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ABSTRACT

Large literatures document positive effects of WIC on birth outcomes, and separately connect health at birth and future outcomes. But little research investigates the link between prenatal WIC participation and childhood outcomes. We explore this question using a unique data set from South Carolina which links administrative birth, Medicaid, and education records. We find that relative to their siblings, prenatal WIC participants have a lower incidence of ADHD and other common childhood mental health conditions and of grade repetition. These findings demonstrate that a "WIC start" results in persistent improvements in child outcomes across a range of domains.

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The Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) provides supplemental foods, nutrition education, and healthcare referrals to low-income pregnant and postpartum women as well as infants and children up to age five who are at nutritional risk. WIC has a huge reach; In 2014, 52% of infants received WIC benefits (almost all of whom started receiving them prenatally) (Hoynes and Schanzenbach, 2016). Hence, it is important to understand the long term impacts of the program.

A voluminous literature, both inside and outside economics, has examined the effects of maternal WIC participation during pregnancy on health at birth. In their 2016 review, Hoynes and Schanzenbach conclude that "The literature on WIC is primarily aimed at estimating the effects of the program on health at birth. The most credible design-based studies show consistent evidence that WIC leads to improvements in outcomes such as average birthweight, the incidence of low birth weight and maternal weight gain. There is much less evidence about how the program affects outcomes for children…" (page 5).

This study begins to fill this gap using administrative data from South Carolina that combine information from birth records, Medicaid claims, and school records for all children born between 2004 and 2009. We start by replicating results from earlier studies showing that in this sample, as in others, WIC participation during pregnancy has a strong positive effect on birth outcomes in models with mother fixed effects: For example, infants prenatally exposed to WIC are 10.5% less likely than siblings who were not on WIC, to be small for gestational age. We then examine the effect of prenatal WIC participation on whether the child is ever diagnosed with a chronic condition as of 6 to 11 years of age, future utilization of medical care, and future grade repetition.

We find that prenatal WIC participation is associated with a 5.0% lower probability of being diagnosed with ADHD and a 5.1% lower probability of being diagnosed with several other mental health conditions that are commonly diagnosed in childhood. The children are also 7.9% less likely to repeat a grade. These effects are concentrated among African-Americans and the lowest income category of Medicaid recipients, groups who are at high risk of negative birth outcomes. Our estimates contribute to the literature by showing that prenatal WIC participation is associated with better child outcomes beyond measures taken at birth and by highlighting the domains that are most affected.

Background

WIC was initially established as a two-year pilot program in 1972 and became permanent in 1975. In fiscal year 2015, eight million people received WIC at a cost to the federal government of $6.2 billion dollars.[1] WIC serves pregnant, breastfeeding and postpartum women, infants (up to age 1), and children (ages 1-5) in households with incomes less than 185% of the federal poverty level. In addition, pregnant women who participate in several other entitlement programs, including Temporary Assistance for Needy Families (TANF), the Supplemental Nutrition Assistance Program (SNAP), or Medicaid, the public health insurance program that covers low income pregnant women and children, are automatically considered income-eligible for WIC. WIC participants also need to be deemed at "nutritional risk" by WIC professional staff, but in practice this requirement seldom seems to be a binding limit on participation (Bitler and Currie, 2005) since virtually all applicants fall into one of the nutritional risk categories.

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[1] U.S. Department of Agriculture, https://www.ers.usda.gov/topics/food-nutrition-assistance/wic-program/. Accessed on January 4, 2018.

WIC participants receive monthly WIC checks or vouchers that can be redeemed for specific types and brands of food at participating stores or farmer's markets. Packages are tailored for each group. For instance, the main component of the infant package is infant formula, while packages for breastfeeding women include a large variety and quantity of foods. Pregnant women can be WIC-certified for the entire pregnancy, breastfeeding women are eligible for the entire period of breastfeeding, and postpartum women are eligible for six months. Children are generally certified for one year at a time up to age five.

In addition to food vouchers, WIC provides breastfeeding information and counseling through breastfeeding peer counselors. WIC also offers nutrition education through initial one-on-one appointments followed by group sessions or on-line classes. Those with serious nutrition and health risks can receive help from a registered dietitian. Finally, WIC clinics refer mothers to healthcare and social services as well as providing immunization screenings. In fact, WIC services are often available through medical clinics serving low income women and children.

The evaluation of prenatal WIC participation has attracted a great deal of interest from economists. A fundamental issue is that women are not randomly selected into the program. Careful analyses of the WIC participation decision suggest that relative to eligible non-participants, WIC mothers are more disadvantaged. For instance, Bitler and Currie (2005) focus on Medicaid-eligible mothers, and find that the WIC mothers were younger, less educated, less likely to have a father listed on the birth certificate, more likely to smoke, more likely to be obese, and so on. Currie and Rajani (2014) examine mothers in New York City who changed WIC status between births and find that women received WIC when they were young and unmarried, or when they were unemployed. Rossin-Slater (2013) studied WIC clinic closings in Texas and found that distance to a clinic also negatively affected participation.

Studies generally find positive effects of prenatal WIC participation on birth outcomes. For instance, Bitler and Currie (2005) and Figlio et al. (2009) evaluate WIC by choosing control groups similar to the WIC participants in terms of poverty and participation in other transfer programs. Rossin-Slater (2013) finds that reductions in participation due to clinic closings reduced pregnancy weight gain, birth weight, and breastfeeding. Similarly, Sonchak (2016) finds that WIC participation among South Carolina (SC) mothers is associated with an increase in birth weight and length of gestation, decrease in the probability of low birth weight, prematurity, and Neonatal Intensive Care Unit admission.

Studies of the roll-out of WIC in the 1970s have also found evidence of positive effects on birthweight, and no evidence of effects on fertility (Hoynes, Page and Stevens, 2011). Estimated effects on breastfeeding have been mixed, but some studies suggest that recent efforts to promote breastfeeding among WIC mothers, and incentivize it by upgrading WIC packages for nursing mothers mean that WIC now promotes breastfeeding (Chatterji and Brooks-Gunn, 2004).

Currie and Rajani (2014) estimate models with maternal fixed effects and find that WIC reduced the incidence of low birth weight and of being "small for gestational age" (or below the 10^{th} percentile of the distribution of weight conditional on gestation). However, they also find an increase in the use of medical care among infants born to WIC participants. One reason to look at small for gestational age (SGA) as an outcome is that as Joyce (2008) points out, the longer a pregnancy lasts, the more opportunity a woman has to sign up for WIC. Hence, it is important to control for gestation, or to focus on measures like SGA, when evaluating the effect of prenatal WIC participation.

To date, there are virtually no studies examining the longer term effects of WIC on child outcomes. Hoynes and Schanzenbach (2016) comment: "Reflecting on the designs used in the analysis of birth outcomes… it appears possible to apply similar approaches to examine child health. However, this would likely require rich administrative data, combining child health records, linked across siblings, and family WIC participation." Our analysis is based on just such rich data, with the addition of children's educational records.

Given the strong prior evidence of effects of prenatal WIC participation on birth outcomes, what might one expect to see in terms of longer-run effects? A great deal of previous research links higher birth weights with child health and educational attainment (see Almond and Currie, 2011 and Almond et al., forthcoming for reviews). For example, Figlio et al. (2014) find using linked birth records and educational records that lower birth weight twins had persistently lower test scores in Florida, and that gaps that were present at 3rd grade were still present, largely unchanged, at 8th grade. The effects were qualitatively similar in Ordinary Least Squares models but larger and more precisely estimated in models with mother fixed effects estimated using twins. In addition, several common childhood health conditions including asthma and ADHD (Attention Deficit Hyperactivity Disorder) have been linked to low birth weight (see for example, Alexander and Currie, 2017 and Villamor et al., 2009), and ADHD has been linked to school failure (Currie and Stabile, 2006; Currie, Stabile, Jones, 2014; Kitashima and Chorniy, 2017). Hence, one might well expect to see positive effects of prenatal WIC in terms of reduced incidence of chronic conditions and improved schooling attainment, though this has not been previously demonstrated.

Another possible channel for prenatal WIC participation to have long-term effects is through its facilitation of WIC services after birth. Nationally, over 90% of infants who were prenatally covered by WIC continue to receive services in the year after birth; however, participation rates fall off as children get older (USDA, https://www.fns.usda.gov/wic/wic-eligibility-and-coverage-rates.)

Unfortunately, we only have data on post-natal WIC participation for cohorts born in 2009 to 2013, that is after the dates when most of the children in our sample were born. However, in these cohorts the pattern of postnatal WIC participation in South Carolina is consistent with national participation rates. Among children who were covered prenatally, 89.3% of them continued to receive WIC services in their first year of life, dropping to 60.6%, 42.8%, 31.0%, and 22.0% in the five years that follow.[2] Thus, prenatal WIC participation appears to bring with it a high probability of participation in the first year or so of the child's life, and this participation may also have positive effects on child outcomes.

In addition to providing infant formula and food benefits, WIC has a mandate to help infants and children access medical care. Chatterji and Brooks-Gunn (2004) find positive effects on the use of well-child visits among low-income, single mothers. Bersak and Sonchak (2018) find that prenatal WIC participation increases the number of well-child visits. They use a maternal fixed effects design and focus on infants within the first year of life. To the extent that WIC is successful in linking mothers of young children with providers willing to care for their largely Medicaid-eligible children, and to the extent that these relationships endure over time, we might see positive effects in terms of utilization of care: More preventive visits for primary care, and fewer preventable hospitalizations and emergency room (ER) visits. Many providers refuse

[2] The children who participate longest, tend to come from the most disadvantaged backgrounds. Also, we see that about 30% of children who did not participate prenatally, participate at some point before age 6. To the extent that these unobserved benefits have positive effects on child outcomes, we will tend to under-estimate the effect of prenatal WIC participation.

to serve Medicaid patients, or limit the number of such patients in their practices, so it can be difficult for these children to access care (see Alexander and Schnell, 2018).

Data

Using social security numbers, our data set links together information from several South Carolina state agencies: birth certificates from the Department of Health and Environmental Control; Medicaid claims from the Revenue and Fiscal Affairs Office; and school records from the Department of Education. We merge these files and focus on a sample of children aged 6 to 11 years old who were born between 2004 and 2009, but can be followed up to 2015 in the Medicaid and education data.

We focus on this age range because educational outcomes are only available for children once they reach school age and because health care utilization measures for children five and under may be directly affected by WIC eligibility (e.g. if they receive WIC benefits from a medical clinic or if they receive referrals) rather than reflecting differences in health. Our mother fixed effects models further restrict the sample to children who have a sibling in the data, resulting in an analysis sample of 59,530 children.

Table 1 presents summary statistics about background characteristics for the whole set of 2004 to 2009 SC births, the subset that can be matched to Medicaid records, the further subset that can be matched to educational records, and the final data set of children with siblings in the sample. Table 1 is based on birth certificate data, which is available for all SC-born children and on Medicaid eligibility data. From the birth certificate data, we know whether the mother received WIC prenatally, as well as child and mother background characteristics such as the child's race, maternal education, maternal behaviors such as smoking, previous pregnancy outcomes, and maternal health conditions, such as hypertension. Birth certificates also have information about the child's health outcomes at birth which have been widely exploited in previous studies, including low birth weight, prematurity, likelihood of being small for gestational age, admission to a neonatal intensive care unit, and whether the infant was breastfed. Medicaid eligibility data has the eligibility category, and also has income categories, though the later are often missing.[3]

Column 1 shows that 54.3% of all SC births were to mothers who received WIC prenatally. Since mothers on WIC are automatically eligible for Medicaid, virtually all of these mothers also received Medicaid coverage of their pregnancies. The question about whether a mother received WIC food assistance for herself during pregnancy was introduced as a part of the 2003 Birth Certificate Revision. It is obtained directly from a mother as a response to a check box item on a Mother's Worksheet which is completed after delivery and before the mother leaves hospital. Unfortunately, the birth certificate data do not indicate the timing and duration of WIC enrollment.

Almost exactly half of the children have Medicaid records at age six plus. A comparison of columns 1 and 2 shows that as expected, children on Medicaid at age six and older are more likely to have received WIC prenatally (and therefore also Medicaid coverage of prenatal care and delivery), but are disadvantaged in other respects. The Medicaid children are more likely to be African-American, have younger and less educated mothers, and have mothers who were more likely to smoke prior to the pregnancy and during the pregnancy, or to be obese. However, the

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[3] Although children's benefits do not depend on the enrollment category, the enrollment category may be a more accurate reflection of family income than the actual income category variables, since the later are often missing or zero. The major enrollment categories in our data are OCWI (Optional Coverage for Pregnant Women/Infants with a cutoff of 185% the federal poverty line in 2013); Children (200% FPL in 2013); Low income families (50% FPL in 2013); and disabled (4.4% of qualifying children). Note that "Low Income Families" (LIF), or less formally, Parent/Caretaker Relatives is a title given to an eligibility group in the South Carolina Medicaid program. To qualify as a low income family, family income must be no higher than 50% of the FPL during most of our sample period. In 2014-2015 the cutoff was raised to 62% FPL. Monthly net family income in 2015 dollars at the time of the birth is be coded as zero or in $500 bins, with the excluded category being $1,000-1,500, monthly.

mothers of the Medicaid children appear quite similar to the full sample in terms of other health indicators such as whether they have diabetes, hypertension, or previous poor pregnancy outcomes.

Matching to education records results in a loss of 7% of the remaining observations, suggesting that most of the children for whom we have Medicaid records when they are six or older attend public schools so that they are in our education data base.

Finally, the requirement that the child has a sibling in the sample is a stringent one, resulting in the loss of many "lone children" from the data set. Comparing columns 3 and 4 shows that the sibling sample is slightly more likely to be African-American, and has mothers who are slightly younger and less educated than the full matched sample. They are also more likely to have had a previous C-section, and a previous preterm birth, though they are somewhat less likely to have had diabetes or hypertension. In summary, the analysis sample is more disadvantaged in a variety of ways than the overall sample of SC births in these cohorts.

To summarize the way that we build our sample, we start with all of the births in South Carolina. From this set, we retain children who have Medicaid records available at ages six or older, *and* have educational records available, *and* who also have a sibling in the data.

The Medicaid claims include outpatient, inpatient visits, and dental visits and thus are a very important source of outcomes data, as well as of family background information. These records include information on diagnoses, detailed procedures performed as reflected in Current Procedural Terminology Codes (CPT), and the dates and locations where these services were provided. Additionally, we can control for each individual's annual enrollment information which includes his or her Medicaid qualifying category and monthly family income categories. Children in our sample are continuously eligible for Medicaid, so we have income measured at various points in time. In our models we control for net family income both at birth and at age six. Since we are focusing on the Medicaid population, all age-eligible children are automatically eligible for WIC and there is less variation in income than in the full population. However, we also include a measure of the variability of income prior to age six (the standard deviation) to reflect the idea that income shocks could affect health directly.

Diagnoses codes recorded on Medicaid claims allow us to look at whether the child has been treated for a childhood chronic condition after age 5, including a mental health condition, or for an acute condition such as an infection. One of the most common chronic conditions in our sample is asthma affecting 14.7% of children (means for all the outcomes are shown in Tables, 3, 4, and 5 so that they can easily be compared to the regression estimates discussed below). The two most common mental health conditions are ADHD, which affects 16.6% of our sample children and "Mental disorders diagnosed in childhood (312–316) excluding ADHD" which includes "Disturbance of conduct"; "Disturbance of emotions"; and "Specific delays in development" and affects 18.6% of sample children. Mental retardation is a separate and much smaller category (ICD9: 317-319 affecting 1.8% of the sample); as is depression and anxiety (affecting 3.0% of the sample), while autism affects 1.0% of the sample. A large fraction of children in our sample also had common childhood illnesses such as acute respiratory infections (48.7%) and otitis media (21.8%). In what follows, we focus on conditions with a prevalence of 3.0% or greater for reasons of statistical power.

The measures of healthcare utilization we examine include emergency room (ER) visits categorized into those that could be prevented (24.8%) or treated by a primary care physician (38.7%) and those that were not preventable (22.3%).[4] Although there are few hospitalizations in

[4] Following earlier work (e.g. Miller (2012)), we adopted the coding algorithm and classification of ER visits developed by John Billings and colleagues at New York University (see, e.g., Billings et al., 2000). The categories are based on the patient's diagnostic code include: non-urgent ER visits (e.g. sore throat); PC-treatable (e.g. ear infection); PC-preventable (e.g. asthma attack); Non-preventable visits (e.g. a cardiac dysrhythmia); Injuries, and other.

this age group, we also categorize hospitalizations into those that were avoidable (0.8%) and those that were unavoidable (1.4%). With regard to doctor's visits, 88.0% of children in our sample had at least one doctor's visit after age 6 which can be interpreted as a marker for access to care. On average, children have 10.4 visits per year, though this number combines both the effects of illness and access. One indicator of use of preventive services *per se* is receipt of a routine child health check (general screen) after age 6 (48.6% of children in our sample).

Dental services are another important class of care that is covered by Medicaid. In our sample, 84.8% of children received dental diagnostics, 86.7% had a preventative dental care services (e.g. fluoride application), and 54.3% received a restorative procedure while in sample (such as a cavity being filled). More alarmingly, 28.7% had dental surgery, such as a tooth extraction which may indicate inadequate dental care. WIC could have a lasting impact on children's dental health both by facilitating access to preventive care and by discouraging mothers from giving their children sugary drinks instead of water or milk.

Annual school records provide information on children's grade progression from pre-kindergarten up to sixth grade, as well as recording children's special education status based on the South Carolina Education Finance Act (EFA) codes. Taking kindergarten and higher grades together, about 9.8% of children repeat a grade in our sample. A fifth of the children in our sample (20.8%) have been diagnosed with mental, emotional, learning and physical disabilities and are receiving special education services based on their condition. The most common disability in our age group is speech-handicapped (14%), followed by learning disability (5%). Physical disabilities, developmental delays, and autism each have a prevalence of about 1%.

Methods

The methods used in this study are straightforward, primarily involving comparisons of sibling outcomes obtained by estimating models with mother fixed effects:

$$(1)\ Outcome_{ij} = \alpha_j + \beta_1 WIC_{ij} + \mathbf{Child}_i\beta_2 + \mathbf{Mother}_j\beta_3 + \varphi_{\text{county}} + \varphi_{\text{birth\_year}} + \varepsilon_{ij},$$

where i indexes the child and j indexes the mother. WIC is an indicator for prenatal WIC participation, and α_j is a fixed effect for each mother. Child characteristics ($Child_i$) include gender, race, and birth order (1…5, 6 or more, as well as indicators for prescence of a sibling 1 year older, 2 years older, up to 5 years older). Possibly time varying mother characteristics ($Mother_j$) include the mother's age (single year of age dummies), education (<12, 12, some college, college), county of residence (captured using county fixed effects, φ_{county}), household income measured at birth, and several measures of health risk factors for the pregnancy (pre-pregnancy diabetes, gestational diabetes, pre-pregnancy hypertension, eclampsia, previous C-section, previous preterm birth, other previous poor birth outcomes,[5] pre-pregnancy smoking and smoking during the pregnancy, pre-pregnancy obesity). In addition, we control for measures of county economic conditions at birth (rate of unemployment, median income, and population density). Finally, we also include indicators for each year of birth ($\varphi_{\text{birth\_year}}$).[6] For models of health care utilization, health outcomes, and academic outcomes later in life we also include household income measured at age 6, the standard deviation of income between birth and age six, and measures of county economic conditions at age six as well as at birth (rate of unemployment, median income, and population density). In addition, we control for birth weight and gestation, which is likely to yield conservative estimates of the effects of WIC as possible

[5] In the Medical and Health information section, birth certificates include a check list of pregnancy risk factors. Other previous poor pregnancy outcomes include perinatal death, and previous small-for-gestational age/intrauterine growth restricted birth.
[6] It is unfortunately not possible to control for month of conception as we were not given access to month of birth data.

effects on birth weight and gestation might be an important mechanism for longer-term outcomes. Models that do not include these controls for birth weight and gestation are shown in Appendix Table 3 and discussed further below.

The birth outcomes that we examine include several measures that are common in the literature: birth weight in grams, an indicator for birth weight less than 2500g (low birth weight), an indicator for birth weight less than 1500g (very low birth weight), whether the infant is preterm (gestation less than 37 weeks), whether the infant is small for gestational age (that is below the 10^{th} percentile of babies with the same gestational age), whether the infant was in the neonatal intensive care unit after birth, and whether the infant was breastfed.

For children 6 to 11 years old, we examine both mental and physical health outcomes. Mental health outcomes include whether the child has been diagnosed with ADHD, whether a child has been diagnosed with another common childhood mental health condition, and whether the child has been diagnosed with depression. The physical health outcome measures include whether the child has ever been diagnosed with asthma or other acute respiratory infections, otitis media (ear infections), injuries, nausea, or serious infections. These conditions include all those that had an estimated prevalence in our sample of 3% or more.

We also examine several measures of utilization of care including ER visits, hospitalizations, doctor visits, and dental care. Since we are focusing on children who are all currently enrolled in Medicaid (at ages 6 to 11) it is unlikely that WIC status (at birth) on its own could result in current differential eligibility for services within Medicaid. Even if children qualified for Medicaid based on different eligibility categories (e.g. if one was disabled), they would still be entitled to receive exactly same benefits.

The education outcome measures for children in our age group include indicators for grade repetition and special education status.

The past literature suggests that even within family, mothers tend to receive WIC at a time when they are relatively disadvantaged (e.g. younger and less likely to be married). We investigate this issue by examining the within-family determinants of WIC participation in models, where the WIC indicator is the dependent variable and the other variables include those in (1). These models take the form:

$$(2)\ WIC_{ij} = \alpha_j + \textbf{\textit{Child}}_i\gamma_1 + \textbf{\textit{Mother}}_j\gamma_2 + \varphi_{\text{county}} + \varphi_{\text{birth\_year}} + \mu_{ij}.$$

Results

Table 2 shows estimates from a model examining selection into WIC (Equation 2), both for the full sample with Medicaid and education records as well as siblings in the data, and for subsamples divided by race and by Medicaid eligibility status. Estimates are shown separately for non-Hispanic whites, African-Americans, and for children in the lowest income eligibility category (i.e. families with income less than 50% of the federal poverty line).

These mother fixed-effects estimates suggest that the probability of WIC participation in pregnancy declines with birth order, so that within a household, first-born children are most likely to have participated. This finding might indicate that pregnant women with other young children find it more difficult to get to WIC clinics. Mothers carrying male children are slightly less likely to participate, which might possibly reflect greater paternal support when a mother is expecting a male child (see Dahl and Moretti, 2008).[7] Within family, mothers are more likely to use WIC (conditional on the effects of birth order) as they age, and when they have attended

[7] Unfortunately we do not observe marital status in these data.

"some college" (relative to when they have either completed high school or less or completed college). In terms of risk factors for the pregnancy, women are more likely to use WIC when they are not smoking prior to pregnancy and when they have been diagnosed with diabetes prior to pregnancy. Other things being equal, they are also most likely to participate when they are in the lowest income category. One of the strongest predictors of differences in WIC participation within families is gestation. The longer the pregnancy lasts, the more time a woman has to become enrolled in WIC. This result highlights the importance of controlling for gestation in our models. Qualifying for Medicaid through disability also has a strong negative effect on the probability of WIC participation.

Overall, it is hard to say from these estimates whether in a household in which one child received WIC prenatally and one did not, one would expect the WIC child to be either more or less healthy than the non-WIC child. On the one hand, mothers are more likely to use WIC when the child is the first born, the family is in the lowest income category, the mother is older, when the father may be providing less support, and when they have been diagnosed with diabetes prenatally. These factors would suggest a higher probability of negative birth outcomes. On the other hand, women are more likely to use WIC when they have not been smoking prior to pregnancy, when they have attained some college (relative to being a high school dropout or graduate), and when they are not qualifying for Medicaid through disability. These factors are generally associated with positive birth outcomes.

Perhaps the most important takeaway from Table 2 though is that the detailed observable information in this administrative data explains only four to seven percent of the within household variation in WIC use, leaving most of it unexplained. Thus, the implicit sibling fixed effects assumption that conditional on observables WIC is "as good as" randomly assigned within the family may not be unreasonable.   We return to this issue below when we consider the possible effects of omitted variables on our estimates.

Effects on birth outcomes

Table 3 presents estimates of the effects of prenatal WIC participation on birth outcomes. We find statistically significant effects on birth weight, the probability of low birth weight, and the probability that the infant is small for gestational age (SGA). In the maternal fixed effects estimates, the increase in birth weight due to the WIC program is 1.1% without gestation controls and is less than 1% when controls for the length of gestation and included. These are very small effects. However, one might expect a larger impact on the left tail of the birth weight distribution. The mother fixed effect estimate of the effect on SGA corresponds to a 10.5% reduction in the incidence of SGA. This effect is roughly twice as large as the 4.2% reduction in SGA among Medicaid mothers in New York city reported by Currie and Rajani (2015), which might reflect the greater neediness of the South Carolina sample. The reduction in the probability of low birth weight is 7.8 percent. Comparing columns (1) and (2) shows that the estimates for low birth weight and SGA are quite similar with or without maternal fixed effects.

The remaining columns of Table 3 break out non-Hispanic whites, African-Americans, and those in the lowest Medicaid income category. A comparison of columns (4) and (6) shows that WIC participation only appears to have statistically significant effects for African-Americans, and that the estimated effects on birth weight, low birth weight, and SGA are much larger in this subsample. For example, SGA falls by 2.06pp (12.7%) among African-Americans compared to 1.02pp (11.3%) among non-Hispanic whites. In addition, WIC increases breast feeding among African-Americans by 2.33pp (6.6%).

Means of each outcome are also shown for each group. These means demonstrate that African-Americans are at much higher risk of poor outcomes than non-Hispanic whites. For example, the probability of low birth weight is 12.9% among African-Americans compared to a near zero mean among non-Hispanic whites. Hence, a possible interpretation of the difference between African-Americans and non-Hispanic whites is that WIC has larger effects on more disadvantaged mothers who are at higher risk. This interpretation is supported by the last column, which shows that mothers in the lowest income category (regardless of race) show larger effects than in the full sample on birth weight, and have point estimates for low birth weight and SGA that are similar to those of the full sample, though less precisely estimated given that the sample is roughly half the size of the full sample.

Having established that prenatal WIC has positive effects on birth outcomes in SC, Table 4 turns to the longer-term effects on child health and utilization of care among children six to 11. The table is divided into two panels, first assessing the impact on mental health conditions, and then turning to physical health conditions.

The contrast between the OLS estimates in column 1 and the mother fixed effects estimates in column 2, indicate that children who received WIC prenatally come from families in which children are less healthy than other children on average in terms of both physical and mental health. For instance, the OLS estimates indicate that they are 13.4% more likely to have been diagnosed with asthma and 10.8% more likely to have been diagnosed with ADHD. However, within family there is no significant “effect” of WIC on asthma, and the effect on ADHD actually changes sign indicating that WIC reduces ADHD. In addition, there is a statistically significant reduction in the probability of other childhood mental health conditions for a WIC child compared to a sibling who did not get WIC prenatally.

Given the strong relationship between poverty and negative child outcomes, and our relatively crude or absent controls for family backgrounds characteristics such as income, maternal employment, parenting skills, parent's mental health status or parental marital status, it is perhaps unsurprising that OLS estimates are biased towards finding negative "effects" of WIC. While fixed effects cannot capture changes in these variables between the siblings, they do capture the effect of any omitted variable that remained constant. We will further consider the effect of time-varying omitted variables below.

The remaining columns of Table 4 show the same breakdowns by race and Medicaid eligibility category as before. Since in Table 3 we found significant effects of WIC on birth outcomes only for African-Americans and not for whites, effects on future health that operate through better birth outcomes should be apparent only for African-Americans, if at all. The first panel dealing with mental health shows that this is indeed the case. For African-Americans, prenatal WIC participation is associated with reductions in the probability of both ADHD and other common childhood mental health conditions excluding ADHD. We do not find any effect on the probability of being diagnosed with depression. For the lowest-income, where we found weak effects of WIC on health at birth, we see some weak evidence of improvements in mental health. For non-Hispanic whites, where we saw no effect of WIC on birth outcomes, we similarly see no effect on mental health conditions.

Overall, children who participated in WIC prenatally are 5.0% likely than their non-WIC siblings to have been diagnosed with ADHD and 5.1% less likely to be diagnosed with other mental health conditions that are commonly diagnosed in childhood including "Disturbance of conduct"; "Disturbance of emotions"; and "Specific delays in development." Currie and Stabile

(2009) show that these specific conditions are in turn linked to poorer outcomes among teens and young adults.

The patterns are much less consistent for physical health conditions, and suggest, overall that prenatal WIC participation has little effect on physical health of children between 6 and 11 years old. We see no statistically significant effect of WIC on the physical health of African-Americans despite the fact that the effects on birth outcomes are concentrated in this group. For non-Hispanic whites, where we saw no effects of WIC on birth outcomes, there only estimate that is statistically significant is a positive effect on acute respiratory infections that likely reflects increase in health care utilization. The robustness section below shows estimates using an index of physical health outcomes and an index of utilization. Given that we find no effect of WIC on the indices for non-Hispanic whites, this one statistically significant estimate is unlikely to be meaningful. The lack of significant effects on longer term outcomes in this group is not surprising given that we saw no evidence of any positive effect on birth outcomes for non-Hispanic whites.

We examine the impact of prenatal WIC participation on longer-term utilization of health care in Table 5. It is conceivable, for instance, that gaining greater access to medical care in infancy and early childhood, could increase utilization of care at older child ages. The OLS estimates in column (1) do suggest that children who received WIC prenatally have more visits of virtually all types (ER, hospitalizations, office visits) even after they leave the program. However, the mother fixed effects estimates in column (2) suggest that there is no within-family difference in access to care between a WIC child and a non-WIC sibling. This null finding in the fixed effects models holds for each of the three subgroups examined, as shown in columns (4), (6) and (8). Taken at face value, the fact that adding maternal fixed effects reduces all of the effects to statistical insignificance suggests that the families of children who participate in WIC are simply different in that their children are likely to utilize more health care with or without WIC. However, as discussed above, spillovers may be a significant issue in family fixed-effects models of utilization since it could be the case that when one child gains access to care, all other children in the family benefit. In this case, fixed effects estimates could be biased towards zero for utilization.

The sole place where we find long-term effects of prenatal WIC participation on utilization is with respect to dental care. Table 6 shows the estimated effects on diagnostic, preventive care, restorative procedures and dental surgery. The OLS estimates in column (1) suggest that children covered by WIC prenatally consume more dental care and are more likely to need restorative procedures and dental surgery. However, a comparison of columns (1) and (2) indicates that there is no within-family difference in the need for restorative procedures and dental surgery, suggesting that children in WIC families are generally more likely to have bad teeth.

Looking at subgroups suggests that there are no effects of prenatal WIC on dental care for non-Hispanic whites, but that African-Americans who participated prenatally are more likely than their siblings to receive dental diagnostics and preventive care. Similarly, amond children in the lowest income category those on WIC are also more likely than their siblings to receive preventive care. It appears that unlike hospitals and ERs, dental offices find it feasible to treat some children in a family (e.g. those with whom they began a relationship when the child had WIC coverage) but not others. In any case, there does not appear to be a protective effect of prenatal WIC participation on dental health per se, since there is no impact on the need for restorative procedures or surgery within family in any of the subgroups.

So far, the estimates suggest that prenatal WIC participation improves birth outcomes and reduces the incidence of ADHD and other common childhood mental health conditions and that these effects are concentrated among African-Americans and lower-income Medicaid recipients. As discussed above, childhood mental health conditions have frequently been linked to a higher probability of grade repetition. Because the SC health records can be linked to data on educational attainment, it is possible to explore that connection here. Table 7 shows estimates of the effects of prenatal WIC participation on whether a child ever repeated a grade, and whether a child has a registered disability. We find no effect on the later variable. However, we find that both the OLS and mother fixed effects estimates suggest that prenatal WIC participation reduces the probability of grade repetition. The mother fixed effects estimate for any grade repetition is somewhat larger than the OLS estimate and suggests a reduction of about 7.9%, which is about the same magnitude as the reduction in ADHD and other common mental health disorders discussed above. Since mental health problems are one of the causes of grade repetition, it may be the case that WIC prevents grade repetition by improving children's mental health.

The remainder of the table breaks out the estimates by race and Medicaid eligibility group. Among African-Americans, the OLS estimate of the effect of prenatal WIC participation is strongly negative, which is remarkable given how disadvantaged these children are. When we look within families, the estimate is slightly attenuated though larger than the fixed effects estimate in the full sample. It is statistically insignificant, though this is largely due to a higher standard error in this smaller sample rather than to any change in the point estimate. We also see a large and significant effect of WIC participation in the lowest income sample of Medicaid participants. In this sample, prenatal WIC participation reduces the probability of grade repetition by 1.54pp on a baseline of 11.3%, which is a 13.6% reduction. It is noteworthy that the fixed effect estimate is about a third larger than the OLS estimate in this subsample.

Robustness

We have conducted three additional analyses in order to test the robustness of our main results. Appendix Table 1 reports the results using an estimator proposed by Oster (2017), who suggests a procedure related to Altonji, Elder, and Taber (2005) for assessing the likely degree of bias stemming from omitted variables. Oster (2017) notes that the magnitude of the bias will be related not only to changes in the magnitude of the coefficient of interest when other controls are varied, but also to changes in the of R^2. The proposed estimator requires two assumptions. First, it depends on the relative degree of selection on observed and unobserved variables; and second, it depends on the amount of the variance in the dependent variable that is explained by a hypothetical regression that includes all relevant observable and unobservable variables. Given these assumptions, one can place bounds on biases due to omitted variables. Oster (2017) offers a standard value based on her tests of the estimator in randomized data, which we adopt. Since in practice it might not be realistic to be able to explain all the variation in the dependent variable ($R^2 = 1$), it is assumed that the maximum attainable R^2 is 1.3 times the R^2 obtained in the specification that includes all of the observable controls.

As for the relative importance of observables and unobservables, we report two cases (see Appendix, Table 1). First, we assume that unobservables are as important as observables (the delta parameter from Oster is equal to 1). Second, since we have a rich variety of observable variables in our administrative data, we also report estimates under the assumption that the unobservables are half as important as the observables. In order to calculate the proposed estimator, we run baseline regressions that only control for child sex and compare them to our main specification that has a large set of controls. In most cases, the results are robust in the sense that estimates that are statistically significantly different than zero in the main specifications remain so after accounting for omitted variables bias. (The only exceptions are the estimated effects on dental health care procedures and on acute respiratory infections in the first case of equal influence of observables and unobservables. Inferences are all unchanged in second case in which unobservables are assumed to have only half the influence of the observables).

Given the large number of outcomes examined, the second robustness check we conduct involves using indices of variables from similar domains. Appendix Table 2 shows estimates using indices constructed following Kling et al. (2007) and Deming (2009) for the following domains: Birth outcomes, mental health, physicial health, ER visits and hospitalizations, office visits, dental health, and academic outcomes. These indices are computed by first standardizing the variables so that a more positive value is a "good," taking the z-score, and then taking an equally weighted average of the z-scores.

Appendix Table 2 is consistent with the estimates discussed above in that we find positive effects of WIC on birth outcomes, dental health, and academic outcomes in the full sample, among African-Americans and among the lowest income WIC recipients. We also find positive effects of WIC on mental health outcomes in the full sample and among African-Americans.

As a final robustness check, we re-estimate all of our models excluding controls for birth weight and gestation, since some of the effect of prenatal WIC participation could come through these birth outcomes. These estimates appear in Appendix Table 3. For the most part, they are qualitatively similar to our earlier estimates.

Discussion and Conclusions

This paper relies on mother fixed effects models, which have several well-known shortcomings.[8] Most obviously, they can only be estimated in families with two or more siblings. We have tried to be transparent about this limitation by showing how the progressive steps to select our sample affect its mean characteristics in Table 1. Overall, our sample is somewhat more disadvantaged than the full sample of SC children covered by Medicaid; for example, 57% of the children were in the lowest income category compared to 51% of the full Medicaid sample. To the extent that WIC has larger effects on poorer children, this may cause our estimates to be larger than they would be in the whole Medicaid sample.

The sample selection critique is about the external validity of our estimates, but there may also be concerns about internal validity. Specifically, in the presence of random measurement error, our estimates are likely to be biased downwards. Here, the use of administrative data may be helpful; while administrative data are subject to input errors, they may be more accurate than survey-based responses, for example. Another concern is that there may be spillover effects between siblings. This would also tend to bias our estimates towards

[8] See Neumark (1999) for one discussion of limitations of fixed effects models. We also explored the identification strategy used in Rossin-Slater (2013), which exploits the opening and closing of WIC clinics and the relationship between distance to a clinic, and WIC participation in Texas. In our sample, between 2004 and 2012, 13 clinics closed, however, these closures had little impact on the average distance between children in the Medicaid sample and the nearest clinic. We also tried to exploit significant fluctuations in gasoline prices over our sample period, using monthly gas prices from the American Automobile Association that was collected and generously shared with us by Matthew Lewis. However, the relationship between the cost of driving to a clinic and WIC participation was weak. This later result may reflect the fact that most mothers are fairly close to a WIC clinic in South Carolina, and that the clinics that closed seem to have been located close to other clinics. Distances were calculated using the addresses on Medicaid enrollment records, and hence are only available for children who were enrolled in Medicaid at some point.

zero. We think that spillovers are unlikely to be a big threat to the estimated effects of WIC on chronic and acute conditions, but that they could possibly be a larger issue for the estimated effects on health care utilization. To the extent that both children can use the same provider, improving access for one child could have the effect of improving it for the other. Hence spillovers in the utilization of care could possibly explain our null findings with respect to health care utilization using within-family estimates.

The most fundamental critique of mother fixed effects estimates concerns the reasons why one child obtained WIC prenatally while the other did not? If these reasons are correlated with future child outcomes then they could bias the estimated effects of WIC in the fixed effects models. When we examine this question directly, we find several factors that are associated with differential WIC participation, although most of the within-family variation is unexplained. The most important factor in our sample has to do with birth order. Mothers who already have young children in the home are less likely to participate in WIC. Family income is also important, with families being more likely to participate when they are poorer. While there are observable factors that help explain why a mother uses WIC for some pregnancies rather than others, and we control for these observable factors in our models, they explain relatively little of the within-family variation.

We cannot rule out the possibility that there is a time-varying unobserved factor that is correlated both with WIC participation and with better outcomes for one particular child in a household. However, our investigation of the likely magnitude of these biases, following Oster (2017) suggests that they are not likely to be large enough to overturn our main findings.

In summary, there is a large literature demonstrating positive effects of WIC on birth outcomes, and an even larger literature showing a connection between health at birth and future child outcomes. To date, it has not been demonstrated that prenatal WIC participation has positive effects on later child outcomes. This paper leverages a unique data set from South Carolina which links administrative Vital statistics natality records, Medicaid, and public school records in order to explore this question.

We find that while children who participated in WIC prenatally remain disadvantaged relative to other children, their outcomes are improved relative to close-in-age siblings who did not receive WIC. In particular, we find a lower incidence of common mental health conditions including ADHD, and a lower probability of grade repetition. These findings hold whether or not we include controls for birth weight and gestational age, suggesting that they may reflect another channel for WIC effects other than via these birth outcomes. Previous work has shown that the developing brain is sensitive to being deprived of micro-nutrients such as iodine and folic acid both prenatally and throughout childhood and it is possible that nutritious food and nutrition education offered through WIC helps prevent such deficiencies (See WHO et al., 2007 and Eryilmaz, 2018). These findings demonstrate that a "WIC start" is not only a healthy start, but one that is likely to result in persistent improvements in child outcomes across a range of domains. Research to further understand the mechanisms underlying these effects could lead to further improvements in food packages and outcomes.

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Table 1. Descriptive statistics: Child and Mother Characteristics, Children born 2004-2009

	All SC Births	Medicaid at Age 6	Medicaid matched to Education	Matched Sample with Siblings
Prenatal WIC	0.543	0.804	0.808	0.789
Child characteristics				
Male	0.510	0.510	0.511	0.511
First born	0.414	0.404	0.403	0.269
Race: White	0.643	0.492	0.485	0.461
Black	0.334	0.494	0.501	0.527
Years in sample		3.150	3.238	3.372
		(1.634)	(1.612)	(1.619)
Child Medicaid Eligibility				
Net monthly family income, in $2015				
0 or missiong		0.731	0.726	0.728
0-500		0.081	0.083	0.087
500-1000		0.072	0.074	0.076
1000-1500		0.067	0.068	0.064
1500-2000		0.031	0.031	0.029
2000-2500		0.012	0.012	0.012
2500-3000		0.004	0.004	0.004
3000+		0.001	0.001	0.001
Elig.: Low inc. family category, ever		0.510	0.515	0.571
Children		0.962	0.963	0.965
Disabled		0.044	0.045	0.044
Mother characteristics				
Mother's age	26.198	23.933	23.880	23.081
	(5.947)	(0.482)	(5.344)	(4.583)
Educ: < HS	0.239	0.368	0.372	0.417
HS	0.261	0.344	0.347	0.348
Some college	0.296	0.256	0.252	0.215
College	0.202	0.030	0.027	0.017
Prepregn.: Smoking	0.165	0.216	0.216	0.218
Diabetes	0.009	0.010	0.010	0.008
Hypertension	0.022	0.023	0.023	0.019
BMI>30	0.274	0.317	0.318	0.319
Previous c-section	0.127	0.125	0.125	0.146
Previous preterm	0.025	0.029	0.029	0.035
Previous poor outcome	0.063	0.061	0.060	0.059
Gest.: Smoking	0.133	0.182	0.182	0.187
Diabetes	0.048	0.044	0.044	0.037
Hypertension	0.052	0.052	0.052	0.044
N mothers	**257,563**	**128,267**	**119,361**	**27,732**
N children	**325,839**	**164,114**	**151,159**	**59,530**

Table 2: Selection into WIC, Models with Mother Fixed Effects

	Sample with Medicaid and Educational Outcomes			
	Full sample	**Whites only**	**Blacks only**	**Low Income only**
Birth order: 2nd	-0.0540***	-0.0366***	-0.0710***	-0.0623***
	(0.0091)	(0.0140)	(0.0121)	(0.0123)
3rd	-0.0732***	-0.0349	-0.1039***	-0.0905***
	(0.0162)	(0.0250)	(0.0215)	(0.0220)
4th	-0.0748***	-0.0419	-0.1013***	-0.0937***
	(0.0231)	(0.0358)	(0.0305)	(0.0313)
5th	-0.0658**	-0.0187	-0.1016**	-0.0964**
	(0.0307)	(0.0479)	(0.0403)	(0.0414)
6th+	-0.0520	0.0007	-0.0901*	-0.0834
	(0.0389)	(0.0613)	(0.0511)	(0.0535)
Presence of older sibling: +1 y.o.	-0.0658***	-0.0554***	-0.0756***	-0.0771***
	(0.0096)	(0.0152)	(0.0126)	(0.0129)
2 y.o.	-0.0805***	-0.0702***	-0.0900***	-0.0897***
	(0.0114)	(0.0180)	(0.0149)	(0.0153)
3 y.o.	-0.0684***	-0.0742***	-0.0642***	-0.0752***
	(0.0144)	(0.0230)	(0.0188)	(0.0192)
4 y.o.	-0.0700***	-0.0884***	-0.0520**	-0.0874***
	(0.0177)	(0.0286)	(0.0230)	(0.0239)
5 y.o.	-0.0643***	-0.0825**	-0.0504*	-0.0756**
	(0.0221)	(0.0356)	(0.0288)	(0.0303)
Male	-0.0099**	-0.0177***	-0.0047	-0.0092*
	(0.0040)	(0.0061)	(0.0053)	(0.0053)
Mother's age: 20-24 y.o.	0.0112	0.0197*	0.0054	0.0212**
	(0.0072)	(0.0108)	(0.0099)	(0.0092)
25-29 y.o.	0.0345***	0.0418**	0.0306*	0.0417**
	(0.0126)	(0.0192)	(0.0169)	(0.0167)
30-34 y.o.	0.0736***	0.0659**	0.0795***	0.0808***
	(0.0199)	(0.0303)	(0.0268)	(0.0285)
35+ y.o.	0.1328***	0.1299***	0.1392***	0.1412***
	(0.0310)	(0.0466)	(0.0414)	(0.0449)
Educ: < HS	-0.0016	0.0010	-0.0064	0.0058
	(0.0080)	(0.0131)	(0.0103)	(0.0103)
Some college	0.0199**	0.0185	0.0198*	0.0200
	(0.0089)	(0.0152)	(0.0109)	(0.0122)
College	0.0414	0.0672	0.0341	0.0671
	(0.0384)	(0.0605)	(0.0512)	(0.0669)
Prepregn.: Smoking	-0.0177**	-0.0079	-0.0286**	-0.0105
	(0.0075)	(0.0096)	(0.0120)	(0.0094)
Diabetes	0.0444*	0.0631	0.0421	0.0538*
	(0.0233)	(0.0400)	(0.0275)	(0.0294)
Hypertension	0.0092	0.0347	0.0013	-0.0032
	(0.0166)	(0.0328)	(0.0192)	(0.0216)
BMI>30	0.0059	-0.0030	0.0133	0.0100
	(0.0069)	(0.0107)	(0.0090)	(0.0092)

Previous: C-section	-0.0034	0.0019	-0.0067	-0.0010
	(0.0072)	(0.0109)	(0.0097)	(0.0097)
Preterm birth	-0.0012	-0.0040	0.0009	0.0056
	(0.0123)	(0.0203)	(0.0156)	(0.0164)
Poor pregn outcome	0.0003	0.0008	-0.0022	0.0039
	(0.0098)	(0.0159)	(0.0125)	(0.0128)
Gestation, weeks	0.0089***	0.0084***	0.0092***	0.0090***
	(0.0013)	(0.0021)	(0.0018)	(0.0018)
Net family income: 0 or missing	0.0197**	0.0141	0.0264**	0.0076
	(0.0079)	(0.0115)	(0.0109)	(0.0105)
0-500	0.0008	0.0020	0.0042	-0.0140
	(0.0100)	(0.0154)	(0.0133)	(0.0125)
1000-1500	-0.0160	-0.0090	-0.0218	-0.0132
	(0.0113)	(0.0152)	(0.0173)	(0.0171)
1500-2000	-0.0240*	-0.0278	-0.0075	-0.0848***
	(0.0143)	(0.0187)	(0.0223)	(0.0240)
2000-2500	-0.0011	0.0094	-0.0072	-0.0103
	(0.0222)	(0.0267)	(0.0404)	(0.0389)
2500-3000	0.0300	0.0282	0.0649	0.0069
	(0.0390)	(0.0448)	(0.0835)	(0.0841)
3000+	0.0484	0.0278	0.1878*	-0.0180
	(0.0692)	(0.0820)	(0.1091)	(0.1532)
Elig.: Low inc. family category, ever	-0.0002	0.0094	-0.0066	
	(0.0099)	(0.0156)	(0.0128)	
Infants & Children	-0.0102	-0.0496**	0.0149	-0.0193
	(0.0141)	(0.0229)	(0.0179)	(0.0171)
Disabled	-0.0610*	-0.1193*	-0.0303	-0.0921*
	(0.0357)	(0.0630)	(0.0435)	(0.0492)
Birth year and County FEs	Y	Y	Y	Y
Mother FEs	Y	Y	Y	Y
N obs.	59,530	27,425	31,372	33,986
R-squared	0.0503	0.0383	0.0694	0.0639
N mothers	27,732	12,923	14,461	16,971

Notes: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1. An omitted category of mother's age is 15-19 y.o.; Family income is monthly, in $2015; and $500-$1000 is the omitted category. Standard errors are clustered on mother's ID.

Table 3: Effects of WIC on Birth Outcomes Conditional on Weeks of Gestation

	Full Sample		Non-Hispanic whites		African-Americans		Lower Income	
	OLS	**FE**	**OLS**	**FE**	**OLS**	**FE**	**OLS**	**FE**
Birth weight	17.6466***	9.1641*	16.3302***	3.2520	22.1320***	16.0835**	21.0578***	15.8503**
	(4.2522)	(4.8887)	(6.2762)	(7.2461)	(5.8294)	(6.7318)	(5.7683)	(6.6491)
Mean of Outcome	3154.0090		3268.7430		3051.8470		3138.9950	
Birth weight<2500g	-0.0082***	-0.0075**	-0.0003	-0.0004	-0.0160***	-0.0159***	-0.0096***	-0.0072
	(0.0025)	(0.0036)	(0.0030)	(0.0045)	(0.0041)	(0.0057)	(0.0036)	(0.0052)
Mean of Outcome	0.0956		0.0653		0.1230		0.0997	
Birth weight<1500g	-0.0013	-0.0001	-0.0022*	-0.0012	0.0001	0.0010	-0.0011	-0.0015
	(0.0010)	(0.0015)	(0.0012)	(0.0018)	(0.0017)	(0.0024)	(0.0013)	(0.0020)
Mean of Outcome	0.0121		0.0072		0.0165		0.0089	
Small for Gestational Age	-0.0127***	-0.0134***	-0.0106**	-0.0102*	-0.0154***	-0.0206***	-0.0128***	-0.0135**
	(0.0034)	(0.0047)	(0.0043)	(0.0060)	(0.0055)	(0.0073)	(0.0049)	(0.0068)
Mean of Outcome	0.1282		0.0902		0.1618		0.1380	
Neonatal Intensive Care Unit	-0.0050**	-0.0045	-0.0004	-0.0019	-0.0085***	-0.0064	-0.0061**	-0.0040
	(0.0020)	(0.0030)	(0.0027)	(0.0041)	(0.0030)	(0.0043)	(0.0028)	(0.0042)
Mean of Outcome	0.0486		0.0432		0.0538		0.0451	
Infant breastfed	0.0024	0.0112*	-0.0240***	-0.0000	0.0353***	0.0233***	0.0138**	0.0072
	(0.0050)	(0.0058)	(0.0071)	(0.0083)	(0.0070)	(0.0083)	(0.0068)	(0.0083)
Mean of Outcome	0.4409		0.5395		0.3516		0.3924	
County fixed effects	x	x	x	x	x	x	x	x
Mother fixed effects		x		x		x		x
Year fixed effects	x	x	x	x	x	x	x	x
N obs.	59,530		27,425		31,372		33,986	
N mothers	27,732		12,923		14,461		16,971	

Notes: Every coefficient is from a separate regression. Controls include the variables shown in Table 2 as well as mother age (dummies), indicators for income categories, and gestation in weeks. Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1. Standard errors are clustered on mother's ID.

Table 4: Effects of Prenatal WIC on Common Health Conditions at Age 6+

	Full Sample		Non-Hispanic whites		African-Americans		Lower Income	
Mental conditions	**OLS**	**FE**	**OLS**	**FE**	**OLS**	**FE**	**OLS**	**FE**
ADHD	0.0179***	-0.0083*	0.0198***	-0.0010	0.0138***	-0.0148**	0.0168***	-0.0165**
	(0.0035)	(0.0050)	(0.0052)	(0.0073)	(0.0050)	(0.0069)	(0.0054)	(0.0076)
	0.1658		0.1863		0.1494		0.1978	
Childhood mental, excl. ADHD	0.0056	-0.0095*	0.0119**	0.0000	-0.0013	-0.0193**	0.0085	-0.0145*
	(0.0038)	(0.0054)	(0.0055)	(0.0079)	(0.0054)	(0.0076)	(0.0054)	(0.0079)
	0.1878		0.1996		0.1785		0.2030	
Depression/Anxiety	0.0015	-0.0000	0.0032	0.0037	0.0000	-0.0022	0.0023	0.0043
	(0.0016)	(0.0025)	(0.0026)	(0.0041)	(0.0021)	(0.0031)	(0.0024)	(0.0037)
	0.0294		0.0391		0.0214		0.0342	
Physical conditions								
Asthma	0.0197***	-0.0007	0.0199***	0.0000	0.0174***	-0.0028	0.0207***	0.0014
	(0.0035)	(0.0049)	(0.0046)	(0.0065)	(0.0053)	(0.0073)	(0.0049)	(0.0071)
	0.1466		0.1261		0.1649		0.1557	
Acute resp. infection	0.0297***	0.0155**	0.0261***	0.0192**	0.0295***	0.0151	0.0239***	0.0116
	(0.0050)	(0.0067)	(0.0071)	(0.0097)	(0.0071)	(0.0094)	(0.0068)	(0.0094)
	0.4869		0.5519		0.4307		0.5034	
Injuries	0.0220***	-0.0079	0.0276***	-0.0161	0.0077	-0.0034	0.0135**	-0.0046
	(0.0049)	(0.0069)	(0.0069)	(0.0099)	(0.0070)	(0.0099)	(0.0067)	(0.0099)
	0.5051		0.5397		0.4771		0.5449	
Otitis media	0.0083**	-0.0013	0.0114*	0.0040	0.0044	-0.0043	0.0071	-0.0068
	(0.0040)	(0.0060)	(0.0065)	(0.0097)	(0.0048)	(0.0072)	(0.0055)	(0.0083)
	0.2179		0.3057		0.1414		0.2186	
Nausea	0.0130***	0.0022	0.0167***	0.0044	0.0083	0.0025	0.0148***	0.0037
	(0.0038)	(0.0056)	(0.0057)	(0.0086)	(0.0052)	(0.0075)	(0.0052)	(0.0079)
	0.1908		0.2194		0.1654		0.1991	
Infections, med. & high	0.0042**	-0.0027	0.0062*	-0.0034	0.0012	-0.0025	0.0040	-0.0021
	(0.0019)	(0.0029)	(0.0034)	(0.0051)	(0.0019)	(0.0029)	(0.0027)	(0.0040)
	0.0399		0.0637		0.0191		0.0411	
County fixed effects	x	x	x	x	x	x	x	x
Mother fixed effects		x		x		x		x
Year fixed effects	x	x	x	x	x	x	x	x
N obs.	59,530		27,425		31,372		33,986	

N mothers	27,732	12,923	14,461	16,971

Notes: Controls include the variables shown in Table 2 as well as birth weight, mother age (dummies), indicators for income and Medicaid eligibility categories, number of years in sample, and gestation in weeks. Means of dependent variables are shown for each outcome/group. Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1. Standard errors are clustered on mother's ID.

Table 5: Effects of Prenatal WIC on Health Services Utilization at Age 6+

	Full Sample		Non-Hispanic whites		African-Americans		Lower Income	
	OLS	FE	OLS	FE	OLS	FE	OLS	FE
ER visits								
Not preventable	0.0139***	0.0015	0.0132**	-0.0105	0.0122**	0.0115	0.0105*	-0.0014
	(0.0041)	(0.0058)	(0.0057)	(0.0082)	(0.0060)	(0.0083)	(0.0060)	(0.0085)
	0.2227		0.2088		0.2361		0.2491	
Preventable	0.0145***	-0.0023	0.0238***	0.0019	0.0017	-0.0051	0.0195***	0.0005
	(0.0043)	(0.0060)	(0.0060)	(0.0082)	(0.0062)	(0.0087)	(0.0061)	(0.0087)
	0.2475		0.2448		0.2512		0.2760	
Treatable in Primary Care Setting	0.0206***	-0.0021	0.0258***	-0.0087	0.0102	0.0034	0.0191***	-0.0071
	(0.0049)	(0.0065)	(0.0068)	(0.0090)	(0.0071)	(0.0095)	(0.0069)	(0.0094)
	0.3865		0.3709		0.4024		0.4260	
Not emergent	0.0214***	-0.0017	0.0255***	-0.0080	0.0133**	0.0041	0.0184***	-0.0095
	(0.0046)	(0.0062)	(0.0065)	(0.0088)	(0.0067)	(0.0090)	(0.0066)	(0.0091)
	0.3146		0.3084		0.3216		0.3476	
Hospitalizations								
Avoidable	0.0020**	0.0011	0.0016	0.0009	0.0022*	0.0016	0.0008	0.0007
	(0.0008)	(0.0013)	(0.0011)	(0.0019)	(0.0012)	(0.0019)	(0.0012)	(0.0020)
	0.0084		0.0077		0.0091		0.0089	
Unavoidable	-0.0010	-0.0002	-0.0010	0.0007	-0.0009	-0.0014	-0.0031*	-0.0036
	(0.0012)	(0.0019)	(0.0018)	(0.0028)	(0.0016)	(0.0026)	(0.0018)	(0.0029)
	0.0142		0.0160		0.0128		0.0152	
Office visits								
At least one visit	0.0162***	-0.0045	0.0127***	-0.0026	0.0184***	-0.0052	0.0188***	-0.0042
	(0.0035)	(0.0050)	(0.0046)	(0.0065)	(0.0054)	(0.0076)	(0.0048)	(0.0071)
	0.8796		0.9020		0.8607		0.8880	
N visits, per year	1.0947***	0.0235	1.1654***	0.1748	1.0496***	-0.0567	1.0799***	-0.0910
	(0.1735)	(0.2275)	(0.2506)	(0.3235)	(0.2427)	(0.3287)	(0.2198)	(0.2745)
	10.4279		11.6084		9.4471		10.5915	
General screen	0.0249***	0.0036	0.0206***	0.0085	0.0326***	-0.0018	0.0424***	0.0151*
	(0.0050)	(0.0064)	(0.0072)	(0.0093)	(0.0072)	(0.0091)	(0.0069)	(0.0091)
	0.4855		0.4879		0.4827		0.4796	
County fixed effects	x	x	x	x	x	x	x	x
Mother fixed effects		x		x		x		x

Year fixed effects	x	x	x	x	x	x	x	x
N obs.	59,530		27,425		31,372		33,986	
N mothers	27,732		12,923		14,461		16,971	

Notes: Controls include the variables shown in Table 2 as well as birth weight, mother age (dummies), indicators for income and Medicaid eligibility categories, number of years in sample, and gestation in weeks. Means of dependent variables are shown for each outcome/group. Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1. Standard errors are clustered on mother's ID.

Table 6: Effects of Prenatal WIC on Dental Health at Age 6+

	Full Sample		**Non-Hispanic whites**		**African-Americans**		**Lower Income**	
	OLS	**FE**	**OLS**	**FE**	**OLS**	**FE**	**OLS**	**FE**
Diagnostics	0.0342***	0.0090**	0.0277***	0.0016	0.0405***	0.0153**	0.0397***	0.0058
	(0.0040)	(0.0044)	(0.0056)	(0.0062)	(0.0057)	(0.0063)	(0.0054)	(0.0063)
	0.8475		0.8478		0.8473		0.8572	
Preventive care	0.0275***	0.0102**	0.0224***	0.0033	0.0330***	0.0161***	0.0308***	0.0110*
	(0.0037)	(0.0042)	(0.0054)	(0.0060)	(0.0054)	(0.0061)	(0.0050)	(0.0060)
	0.8672		0.8633		0.8706		0.8706	
Restorative procedure	0.0201***	-0.0026	0.0100	-0.0130	0.0304***	0.0039	0.0275***	-0.0056
	(0.0050)	(0.0064)	(0.0072)	(0.0091)	(0.0072)	(0.0091)	(0.0069)	(0.0090)
	0.5434		0.5561		0.5313		0.5560	
Surgery	0.0096**	-0.0070	0.0072	-0.0088	0.0112*	-0.0046	0.0133**	-0.0022
	(0.0045)	(0.0063)	(0.0065)	(0.0092)	(0.0063)	(0.0089)	(0.0062)	(0.0090)
	0.2874		0.2982		0.2766		0.2766	
County fixed effects	x	x	x	x	x	x	x	x
Mother fixed effects		x		x		x		x
Year fixed effects	x	x	x	x	x	x	x	x
N obs.	59,530		27,425		31,372		33,986	
N mothers	27,732		12,923		14,461		16,971	

Notes: Controls include the variables shown in Table 2 as well as birth weight, mother age (dummies), indicators for income and Medicaid eligibility categories, number of years in sample, gestation in weeks. Means of dependent variables are shown for each outcome/group. Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1. Standard errors are clustered on mother's ID.

Table 7: Effects of Prenatal WIC on Educational Outcomes

	Full Sample		Non-Hispanic whites		African-Americans		Lower Income	
	OLS	**FE**	**OLS**	**FE**	**OLS**	**FE**	**OLS**	**FE**
Ever repeated grade	-0.0056*	-0.0077*	-0.0096**	-0.0087	-0.0037	-0.0074	-0.0109**	-0.0154**
	(0.0029)	(0.0043)	(0.0044)	(0.0063)	(0.0041)	(0.0058)	(0.0044)	(0.0063)
	0.0975		0.0910		0.1039		0.1130	
Any registered disability	0.0058	-0.0026	0.0070	0.0012	-0.0005	-0.0064	0.0084	0.0003
	(0.0046)	(0.0071)	(0.0067)	(0.0106)	(0.0063)	(0.0097)	(0.0063)	(0.0099)
	0.2075		0.2186		0.1991		0.2155	
County fixed effects	x	x	x	x	x	x	x	x
Mother fixed effects		x		x		x		x
Year fixed effects	x	x	x	x	x	x	x	x
N obs.	59,530		27,425		31,372		33,986	
N mothers	27,732		12,923		14,461		16,971	

Notes: Ever repeated a grade includes kindergarten. Controls include the variables shown in Table 2 as well as birth weight, mother age (dummies), and indicators for income and Medicaid eligibility categories, and gestation in weeks. Means of dependent variables are shown for each group. Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1. Standard errors are clustered on mother's ID.

Appendix Table 1. Bias-adjusted estimates of the Effect of WIC participation in SC Medicaid populatio

Bold entry in identified set indicates original estimate. Non-bold indicates bias-corrected estimate.

		Rmax=1.3*Rf; delta=0.5		Rmax=1.3*Rf; delta=1	
	Null rejected?	**Identified Set**	**Excludes zero?**	**Identified Set**	**Excludes zero?**
Birth outcomes					
Birth weight	Y	[5.5394, **9.1640**]	Y	[1.9147, **9.1640**]	Y
Birth weight<2500g	Y	[**-0.0075**, -0.0059]	Y	[**-0.0075,** -0.0041]	Y
Birth weight<1500g	N	[**-0.0001**, 0.0007]	N	[**-0.0001**, 0.0015]	N
Small for Gestational Age	Y	[-0.0153, **-0.0134**]	Y	[-0.0173, **-0.0134**]	Y
Neonatal Intensive Care Unit	N	[**-0.0045**, -0.0030]	Y	[**-0.0045**, -0.0015]	Y
Infant breastfed	Y	[**0.0112**, 0.0154]	Y	[**0.0112**, 0.0195]	Y
Mental conditions Age 6+					
ADHD	Y	[-0.0181, **-0.0083**]	Y	[-0.0277, **-0.0083**]	Y
Childhood mental, excl. ADHD	Y	[-0.0146, **-0.0095**]	Y	[-0.0197, **-0.0095**]	Y
Depression/Anxiety	N	[-0.0009, **0.0000**]	N	[-0.0017, **0.0000**]	N
Physical conditions Age 6+					
Asthma	N	[-0.0068, **-0.0007**]	Y	[-0.0130, **-0.0007**]	Y
Acute resp. infection	Y	[0.0066, **0.0155**]	Y	[-0.0022, **0.0155**]	N
Injuries	N	[-0.0186, **-0.0079**]	Y	[-0.0296, **-0.0079**]	Y
Otitis media	N	[-0.0054, **-0.0013**]	Y	[-0.0096, **-0.0013**]	Y
Nausea	N	[-0.0029, **0.0022**]	N	[-0.0080, **0.0022**]	N
Infections, med. & high	N	[-0.0041, **-0.0027**]	Y	[-0.0057, **-0.0027**]	Y
ER visits Age 6+					
Not preventable	N	[-0.0052, **0.0015**]	N	[-0.0120, **0.0015**]	N
Preventable	N	[-0.0100, **-0.0023**]	Y	[-0.0178, **-0.0023**]	Y
Treatable in Primary Care Setting	N	[-0.0126, **-0.0021**]	Y	[-0.0232, **-0.0021**]	Y
Not emergent	N	[-0.0115, **-0.0017**]	Y	[-0.0215, **-0.0017**]	Y
Hospitalizations Age 6+					
Avoidable	N	[0.0007, **0.0011**]	Y	[0.0003, **0.0011**]	Y
Unavoidable	N	[-0.0004, **-0.0002**]	Y	[-0.0005, **-0.0002**]	Y
Office visits Age 6+					
At least one visit	N	[-0.0093, **-0.0045**]	Y	[-0.0142, **-0.0045**]	Y
N visits, per year	N	[-0.1488, **0.0235**]	N	[-0.3210, **0.0235**]	N
General screen	N	[-0.0020, **0.0036**]	N	[-0.0076, **0.0036**]	N
Dental Health at Age 6+					
Diagnostics	Y	[0.0016, **0.0090**]	Y	[-0.0057, **0.0090**]	N
Preventive care	Y	[0.0040, **0.0102**]	Y	[-0.0022, **0.0102**]	N
Restorative procedure	N	[-0.0104, **-0.0026**]	Y	[-0.0185, **-0.0026**]	Y
Surgery	N	[-0.0130, **-0.0070**]	Y	[-0.0188, **-0.0070**]	Y
Educational Outcomes Age 6+					
Ever repeated grade	Y	[-0.0105, **-0.0077**]	Y	[-0.0132, **-0.0077**]	Y
Any registered disability	N	[-0.0052, **-0.0026**]	Y	[-0.0081, **-0.0026**]	Y

Notes: The table shows identified sets of estimated effects of WIC participation on children's outcomes based on the preferred specifications shown in the main results tables and on a bias-adjusted estimator proposed by Oster (2017). The first column indicates whether our preferred specification yielded statistically-significant results. The Oster method requires assumptions about the R-squared that would be obtained if the omitted variables causing the bias were included in the regressions. Oster suggests using 1.3 times the R-squared in the original model, which is what we do here. The second assumption involves the ratio between the variance explained by the unobserved variables and the variance explained by the observed variables. This is referred to as delta and we show estimates using delta=0.5 and delta=1.

Appendix Table 2. Effects of WIC Participation on Index-based Children's Outcomes

	Full Sample	**Non-Hispanic whites**	**African-Americans**	**Lower Income**
Birth outcomes	0.0345***	0.0147	0.0588***	0.0393***
	(0.0107)	(0.0142)	(0.0160)	(0.0146)
Mental health	0.0227*	-0.0092	0.0494***	0.0271
	(0.0133)	(0.0204)	(0.0177)	(0.0200)
Physical health	-0.0006	-0.0032	0.0003	-0.0001
	(0.0122)	(0.0187)	(0.0162)	(0.0173)
ER visits & hospitalizations	-0.0001	0.0106	-0.0099	0.0157
	(0.0131)	(0.0183)	(0.0190)	(0.0193)
Office visits	0.0028	-0.0097	0.0118	-0.0064
	(0.0130)	(0.0178)	(0.0192)	(0.0179)
Dental health	0.0391***	0.0309	0.0476**	0.0333*
	(0.0142)	(0.0201)	(0.0203)	(0.0200)
Academic outcomes	0.0278**	0.0215	0.0367*	0.0468**
	(0.0139)	(0.0198)	(0.0200)	(0.0203)
County fixed effects	x	x	x	x
Mother fixed effects	x	x	x	x
Year fixed effects	x	x	x	x
N obs.	59,530	27,425	31,372	33,986
N mothers	27,732	12,923	14,461	16,971

Notes: The outcome variables are summary indices for birth, health, health care utilization, and educational child outcomes. All specifications include county, year, and mother fixed effects. Controls include the variables shown in Table 2 as well as birth weight (except for birth outcomes), mother age (dummies), and indicators for income and Medicaid eligibility categories, and gestation in weeks. Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1. Standard errors are clustered on mother's ID.

Appendix Table 3: Effects of Prenatal WIC on Children's Well-being, without controls for birth weight and gestation. Mother Fixed Effects Specification.

	Full Sample	Non-Hispanic whites	African-Americans	Lower Income
Mental conditions				
ADHD	-0.0085*	-0.0013	-0.0147**	-0.0169**
	(0.0050)	(0.0073)	(0.0069)	(0.0076)
Childhood mental, excl. ADHD	-0.0102*	-0.0007	-0.0195**	-0.0153*
	(0.0054)	(0.0080)	(0.0076)	(0.0080)
Depression/Anxiety	0.0000	0.0037	-0.0023	0.0042
	(0.0025)	(0.0041)	(0.0031)	(0.0037)
Physical conditions				
Asthma	-0.0016	-0.0015	-0.0032	0.0003
	(0.0049)	(0.0065)	(0.0073)	(0.0071)
Acute resp. infection	0.0157**	0.0196**	0.0153	0.0122
	(0.0067)	(0.0097)	(0.0094)	(0.0094)
Injuries	-0.0077	-0.0158	-0.0033	-0.0046
	(0.0069)	(0.0099)	(0.0099)	(0.0099)
Otitis media	-0.0014	0.0043	-0.0052	-0.0071
	(0.0059)	(0.0097)	(0.0073)	(0.0083)
Nausea	0.0025	0.0047	0.0029	0.0040
	(0.0056)	(0.0086)	(0.0075)	(0.0079)
Infections, med. & high	-0.0026	-0.0035	-0.0023	-0.0021
	(0.0029)	(0.0051)	(0.0029)	(0.0040)
ER visits				
Not preventable	0.0013	-0.0109	0.0113	-0.0014
	(0.0058)	(0.0082)	(0.0083)	(0.0085)
Preventable	-0.0022	0.0018	-0.0052	0.0006
	(0.0060)	(0.0082)	(0.0087)	(0.0087)
Treatable in Primary	-0.0019	-0.0090	0.0036	-0.0067
Care Setting	(0.0065)	(0.0090)	(0.0095)	(0.0094)
Not emergent	-0.0016	-0.0081	0.0042	-0.0091
	(0.0062)	(0.0088)	(0.0090)	(0.0091)
Hospitalizations				
Avoidable	0.0011	0.0008	0.0016	0.0006
	(0.0013)	(0.0019)	(0.0019)	(0.0020)
Unavoidable	-0.0000	0.0008	-0.0012	-0.0035
	(0.0019)	(0.0028)	(0.0026)	(0.0029)
Office visits				
At least one visit	-0.0045	-0.0025	-0.0050	-0.0042
	(0.0050)	(0.0065)	(0.0075)	(0.0071)
N visits, per year	0.0136	0.1563	-0.0531	-0.1047
	(0.2287)	(0.3249)	(0.3301)	(0.2744)
General screen	0.0033	0.0086	-0.0026	0.0145
	(0.0064)	(0.0093)	(0.0091)	(0.0091)
Dental health				
Diagnostics	0.0092**	0.0017	0.0155**	0.0057

	(0.0044)	(0.0062)	(0.0063)	(0.0063)
Preventive care	0.0104**	0.0035	0.0163***	0.0110*
	(0.0042)	(0.0060)	(0.0061)	(0.0060)
Restorative procedure	-0.0020	-0.0129	0.0047	-0.0050
	(0.0064)	(0.0091)	(0.0091)	(0.0090)
Surgery	-0.0071	-0.0087	-0.0049	-0.0021
	(0.0063)	(0.0092)	(0.0089)	(0.0090)
School outcomes				
Ever repeated grade	-0.0081*	-0.0079	-0.0090	-0.0159**
	(0.0042)	(0.0058)	(0.0063)	(0.0063)
Any registered disability	-0.0030	0.0009	-0.0064	0.0002
	(0.0071)	(0.0106)	(0.0096)	(0.0099)
N obs.	**59,530**	**27,425**	**31,372**	**33,986**
N mothers	**27,732**	**12,923**	**14,461**	**16,971**

Notes: Controls include the variables shown in Table 2, except for gestation. They also include mother age (dummies), indicators for income and Medicaid eligibility categories, and number of years in sample. All specifications are include county and year fixed effects. Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1. Standard errors are clustered on mother's ID.