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ABSTRACT

In the U.S., nearly 11% of school-age children have been diagnosed with ADHD, and approximately 10% of children suffer from asthma. In the last decade, the number of children diagnosed with these conditions has inexplicably been on the rise. This paper proposes a novel explanation of this trend. First, the increase is concentrated in the Medicaid caseload nationwide. Second, nearly 80% of states transitioned their Medicaid programs from fee-for-service (FFS) reimbursement to managed care (MMC) by 2016. Using Medicaid claims from South Carolina, we show that this change contributed to the increase in asthma and ADHD caseloads. Empirically, we rely on exogenous variation in MMC enrollment due a change in the "default" Medicaid plan from FFS or MMC, and an increase in the availability of MMC. We find that the transition from FFS to MMC explains most of the rise in the number of Medicaid children being treated for ADHD and asthma. These results can be explained by the incentives created by the risk adjustment and quality control systems in MMC.

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The prevalence of childhood chronic conditions has continued to increase over the past decade. This paper focuses on the two most common childhood conditions: asthma and attention-deficit hyperactivity disorder (ADHD). The number of children whose parents reported that they had ever been diagnosed with ADHD increased by two million between the 2003 and 2011 waves of the National Survey of Children's Health, rising to 11% of all school-aged children (Visser et al., 2014). Between 2001 and 2010, the number of children who had been diagnosed with asthma increased from 8.7 to 9.3%, although the number who reported an asthma attack in the past month held steady and the number of asthma-related hospitalizations and deaths continued to fall (CDC, 2012). These asthma trends may reflect either more diagnoses of milder cases or better treatment for those who have been diagnosed.

In this paper, we propose and test a novel hypothesis, which is that the increase in diagnoses for these childhood conditions was driven at least partially by changes in Medicaid, the means-tested public health insurance program that covers low to moderate income children. One motivation for this hypothesis is the observation that in national data, the increase in treatment for ADHD and asthma over the course of the 2000s was largely driven by children on Medicaid, and not by children with private health insurance coverage.

Figures 1 and 2, are based on data from the national-level Medical Expenditure Panel Survey (MEPS), for children less than 17 years of age. Figure 1 shows that while the overall number of children taking any kind of prescription drug fell, the fraction with prescriptions for ADHD medications rose, and all of the increase is accounted for by children on Medicaid. Figure 2 shows that the fraction of children taking prescription drugs for asthma has also increased. Up to 2009, it increased at a similar rate for the privately and publicly insured, while after 2009, all of the increase has been among Medicaid recipients.[1]

One of the largest changes in Medicaid over the course of the 2000s is that it was converted from a largely "fee-for-service" (FFS) program, in which physicians were reimbursed for each service provided, to a managed care model in which providers received a capitated fee intended to cover all services provided to a covered child. There are several features of Medicaid Managed Care (MMC) which might lead to an increase in diagnoses and treatment of chronic conditions.

First, children may gain access to providers under MMC. For example, children who did not have a primary care physician would be assigned one under MMC. Second, insurers often receive a higher capitated fee for a child with a disability. The intent of these "risk-adjustment" payments is to encourage managed care plans to enroll all children rather than "cream-skimming" by enrolling healthy children and encouraging children with chronic conditions to enroll elsewhere. However, the higher payments may also create incentives to increase diagnoses of disability. Third, MMC providers are subject to regular reporting requirements for a number of quality measures. While FFS providers are subject to similar requirements, it may be easier for the state to monitor a handful of insurers who contract with the state to provide MMC services than to monitor a large number of individual providers. One important quality measure involves requirements for timely preventive screening of children. More screening is likely to result in more diagnosed cases of childhood disability, other things being equal.

[1] MEPS asks whether children took particular medications. The NSCH incidence numbers are in response to questions about whether a child was ever diagnosed with a particular condition, whether a child has it currently, and whether a child is currently taking medication. Our work will focus on whether the child is currently being treated for a condition. See Appendix Table 1 for a comparison of South Carolina current prevalence rates with national rates from NSCH.

We investigate these issues using a 60% random sample of all children on Medicaid in South Carolina (SC) during the period of 2004 to 2015. Our sample focuses on children under 17, and the claims data are matched to birth certificate records in order to obtain more nuanced background information about the children.

We rely on exogenous variation in MMC enrollments created by changes in South Carolina's Medicaid program. Between Oct. 2007 and May 2008, South Carolina changed the "default" plan for an enrollee from FFS to a MMC plan, which resulted in a sharp increase in MMC enrollments.[2] In 2013 a number of FFS Primary Care Case Management plans were converted to MMC, which again sharply increased MMC enrollments.

We find that the transition to MMC increased the probability of being treated for ADHD by 26.6% and increased the number of children being treated for asthma by 29.9%. These estimates in turn suggest that the switch to MMC can explain 89.0% of the 30.4% increase in the probability of being diagnosed with ADHD and 82.1% of the 36.4% increase in asthma caseloads over our sample period.

The evidence indicates that increases in access to primary care, additional screenings, and the incentives created by risk adjustment were all important mechanisms. In fact, these explanations are not mutually exclusive because the incentives created by risk adjustment reinforce explicit incentives to increase screening, which in turn is facilitated by greater access. We find that children are 49.0% more likely to have had a well-child visit, and approximately

[2] This change was part of the "Healthy Connections Choices" program which was rolled out in the Midlands in October 2007, followed by the Piedmont in Jan. 2008, the Low country in March 2008, and the Pee Dee in May 2008. In addition to the change in the default rule, the number of MMC plans in the county was also an important factor. In regressions that included enrollee characteristics, county fixed effects and year fixed effects, we found that the probability of being enrolled in MMC for at least one month went up by 2.6 percentage points with each additional plan available. In 2003, two counties had no MMC plan, while the rest had one plan. By 2008, one county had three plans, six had five plans, twelve had six plans, and the remaining 27 counties had seven plans. By 2012, all counties had converged to four plans.

69.0% more likely to have received a developmental screening, as well as 88.1% more likely to have received a hearing test, and 56.0% more likely to have received vaccinations.

There is also some evidence that children are more likely to be prescribed medications that lead to a higher risk adjustment weight. The child's individual weight in the risk adjustment formula goes up by 58.3% under MMC. Our calculations suggest that no more than half of the increase in diagnoses could be a mechanical effect of increased screening, while the remainder reflects "up coding" of child health conditions.

Finally, we ask whether the increase in diagnosis and treatment is accompanied by improvements in child health. We actually find increases in office visits for sickness, emergency room (ER) visits for preventable, non-preventable, and also non-urgent conditions, as well as hospitalizations for preventable conditions. These patterns may reflect gatekeeping by MMCs since fewer children were able to obtain an appointment with a specialist. They may also reflect difficulty accessing primary care physicians for care beyond the annual well child visit.

A large part of the increase (especially for ER visits) is driven by asthma, and we see that over 40% of children with asthma received fewer than two prescriptions for asthma in the past twelve months, a proportion that remained constant with the advent of MMC. We cannot say whether these large and striking changes in patterns of utilization reflect changes in underlying health, but they are certainly not consistent with improvements in the efficiency of the care provided under the Medicaid program.

The paper is organized as follows. The background section 2 outlines the relevant features and changes in the SC Medicaid program. We then provide a brief overview of features of ADHD and asthma, and their treatment. Sections 3 and 4 provide an overview of the data and of our empirical strategy. Section 5 describes our results and Section 6 provides a discussion and conclusions.

2. Background

2.1 South Carolina's Medicaid Program and the Roll-out of MMC

Under federal regulations, states have some scope to set income eligibility guidelines, define services, and set payments for providers in the Medicaid program. In South Carolina, two changes occurred over our sample period that might be expected to have off-setting effects on the composition of the caseload. First, income cutoffs were raised from 150% of the federal poverty level (FPL) to 200% in 2008 and 208% in 2014. Second, in 2011, South Carolina launched an initiative to use administrative data from other welfare programs to identify families who were eligible for Medicaid. This initiative, called Express Lane Eligibility, also streamlined the re-enrollment processes.

As a result of these changes, Medicaid enrollment in South Carolina grew over our sample period, as shown in Figure 3. To the extent that the composition of the Medicaid caseload was changing over time in a way that would be expected to alter asthma and ADHD caseloads, such changes could complicate our interpretation of the effects of the switch within Medicaid from FFS to MMC. Table 1 shows that among households with a positive monthly income, income approximately doubled. However, the fraction of the caseload with zero countable incomes also almost doubled. The fraction of children who were African-American fell from 52.3% to 45.3% and the fraction Hispanics increased correspondingly. The children's mean birth weight stayed approximately constant, and the fraction of mothers with some college increased slightly over time.

Table 2 attempts to assess the likely effect of these changes in the composition of the caseload on rates of asthma and ADHD. We first used data from 2004-2005 to estimate the prevalence of ADHD and asthma as a function of observed characteristics including gender, race, age, birth month, enrollment category, monthly family income, county, birth weight, mother's age at birth, and mother's education at the time of the birth.

We then used the estimated coefficients to predict ADHD and asthma rates for each year from 2006 to 2015. Table 2 also shows the actual rates of ADHD and asthma observed in our data in each year. The table suggests that very little of the observed increase in ADHD can be predicted using changes in the sample composition. For asthma, the changes in sample composition actually predict a fall in the rate rather than the observed increase, which is consistent with a relatively more advantaged population being drawn into care by the expansions. We conclude that changes in the composition of the caseload are unlikely to be responsible for the increasing rates of asthma and ADHD that we observe.

Prior to 2007, SC Medicaid operated a predominantly FFS system. In 2007, the state began a two pronged effort to increase enrollments in MMC. First, the state began defaulting new enrollees into MMC (Madalena and Tester, 2010). Since it was not possible to enroll people in MMC in areas that were not served by plans, the state also made a concerted effort to increase the number and geographic coverage of MMC plans.

Figure 3 shows the dramatic increase in the fraction of the Medicaid caseload enrolled in MMC after 2007. MMC enrollment is captured in two different ways: Whether a child was enrolled for at least a month, and whether the child was enrolled for ten months or more. The gap between these two series reflects the fact that children who were "defaulted" into Medicaid would be counted as enrolled for at least one month, but could take action to return to FFS

Medicaid, in which case they would not be enrolled for ten months or more. We chose to focus on ten months because Medicaid has a two month grace period meaning that someone whose coverage lapsed could still expect claims to be covered by Medicaid retroactively for two months if the beneficiary re-enrolls. Hence, anyone with at least ten months of coverage was effectively covered for the whole year. We have also used a six-month cutoff, with similar (though somewhat smaller) results.

The two series show similar trends, but there are always fewer children enrolled for a continuous ten-month period than are enrolled for at least one month. Conditional on being enrolled in Medicaid, we view being enrolled in MMC for a month as a largely exogenous decision determined by the state while being enrolled for ten months is an endogenous choice which reflects the decision to stay in MMC and not to exercise the right to leave the program.

MMC became nominally mandatory for most classes of enrollees as of 2011, but this nominal change did not result in any uptick in MMC enrollment, as shown in Figure 3. It does seem to have narrowed the gap between one month and ten month enrollment rates, but did not eliminate it, suggesting that families could still choose to exit MMC.

There is a sharp increase in enrollment in 2013 which corresponds to the conversion of primary care case management (PCCM) networks to MMC providers. These PCCMs were operated on a FFS basis, with providers receiving an additional fee for providing case management services. They were phased out largely because there did not seem to be any difference in performance between PCCMs and other FFS providers even though PCCMs were more expensive to the government given the additional case management fee. With the conversion to MMC, these plans became subject to all the regulations governing MMCs, as described further in section 2.2 below.

While the broad trends are similar across SC counties, there was considerable geographic variation in timing across the state, which was driven in part by a lack of plan capacity in some counties. Figure 4 shows the distribution of MMC enrollments across counties in various sample years, showing the general tendency towards higher enrollments over time but also the wide geographic variation across SC at a point in time over most of the sample period.

The passage of the Affordable Care Act in 2010 had relatively little impact on children in South Carolina since children in families with incomes less than 200% of the FPL were already covered by 2010, and since South Carolina chose not to take up the optional Medicaid expansion to previously uncovered groups (mainly adults).

2.2 Important Features of MMC

In this section we describe three key features of MMC contracts that could impact the diagnosis and treatment of childhood chronic conditions including asthma and ADHD. These features are a responsibility to ensure access to providers; risk adjusted compensation mechanisms; and quality of care requirements (in particular, provision of health screenings).

MMCs are required to show that they have an adequate network of providers in a county. In particular, they must show that there is at least one primary care provider available to serve patients within a 30-mile radius of the patient's address and assign the patient to a particular provider. MMCs are also required to accept new patients who present themselves and to provide referrals to specialists and hospitals if necessary. Furthermore, plans often require PCPs to contact new enrollees and see them for an initial office visit and assessment within the first 90 days of enrollment (e.g. see WellCare provider manual). A higher number of plans in a county is associated with a greater willingness of physicians to participate in managed care.[3] Hence, it is reasonable to hypothesize that higher MMC enrollments will be associated with a higher likelihood of having access to preventive care such as well-child visits and immunizations.

MMCs are reimbursed a fixed amount (the capitated payment) for each enrollee per month of enrollment.[4] The base fee depends on the patient's characteristics including their age, sex (in some age groups), and Medicaid qualifying category. These fees are calculated annually based on the expected expenses generated in the past by enrollees in each group. Capitated payments create an incentive for plans to seek out healthy patients within a group and to try to steer sicker, more expensive ones elsewhere. This tendency is called "cream skimming."

In order to encourage MMC plans to serve sicker patients with complicated conditions, starting in 2009, the state adjusts capitation rates based on the relative number of these more expensive patients in each plan. In order to identify patients with chronic conditions, South Carolina uses "Restricted Medicaid Rx Model," (MRx) developed by the University of California San Diego (UCSD) (http://medicaidrx.ucsd.edu/). The MRx model is one of several different risk adjustment methods that are used by state Medicaid programs across the country. The model is based on the prescription drugs taken by the enrollees rather than on diagnoses *per se*. The argument underlying the reliance on prescriptions is that prescriptions are more accurately reported than diagnoses and less subject to gaming.

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[3] As Ly and Glied (2014) point out, having multiple plans available in a market enables a physician to decline participation in a plan that offers low rates and avoid situations where a single plan could reduce payments in the future. The availability of multiple plans increases doctor bargaining power and remuneration (Dafny et al., 2013).

[4] Two previous studies (Bokhari et al. (2005) and Conrad (2005)) have suggested that capitation might encourage the use of stimulant medications for ADHD because it is cheaper than therapy. However, in SC, behavioral therapy is "carved out" of MMC plans in our sample period, which means that plans are not responsible for the cost of such therapy and this type of cost incentive for promoting the use of stimulant medication is not present.

At the beginning of each month, an insurer receives the capitated fee. At the end of the year, all the claims submitted to the SC Department of Health and Human Services (DHHS) are run through the MRx model to determine the number of plan enrollees who filled at least one prescription for drug classes that are specified in the model. Each drug class has a weight that reflects the additional cost of treating a child with that condition. Each enrollee's score is the sum of these additional weights and the base weight for their group. The average score is then calculated for every plan. Finally, plans that have higher average enrollee scores have their capitation rate bumped up for all enrollees, while the plans that have the healthiest enrollees by these criteria may see a retroactive reduction in their capitation rate. For example, in the last two years of our data, two out of six insurers received a 4% rate bump in both years, while the lowest ranked plan received a 7% reduction in capitated fees.

A partial list of drug classes and weights is shown in Table 3. The complete list can be found on the UCSD website listed above. Both ADHD and asthma are included on the list of conditions with weights of 0.777 and 0.322 respectively. That is, if an enrollee took one of the listed ADHD medications at least once, then his or her weight would be the sum of the age category weight and 0.777, while if they took an asthma medication it would be the base weight plus 0.322. A child with multiple conditions could have an even higher weight.

Figure 5 provides anecdotal evidence that MMC plans devote considerable attention and resources to encouraging providers to properly code all of a child's medical conditions. Insurers "educate" providers on a regular basis. As the information on the Blue Cross-Blue Shield (BCBS) website suggests, they offer monthly webinars, newsletters and bulletins, monthly regional workshops, direct support, monthly "Gaps in Care" reports, provider report cards, and on-site visits aimed at encouraging providers to code correctly. BCBS of SC also has an internal system that rates providers based on how many patients are treated according to the guidelines and how the provider compares to other providers in his or her locality, with monetary rewards at stake (a physician recognition program). Other insurers have similar programs.

Risk adjustment creates an incentive for providers to diagnose and prescribe medications for ADHD, asthma, and other conditions. Whether or not it is attractive to increase diagnoses of a particular condition will depend on the cost of screening for the condition, the probability of finding the conditions if the child is screened, how costly it is to treat that condition, and the expected future cost of not treating it. As we will argue below, ADHD and asthma are diseases with characteristics that may make them particularly attractive targets for additional screening and diagnosis under this risk adjustment system.

A third component of MMC regime that encourages the diagnosis and treatment of childhood chronic conditions is mandated screening for such conditions. In principle, all children in the Medicaid program are entitled to Early and Periodic Screening, Diagnostic and Treatment (EPSDT) benefits and states must cover a broad array of preventive services. The SC Department of Health and Human Services specifies that Medicaid children are to receive all screenings according to the American Academy of Pediatrics schedule. In practice however, rates of screening are low in most jurisdictions. For example, in our sample overall, only 43.9% of Medicaid children received a general health screening each year.

MMC plans are required to have written procedures for notifying, tracking, and following up eligible children. In order to improve compliance, plans are allowed to provide incentives to their members at their own expense, such as monetary rewards and prepaid gift cards. For example, one of the SC MMC plans, WellCare, offers enrollees a $20.00 reward for completing annual child health check-ups. WellCare also sends providers lists of children who are noncompliant. They assess primary care providers' adherence to EPSDT tracking and follow-up guidelines via random audits and require poor performers to implement corrective action plans. The BCBS BlueChoice Medicaid Health Plan urges providers to use their Gaps in Care Reports to identify patients in need of well-child visits and pays an additional $30 for each well-child visit provided. These examples suggest that MMCs take the screening requirements seriously, perhaps because MMC plans are required to submit quality data, including information on EPSDT compliance, to the state.

These performance data feed into performance measures, compensation, ranking, and enrollment auto-assignment mechanisms. A part of the capitation fee is withheld if performance falls below the required minimum, and the undistributed funds are re-allocated to providers above the 75^{th} percentile on quality measures. If a plan does not achieve the National Medicaid 25^{th} percentile for any quality measure, it has to submit a corrective action plan and may be subject to liquidated damages of $250,000 for each unmet measure. In 2012, SC withheld 1% from capitation fees and allowed MCCs that improved their quality measures by one standard deviation on 10 measures to receive a bonus payment. In 2013, the amount withheld was 1.5% and improvement was required for 16 measures. Other things being equal, we would expect these incentives to increase screening, and the increased screening should lead to more diagnoses of childhood chronic conditions.

2.3 Characteristics of ADHD and Asthma

ADHD is a neurological condition defined by persistent symptoms of inattention and/or hyperactivity-impulsivity. It is one of the most common mfental health disorders affecting school-aged children. Asthma is a chronic inflammation of the airways in the lungs. It is one of the most common physical chronic childhood illnesses, and the most frequent cause of childhood ER visits and hospitalizations.

While ADHD and asthma are quite different disorders, they do share certain similarities. First, they affect large numbers of children, suggesting that greater screening is likely to turn up additional cases. Second, diagnosis is often difficult. For ADHD, there is no fully “objective” test to determine whether a child has the condition or not. The diagnostic criterion states that a child with ADHD must have had at least six of the symptoms for six months or more to a degree that is maladaptive and inconsistent with the child’s developmental level. The symptoms must also be present in two or more settings. For asthma, physicians can conduct a test of lung capacity using a spirometer, but this test is difficult to do in young children. In practice, it is often difficult to distinguish the symptoms of asthma (including wheezing, coughing, chest tightness, and breathlessness), from other respiratory conditions such as allergies, influenza, or bronchitis.

A third common feature is that medication is the first-line treatment for both conditions. The vast majority of children diagnosed with ADHD receive medication, with some also receiving behavioral therapies. Many studies have shown short-term improvements in attention and decreases in disruptive behavior in medicated children, though the longer-term effects of medication for ADHD are more controversial (Scheffler et al., 2009; Visser et al., 2014; Currie et al., 2014; Dalsgaard et al., 2014; Chorniy and Kitashima, 2016). Although research is ongoing, the bulk of the evidence suggests that ADHD medication affects behavior in a way that may improve safety and health outcomes, however there is little evidence of long-term improvements in academic performance.

Asthma is managed by avoiding triggers and using medications for both long-term control and for the immediate relief of symptoms. Children who adhere to their medication regime are much less likely to experience asthma symptoms or to need care in ERs or hospitals (Donahue et al., 1997; Adams et al., 2001).[5] Early asthma treatment is also thought to prevent the development of irreversible airway obstruction (Agertoft and Pedersen, 1994).

A fourth characteristic of both ADHD and asthma is that medications for these conditions are often prescribed by general practitioners, and general practitioners seem to feel confident in their ability to diagnose and treat these conditions. Davis et al. (2012) survey primary care pediatricians in Kentucky and finds that 98.5% respondents report being comfortable diagnosing ADHD and 100% feel comfortable treating it. To provide some context, out of these same respondents only 41.5% feel comfortable diagnosing eating disorders (with 21.5% comfortable treating them) and only 69.2% are comfortable diagnosing autism (with 41.5% comfortable treating it). All of the respondents reported encountering ADHD patients at least monthly, with all other conditions trailing behind. Finally, these doctors are confident of their ability to treat ADHD even though only 10% of the survey respondents believed that they were "well prepared" by their residency program to either diagnose or treat behavioral or mental health problems. Anderson et al. (2015) analyze 2008-2011 MEPS data and find that 42% of ADHD children only see a primary care provider. In contrast, 83% children with anxiety or mood disorders were referred to a mental health specialist.

A fifth point of commonality between asthma and ADHD is that untreated, both conditions can lead to severe consequences. Asthma is a cause of about 2 million child emergency room visits each year and 439,000 child hospitalizations. In extreme cases, it can

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[5] The most common medications used for long-term control of asthma are inhaled corticosteroids, which should be used daily to reduce the reactivity of air-ways and prevent attacks.

result in death. Children suffering from ADHD face behavioral, learning, developmental and emotional problems that extend into adulthood. Currie and Stabile (2006) find a large negative effect of ADHD on children's academic test scores and schooling attainment, while Fletcher and Wolfe (2009) report a higher probability of engaging in criminal behavior.

In summary, both ADHD and asthma are conditions with features that may make increases in diagnosis and treatment likely given the provider incentives created by MMC. They are common, so that additional screening is likely to uncover undiagnosed cases. They are difficult to definitively diagnose, but paradoxically, frequently diagnosed and treated by non-specialists. They are straightforward to treat in that the first-line treatment in both cases involves the prescription of common medications which are widely viewed as safe and which receive a positive weight in the MRx risk adjustment model used in many states, including South Carolina. And finally, the consequences of missing a serious case could be severe for the affected individual, leading providers to wish to err on the side of being aggressive about diagnosis and treatment.

3. Data

Our analysis is based on a 60% random sample of Medicaid enrollees under 17 years of age who were enrolled at some time over the period from 2005 to 2015. The sample has complete information about health services utilization for 577,209 individuals, including hospital, ER, outpatient, and pharmacy claims. We exclude children who ever qualified for Medicaid based on foster care or disability status because these children are not eligible for MMC.   In total, there are 2,960,843 child-year observations.

Claims include information on primary and secondary diagnoses, procedure codes (Current Procedural Terminology Codes or CPT), dates of service, the Medicaid plan type, payment amounts, and basic information about the provider. An unusual and important feature of these claims data is that we have detailed information about both FFS and MMC providers (rather than observing, for example, only the capitated MMC payment).

The claims are coupled with a file that details the enrollment status of every child, the basis of their eligibility, and family characteristics. For children born after 1993, we merge the SC Medicaid claims data with the SC birth certificate (Vital Statistics) data which were obtained from the SC Department of Health and Environmental Control. These data are collected from maternal and hospital worksheets a few days after birth. They provide information about a child's health at birth, and the mother's basic demographic information including level of schooling.

We identify children as currently having ADHD or asthma if the respective ICD-9/10 (International Classification of Disease) codes are recorded as either a primary or secondary diagnosis for a visit over the past 12 months, or if the child was prescribed medication for one of these conditions in the past 12 months. Over the entire period, 6.4% of children had an ADHD-related event in a given year, while 16.4% had an asthma-related event.

Table 4 provides an overview of the characteristics of the children in our sample. The sample is evenly divided between boys and girls. In terms of race, 41% of the children are African-American and a further 8% are Hispanic. The average age when a child is first observed is about 3 years old (though many children are observed from birth on). On average, children stay in the sample for five years. Sixty-four percent of the sample enrollees qualified for Medicaid through the Optional Coverage for Women and Infants category (OCWI) which covers those with incomes between 50 and 150/200/208% of the FPL depending on the year, and 20% qualified through the low income family category which covers those with incomes less than 50% of the FPL. About 42% of children lived in families with zero net income, a fraction that rose sharply after 2011 when the state stepped up efforts to auto-enroll people who had already proven eligible for other welfare programs. Sample mothers were 24 years old on average, and only 21% had any college education. Overall then, the sample is very disadvantaged.

4. Methods

We wish to estimate the effect of MMC enrollment on the probability that a child is diagnosed and treated for asthma or ADHD, and on the probability that they receive different types of care. Hence, the main equation of interest is:

$$(1)\ D_{ict} = \alpha Managedcare1_{ict} + \boldsymbol{X}_{ict}\beta + \mu_{county} + \mu_{year} + \varepsilon_{ict},$$

or

$$(2)\ D_{ict} = \alpha Managedcare10_{ict} + \boldsymbol{X}_{ict}\beta + \mu_{county} + \mu_{year} + \varepsilon_{ict},$$

where for individual i, in county c, at time t, D_{ict} represents the probability of being diagnosed and/or treated for asthma or ADHD; $Managedcare1_{ict}$ is equal to 1 if an individual is enrolled in MMC for at least one month in year t and is zero otherwise; $Managedcare10_{ict}$ is equal to 1 if an individual is enrolled in MMC for at least ten months in year t and is zero otherwise; $\boldsymbol{X}_{ict}$ is a vector of individual and family characteristics including the child's gender, race, birth month, child age and maternal age (single year of age dummies), birth weight (<1500g, 1500-2499g, 2500-2999g, 3000-3499g, 3500-3999g, 4000-4999g, >=4500g) maternal education category (<9, 9-11, high school diploma, some college, college plus, missing), Medicaid enrollment category and monthly family income ($0, $200, $200-399…). Mother characteristics are collected at child's birth. Medicaid enrollment categories and family income are recorded annually, as a part of the enrollment renewal process.[6] We include county (μ_{county}) and year (μ_{year}) fixed effects in all specifications to control for county and year-level determinants of diagnosis and treatment rates. All standard errors are clustered at the county level, in order to allow for correlations between outcomes of children within the same county.

As discussed above, the fraction of children enrolled in MMC for at least one month increased dramatically between 2007 and 2008 because children were defaulted into MMC plans where those plans were available. It increased slowly for the next few years as MMC penetration spread. It increased sharply again in 2013 when PCCM plans were converted to MMC. The extent of these increases varied across counties over time because of differences in MMC capacity (number and size of plan networks). We regard these increases in one month enrollments as largely exogenous to the actions of families.

Other things being equal, one might expect a longer period of enrollment in MMC to have a greater effect on outcomes. It would take time to get diagnosed and treated for a chronic condition. However, as Figure 3 shows, the fraction of children who remain enrolled in MMC for ten months or more is much smaller than the fraction of those who were initially defaulted into these plans. Clearly, remaining enrolled in MMC is a choice. The endogeneity of remaining enrolled makes it difficult to distinguish between the causal effects of staying enrolled for a longer period and selection into remaining enrolled. Hence, in addition to estimating OLS models of the form (2), we also estimate instrumental variables models in which the endogenous $Managedcare10_{ict}$ is instrumented using the exogenous $Managedcare1_{ict}$.

[6] Although both variables are income-related, each of them is valuable. Medicaid enrollment is precisely recorded and does not have missing values. However, it provides us with little variation, since most enrollees are signed up through either Low Income Family program or OCWI. Family income, on the other hand, is a continuous variable, but it has missing values, in part due to the fact that some enrollees are eligible through other social programs and their income was not recorded in the Medicaid data base.

Hence, the first stage equation is:

(3) $Managedcare10_{ict} = \delta Managedcare1_{ict} + \mathbf{X}_{ict}\gamma + \mu_{county} + \mu_{year} + \varpi_{ict}.$

One key contribution of this paper is that we are able to go beyond simply asking whether MMC has an effect on diagnosis and treatment and investigate the mechanisms underlying this effect. We estimate a series of models examining the role of several features of the managed care model: risk adjustment mechanism, screening requirements, and access to care, in driving our results about the effects of MMC.

In order to evaluate the role of risk adjustment, we estimate models with the same form as (1) and (2) using the following dependent variables: The child's individual weight in the MRx model; and the child's individual weight excluding drugs prescribed for ADHD or asthma. A comparison of these two outcomes helps us to measure how much of any observed upweighting of the child is accounted for by asthma and ADHD alone.

In order to examine access to care and screening, we look for procedures that indicate that screening or preventive procedures took place. These include child well visits, blood work, developmental screening, hearing tests, and vaccinations.

Asthma is a condition that can lead to acute health emergencies, and thus these emergencies should be less likely to occur if someone is properly diagnosed and treated, we examine hospital stays and ER visits for asthma, as well as for asthma-related diseases including upper respiratory infections (URI). And because we find that MMC is associated with increases in hospitalizations and ER visits for asthma, we also conduct a deeper look at the type of medications that are being prescribed for asthma when patients switch to MMC, asking whether new patients are more likely to receive long-acting preventive drugs, or short-term acute response drugs.

Finally, given previous evidence that treatment for ADHD can reduce ER visits and hospitalization for injuries (Chorniy and Kitashima, 2016; Dalsgaard et al., 2014) we also examine the effect of MMC on these outcomes.

5. Estimation Results

The first column of Table 5 shows the first stage regression, (3). Not surprisingly, the estimate suggests that being defaulted into a plan increases the probability of being enrolled ten months or more: Relative to the baseline ten-month enrollment rate of 36.5%, the probability of being enrolled ten months or more doubles.

The remaining columns show the effect of being enrolled for one month or ten months on the probability of being treated for ADHD (Panel A) or asthma (Panel B) in a given year.[7] We first show OLS estimates of the one month and ten month effects without controls in columns (2) and (3). We then show the effect of including controls on the coefficient for being enrolled ten months or more in column (4), and finally, we show the instrumental variables estimate of the effect of being enrolled ten months or more in column (5). We follow this presentation format across all the tables.

The OLS estimates without controls suggest that, as expected, being enrolled for ten months or more has a larger effect on drug treatment for these two conditions than being enrolled for one month. A comparison of columns (3) and (4) shows that the effect is only somewhat

[7] We observe a child having a physician visit and/or filling a prescription in a given year with a nearly the same probability as just filling a prescription. On average 6.4% of children have a visit for ADHD in a given year and/or fill a prescription for ADHD medication in our sample, while 6.2% only fill a prescription. For asthma the comparable figures are 16.4% and 13.5%. Hence, it is not surprising that the estimates using prescriptions are very similar to those using both diagnoses and prescriptions, as shown in Appendix Table 2.

attenuated by adding an extensive set of controls, including the personal and family characteristics listed above, as well as indicators for county and year.

As discussed earlier, OLS estimates of the ten-month effect may be biased by the endogeneity of the choice to remain enrolled in MMC. For example, we might expect sicker children who were more in need of services to be either more likely to exit MMC (if they strongly prefer FFS) or to stay in MMC (if some aspects of managed care are better for children with chronic conditions). A comparison of columns (4) and (5) indicates that the IV estimates are slightly smaller than the corresponding OLS estimates, but the difference is not significant.

Our preferred estimate of 0.017 for ADHD suggests that being enrolled in managed care for ten months or more increases the probability of being prescribed medication for ADHD by 26.6%. This estimate in turn suggests that the switch to MMC can explain 89.0% of the 30.4% increase in the probability of being diagnosed with ADHD that occurred in our sample population between 2004 and 2015 (see Table 2). For asthma, the increase in the probability of having an asthma-related event is 29.9%, which explains 82.1% of the 36.4% increase in asthma caseloads over our sample period.

We begin our analysis of the mechanisms underlying these results with Table 6, which shows the effect of enrollment in MMC on individual risk adjustment scores. Comparing columns (1) and (2), we again see that enrollment for ten months or more is estimated to have a larger effect on risk adjustment scores than enrollment for one month or more. Comparing columns (2) and (3) shows that in this case, adding controls substantially lowers the estimated effect of MMC. This comparison suggests that children in MMC have characteristics that make them likely to be coded as sicker than children still in FFS. The IV estimates of being in MMC for ten months or more are slightly smaller than the OLS, though still large relative to their respective baselines and also statistically significant.

Our preferred estimate from Panel A suggests that MMC enrollment for ten months or more increases the risk adjustment score by 0.067 on a baseline of 0.115, an increase of 58%. Panel B presents an estimate excluding the extra weight associated with ADHD and asthma. Here our preferred estimate suggests an increase of 0.043. Hence about 36% of the increase in the risk adjustment score that accompanies MMC is accounted for by ADHD and asthma alone. The importance of these two conditions is consistent with the fact that these are very common diagnoses.

The third panel of Table 6 examines the estimated impact of MMC on risk adjustment scores if we require patients to have at least two prescriptions for a given condition in the past twelve months in order to be assigned a higher weight associated with this condition. The reason for this thought experiment is that if there is even one prescription for a condition such as ADHD, then providers are entitled to the higher risk adjustment weight. By comparing the actual increase in risk adjustment weights in Panel A to the increase in the risk adjustment weight that would be observed if we excluded people with only one prescription, we can get a sense of how much upweighting is accounted for by single prescriptions. The comparison of Panel A and Panel C suggests that over half of the increase in the weight (56%) can be accounted for this way.

Table 7 explores the effect of MMC on access to care in doctors' offices and to the various types of screening activities that we can observe in the claims data. The estimates shown here imply that being enrolled in MMC for ten months or more increases the probability that a child received a well-child visit in the past twelve months by 49.0%. Turning to some of the individual screening activities that might take place during a well-child visit, we see a 38.5% increase in the probability of blood work; a 69.0% increase in the probability that the child is assessed using a developmental screen (from a very low baseline of 2.9%); an 88.1% increase in the probability of a hearing screen; and a 56.0% increase in the probability that the child received any vaccinations.[8]

These findings suggest that the switch to MMC could have had a large effect on diagnoses through the mechanism of increased access to care and screenings. If for example, the true incidence of ADHD was 7.3%, and the true incidence of asthma was 16.5% (our measured rates in 2015), and all well-child visits resulted in appropriate screening for children who would have been undiagnosed previously, then the increase in well-child visits could potentially increase diagnoses of ADHD by 0.88pp ((7.3-5.5)*0.490) and diagnoses of asthma by 2.2pp ((16.5-12.1)*0.490). These calculations suggest that increases in screenings could translate into 15.7% more ADHD cases and 18.2% more asthma cases, relative to the 2004 baseline which can be compared to the actual percentage increases of 30.4 and 36.4 for ADHD and asthma, respectively. This calculation represents an upper bound on the effect of screening because it assumes that all of the new diagnoses are accurate. It is possible that some of them actually reflect up-coding of the child's condition due to the incentives created by risk adjustment.

If MMC is helping children in need of care to access necessary care then one might hope that increases in diagnosis and treatment to result in fewer sick visits to physicians, although it is also possible that sick visits could increase with access. One should, however, expect to see

[8] Unfortunately, it is difficult to determine whether the child is up to date in their immunizations because the records usually do not say what vaccine or a combination of vaccines was administered. This common limitation in claims data can make it difficult to assess provider compliance with mandated vaccination schedules.

decreases in ER visits and hospitalizations that could be prevented through adequate access to preventable care (dubbed preventable ER visits and preventable hospitalizations) below.

These hypotheses are examined in the last panels of Table 7 and in Table 8. Panel F of Table 7 shows that in addition to having increasing well-child visits, MMC is also associated with a significant 26.3% increase in the number of sick-child visits to doctor's offices. Panel G indicates that children received 30.3% more visits to mental health specialists under managed care. It is important to note that mental health was "carved out" of the managed care contract, which means that it was covered on a FFS basis even for children in managed care (and managed care companies were not responsible for paying for outpatient and inpatient mental health visits until July 2016). Managed care did have to pay for all other specialists, and Panel H shows that access to such specialists was reduced under MMC by 17.1%.

Table 8 considers hospitalizations and ER visits for different types of conditions. We distinguish visits for conditions that are considered to be preventable by adequate primary care (e.g. asthma); visits for conditions that could have been treated in a primary care setting (though doctors offices may not have been open when the ER visit occurred); visits for non-urgent conditions (i.e. someone could have waited to be seen in a primary care setting); and visits that were appropriately treated in an ER setting.[9,10] The table shows that most types of visits

[9] Lu and Kuo (2012) analyze pediatric ambulatory care-sensitive (ACS) conditions, or hospitalizations that are potentially preventable, using the 2006 Kids' Inpatient Database. They include asthma, bacterial pneumonia, diabetes, immunization preventable conditions, among other conditions. They found that respiratory conditions comprised the largest share of potentially preventable pediatric hospitalizations. We use the ICD9/10 condition codes provided by Lu and Kuo (2012) and identify claims with these conditions as a primary diagnosis on hospital claims as "preventable."

[10] 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-treatabla (e.g. ear infection); PC-preventable (e.g. asthma attack); Non-preventable visits (e.g. a cardiac dysrhythmia); Injuries, and other.

increased substantially. The only exception was hospitalizations that were not considered preventable, which showed no change (Panel B). Our preferred IV estimates suggests that preventable hospitalizations increased by 10.0% with MMC, while ER visits for preventable conditions increased by 27.2% (Panel A and Panel C).   Even non-urgent visits to the ER increased by 28.9%, suggesting that patients either don't have access to primary care or prefer to use the ER rather than their assigned primary care physician, who might be as far as thirty miles away from their home. Note that unlike it is for most patients with private insurance, Medicaid patients had no co-pays for using the ER under either FFS or MMC.

Table 9 focuses on asthma and injuries, two important causes of hospitalization and ER use in our sample. Panels A and B focus on asthma, which accounts for one seventh of the preventable hospitalizations, and half of the children with an ER visit for a preventable cause in our sample.   We see no effect of MMC on hospitalization for asthma (Panel A), but Panel B shows that MMC is associated with a 27.6% increase in ER visits for asthma.   Since asthma can be difficult to diagnose and there may be some confusion with other upper respiratory diagnoses, Panel C shows the estimated impact of MMC on upper respiratory tract infections. These estimates also indicate an increase with MMC (which rules out the possibility that MMC merely caused a relabeling of upper respiratory diagnoses as asthma).

The remaining four panels of Table 9 examine the effect of MMC on the probability of hospitalization and ER use for injuries. Other things being equal, one would not expect the type of health insurance a child has to cause increases in the probability of serious injury so that statistically significant effects here are likely to reflect changes in access or patterns of utilization. Yet, Panel D indicates that the probability of hospitalization for injury increases by

50.0% with MMC. Panel E shows that the probability of using the ER for injury increases by 28.1%. One population that might experience a decline in injury in response to the switch to MMC are children with ADHD. In this population, medication has been shown to have positive effects in terms of reducing the risk of injury (Chorniy and Kitashima, 2016; Dalsgaard et al., 2014). Panels F and G examine the subsample of children who had at least one visit or prescription for ADHD over the entire sample period. In this subsample, we see no increase in the use of hospitalization for injury, and the use of ERs goes up by a smaller amount than in the full sample (10.0%).

It is puzzling that finding more cases of asthma and providing these patient with access to asthma medication is not just ineffective when it comes to reducing ER visits related to asthma, but actually coincides with increases in the use of the ER. One possibility is that asthma medication is not being used correctly. Figure 6 examines the fraction of children in each year who a) had at least one visit or prescription for ADHD or asthma, and b) got two or more prescriptions. This fraction is quite low for asthma in both MMC and FFS and relatively constant over the sample period. The figure suggests that the large increase in diagnoses did not translate into more effective asthma control.

Table 10 shows several tests of this hypothesis. The first two panels examine the impact of MMC on the probability that children on Medicaid received either three or more (Panel A) or six or more (Panel B) prescriptions for asthma in a given year, and shows that MMC had no statistically significant effect. Effective asthma control would have required a child to continuously take corticosteroid medication, something that could not be achieved with a single 30-day prescription.

Generally asthma patients require both a long-acting steroid medication which reduces the likelihood of an asthma attack, and a short-acting asthma attack medication. Panels C and D of Table 10 examine the effects of MMC on the types of medication taken. They show that MMC was associated with increases in the number of children who were prescribed only long-acting medications, or only short-acting asthma attack medications in the past 12 months. Both of these patterns suggest improper treatment of asthma which could possibly be a factor in the increasing ER asthma visits.[11]

6. Discussion and Conclusions

Increasing rates of chronic conditions among children are a grave concern, and also a puzzle given that other health indicators such as mortality have shown great improvement, and underlying causes, such as smoking and pollution, have been declining (Currie and Schwandt, 2016). This study focuses on two of the most common serious childhood chronic conditions, ADHD and asthma.

Starting from the observation that in national data, the rise of these conditions appears to be occurring mainly among children on Medicaid, we document a remarkable finding, which is that in the South Carolina Medicaid caseload, most of the increase in ADHD and asthma over the period from 2004 to 2015 can be attributed to the switch to from Fee-for-Service to Medicaid Managed Care. By September 2014, all but twelve states were contracting with managed care

[11] Another possibility that cannot be investigated using our data is that patients are not receiving sufficient education in how to use their medications properly. Inhalers require some basic training to be used correctly and it is "well documented that patients can have problems adopting the correct inhaler technique and thus receiving adequate medication" (Price et al, 2012). Sestini et al. (2006) report that many doctors are unfamiliar with the characteristics of the available inhalers and have only limited ability to guide patients in their usage.

organizations to cover Medicaid recipients, suggesting that the switch from FFS to MMC may be driving changes in caseloads in other states as well (Paradise, 2015).

We focus on three aspects of risk-based managed care systems which may jointly have contributed to increases in the treatment of asthma and ADHD. First, managed care may improve access to care. Second, through the risk adjustment mechanism, MMC creates incentives to diagnose children with conditions that increase a child's weight in the risk adjustment formula. In the methodology adopted by South Carolina, children are "counted" in the weighting formula only if they receive a prescription, and hence, there is a strong incentive to write at least one prescription for a condition with an added weight, and less incentive to ensure follow through on medication compliance. Third, both because of these financial incentives and quality control mechanisms, MMC may increase screening for chronic conditions, which, other things being equal, would be expected to yield more cases.

Our estimates suggest that all of these forces are at work. MMC increases the probability that a child received a well-child visit by 49.0%, and we see increases in the probability of having blood work, developmental and hearing screens, and vaccinations. We also see a 58% increase in the child's individual risk adjustment weight, with a third of the increase being accounted for by asthma and ADHD alone.

To summarize the results, the actual increase in ADHD and asthma caseloads was 30.4% and 36.4% respectively. We calculate that the switch to MMC increased caseloads for these two conditions by 26.6% (ADHD) and 29.9% (asthma). And an upper bound on the effect of increased screening alone is 15.7% (ADHD) and 18.2% (asthma).

In principle, increases in diagnoses and treatment should improve health outcomes. Unfortunately, we find little evidence that this is the case. Instead, we find increases in preventable hospitalizations and in almost all types of ER visits. A large part of the increase in ER visits is driven by asthma, and we see that over 40% of children with asthma received fewer than two prescriptions for asthma in the past 12 months, a proportion that remained constant with the advent of MMC. The only category of care that shows a decrease is office visits to specialists.

While managed care plans improve access to primary care physicians and ensure that a larger share of Medicaid enrollees benefit from preventive care, other features of the program apparently backfired. First, risk adjustment incentives distort prescribing practices in that more children receive medications but providers have no incentive to follow-up on adherence. Second, access to primary care and specialists seems to have changed in a way that encourages reliance on emergency rooms for even non-urgent care. We cannot say whether these large and striking changes in patterns of utilization reflect a deterioration in underlying child health, but they are certainly not consistent with improvements in the efficiency of the care provided under the Medicaid program. They suggest that patients in MMC may have experienced difficulties accessing primary care outside of the annual well-child visit.

Children on Medicaid are among the most vulnerable patient populations. Our results indicate that their care is very sensitive to the incentives provided by the reimbursement system. The switch to MMC plans in South Carolina was associated with more screening and more detected cases of the two most common childhood chronic conditions: ADHD and asthma. However, the switch to MMC does not seem to have resulted in an increase in the quality of care the children received, judged by using the metric of preventable hospitalizations, ER visits, and medication compliance. Further research into the disappointing results in terms of health care utilization is warranted.

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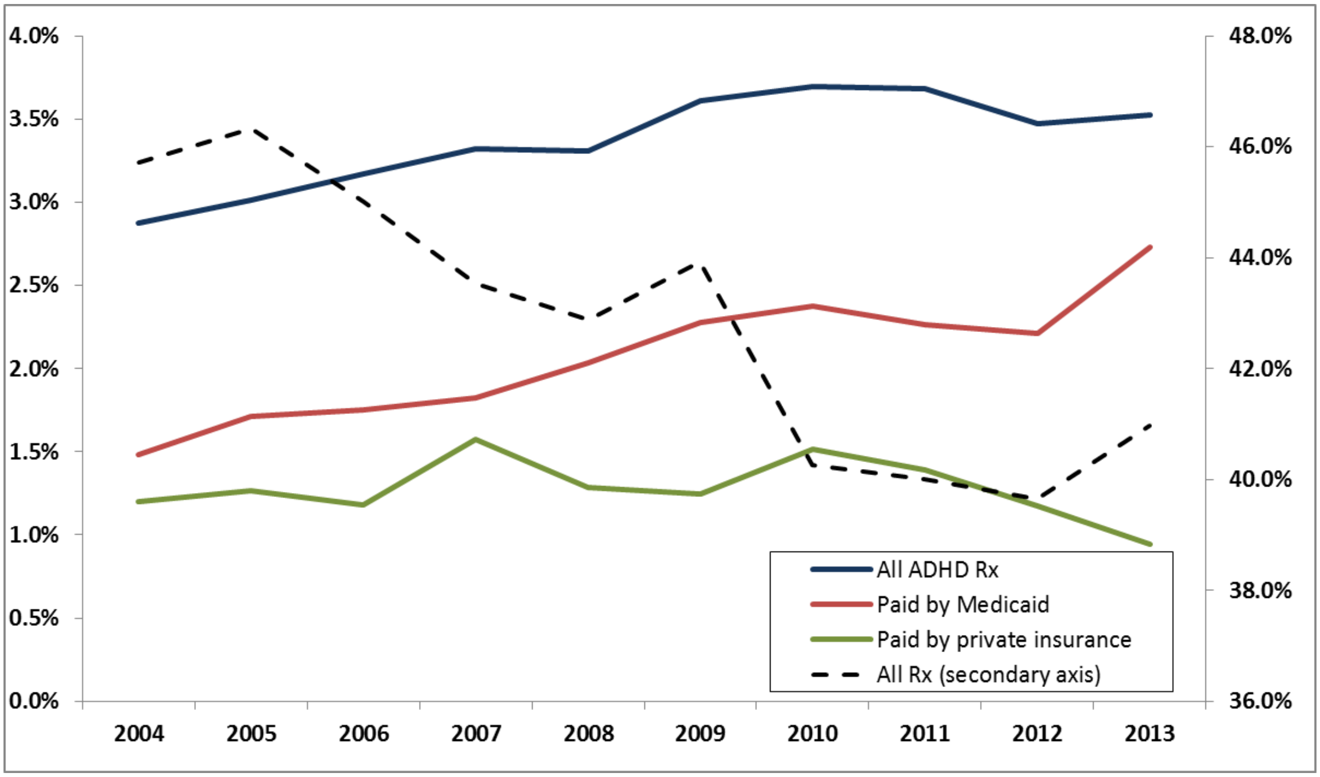
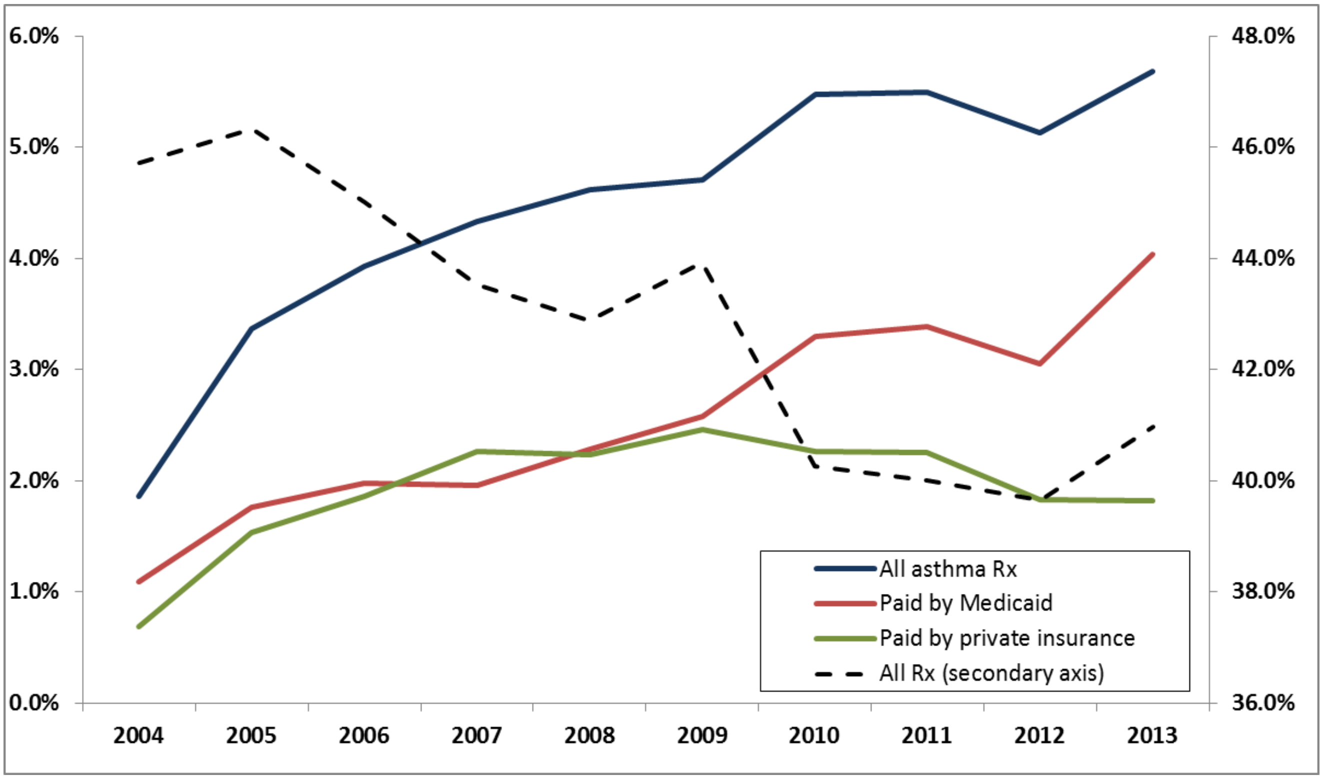
FIGURES

Figure 1. Nationwide trends in filled ADHD prescriptions



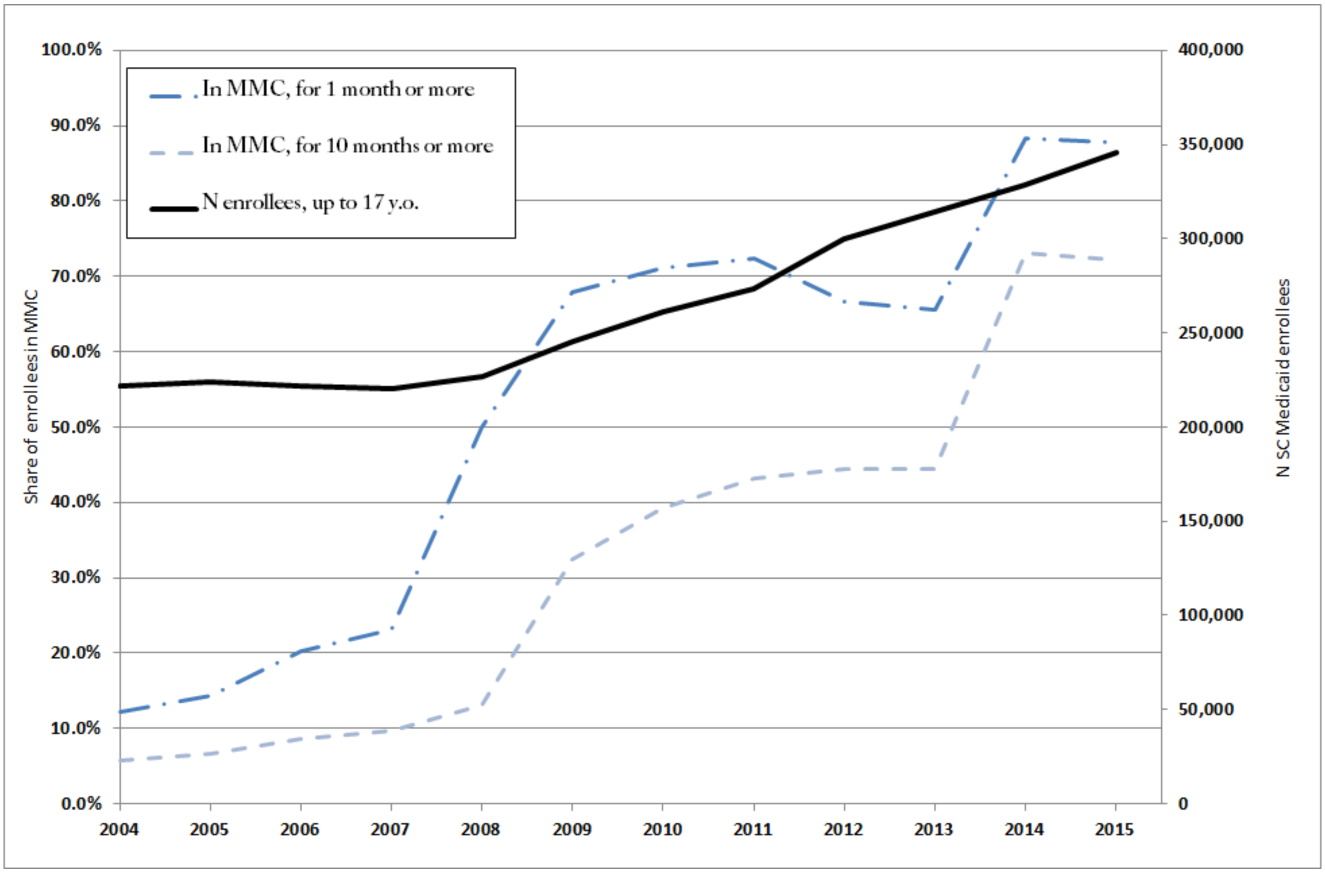
Notes: Data source: Medical Expenditures Panel Survey (MEPS), 2004-2013. The sample includes all ADHD prescriptions filled by children under 17 years old.

Figure 2. Nationwide trends in filled asthma prescriptions



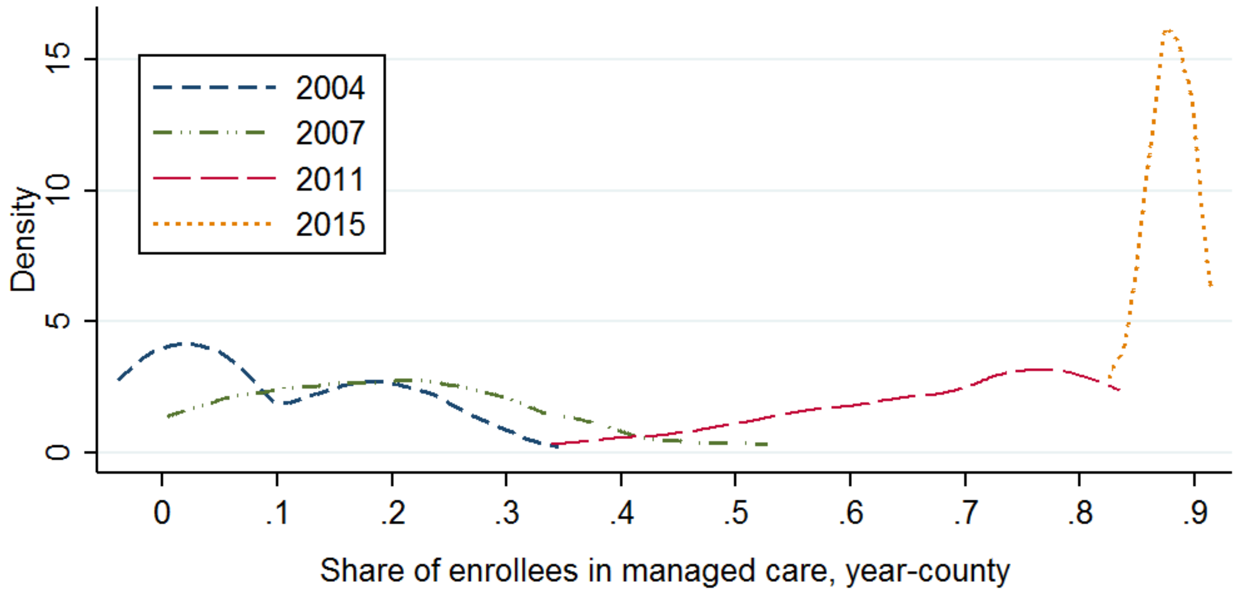
Notes: Data source: Medical Expenditures Panel Survey (MEPS), 2004-2013. The sample includes all asthma prescriptions filled by children under 17 years old.

Figure 3. Share of SC Medicaid enrollees in Medicaid managed care (MMC)



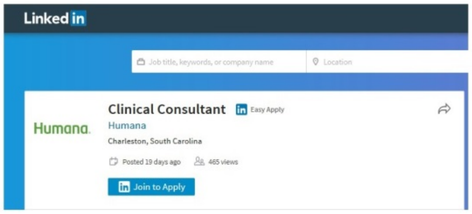
Notes: Data source: SC Medicaid, 2004-2015. The enrollment figures are based on monthly enrollment information of patients up to 17 years old. "MMC" stands for Medicaid managed care. The number of enrollees (solid line) is depicted using the secondary, right-hand side axis.

Figure 4. Distribution of counties by share of SC Medicaid enrollees in MMC



Notes: Data source: SC Medicaid, 2004-2015. The enrollment figures are based on monthly enrollment (one more or more) information of patients under 17 years old. “MMC” stands for Medicaid managed care.

Figure 5. Sample job postings for a managerial position at insurance companies that provide managed care plans



Job description

Humana is seeking a Clinical Consultant to bridge gaps in care for all lines of business and work with providers to close HEDIS gaps while EMR capability improves, and progress toward all Stars program achievement.

- Analysis and subsequent work on ensuring accurate and complete documentation and coding of open conditions with provider
- Requires clinical expertise (and possibly field coding)
- Majority of time is external facing representing Humana with provider partners
- Clinical coding (related to Stars, such as CPTII), clinical, project management, communication/education, quality improvement

Role Essentials

- Working knowledge of STARS,CAHPS and HOS
- Working knowledge of Medicare Risk Adjustment
- Ability to build strong relationships, identify risk, remove barriers and improve clinical outcomes and the member experience
- Strong presentation skills, with the ability to communicate and effectively present to all levels internal and external to the organization.

UHG

Manager of HEDIS and Risk Adjustment - Charleston

UnitedHealth Group

North, SC, US

Job description

The Manager of HEDIS and Risk Adjustment will be responsible for working directly with providers in a consultative approach to ensure that they are utilizing highly specific codes.This will be accomplished through coding education and chart review.

Primary responsibilities

- Target local providers who would benefit from our Medical Risk Adjustment& HEDIS / STARS training
- Contact physicians, medical groups, IPAs and hospitals, and build positive, consultative relationships
- Educate providers on how to improve their Risk Adjustment Factor (RAF) scores and Stars ratings, which measure their patients' health status
- Collaborate with doctors, coders, facility staff and a variety of internal and external personnel on a wide scope of Risk Adjustment & HEDIS education efforts
- Conducts onsite physician chart audits (including research and presentation) and identifies potential suspects through clinical documentation where diagnosis is clinically indicated but not documented
- Assess and interpret whether the coding assigned by the provider was properly assigned based upon review of the medical documentation and application of the coding guidelines

Notes: These job advertisements have been accessed on April 20th, 2017 using LinkedIn search tool. Selected categories describing the positions are included.

Figure 6: Share of Children with at Least One Asthma or ADHD Event in a Given Year With 2+ Prescriptions in Past 12 Months

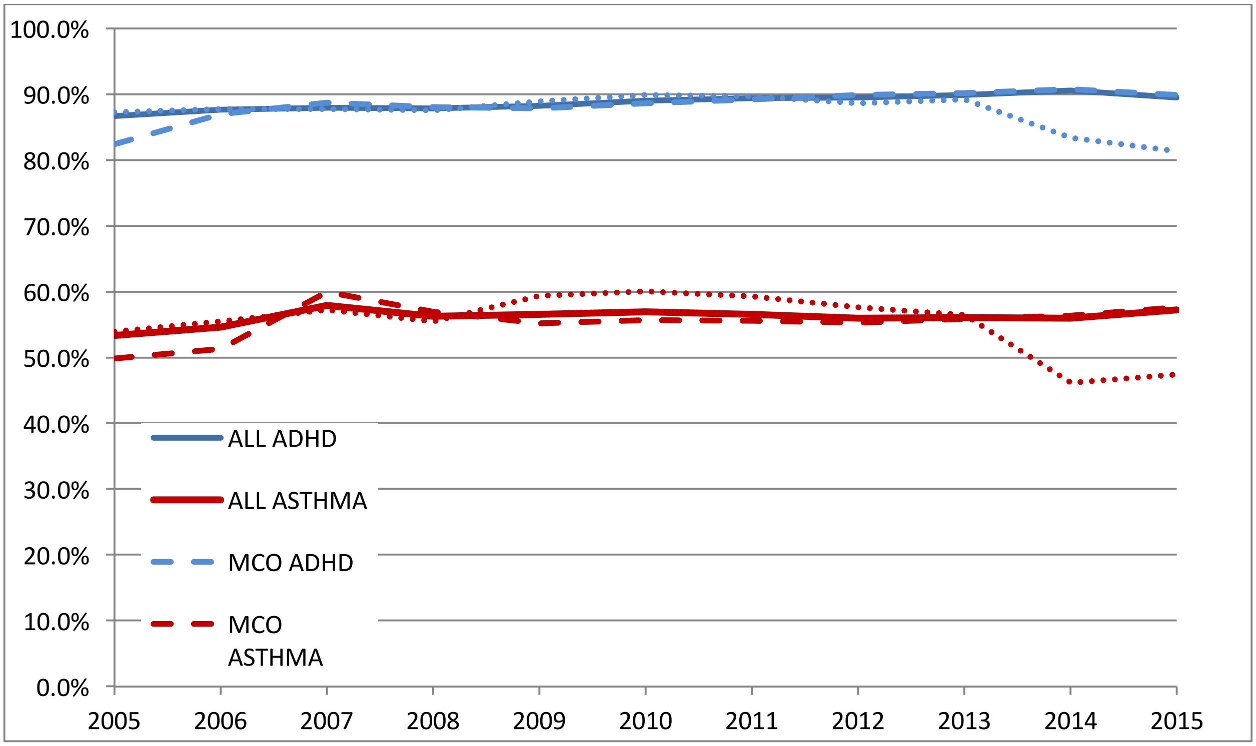


Table 1. SC Medicaid Sample Population Characteristics

Characteristics	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Family net income												
Monthly income	605.7	561.4	479.4	577.4	701.7	703.2	762.5	813.0	745.1	688.6	798.6	738.8
Monthly income, if >0	902.7	965.0	1016.9	1053.9	1113.9	1120.8	1168.3	1252.8	1314.9	1384.3	1551.2	1745.5
Missing, %	5.7%	6.2%	7.1%	7.3%	7.2%	6.4%	5.8%	4.8%	4.6%	3.2%	2.6%	1.6%
Zero, %	31.0%	39.2%	49.1%	41.9%	34.3%	34.9%	32.7%	33.4%	41.4%	48.7%	47.2%	56.7%
Demographics												
Male	52.4%	51.8%	51.4%	51.2%	50.8%	50.5%	50.2%	50.1%	50.1%	50.1%	50.2%	50.4%
Age	6.9	6.9	6.7	6.5	6.4	6.6	6.7	6.9	7.2	7.4	7.5	7.6
Race: White	40.2%	40.0%	39.6%	39.3%	39.1%	39.7%	40.2%	40.6%	41.0%	41.4%	41.5%	41.7%
Black	52.3%	51.4%	50.8%	49.9%	49.0%	47.9%	47.1%	46.5%	46.5%	46.1%	45.8%	45.3%
Hispanic	5.3%	6.2%	7.3%	8.4%	9.4%	9.7%	9.8%	9.8%	9.3%	9.3%	9.4%	9.4%
N obs.	222,091	223,736	221,764	220,497	226,781	245,539	261,412	273,409	299,608	314,061	328,512	345,524
Birth certificate data												
Birth weight, g	3,192	3,188	3,183	3,180	3,180	3,181	3,181	3,182	3,182	3,183	3,185	3,186
Mother's age	23.6	23.7	23.7	23.7	23.7	23.8	23.9	24.0	24.2	24.3	24.5	24.6
School: Elem	5.3%	5.5%	5.7%	5.9%	6.1%	6.0%	5.8%	5.6%	5.2%	5.0%	4.9%	4.8%
High school	29.7%	30.0%	30.4%	30.5%	30.5%	30.1%	29.4%	28.8%	28.1%	27.4%	26.5%	26.0%
High school diploma	42.6%	41.7%	40.7%	40.0%	39.3%	39.0%	38.4%	37.8%	37.4%	36.9%	36.2%	35.8%
Some college	15.4%	16.0%	16.6%	17.2%	17.7%	18.2%	19.1%	20.1%	21.0%	22.0%	22.9%	23.4%
College diploma	7.0%	6.8%	6.6%	6.5%	6.4%	6.7%	7.2%	7.7%	8.2%	8.7%	9.5%	9.9%
N obs.	138,810	149,025	157,108	165,121	177,561	197,634	210,582	220,272	238,745	248,351	257,381	249,506

Notes: The table is based on a 60% random sample of SC Medicaid population under 17 years old in 2004-2015, excluding children in foster care and disabled children. Birth certificates data are available for in-state births for children born after 1992. These records are matched to Medicaid records on name, date of birth, race, gender, and hospital of birth, when available.

Table 2: Current ADHD and Asthma

Actual and predicted incidence rate based on SC Medicaid population characteristics

Year	ADHD			ASTHMA		
	Actual	Predicted OLS	Predicted Logit	Actual	Predicted OLS	Predicted Logit
2004	5.6%	5.5%	5.5%	12.1%	13.0%	13.0%
2005	5.5%	5.5%	5.5%	12.7%	12.9%	12.9%
2006	5.4%	5.4%	5.4%	13.4%	12.9%	12.9%
2007	5.3%	5.3%	5.3%	14.2%	13.1%	13.1%
2008	5.5%	5.2%	5.2%	15.1%	13.2%	13.2%
2009	5.9%	5.4%	5.3%	17.2%	13.1%	13.1%
2010	6.4%	5.5%	5.4%	17.5%	13.1%	13.1%
2011	6.8%	5.5%	5.4%	17.7%	13.0%	13.0%
2012	6.8%	5.8%	5.6%	18.2%	12.8%	12.7%
2013	7.2%	5.9%	5.8%	18.1%	12.5%	12.5%
2014	7.3%	5.9%	5.7%	17.6%	12.3%	12.3%
2015	7.3%	5.9%	5.8%	16.5%	11.9%	11.9%

* Actual: measures "current" ADHD (doctor visit or prescription medication in a given year).

Table 3. Selected Medicaid Rx risk adjustment model components

Conditions	Mean outcome	Weight
Asthma	15.4%	0.322
ADHD	6.1%	0.777
Infections, Low Severity	36.9%	0.000
Infections, Medium Severity	18.0%	0.137
Eye, Ear, Nose and Throat	17.2%	0.151
Inflammatory/Autoimmune	10.5%	0.156
Pain	5.4%	0.000
Gastric Acid Disorder	4.2%	0.000
Nausea	4.2%	0.316
Cardiac	1.6%	1.175
Depression/Anxiety	1.6%	1.110

Notes: The table lists the conditions that have a prevalence of at least 1% in our sample, measured by the share of patients taking medications from the MRx Risk adjustment model, per year.

Table 4. Descriptive statistics

Characteristics	Mean (SD)	Characteristics	Mean (SD)
PANEL A		**PANEL B**	
Individual characteristics		*Yearly enrollment information*	
Male	0.51	Cat: Low income family	0.20
Race: White	0.41	OCWI Children	0.64
Black	0.41	OCWI Infants	0.12
Hispanic	0.08	Monthly family income: $0	0.42
		Monthly family income, if >$0	1,264.72
Age (December)	7.00		(914.48)
	(4.79)		
Age 1st in sample	2.73		
	(4.12)		
Years in sample	5.13		
	(3.28)		
PANEL C			
Birth certificate information			
Mother's educ.: Elem. school	0.03		
Some High school	0.16		
High school diploma	0.23		
Some college	0.14		
College/grad school	0.07		
Mother's age	24.49		
	(5.61)		
Birth weight, g	3,198		
	(558)		
N counties	46		
N enrollees, <=16 y.o.	577,209		
N obs., person-year	2,960,843		

Notes: Descriptive statistics are based on a sample that excludes children and teens, who at any time during the sample period qualified for Medicaid based on their foster care or disability status, because they are not eligible for MMC.

Table 5: OLS and IV Estimates of the Effect of MMC on ADHD and Asthma Diagnoses, and First Stage

	(1)	(2)	(3)	(4)	(5)
Estimation Type	**1st Stage**	**OLS**	**OLS**	**OLS**	**IV**
Time Enrolled	**10+ mo**	**1+ mo**	**10+ mo**	**10+ mo**	**10+ mo**
County; Year Fixed Effects	YES	NO	NO	YES	YES
Controls (incl. b.cert.)	YES	NO	NO	YES	YES
Panel A: The effect of MMC on ADHD					
Child in MMC		0.011***	0.028***	0.020***	0.017***
		(0.002)	(0.002)	(0.001)	(0.003)
Mean outcome			0.064		
Panel B: The effect of MMC on asthma					
Child in MMC		0.042***	0.077***	0.057***	0.049***
		(0.003)	(0.003)	(0.003)	(0.006)
Mean outcome			0.164		
Panel C: First stage -- The effect of MMC Enrollment 1+ months on Enrollment 10+ months					
Child in MMC 1+ months	0.529***				
	(0.003)				
Mean outcome	0.365				

Notes: There are 2,960,843 observations. Standard errors are clustered at the county level. Controls inc the child's gender, race, birth month, child and maternal age (single year of age dummies), birth weight (<1500g, 1500-2499g, 2500-2999g, 3000-3499g… >=4500g), maternal education (<12, 12, some college, college plus, missing), Medicaid enrollment category, and monthly family income ($200, $200-399,…). The F-statistic for the first stage is 41,566.

Table 6: OLS and IV Estimates of the Effect of MMC on Individual Risk Adjustment Scores

	(1)	(2)	(3)	(4)
Estimation Type	**OLS**	**OLS**	**OLS**	**IV**
Time Enrolled	**1+ mo**	**10+ mo**	**10+ mo**	**10+ mo**
County; Year Fixed Effects	NO	NO	YES	YES
Controls (incl. b.cert.)	NO	NO	YES	YES
Panel A: The Effect of MMC on Risk Adjustment Score				
Child in MMC	0.139***	0.181***	0.088***	0.067***
	(0.006)	(0.006)	(0.004)	(0.008)
Mean outcome		0.115		
Panel B: The Effect of MMC on Risk Adjustment Score Excluding Extra Weight for Asthma and ADH				
Child in MMC	0.091***	0.118***	0.060***	0.043***
	(0.004)	(0.005)	(0.003)	(0.006)
Mean outcome		0.053		
Panel C: The Effect of MMC on Risk Adjustment Score, Including Only Children with 2+ Prescriptior				
Child in MMC	0.078***	0.108***	0.058***	0.038***
	(0.004)	(0.004)	(0.003)	(0.006)
Mean outcome		0.038		

Notes: There are 2,960,843 observations. Standard errors are clustered at the county level.
Controls include the child's gender, race, birth month, child and maternal age (single year dummies), birth weight (<1500g, 1500-2499g, 2500-2999g, 3000-3499g… >=4500g), maternal education (<12, 12, some college, college plus, missing), Medicaid enrollment category, and monthly family income ($200, $200-399…)

Table 7: The Effect of MMC on Office Visits for Well and Sick Child Care, Past 12 Months

	(1)	(2)	(3)	(4)
Estimation Type	**OLS**	**OLS**	**OLS**	**IV**
Time Enrolled	**1+ mo**	**10+ mo**	**10+ mo**	**10+ mo**
County; Year Fixed Effects	NO	NO	YES	YES
Controls (incl. b.cert.)	NO	NO	YES	YES
Panel A: The effect of MMC on Probability of Any Well Child Visits				
Child in MMC	0.121***	0.112***	0.162***	0.215***
	(0.007)	(0.006)	(0.005)	(0.013)
Mean outcome		0.439		
Panel B: The effect of MMC on Probability of Any Blood Work				
Child in MMC	0.036***	0.049***	0.050***	0.050***
	(0.010)	(0.010)	(0.009)	(0.015)
Mean outcome		0.130		
Panel C: The effect of MMC on Developmental Screen				
Child in MMC	0.025***	0.024***	0.014***	0.020***
	(0.004)	(0.004)	(0.003)	(0.005)
Mean outcome		0.029		
Panel D: The effect of MMC on Hearing Screen				
Child in MMC	0.030***	0.023***	0.028***	0.052***
	(0.005)	(0.004)	(0.003)	(0.011)
Mean outcome		0.059		
Panel E: The effect of MMC on the Probability of Receiving Any Vaccinations				
Child in MCO	0.116***	0.101***	0.121***	0.172***
	(0.011)	(0.010)	(0.007)	(0.016)
Mean outcome		0.307		
Panel F: The effect of MMC on Probability of Any Sick Visits				
Child in MMC	0.089***	0.119***	0.148***	0.211***
	(0.006)	(0.005)	(0.004)	(0.012)
Mean outcome		0.802		
Panel G: The effect of MMC on Probability of Sick Visits, MH Professional				
Child in MMC	0.049***	0.099***	0.066***	0.074***
	(0.010)	(0.010)	(0.004)	(0.007)
Mean outcome		0.244		
Panel H: The effect of MMC on Probability of Sick Visits, Other Specialist				
Child in MMC	-0.084***	-0.046***	0.003	-0.084***
	(0.012)	(0.012)	(0.010)	(0.022)
Mean outcome		0.490		

Notes: There are 2,960,843 observations. Standard errors are clustered at the county level.
Controls include the child's gender, race, birth month, child and maternal age (single year of age dummies), birth weight (<1500g, 1500-2499g, 2500-2999g, 3000-3499g… >=4500g), maternal education (<12, 12, some college, college plus, missing), Medicaid enrollment category, and monthly family income ($200, $200-399…).

Table 8: OLS and IV Estimates of the Effect of MMC on Hospital and ER Use in Past 12 Months

	(1)	(2)	(3)	(4)
Estimation Type	**OLS**	**OLS**	**OLS**	**IV**
Time Enrolled	**1+ mo**	**10+ mo**	**10+ mo**	**10+ mo**
County; Year Fixed Effects	NO	NO	YES	YES
Controls (incl. b.cert.)	NO	NO	YES	YES
Panel A: The Effect of MMC on Probability of Any Hospitalizations for Preventable Conditions				
Child in MMC	-0.0016***	-0.0012***	0.0012***	0.0007*
	(0.0003)	(0.0003)	(0.0002)	(0.0004)
Mean outcome		0.007		
Panel B: The effect of MMC on Probability Of Any Hospitalization for non PC-Preventable Conditions				
Child in MMC	-0.0033***	-0.0048***	0.0019***	0.0002
	(0.0004)	(0.0003)	(0.0002)	(0.0005)
Mean outcome		0.013		
Panel C: The effect of MMC on Probability of Any ER Visit for PC-Preventable Conditions				
Child in MMC	0.0027***	0.0044***	0.0061***	0.0079***
	(0.0006)	(0.0006)	(0.0005)	(0.0008)
Mean outcome		0.029		
Panel D: The effect of MMC on Probability of Any ER Visit for PC-Treatable Conditions				
Child in MMC	0.0056***	0.0073***	0.0188***	0.0260***
	(0.0018)	(0.0014)	(0.0012)	(0.0023)
Mean outcome		0.093		
Panel E: The effect of MMC on Probability of Any ER Visit for Not PC Preventable/Treatable Conditions				
Child in MMC	0.0034***	0.0039***	0.0065***	0.0081***
	(0.0006)	(0.0006)	(0.0005)	(0.0010)
Mean outcome		0.024		
Panel F: The effect of MMC on Probability of Any ER Visit for Non-urgent Conditions				
Child in MMC	0.0084***	0.0116***	0.0161***	0.0228***
	(0.0017)	(0.0013)	(0.0009)	(0.0020)
Mean outcome		0.079		

Notes: There are 2,960,843 observations. Standard errors are clustered at the county level.
Controls include the child's gender, race, birth month, child and maternal age (single year of age dummies), birth weight (<1500g, 1500-2499g, 2500-2999g, 3000-3499g… >=4500g), maternal education (<12, 12, some college, college plus, missing), Medicaid enrollment category, and monthly family income ($200, $200-399…).
Only claims with asthma as a primary diagnosis; all birth-related claims were excluded.

Table 9: Effects of MMC on Hospital and ER Use for Asthma and Injuries in Past 12 Months

	(1)	(2)	(3)	(4)
Estimation Type	**OLS**	**OLS**	**OLS**	**IV**
Time Enrolled	**1+ mo**	**10+ mo**	**10+ mo**	**10+ mo**
County; Year Fixed Effects	NO	NO	YES	YES
Controls (incl. b.cert.)	NO	NO	YES	YES
Panel A: The effect of MMC on Any Hospitalizations for Asthma				
Child in MMC	-0.0001	0.0001	0.0002***	0.0001
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Mean outcome		0.001		
Panel B: The effect of MMC on Any ER Visit for Asthma				
Child in MMC	0.0070***	0.0038***	0.0028***	0.0026***
	(0.0003)	(0.0003)	(0.0002)	(0.0004)
Mean outcome		0.008		
Panel C: The effect of MMC on the Probability of an ER Visit for Other Respiratory Infection				
Child in MMC	0.0072***	0.0088***	0.0187***	0.0234***
	(0.0020)	(0.0016)	(0.0012)	(0.0024)
Mean outcome		0.092		
Panel D: The Effect of MMC on the Probability of a Hospitalization for Injury				
Child in MMC	0.0001	0.0002	0.0003**	0.0005**
	(0.0001)	(0.0002)	(0.0001)	(0.0002)
Mean outcome		0.001		
Panel E: The Effect of MMC on the Probability of an ER Visit for Injury				
Child in MMC	0.0067***	0.0212***	0.0206***	0.0225***
	(0.0018)	(0.0015)	(0.0010)	(0.0020)
Mean outcome		0.080		
Panel F: The Effect of MMC on the Probability of a Hospitalization for Injury, Ever ADHD Sample				
Child in MMC	0.0001	0.0001	0.0002	0.0005
	(0.0002)	(0.0002)	(0.0002)	(0.0004)
Mean outcome		0.001		
Panel G: The Effect of MMC on the Probability of an ER Visit for Injury, Ever ADHD Sample				
Child in MMC	-0.0014	0.0114***	0.0191***	0.0115***
	(0.0026)	(0.0024)	(0.0017)	(0.0030)
Mean outcome		0.115		

Notes: There are 2,960,843 observations. Standard errors are clustered at the county level.
The "Ever ADHD" sample includes all 440,734 children ever diagnosed or treated for ADHD.
Controls include the child's gender, race, birth month, child and maternal age (single year of age dummies), birth weight (<1500g, 1500-2499g, 2500-2999g, 3000-3499g… >=4500g), maternal education (<12, 12, some college, college plus, missing), Medicaid enrollment category, and monthly family income ($200, $200-399…).
Only claims with asthma as a primary diagnosis; all birth-related claims were excluded. Obs, where hospital stay/ER visits that preceded the prescription event were excluded.

Table 10: OLS and IV Estimates of the Effect of MMC on Adherence to Asthma Med. Regime Conditional on Having an Asthma Event at Some Time While in Sample, Past 12 Months

	(1)	(2)	(3)	(4)
Estimation Type	**OLS**	**OLS**	**OLS**	**IV**
Time Enrolled	**1+ mo**	**10+ mo**	**10+ mo**	**10+ mo**
County; Year Fixed Effects	NO	NO	YES	YES
Controls (incl. b.cert.)	NO	NO	YES	YES
Panel A: The Effect of MMC on Probability of Filling Prescriptions Covering 3+ Months				
Child in MMC	0.024***	0.047***	0.025***	0.001
	(0.003)	(0.003)	(0.002)	(0.005)
Mean outcome		0.109		
Panel B: The effect of MMC on Probability of Filling Prescriptions Covering 6+ Months				
Child in MMC	0.011***	0.026***	0.016***	-0.0005
	(0.002)	(0.002)	(0.002)	(0.005)
Mean outcome		0.052		
Panel C: Effect of MMC on Probability of Only Filling Prescriptions for Long-Acting Steroids				
Child in MMC	0.0125***	0.0246***	0.0192***	0.0203***
	-0.0013	-0.0013	-0.001	-0.0021
Mean outcome		0.044		
Panel D: Effect of MMC on Probability of Only Filling Prescriptions for Asthma Attack Reliever				
Child in MMC	0.0160***	0.0181***	0.0089***	0.0112***
	-0.0007	-0.0005	-0.0004	-0.0009
Mean outcome		0.023		

Notes: There are 1,346,493 observations. Standard errors are clustered at the county level. Controls include the child's gender, race, birth month, child and maternal age (single year dummies), birth weight (<1500g, 1500-2499g, 2500-2999g, 3000-3499g… >=4500g), maternal education (<12, 12, some college, college plus, missing), Medicaid enrollment category, and month family income ($200, $200-399…).

Appendix Table 1: Prevalence of ADHD and Asthma in SC Medicaid Sample and in MEPs

ADHD

Year	NSCH US	NSCH SC	NCHS SC Public Ins.	SC Medicaid, 2-17	SC Medicaid
2005				7.1%	5.5%
2006				7.1%	5.4%
2007	6.4%	8.5%	15.0%	7.2%	5.3%
2008				7.5%	5.5%
2009				7.8%	5.9%
2010				8.3%	6.4%
2011	7.9%	10.1%	12.4%	8.7%	6.8%
2012				8.5%	6.8%
2013				8.8%	7.2%
2014				8.9%	7.3%
2015				8.9%	7.3%

ASTHMA

Year	NSCH US	NSCH SC	NSCH SC Public Ins.	SC Medicaid, 0-17	SC Medicaid
2005				12.6%	12.7%
2006				13.3%	13.4%
2007	9.0%	8.5%	12.7%	14.0%	14.2%
2008				14.9%	15.1%
2009				17.1%	17.2%
2010				17.5%	17.5%
2011	8.8%	8.5%	10.9%	17.6%	17.7%
2012				18.1%	18.2%
2013				18.1%	18.1%
2014				17.6%	17.6%
2015				16.6%	16.5%

Note: NSCH sample is 0-17, while our Medicaid sample is 0-16.
Our prevalence numbers are shown in the last column. In our sample,
current means the child had a doctor visit or a prescription in the past 12 months.

Appendix Table 2: OLS and IV Estimates of the Effect of MMC on ADHD and Asthma Prescriptions

	(1)	(2)	(3)	(4)	(5)
Estimation Type	**1st Stage**	**OLS**	**OLS**	**OLS**	**IV**
Time Enrolled	**10+ mo**	**1+ mo**	**10+ mo**	**10+ mo**	**10+ mo**
County; Year Fixed Effects	YES	NO	NO	YES	YES
Controls (incl. b.cert.)	YES	NO	NO	YES	YES
Panel A: The effect of MMC on ADHD					
Child in MMC		0.011***	0.027***	0.019***	0.017***
		(0.002)	(0.002)	(0.001)	(0.003)
Mean outcome			0.062		
Panel B: The effect of MMC on asthma					
Child in MMC		0.044***	0.076***	0.050***	0.041***
		(0.004)	(0.003)	(0.003)	(0.006)
Mean outcome			0.135		
Panel C: First stage -- The effect of MMC Enrollment 1+ months on Enrollment 10+ months					
Child in MMC 1+ months	0.529***				
	(0.003)				
Mean outcome	0.365				

Notes: There are 2,960,843 observations. Standard errors are clustered at the county level.
Controls include the child's gender, race, birth month, child and maternal age (single year of age dummies), birth weight (<1500g, 1500-2499g, 2500-2999g, 3000-3499g… >=4500g), maternal education (<12, 12, some college, college plus, missing), Medicaid enrollment category, and monthly family income ($200, $200-399…).
The F-statistic for the first stage is 41,566.