

An employer perspective on annual employee and dependent costs for pediatric asthma

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Background: The burden of pediatric asthma on parents' health care costs is not well described.

Objective: To evaluate direct and indirect health care costs of employees with children with asthma (asthma cohort) compared with employees with children without asthma (control cohort).

Methods: Retrospective analysis of 2001–2007 employer data including employee medical and pharmacy claims, payroll, work absence, demographics, and dependent medical and pharmacy claims. Asthma diagnosis or pharmacy claims for asthma controller medications were used to identify employees with dependents younger than 12 years for the asthma cohort. Controls were identified based on dependent age and lack of an asthma diagnosis or pharmacy claim for a controller medication. All costs were calculated using 2-part regression models that controlled for demographics, job information, Charlson Comorbidity Index, and region. Costs were calculated for employee health care, prescriptions, sick leave, short- and long-term disability, and workers' compensation and dependent health care and prescriptions. Costs were compared for employees with children aged 0 through 3 years, 4 through 7 years, 8 through 11 years, and younger than 12 years.

Results: Data were available for 11,794 asthma cohort employees and 64,812 controls. Statistically significant annual cost differences were identified for employee health care (\$154, $P < .001$), prescriptions (\$95, $P < .001$), sick leave (−\$41, $P < .001$), short-term disability (−\$41, $P = .008$), dependent health care (\$862, $P < .001$), and prescriptions (\$534, $P < .001$).

Conclusions: Pediatric asthma is associated with significant additional health care and prescription costs for both employees and dependents.

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INTRODUCTION

Asthma is the most common chronic disorder in childhood, currently affecting an estimated 6.8 million children younger than 18 years, of whom 4.1 million experienced an asthma attack or episode in 2006.¹ Management of pediatric asthma is known to be costly from a societal perspective²; however, little is known about the specific cost burden that pediatric asthma imposes on the family and caregivers of children with asthma.

According to a 2005 report, the total economic impact (direct and indirect costs) of asthma in school-age children was \$1.9 billion (in 2003 dollars).³ Annual direct medical expenditure for pediatric asthma was approximately \$1.01 billion, including payments for prescription medications, hospital inpatient stays, hospital outpatient care, emergency de-

partment visits, and office-based visits.³ Indirect costs contributed approximately another \$1 billion and include \$264.7 million in future lifetime earnings lost because of asthma-related deaths among school-age children³ and \$719.1 million in parents' self-reported loss of productivity because of a child's asthma-related school absence. Asthma is one of the leading causes of school absenteeism⁴; in 2003, asthma accounted for an estimated 12.8 million lost school days in children 5 to 17 years old who reported at least 1 asthma attack in the previous year.⁵

Recent studies also demonstrated that inadequately controlled asthma worsens caregiver and child productivity losses and decreases quality of life.⁶ Many asthma caregiver studies use survey-based instruments, such as the Pediatric Asthma Caregiver's Quality of Life Questionnaire,⁷ and focus on the caregiver's quality of life^{8,9} but provide no objective data on the actual economic burden that pediatric asthma imposes on the parent or caregiver. A MEDLINE search conducted in February 2008 with *asthma* and *caregiver* as keywords in the title identified several articles that focused on health care utilization, quality-of-life issues, and/or health consequences (eg, depression) for the caregiver of a child with asthma.^{6,10–13} However, we know of no studies that use objective measures to quantify the health care costs of pediatric asthma to the parents or caregivers. The present study aims to objectively determine employee and dependent costs for employees with children (<12 years old) with asthma (asthma cohort) compared with employees with children (<12 years old) without asthma (control cohort).

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METHODS

A retrospective analysis was performed on data from the Human Capital Management Services Research Reference Database, which consists of data from approximately 650,000 employees throughout the United States representing the retail, service, manufacturing, and financial industries. Information from this database has been used previously in similar research.^{14–18}

The data covered the period between January 1, 2001, and March 31, 2007, and included medical claims, pharmacy claims, payroll, work absence, and demographics. To be included in the analysis, employees had to have at least 1 child dependent that was younger than 12 years. Children with asthma were identified based on the presence of *International Classification of Diseases, Ninth Revision (ICD-9)* diagnostic codes of 493.xx or pharmacy claims for an asthma controller medication based on the National Drug Code product identifier. Controller medications included inhaled corticosteroids (ICSs), combination fluticasone-salmeterol, non-montelukast leukotriene modifiers, and inhaled long-acting β_2 -agonists.

Employees in the control cohort were identified based on dependent age, lack of an asthma diagnosis (*ICD-9* code) among the employee's child dependents, and lack of a pharmacy claim for a controller medication. The index date in the asthma cohort was defined as the date of a child's first asthma diagnosis during 2001 or later; the first pediatric medical or pharmacy claim date was used as the index date in the control cohort. Employees included in the analysis were required to be continuously employed and eligible for health benefits for at least 12 months after their index date.

Eligible study participants were further analyzed overall (all eligible participants with dependents <12 years of age) and based on the following subgroups at index date: younger than 4 years, 4 through 7 years old, and 8 through 11 years old. Comparisons were made between the 2 cohorts (asthma and control cohorts) for all age groupings. Outcomes for both cohorts were compared during the 12 months after the index date and included employee direct costs (health care and prescription drug costs) and indirect costs associated with payments for work absences, including sick leave, short- and long-term disability, and workers' compensation. Dependents' direct costs, including insurance payments from health care and prescription drug claims for any condition, were also compared. All costs were inflation adjusted to 2007 US dollars.

For the asthma cohort, the percentages of employees with dependents taking short-acting β -agonists (SABAs; eg, albuterol, bitolterol, levalbuterol, and pirbuterol) and ICSs (eg, beclomethasone, budesonide, flunisolide, fluticasone, mometasone, and triamcinolone¹⁹) were calculated.

The 2 cohorts were compared for demographic differences using *t* tests for continuous variables and χ^2 tests for binary variables. Two-part regression analysis was used to model the cost differences between the asthma and control cohorts using

separate regression models for each cost variable and each age group. Because of differences between the cohorts, the models controlled for differences in employee age, sex, marital status, race, exempt or nonexempt status (exempt employees are not paid on an hourly basis and are not paid for overtime work), full-time or part-time status, salary, the employee's Charlson Comorbidity Index score,²⁰ the employee's children's Charlson Comorbidity Index score, and geographic location (defined by the first digit of the employee's zip code). The Charlson Comorbidity Index is a weighted score built from claims data indicators of serious comorbid conditions that are predictive of mortality and is frequently used in health economics research. Only employees eligible for each specific benefit were included in the regression models for that benefit. Indirect costs were summed over all absence claims begun at some point during the year after the index date. Differences were considered statistically significant if $P < .05$.

RESULTS

Descriptive Characteristics

Data were available for the 11,794 employees with children with asthma (<12 years old) and for the 64,812 employees with children without asthma (<12 years old). Table 1 presents descriptive statistics for the overall study cohorts (descriptive statistics for the individual age group cohorts available on request from the corresponding author). Average employee age ranged from 34 years for employees with children younger than 4 years to 39 years for employees with children 8 to 11 years old. Approximately one-third of employee caregivers in each cohort and age grouping were female. More than 90% of employees worked full time rather than part time, and more than three-quarters were married. Table 1 indicates that the asthma cohort had statistically significantly higher values of salary, percentage of Hispanic patients, percentage exempt, percentage working full time, employee Charlson Comorbidity Index score, children's Charlson Comorbidity Index score, and number of dependent children than controls.

Health Benefit Costs

Table 2, Table 3, and Table 4 compare the annual health benefit costs per employee caregiver of children younger than 4 years, 4 through 7 years old, and 8 through 11 years, respectively, with and without asthma during the year after each person's index date. Statistically significantly higher costs ($P \leq .001$) are seen for the asthma cohort in the employee health care, employee prescription drug, dependent health care, and dependent prescription drug categories than for the control cohort in all of the age groups, with the exception being employee health care with the youngest children (<4 years old, $P = .15$). The cost differences were most apparent in the dependent and employee health care and prescription drug cost categories. In both cohorts, employees with the youngest children (<4 years old) had the lowest prescription drug costs. However, dependent health care costs

Table 1. Descriptive Statistics for Study Cohorts^a

Variable	Asthma cohort		Control cohort	
	No.	Mean (SE) or %	No.	Mean (SE) or %
Caregivers of children <12 years old ^b				
Age at index date, y ^{b,c}	11,794	36.45 (0.06)	64,808	36.17 (0.03)
Tenure at index date, y ^{b,d}	11,794	7.19 (0.06)	64,812	7.37 (0.03)
Annual salary, \$ ^c	11,772	61,079 (413)	64,537	55,163 (305)
Female ^c	11,794	34.4	64,812	36.8
Married ^c	10,730	77.7	58,207	76.0
White ^c	9,528	59.1	48,142	63.2
Black ^c	9,528	13.1	48,142	14.6
Hispanic ^c	9,528	16.8	48,142	11.6
Exempt ^c	11,794	41.0	64,810	36.4
Full time ^c	11,794	95.4	64,812	91.1
Employee's Charlson Comorbidity Index score ^c	11,794	0.18 (0.01)	64,812	0.12 (0.00)
Children's Charlson Comorbidity Index score ^c	11,794	0.07 (0.00)	64,812	0.04 (0.00)
No. of dependent claimant children ^c	11,794	2.32 (0.01)	64,812	1.98 (0.00)

^a Differences are considered statistically significant if $P < .05$ (based on t tests for continuous variables and χ^2 tests for binary variables).

^b Children's ages are based on the index date and required 1-year postindex date eligibility for the age grouping. For employees with children with asthma, the index date is the date of the first asthma diagnosis (*International Classification of Diseases, Ninth Revision [ICD-9] codes 493.xx*) or the first controller medication prescription in the study period. For employees without asthmatic children, the index date is the date of a child's first medical or drug claim in the data.

^c $P \leq .001$.

^d $P = .005$.

Table 2. Comparison of Annual Costs per Employee Caregiver of Children Younger Than 4 Years With and Without Asthma^a

Cost category	Asthma cohort		Control cohort	
	No.	Adjusted mean cost, \$	No.	Adjusted mean cost, \$
Employee health care	4,577	1,738	32,558	1,793
Employee prescription drug ^b	4,577	395	32,558	322
Employee sick leave	2,306	539	15,347	558
Employee short-term disability ^c	2,737	248	17,781	312
Employee long-term disability	3,933	11	25,483	2
Employee workers' compensation ^b	4,227	243	29,286	152
Dependent health care (any child) ^b	4,577	3,951	32,558	3,288
Dependent prescription drug (any child) ^b	4,577	741	32,558	173

^a Children were born before the index date but did not turn 4 years old until after. Costs were determined during the year after each person's index date. For the asthma cohort, this is the date of the first asthma diagnosis or first controller medication prescription in the study period. For the controls, the index date is the date of a child's first medical or drug claim in the data.

^b $P \leq .001$.

^c $P = .01$.

(\$3,951) were the highest for employees with the youngest children with asthma (<4 years old).

Table 5 compares costs between the 2 cohorts for all dependents younger than 12 years. Statistically significant annual cost differences between the cohorts were identified for employee health care (\$154, $P < .001$), employee prescription drugs (\$95, $P < .001$), sick leave (−\$41, $P < .001$), short-term disability (−\$41, $P = .008$), dependent health care (\$862, $P < .001$), and dependent prescription drugs (\$534, $P < .001$).

Workers' compensation costs were significantly higher for the asthma cohort than controls in the younger than 4 years age group ($P < .001$) but lower in the 4- to 7-year-old ($P < .001$) and 8- to 11-year-old ($P = .05$) age groups. Sick leave costs were significantly lower for the asthma cohort than for controls in all age groups ($P < .001$) except those younger than 4 years ($P = .16$). Short-term disability costs were significantly lower for the asthma cohort than for controls in the younger than 4 years ($P = .01$) and younger than 12 years ($P = .008$) age groupings.

Table 3. Comparison of Annual Costs per Employee Caregiver of Children 4 to 7 Years Old With and Without Asthma^a

Cost category	Asthma cohort		Control cohort	
	No.	Adjusted mean cost, \$	No.	Adjusted mean cost, \$
Employee health care ^b	4,343	1,776	28,017	1,578
Employee prescription drug ^b	4,343	481	28,017	371
Employee sick leave ^b	2,109	445	13,679	505
Employee short-term disability	2,561	180	14,821	187
Employee long-term disability	3,645	2	21,921	4
Employee workers' compensation ^b	3,977	154	25,251	212
Dependent health care (any child) ^b	4,343	2,818	28,017	1,914
Dependent prescription drug (any child) ^b	4,343	809	28,017	254

^a Children turned 4 years old before the index date but did not turn 8 years old until after. Costs were determined during the year after each person's index date. For the asthma cohort, this is the date of the first asthma diagnosis or first controller medication prescription in the study period. For controls, the index date is the date of a child's first medical or drug claim in the data.

^b $P \leq .001$.

Table 4. Comparison of Annual Costs per Employee Caregiver of Children 8 to 11 Years Old With and Without Asthma^a

Cost category	Asthma cohort		Control cohort	
	No.	Adjusted mean cost, \$	No.	Adjusted mean cost, \$
Employee health care ^b	3,954	2,031	27,863	1,667
Employee prescription drug ^b	3,954	540	27,863	424
Employee sick leave ^b	1,911	475	13,331	533
Employee short-term disability ^c	2,277	226	14,057	229
Employee long-term disability	3,243	4	21,568	4
Employee workers' compensation	3,650	197	25,243	239
Dependent health care (any child) ^b	3,954	2,922	27,863	1,840
Dependent prescription drug (any child) ^b	3,954	919	27,863	333

^a Children turned 8 years old before the index date but did not turn 12 years old until after. Costs were determined during the year after each person's index date. For the asthma cohort, this is the date of the first asthma diagnosis or first controller medication prescription in the study period. For controls, the index date is the date of a child's first medical or drug claim in the data.

^b $P \leq .001$.

^c $P = .008$.

Table 5. Comparison of Annual Costs per Employee Caregiver of Children Younger Than 12 Years With and Without Asthma^a

Cost category	Asthma cohort		Control cohort	
	No.	Adjusted mean cost, \$	No.	Adjusted mean cost, \$
Employee health care ^b	11,794	1,890	64,812	1,736
Employee prescription drug ^b	11,794	460	64,812	364
Employee sick leave ^b	5,782	481	30,514	522
Employee short-term disability ^c	6,856	250	33,572	291
Employee long-term disability	9,863	7	49,679	5
Employee workers' Compensation	10,833	223	58,317	207
Dependent health care (any child) ^b	11,794	3,208	64,812	2,345
Dependent prescription drug (any child) ^b	11,794	767	64,812	233

^a Children were born before the index date but did not turn 12 years old until after. Costs were determined during the year after each person's index date. For the asthma cohort, this is the date of the first asthma diagnosis or first controller medication prescription in the study period. For controls, the index date is the date of a child's first medical or drug claim in the data.

^b $P \leq .001$.

^c $P = .008$.

Treatments by Age

Figure 1 illustrates the percentage of dependents taking SABAs and ICSs by age group. Across all age groups, a greater

percentage of employees had child dependents that used SABAs compared with ICSs. The percentage of employees with child dependents using SABAs was similar across all

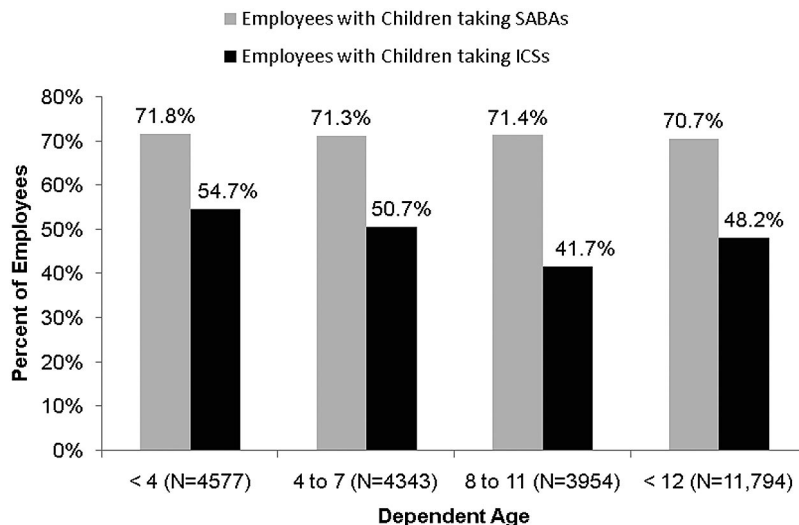


Figure 1. Percentages of employees with dependents using short-acting β -agonists (SABAs) or inhaled corticosteroids (ICSs).

age groups and ranged from 71.3% (4 to 7 years old) to 71.8% (<4 years old). The greatest use of ICSs (54.7%) occurred among the youngest (<4 years old) children and was lowest (41.7%) among the oldest (8 to 11 years old).

DISCUSSION

The vast economic burden attributed to pediatric asthma relates to the direct (eg, health care utilization and prescription drugs) and indirect (eg, lost productivity and decreased quality of life) costs from the societal and/or payer perspective. Evaluation of the direct and indirect costs of asthma from the point of view of the parent or caregiver has been limited to self-reports of productivity losses⁶ and decreased quality of life^{8,9} based on caregiver survey instruments.⁷ The impact of pediatric asthma on the parents' health care costs has not been previously studied.

To our knowledge, this is the first study to evaluate the costs of pediatric asthma to the parents and caregivers using objective measures. This analysis used a comprehensive source of data that included medical and pharmaceutical claims and employee benefit claims for sick leave, short-term disability, long-term disability, and workers' compensation to compute the health care, prescription drug, and absence costs of employees with children with asthma compared with employees with children without asthma.

The most obvious difference between the cohorts was in the area of dependent health care and prescription drug costs. Note that the costs shown are for all dependents in the family (dependent costs per employee). The costs were calculated "per employee" instead of "per dependent" for 2 reasons. First, nonclaimant dependents are not always identifiable in the data, and second, the purpose of the study was to show costs from the employer's perspective (and insurance premiums are "per employee"). The overall cost increment for employees with children younger than 12 years with asthma

was \$862 in child dependent health care costs per employee and \$534 in child prescription drug costs per employee. The greatest child dependent drug expenditure (\$919) was for employees with the oldest children with asthma, whereas child dependent prescription drug costs were lowest for employees in the youngest cohort (\$741). Dependent drug costs increased with age in the control groups as well.

Conversely, child dependent health care costs were highest in the employees with the youngest group of children with asthma. These results are consistent with reports that show the highest use of health care among the youngest patients with asthma.²¹ These reports suggest that confirming a definitive diagnosis of asthma in infants and toddlers can be difficult given the many possible causes of asthma symptoms (ie, wheezing) in the very young, and physicians may be reluctant to label the symptoms as asthma.²¹ This may explain the lower cost for prescription drugs in this age group. However, because respiratory distress in young children can rapidly become life-threatening, use of emergency department and hospital services for asthma symptoms is high in this age group,²¹ which may account for the higher child dependent health care costs. The difference in dependent health care costs was smallest in the youngest cohort, and this may be because younger children tend to require more health care services in general and because of newborn costs.

In this study, more than 70% of all employees with children with asthma filled SABA prescriptions for their children, whereas only 42% of employees with children 8 to 11 years old filled ICS prescriptions for their children. The greatest use of ICSs occurred in the youngest children (<4 years old), yet that figure only approached 55%. Although inhaled SABAs are an important part of asthma management for intermittent asthma and as a quick-relief medication for symptom control, current national guidelines promote the use of ICSs for long-term asthma control¹⁹ in children with per-

sistent asthma. The guidelines further recommend that increased reliance on SABAs may be a sign that the patient's asthma is inadequately controlled and requires long-term control therapy.¹⁹ The data illustrated in Figure 1 indicate that many children with asthma in this study do not receive ICSs. However, we do not know which if any of these children have persistent asthma and are thus not being treated according to the guideline recommendations. Nonadherence to guidelines regarding the use of ICSs in children with persistent asthma may explain the high use of SABAs and the significantly higher child dependent health care utilization among the entire asthma cohort.

Statistically significant ($P < .001$) overall annual cost differences were also identified for employee health care (\$154) and prescription drugs (\$95) in the asthma cohort vs the control cohort (<12 years old). Similar incremental employee prescription drug costs were seen in the asthma cohort in all 3 age subgroups. This finding may reflect the burden asthma places on the caregiver and the impact on overall health and quality of life.

These employee cost differences were highest for those employees with dependents in the 8- to 11-year age group (\$364 incremental health care and \$116 incremental drug for the asthma cohort vs control cohort)—the same age group that had the lowest use of the long-term controller medications (ie, ICSs). The higher employee health care costs of the asthma cohort recorded herein are consistent with the self-reported decreases in quality of life of asthma caregivers.^{6,8,9}

The most important asset of this study is the use of objective data and 2-part regression methods to quantify the burden of pediatric asthma to the parent or caregiver. The regression models controlled for the demographic differences between the cohorts. As such, this study goes beyond subjective reports of decreased productivity and diminished quality of life for the asthma caregiver that must then be "translated" into economic terms. However, this investigation also has some important limitations. Although the health care costs for both the employees and their dependents are based on objective claims data, costs were not examined by condition or comorbidity to determine the reasons for the differences. The results show that at all ages, children with asthma (and their caregivers) have higher health care costs compared with the cohorts without asthma. We have not, however, examined the specific nature of the services received. Increased emergency department visits for the children, for example, would indicate a pattern of inadequate asthma control. Also, although the comparisons controlled for many demographic, employment, and health characteristics among employees in the 2 cohorts, differences in other nonmeasured factors (eg, child-care providers, sick leave policies) may exist that could have lead to the result showing lower sick leave costs for employees in the asthma cohort. Lastly, because the controls were only limited to eligible employees without asthma, they may have had other conditions or been healthy. Use of a control group such as this is a common method for assessing the incremental impact (cost) of a disease (or condition).

In conclusion, pediatric asthma results in significant, objectively measured additional health care and prescription drug costs for both employees and their dependents. Follow-up studies should seek to quantify the relationships among dependent health care costs, asthma control, and parental costs.

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