002***	0.002	0.005	0.003***
Unknown	0.010	0.003	-0.007***	0.005	0.005	-0.001	0.003	0.001	-0.002***
Marital Status:									
Single	0.676	0.721	0.045***	0.647	0.759	0.111***	0.612	0.748	0.137***
Unknown	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Mother's Birth Place:									
Foreign born	0.424	0.461	0.037***	0.572	0.551	-0.020***	0.629	0.591	-0.038***
% Unknown	0.003	0.004	0.001	0.009	0.007	-0.002***	0.008	0.005	-0.003***
Pre-Pregnancy Weight:									
Mean (lbs)	136.359	140.243	3.884***	135.245	139.895	4.650***	134.375	137.725	3.351***
% Unknown	0.637	0.237	-0.400***	0.259	0.151	-0.108***	0.086	0.059	-0.027***
Prenatal Doctor Visits:									
Mean	9.531	10.306	0.774***	10.285	10.430	0.145***	10.432	10.664	0.232***
% Unknown	0.031	0.021	-0.010***	0.026	0.023	-0.002**	0.021	0.011	-0.010***
Drug Use d. Pregnancy:									
Heroin/cocaine	0.011	0.007	-0.004***	0.004	0.003	-0.001	0.002	0.001	0.000
% Unknown	0.023	0.016	-0.007***	0.021	0.014	-0.007***	0.001	0.000	-0.001***
Cigarettes	0.047	0.052	0.004**	0.042	0.036	-0.005***	0.021	0.028	0.008***
% Unknown	0.023	0.016	-0.007***	0.018	0.014	-0.004***	0.001	0.000	-0.001***

*p<.10; **p<.05; ***p<.01

in birth outcomes by WIC participation are qualitatively consistent with the literature between 1988–1992, but of a smaller magnitude. There are statistically significant differences in mean birth weight (21 grams), low birth weight (1.0 percentage points), preterm birth (1.0 percentage points), and infants that are small for gestational age (0.7 percentage points). The characteristics of women in WIC in 1988–1992 are marginally more favorable with respect to prenatal care visits and illicit drug use than their non-WIC counterparts. By 1993–1997 there are few meaningful differences in birth outcomes and women in WIC are now more disadvantaged, albeit modestly, than their non-WIC counterparts with respect to education, marital status, and teen motherhood. These modest disadvantages increase slightly by 1998–2001.

However, the racial and ethnic distribution of WIC and non-WIC participants change more substantially over the study period. For instance, the proportion of births to Asians on Medicaid but not on WIC rises from 5.1 percent in 1988–1992 to 25.3 percent in 1998–2001; over the same period, the proportion of Puerto Ricans and black non-Hispanics not on WIC falls 9.4 and 15.2 percentage points, respectively. The racial and ethnic composition among WIC participants changes similarly, but not as dramatically. These shifts would appear responsible in part for the narrowing of birth outcomes between WIC and non-WIC participants as displayed in Figure 1, since Asians and other Hispanics have lower rates of adverse birth outcomes than do Puerto Ricans and non-Hispanic blacks. Thus, Besharov and Germanis (2001) were correct that the Medicaid eligibility expansions altered the distribution of characteristics among WIC and non-WIC participants in New York City. Yet dichotomous indicators for race and ethnicity might not adequately control for the myriad of differences among these groups and their possible interactions with observed characteristics. This is a major reason why we stratify our analyses by race, ethnicity, and nativity.

Multivariate Analysis

In order to provide a point of comparison with previous research, we first contrast adjusted and unadjusted differences in birth outcomes between WIC and non-WIC participants. We focus on three birth outcomes: birth weight, gestational age, and birth weight adjusted for gestational age.

The first column of each Panel in Table 2 presents unadjusted mean differences in the birth outcomes between WIC and non-WIC participants among singleton births to all women on Medicaid. In the second column we display the adjusted difference [α_1 in equation (1)], and the last two columns in Table 2 display adjusted estimates for the subsample of women who initiate prenatal care early and who have no previous live births. In the rows of each panel we display effects of WIC for all years followed by estimates of the interactions between WIC and the year dummies.

The unadjusted difference in mean birth weight between WIC and non-WIC participants is 44 grams over the 14 years of the sample (Panel A, Column 1). After adjustment, mean differences fall 44 percent, to 25.5 grams. However, among women who initiate care early, mean differences are smaller still, at 17.3 grams, and if we restrict the analysis to those who begin care early and who have had no previous live births—and thus no prior experience with WIC—adjusted mean differences fall to 9.8 grams. The same pattern persists across specifications when we allow average treatment effects to vary by year. The adjusted estimate for 1988–1992 among all women, 69 grams, is broadly consistent with the literature (Devaney et al., 1992). Other researchers have also found that average treatment effects are smaller for women who enrolled in WIC earlier in pregnancy (Devaney et al., 1992 Gordon and Nelson, 1995).

The association between WIC and gestational age is more robust (Table 2, Panel B). Adjusted and unadjusted differences in mean gestational age are the same, and although they fall over time, they are precisely estimated. Finally, there is only a modest and inconsistent association between birth weight adjusted for gestational age, a proxy for fetal growth (Panel C). Differences adjusted for covariates are much smaller than unadjusted differences, are clinically inconsequential or have the wrong sign, and are essentially zero after 1988–1992.

Table 2
Differences in Birth Weight between WIC and Non-WIC Participants for Singleton Births in New York City 1988–2001 among Women on Medicaid, by Timing of Prenatal Care and Parity

	Unadjusted Mean Difference	Adjusted Mean Difference		
		All Women	Early Prenatal Care	Early Care, First Birth
Panel A: Birth Weight (in grams)				
All years	44.220**	25.481**	17.280**	9.785**
1988–1992	69.204**	44.024**	31.410**	25.650**
1993–1997	30.490**	21.011**	14.010**	4.723
1998–2001	1.682	5.765*	6.080	-1.896
Panel B: Gestational Age (in weeks)				
All years	0.124**	0.120**	0.095**	0.104**
1988–1992	0.198**	0.151**	0.107**	0.126**
1993–1997	0.119**	0.116**	0.092**	0.085**
1998–2001	0.050**	0.082**	0.087**	0.102**
Panel C: Birth Weight Adjusted for Gestation				
All years	24.819**	7.260**	2.365	-6.291**
1988–1992	40.047**	21.062**	14.638**	6.075
1993–1997	11.610**	3.456	-0.347	-8.434*
1998–2001	-6.718**	-6.748**	-7.521**	-17.719**
N	811,190	811,190	452,207	197,656

Notes: All models include dummy variables for race/ethnicity (6), marital status (1), parity (2), mother's education (4), mother's age (3), heroin or cocaine use (2), smoking (2), health center districts (29), and years (13). All estimates are obtained by ordinary least squares with robust standard errors.
*p.<.05; ** p<.01

The results in Table 2 reveal a pattern that persists in subsequent analyses. First and foremost, there is little association between WIC and fetal growth. Thus, the estimated association between WIC and birth weight is driven by prolonged gestation. Second, differences in birth weight and fetal growth between WIC and non-WIC participants adjusted for covariates are much smaller than unadjusted differences. In other words, there is clear evidence of selection on observables into WIC. Third, the effect of WIC on birth weight and fetal growth falls over time, which suggests that the composition of women changes over the study period, or there is some omitted variable specific to the 1988–1992 period that is correlated with both WIC participation and birth outcomes. Fourth, mean differences in gestational age are unaffected by adjustment (columns 1 and 2). This is consistent with findings from the clinical literature that find preterm birth extremely difficult to predict (Tucker et al., 1991).

The finding that the average treatment effects of WIC fall over time suggests that controls for maternal characteristics may not adequately adjust for the changing composition of Medicaid recipients and the distribution of these women between WIC and non-WIC participants. In Table 3, therefore, we present estimates of average treatment effects for specific subgroups and a larger set of outcomes. We limit the sample to women who begin prenatal care early and who have no previous live births. We show estimates for all women on Medicaid, as well as the subsamples of U.S.-born blacks and foreign-born Hispanics. There are eight birth outcomes. The first three pertain to various measures of birth weight; the second set pertains to gestational age; and the final set contains three proxies for fetal growth that are standard in the literature. As before, we first show estimates for all years and then estimates from the interaction of WIC and year. For dichotomous outcomes we show the percentage-point change associated with WIC.

There is modest evidence at best of an association between WIC and measures related to birth weight among the sample that includes all races and ethnicities (Table 3, Panel A). Although precisely estimated, effects are small. Increases of 10 to 25 grams (Panel A, column 1) represent increases of between 0.3 and 0.8 percent in mean birth weight. Moreover, the statistically significant results that do exist are primarily limited to the period 1988–1992. WIC is associated with increased gestation and a

Table 3
Differences in Birth Outcomes between WIC and Non-WIC Participants for Singleton Births in New York City 1988–2001 among Women on Medicaid, Who Have No Previous Live Births, and who Initiated Prenatal Care in the First Four Months of Pregnancy, by Year, Race, Ethnicity, and Nativity[a]

	Birth Weight			Gestational Age		Weight| Gestation	Fetal Growth	
	Mean (g)	<2500g	<1500g	Mean (weeks)	Preterm		SGA	Term LBW
Panel A: All Women (N = 197,656)								
All years	9.785**	-0.005**	-0.002**	0.104**	-0.011**	-6.291**	0.003	0.000
1988–1992	25.650**	-0.009**	-0.002*	0.126**	-0.011**	6.075	-0.003	-0.003
1993–1997	4.723	-0.004	-0.002*	0.085**	-0.013**	-8.434*	0.002	0.003*
1998–2001	-1.896	-0.002	-0.003**	0.102**	-0.007**	-17.719**	0.013**	0.001
Panel B: U.S.-Born Blacks (N = 39,477)								
All years	39.759**	-0.018**	-0.007**	0.235**	-0.021**	3.388	0.001	-0.002
1988–1992	57.472**	-0.024**	-0.005	0.308**	-0.028**	9.758	-0.001	-0.004
1993–1997	27.168*	-0.015*	-0.005	0.141**	-0.015*	5.435	0.002	0.000
1998–2001	25.214	-0.012	-0.010**	0.236**	-0.017*	-11.211	0.003	-0.001
Panel C: Foreign-Born Hispanics (N = 53,246)								
All years	6.209	-0.004	0.001	0.051*	-0.009**	-1.688	-0.003	0.000
1988–1992	4.241	-0.001	0.000	0.019	-0.006	1.241	-0.001	0.002
1993–1997	5.565	-0.006	0.001	0.060	-0.012**	-3.717	-0.010	0.001
1998–2001	9.293	-0.003	0.001	0.075*	-0.007	-2.291	0.005	-0.002

[a]Model with continuous outcomes—birth weight (in grams), gestational age (in weeks), and birth weight adjusted for gestational age (in grams)—are estimated by OLS. The other outcomes are estimated as probits. We show the coefficients in the case of OLS and the marginal effects or percentage point changes in the case of probits. Sample sizes vary slightly across the dichotomous outcomes. We show the sample size for the continuous outcomes. Models include dummy variables for race/ethnicity (6) and nativity (2) in the pooled model, marital status (1), mother's education (4), mother's age (3), heroin or cocaine use (2), smoking (2), health center districts (29), and years (13). All estimates are obtained by ordinary least squares with robust standard errors. *p.<.05; ** p<.01.

1.1-percentage-point decline in preterm birth (Panel A, columns 4 and 5). WIC, however, is unassociated

with improvements in fetal growth (Panel A, columns 6–8). The statistically significant correlations

between WIC and fetal growth that do exist have the wrong sign. This implies that the association between

WIC and birth weight operates through prolonged gestational age and decreases in preterm birth. In sum,

the strong association between WIC and preterm birth, coupled with a lack of association between WIC and

fetal growth, undermines a causal interpretation. As noted repeatedly, there is little credible evidence in the

clinical literature to suggest that supplemental nutrition and counseling in a developed country like the

United States could appreciably affect the incidence of preterm birth.

Regression estimates for U.S.-born blacks and foreign-born Hispanics are shown in Panels B and C

of Table 3. The rate of low birth weight for U.S.-born blacks who participate in WIC is 2.4 percentage

points less than non-WIC participants in 1988–1992 (p <.01). Effects decline over the subsequent years.

The association between WIC and preterm birth among U.S.-born blacks is even more robust. As with birth

weight, the largest improvement in preterm birth associated with WIC (2.8 percentage points) occurs in

1988–1992 and then declines (Panel B, column 5). Importantly, however, there is no association between

WIC and measures of fetal growth among U.S.-born blacks (Panel B, columns 6–8).

The results for foreign-born Hispanics differ substantially from those of U.S.-born blacks. As

shown in Panel C of Table 3, there is no association between WIC and any measure of birth weight or fetal

growth. Nor is the result due to a lack of power. Few of the coefficients are of a clinically meaningful

magnitude.[16]

One concern is that even within our subgroups the changing characteristics of women over the

study period and their distribution between WIC and non-WIC participants may mask improvements

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[16]Foreign-born Hispanics may be at low nutritional risk given the protective effect of immigrant culture as it relates to diet and social support. Our finding, however, that WIC has a protective effect on preterm birth and not on fetal growth among U.S.-born blacks points to some other risk factor besides nutritional deficits as an explanation for these findings.

among women at higher risk for adverse birth outcomes. For instance, among U.S.-born blacks, the

proportion of non-WIC participants with 13 to 16 years of schooling increases from 15 percent in

1988–1992 to 30 percent in 1998–2001. The increase among WIC participants is from 16.7 percent to

23.2.[17] To lessen this source of heterogeneity, we re-estimate the results in Table 3 but further limit the

sample to women with less than a high school education and who are 20 years of age or older at delivery.

We display the results in Table 4. The most striking findings pertain to U.S.-born blacks in Panel B.

Differences in rates of low birth weight and preterm birth between WIC and non-WIC women are roughly

double the differences obtained for the larger sample of U.S.-born blacks in Table 3. Despite the very large

negative association between WIC and low birth weight as well as between WIC and preterm birth, WIC is

unrelated to measures of fetal growth *for all groups in all years* (columns 6–8). The statistically significant

differences that exist have the wrong sign.

The pattern of results in Tables 3 and 4 is too inconsistent across time, groups, and outcomes to

support a causal interpretation. First, associations between WIC and preterm birth—especially

improvements as large as those observed among U.S.-born blacks—are implausible clinically (Goldenberg

and Rouse, 1998; Kramer et al., 2000). Second, there is no association between WIC and fetal growth

among any group of women. The lack of an association among U.S.-born blacks is particularly noteworthy,

given that WIC appears to reduce the incidence of low birth weight and preterm birth. Third, the robust

association between WIC and preterm birth suggests that the lack of association between WIC and fetal

growth is not the result of measurement error in gestational age. Further support for this argument is that

WIC is also associated with a 50-percent decline in the rate of very low birth weight among U.S.-born

blacks. Birth weight is well measured, and very low birth weight is an effective proxy for preterm birth,

since 95 percent of very low birth weight births are born preterm. Finally, the reduction in low birth weight

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[17]The complete set of summary statistics for each sub-group is available upon request.

Table 4
Differences in Birth Outcomes between WIC and Non-WIC Participants for Singleton Births in New York City 1988–2001 among Low-Educated Adult Women on Medicaid, Who Have No Previous Live Births, and Who Initiated Prenatal Care in the First Four Months of Pregnancy, by Year, Race, Ethnicity, and Nativity

| | Birth Weight | | | Gestational Age | | | Fetal Growth | |
	Mean (g)	<2500g	<1500g	Mean (weeks)	Preterm	Weight | Gestation	SGA	Term LBW
Panel A: All Women (N = 38,275)								
All years	4.692	-0.006	-0.002*	0.140**	-0.016**	-16.514**	0.013**	0.001
1988–1992	16.617	-0.007	-0.001	0.138**	-0.014**	-4.279	0.000	0.000
1993–1997	3.076	-0.010*	-0.002	0.154**	-0.022**	-20.151*	0.015*	-0.002
1998–2001	-8.466	0.001	-0.004*	0.127**	-0.011	-27.664**	0.030**	0.007
Panel B: U.S.-Born Blacks (N = 4,975)								
All years	71.350**	-0.042**	-0.010*	0.452**	-0.053**	5.255	-0.004	-0.011
1988–1992	95.285**	-0.043**	-0.004	0.561**	-0.063**	13.266	-0.007	-0.007
1993–1997	34.731	-0.058**	-0.012	0.339*	-0.052**	-14.858	-0.014	-0.024
1998–2001	61.626	-0.012	-0.014	0.323	-0.029	14.362	0.024	0.003
Panel C: Foreign-Born Hispanics (N = 14,791)								
All years	4.293	-0.005	-0.001	0.117**	-0.017**	-13.154	0.006	0.005
1988–1992	-15.446	0.006	-0.002	-0.018	-0.006	-12.805	0.004	0.010*
1993–1997	14.610	-0.014*	0.001	0.162**	-0.023**	-9.611	-0.009	-0.001
1998–2001	16.238	-0.005	-0.003	0.230**	-0.019*	-18.146	0.033*	0.008

See notes to Table 3. *p.<.05; ** p<.01.

and preterm birth associated with WIC is limited almost exclusively to U.S.-born blacks and is generally

greatest in 1988–1992.

One explanation for this pattern of results among U.S.-born blacks is the greater exposure to

crack-cocaine and its attendant lifestyle among non-WIC recipients. As the epidemic waned during the

1990s, differences in birth outcomes narrowed. Consider the evidence in Figure 3. The series show the

proportion of births to women on Medicaid who were exposed to illicit drugs during pregnancy from 1980

to 2001 by race and ethnicity.[18] There is a dramatic increase in exposure among U.S.-born blacks beginning

in 1985; the series peaks in 1989 and returns to its initial level by 1998. Among foreign-born Hispanics,

however, the prevalence of exposure is never more than 1 percent over the entire period. Figure 4 shows the

rate of low-birth-weight births over the same period and for the same groups. Among U.S.-born blacks, the

rate of low birth weight increases approximately four percentage points between 1985 and 1988 before

returning to its initial level by 1993. The rate of low birth weight among foreign-born Hispanics is

essentially unchanged over the entire period.

The data in Figure 3 should be interpreted cautiously. The indication of illicit drug use on the New

York City birth certificate is problematic. Exposure is underreported and screening likely varied by year

and group (Joyce et al., 1995). Nevertheless, relative differences in exposure to cocaine and heroin by race,

ethnicity, and nativity from rigorous studies of prenatal exposure are dramatic and are consistent

qualitatively with the differences in Figure 3.[19] Moreover, the rise in low birth weight is well measured and

clearly coincident with the rise in illicit drug use. Thus, the decline in low birth weight observed among

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[18]From 1980 to 1987 the NYC birth certificate indicates whether exposure to "narcotics" was a risk factor for the pregnancy. The NYC birth certificate was revised in 1988 with separate indications for heroin and cocaine. The data in Figure 3 join these two series.

[19]In the largest prevalence study of prenatal exposure to illicit substances ever undertaken, researchers in California tested the urine of almost 30,000 mothers at delivery in 1992. Seven-and-a-half percent of all Blacks tested positive for cocaine, versus only 0.5 percent of Hispanics (Vega et al., 1993). In New York City a prevalence study of cocaine use among mothers based on analyses of urine at delivery found rates of exposure as great as 20 percent among U.S.-born blacks (authors' calculations based on the data reported by McCalla et al., 1991).

Figure 3
**Proportion of Singleton Births to Women on Medicaid Exposed to Illicit
Drugs by Race and Ethnicity, NYC 1980-2001***
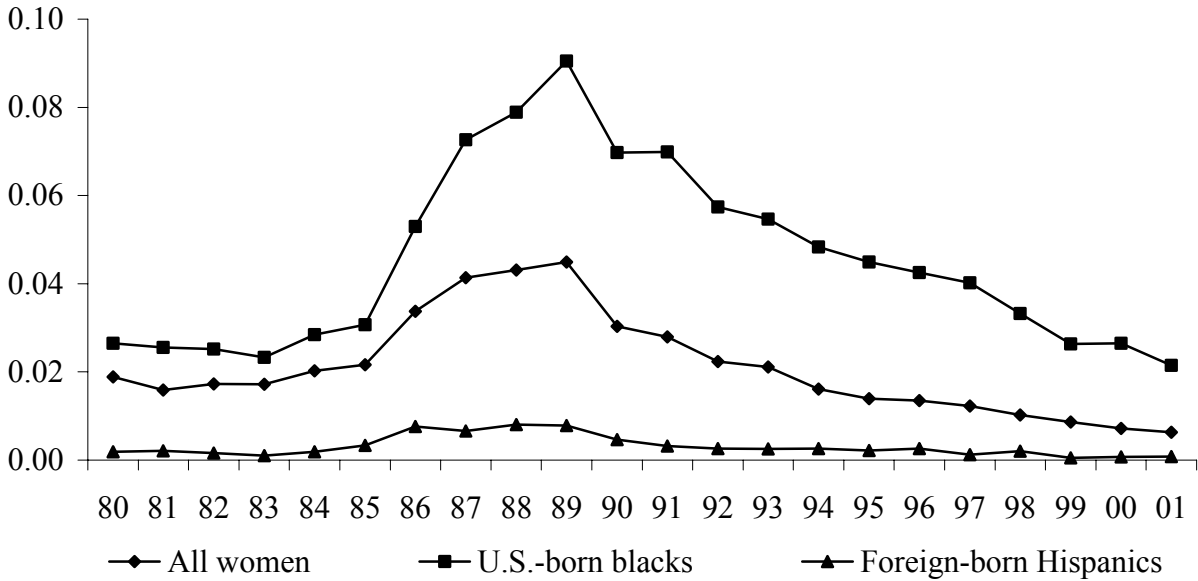
*Between 1980-1987 indication is for narcotics; from 1988-2001 indication is for cocaine or heroin.

Figure 4
**Proportion of Singleton Births with Weight Less than 2500 grams to
Women on Medicaid by Race and Ethnicity, NYC 1980-2001**
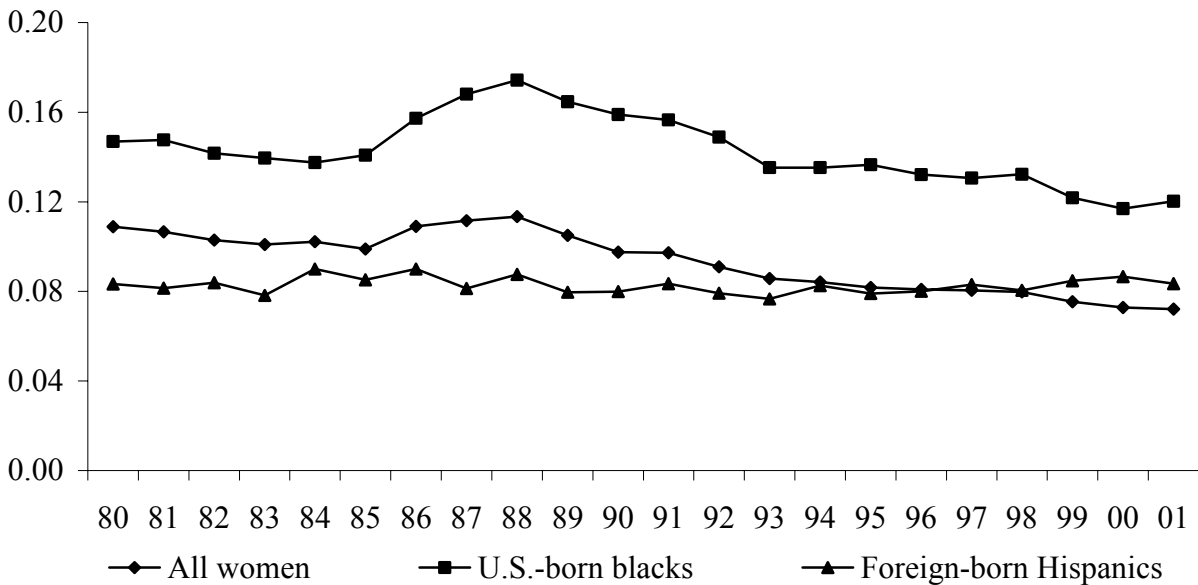
U.S.-born blacks in our sample likely reflects regression to the mean as opposed to treatment effects associated with WIC. This is difficult to test formally with our data, given the lack of information on WIC prior to 1988 and the measurement error in the illicit drug use measure. For instance, we re-estimated the regressions in Table 3 without controls for reported cocaine and heroin exposure. As expected, differences in birth outcomes associated with WIC were consistently greater in specifications without these controls, but only modestly (available upon request). The result is not surprising given the relatively small proportion of births to women with reported exposure to heroin or cocaine in our sample.[20]

Analysis of Twins

The notion that WIC should have a greater impact among women at greater nutritional risk remains an important rationale for the existence of supplemental nutrition and nutritional counseling. In this section we present results of the association between WIC and birth outcomes for a sample of twins. The rate of low birth weight is over 50 percent in our sample, which is consistent with national data. In Table 5 we show adjusted mean differences in birth outcomes by WIC for the sample of twins obtained from the estimation of equation (1). We present estimates for the entire 14-year period and then separately by various years. As before, we analyze three samples: all women, U.S.-born blacks, and foreign-born Hispanics. The pattern of results for all women and foreign-born Hispanics largely reflects those of singletons. We show a modest association between WIC participation and infants that are small for gestational age among all women, but no association with birth weight adjusted for gestation or term low birth weight. There is no association between WIC and fetal growth among foreign-born Hispanics. For U.S.-born blacks, we find that WIC is associated with an increase of 57 grams in birth weight adjusted for gestation and a decline of 4.1 percentage points in the rate of SGA (p <.01). The effects are concentrated in the 1993–1997 period. We

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[20]As shown in Table 1, reported exposure to cocaine and heroin between 1988–1992 is between 0.7 and 1.1 percent. Among U.S.-born blacks it ranges between 3 and 5 percent.

Table 5
Differences in Birth Outcomes between WIC and Non-WIC Participants for Twin Deliveries in New York City 1988–2001 among Women on Medicaid Who Initiated Prenatal Care in the First Four Months of Pregnancy, by Year, Race, Ethnicity, and Nativity

	Birth Weight			Gestational Age		Weight | Gestation	Fetal Growth	
	Mean (g)	<2500g	<1500g	Mean (weeks)	Preterm		SGA	Term LBW
Panel A: All Women (N = 2,640)								
All years	22.262	-0.019	-0.010	0.055	-0.016	14.369	-0.019**	0.000
1988–1992	91.348**	-0.037	-0.054**	0.444**	-0.062**	27.923	-0.026*	0.007
1993–1997	11.566	-0.025	0.009	-0.080	-0.004	22.942	-0.028*	-0.010
1998–2001	-41.506	0.005	0.025	-0.221	0.019	-9.911	0.003	0.003
Panel B: U.S.-Born Blacks (N = 2,640)								
All years	43.166	-0.045*	-0.010	-0.100	-0.012	56.960**	-0.041**	-0.026
1988–1992	110.202*	-0.042	-0.058*	0.572*	-0.056	31.448	-0.017	-0.006
1993–1997	19.886	-0.064	0.041	-0.586	0.052	100.611**	-0.070**	-0.075**
1998–2001	-32.970	-0.025	0.015	-0.550	-0.022	42.756	-0.036	0.022
Panel C: Foreign-Born Hispanics (N = 2,341)								
All years	22.489	-0.002	-0.029	0.070	0.015	12.333	-0.005	-0.026
1988–1992	54.144	-0.029	-0.057	0.313	-0.070	8.860	0.024	-0.005
1993–1997	-43.437	0.074	-0.015	-0.122	0.043	-25.749	-0.014	0.024
1998–2001	54.608	-0.049	-0.026	0.014	0.071	52.631	-0.020	-0.071**

See notes to Table 3. *p<.05; **p<.01.

also allow the estimated effect of WIC to vary by age (results not shown). We are concerned that estimates for older women may be contaminated by self-selection associated with assisted reproductive technologies. We find that WIC participation is related to birth weight adjusted for gestational age and term low birth weight among U.S.-born blacks 24 years of age or less. For U.S.-born blacks 30 years of age or older, the pattern of results across the fetal growth outcomes is less consistent with an effect of WIC. There is little evidence that WIC is effective among all women and the subgroup of foreign-born Hispanics. Overall, the exercise based on twins suggests that the association between WIC and fetal growth is modest and limited primarily to U.S.-born blacks.

CONCLUSION

We use New York City birth certificates from 1988 to 2001 to analyze the association between prenatal participation in WIC and birth outcomes. A primary motivation of the study was to reconcile the view among policy analysts that prenatal participation in WIC improves birth outcomes with the perspective among clinical researchers that nutritional supplementation during pregnancy in developed countries has only a minor impact on birth weight. We have argued that a convincing association between WIC and birth outcomes would require clinical support for an underlying mechanism and broadly consistent effects over time and across groups. Our results are largely at odds with these expectations. We find that WIC is unrelated to fetal growth among singleton births across race and ethnicity. The association between WIC and other less clinically supportable birth outcomes diminished over time and varied by race and ethnicity. We do report a strong association between WIC and preterm birth among U.S.-born blacks. However, we suspect that the result is confounded by the waning of the crack-cocaine epidemic. Given these findings, we conclude that WIC has had relatively little impact on infant health in New York City over the past 14 years.

Many will question the generalizability of our results, since they pertain to one city, albeit the most populous in the nation and one with an exceedingly large caseload of WIC participants. However, our

results are consistent with the literature with respect to the generally weak association between WIC and fetal growth. This includes the recent study by Bitler and Currie (2005) based on the Pregnancy Risk Assessment Monitoring System in 19 states, as well as Gordon and Nelson's (1995) national analysis of WIC using the NMIHS. The strong association between WIC and birth weight as summarized by the 1992 GAO report reflects decreases in preterm birth and not fetal growth. More generally, if we focus on fetal growth as an appropriate outcome by which to assess the effectiveness of WIC, then the findings by policy analysts, public health researchers, and clinicians are largely in agreement: prenatal WIC participation has at best a modest effect on fetal growth. This should not be surprising, given that the average cost of a food package per woman on WIC in New York is $44 dollars per month (U.S. Department of Agriculture, 2000). It is unlikely that such modest expenditures could dramatically improve birth outcomes for the average WIC recipient. We did find a positive association between WIC and fetal growth among U.S.-born blacks who deliver twins. This suggests that if properly targeted, nutritional supplementation during pregnancy may be useful, but further well-designed research is needed.

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