Private Insurance and Outcomes for Children with Asthma[1]

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I. Introduction

Little attention has focused on barriers to coverage among the privately insured children, although a large portion of the American children are covered under private insurance. Employment based and private health insurance covers approximately 60% of children under age 18 in the U.S. corresponding to about 45 million children.[5] While insurance coverage is typically associated with increased access to care, there has been a recent trend to deteriorating private coverage with increased premiums, deductibles and out-of-pocket responsibilities (Kaiser Family Foundation, 2006ab, 2007, 2008, 2009, 2010). These changes may have an impact on children's health.

Studies examining the 1997-2006 period repeatedly stress that health care financial burden (ratio of total out-of-pocket costs of healthcare to total family income) has significantly worsened nationally such that insurance no longer provides a financial protection for a large share of families. In fact, high and middle income families with private insurance have had the largest increases in health care financial burden. Moreover, an increasing share of adults with chronic conditions have had cost related barriers to health care access over this period both among the uninsured and the privately insured (Banthin, Cunningham, & Bernard, 2008; Cunningham, 2010; Hoffman & Schwartz, 2008).

Children with special heath care needs such as those with chronic conditions, physical, neurological, developmental, emotional, and mental disabilities may also be at increased risk due to deteriorating private coverage generosity. Such children require services of a type or amount beyond that required by children generally (Bethell, Read, Blumberg, & Newacheck, 2008;

[5] Source: U.S. Census Bureau, Current Population Survey, Annual Social and Economic Supplement, 2010 (accessed via online CPS table creator)

Chevarley, 2006). Among the privately insured children, 19% are characterized to have special healthcare needs.[6]

Previous studies on the adult population have shown that individuals respond to increases in out-of-pocket costs and cost sharing by reducing their own use of health services, often leading to adverse health outcomes. How parents respond to private insurance cost sharing regarding health services use of their chronically ill children, and how this translates to children's health outcomes is an empirical question.

We used a unique longitudinal dataset that contains information on a large group of privately insured children, and their families. We determined how changes in prescription drug cost sharing affect adherence to prescription drug therapy focusing on children with asthma. Then we identified the effect of prescription drug cost sharing on asthma related inpatient, outpatient and emergency department spending among the children. In both sets of analyses, we controlled for child's own characteristics, co-morbid conditions, general family demographic and health characteristics. For the latter analysis, we also controlled for plan generosity for medical (non-drug) services.

For chronic illness management, prescription drugs can be a very cost-effective treatment option for children and adolescents (Carlsen, 2005; Chase et al., 2003; Danne et al., 2003; Garland, 2004; Newcorn, Spencer, Biederman, Milton, & Michelson, 2005; Schachter, Pham, King, Langford, & Moher, 2001; Tamborlane, Bonfig, & Boland, 2001; Wagner et al., 2003; Wagner et al., 2004), however studies routinely stress under-utilization and inadequate therapy (Diaz et al., 2000; Eggleston et al., 1998; Halterman, Aligne, Auinger, McBride, & Szilagyi, 2000). In recent years, there have been significant cost containment strategies by health plans and pharmacy benefit managers (PBMs), resulting in deteriorating pharmacy coverage with the

[6] Authors' estimates based on Medical Expenditure Panel Survey (MEPS), 2008.

introduction of multi-tier formularies, benefit caps and higher cost sharing (Goldman et al., 2004; Huskamp et al., 2003; Joyce, Escarce, Solomon, & Goldman, 2002). Under these changes, many children covered under their parents' private insurance policies face substantial cost sharing.

Literature on utilization among adult and elderly population has shown that individuals subjected to higher pharmacy coinsurance rates reduce their own use of prescription medications (Goldman et al., 2004; Harris, Stergachis, & Ried, 1990; Johnson, Goodman, Hornbrook, & Eldredge, 1997; Joyce et al., 2002; Lillard, Rogowski, & Kington, 1999; Smith, 1993). Such responses lead to adverse health outcomes indicated by increased hospitalizations, emergency department visits or outpatient visits (Chandra, Gruber, & McKnight, 2007; Cole, Norman, Weatherby, & Walker, 2006; Fairman, Motheral, & Henderson, 2003; T. B. Gibson et al., 2006; Goldman, Joyce, & Karaca-Mandic, 2006; Mahoney, 2005; Tamblyn et al., 2001; Tseng, Brook, Keeler, Steers, & Mangione, 2004). A detailed review of literature examining the effects of cost sharing and benefit plan on healthcare utilization is given by Goldman et al (2007).

Despite the evidence on the association of private insurance cost sharing with health outcomes based on the adult and elderly populations, literature is very limited for chronically ill children. The notable exception is Huskamp et al (2005) who studied the implementation of a three-tier drug formulary by one employer sponsored health plan. The implementation increased out-of-pocket costs, and resulted in a decreased likelihood of using attention-deficit/hyperactivity disorder (ADHD) medications by children. However authors did not investigate consequences of this implementation on other health outcomes of children. From a policy perspective, it is very important to investigate whether parents, who decide on behalf of their children, limit their chronically ill children's access to prescription medications when faced with higher cost sharing,

and whether such response is associated with increased spending on other medical services by the children.

We chose to focus on children with asthma primarily because asthma is one of the most common childhood chronic diseases affecting about 6 million children in the U.S. Asthma is also associated with substantial avoidable morbidity and mortality as well as high burden on children and their families in terms of missed school days, lost work hours and lower quality of life (National Asthma Education and Prevention Program, 2007). Fortunately, clinical evidence suggests asthma can be managed effectively with medications, although studies typically based on self-reports repeatedly document underutilization of asthma medications by children (Adams, Fuhlbrigge, Guilbert, Lozano, & Martinez, 2002; Finkelstein, Lozano, Farber, Miroshnik, & Lieu, 2002; N. A. Gibson, Ferguson, Aitchison, & Paton, 1995; Halterman et al., 2000; Milgrom et al., 1996; Rohan et al., 2010; Ungar, Kozyrskyj, Paterson, & Ahmad, 2008).

We find that increased prescription drug cost sharing for long term asthma control drugs is negatively associated with adherence to long term asthma control therapy and positively associated with the likelihood of having an asthma related hospitalization for privately insured asthmatic children over age five. For children under age four, we did not find evidence for association of prescription drug cost with therapy adherence.

This study offers several contributions to the literature. First, it is the first to analyze directly the impact of private insurance coverage generosity, separate from the impact of insurance enrollment on chronically ill children's prescription adherence, and the subsequent use of other health services. Second, our findings shed light on the recent developments in the economics literature relating to multi-good insurance, and its implications for children's health

by estimating the degree to which prescription drugs, inpatient and outpatient services are substitutes or complements for chronically ill children (Goldman & Philipson, 2007).

Though the study is limited to the privately insured children, most likely of middle and upper income families, it has significant policy implications for the optimal design of private and public insurance. There may be important market failures that affect prescription drug adherence and subsequent health outcomes of children regardless of income status. For example, non-portability of health insurance restrains possibilities to select more or less generous coverage through job changes. Purchasing more generous coverage either through the individual market or coverage under a new employer in most cases is subject to pre-existing condition exclusions as well as waiting periods. These constraints are especially pronounced for those with chronic conditions. In addition, our findings have the potential to inform policy by providing evidence as to the need for and effectiveness of various policy proposals such as benefit design mandates for children, government provision of insurance and eligibility criteria for children.

In the next section, we review the background on asthma. Section 3 outlines the empirical strategy, including discussion of the data and measures and our econometric approach. Section 4 provides results. Finally, section 5 concludes.

II. Background on Asthma

Asthma is a chronic respiratory disease characterized by recurrent episodes of wheezing, breathlessness, chest tightness, and coughing. It affects all racial groups and ages, however presentation differs in each in individual. Asthma is the most common chronic condition among children (National Academy on an Aging Society, 2000), with a national prevalence rate of 9.6% for children under age 18-years (National Health Interview Survey, 2009). It accounts for about 1.75 million visits to the emergency department, 456,000 hospitalizations, 14.2 million lost

work-days and 10.5 million missed school days each year (Akinbami, Moorman, & Liu, 2011). The lost work-days include days spent caring for a child who is asthmatic.

There are many definitions for asthma however the definition by the National Asthma Education and Prevention Program (NAEPP) is the most widely accepted. The NAEPP Expert Panel Report 3 defines asthma as "*a chronic inflammatory disorder of the airways in which many cells and cellular elements play a role: in particular, mast cells, eosinophils, neutrophils (especially in sudden onset, fatal exacerbations, occupational asthma, and patients who smoke), T lymphocytes, macrophages, and epithelial cells. In susceptible individuals, this inflammation causes recurrent episodes of coughing (particularly at night or early in the morning), wheezing, breathlessness, and chest tightness. These episodes are usually associated with widespread but variable airflow obstruction that is often reversible either spontaneously or with treatment.*" (National Asthma Education and Prevention Program, 2007)

This definition incorporates the features of asthma, including the role of inflammation in the pathogenesis and treatment of asthma. Although the etiology of asthma is unknown, its manifestation is due to interplay of genetic and environmental factors. Children of asthmatics have been shown to have a higher risk to asthma (Akinbami, 2006; Martinez et al., 1995) and environmental factors only act as trigger in such individuals. Such environmental factors include allergens, respiratory infections, and exposure to airway irritants.

Diagnosis involves medical history, physical examination and pulmonary function tests (spirometry). In children under age 5-years, difficulty in performing pulmonary function tests reduces the ability to make an objective diagnosis. Diagnosis in this age-group is based on history and physical examination, and the decision to initiate therapy depends on a balance between the need to avoid unnecessary asthma therapy and missing a diagnosis.

Current trends in asthma management is based on the 2007 NAEPP guidelines which recommends a stepwise approach (see Table 1) to managing asthma to control disease progression and reduce acute exacerbations. Patient education and control of environmental factors is important irrespective of severity of disease, however choice of medications depends on severity. The medications are classified into medication for symptomatic relief of acute symptoms (Step 1 in Table) and daily medication for chronic asthma to control disease and reduce risk of progression (Steps 2-6). Across all age groups, therapy is often started with a short-acting beta-2 agonist (SABA) as drug of choice for acute symptoms. The medication is usually prescribed for use as needed, however increased use of more than 2 days a week is an indication for stepping up therapy.

The management guidelines for steps 2-6 differ across the age-groups as shown in Table 1. Therapy is stepped up or down based on control of symptoms and periodic results of pulmonary function test. Inhalational corticosteroids (ICS) such as fluticasone and budesonide are the medication of choice for persistent asthma with dose titration based on disease severity. Other long-term control medications include Long Acting Beta-2 Agonist (LABA) such as Salmaterol and Formoterol; Leukotriene Receptor Antagonists (LTRA) such as Montelukast and Zafirlukast; ICS and LABA combination agents such as Fluticasone/Salmaterol and Budesonide/Formoterol; Cromolyn Sodium and Nedocromil; Methylxanthines (i.e. Theophylline) and Immunomodulators such as Omalizumab.

Though the NAEPP guidelines are widely accepted, studies report low use of pharmacotherapy in the management of asthma, even among publicly insured children. Lower socioeconomic status is an important factor associated with inadequate use of asthma controller medications (Bloomberg et al., 2009; Finkelstein et al., 2002; Halterman et al., 2000; Kozyrskyj,

Mustard, & Simons, 2001; Kozyrskyj, Mustard, Cheang, & Simons, 2001; Kozyrskyj, Mustard, & R. Simons, 2003; Ungar et al., 2011). The complex nature of the disease and multiple medications in the therapy also impact utilization. Cabana and Coffman (2011) advocate involvement of children in the management of their conditions. They suggest that increased availability of patient education services may lead to greater utilization of medications.

Two studies, that are the most related to our project, have examined the role of medication out-of-pocket costs using data from Canada. Ungar et al (2008) analyze claims data from privately insured direct-pay drug plans in the province of Ontario and show that individuals who paid higher cost-sharing for asthma medications on average also had fewer claims for asthma medications. However, the study does not specifically address adherence to long term control therapy. Ungar et al (2011), study interview and administrative data for publicly and privately insured 490 asthmatic children in Canada to examine factors associated with exacerbations (hospitalizations and emergency department (ED) visits). They find asthma history, disease management factors, and socioeconomic status to be important predictors of exacerbations. In addition, total out-of-pocket spending for asthma medications as a share of the income was positively associated with the number of exacerbations. Given the universal health care in Canada for services other than for prescription medications, the results of these studies raise concern that the effects of prescription drug cost sharing can be even larger in the U.S. where families face higher financial burden due to health care costs.

III. Empirical Strategy

III.1. Data

We used an extensive data set of de-identified administrative, medical and pharmacy claims from 45 large, geographically diverse U.S. employers. Each firm offers one or more

health plans to its active or retired employees and their dependents. The data span 1997-2007, a period of rapid transformation in the pharmacy benefits arena. Each plan is characterized by employer-plan id-year combination.

The medical claims include information on date of service, billed charges, patient out-of-pocket payments, excluded expenses, health plan payments as well as diagnosis/procedure codes for the type of services incurred, and the type of provider/facility. The information consists of possible utilization sources such as inpatient, outpatient and emergency services. The pharmacy claims include similar information for all prescription drugs. We observe the date drug was dispensed, drug name, National Drug Code, dosage, days supplied, place of purchase (retail, mail-order), patient out-of-pocket expense, and health plan payment. The administrative enrollment files include information on a limited number of individual level demographics such as age, gender, active vs. retiree status of the primary beneficiary, relationship to primary beneficiary and three digit zip code of the residential location.

III.2. Study Sample Selection

We limited attention to beneficiaries in 0-18 age range, whose relation to the primary beneficiary was identified as the "child/dependent" in enrollment files. We required the presence of enrollment files for the primary beneficiary, and excluded cases that involved coordination of benefits to ensure that all claims history of the enrollee was included in our database. We identified children with asthma based on the existence of two or more pharmacy claims, or medical claims with the International Classification of Diseases (ICD-9) for asthma (493.XX). Resulting sample included 63,642 children with asthma.

Next, we identified children who initiated therapy with a long-term asthma control medication. Long term therapy medications were identified by a fill for a medication in the

following drug categories: ICS, LABA, LTRA, ICS/LABA combination agent, Cromolyn Sodium, Nedocromil, and Immunomodulators. In our sample, 43,785 children had at least one fill for a long-term asthma control drug. Initiation of therapy was defined as the absence of any pharmacy claim for a long-term control drug prior 6 months (25, 624 children). To be eligible for our sample, a child had to be continuously enrolled for at least one year after initiating therapy (index date) reducing the sample size to 11,843 children. Finally, we required that the children had fills for a long term control drug beyond the first 30 days after the index date. Our final sample included 7,288 asthmatic children who initiated therapy from 39 employers and 628 distinct plans.

III.3. Measures

III.3.I. Outcome Variables

Adherence: We examined the 365 days following the index date. Using information on fill date, and the days supplied in each fill, we identified days that had a fill for any of the long-term asthma control medication discussed above.[7] For beneficiaries using multiple categories of long term control drugs (for example ICS used as primary therapy and LABA as adjuvant therapy), the beneficiary was considered adherent in a given day if s/he had a fill for either one of the drug categories. As such, this method identifies the "best adherence" in any given day. Days spent in the hospital were assumed to be adherent days. We summed across the number of days covered with a drug during the year. Our final measure of adherence was the proportion of days covered (PDC) by a fill within the 365 day period.

[7] For all fills, we limited the accumulated stock from the previous fill to 30 days of supply. If a beneficiary fills a drug and then switches drugs before finishing all the pills supplied in the original fill (i.e. fills a new drug in the same therapeutic class), it is not possible to know without clinical data whether the beneficiary plans to finish the initial stock of pills before starting the new drug, or will throw away the existing stock. This rule on maximum stock accumulation allows us to be consistent across all cases.

Health Care Expenditures: We calculated yearly total spending on asthma related total spending on inpatient, outpatient and emergency department services as identified in medical claims. Asthma specific expenditures were identified using the primary ICD-9-CM diagnosis codes. This measure of expenditure is the sum of expenditures paid by the insurer and the out-of-pocket paid by the insured individual. All dollar amounts were converted to 2007 dollars to account for inflation over time.

III.3.II. Explanatory Variables

Prescription Drug Coverage (PlanRxOOP): Our key covariate is a proxy for pharmacy cost sharing. It is difficult to capture plan generosity in one summary measure since most plans use multi-tier formularies and offer mail-order discounts. We follow an approach similar to those used in Joyce et al (2002), Goldman et al (2004), Goldman et al (2006) and Karaca-Mandic et al (2010). For each plan, we constructed an average out-of-pocket price (OOP) for a representative basket of drugs for long term asthma control medications used by children. The general idea is to estimate how much an average asthmatic beneficiary would pay under each plan for a fixed basket of drugs.

We first started with the full sample of pharmacy claims in our data (claims for children and adults) across all plans and empirically constructed OOP spending by drug (i.e. fluticasone, budesonide, formoterol) for a 30-day fill for each plan. All dollar amounts were converted to 2007 dollars. Second, we constructed the weighted average OOP for 30-day fill by drug category (i.e ICS, LABA, LTRA) using the number of scripts by drug category in the plan as weights. Third, we focused only on our sample of asthmatic children and extracted the total scripts (normalized to 30-day equivalent scripts) by drug category and year (not by plan). We also

computed the number of any long term control drug users by year. Finally, for each plan p in our data, we computed the average OOP for a fixed basket of drugs as:

$$PlanRxOOP_p = \sum_{j=1}^{DrugCat} AvgOOP_{pj} * \frac{Scripts_j}{users}$$

where j indexes drug category (i.e. ICS, LABA, LTRA); $AvgOOP_{pj}$ is the average OOP for each drug category by plan; $Scripts_j$ and $users$ are the number of 30-day equivalent scripts for drug category and the total number of children using a long term control drug corresponding to the year of the observed plan respectively.

It is important to note that the annual scripts per drug category and the number of users are extracted from the overall sample of asthmatic children, and are not plan specific. Therefore, the weights that multiply $AvgOOP_{pj}$ do not represent a utilization response to plan specific cost sharing. We chose not to use plan specific weights in our construction as such a measure may be endogenous to plan generosity. In less generous plans, individuals may use the drugs sub optimally resulting in lower scripts per year relative to more generous plans.[8]

Because we examined each child for 365 days starting with the index date, follow-up period is typically split across two years (hence two plans). Therefore, for each child we use a weighted average of the $PlanRxOOP_p$ across the two plans using the proportion of the 365 day follow up period covered under each plan as weights.

[8] An alternative index could use the un-weighted average OOP in each plan. The concern with that approach is that it reflects choices made by patients, who may switch to lower-cost medications because of high costs for some medications. These choices can distort comparisons of benefit generosity. As an example, consider a situation with two drugs. Plan A may charge $X for either drug, whereas Plan B charges $X for one drug, and significantly more for the other one. If virtually all patients take the cheaper drug in Plan B, there is little difference observed in the prices consumers pay in the two plans. However, a comparison of the benefits suggests otherwise.

Child Characteristics: We included age, gender, years since initial asthma diagnosis, and an indicator for whether the index date was within the winter season (November-March) as opposed to the pollen season (April-October). We also controlled for the presence of allergic rhinitis, another inflammatory disease with similar pathogenesis and epidemiology to asthma. In most cases rhinitis precedes a diagnosis of asthma and allergens which cause allergic rhinitis could also trigger an asthmatic event, known as the allergic/atopic asthma. Studies have shown that treatment of allergic rhinitis reduces the risk of asthma exacerbation (Crystal-Peters, Neslusan, Crown, & Torres, 2002; Pawankar, 2004). Similarly, treatment for asthma typically reduces the incidence and severity of allergic rhinitis (Bousquet, Vignola, & Demoly, 2003). Finally, we controlled for the number of co-morbid conditions besides asthma and allergic rhinitis. All other co-morbid conditions were identified by ICD-9 codes as in Joyce et al. (2002). All models included fixed effects for the year of diagnosis.

Family Characteristics: We included the number of adults, average age of adults, number of other children, and separate indicators for the presence of co-morbidities among other family members. Similarly, these co-morbid conditions were identified by ICD-9 codes as in Joyce et al. (2002). We also included census region fixed effects. Because the claims data does not include any information on socio-economic characteristics, we included several variables at the three-digit zip code level from the decennial Census 2000 Summary File 3. These variables included age composition (percentage of children under age 18, percentage of elderly over age 65); race/ethnicity composition (percentages of Hispanic, White, Black and Asian populations); education (percentage of non-elderly adults with at least bachelors' degree); income (median family income among families with a child), and rural/urban composition (percentage of urban population).

III.4. Empirical Model

First, we examined the relationship between prescription drug generosity of the plan toward long-term asthma control medications and adherence to therapy. We estimated

$$Adherence_i = f(PlanRxOOP_i, ChildCharacteristics_i, FamilyCharacteristics_i)$$

using a generalized linear model (GLM) with log link and gamma family (i indexes a child) separately for children aged 0-4 years and those 5 years and above. As discussed earlier, asthma therapy guidelines are slightly different for these two age groups. Standard errors are clustered at the employer-year level.

Second, we examined how plan prescription drug generosity of the plan is associated with subsequent expenditures on hospitalizations, outpatient visits and ED visits. Because a significant proportion of individuals do not generate any expenditure during a year, these expenditures do not typically follow a normal distribution. Rather, they tend to have a mode at zero and a distribution with a long, heavy right tail. Given this, we use a two-part modeling approach (Duan, Manning, Morris, & Newhouse, 1983). The first part of the model predicts the probability of an individual having any positive expenditure. We specify the following logit model specification:

$$\Pr(Q_i > 0 \mid X_i) = \Lambda(X_i\beta) \qquad (2)$$

where Q_i denotes asthma related inpatient, outpatient or ED expenditures for child *i*. The vector X_i represent $PlanRxOOP_i$, $ChildCharacteristics_i$, $FamilyCharacteristics_i$ as well as a measure of plan's average OOP for the non-drug services.

The second part of the model uses a generalized linear model to predict the level of expenditures, given that a child incurs positive expenditures. Standard errors are clustered at the employer-year

level. The product of the predictions from each part of the model provides for an estimate of expected expenditures for the child.

IV. Results

Table 2 describes the distribution of long-term asthma control medications in our sample. A substantial fraction of the children in the sample use multiple categories of drugs during the one-year follow up period, with 46% using two drug categories, and 20% using three or more. Among those on one drug category alone, ICS is the most common (63%) followed by LTRA (26%) and ICS/LABA combination agents (9%). Cromolyn Sodium/ Nedocromil and LABAs are very rare, and Methylxanthines and Immunomodulators are never used as monotherapy. Among children using two drug categories, 90% use ICS, and 82% use LTRA, suggesting these two categories are commonly used together as adjuvant therapy, which is consistent with the therapy guidelines detailed in Table 1. Similarly, children who use three or more drug categories most commonly use ICS, LTRA and LABA.

Table 3 presents summary statistics of our key adherence measure, PDC. Consistent with other studies discussed earlier, adherence with long term control medications is poor. Among the 0-4 age group, average PDC is 46% with only 10% of the children having a medication 90% or more of the days during the one year follow up. Adherence among children 5 and above is slightly worse with average PDC of 42%, and 10% of the children with PDC of 82% or above.

Table 4 reports our constructed measure of prescription drug coverage. The plan's expected annual OOP for the fixed basket of asthma drugs is on average $112 (standard deviation of $61) with 10% of the beneficiaries facing $190 or more OOP costs. Average beneficiary faces 24% coinsurance rate (ratio of OOP to total paid by beneficiary and insurer), while 10% of the beneficiaries face 34% or more.

Table 5 describes characteristics of the children separately for the two age groups: 0-4 and 5 and above. Overall, in both age groups, children start long term control therapy soon after their first asthma diagnosis (within 0.24 years for 0-4 age group, 0.40 years for 5 and above age group). About 12% of both age groups also have a diagnosis for allergic rhinitis. Number of co-morbid conditions other than asthma and allergic rhinitis are on average 0.22 (standard deviation of 0.45) for 0-4 age group and 0.23 (standard deviation of 0.45) for children 5 and above. On average there are 2 adults and one additional child in the families. Among family members other than the study child, asthma is the most common co-morbid condition. For 18% of the children in our study, at least one other family member has asthma.

Table 6 presents results from the estimation of adherence model. For younger children under 5, we do not find any evidence that plan OOP costs are associated with PDC. However for the 5 and above age group, we find that plan's average annual OOP for the fixed basket of drugs is negatively associated with PDC. Using the parameter estimates, we predict that doubling the plan's OOP reduces PDC by almost 5%, suggesting an elasticity of -0.05. Goldman et al (2004) study non elderly adults aged 18-64 years using the same database we use (for the 1997-2000 period) and report that within the sample using asthma medications, doubling co-payments for asthma drugs reduces days supplied by 22%. Our finding suggests that demand for asthma medications is substantially more inelastic for children relative to non-elderly adults. We also computed the arc-elasticity[9] from doubling plan OOP, and found it to be approximately -0.076. This arc elasticity is actually very similar to the one reported for the elderly population. Chandra, Gruber, & McKnight, 2007 study the retired public employees in California, and report arc-

[9] Arc elasticity is calculated as $((PDC_2-PDC_1)/(PDC_2+PDC_1)/2)/(OOP_2-OOP_1)/(OOP_1+OOP_2)/2)$. In this calculation, OOP_2 and OOP_1 are the average values of doubled OOP and original OOP respectively; PDC_2 is the average PDC predicted at OOP_2, while PDC_1 is the average PDC predicted at OOP_1.

elasticities of drug utilization with respect to OOP costs ranging from -0.08 to -0.15. They do not distinguish the effect by therapeutic class, so a direct comparison between the asthmatic elderly and asthmatic children is not possible.

Within each age group, PDC decreases with the age of the child and increases with the number of adults in the family as well as with the average age of adults in the family. Children with allergic rhinitis have higher PDC providing support for the clinical observation that asthma and allergic rhinitis are related conditions as discussed earlier. The season for therapy initiation is also associated with PDC, although the effect differs across the two age groups. Therapy initiation during the winter season is negatively associated with PDC for the 0-4 age group, but positively associated with PDC for children 5 and over.

Among children under age 5, other factors that are positively associated with PDC include male gender. For children age 5 and above, asthma prevalence among other family members is positively associated with PDC likely reflecting increased asthma awareness and experience in the family. Several co-morbid conditions among other family members such as COPD and heart disease, on the other hand, are negatively associated with PDC. This could be because families with higher disease burden may have to allocate resources to other family members due to budgetary, time and other constraints. Regional characteristics at the 3-digit zip code level were not significantly associated with PDC for either of the age groups with the exception of Hispanic share of the population. PDC was lower for children under age 5 in zip codes with higher Hispanic share.

Having shown the negative association with plan's OOP for the basket of drugs and PDC for children over age 5, it is important to investigate whether plan's OOP for the basket of

asthma drugs is also associated with asthma related inpatient, outpatient and ED expenditures. Focusing on asthma specific services for the children age 5 and over, 2% had inpatient expenditures, 54% had outpatient expenditures, and 5% had ED expenditures during the year following the year of therapy initiation. Conditional on having positive expenditure, average annual expenditures were $4,356 (standard deviation of $5769) for inpatient, $393 (standard deviation of $569) for outpatient, and $716 (standard deviation of $873) for ED visits.

Table 7 presents estimates of two-part models for the three outcomes: asthma related inpatient, outpatient and ED expenditures. The first part of the model predicts the probability of any expenditure using a logit specification while the second part estimates the amount of expenditures conditional on positive expenditures with a log link and gamma family using a generalized linear model. In addition to all the control variables used in the adherence model, these models also control for the average plan OOP for non-drug medical services, a measure of non-drug generosity of the plan.

We find that plan's average OOP for the basket of asthma drugs is positively associated with the probability of having any asthma related inpatient expenditures suggesting that asthma drug therapy is a substitute to asthma related hospitalizations. Doubling plan's asthma drug OOP increases the likelihood of having any hospitalization expenditures from 0.019 to 0.03 (58%) on average. Conditioning on positive inpatient expenditures, we do not find evidence for association of plan's OOP for the drugs with the amount of expenditures. Overall, our estimates suggest that doubling asthma drug OOP increases average predicted annual asthma related inpatient expenditures per asthmatic child over age 5 (not conditioning only on those with an inpatient stay) by 24% from $105 to $171 This suggests a substantial offset-effect such that doubling asthma drug OOP reduces insurer payments on average by $100, but leads to an increase of $66

in hospital expenditures. In our data, average insurer share of asthma related expenditures for the children over age 5 is 87%, suggesting $57 of the $66 is paid by the insurer. Our finding is similar to Chandra, Gruber, & McKnight, 2007 who report that for elderly, increases in inpatient spending offset 20% of the savings from higher patient OOP for prescription drugs and physician copayments. For the elderly with more co-morbid conditions, this offset effect was substantially higher such that hospital spending increased by almost $2 for every $1 saved in spending associated with prescription drugs and physician services. We do not find evidence that plan's drug OOP is associated with the likelihood of, or with the amount of outpatient or ED expenditures.

IV.I. Sensitivity Analyses

We conducted several sensitivity analyses. The first set of analyses was primarily driven by our observation that children of both age groups had poor adherence as measured by PDC over a year. The second set of analyses investigated potential bias due to selection of health plans. The third set of analyses focused on the models of hospitalization outcomes.

Investigating Low Adherence

First, we investigated whether the plan OOP for the basket of drugs is also associated with PDC over a three-month period after therapy initiation. Clinically, long term asthma medications for chronic asthma therapy need to be used daily to control disease and reduce risk of progression as we discussed before, but we are not able to observe from the claims data whether the physician suggests termination of therapy due to clinical considerations. It is unlikely that the therapy will be discontinued, however, within a three month period after initiation. Asthma guidelines recommend at least an observation of three months before adjusting

therapy. We found that PDC over the first three months was higher relative to the one-year period. Average three-month PDC was 0.65 for children under 4 (standard deviation of 0.25), and 0.62 (standard deviation of 0.26) for children 5 and above. We estimated our adherence model for the three-month PDC using the same explanatory variables. We adjusted our measure of plan OOP for the basket of drugs as the weighted average plan OOP across the plans child has during the first three months. Similar to our benchmark models presented in Table 6, plan OOP for the asthma drugs was negatively associated with the three-month PDC for the children age 5 and over (p-value 0.03). Our estimates suggested that PDC during the first three months after initiation decreased by 2.33% from doubling plan OOP for the basket of drugs. We did not find evidence of a statistically significant association between plan OOP for asthma drugs and PDC for children under age 5.

As another sensitivity analysis, we considered whether adherence to therapy is seasonal such that children who initiate therapy during the winter season (November-March) are more adherent during the winter season, and those who initiate during the pollen season (April-October) are more adherent during the pollen season. This observation was somewhat supported by the data. Among children under age 5 who initiated therapy during the winter season, average PDC during the winter season was 0.53 (standard deviation of 0.25) while average PDC during the pollen season was 0.37 (standard deviation of 0.33). For the same age group who started therapy during the pollen season, average PDC during the pollen season was 0.50 (standard deviation of 0.28) while average PDC during the winter season was 0.46 (standard deviation of 0.33). Similarly, for children over age 5 who started therapy during the winter season, PDC during the winter was on average 0.48 (standard deviation of 0.26) while PDC during the pollen season was 0.36 (standard deviation of 0.31). For those who started therapy during the pollen

season, PDC during the pollen season was 0.43 (standard deviation of 0.25) while PDC during the winter was 0.35 (standard deviation of 0.30).

Based on this observation, we investigated whether plan's OOP for the basket of drugs is associated with seasonal PDC. For children who initiated therapy during the winter, we considered the PDC during the winter as the relevant outcome variable, while for those who initiated during the pollen season, we considered PDC during the pollen season. Plan's OOP for the basket of drugs represented the weighted average for the plans during the relevant season. We conducted separate analyses by the two age groups and by season of therapy initiation. As before, we did not find evidence that plan OOP for the asthma drugs was significantly associated with PDC during either of the seasons among the children under age 5. For children age 5 and older, we found that plan OOP for asthma drugs was negatively associated with the PDC during the pollen season for those who started therapy during the pollen season (p-value 0.035). Doubling plan OOP for asthma drugs was associated with a reduction of PDC by 5.6% during the pollen season. Association between winter season PDC and plan OOP for asthma drugs was not statistically significant for those who started therapy during the winter.

Investigating plan selection bias

Another set of analyses focused on investigating the extent of plan selection and potential implications for our estimates. If patients have a choice of drug plans, it is possible that they select their plan based on factors unobserved to us. This selection issue is a major concern for health insurance generally. In the case of drug benefit design, such selection is mitigated substantially because, while many employers offer employees a choice of medical plans, the vast majority standardize on one drug benefit regardless of medical plan choice. In our sample, we identified that 2423 of the 2433 children under age 5, and 4,822 of the 4,855 over age 5 had a

choice of only one drug plan. As a sensitivity analysis, we limited our analysis only to the children who had only one drug plan option from the employer. Our results were very similar to those reported in Table 6. For children age 5 and above, plan OOP for asthma drugs was negatively associated with PDC with a p-value of 0.004. Doubling plan OOP for asthma drugs was associated with a reduction of 5.22% in PDC. For children under age 5, we did not find a statistically significant association between plan OOP for asthma drugs and PDC.

Nevertheless, there may be another source of selection bias. Job changes may be motivated by insurance coverage. In particular, those who need more generous coverage may switch to an employer with a more generous coverage. Although job changes are costly, and chronically ill may be subject to a pre-existing condition exclusions or waiting periods under a new employer coverage, and that the new coverage may require provider changes (Madrian, 2006), this is still a valid concern. We conducted a robustness test by including employer fixed effects. Such fixed effects should control for employer selection based on time-invariant factors unobserved to the researcher. Our results reported in Table 6 were robust to this specification as well. For children age 5 and above, plan OOP for asthma drugs was negatively associated with PDC with a p-value of 0.017. Doubling plan OOP for asthma drugs was associated with a reduction of 9% in PDC. As before, for children under age 5, we did not find a statistically significant association between plan drug OOP for asthma drugs and PDC.

Falsification tests for hospitalization offsets

We conducted two falsification tests related to our models of non-drug spending (Table 7). First, we focused on children under age 5. For this younger group of children, we did not find evidence that plan OOP for asthma drugs is associated with adherence to asthma drugs (Table 6). Accordingly, we would not expect to find any evidence for an association between plan OOP for

asthma drugs and inpatient spending for children under age 5. We estimated a two-part model where the first part of the model predicted the probability of any asthma related inpatient expenditures using a logit specification while the second part estimated the amount of expenditures conditional on having positive expenditures with log link and gamma family using a generalized linear model. We included the same control variables as we did for models reported in Table 7. We did not find evidence of association between plan OOP for asthma drugs neither with the probability of any asthma related hospitalization expenditures (coefficient estimate of 0.15, standard error of 0.18, p-value of 0.4), nor with the level of hospitalization expenditures conditional on any hospitalization expenditures (coefficient estimate of 0.22, standard error of 0.30, p-value of 0.47).

Our second falsification test focused on the non-asthma related hospitalization expenditures of children age 5 and above. We further limited the sample to children whose only co-morbid condition as identified from the claims data was asthma resulting in a sample of 3,680 children. About 2% had a non-asthma related hospitalization. However, for this group of children, we would not expect a significant association between plan OOP for asthma drugs and the probability of hospitalization, or the level of inpatient expenditures. As expected, we did not find evidence of such associations (coefficient estimate of 0.12, standard error of 0.20, p-value of 0.56 for the first part of the model; coefficient estimate of -0.45, standard error of 0.33, p-value of 0.17 for the second part of the model).

V. Conclusion

Rising health care costs have resulted in less generous private insurance coverage shifting more financial responsibility to the consumers. A large body of research we discussed earlier demonstrated that individuals subject to higher OOP reduced their demand for care, and this may

result in adverse health outcomes. While most studies focused on non-elderly and elderly adults, very few studies examined outcomes for children. Among studies on children, most examined the effects of insurance enrollment rather than insurance generosity on chronically ill children's health outcomes. While insurance enrollment facilitates access to care, it doesn't guarantee it especially if the insurance has non-generous coverage.

Our paper is the first to focus on the privately insured children in the U.S. and to examine the association between prescription drug coverage generosity and adherence to prescription medications as well as inpatient, outpatient and ED spending. We studied outcomes for children with asthma, and found that asthmatic children age 5 and above are at risk for reduced prescription drug adherence and increased asthma related hospitalizations associated with higher plan OOP for asthma drugs. We predicted that doubling the plan's OOP reduces adherence (measured by PDC) by almost 5%, and increases the likelihood of asthma related hospitalizations by 58%. Conditioning on positive asthma related inpatient expenditures, we do not find evidence for association of plan's OOP for the drugs with the amount of expenditures. Our results suggest that, from a private insurer perspective, insurer's asthma related hospital spending of children over age 5 increases by almost $0.57 for every $1 saved in prescription drug spending resulting from increased patient OOP for the prescription drugs. We did not find evidence of any statistically significant associations for asthmatic children under age 5 between plan OOP for drugs and adherence to drug therapy.

These results shed light on the recent developments in the economics literature relating to multi-good insurance, and its implications for children. The economic theory underlying prescription drug coverage is not settled. Goldman et al (2007) suggest a model of health insurance benefit design that takes into account cross-price elasticities between all services.

Their model suggests that even a highly elastic demand for prescription drugs may warrant low co-payments when drug consumption lowers the use of other medical services. More generally, if an insured good has many other services insured that are substitutable, then its optimal co-payments should be lower as raising co-payments will lead to additional use of those other services. Our study provides string evidence that prescription drugs and inpatient services are substitutes for these chronically ill children.

Overall, our study is limited to the privately insured children most likely of middle and upper income families, but it has significant policy implications for the optimal design of private and public insurance in general. There may be important market failures that affect prescription drug adherence and subsequent inpatient and outpatient outcomes of children regardless of income or insurance status. First, empirical evidence suggests that patients may have incomplete information regarding the benefits of prescription medications, may not able to distinguish between drugs essential to their health and those that provide only marginal benefit, and may not fully internalize potential future benefits of essential drugs in their decision to adhere with therapy (Fendrick et al, 2001, Gibson 2005). This suboptimal adherence may lead to subsequent adverse health outcomes. We find such evidence for asthmatic children, suggesting the need for setting optimal cost sharing that appropriately rewards adherence. For example, policy initiatives may be directed toward benefit design mandates and coverage mandates for children. Secondly, non-portability of health insurance restrains possibilities to select more or less generous coverage through job changes (Currie and Madrian, 1999, Madrian and Gruber 2004, Madrian 2006), resulting in another form of market failure. Purchasing more generous coverage either through the individual market or coverage under a new employer in most cases is subject

to pre-existing condition exclusions as well as waiting periods. These constraints are especially pronounced for those with chronic conditions which constitute our study sample.

Even in the absence of market failures, our findings have the potential to inform policy by providing evidence as to the need for and effectiveness of various policy proposals such as benefit design mandates for children, government provision of insurance, and eligibility criteria for children. The Patient Protection and Affordable Care Act (PPACA) of 2010 includes various provisions that impact access to coverage, access to medical care and OOP spending of children and their families. In terms of access to coverage, starting in 2014, PPACA expands Medicaid eligibility to all individuals in families earning less than 133 percent of the federal poverty level (FPL), and provides premium assistance credits (for purchasing coverage in the individual market) for those without access to employer-sponsored insurance, and earning between 133-400 percent of FPL. In terms of coverage mandates, starting in 2010, PPACA prohibits insurers from excluding or delaying coverage for particular services for children with pre-existing health conditions. Moreover, plans are required to cover certain preventive health services with no cost-sharing. Among these services those that are relevant for children include routine vaccines, well child visits, vision and hearing tests, counseling on healthy weight maintenance. Our results point to a wider range of coverage mandates and perhaps generosity mandates with regards to preventive prescription medications for the chronically ill children who are privately insured.

Our study has several limitations. The longitudinal claims level data use for this study is very well situated for following families/individuals over time, and for observing the diagnosis dates of various conditions and for tracking utilization of health care services and prescription

drugs. However, the major limitation of the claims level data is the limited availability of socioeconomic information at the individual level. The literature on children's access and utilization of health services has shown that socioeconomic status such as family income, and parental education, race and ethnicity are influential factors. To circumvent this issue, our specifications include such socioeconomic variables at the three-digit zipcode level as control variables. Second, our study population is limited to children diagnosed with asthma who are new users of long term asthma control therapy. While it would have been interesting to study a more general asthmatic children population, claims data does not allow for identification of clinical disease severity. By limiting to new long-term disease control drug therapy initiators, we reduce the extent of unobserved heterogeneity in disease severity that could be an important factor in influencing drug therapy adherence as well as other asthma related service utilization.

Table 1. Guidelines for therapeutic management of asthma*

Age (years)	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6
0-4	SABA[a] PRN[b]	Low dose ICS[c] *Alternative:* Cromolyn/ Montelukast	Medium dose ICS	Medium dose ICS + LABA[d]/ Montelukast	High dose ICS + LABA/ Montelukast	High dose ICS + LABA/ Montelukast + Oral Corticosteriods
5-11	SABA PRN	Low dose ICS *Alternative:* Cromolyn LTRA[e] Nedocromil/ Theophylline	Low dose ICS + LABA/LTRA/ Theophylline *OR* Medium dose ICS	Medium dose ICS + LABA *Alternative:* Medium dose ICS + LTRA or Theophylline	High dose ICS + LABA *Alternative:* High dose ICS + LTRA or Theophylline	High dose ICS + LABA + Oral Corticosteriods *Alternative:* High dose ICS + LTRA/ Theophylline + Oral Corticosteriods
≥ 12	SABA PRN	Low dose ICS *Alternative:* Cromolyn LTRA Nedocromil/ Theophylline	Low dose ICS + LABA *OR* Medium dose ICS *Alternative:* Low dose ICS + LTRA/ Theophylline/ Zileuton	Medium dose ICS + LABA *Alternative:* Medium dose ICS + LTRA/ Theophylline/ Zileuton	High dose ICS + LABA AND Consider Omalizumab for patients with allergies	High dose ICS + LABA + Oral Corticosteriods AND Consider Omalizumab for patients with allergies

*Adapted from National Asthma Education and Prevention Program Expert Panel Report 3 (National Asthma Education and Prevention Program, 2007)

a – Short Acting Beta-2 Agonists
b – Medication to be used as needed
c – Inhalational Corticosteroids
d – Long Acting Beta-2 Agonist
e – Leukotriene Receptor Antagonist

Table 2. Distribution of Long-Term Control Medications

	Number of drug categories used during the year following index date		
	1 (N=2,551)	2 (N=3,317)	3 or more (N=1,420)
Inhaled Corticosteroids (ICS) (%)	63.23	89.51	98.52
Leukotriene Receptor Antagonists (LTRA) (%)	25.64	81.79	94.44
Long-Acting Beta 2-Agonists (LABA) (%)	0.35	2.44	23.94
ICS/LABA combination agents (%)	9.25	21.95	79.3
Cromolyn Sodium & Nedocromil (%)	1.53	4.19	19.44
Methylxanthines (%)	0	0.12	1.9
Immunomodulators (%)	0	0	0.7

Table 3. Distribution of Proportion of Days Covered (PDC)

	Number of Children	Mean	Sd	Median	75th Percentile	90th Percentile
Ages 0-4	2433	0.46	0.27	0.41	0.67	0.90
Ages 5 +	4855	0.40	0.25	0.33	0.58	0.82
All ages	7288	0.42	0.26	0.33	0.60	0.85

Table 4. Distribution of Average Annual OOP for the basket of drugs (PlanRxOOP)

	Mean	Sd	Median	75th Percentile	90th Percentile
Plan's Average Annual OOP for the representative basket of drugs - in $100	1.12	0.61	0.95	1.42	1.9
Plan's Average Coinsurance Rate for the representative basket of drugs	0.24	0.09	0.22	0.3	0.34

Table 5. Summary Statistics for the Study Sample of Children with Asthma

	Ages 0-4		Ages 5+	
	N=2433		N=4855	
	Mean	Sd	Mean	Sd
Child Characteristics				
years since diagnosis	0.27	0.57	0.40	0.92
index date in winter season	0.61	0.49	0.55	0.50
age	2.49	1.20	9.55	3.43
male (1/0)	0.64	0.48	0.59	0.49
allergic rhinits	0.12	0.33	0.12	0.33
# chronic conditions besides asthma and allergic rhinitis	0.22	0.45	0.23	0.45
Family characteristics				
Number of adults	1.86	0.40	1.93	0.51
Average age of adults	35.13	5.27	39.99	6.05
Number of other children	0.92	0.92	1.17	0.96
Northeast region (1/0)	0.23	0.42	0.24	0.43
Midwest region (1/0)	0.16	0.37	0.21	0.41
West region (1/0)	0.12	0.32	0.13	0.33
South region (1/0)	0.50	0.50	0.43	0.49
Presence of co-morbidities among other family members (1/0)				
Asthma	0.18	0.38	0.18	0.39
COPD	0.00	0.06	0.01	0.08
Hypertension	0.08	0.27	0.12	0.33
Diabetes	0.02	0.14	0.05	0.21
Lipid Disorder	0.06	0.23	0.07	0.25
Heart Disease	0.01	0.11	0.02	0.15
Stroke	0.00	0.06	0.00	0.06
Multiple Sclerosis	0.06	0.23	0.05	0.22
Depression/Anxiety	0.08	0.27	0.11	0.31
Cancer	0.02	0.13	0.03	0.16
Regional Characteristics at 3-Digit Zipcode of Residence				
% Children	25.74	2.67	25.81	2.49
% Elderly	11.72	3.68	11.91	3.49
% Urban	81.18	19.53	79.55	19.64
% Hispanic	11.48	12.63	10.53	11.79
%White	78.09	13.27	79.69	13.08
%Black	11.46	11.13	10.05	10.39
%Asian	3.00	3.28	2.86	3.14
%Bachelors Degree among non-elderly adults	25.87	8.82	25.40	8.51
Median Family Income among families with children (in$10,000)	5.53	1.41	5.53	1.38

Table 6. Adherence Model (Generalized Linear Model, Log Link, Gamma Family)

	0-4 years		5 or more years	
	coef	**se**	**coef**	**se**
Plan's Average Annual OOP for the representative basket of drugs - in $100	0.013	0.019	-0.047***	0.017
Child Characteristics				
years since diagnosis	0.049*	0.029	0.023*	0.013
index date in winter season	-0.050**	0.022	0.063***	0.024
age	-0.025**	0.011	-0.019***	0.002
male (1/0)	0.057**	0.025	0.018	0.016
allergic rhinits	0.077**	0.036	0.123***	0.024
# chronic conditions besides asthma and allergic rhinitis	0.078*	0.042	0.016	0.030
Family characteristics				
Number of adults	0.062**	0.029	0.046**	0.020
Average age of adults	0.007**	0.003	0.005***	0.002
Number of other children	-0.057***	0.012	-0.011	0.008
Presence of co-morbidities among other family members (1/0)				
Asthma	0.041	0.032	0.067***	0.023
COPD	-0.091	0.293	-0.238***	0.090
Hypertension	0.041	0.044	0.051*	0.029
Diabetes	-0.186*	0.097	-0.066	0.042
Lipid Disorder	0.038	0.050	0.040	0.035
Heart Disease	-0.048	0.106	-0.107**	0.051
Stroke	0.081	0.251	0.170	0.121
Multiple Sclerosis	0.020	0.043	0.014	0.035
Depression/Anxiety	0.077*	0.043	-0.036	0.030
Cancer	0.017	0.094	-0.030	0.049
Regional Characteristics at 3-Digit Zipcode of Residence				
% Children	-0.014*	0.008	-0.004	0.007
% Elderly	-0.000	0.006	-0.004	0.005
% Urban	-0.001	0.001	0.000	0.001
% Hispanic	-0.003**	0.002	-0.001	0.002
%White	-0.003	0.004	-0.001	0.004
%Black	-0.004	0.004	-0.004	0.004
%Asian	-0.011	0.007	-0.007	0.006
%Bachelors Degree among non-elderly adults	0.008*	0.004	0.002	0.003
Median Family Income among families with children (in	-0.024	0.023	-0.019	0.017
Other				
Census region fixed effects		included		
Year of diagnosis fixed effects		included		

note: *** p<0.01, ** p<0.05, * p<0.1

Table 7. Two-Part Models of Asthma Related Expenditures the year following the year of therapy initiation, Children ages 5 and over

	Any IP Expenditures		IP Expenditures conditional on Positive IP Exp		Any OP Expenditures		OP Expenditures conditional on Positive OP Exp		Any ER Expenditures		ER Expenditures conditional on Positive ER Exp	
	Logit		GLM (log/gamma)		Logit		GLM (log/gamma)		Logit		GLM (log/gamma)	
	coef	se	coef	se	coef	se	coef	se	coef	se	coef	se
Plan's Average Annual OOP for the representative basket of drugs - in $100	0.429**	0.190	-0.283	0.320	0.060	0.061	-0.036	0.043	0.139	0.124	-0.032	0.137
Plan's Average Annual OOP for the non-drug services - in $100	0.017	0.011	0.035	0.027	0.003	0.006	0.016**	0.007	0.016**	0.006	0.023**	0.011
Child Characteristics												
years since diagnosis	0.021	0.104	-0.512	0.316	0.025	0.033	-0.077***	0.026	0.075	0.062	-0.057	0.068
index date in winter season	0.077	0.226	0.258	0.513	0.010	0.046	0.024	0.051	0.172	0.143	0.073	0.148
age	-0.069	0.043	-0.016	0.081	-0.040***	0.009	-0.003	0.008	-0.006	0.026	0.008	0.021
male (1/0)	0.171	0.223	0.128	0.484	0.065	0.066	-0.047	0.043	0.037	0.146	0.001	0.127
allergic rhinits	-1.256***	0.483	0.282	1.087	-0.008	0.079	0.042	0.072	-0.007	0.207	-0.149	0.204
# chronic conditions besides asthma, allergic rhinitis and COPD	0.714***	0.262	-0.327	0.379	0.032	0.112	0.297**	0.121	-0.016	0.218	0.432*	0.250
Family characteristics												
Number of adults	-0.682***	0.247	0.470	0.356	-0.066	0.061	0.021	0.052	-0.319**	0.142	0.022	0.105
Average age of adults	-0.021	0.018	-0.006	0.034	-0.017***	0.005	0.007	0.005	-0.026**	0.012	-0.012	0.011
Number of other children	-0.120	0.127	0.255	0.218	-0.033	0.031	0.027	0.026	0.027	0.080	0.011	0.058
Presence of co-morbidities among other family members (1/0)												
Asthma	0.095	0.307	-0.333	0.478	0.515***	0.079	0.102	0.063	-0.073	0.176	-0.458***	0.174
COPD	1.862***	0.678	-3.687***	1.341	0.453	0.429	0.157	0.310	0.956	0.605	-0.402	0.463
Hypertension	0.547**	0.276	0.604	0.454	0.255***	0.088	-0.148**	0.075	0.281	0.221	-0.010	0.164
Diabetes	0.836**	0.393	0.860	0.785	0.164	0.128	-0.070	0.109	0.726***	0.250	0.432	0.267
Lipid Disorder	0.117	0.437	-0.508	0.610	0.058	0.116	-0.006	0.093	-0.416	0.313	-0.266	0.175
Heart Disease	-1.564**	0.668	7.041***	2.106	0.169	0.189	0.092	0.152	0.231	0.386	-0.835**	0.328
Stroke	1.744***	0.592			0.254	0.468	-0.353	0.251				
Multiple Sclerosis	0.510	0.446	-1.707	1.400	-0.009	0.113	0.091	0.118	-0.167	0.334	0.215	0.244
Depression/Anxiety	0.551**	0.267	-0.491	0.530	-0.145	0.104	-0.022	0.085	0.082	0.211	0.025	0.173
Cancer	-0.493	1.001	0.805	1.045	-0.240	0.214	0.026	0.198	-0.998	0.712	-0.183	0.365
Regional Characteristics at 3-Digit Zipcode of												
% Children	-0.038	0.062	0.077	0.132	-0.001	0.022	0.002	0.017	-0.076*	0.044	0.036	0.041
% Elderly	-0.009	0.050	0.032	0.062	0.012	0.017	0.004	0.012	-0.011	0.033	0.010	0.030
% Urban	0.005	0.008	0.007	0.012	0.000	0.003	-0.000	0.002	0.006	0.006	0.006	0.006
% Hispanic	0.040**	0.016	0.030**	0.013	-0.005	0.005	-0.002	0.003	0.021**	0.011	0.003	0.006
%White	0.140***	0.036	0.109*	0.061	-0.010	0.012	0.009	0.009	0.029	0.034	0.006	0.020
%Black	0.140***	0.039	0.122**	0.056	-0.014	0.012	0.010	0.008	0.027	0.031	0.007	0.019
%Asian	0.205***	0.050	0.192*	0.114	-0.007	0.024	0.015	0.017	0.031	0.056	0.034	0.043
%Bachelors Degree among non-elderly adults	-0.011	0.035	-0.010	0.058	0.005	0.009	-0.003	0.008	-0.033	0.021	0.007	0.025
Median Family Income among families with children (in$10,000)	-0.225	0.214	0.164	0.381	-0.037	0.058	0.038	0.050	0.114	0.131	0.031	0.123
Other												
Census region fixed effects	included											
Year of diagnosis fixed effects	included											

note: *** p<0.01, ** p<0.05, * p<0.1

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