

Estimating Lifetime Cost of Illness

An Application to Asthma

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Abstract

Rationale: Approximately 8% of the U.S. population suffers from asthma, a chronic condition. It poses a substantial economic burden to society in the form of lost productivity and healthcare costs.

Objectives: We use the Medical Expenditure Panel Survey 2002–2010 to quantify the lifetime costs of asthma at each age, the impact of adult asthma on earnings and choice of occupation, and the impact of childhood asthma on parental income.

Methods: We developed a framework to estimate the present discounted value of the cumulative lifetime asthma-related healthcare costs and lost productivity experienced by an individual after onset. This approach allows for age- and

asthma duration-related variability in annual costs as well as for the intermittent nature of asthma symptoms.

Results: Estimated asthma-related annual healthcare expenditures across all life stages are \$700–\$2,200 (2010 U.S. dollars). Lost annual earnings among individuals aged 30–49 are over \$4,000 (2010 U.S. dollars). The present discounted value of the cumulative lifetime healthcare costs and lost productivity for a new case of asthma is estimated at \$36,500 using the 3% discount rate (2010 U.S. dollars).

Conclusions: The economic burden of asthma is substantial and larger than previously estimated, reflecting expenditures on treatment and lost earnings.

Keywords: asthma; health care; foregone income; occupational choice; labor productivity

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Asthma is a chronic illness affecting about 8.4% of children and 7.6% of adults in the United States (1, 2). Asthma reduces lung function and increases the risk and frequency of respiratory symptoms, medication use, doctor and emergency room visits, hospital admissions, and

absences from school and work. These outcomes impose substantial costs to society, the value of which have been estimated to be \$81.9 billion in 2013 (3–5). These estimated societal costs of asthma do not capture the value society places on avoiding the pain and suffering

associated with asthma. A willingness-to-pay measure reflects the value of both the direct medical costs and this pain and suffering, but it is difficult to estimate. Thus, cost-of-illness estimates can represent a lower bound on the societal willingness to pay to avoid asthma (6, 7).

Table 1. Average annual healthcare cost of asthma based on the 2002–2010 MEPS (13–30)

Onset Age Group (yr)	Percentage Share of New Incidents in Age Group*	Annual Cost (2010 USD) by Asthma Duration		
		0–5 yr	6–19 yr	20+ yr
Ages 0 to 5	8 (7 to 9)	1,100 (900 to 1,200)	800 (700 to 900)	1,700 (1,500 to 1,900)
Ages 6 to 9	7 (6 to 8)	900 (800 to 1,100)	700 (600 to 800)	1,700 (1,500 to 1,900)
Ages 10 to 19	18 (17 to 19)	700 (600 to 900)	700 (600 to 800)	1,800 (1,600 to 2,000)
Ages 20 to 29	13 (12 to 14)	800 (600 to 1,000)	800 (700 to 900)	1,900 (1,700 to 2,100)
Ages 30 to 49	25 (24 to 26)	1,000 (900 to 1,200)	1,600 (1,400 to 1,900)	2,100 (1,800 to 2,300)
Ages 50 to 59	13 (12 to 14)	1,200 (1,100 to 1,400)	1,900 (1,600 to 2,300)	2,200 (1,800 to 2,500)
Ages 60+	16 (15 to 17)	1,900 (1,500 to 2,200)	1,900 (1,400 to 2,300)	2,200 (1,800 to 2,500)
All ages	—	1,100 (1,000 to 1,200)	1,300 (1,200 to 1,500)	2,000 (1,700 to 2,200)

Definition of abbreviations: MEPS = Medical Expenditure Panel Survey; USD = U.S. dollars.

Figures in parentheses are 95% confidence intervals reflecting sampling and imputation uncertainty. Costs are rounded to the nearest hundred.

*Age distribution of new asthma incidents was estimated using 2008–2010 MEPS data on lifetime history of asthma and included individuals who had asthma diagnosed within the past but are currently not experiencing it (28–30).

Asthma symptoms range from mild and intermittent attacks to severe and persistent exacerbated asthma typified by continual symptoms and limited physical activity affecting daily lives (2). Hence, the costs of asthma vary widely and can depend on the age at which asthma is initially diagnosed, changes in severity over time, and how well individuals manage the condition.

Recent literature has estimated specific components of the cost of asthma, including the cost of emergency room visits (8) and the average annual cost of illness and lost productivity (3, 4, 9). However, these approaches either account for a small component of the total costs or incompletely account for the lifetime costs of asthma. A more complete estimate of the lifetime cost would account for how individuals manage the illness in a way that reflects the expected severity and costs of the condition over their lifetime. These lifetime costs may also be useful to policy analysts characterizing the full costs of new cases of asthma (10).

This study estimates lifetime costs of illness for asthma capturing both healthcare costs and lost productivity. Similar to the authors of other asthma-cost studies (4, 9), we use data available from the Medical Expenditure Panel Survey (MEPS). For the first time, we evaluate the lifetime costs for individuals by age, considering how costs vary according to the disease duration, and by sex. We also account for the influence of asthma on worker productivity. Such information can be useful to decision-makers as they evaluate policies designed to reduce the incidence of asthma in the U.S. population.

Methods

Analytical Framework

Our goal is to estimate a present discounted value (PDV) of the lifetime aggregate of asthma-related healthcare costs and lost productivity experienced by an individual after asthma onset. We calculate a PDV because it allows us to express costs occurring over an individual's lifetime in current terms, accounting for society's time preferences (e.g., costs incurred today are more highly valued than the same costs incurred in future years). Because the intensity of asthma symptoms varies across individuals and over time (11, 12), our approach allows for age- and asthma duration-related variability in annual costs as well as for the intermittent nature of asthma symptoms. For the details of our analytical framework, see the online supplement. In brief, we calculate the PDV as a function of six factors: 1) the age of asthma onset, 2) the duration of the disease, 3) the probability that an individual will continue to experience asthma in a future year, 4) the asthma-attributable costs of health care, 5) the loss in productivity among individuals with asthma, and 6) a discount rate, which accounts for the lower value that people place on costs borne in the future.

Data and Estimation Approach

Our primary data source is the MEPS, a nationally representative survey of the U.S. civilian noninstitutionalized population implemented by the Agency for Healthcare Research and Quality (AHRQ). The survey has an overlapping panel design, tracking

individuals for at most 2 years and interviewing participants up to six times during the observation period. The MEPS collects demographic, socioeconomic, and health-status information at the first interview and in each subsequent interview asks about medical events experienced between the current and the previous interview (generally 4–5 mo) as well as about changes in employment status, health insurance coverage, etc. Below are details regarding specific MEPS data sets and other data used to estimate asthma-related annual healthcare costs and productivity losses. Further details regarding the MEPS database and our approach to estimating asthma-remission probability is detailed in the online supplement.

Identifying and characterizing asthma cases. We used *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD-9) code 493 in the MEPS Medical Conditions Files (13–21) to identify all individuals with current asthma. Of the 158,867 individuals surveyed from 2002 to 2010, 9,409 individuals (6%) had current asthma. Because the duration of asthma affects lifetime cost, we estimated it using the date of asthma onset in the Medical Conditions Files (for 2002–2007) and age at asthma onset in the Full Year Consolidated Files (for 2008–2010) (22–30).

Estimating annual healthcare cost. We estimate the annual cost of managing asthma as a function of age and asthma duration using data from the 2002–2010 MEPS. We constructed our data set by using the following 2002–2010 MEPS healthcare-use event data: Hospital Inpatient Stays Files, Emergency Room

Visits Files, Outpatient Visits Files, Office-Based Medical Provider Visits Files, Prescribed Medicines Files, Other Medical Expenses Files (see the online supplement for file references). Each event is characterized by the MEPS reference period during which it occurred, medical billing codes and procedure codes, and itemized payments and provider charges. To measure healthcare costs, we use inflation-adjusted total expenditures, which are the sum of itemized event-related payments.

When available, we use ICD-9 medical billing codes to identify asthma-related healthcare-use events for each current asthma case in our sample. An individual with current asthma may not use health care, in which case expenditures are zero. Approximately 30% of all medical events in

the MEPS are characterized by multiple ICD-9 codes. Because it is not possible to determine the primary condition treated during an event (and it is not possible to isolate the cost of one disease from the cost of another during a medical event) we used regression modeling to estimate the costs associated with asthma for each event. Specifically, we have estimated a generalized linear model (31), which is a regression predicting event-specific expenditures as a function of non-asthma condition indicators (i.e., those conditions the MEPS listed as occurring jointly with asthma). Further details regarding the regression are in the online supplement.

Several healthcare cost types exist that are not captured by the MEPS. First, the MEPS data collection omits medical billing codes for home health services and other

in-scope healthcare expenses (e.g., ambulance services, medical equipment). Second, the MEPS does not collect information on long-term medical care, over-the-counter medications, payments for phone contacts with medical providers, and indirect payments not related to specific medical events, such as Medicaid Disproportionate Share and Medicare Direct Medical Education subsidies (32). The online supplement describes our process for augmenting the MEPS-reported use data to account for these healthcare cost types.

Using the MEPS data adjusted using the procedure described in the online supplement, we have created the analytic data set containing the reference-period duration and total healthcare expenditures for each current asthma case in the 2002–2010

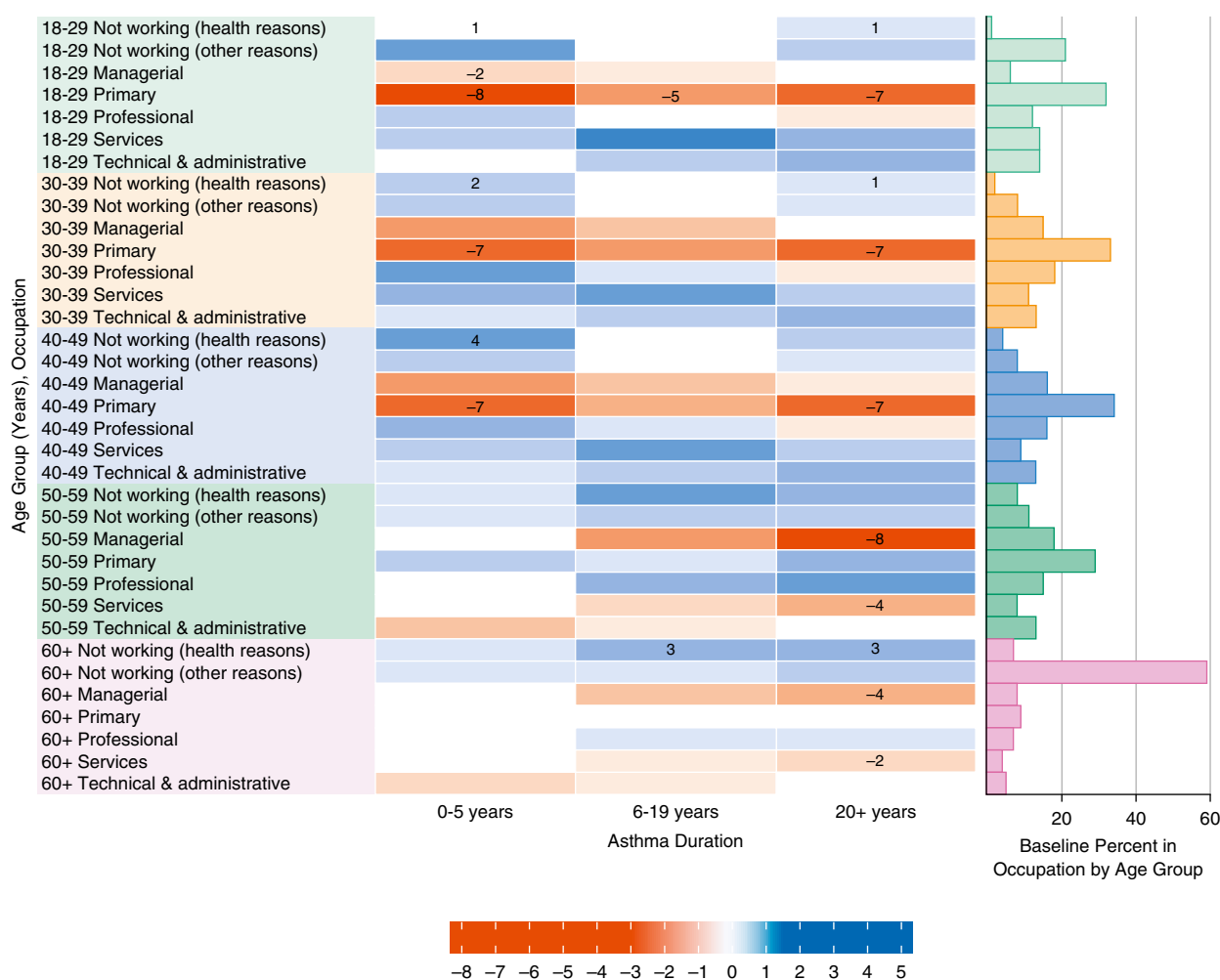


Figure 1. Effect of asthma on occupational choice by men. Values in cells represent the percentage change in baseline probability. Labeled cells represent statistically significant effects at a 5% level.

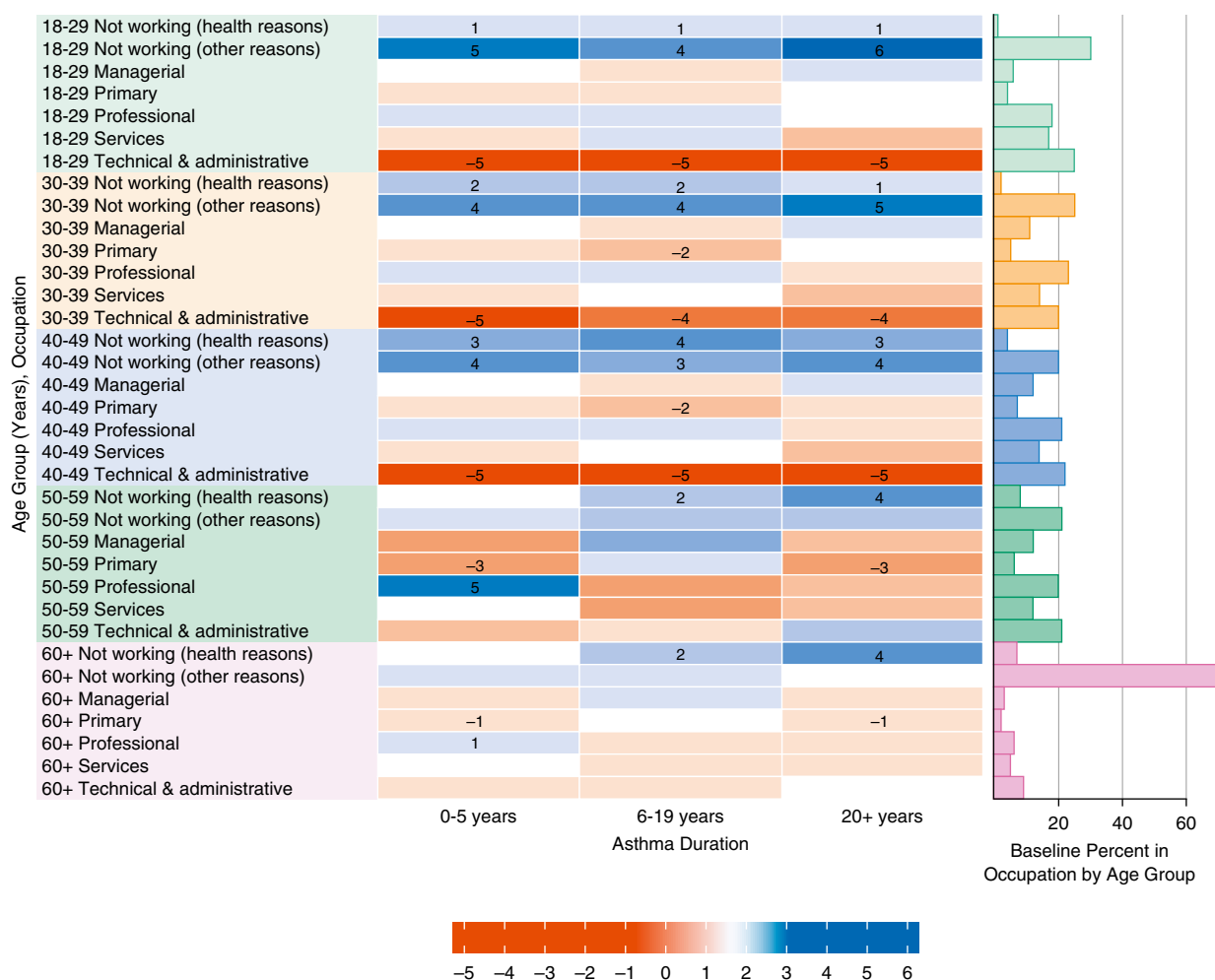


Figure 2. Effect of asthma on occupational choice by women. Values in cells represent the percentage change in baseline probability. Labeled cells represent statistically significant effects at a 5% level.

MEPS. Finally, we estimated annual asthma expenditures by dividing the total bias-adjusted expenditures by the total number of person-years under observation for 48 data bins. Each bin contains at least 100 person-years of observation, with an average of 300 person-years of observation, and is defined jointly by the asthma duration-based category (0, 1, 2–5, 6–9, 10–19, and 20 or more years since asthma onset) and the age-based category (0, 1, 2–5, 6–9, 10–19, 20–39, 40–64, and 65–88 years).

Estimating annual productivity

loss. We developed three models capturing the labor-productivity impacts of asthma:

1. The probability of not being able to work because of asthma health reasons;
2. The impact of asthma on occupational choice for those physically able to work; and

3. The impact of asthma on weekly earnings.

We estimated the overall productivity loss, as measured by the change in annual earnings, via simulating the combined impact of asthma on the likelihood of not being able to work for health reasons, the likelihood of being in particular occupations or unemployed, and the weekly earnings by occupation. This approach is detailed in the online supplement.

Estimating lifetime costs. We combined information on asthma-related healthcare costs, productivity losses, remission probability, and survival using Equations E1–E3 in the online supplement to calculate 1,290 sets of PDV estimates, one for each integer age at onset for ages 0–88. For ages at onset under 19 years, we use estimated fathers' earnings loss to represent productivity loss in the childhood years. This is because we have

found statistically significant productivity impacts only for fathers of children with asthma. Note that parental productivity loss that we model has not been conditioned on the primary caregiver status because this information is not available in the MEPS. Therefore, our earnings-loss estimates for fathers of children with asthma represent an average over all fathers, some of whom may not be primary caregivers. Also note that, because we have not explicitly modeled productivity impacts for sole-provider mothers, our parental earnings-loss estimates may not be appropriate for the 15% of children who live in households of this type (33, 34).

Results

Annual Healthcare Costs

The estimated annual asthma healthcare costs vary according to the age of onset and

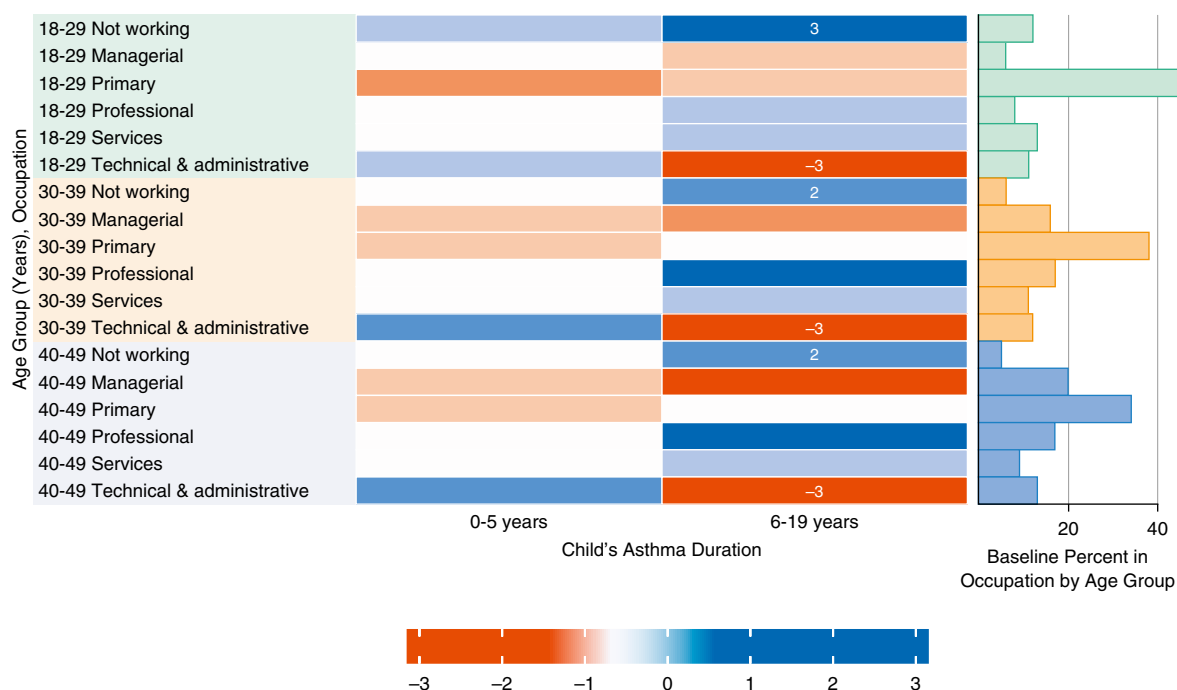


Figure 3. Effect of child's asthma on occupational choice by fathers. Values in cells represent the percentage change in baseline probability. Labeled cells represent statistically significant effects at a 5% level.

the number of years over which the individual experiences the illness (Table 1). For the first 5 years after onset, annual costs are relatively similar across ages, with the

exception of ages 60 years or older. Individuals aged 5 years or younger, and those aged 50 years or older, experience the greatest annual cost for the first 5 years of

the illness. The estimated annual cost also varies according to the duration of illness. Individuals experiencing asthma for over 20 years have greater costs compared with

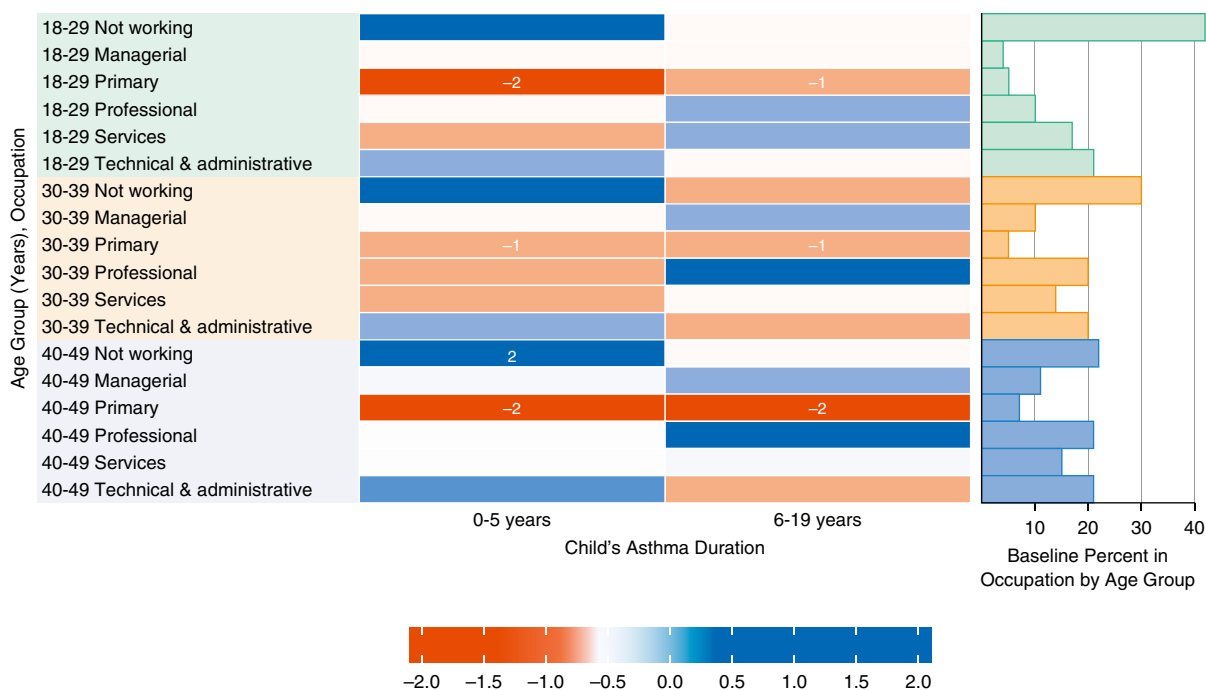


Figure 4. Effect of child's asthma on occupational choice by mothers. Values in cells represent the percentage change in baseline probability. Labeled cells represent statistically significant effects at a 5% level.

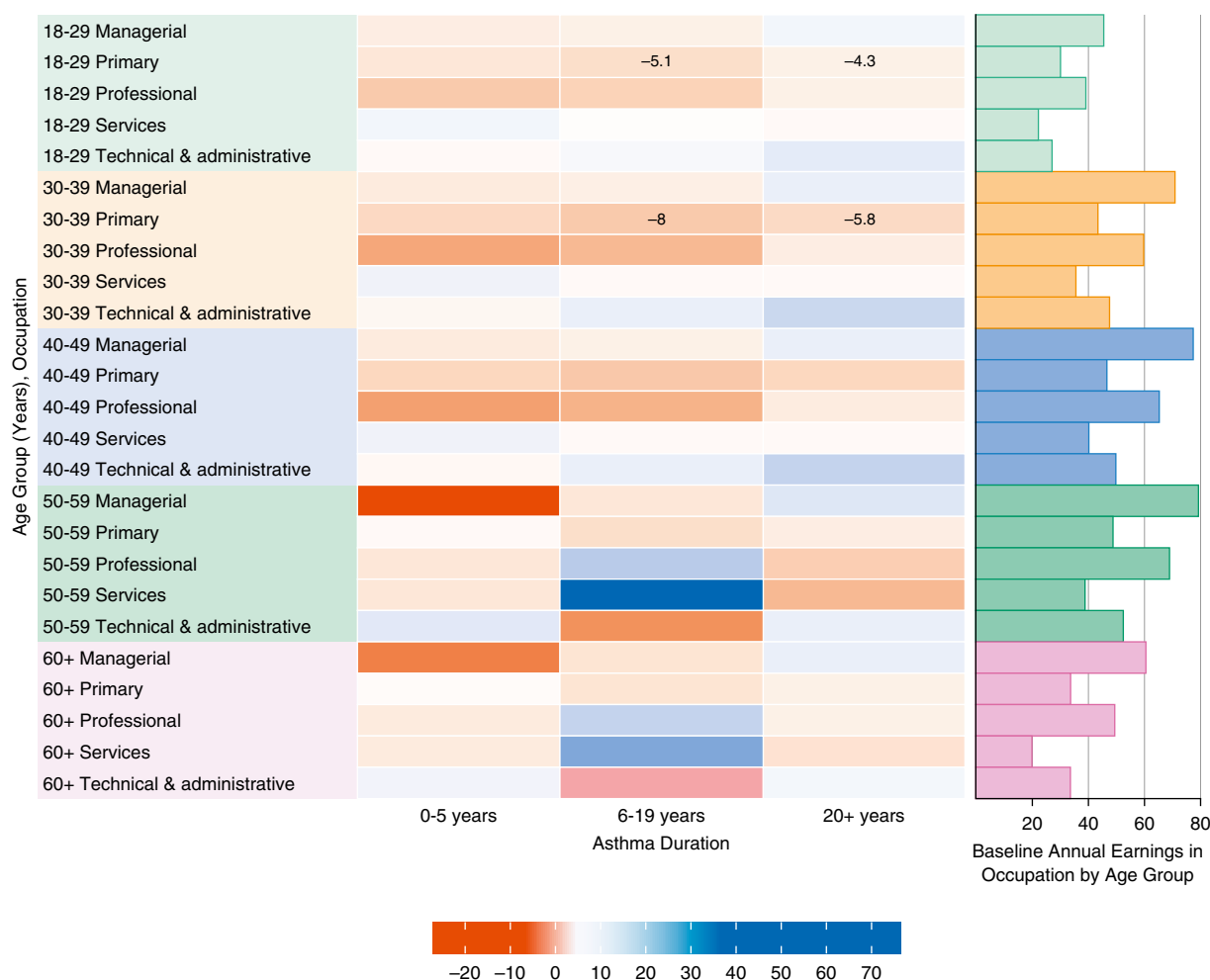


Figure 5. Effect of asthma on conditional earnings by men. Values in cells represent a change in annual income (thousands, 2010 U.S. dollars). Labeled cells represent statistically significant effects at a 5% level.

those with shorter-duration experiences, ranging from 1.2 to 2.6 times the minimum expenditure for the age-at-onset cohort. The cost among those aged 30 years or older increases with the disease duration, whereas individuals younger than 10 years experience a decreased cost at an asthma duration of 6–19 years before seeing an increase in the annual cost at an asthma duration exceeding 20 years.

The Influence of Asthma on Choice of Occupation

Occupational choice effects are summarized in Figure 1 (men), Figure 2 (women), Figure 3 (fathers), and Figure 4 (mothers). Negative impacts are shown in red, and positive impacts are shown in blue. Numerical estimates are shown for

significant (at the 5% significance level) results. For example, Figure 1 shows that for men in the 30–39 age group with an asthma duration of 0–5 years, there is 7% reduction in the probability of being in a primary occupation; 35% of men in this age group are in primary occupations.

The effect of asthma on not working (for health reasons or otherwise) is strongest in females younger than 50 years, with increased probability of 1–6% depending on age and the duration of asthma. Men with asthma under 50 are also less likely to work, but the results are more varied, ranging from a 0% to 4% increase in probability and limited to not working for health reasons. Men and women over 50 with asthma do not have a significantly higher unemployment probability, yet they are more likely to not work for health

reasons, with an increase in the probability of 0–4%.

Among men with asthma in the 18–29 age group, we estimate a 5–8% decrease in the probability of being in a primary occupation. These occupations include jobs in farming, fishing, and forestry; construction, extraction, and maintenance; and production, transportation, and material moving. A similar effect is seen for men with asthma in the 40–49 age group, although it is not always statistically significant. The largest effect of asthma on occupational choice for women is observed in the 40–49 age group, for which we consistently estimate a 5% decrease in probability of being in a technical or administrative occupation, regardless of asthma duration. We also estimate a 5% increase in the probability

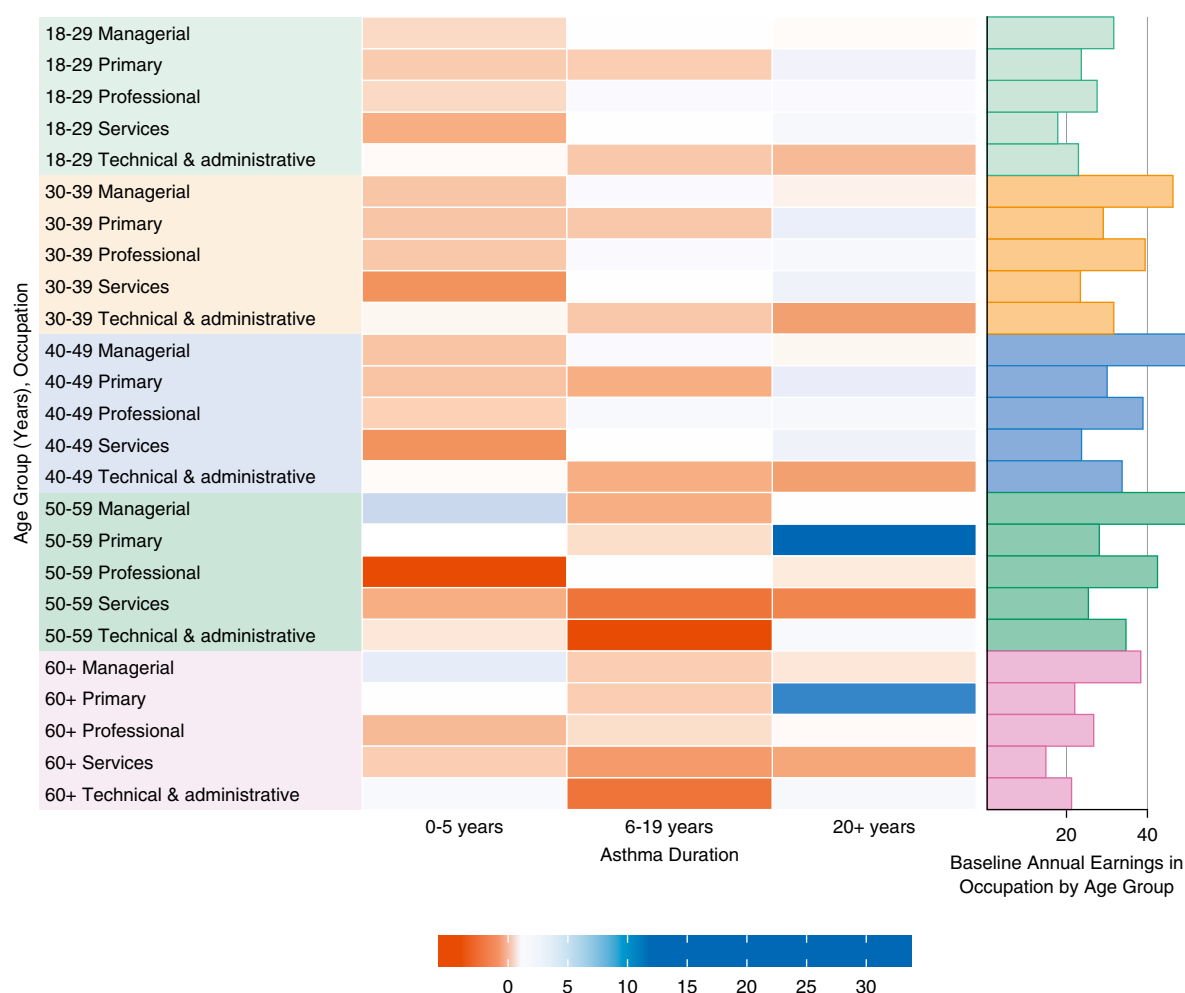


Figure 6. Effect of asthma on conditional earnings by women. Values in cells represent a change in annual income (thousands, 2010 U.S. dollars). Labeled cells represent statistically significant effects at a 5% level.

of being in a professional occupation for women with asthma in the 50–59 age group.

Our parental occupational choice model suggests that mothers of children with asthma are significantly less likely to work in primary occupations and are more likely to not work. The latter effect is only significant among 40- to 49-year-old mothers of children with recent asthma. However, fathers of children with asthma with a longer asthma duration are 3% more likely to not work and 3% less likely to work in technical and administrative occupations.

The Influence of Asthma on Earnings

Asthma affects earnings conditional on occupational choice for only some occupations and age groups, and this applies

only for men and fathers (see Figures 5–8). Men aged 18–49 years with an asthma duration of over 5 years have significantly lower conditional earnings in primary occupations. The largest magnitude of the reduction in annual earnings—\$8,000 (2010 U.S. dollars [USD]) or –20%—is estimated for men with asthma aged 40–49 years working in primary occupations. Fathers of children with asthma have consistently lower earnings in technical and administrative occupations, compared with fathers without children with asthma employed in these occupations. However, a statistically significant loss in annual earnings from technical and administrative occupations—\$6,200 (2010 USD) or –17%—is seen only for 18–29-year-old fathers of children with a longer asthma duration.

Annual Productivity Loss

Table 2 shows the change in annual earnings among five age groups (ages of 18–29, 30–39, 40–49, 50–59, and over 60 yr) and within three asthma-duration time periods (0–5 yr or short term, 6–19 yr or medium term, and over 20 yr or long term). Estimated annual earnings are significantly lower for individuals with asthma ages 18–49 during the first 5 years after onset. Lost earnings are also significant for individuals experiencing asthma for 20 or more years, but the magnitude is not large, perhaps because these individuals have adapted to the chronic illness when selecting an occupation. For those with short-term asthma, we estimate the greatest drop in annual earnings among individuals aged 30–39 years, followed by those aged 40–49 years. We estimate the smallest change in

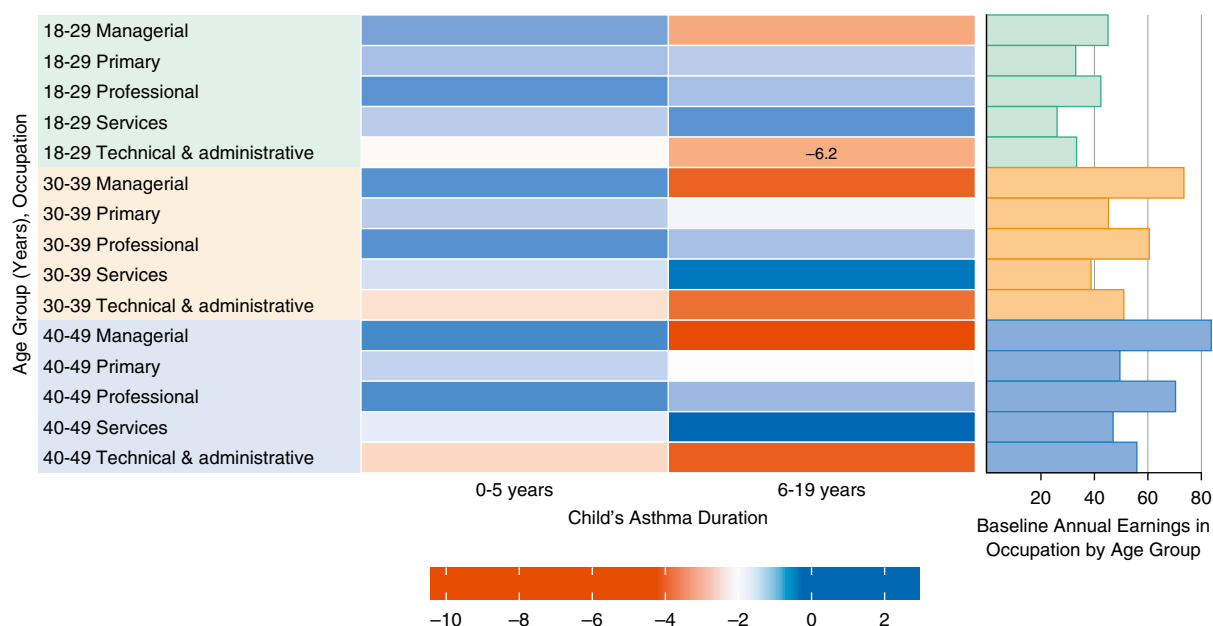


Figure 7. Effect of child's asthma on conditional earnings by fathers. Values in cells represent a change in annual income (thousands, 2010 U.S. dollars). Labeled cells represent statistically significant effects at a 5% level.

earnings among those aged 60 or older. Among individuals aged 18–49 years, foregone earnings are lowest for the medium-term asthma duration, compared with those observed for short-term and long-term asthma duration. Conversely, those 50 years and older experience the

largest foregone annual earnings in the medium-term asthma-duration period.

Table 3 shows that parents of children with short-term asthma experience a reduction in annual earnings of \$1,600 (2010 USD), whereas parents of children

with medium-term asthma experience a reduction in annual earnings of \$3,500 (2010 USD). However, these effects are not statistically significant. Focusing on these effects by sex, we find that fathers appear to experience larger losses in annual income compared to mothers.

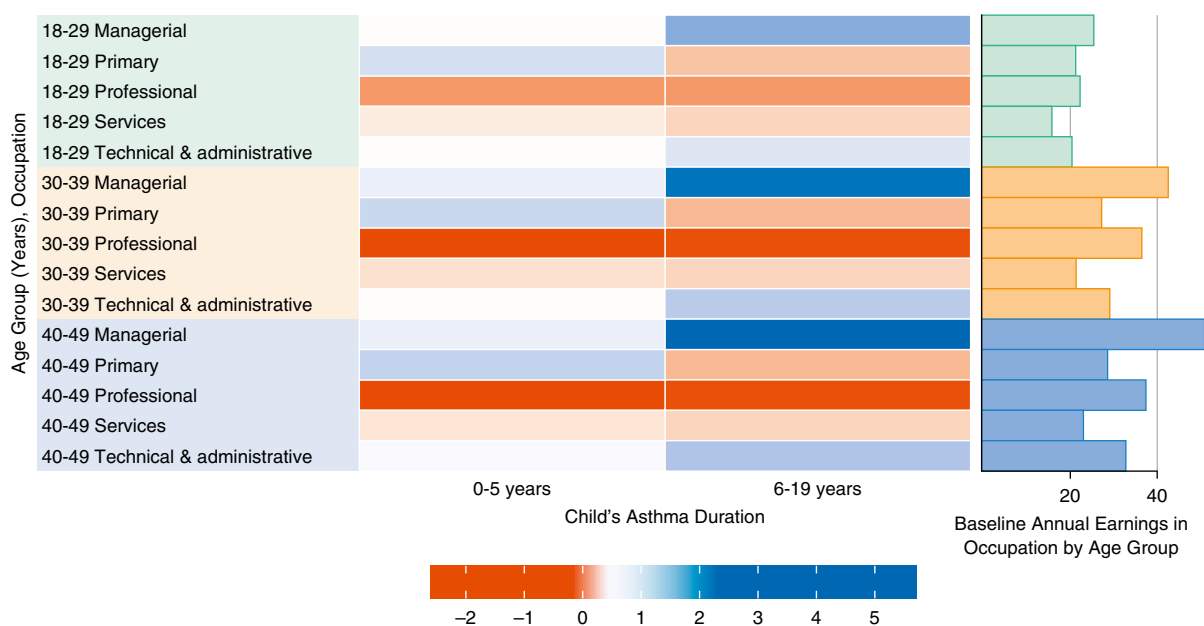


Figure 8. Effect of child's asthma on conditional earnings by mothers. Values in cells represent a change in annual income (thousands, 2010 U.S. dollars). Labeled cells represent statistically significant effects at a 5% level.

Table 2. Estimated change in productivity associated with asthma

Age Group (yr)	Change in Expected Annual Earnings (2010 USD)		
	Asthma Duration: 0–5 yr	Asthma Duration: 6 to 19 yr	Asthma Duration: 20+ yr
Ages 18 to 29	–900 (–1,400 to –300)	–100 (–300 to 100)	–600 (–1,200 to –100)
Ages 30 to 39	–4,200 (–6,900 to –1,600)	–700 (–3,400 to 2,000)	–2,600 (–5,200 to –100)
Ages 40 to 49	–4,100 (–6,700 to –1,600)	–900 (–3,800 to 1,900)	–3,100 (–5,800 to –400)
Ages 50 to 59	–2,200 (–6,600 to 2,100)	–2,600 (–6,900 to 1,700)	–1,400 (–7,100 to 4,300)
Ages 60+	–800 (–2,200 to 600)	–1,200 (–2,200 to –100)	–900 (–2,300 to 600)

Definition of abbreviation: USD = U.S. dollars.

Data are from the 2002–2010 Medical Expenditure Panel Survey (13–30, 35, 36) and additional sources described in the online supplement. Figures in parentheses are 95% confidence intervals reflecting sampling and imputation uncertainty. Dollar values are rounded to the nearest hundred.

Lifetime Cost

The estimated present values of the cumulative of healthcare costs and productivity losses among the population stratified by age-at-onset are reported in Table 4 (using a 3% discount rate) and Table 5 (using a 7% discount rate). We found the largest asthma healthcare costs among individuals with ages of 50–59 years at asthma onset. By contrast, we found the greatest productivity losses for parents of individuals aged 0–5 years at asthma onset. The present value of the total cost is the largest among populations aged 30–49 years at asthma onset.

Discussion

Asthma is a large and growing public health and economic burden in the United States. Existing information on the total economic cost of asthma is not sufficient for informing individual resource-management decisions or supporting assessments of the economic benefits of policies or programs that reduce the incidence of new cases of asthma (e.g., see References 37–39). We address this literature gap by providing incidence-focused estimates of the lifetime costs of asthma, differentiated by age at onset and duration of asthma. We estimated the expected lifetime PDV of asthma healthcare costs and lost productivity to be \$36,500 at a 3% discount rate and \$26,000 at a 7% discount rate (2010 USD). Our methods build on prior cost-of-illness literature but add several cost components via estimating the complex relationship among asthma, labor-force participation, unemployment, occupational choice, and earnings.

Healthcare Costs

The annual healthcare costs for asthma—as measured by healthcare expenditures by all paying parties—vary with asthma duration and age at onset. Our estimated annual costs for asthma (\$700–\$1,800 for children and \$800–\$2,200 for adults) are in line with other estimates reported in the literature, although no paper to date has modeled cost variation with respect to asthma duration. Kamble and Bharmal (40) estimated asthma-related annual healthcare costs of \$1,100 for children and \$2,300 for adults (2010 USD) using the 2004 MEPS. Barnett and Nurmagambetov (3) have estimated the annual healthcare cost of asthma to be \$3,400 (2010 USD) using the 2002–2007 MEPS. Sullivan and colleagues (41) estimated medical asthma-related costs for adults to be \$2,000 (2010 USD) using the 2003 and 2005 MEPS data. The annual cost estimates from other studies are adjusted for inflation in medical-care prices.

Our methods differ from those employed by prior studies in several ways. First, none of the studies bias-corrected MEPS, which could considerably increase the magnitude of annual cost estimates. Our sensitivity analyses show that the annual

asthma-related healthcare cost estimates without these adjustments range between \$500 and \$2,000. Second, Barnett and Nurmagambetov (3) and Sullivan and colleagues (41) use only treated asthma cases, which may explain their comparatively higher estimates. In contrast, our methods and methods used by Kamble and Bharmal (40) include all current asthma cases. Third, all three papers used top-down cost modeling. This approach assesses total annual expenditures for all individuals as a function of their medical conditions and determines the incremental impact of asthma. This approach accounts for the MEPS healthcare-use events not characterized by ICD-9 codes and, potentially, synergistic effects of multiple conditions on costs. However, we have found top-down modeling to be sensitive to the model specification and chose not to use it.

The limitations of the MEPS introduce uncertainty into our analysis; these include the underreporting of healthcare use, out-of-scope health-expenditure types, and out-of-scope populations, particularly in institutional healthcare settings. Although we compensated for these biases, future researchers may improve on our methods in

Table 3. Estimated change in parental productivity associated with childhood asthma

Parent Type	Change in Expected Annual Earnings (2010 USD)	
	Child's Asthma Duration: 0 to 5 yr	Child's Asthma Duration: 6 to 19 yr
Both parents*	–1,600 (–5,300 to 2,100)	–3,500 (–8,900 to 1,900)
Father	–900 (–4,500 to 2,800)	–4,100 (–9,200 to 900)
Mother	–700 (–2,000 to 500)	700 (–1,400 to 2,700)

Definition of abbreviation: USD = U.S. dollars.

Data are from the 2002–2010 Medical Expenditure Panel Survey (13–30, 35, 36) and additional sources described in the online supplement. Figures in parentheses are 95% confidence interval reflecting sampling and imputation uncertainty. Dollar values are rounded to the nearest hundred.

*This estimate is a sum of the mother's and father's change in productivity.

Table 4. Present discounted value of the lifetime cost stream for an asthma case (2010 USD, 3% discount rate)

Onset Age Group (yr)	Percentage Share of New Incidents in Age Group	Present Value of the Cost Stream (2010 USD)		
		Healthcare Cost	Productivity Loss	Total Cost
Ages 0 to 5	8 (7 to 9)	16,200 (14,900 to 17,500)	31,800 (−8,100 to 71,600)	47,900 (7,900 to 88,000)
Ages 6 to 9	7 (6 to 8)	15,200 (13,900 to 16,500)	26,400 (−5,400 to 58,200)	41,600 (9,700 to 73,500)
Ages 10 to 19	18 (17 to 19)	14,200 (13,000 to 15,400)	20,200 (1,700 to 38,700)	34,300 (15,600 to 53,000)
Ages 20 to 29	13 (12 to 14)	10,400 (9,100 to 11,800)	23,000 (9,400 to 36,700)	33,500 (20,000 to 47,100)
Ages 30 to 49	25 (24 to 26)	16,300 (14,600 to 18,000)	34,000 (14,300 to 53,700)	50,200 (30,800 to 69,700)
Ages 50 to 59	13 (12 to 14)	17,400 (15,200 to 19,600)	16,200 (−6,800 to 39,100)	33,500 (10,400 to 56,500)
Ages 60+	16 (15 to 17)	10,200 (8,400 to 12,100)	4,400 (−1,700 to 10,600)	14,500 (8,000 to 20,900)
All ages	—	14,300 (13,400 to 15,200)	22,300 (10,900 to 33,700)	36,500 (25,100 to 47,800)

Definition of abbreviation: USD = U.S. dollars.

Figures in parentheses are 95% confidence intervals reflecting sampling and imputation uncertainty. Costs are rounded to the nearest hundred.

two ways. First, the researchers could focus on healthcare costs of asthma in institutional healthcare settings. Second, researchers could correct for the MEPS underreporting bias by developing individual-level cost inflation and reweighting using matched claims data for the children and working-age populations.

Productivity Impacts

The effect of asthma on productivity is complex. Asthma primarily influences one's ability to work and occupational choice, which differ between men and women. Direct effects of asthma on weekly earnings once an individual with asthma is in an occupation are small. When an individual manifests asthma, it restricts the ability to work and the ability to choose higher-income occupations, lowering overall earnings. These effects are consistent with findings from Sullivan and colleagues (41), who report that individuals with asthma are significantly less likely to be employed (odds ratio, 0.78) using the 2003 and 2005 MEPS data.

Sullivan and colleagues (42) observed a significant increase in missed workdays for parents of children with asthma, but the authors did not evaluate employment status or occupational choice. Wang and colleagues (43) and Barnett and Nurmagambetov (3) also looked at the lost productivity due to childhood asthma, as measured by the number of asthma-related of school absences using the 1996 MEPS and the 2002–2007 MEPS, respectively. Dean and colleagues (44) examined parents of children with controlled versus uncontrolled asthma, finding that uncontrolled asthma reduced parental productivity but did not affect the likelihood of being employed. Conversely, we found that fathers of children with asthma are more likely not to work and less likely to work in technical/administrative occupations. We have also found that mothers in their 40s are less likely to work, and less likely to work in primary occupations, if their child has had recent asthma. Consistent with Dean and colleagues (44), we have found lower

earnings for younger fathers with asthma in technical and administrative occupations.

The findings of our productivity-loss analysis should be viewed in light of its limitations. First, our occupational choice used a multinomial logit model, which is predicated on the assumption of “independence of irrelevant alternatives” (e.g., one's odds of selecting option A over option B should not depend on whether an irrelevant option C is available). However, alternative approaches in the literature not relying on this assumption (e.g., nested logit, multinomial probit) have not produced a convergent model. Second, the lack of appreciable asthma impacts on conditional earnings could be an artifact of the way in which AHRQ imputes hourly wages, such that it does not account for health status (thus accounting for the role of health status in affecting hourly wages). However, our sensitivity analyses excluding these imputed records did not produce any additional insights. Researchers wishing to extend our work could focus on health

Table 5. Present discounted value of the lifetime cost stream for an asthma case (2010 USD, 7% discount rate)

Onset Age Group (yr)	Percentage Share of New Incidents in Age Group	Present Value of the Cost Stream (2010 USD)		
		Healthcare Cost	Productivity Loss	Total Cost
Ages 0 to 5	8 (7 to 9)	10,100 (9,300 to 10,900)	20,600 (−9,700 to 50,800)	30,700 (300 to 61,100)
Ages 6 to 9	7 (6 to 8)	9,200 (8,300 to 10,000)	17,300 (−8,200 to 42,800)	26,400 (900 to 52,000)
Ages 10 to 19	18 (17 to 19)	8,000 (7,300 to 8,800)	12,500 (−2,200 to 27,200)	20,500 (5,800 to 35,200)
Ages 20 to 29	13 (12 to 14)	7,100 (6,000 to 8,200)	16,200 (7,000 to 25,400)	23,300 (14,300 to 32,300)
Ages 30 to 49	25 (24 to 26)	11,400 (10,200 to 12,700)	27,200 (12,000 to 42,400)	38,600 (23,700 to 53,500)
Ages 50 to 59	13 (12 to 14)	12,700 (11,100 to 14,200)	13,200 (−6,900 to 33,300)	25,800 (5,600 to 45,900)
Ages 60+	16 (15 to 17)	9,000 (7,300 to 10,700)	3,900 (−1,700 to 9,400)	12,700 (7,000 to 18,400)
All ages	—	9,800 (9,200 to 10,400)	16,300 (7,600 to 25,100)	26,000 (17,400 to 34,700)

Definition of abbreviation: USD = U.S. dollars.

Figures in parentheses are 95% confidence intervals reflecting sampling and imputation uncertainty. Costs are rounded to the nearest hundred.

status-dependent imputed MEPS employment variables.

Lifetime Cost

Lost productivity constitutes approximately 60% of the total lifetime asthma costs. This relationship varies with age. For ages of onset under 50 years, healthcare costs represent far less than half of the total lifetime cost, with the remainder being lost earnings to the individual or the parent of a child with asthma. For ages of onset over 50 years, lost earnings are a smaller fraction of total costs, perhaps reflecting lower overall workforce participation for the older age cohorts as a whole. As such, there are two distinct lifetime cost regimes for asthma,

depending on whether the disease manifests during childhood and young adulthood (before age 30) or during later adulthood (after age 30). Within each regime, lifetime costs are highest for the youngest age-at-onset group and then decrease with age of onset. This may reflect differences in how asthma manifests itself in these different life stages (45).

Our approach to estimating the lifetime cost of asthma does not account for reduced life expectancy. However, the short-panel nature of the MEPS does not permit measurement of this effect, and the literature also does not point to significant life-expectancy implications of asthma (46–48). Our approach also does not account for

the influence of asthma intensity, the intraannual variability of asthma symptoms, or the quality of health care on the probability of an individual continuing to experience asthma throughout their life. Measuring these effects is not possible because the MEPS lacks detailed clinical information that would enable separating the effects of care from the individual asthma-related idiosyncrasies. ■

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