

Economic burden of asthma in Korea

Yo-Han Lee, M.D., M.P.H.,¹ Seok-Jun Yoon, M.D., Ph.D.,¹ Eun-Jung Kim, Ph.D.,²
Young-Ae Kim, M.P.H.,³ Hye-Young Seo, B.A.,³ and In-Hwan Oh, M.D., Ph.D.¹

ABSTRACT

Understanding the magnitude of the economic impact of an illness on society is fundamental to planning and implementing relevant policies. South Korea operates a compulsory universal health insurance system providing favorable conditions for evaluating the nationwide economic burden of illnesses. The aim of this study was to estimate the economic costs of asthma imposed on Korean society. The Korean National Health Insurance claims database was used for determining the health care services provided to asthma patients defined as having at least one inpatient or outpatient claim(s) with a primary diagnosis of asthma in 2008. Both direct and indirect costs were included. Direct costs were those associated directly with treatment, medication, and transportation. Indirect costs were assessed in terms of the loss of productivity in asthma patients and their caregivers and consisted of morbidity cost, mortality cost, and caregivers' time cost. The estimated cost for 2,273,290 asthma patients in 2008 was \$831 million, with an average per capita cost of \$336. Among the cost components, outpatient and medication costs represented the largest cost burden. Although the costs for children accounted for the largest proportion of the total cost, the per capita cost was highest among patients ≥ 50 years old. The economic burden of asthma in Korea is considerable. Considering that the burden will increase with the rising prevalence, implementation of effective national prevention approaches aimed at the appropriate target populations is imperative.

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Asthma imposes a substantial economic burden on individuals and society given that it is a highly prevalent, chronic illness that requires continued use of the health care system.^{1–3} Globally, asthma-related costs have been estimated to exceed those of human immunodeficiency virus/acquired immunodeficiency syndrome and tuberculosis combined, and in developed countries, health care expenditures for asthma represent 1–2% of the entire health care budget.^{3,4}

Studies regarding the costs of asthma have been performed in many countries because understanding the magnitude of the economic impact of asthma on society is fundamental to planning and implementing relevant policies.^{5,6} However, many of the previously conducted studies used small, select population samples or secondary data that are not generalizable.^{1,7,8} Consequently, there is a lack of accurate national-level estimates and it is difficult to make cross-country comparisons.

South Korea has a compulsory universal health insurance system that includes medical claims records

for nearly all of the Korean population.⁹ The National Health Insurance (NHI) claims database provides a unique and favorable mechanism for evaluating the nationwide magnitude of an illness and consequent health care use.¹⁰ Nevertheless, studies on the economic impact of illnesses, including asthma, have not been routinely conducted in South Korea.

The disease burden of asthma in Korea is large and growing, as evidenced by previous studies showing that asthma was ranked as the fourth most burdensome disease by disability-adjusted life years among major diseases¹¹ and the prevalence and mortality rate of asthma is continually increasing.^{12,13} Thus, it is anticipated that the economic burden of asthma on Korean society is substantial. The aims of this study were (1) to estimate the total economic cost of asthma in Korea, (2) to assess the relative contribution of different cost components and age groups to the total costs, and (3) to evaluate the per capita cost associated with asthma.

MATERIALS AND METHODS

Overview

Using a prevalence-based approach, which estimates the economic cost of all cases existing in a given period,⁶ we measured annual costs attributable to asthma for the year 2008. The primary source for estimating costs was the NHI claims database, which contains almost all of Korea's claim records.⁹ Records for the period of January 1 to December 31, 2008 were used. Our criteria for classifying a person as an "asthma

From the ¹Department of Preventive Medicine, College of Medicine, Korea University, Seoul, Korea, ²Department of Nursing, Cheju Halla College, Jeju, Korea, and ³Graduate School of Korea University, Department of Public Health, Seoul, Korea
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Address correspondence and reprint requests to In-Hwan Oh, M.D., M.P.H., Department of Preventive Medicine, College of Medicine, Korea University, 126-1, 5-ka, Anam-dong S-ga, Seongbuk-gu, Seoul, 136-701 Korea
E-mail address: bebetter@korea.ac.kr
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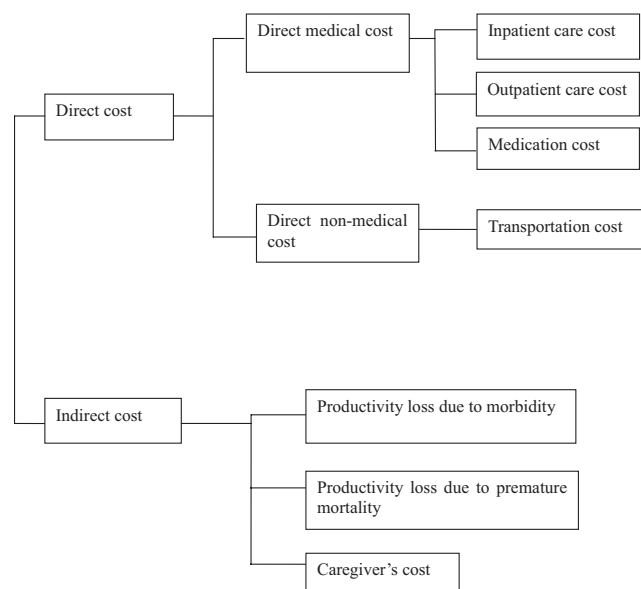


Figure 1. Cost components of asthma.

patient" were at least one inpatient or outpatient claim(s) with a primary diagnosis of asthma ("asthma" and "status asthmaticus.")¹⁴ We included both direct and indirect costs in our assessment. Direct costs calculated were those associated directly with treatment, medication, and transportation, and indirect costs were defined as patients' and caregivers' productivity losses associated with inpatient and outpatient treatments¹⁰ (Fig. 1). All estimated costs are presented in U.S. dollars with an exchange rate of \$1 equaling 1040 Korean won (exchange rate on July 2, 2008).

Direct Cost

Direct costs consisted of medical and nonmedical expenses. Direct medical costs were defined as formal expenses for diagnosis and treatment of asthma within the official health care system and consisted of inpatient and outpatient care costs, along with the cost of any medication. Annual inpatient and outpatient care costs covered by insurance were estimated using NHI claims records. To estimate inpatient and outpatient costs not covered by insurance, such as elective services, which are not included in the NHI claims database, a government report detailing such costs was used.¹⁵ To estimate medication costs, besides NHI claims database, we extracted prescription claims for asthmatic patients for 2008 from the drug claims records of Health Insurance Review and Assessment Service, which is another governmental institution. We made the assumption that money spent on noninsurance covered drugs and over-the-counter drugs was negligible, given that there is little evidence that asthma patients self-treat using these types of drugs.¹⁶ Transportation costs for patients and caregivers in seeking both inpatient and outpatient services were

counted as direct nonmedical costs. A one-way trip unit cost with one caregiver for both an inpatient and an outpatient visit was calculated using data from the Korean Health Panel Study, which was conducted by the government in 2008.¹⁷

Indirect Cost

Indirect costs are generally defined as "output lost because of cessation or reduction of productivity due to morbidity or mortality."¹⁸ In this study, indirect costs consisted of morbidity cost, mortality cost, and caregivers' time cost and were calculated based on human capital approach that values human's productivity using market earnings.^{19,20} Morbidity costs were defined as loss of earning due to inpatient and outpatient visits for asthma treatment and estimated by multiplying the amounts of visits with age- and gender-specific average daily earning and employment rates for ages 20–69 years.²¹ The amounts of visits were calculated from length of stays in hospital(days) added with 1/3 of the number of outpatient visits.²² However, the loss of productivity at work (presenteeism)²³ was not taken into account. Mortality costs were defined as loss of future potential earnings until age 69 years as a result of premature death⁵ and estimated by multiplying the number of asthma-related deaths in 2008²⁴ with age- and gender-specific average yearly earning and employment rates for each deceased persons. A discount rate of 3% was applied to reflect the present value of future earnings.⁶ Caregivers' time costs were assessed from both inpatient and outpatient sources. In Korea, almost all caregiving for asthma patients is performed by a family member, primarily a middle-aged woman.¹⁶ Therefore, we assumed that the caregiver was a woman, aged 50–54 years, for all inpatient visits. For outpatient visits, we assumed that a woman, aged 50–54 years, accompanied patients <20 years old and those >70 years old. We calculated a 50- to 54-year old woman's time cost for inpatient and outpatient care using the same method used for determining loss of productivity.

The scheme for estimating indirect costs as followed:

Indirect costs = Morbidity costs + Mortality costs + Caregivers' time costs

Morbidity costs

$$= \sum_i \sum_j \{(I_{ij} + \frac{1}{3}O_{ij})\} \times D_{ij} \times E_{ij}$$

where i = age, j = gender, I = total days of inpatient, O = number of outpatient visit, D = average daily earning, and E = employment rate.

Table 1 Total estimated costs

Cost Component	Costs*	Percent#
Direct medical cost		
Inpatient care	61.0	7.4
Outpatient care	310.8	37.4
Medication	144.9	17.4
Direct nonmedical cost		
Transportation	19.6	2.4
Indirect cost		
Morbidity	103.1	12.4
Mortality	74.6	9.0
Caregiving	117.1	14.1
Total	831.1	100.0

*In U.S. million dollars.

#Percent of the total cost.

Mortality costs

$$= \sum_i \sum_j \sum_t \left\{ \frac{F_{ij} \times Y_{ij}^{t+k} \times E_{ij}}{(1+r)^k} \right\}$$

where i = age, j = gender, t = age of death, F = number of death, Y = average yearly earning at $t+k$, E = employment rate, k = number of years after death till age 70, r = discount rate.

Caregivers' time costs

$$= \sum_i \sum_j \{(I_{ij} + \frac{1}{3}O_{ij})\} \times D \times E$$

where i = age, j = gender, I = total days of inpatient, O = number of outpatient visit, D = average daily earning for aged 50–54 woman, and E = employment rate for aged 50–54 woman.

Data Analysis

Total costs are presented according to each cost component and age group. To determine a per capita cost, estimated total costs were divided by the number of patients according to age group. A sensitivity analysis was conducted to identify the range of cost estimation and prevalence, according to two different outpatient case definitions for asthma, having at least three outpatient claims and present criteria. Data collection and analyses were performed using Stata 11.0 (StataCorp, College Station, TX).

RESULTS

Cost of Asthma

A total of 2,273,290 asthma patients were identified. The total costs incurred by these asthma patients in South Korea in 2008 were estimated at \$831.1 million (Table 1). Outpatient costs were the largest component

(37.4%), followed by medication costs (17.4%) and caregiver's time cost (14.1%). Inpatient costs accounted for only 7.4% of the total cost, making it the sixth of seven components. Morbidity costs and mortality costs accounted for 12.4 and 9.0% of the total cost, respectively. Direct costs were calculated to be \$536.3 million (64.5%) and indirect costs were \$294.8 million (35.5%).

Prevalence and Costs According to Age Group

The prevalence of asthma in the Korean population was 4.7%. Approximately 40% of the patients were children <10 years of age, making the prevalence for this age group 18.0%, which was overwhelmingly high compared with other age groups. Children <10 years of age accounted for 31.2% of total costs. Cost occupancy rates for patients ≥ 50 years of age were also relatively high, ranging from 13.6 to 16.2% of the total cost (Table 2). Average per capita cost was calculated to be \$366. For children, cost occupancy rate was low compared with patient occupancy rate because of the relatively low per capita cost. On the other hand, for patients ≥ 40 years old, the cost occupancy rate was high compared with patient occupancy rate because of the high per capita cost. In particular, the per capita costs for patients ≥ 50 years old were almost twice that of children.

Sensitivity Analysis

With more strict case definition, a total of 788,419 patients were identified and the prevalence of asthma was 1.6%. Estimated total costs were \$505.1 million, which was lower than the original estimate by 65% and per capita cost was \$641. Inpatient care costs accounted for 12.1% and outpatient care costs were 19.1%. Medication costs were the largest component (Table 3).

DISCUSSION

We estimated the economic burden of asthma on Korean society using a unique nationwide data set and the general methodology for a cost-of-illness study. The estimated cost for 2,273,290 asthma patients in 2008 was \$831 million, with an average per capita cost of \$366 and the total cost estimate goes down to \$505 million with a more strict criteria. Among the cost components, outpatient and medication costs represented the largest cost burden. Although the costs for children accounted for the largest proportion of the total cost, the per capita cost was highest among patients ≥ 50 years old.

To understand the relative magnitude of economic burden found in this study, it is useful to compare our study with other domestic studies that have used similar methods in terms of data sources, cost components, and some assumptions. When compared with major diseases such as cancer, liver disease, cardiocerebro-

Table 2 Prevalence and costs according to age group

Age Group (yr)	Prevalence		Patient Occupancy(%)	Costs*	Cost Occupancy (%)	Per Capita#
	<i>n</i>	Percent				
Total	2,273,290	4.7	100.0	831.1	100.0	366
0–9	914,745	18.0	40.2	258.9	31.2	283
10–19	180,732	2.7	8.0	31.7	3.8	175
20–29	111,779	1.6	4.9	25.5	3.1	228
30–39	200,053	2.4	8.8	53.5	6.4	268
40–49	214,577	2.6	9.4	82.5	9.9	385
50–59	212,909	3.5	9.4	113.0	13.6	531
60–69	214,905	5.6	9.5	135.0	16.2	628
≥70	223,590	7.0	9.8	130.9	15.8	586

*In millions.

#In dollars.

Table 3 Sensitivity analysis by varying the outpatient case definition

Cost Component	One or More Visits (present criteria)	Three or More Visits
	Cost* (%)	Cost* (%)
Prevalence	4.7%	1.6%
No. of patients	2,273,290	788,419
Direct medical cost		
Inpatient care	61.0 (7.4)	61.0 (12.1)
Outpatient care	310.8 (37.4)	96.5 (19.1)
Medication	144.9 (17.4)	120.1 (23.8)
Direct nonmedical cost		
Transportation	19.6 (2.4)	9.9 (2.0)
Indirect cost		
Morbidity	103.1 (12.4)	61.4 (12.2)
Mortality	74.6 (9.0)	74.6 (14.8)
Caregiving	117.1 (14.1)	81.7 (16.2)
Total	831.1 (100.0)	505.1 (100.0)
Per capita cost#	366	641

*In U.S. million dollars.

#In dollars.

vascular disease, and diabetes mellitus, with annual costs ranging from \$1 to 3 billion^{10,22,25} (Table 4), asthma seems to impose less of an economic burden. However, considering that the costs for asthma were much more than those of cervical cancer,²⁵ allergic rhinitis,²⁶ and chronic hepatitis B and similar to breast cancer and hepatitis B–related hepatocellular carcinoma,²⁷ it can be concluded that the economic burden of asthma in Korea is substantial.

On one hand, it is useful to consider estimated costs as a rate of gross domestic product (GDP), particularly when making comparisons with international studies that have been conducted using a variety of data sources and study methodologies.²⁸ Studies published in some of the most industrialized countries (United

States, United Kingdom, Canada, Australia, and Sweden) showed that the cost of asthma represents 0.1–0.3% of the GDP.²⁹ Meanwhile, the estimated cost of asthma in Korea accounted for 0.08% of the Korean GDP. Considering that the per capita cost from this study (\$366–641) is not much lower than that of other industrialized nations, ranging from \$300 to 1300,³⁰ it could be said that the relatively low percent of GDP in Korea is caused by the low prevalence of asthma (4.7%) compared with other developed countries in which its prevalence of asthma exceeds, generally, 10%.³

Some large-scale studies in Korea have documented a broad range of the prevalence of asthma in Korea ranging from 2 to 13% because of various case definitions and study methodologies.¹² According to an in-

Table 4 Economic burden of major diseases in Korea

Study	Disease	Costs (in U.S. million dollars, 2008)
Yang <i>et al.</i> ²⁶	HBV related diseases	1862
	HBV-related HCC	830
	HB-related cirrhosis	512
	Chronic hepatitis B	447
Kim <i>et al.</i> ²⁵	Allergic rhinitis	333
Lim <i>et al.</i> ¹⁰	Stroke (overall)	3593
	Ischemic stroke	1494
	Hemorrhagic stroke	1273
Kim <i>et al.</i> ²⁴	Overall cancer	14,000
	Liver cancer	2365
	Stomach cancer	2307
	Lung cancer	1596
	Colon cancer	1326
	Breast cancer	932
	Cervical cancer	350
Chung <i>et al.</i> ²¹	Heart disease	2059
	Diabetes mellitus	1114
	Liver diseases	2519

HBV = hepatitis B virus; HCC = hepatocellular carcinoma.

ternational report issued by the Global Initiative for Asthma, the prevalence of asthma in Korea is estimated to be 3.9%,³ and, generally, it is considered that the prevalence of asthma for total population in Korea exceeds 4%.^{8,13,31} Considering the fact that the prevalence of asthma in Korea has gradually risen, it is believed that the economic burden of asthma will increase substantially.

The fact that outpatient and medication costs were the largest components of the total cost shows that asthma is a burdensome chronic disease, requiring continuous outpatient-based management. However, this phenomenon, seen in other industrialized countries,^{1,29,32} may be viewed as an indirect indicator of asthma being well managed at the outpatient level and not progressing to the emergency or inpatient level. In previous studies, the proportions of emergency and inpatient costs associated with asthma in Korea were very small¹⁶ and the rate of emergency room visits due to asthma was the lowest among Asian countries.³³ This supports the idea that asthma has been well controlled in Korea, although it needs further studies to verify this hypothesis. Caregiver's time costs ranked third of the seven components measured, with 68.1% of the total caregiver's costs due to children who were patients (data not shown). This indicates that families with children needing medical attention for asthma suffer substantial lost productivity, as other studies have already established.¹

The heaviest economic burden was on patients 50–69 years old because of the substantial indirect cost for these age groups because of their relatively high economic power and mortality rate representing 60.1% of the total morbidity costs and 72.3% of the total mortality costs, respectively (data not shown); however, cost burden on patients ≥ 70 years old is caused by, mainly, high proportion of inpatient treatment, which is more expensive than outpatient treatment (data not shown). This finding may have important policy implications regarding the reduction of economic burden. Given that it is difficult to find and implement effective interventions to prevent the occurrence of childhood asthma,³⁴ for minimizing health care utilization in middle age, it is potentially more practical and effective to take intensive strategies for prevention and symptom management targeted at young adult patients.^{35,36}

The main limitation of this study was that the presenteeism was not taken into account in estimating indirect costs. Many cost-of-illness studies including the present study do not include presenteeism because existing data sets do not routinely collect this type of information, which is typically acquired only by self-report.⁵ Nevertheless, to evaluate an accurate picture of true indirect costs, presenteeism needs to be considered in any form or by any means because it accounts for a significant proportion of indirect costs in asthma-related diseases.^{37,38} Thus, real socioeconomic burden including presenteeism of asthma in Korea will be much larger than the estimates of this study. Considering that in a study the proportion of presenteeism accounted for 50% of total productivity losses,³⁷ the real socioeconomic costs of asthma in Korea would exceed \$1 billion.

Some subjective assumptions regarding productivity loss, productive period, and caregiver's characteristics could weaken the validity of estimated indirect costs. The methodologies for estimating indirect costs in cost-of-illness studies are inherently based on much assumptions regarding human and productivity values.¹⁹ So, it is important to compare across studies that have similar assumptions and methodologies to catch the real meanings of cost-of-illness studies.³⁹

Another limitation of this study is about diagnosis accuracy of NHI claims data and there has been disagreement about the value of the NHI claims data. In one study, the validity of discharged diagnoses in NHI claims data has been shown to be only 70% concordant with medical records.⁴⁰ To account for this discrepancy and avoid any misclassification, we tried to suggest the possible range of cost estimation with two different case definitions.

In conclusion, this study shows that the economic burden of asthma in Korea is considerable and the significant proportions of total costs were attributed to

office visit use and, children and middle age patients. Considering that the burden will increase with the rising prevalence, implementation of effective prevention and management approaches aimed at the appropriate target populations is imperative.

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