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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 what the program does.

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 combines 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 9.5% less likely than siblings 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 5.3% lower probability of being diagnosed with ADHD and a 6.4% lower probability of being diagnosed with several other mental health conditions that are commonly diagnosed in childhood. The children are also 17.7% less likely to have a moderate to severe infection. Finally, they are 8.2% less likely to repeat a grade. These 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.

[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 provide mothers with referrals to healthcare and social services as well as provide 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. 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. Similarly, Sonchak (2016) finds that indicate that WIC participation among 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.

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 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. 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 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

[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.

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 59,641 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 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 income category, though the later is often missing. [3]

Column 1 shows that 54.2% of SC births were to mothers who received WIC prenatally. 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 and is used to create a baby's birth certificate. Unfortunately, the birth certificate data does 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 are more likely to have received WIC prenatally, 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 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 attend public schools so that they are in our education data base.

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[3] Although children's benefits do not depend on the enrollment category, it is perhaps a more accurate reflection of low income than the actual income category variables, which 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). Monthly net family income in 2015 dollars at the time of the birth is be coded as zero (missing values were also coded as zero in the data we received) or in $500 bins, with the excluded category being $1,000-1,500, monthly.

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 somewhat are less likely to have had diabetes or hypertension. In summary, the analysis sample is somewhat more disadvantaged in a variety of ways than the overall sample of SC births in these cohorts.

To track the health status of children six and older, we link the birth records to Medicaid claims data. Medicaid claims include outpatient and inpatient visits, and dental visits. 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.

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.[4] Mental retardation is a separate and much

[4] 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), and autism (affecting 1.0% of the sample).

smaller category (ICD9: 317-319 affecting 1.8% of the sample); as is depression and anxiety (affecting 3.0% of the sample). A large fraction of children in our sample also had common childhood illnesses such as acute respiratory infections (48.5%) and otitis media (21.8%).

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%).[5] Although there are few hospitalizations in this age group, we also categorize hospitalizations into those that were avoidable (0.9%) 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 (48.3% of children in our sample). Dental services are another important class of care that is covered by Medicaid. In our sample, 84.7% 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.

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

[5] 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.

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:

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

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 ($\boldsymbol{Child_i}$) include gender, race, birth order (1…5, 6 or more), and birth spacing (presence of a sibling 1 year older, 2 years older,… 5 years older). Possibly time varying mother characteristics ($\boldsymbol{Mother_j}$) include the mother's age (single year of age dummies), education (<12, 12, some college, college), county of residence (captured using county fixed effects, $\boldsymbol{\varphi_{\text{county}}}$), 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,[6] pre-pregnancy smoking and smoking during the pregnancy, pre-pregnancy obesity). Finally, we also include indicators for each year of birth ($\boldsymbol{\varphi_{\text{birth\_year}}}$).[7]

The birth outcomes 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),

[6] 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.
[7] It is unfortunately not possible to control for month of conception as we were not given access to month of birth data.

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. Except for the model for preterm delivery, all of these models are estimated with and without controls for gestation in weeks.

For children 6 to 11, the health outcome measures include whether the child has ever been diagnosed with a chronic condition, such as asthma and attention deficit disorder, and whether a child is more likely to have various acute conditions, such as respiratory infections that might indicate an unhealthy child. We focus on conditions that have 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. Utilization measures confound access to care with the child's need for care, and WIC could, in principle, affect both. However, focusing on differences between siblings, who are close in age may help to control for some of the differences in access to care. For example, it seems unlikely that one Medicaid-covered child would have more "access" to an ER than another in the same family although it is possible that a mother might have found a doctor or dentist who was willing to treat one child, but not willing to treat an additional Medicaid-covered sibling.

The education outcome measures include measures of grade repetition and special education.

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 also 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 are defined as in (1). These models take the form:

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

Results

Table 2 shows estimates from a model examining selection into WIC, (Equation 2), both for all the children in the cohorts we examine and for the sub-sample with Medicaid and education records as well as siblings in the data. Column 1 indicates that firstborn children are more likely to be exposed to WIC prenatally than children of higher birth order, and that children with older siblings are less likely to get WIC prenatally. Not surprisingly, college educated women are less likely to use WIC. And consistent with the previous literature, a longer gestation is associated with a higher probability of WIC usage. We do not show all the coefficients on the single year of age dummies for space reasons, but they increase monotonically with maternal age from 0.027 (0.023) for 16 year olds to 0.557 (0.118) for those over 45. Hence, other things being equal, older women are more likely to participate.

When we focus on the sub-sample in which both siblings have Medicaid and education records in Column 2, the effects of birth order and older siblings become more pronounced. This finding might indicate that mothers with young children find it more difficult to get to WIC clinics. In this sample, mothers with some college are most likely to use WIC. Mothers with pre-exiting diabetes are also more likely to use WIC, while mothers who smoked before the pregnancy are less likely. These patterns with respect to health and health behaviors may bias positive estimated effects of WIC towards zero since diabetes and smoking are both independently associated with negative birth outcomes. The point estimates on family income (which can be included in this sample because they come from the Medicaid file) are consistent with the idea that mothers from more disadvantaged families are more likely to enroll in WIC than those from relatively higher income families.

Finally, we find a small, but statistically significant effect of male gender on prenatal WIC participation in the sub-sample, though not in the full sample. It is possible that this result reflects greater support from the father and a higher probability of marriage when the mother is carrying a male fetus (Dahl and Moretti, 2008). Unfortunately, we do not have marital status in our data base.[8]

Table 3 presents estimates of the effects of prenatal WIC participation on birth outcomes. These findings replicate those of previous studies in that they find that WIC is strongly associated with improvements in birth outcomes including reductions in preterm delivery and increases in birth weight. Given that WIC participation is increasing in gestation, many commentators prefer to focus on "small for gestational age" (SGA) as an outcome. Table 3 indicates that prenatal WIC participation reduces this outcome by about one percentage point on a baseline of 12.8%. This result is robust to whether OLS or mother fixed effects models are estimated, and to whether additional controls for gestation are included or not. The mother fixed effect estimate conditional on gestation of 1.22 percentage points corresponds to a 9.5% reduction in the incidence of SGA. This effect is roughly twice as large as the 4.2% reduction in

[8] 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.

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.

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 OLS estimates in column 2 indicate that children who received WIC prenatally are less healthy than other children on average. For instance, they are 15% more likely to have been diagnosed with asthma and 10% more likely to have been diagnosed with ADHD. The WIC children are also higher users of acute care services, and are significantly more likely to have been treated at age 6-11 for acute respiratory infections, injuries, and nausea. They are more likely to have had avoidable hospitalizations, are higher users of ERs, and are more likely to have had a restorative dental procedure or dental surgery. On the positive side, they are more likely to have had at least one visit to the doctor, and are more likely to have received a routine health screening. The question however, is what their health and utilization patterns would have looked like in the absence of prenatal WIC participation?

We endeavor to address this question by estimating the mother fixed effects models shown in Column 4 of Table 4. These estimates indicate that relative to their own close-in-age siblings, children who received WIC prenatally are actually healthier. Most of the positive coefficients from the OLS models are greatly reduced and become statistically insignificant. We find that these children are less 5.3% likely than their non-WIC siblings to have been diagnosed with either ADHD and 6.4% 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.

They are also 17.7% less likely to have acute treatment for a moderate to severe infection, which may indicate a more robust immune system.

Turning to utilization of care, we see no evidence of differences within household with the exception of dental care, where the WIC children are more likely to have received diagnostic and preventive dental care services. The estimated positive effect on restorative procedures and dental surgery in the OLS model reverses sign and becomes statistically insignificant in the specification with mother fixed effects.

Table 5 presents estimates of the effects of prenatal WIC participation on educational outcomes. 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 8.2%, 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 next two rows of the table break out the overall repetition variable into repetition of Kindergarten, and repetition of higher elementary grades and shows that most of the effect is accounted for by repetition of higher elementary grades.

Discussion and Conclusions

This paper relies on mother fixed effects models, which have several well-known shortcomings. 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 ever eligible because their families were low income 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 is subject to input errors, it 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 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 it 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, though it is conceivable that a provider with a quota on Medicaid patients might refuse to treat a sibling.

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. 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. We also find that mothers with diabetes are more likely to participate, that mothers who smoke prior to the pregnancy are less likely to participate, and that other things being equal, older mothers are more likely to participate. Family income is also important, with families being more likely to participate when they are poorer. Thus, there are logical, observable factors that help explain why a mother is more likely to use WIC for some pregnancies and not for others. We control for these observable factors in our models.

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. For example, it might be the case that one child was more “wanted” than another. We know from many previous studies that WIC affects birth outcomes, that birth outcomes affect ADHD, and that ADHD affects grade retention. In order for our estimated effects of WIC on ADHD and grade repetition to be spurious, it would have to be the case that unobserved differences in “wantedness” affected ADHD and grade repetition not through birth outcomes, but *only* through a completely separate channel. While this is not impossible, we consider it to be unlikely.

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. However, 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 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.

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

	All SC Births	All Medicaid	Medicaid matched to Education	Matched Sample with Siblings
Prenatal WIC	0.542	0.803	0.807	0.788
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	0.486	0.461
Black	0.334	0.494	0.501	0.527
Years in sample		3.151	3.240	3.372
		(1.634)	(1.613)	(1.619)
Child Medicaid Eligibility				
Net monthly family income, in $2015				
0 or missing		0.731	0.727	0.728
0-500		0.081	0.083	0.087
500-1000		0.072	0.074	0.076
1000-1500		0.067	0.068	0.063
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	0.514	0.571
Children		0.961	0.963	0.965
Disabled		0.044	0.045	0.044
Mother characteristics				
Mother's age	26.198	23.934	23.881	23.081
	(5.946)	(5.374)	(5.345)	(4.584)
Educ: < HS	0.239	0.368	0.372	0.417
HS	0.262	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	0.158	0.207	0.207	0.209
Diabetes	0.009	0.010	0.010	0.008
Hypertension	0.022	0.023	0.023	0.019
BMI>30	0.274	0.316	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	**257,796**	**128,445**	**119,477**	**27,780**
N children	**326,217**	**164,401**	**151,338**	**59,641**

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

	All birth certificates		Medicaid & academic outcome	
	(1)		(2)	
	Coeff.	St.d.	Coeff.	St.d.
Second born	-0.0143**	(0.0063)	-0.0592***	(0.0091)
Third born	-0.0161	(0.0116)	-0.0839***	(0.0159)
Fourth born	-0.0026	(0.0168)	-0.0917***	(0.0224)
Fifth born	0.0107	(0.0225)	-0.0882***	(0.0297)
Sixth born and higher	0.0089	(0.0288)	-0.0821**	(0.0376)
Presence of a sib 1 year older	-0.0514***	(0.0069)	-0.0611***	(0.0093)
...2 years older	-0.0473***	(0.0079)	-0.0748***	(0.0112)
...3 years older	-0.0433***	(0.0100)	-0.0639***	(0.0143)
...4 years older	-0.0478***	(0.0121)	-0.0644***	(0.0178)
...5 years older	-0.0474***	(0.0150)	-0.0562**	(0.0223)
Male	-0.0036	(0.0026)	-0.0100**	(0.0040)
Educ: < HS	-0.0011	(0.0070)	-0.0016	(0.0083)
Some college	0.0058	(0.0070)	0.0196**	(0.0089)
College	-0.0546***	(0.0181)	0.0418	(0.0388)
Prepregn.: Smoking	0.0143	(0.0174)	-0.0169**	(0.0075)
Diabetes	0.0042	(0.0113)	0.0416*	(0.0236)
Hypertension	0.0015	(0.0046)	0.0087	(0.0166)
BMI>30	-0.0055	(0.0086)	0.0056	(0.0069)
Previous c-section	0.0071	(0.0061)	-0.0034	(0.0072)
Previous preterm birth	-0.0037	(0.0058)	-0.0013	(0.0123)
Previous poor preg outcome	0.0040	(0.0049)	0.0021	(0.0098)
Gestation, weeks	0.0102***	(0.0008)	0.0089***	(0.0013)
Net Monthly family income, in $2015				
0 or missing			0.0177**	(0.0080)
>0-500			0.0002	(0.0100)
>1000-1500			-0.0160	(0.0113)
>1500-2000			-0.0243*	(0.0143)
>2000-2500			-0.0045	(0.0222)
>2500-3000			0.0263	(0.0392)
>3000			0.0467	(0.0692)
Elig.: Low inc. family category, ever			-0.0009	(0.0099)
Infants & Children			-0.0070	(0.0141)
Disabled			-0.0607*	(0.0356)
Birth year and County FEs	Y		Y	
Mother FEs	Y		Y	
Observations	326,217		59,641	
R-squared	0.0362		0.0504	
Number of moms	257,796		27,780	

Notes: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1. Additional cor
include single year of maternal age indicators. In the Medicaid sample, controls also include
income in the birth year and Medicaid eligibility category.

Table 3: Effects of WIC on Birth Outcomes

	Means	OLS		Mother FE	
Panel A: No gestation controls		**Coeff.**	**St.d.**	**Coeff.**	**St.d.**
Birth weight	3,154.041	46.7132***	(5.5828)	35.6806***	(6.4343)
Birth weight<2500g	0.096	-0.0226***	(0.0031)	-0.0212***	(0.0042)
Birth weight<1500g	0.012	-0.0060***	(0.0011)	-0.0055***	(0.0016)
Preterm (gestation<37 weeks)	0.113	-0.0277***	(0.0034)	-0.0294***	(0.0046)
Small for Gestational Age	0.128	-0.0125***	(0.0034)	-0.0104**	(0.0047)
Neonatal Intensive Care Unit	0.049	-0.0136***	(0.0023)	-0.0137***	(0.0033)
Infant breastfed	0.441	0.0031	(0.0049)	0.0110*	(0.0058)
Panel B: Controls for gestation					
Birth weight	3,154.041	17.3140***	(4.2360)	8.2190*	(4.8704)
Birth weight<2500g	0.096	-0.0084***	(0.0025)	-0.0073**	(0.0036)
Birth weight<1500g	0.012	-0.0016*	(0.0010)	-0.0003	(0.0014)
Small for Gestational Age	0.128	-0.0123***	(0.0034)	-0.0122***	(0.0047)
Neonatal Intensive Care Unit	0.049	-0.0050**	(0.0020)	-0.0043	(0.0030)
Infant breastfed	0.441	0.0027	(0.0049)	0.0108*	(0.0058)
Number of Observations	59,641				

Notes: Controls include the variables shown in Table 2 as well as mother age (dummies), and indicators for income and Medicaid eligibility categories, and mother, county, and birth 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.

Table 4: Effects of Prenatal WIC on Health Outcomes and Utlization of Care at Age 6+

	Means	OLS		Mother FE	
		Coeff.	St.d.	Coeff.	St.d.
Ever treated for chronic conditions					
Asthma	0.1466	0.0222***	(0.0034)	0.0033	(0.0049)
ADHD	0.1664	0.0160***	(0.0035)	-0.0089*	(0.0050)
Childhood mental, excl. ADHD	0.1863	0.0022	(0.0038)	-0.0119**	(0.0054)
Depression/Anxiety	0.0301	0.0006	(0.0017)	-0.0004	(0.0026)
Acute conditions (ever)					
Acute resp. infection	0.4852	0.0261***	(0.0050)	0.008	(0.0067)
Injuries	0.5052	0.0216***	(0.0049)	-0.0082	(0.0069)
Otitis media	0.2179	0.006	(0.0040)	-0.0046	(0.0059)
Nausea	0.1908	0.0106***	(0.0038)	0.0012	(0.0057)
Infections, med. & high	0.0402	0.0019	(0.0020)	-0.0071**	(0.0029)
ER visits					
Not preventable	0.2227	0.0136***	(0.0041)	0.0014	(0.0058)
Preventable	0.2477	0.0142***	(0.0042)	-0.0025	(0.0059)
Treatable Primary Care Setting	0.3866	0.0205***	(0.0048)	-0.0020	(0.0065)
Not emergent	0.3146	0.0211***	(0.0046)	-0.0020	(0.0062)
Hospital, Avoidable	0.0085	0.0021**	(0.0008)	0.0009	(0.0013)
Unavoidable	0.0143	-0.0009	(0.0012)	-0.0001	(0.0019)
Office visits					
At least one visit	0.8796	0.0178***	(0.0035)	-0.0043	(0.0050)
N visits, per year	10.4460	1.0789***	(0.1729)	0.0193	(0.2266)
General screen	0.4834	0.0174***	(0.0050)	-0.0039	(0.0064)
Dental health					
Diagnostics	0.8474	0.0357***	(0.0040)	0.0087**	(0.0044)
Preventive care	0.8672	0.0286***	(0.0037)	0.0095**	(0.0042)
Restorative procedure	0.5433	0.0213***	(0.0050)	-0.0022	(0.0064)
Surgery	0.2873	0.0103**	(0.0045)	-0.0073	(0.0063)
Number of Observations	59,641				

Notes: Controls include the variables shown in Table 2 as well as mother age (dummies), and indicators for income and Medicaid eligibility categories, and mother, county, and birth 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.

Table 5: Effects of Prenatal WIC on Educational Outcomes

Mean	Mean	OLS		Mother FE	
		Coeff.	St.d.	Coeff.	St.d.
Academic performance					
Grade and kindergarten repetition	0.0976	-0.0061**	(0.0029)	-0.0080*	(0.0043)
Repeated grade (school)	0.0713	-0.0062**	(0.0030)	-0.0093*	(0.0050)
Repeated Kindergarten	0.0440	-0.0013	(0.0021)	-0.0006	(0.0031)
Any registered disability	0.2076	0.0058	(0.0045)	-0.0028	(0.0071)
Number of Observations	59,641				

Notes: Controls include the variables shown in Table 2 as well as mother age (dummies), and indicators for income and Medicaid eligibility categories, and mother, county, and birth 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.