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RESEARCH ARTICLE

The Impact of WIC on Infant Immunizations and Health Care Utilization

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Objective. To test how prenatal participation in the Special Supplemental Nutrition Program for Women, Infants and Children (WIC) impacts health care utilization and immunizations within the first year of an infant's life.

Data Source. We utilize comprehensive South Carolina Medicaid claims data from 2004 to 2013 linked with birth certificates data from 2004 to 2012. These data contain information on WIC participation and all health care utilization within the first year of an infant's life.

Study Design. We employ a maternal fixed-effects empirical design to control for unobserved factors that influence WIC participation and health care utilization.

Principal Findings. We estimate that WIC participation increases infant health care utilization within the first year of life by 0.20 well-child visits (95 percent CI 0.16–0.23), by 0.22 vaccinations (95 percent CI 0.17–0.27), and by increasing the probability of receiving care in an emergency room by 2.9 percentage points (95 percent CI 2.0–3.8). Additionally, our results show that WIC participation decreases the average number of days an infant spends in the hospital within his or her first year of life by 0.41 days (95 percent CI 0.22–0.60).

Conclusions. These findings suggest that WIC may increase health care costs in some dimensions while reducing it in others, and more work is needed to fully evaluate the impact of the program on future expenditures.

Key Words. Women, infants and children, health care utilization, selection bias, fixed-effects model

The Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) is a federally funded supplemental nutrition program for pregnant, breastfeeding, and postpartum women as well as infants and children up to age 5 years. One major goal of the program is to improve infant health at birth by providing supplemental foods, nutrition education, and referrals to health care and social services to pregnant women. WIC is focused on helping the least advantaged; to qualify for the program, women must be at or below the income threshold of 185 percent of the Federal Poverty Level and deemed to be at "nutritional risk" by WIC professional staff (USDA 2012). In a snapshot of participation from April 2012, 9.7 million women and children participated in WIC and 23 percent of participants were infants under the age of 1 year (USDA 2012). While the majority of extant research has focused on how program participation impacts infant health outcomes at birth (Brien and Swann 2001; Bitler and Currie, 2005; Joyce, Gibson, and Colman 2005; Joyce, Racine, and Yunzal-Butler 2008; Hoynes, Page, and Stevens 2011; Currie and Rajani 2015; Sonchak 2016), the impact of WIC on health care utilization and continuity of care has generally been overlooked.

The WIC program offers a wide range of benefits that could lead to a variety of improved outcomes. WIC enrollees receive monthly food packages via vouchers, which can be redeemed in WIC-participating grocery stores and farmers' markets. Women also receive nutrition education through one-on-one sessions or web-based classes, as well as breastfeeding support and counseling, and smoking cessation assistance. WIC clinics also provide referrals to other health care services to familiarize expectant mothers with the welfare system, free health care services available to them, and to stress the importance of preventive health care services during the early stages of a child's life. In an effort to increase immunization rates among low-income children, a variety of interventions targeting WIC eligible children have been employed since as early as 1991 (Birkhead et al. 1995), and the Centers for Disease Control and Prevention (CDC) recommended linking vaccination referrals with WIC services in a 1996 Morbidity and Mortality Weekly Report (CDC, 1996). Additionally, a 2000 White House Executive Memorandum directed WIC to screen the immunization records of infants and children under age 2 years during WIC certification visits. As part of the initiative, WIC staff can review the records and advise parents to get recommended vaccinations for their child.

Given the scope of services provided by WIC, it is reasonable to believe that the benefits of the program extend beyond infant outcomes at birth. The primary objective of this study is to estimate whether participation in WIC during pregnancy affects health care utilization during the first year of an infant's life. Specifically, we focus on two types of care: preventive and acute.

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Our measures of preventive health care are well-child pediatric visits and vaccinations. These outcomes may be affected both by WIC's educational component (informing mothers about services available to them as well as the importance of timely vaccinations and well visits) and through the provision of health care referrals and immunization screenings that remind mothers to actually obtain these services. Well visits are both indicative of a mother's connection to the health care system and are also an important aspect of care for a child. These visits can be crucial to timely identification of health issues which may subsequently improve health outcomes. Similarly, the timely administration of vaccines is critical to protect infants against infectious diseases before their immune systems are fully developed. According to the CDC, children should be immunized against 14 vaccine-preventable diseases before the age of 2 years (CDC, 2017). Our measures of acute care are care delivered in an emergency room (ER) and inpatient hospitalizations. Acute care utilization may be affected through the same channels that impact infant health or a mother's use of health care resources, and these measures of care may also be indicative of an infant's underlying health.

We rely on unique administrative data from South Carolina Medicaid claims between 2004 and 2013 and data from South Carolina birth certificates between 2004 and 2012. Our work is unique in two main ways. First, we explore the effect of WIC on infant health care utilization during the first year of life, as there has only been limited research on infants and children other than newborns (Currie and Almond 2011). Secondly, we contribute to the scarce evidence on outcomes following the WIC vaccination initiative which was implemented in 2003 for infants and children up to age 2 years.

Observed correlations between WIC participation and infant outcomes cannot generally be interpreted as causal because unobserved maternal health attitudes and behaviors may impact both the frequency of health care use and program participation. For example, if health conscious mothers are more likely to take their infant for regular check-ups and more likely to enroll in WIC, the resulting positive selection will overstate the benefits of the program. Alternatively, if a mother chooses to participate in WIC because she is aware of her own poor health (that is not captured by observed covariates), the resulting negative selection will understate the benefits of WIC. To control for the possibility of selection bias, recent economic studies have relied on sibling fixed effects (Kowaleski-Jones and Duncan 2002; Foster et al., 2010; Currie and Rajani 2015; Sonchak 2016), propensity score matching (Foster et al., 2010), and ordinary least squares (OLS) with a rich set of control variables (Bitler and Currie 2005; Joyce, Gibson, and Colman 2005; Joyce, Racine, and

Yunzal-Butler 2008). Despite methodological improvements, the debate over WIC's effectiveness has not yet been settled, with some studies reporting substantial health improvements for infants of WIC mothers, while other studies document only minimal health benefits (see Currie and Almond [2011] for an excellent overview of the WIC literature).

To investigate WIC's effect on health care utilization, we employ maternal fixed-effects estimation. Maternal fixed effects allow us to compare health care utilization patterns of infants born to the same mother with different WIC participation status across multiple pregnancies, accounting for all time-invariant unobserved characteristics of a mother. Under certain conditions, similar to those outlined by Abrevaya (2006), maternal fixed effects will identify causal estimates of WIC's impacts. Notably in our case, these conditions imply that birth outcomes in one pregnancy cannot influence future decisions to enroll in WIC, and changes in WIC status must be independent from changes in other unobserved variables.

To our knowledge, this is the first study that examines the effect of WIC on multiple measures of future health care utilization while employing a large enough data set to account for non-random WIC participation using maternal fixed effects. Understanding whether WIC's impact extends beyond health outcomes measured at birth is an important policy question, particularly in the area of preventive care. The association between adverse health and poor economic outcomes has been extensively documented, and poor health in early childhood could negatively impact future well-being through a variety of channels.

Literature Review

A large body of literature has focused on the impact of WIC participation on infant birth outcomes, with only a handful of studies examining the relationship between program enrollment and health care utilization. Several studies have investigated the relationship between WIC and immunizations, but almost all contain data from only a single year and report associations between WIC status and vaccination rates using multivariate analysis. Santoli et al. (2004) found a negative but statistically insignificant association between WIC participation and the likelihood of children being up to date on their immunizations in a sample of 735 preschoolers. Similarly, Luman et al. (2003) found that children currently participating in WIC were more likely to have up-to-date vaccinations when compared to those who were WIC eligible but never participated, those who were eligible and who participated in the past, and those who were not WIC eligible. Weston and Enger (2010) documented that children who were enrolled in Medicaid, or WIC and Medicaid concurrently were more likely to be vaccinated compared to those in neither WIC nor Medicaid. However, the results did not suggest any association between WIC participation only and hepatitis A vaccination. Finally, Thomas et al. (2014) compared vaccination rates between children who enrolled in WIC and various control groups including those who were eligible but never enrolled and those who had previously enrolled. They found that WIC enrollment was associated with higher vaccination rates than in either comparison group. As with other prior work, they were unable to control for unobserved factors that influenced the enrollment decision as well as immunization rates.

Several studies have investigated the association between WIC enrollment and dental care utilization. Lee et al. (2004) used Medicaid claims data from North Carolina and found that WIC participating children had a higher likelihood of having a dental visit and using both preventive and restorative dental services. In subsequent work, Lee et al. (2005) used the same data and an instrumental variables technique and found a positive effect of WIC on dental services use. However, the instruments utilized, such as number of WIC clinics, hours of operation, and multiple sites may not be exogenous, as the distribution of WIC services depends on the demand for services (Coleman et al., 2012). McCunniff et al. (1998) documented similar findings in regard to WIC and dental care utilization.

Using multiple regression analysis, Buescher et al. (2003) studied the relationship between child WIC participation and the use of health care services in North Carolina. Relying on Medicaid claims combined with WIC data, they found that child WIC participation was associated with a higher likelihood of using preventive, emergency room, and inpatient care. Additionally, children were more likely to be treated for common childhood illnesses such as otitis media, gastroenteritis, upper and lower respiratory infections, and asthma. Chatterji and Brooks-Gunn (2004) found a positive association between WIC and well-child care among low-income unmarried women. While both studies attempted to reduce selection by focusing on WIC eligible women, the issue of possible selection bias related to unobservable factors between WIC and non-WIC participants remained.

Much of the prior literature that has attempted to address the possibility of selection bias has done so by restricting samples to only include mothers who are on Medicaid and thus eligible for WIC. Our sample is also restricted to only include mothers who are enrolled in Medicaid at or before giving birth, but we build on this literature and attempt to address the potential of selection bias related to program enrollment. Because we observe a large number of mothers who switch WIC participation across births, we employ a maternal fixed-effects technique which allows us to account for unobserved time-invariant maternal characteristics that may impact both WIC participation and health care utilization among eligible mothers. We are able to more precisely estimate the impact of WIC than what has been done previously due to the difficulty of locating a sufficiently large sample of mothers with "discordant" WIC participation status across births.

DATA

We employ two major data sources: South Carolina birth certificates from 2004 to 2012 and South Carolina Medicaid claims from 2004 to 2013. South Carolina Vital Statistics provide information from birth certificates including infant health markers such as birthweight, gestation, and any abnormalities. They also provide maternal health risk factors during pregnancy, basic demographic characteristics of the mother, prior pregnancy outcomes, and, most important, maternal WIC participation during pregnancy which is obtained from a maternal worksheet within a few days after delivery. While we do not observe WIC participation status in the first year of a child's life, 97 percent of children who were exposed to WIC in utero participate in WIC at some point before age 3 according to Jackson (2015), who uses prenatal WIC participation as a proxy for early childhood WIC participation. Our own investigation of electronic records from the WIC office for 2008–2012 indicates that 97.6 percent of mothers in our sample who were exposed to WIC during pregnancy had infants enrolled in WIC during the first year of their life. If mothers who were not in WIC prenatally enroll postpartum, our results would underestimate the full extent of WIC's effect. Additionally, the birth certificates data are maternally linked, allowing us the possibility to track a given mother across multiple pregnancies.

We begin with a sample of 312,727 observations of Medicaid eligible mother–infant pairs, which represent all Medicaid eligible infants over the study time frame. To ensure that we observe future medical care, we restrict our sample to infants eligible for Medicaid for at least 11 months, which excludes 15,211 observations, and to mothers between 15 and 45 years of age, which excludes a further 889 observations. We also eliminate observations with missing values of maternal WIC participation (4,907 observations), child birthweight (46 observations), child gender (three observations), and individuals with no observed Medicaid claims in the first year of life (1,294 observations), leaving us with a final unit of analysis of 290,377 observations (208,950 mothers) that is linked with Medicaid claims data. These administrative claims include information on diagnoses, detailed procedures performed, dates of services, Medicaid plan characteristics, payment amounts, basic provider information, and more for both inpatient and outpatient services. Medicaid claims data are combined with Medicaid eligibility files, which provide information on timing of Medicaid enrollment and duration, as well as basic family characteristics such as family net income, number of children, and race. Although we treat observations with zero observed claims as missing values, these observations account for <0.5 percent of our data, and our results are robust to the inclusion of these observations. In our sample, 17,594 distinct mothers (43,076 observations) switch their WIC status across pregnancies. This relatively large sample of "discordant" groups allows us to identity WIC's effect in the context of our maternal fixed-effects model.

Measures of Health Care Utilization

We focus on the following types of health care utilization: well-child pediatric visits (WCVs), vaccinations, inpatient hospitalizations, and emergency room care. WCVs (defined by Current Procedural Terminology [CPT] codes 99381 and 99391 as comprehensive preventive medicine and evaluation) and immunizations are reflective of preventive medical care. The American Association of Pediatrics (AAP) recommends at least six well visits within the first year of an infant's life, and their vaccination schedule indicates that a child should receive several doses of vaccines within the first 12 months of life (AAP 2014). Because we observe each WCV, we estimate the impact of WIC participation on three measures of well-child care: the probability of having at least one visit, the probability of meeting or exceeding the recommended six visits, and the total count of visits. Unfortunately, many Medicaid claims do not identify vaccines individually but instead provide general vaccinations CPT codes. We are thus unable to determine the timing of specific vaccines and instead construct two measures of vaccinations. First, we estimate the impact of WIC on the probability of obtaining at least one vaccination within the first year of life. Second, we count distinct vaccination administration codes and estimate WIC's impact on the number of vaccines a child receives in the first year of life. To measure the utilization of acute care, we construct three measures of care: whether an infant is ever treated in an ER, whether an infant has more than one inpatient claim (as the majority of mothers and their infants have one inpatient claim associated with an initial hospitalization during child birth), and the total number of days associated with inpatient claims.

It is worth noting that utilization of medical care may not always be representative of the underlying health of a child. For example, an infant may have frequent doctor visits resulting from poor health, or a parent who is inclined to intensively utilize health care resources. However, some of our outcome measures seem more likely to accurately reflect the underlying health of the child. Specifically, the number of days that an infant spends in the hospital and the likelihood of having more than one inpatient claim are unambiguously related to adverse health events. Therefore, if WIC improves infant outcomes, we would expect to observe both a lower likelihood and shorter duration of hospitalizations among WIC participating infants. The probability of being vaccinated and obtaining WCVs is indicative of preventive care utilization, and these outcomes should not be interpreted as representing underlying health. Additionally, as there is some evidence indicating that the use of emergency room services is not always indicative of an underlying adverse health event (Cunningham 2006), these results should be interpreted cautiously.

EMPIRICAL APPROACH

To estimate the effect of prenatal WIC participation on health care utilization during the first year of an infant's life, we begin with the following empirical specification:

$$Y_{it} = \beta_1 \mathrm{WIC}_{it} + \beta_2 X_{it} + \mathrm{Year}_t + \mu_i + \varepsilon_{it}. \qquad (1)$$

For mother-child pair i at time period t, Y is a measure of health care utilization; WIC represents a dummy variable equal to 1 if a mother participates in the program during pregnancy; X is a vector of observed maternal and child characteristics including maternal age dummies, educational attainment, and risk factors such as pre-pregnancy tobacco usage, both pre-pregnancy and pregnancy gestational diabetes and hypertension, vaginal bleeding, previous poor birth outcomes, previous preterm infants and previous cesarean sections, as well as the child's gender, birthweight, an indicator for plural birth, and family monthly net income and size; μ represents unobserved maternal attitudes, and ε is an unobserved error term. If the relationship between outcomes and observed covariates is linear and WIC participation is uncorrelated with μ, ordinary least squares will provide unbiased estimates for equation (1).

As the strict assumptions required of OLS are unlikely to hold and to control for the possibility of selection bias, we estimate equation (1) and include maternal fixed effects. As the data are linked over time, we observe some mothers across multiple pregnancies. Maternal fixed-effects estimation allows us to absorb any impacts from time-invariant unobservable maternal characteristics that are associated with both WIC participation and the frequency of health care utilization. The identification of WIC's effect, in this case, comes from variation in maternal WIC participation across multiple pregnancies. If all unobservable characteristics of the mother are constant over time, a fixed-effects model will provide unbiased estimates of the causal effect of WIC participation. Currie (2001) provides an excellent overview of the utilization of fixed effects in non-experimental studies.

However, fixed-effects estimation will not estimate the casual effect if mothers change their WIC status in response to prior birth outcomes (feedback effect) or changes in WIC status are correlated with changes in unobservables. For example, an unfavorable experience during one pregnancy might induce a mother to enroll into WIC or modify behavior in a subsequent pregnancy. However, we control for a wide range of prior pregnancy outcomes and health risks, which mitigates this concern and helps us obtain plausibly causal estimates. Finally, fixed-effects models are biased toward zero in the presence of measurement error and may also eliminate a large amount of variation in the data (Griliches and Hausman 1986), which can lead to noisy estimates. Our data set contains a relatively large sample of discordant mothers (those who switch WIC status), and although our identification in the fixed-effects context is driven by approximately 15 percent of our final sample, this still represents 43,076 births, which allow us to obtain precise estimates on WIC participation.

RESULTS

Table 1 presents sample means for selected demographic characteristics of mothers by WIC participation status. The sample means indicate that non-WIC participating mothers are slightly older and have a higher average educational attainment. Despite a lower likelihood of experiencing adverse pre-pregnancy and pregnancy risks, mothers who do not participate in WIC have a higher likelihood of previous preterm births or previous poor birth outcomes and are more likely to deliver via cesarean section.

Table 1: Sample Characteristics by WIC Participation Status

	WIC		*Non-WIC*		*Difference (Non-WIC-WIC)*	
Variables	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SE*
Mother's age	24.125	5.405	25.509	5.512	1.384	0.025
Child male	0.510	0.500	0.510	0.500	0.000	0.002
Less than high school	0.334	0.471	0.308	0.462	−0.026	0.002
High school education	0.341	0.474	0.293	0.455	−0.048	0.002
Some college	0.287	0.452	0.309	0.462	0.022	0.002
College	0.037	0.189	0.087	0.282	0.050	0.001
Education missing	0.002	0.044	0.002	0.047	0.000	0.000
Prepreg. tobacco	0.135	0.342	0.137	0.344	0.002	0.002
Mother white	0.501	0.500	0.631	0.483	0.130	0.002
Mother black	0.483	0.500	0.340	0.474	−0.143	0.002
Race other	0.015	0.120	0.028	0.165	0.013	0.001
Prepreg. diabetes	0.011	0.103	0.008	0.088	−0.003	0.000
Prepreg. hypertension	0.026	0.158	0.022	0.148	−0.004	0.001
Prev. preterm birth	0.027	0.163	0.037	0.188	0.010	0.001
Prev. poor birth	0.063	0.244	0.065	0.247	0.002	0.001
Vaginal bleeding	0.013	0.113	0.014	0.118	0.001	0.001
Gest. diabetes	0.047	0.211	0.042	0.202	−0.005	0.001
Gest. hypertension	0.054	0.226	0.051	0.219	−0.003	0.001
Prev. c-section	0.127	0.333	0.148	0.355	0.021	0.002
Plural birth	0.030	0.170	0.032	0.177	0.002	0.001
Family net income	522.523	774.233	543.451	865.510	20.928	3.630
Number of children	1.874	1.057	2.151	1.199	0.277	0.005
Birthweight	3,149.857	584.350	3,129.300	660.541	−20.557	2.747
Observations	229,934		60,443			

Notes. Data are from 2004 to 2012 South Carolina Vital Statistics. WIC participation denotes participation during pregnancy.

Table 2 provides summary statistics for our measures of health care utilization during the first year of an infant's life by mother's pregnancy WIC participation status. The sample means suggest that infants of WIC participating mothers spend fewer days hospitalized compared to non-WIC infants. Furthermore, WIC infants have more WCVs, are more likely to meet the AAP recommendation for well visits, are more likely to be vaccinated, and receive a higher number of vaccines. WIC infants are also more likely to utilize acute care, with both a higher probability of having claims originating in an emergency room and having more than one inpatient Medicaid claim.

Table 3 reports the estimated coefficients on WIC program participation for all outcomes related to well-child care for our fixed-effects model, with the baseline OLS estimates for comparison. All regressions account for

Table 2: Outcome Measures by WIC Participation Status

Variables	*All*	*WIC*	*Non-WIC*	*Difference (Non-WIC-WIC)*
Hospital days	5.146 (10.820)	5.053 (10.325)	5.500 (12.520)	0.447 (0.049)
Number of well visits	4.129 (2.123)	4.210 (2.110)	3.819 (2.142)	−0.391 (0.010)
Any well visit	0.931 (0.253)	0.938 (0.242)	0.906 (0.292)	−0.031 (0.001)
Probability of six well visits	0.147 (0.354)	0.153 (0.360)	0.123 (0.328)	−0.030 (0.002)
Any vaccine	0.737 (0.440)	0.739 (0.439)	0.729 (0.445)	−0.010 (0.002)
Number of vaccines	4.437 (3.443)	4.480 (3.451)	4.270 (3.411)	−0.211 (0.016)
Any ER visit	0.516 (0.500)	0.541 (0.498)	0.418 (0.493)	−0.123 (0.002)
Inpatient claim	0.122 (0.328)	0.125 (0.330)	0.112 (0.316)	−0.012 (0.001)
Observations	290,377	229,934	60,443	–

Notes. Health care utilization outcomes are from 2004 to 2013 SC Medicaid claims. Standard deviations are in parentheses for the first three columns and standard errors for the remaining column. WIC participation denotes participation during pregnancy.

Table 3: The Effect of WIC on Well-Child Visits

Variables	*Number of WCVs*	*Probability of WCV*	*At Least Six WCVs*
Ordinary least squares (OLS)			
WIC participation	0.331*** (0.0103)	0.0251*** (0.00134)	0.0245*** (0.00162)
Maternal fixed effects (FE)			
WIC participation	0.197*** (0.0166)	0.0102*** (0.00239)	0.0159*** (0.00278)
Observations	290,377	290,377	290,377

Notes. Standard errors are in parentheses. For OLS and FE models, standard errors are clustered on mother id. The controls include child's gender, maternal age dummies, educational attainment, pre-pregnancy smoking status, pre-pregnancy diabetes and hypertension, indicator for previous preterm birth and previous poor birth outcome, vaginal bleeding, gestational hypertension and diabetes, previous cesarean, number of children in the family, family income, dummy variable for plurality, child's birthweight, and year fixed effects. WIC participation denotes participation during pregnancy.
***$p < .01$, **$p < .05$, *$p < .1$.

maternal and family characteristics described in the sample summary statistics, and the standard errors are clustered by mother. To conserve space, we suppress the estimated coefficients for other covariates and only present WIC estimates. The results with the full set of covariates are reported in the Appendix Tables S1–S6.[1]

Both the OLS and fixed-effects estimates indicate that participation in the WIC program is associated with an increase in all of our measures of preventive health care utilization: the number of pediatric well-child visits as well as the probability of crossing the thresholds of one and six visits, respectively. In all cases, however, the estimated magnitude of WIC's impact is statistically significantly smaller from the fixed effects than OLS estimates. The point estimates imply that infants of WIC participating mothers have 0.20 more preventive visits on average, are 1.0 percentage points more likely to have at least one well visit, and are 1.6 percentage points more likely to obtain the recommended number of visits.

Table 4 reports the estimated coefficients on WIC participation for the probabilities of receiving care in an ER, being vaccinated, number of vaccines received, having more than one inpatient claim, and the total number of inpatient days. As was the case with well-child visits, the fixed-effects results are generally of a smaller magnitude than those obtained from OLS except in the case of hospital days where the maternal fixed-effects point estimates indicate a larger decline in the number of hospital days. Additionally, our fixed-effects estimates show no statistically discernible impact of WIC on the probability of having more than one inpatient claim. The fixed-effects point estimates imply that WIC participation is associated with an increase of 2.9 percentage points in the probability of utilizing the ER, an increase of 1.4 percentage points in the probability of being vaccinated and an increase of 0.22 vaccines received within the first year of life. It is also associated with a decrease in the number of days that an infant spends in the hospital in the first year of life by 0.41 days.

Our estimated impacts of WIC can be interpreted as the average marginal effect of being currently enrolled in WIC for a given pregnancy. However, it is plausible that enrolling in WIC for an early pregnancy may influence future pregnancies if the primary mechanism through which WIC impacts outcomes is by providing information about infant health production to mothers. If WIC participation changes maternal behaviors or attitudes in a durable way, we would not expect to see our results persist when we restrict our sample to mothers with two births who enroll in WIC for only their first pregnancy. However, all results in Tables 3 and 4 are robust to this restriction, suggesting that active enrollment in WIC is driving our results.

CONCLUSIONS

The importance of WIC for infant outcomes at birth has been widely studied by the extant literature. The WIC program is credited with improving various birth outcomes, such as reducing the probability of low birthweight and

Table 4: The Effect of WIC on Health Care Utilization

Variables	*Hospital Days*	*Vaccine*	*Number of Vaccines*	*Emergency Room*	*Inpatient Claims*
Ordinary least squares (OLS)					
WIC participation	−0.268*** (0.0534)	0.0148*** (0.00213)	0.230*** (0.0164)	0.0836*** (0.00232)	0.0134*** (0.00151)
Maternal fixed effects (FE)					
WIC participation	−0.412*** (0.0974)	0.0136*** (0.00365)	0.220*** (0.0258)	0.0292*** (0.00449)	−0.00167 (0.00330)
Observations	290,377	290,377	290,377	290,377	290,377

Notes. Standard errors are in parentheses. For OLS and FE models, standard errors are clustered on mother id. The controls include child's gender, maternal age dummies, educational attainment, pre-pregnancy smoking status, pre-pregnancy diabetes and hypertension, indicator for previous preterm birth and previous poor birth outcome, vaginal bleeding, gestational hypertension and diabetes, previous cesarean, number of children in the family, family income, dummy variable for plurality, child's birthweight, and year fixed effects. WIC participation denotes participation during pregnancy.
***$p < .01$, **$p < .05$, *$p < .1$.

prematurity, as well as reducing maternal smoking and increasing breastfeeding rates. Unfortunately, due to a general lack of data on children's outcomes after birth, little is known about the longer term effects of the program. This study helps fill the gap in the existing literature by focusing on how WIC participation during pregnancy affects medical care utilization in the first year of an infant's life. We rely on unique maternally linked administrative South Carolina Medicaid claims data, in conjunction with data from South Carolina birth certificates, to track both program participation before birth and health care use following birth.

Our results, obtained through fixed-effects estimation, suggest that WIC participation leads to a higher utilization of medical care, including preventive care. By any measure tested, WIC participating mothers were more likely to obtain well-child pediatric visits. We estimate that WIC participation during pregnancy increases the likelihood of receiving the recommended number of well visits by 11 percent when evaluated at the mean. Given that WIC serves 2.24 million infants, our point estimates suggest that WIC causes nearly 30,000 additional infants to be current on WCVs. Our results also indicate that WIC participation during pregnancy is associated with a higher likelihood of infants receiving vaccinations as well as an increase in the number of vaccines received. The point estimates suggest that WIC participation causes a 5 percent increase in vaccinations. As low-income children generally are less likely to receive recommended preventive care and vaccinations than children of higher socioeconomic status, these gains are indicative that WIC participation may help close this gap in care utilization. We also find that WIC participation decreases the number of days spent in the hospital in the first year of life. As length of hospitalization is unambiguously associated with poor infant health, reduction in the length of hospitalizations is indicative of infant health improvement among WIC participants.

The estimates, however, are derived from the subsample of Medicaid mothers in South Carolina and may not be generalizable to other geographic areas or to mothers who have access to other types of health insurance. Because we do not observe the content of WIC appointments (e.g., number of referrals, extent of immunization screening, etc.), we are not able to identify the exact channels that lead to higher health care utilization. Also, we do not observe WIC participation after birth, so if WIC participation during pregnancy increases the probability of continued enrollment in WIC, it is possible that enrollment during the first year of life is driving our results. While fixed-effects estimation allows us to account for unobserved characteristics, it relies on within mother comparison, and therefore, these results may not extend to mothers with singular birth. Finally, while fixed-effects estimation is an important technique in observational studies, it does not allow us to account for unobserved time-variant factors that could confound our estimates; the inclusion of a rich set of control variables should mitigate this issue somewhat.

The general increase in medical care utilization could be expected to lead to a corresponding increase in Medicaid health care costs. However, if WIC participation fosters a stronger attachment to the health care system, these immediate cost increases will likely be counterbalanced with future cost reductions due to the utilization of preventive services such as immunizations and well-child visits. While it is beyond the scope of this study to calculate the entirety of these countervailing forces, we can put our point estimates for the length of hospitalization into perspective and provide a rough back of the envelope calculation for the potential cost savings associated with decreasing the number of days children spend hospitalized during the first year of life. According to the Kaiser Family Foundation, the average cost of an inpatient hospital stay in South Carolina was $1,961 dollars per day in 2014. Assuming this population-wide average is indicative of the costs of infant hospitalization among Medicaid insured individuals, our point estimates from the fixed-effects model suggest that WIC participation could lower these costs by approximately $807.

Similarly, it is well beyond the scope of our study to quantify the benefits from increased preventive care. In the case of vaccinations, a potentially sizeable portion of the benefits may accrue as externalities to outside individuals (see Boulier, Datta, and Goldfarb [2007] for an excellent discussion), but the magnitude of those benefits depends on the initial distribution of vaccination coverage as well as the distribution of increased vaccinations, and quantifying the magnitude of these benefits and estimating WICs causal impact on the full distribution of vaccines would be an important question for future research. While this study is an important first step toward understanding the long-term impacts of the WIC program, more work is needed to fully evaluate the causal impacts of the program and the entirety of its long-term implications for the trajectory of future health care utilization and expenditures.

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Note

1. Additionally, in the supporting information, we provide estimates obtained from propensity score matching (PSM) along with diagnostics. While PSM has been previously used in WIC studies, this technique does not account for selection on unobservables. Our PSM results are virtually indistinguishable from OLS, suggesting it does not offer much improvement over OLS in this setting.

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Supporting Information

Additional supporting information may be found online in the supporting information tab for this article:

Appendix SA1: Author Matrix.
Table S1: The Effect of WIC on Health Care Utilization (OLS results).
Table S2: The Effect of WIC on Health Care Utilization (Fixed effects results).
Table S3: Treatment Model.
Table S4: Covariates Balance Comparisons.
Table S5: The Effect of WIC on Well-Child Visits (OLS vs. PSM).
Table S6: The Effect of WIC on Health Care Utilization (OLS vs. PSM).
Figure S1: Common Support over Estimated Propensity Score.
Figure S2: Bias Reduction from the Propensity Score Matching.