INTRODUCTION

The morbidity, mortality, and costs associated with asthma are imposing an ever increasing burden on society. Evidence obtained worldwide indicates that health care costs related to asthma represent a large percentage of health care expenditures. Nevertheless, little reliable information is available regarding the nature and magnitude of the burden due to asthma at the national level. This study was conducted to characterize the financial burden imposed by asthma in the Republic of Korea at the national level. Methods: The overall prevalence of asthma and the costs of related medical services were determined using data from the National Health Insurance Corporation, which is responsible for the National Health Insurance scheme. Indirect costs, including expenditures on complementary and alternative medicines, and the financial impact of an impaired quality of life (intangible costs) were estimated by surveying 660 asthmatics, and these estimates were transformed to the national level using the prevalence of asthma. Results: The prevalence of asthma and total costs related to the disease in 2004 were 4.19% and $2.04 billion, respectively. Direct costs and indirect costs contributed equally to total costs (46.9% and 53.1%, respectively). However, when intangible costs were included, total costs rose to $4.11 billion, which was equivalent to 0.44% of the national gross domestic product in 2004. Conclusions: The results provide evidence that asthma is a major health cost factor in the Republic of Korea and that intangible costs associated with asthma are significant cost drivers.

Key Words: Asthma; prevalence; cost-of-illness; direct costs; indirect costs; quality of life
payers for National Health Insurance (NHI)] is compulsory; thus, the NHI covers the whole nation. The main sources of the information used in this study were health insurance claims data from the NHI, which enabled us to estimate the nationwide financial burden of asthma. We also estimated the economic impact of impaired QOL (intangible costs) using the willingness-to-pay (WTP) method and the amount spent on CAMs. To our knowledge, this is the first estimate of the economic impacts of impaired QOL and CAMs related to asthma at the national level in the Republic of Korea.

**MATERIALS AND METHODS**

**Asthma prevalence**

We identified subjects with asthma as a main diagnosis by searching the NHI data base for codes J45 and J46 of the International Classification of Diseases-Tenth Revision (ICD-10) associated with any medical event (i.e., hospitalization, office/clinic visit, emergency room visit, or pharmacy visit). We then analyzed insurance claim data for the period 1 January to 31 December 2003 to determine asthma prevalence.

**Patient survey**

Asthma was diagnosed and its severity was determined based on spirometry results, in accordance with international guidelines. All patients with asthma were randomly recruited by allergy specialists who were chosen to represent a range of professional (university, general, and private clinics) and geographical (metropolitan and non-metropolitan) settings throughout the Republic of Korea. At the initial visit, the patient, or the patient’s parent for patients younger than 15 years of age, completed a questionnaire that addressed demographic factors, disease-related variables (symptom severity, current medication, and comorbid conditions), and cost-related variables (recall of medical service usage, expenditure on CAMs, WTP questionnaires, and work loss due to asthma over the previous 12 months). Patients were asked to keep a diary and record absences from school or work, medical services usage, and expenditures related to asthma management for 3 months (from 1 April to 30 June 2004). This prospective evaluation was designed to determine the extent to which recall bias affected questionnaire responses. All patients enrolled in this study provided written informed consent.

**Table 1. Asthma cost categories and resources used for estimation**

| Category                  | Direct formal medical | Direct informal medical | Direct non-medical | Indirect | Intangible |
|---------------------------|-----------------------|-------------------------|--------------------|----------|------------|
| Sub-category              | Reimbursed (patient + insurer) | Non-reimbursed | CAMs | Traffic | Time loss | QOL |
| Data sources              | NHIC data | Patient survey | Patient survey | Patient survey & NHIC data | Patient survey & NHIC data | Patient survey (WTP) |

CAMs, complementary and alternative medicines; QOL, quality of life; NHIC, National Health Insurance Corporation; WTP, willingness-to-pay.

**Costs of asthma**

Asthma-related costs were estimated as prevalence-based costs (the cross-sectional costs of all patients per annum) in 2004. All costs are presented in U.S. dollars calculated using the exchange rate for 30 April 2005: 1 U.S. dollar = 1,000 Korean won (₩). Costs before 2004 were extrapolated to 2004 values using the inflation rate of the field-specific price. The cost and source categories for the estimates are presented schematically in Table 1.

**Direct formal medical costs**

Direct formal medical costs were defined as the amounts expended on asthma management within the official health care system and included reimbursed and non-reimbursed costs. Reimbursed costs were payments for ambulatory care visits, hospital outpatient services, hospital inpatient stays, emergency room visits, physician and facility services, and prescribed medicines. These were extracted from NHIC data for the period 1 January to 31 December 2003 and included payments claimed by oriental medicine hospitals, which are regarded as part of the official health care system. Sometimes, because of stringent benefit coverage, patients paid a substantial sum for uninsured (out-of-coverage) services. For example, patients must pay in full for uninsured services such as meals during hospitalization and private rooms (rooms with fewer than six beds). In the present study, these were collectively categorized as non-reimbursed costs. The ratio of reimbursed to non-reimbursed costs derived from the patient survey was multiplied by the total amount of reimbursed costs calculated from NHIC data.

**Direct informal medical and non-medical costs**

Direct informal medical costs were defined as expenditures on CAMs not recompensed by the official health care system. Direct non-medical costs were defined as expenditures on medical-related services such as transport to the hospital and private nursing personnel. These costs were obtained by patient survey. A geometric mean value was calculated from the mean values of three age groups: elderly, ≥65 years old; adults, 20-64 years old; and children, ≤19 years old. These values were extended to the national level by multiplying by the total number of patients with asthma.
Indirect costs
Indirect costs were defined as costs incurred due to asthma-related loss of work and premature death. To estimate the costs of asthma-related loss of work, the average number of absences per patient or caregiver as a result of admission, ambulatory visits, and care was obtained from the patient survey, and this number was multiplied by age- and gender-specific wages and employment rates. The costs of asthma-related premature death were estimated using the calculated number of asthma-related deaths in 2004 and the expected future income based on demographic characteristics.

Intangible costs
Enrolled patients responded to a QOL questionnaire, developed by the Korean Society of Allergology, using a five-point scale to assess current QOL parameters. The patients also answered WTP questionnaires, which were designed as a bidding game. Patients were each allocated six different random bids, and after responding to yes-or-no questions twice, the patients were asked to evaluate their final WTP to improve their QOL. We used only half of the WTP estimates, because the WTP method generally provides an overestimation. Individually measured costs were transformed to the national level by using asthma prevalence.

RESULTS
The overall prevalence of asthma in the Republic of Korea in 2004 was 4.19%, based on NHIC data. Prevalence rates by age group are shown in Table 2. A total of 660 asthma patients from 31 institutions (18 in urban areas, 13 in rural areas) were enrolled in the patient survey. These included 180 elderly asthmatics (≥65 years old), 350 adult asthmatics (20-64 years old), and 130 child asthmatics (≤19 years old). Among these, 314 (47.8%) were male. According to asthma severity, 470 patients (71.2%) were categorized with mild asthma; 130 (19.7%), with moderate asthma; and 60 (9.1%), with severe asthma.

Costs of asthma
The total direct asthma-related cost in the Republic of Korea in 2004 was approximately $961.9 million. The estimated direct formal medical cost of asthma was $333.4 million in 2004. The largest portion was attributable to medication (35.3%), followed by ambulatory visits and hospitalization (Table 3). Direct informal medical costs amounted to $622.8 million and accounted for 64.7% of total direct medical costs. The direct formal and informal medical costs per patient per annum were $162.20 and $302.80, respectively. Direct non-medical costs were estimated to be $5.7 million, and these were mainly incurred by transpor-

Table 2. Prevalence of asthma by age

| Age group (yr) | Prevalence (%) |
|---------------|----------------|
|               | Total | Male     | Female  |
| 0-4           | 23.68 | 25.28    | 21.94   |
| 5-9           | 10.86 | 11.23    | 10.45   |
| 10-14         | 3.08  | 3.48     | 2.63    |
| 15-19         | 1.11  | 1.11     | 1.11    |
| 20-24         | 0.95  | 0.66     | 1.26    |
| 25-29         | 1.38  | 0.85     | 1.94    |
| 30-34         | 1.90  | 1.17     | 2.66    |
| 35-39         | 1.95  | 1.38     | 2.55    |
| 40-44         | 2.02  | 1.43     | 2.63    |
| 45-49         | 2.30  | 1.64     | 2.98    |
| 50-54         | 2.80  | 2.06     | 3.55    |
| 55-59         | 3.62  | 2.80     | 4.42    |
| 60-64         | 4.71  | 3.98     | 5.37    |
| 65-69         | 6.00  | 5.64     | 6.30    |
| 70-74         | 7.20  | 7.39     | 7.07    |
| >75           | 7.65  | 8.64     | 7.16    |
| Overall prevalence | 4.19 | 3.92     | 4.47    |

*In millions; †percentage of lost productivity of patients.

Table 3. Estimated direct costs of asthma in 2004

| Cost category | Cost ($)† | % |
|---------------|-----------|---|
| Formal medical | 333.4 | 34.7 |
| Medication | 117.8 | 35.3† |
| Ambulatory visit | | |
| To general practitioner | 110.4 | 33.1† |
| To specialist | 48.5 | 14.6† |
| Hospitalization | 56.1 | 16.8† |
| Oriental medicine | 0.6 | 0.2† |
| Informal medical | 622.8 | 64.7 |
| Non-medical | 5.7 | 0.6 |
| Total | 961.9 | 100.0 |

*In millions; †percentage to the formal medical costs.

Table 4. Estimated indirect costs of asthma in 2004

| Cost category | Sensitivity analysis |
|---------------|---------------------|
|               | Excluding the elderly* | Including the elderly |
|               | Cost ($)† | % | Cost ($)† | % |
| Loss of productivity as a patient | 1,085.2 | 99.9 | 1,180.5 | 99.9 |
| Due to ambulatory visit | 60.1 | 5.5† | 68.3 | 5.7† |
| Due to admission | 6.2 | 0.6† | 9.7 | 0.9† |
| Due to absence or early leave | 952.5 | 87.8† | 1,036.1 | 87.8† |
| Due to premature death | 66.4 | 6.1† | 66.4 | 5.6† |
| Loss of productivity as a caregiver | 1.2 | 0.1 | 1.2 | 0.1 |
| Total | 1,086.4 | 100.0 | 1,181.7 | 100.0 |

*Age ≥65 years; †In millions; †Percentage of lost productivity of patients.
asthma in the elderly is exceptional (12.7% in 2001)\(^\ddagger\), and life expectancy for the elderly group (≥65 years old) was minimal. However, the prevalence of asthma in 2004 were 4.19% and $2.04 billion, respectively, in the Republic of Korea. Direct and indirect costs contributed equally to total costs (46.9% and 53.1%, respectively). Furthermore, when intangible costs were included, the total cost increased to $4.11 billion, which is nearly equivalent to 0.44% of the gross domestic product in 2004.

The present study was performed using NHIC data, which has both advantages and disadvantages. Since 2000, the health insurance system in the Republic of Korea has provided coverage for the entire population.\(^\ddagger\) Under this system, all medical costs incurred for prescriptions, hospital admissions, and ambulatory visits are reimbursed by the NHIC. Thus, NHIC data provide nationwide, comprehensive estimates of disease-related costs, which cannot be acquired by secondary analysis of data or small-scale surveys. However, there are some concerns regarding NHIC data, particularly the possible misclassification of asthma listed as J45 or J46. For example, in children younger than 10 years of age, a wheezing episode caused by a non-asthmatic condition such as bronchiolitis is frequently diagnosed as asthma. Accordingly, this may limit the generalization of our results. Nevertheless, whether or not those listed by the NHIC as J45 or J46 were actually asthmatics, the estimated costs in this study represent the financial burden imposed on society by those diagnosed as having asthma. Thus, the estimations provide valuable information regarding health service planning.

Direct costs are usually determined by disease severity, medication compliance, overall prevalence of a disease, and health care costs. For example, in the US in 1994, direct costs represented the majority (88%) of the total costs, while indirect costs comprised only 12%, because health care costs are higher in the US.\(^\ddagger\) The health insurance system in the Republic of Korea relies on a fee scheduling system for reimbursement of health care providers, and the government scrupulously regulates this system, to the extent that reimbursements at best barely cover the cost of providing medical care.\(^\ddagger\) This regulated fee-for-service system is probably one reason for the difference in the proportion of direct costs between the US and the Republic of Korea.

Although many reports have mentioned the high prevalence of CAMs among asthmatics,\(^\ddagger\) little information is available regarding the costs at the national level. Surprisingly, the total expenditure on CAMs for asthmatics, presented as direct informal medical costs in the present study, was almost double the direct formal medical costs. Although there are undoubtedly national differences regarding individual methods and providers, CAMs for asthma should be recognized as a considerable cost burden on society and on individual patients.

One important challenge faced by those studying the financial burden of disease is how to precisely measure, value, and incorporate health-related QOL changes into an economic analysis. A cost-benefit analysis, also known as WTP, is one method of performing these evaluations. This type of analysis involves the use of survey techniques to elicit the amount of money an individual would be willing to pay for a specified health change.\(^\ddagger\) Zillich et al.\(^\ddagger\) demonstrated that WTP for an asthma cure is related to both objective and subjective disease severity. The mean monthly WTPs were $90, $131, and $331 for individual mild, moderate, and severe asthmatics, respectively.\(^\ddagger\) A similar trend was also found in the present study, but the differences by severity were smaller (the corresponding numbers were $137,

### Table 5. Total costs of asthma in 2004

| Cost category          | Cost ($)\(^*\) | %    |
|------------------------|---------------|------|
| Direct                 | 0.96          | 46.9\(^\ddagger\) |
| Indirect               | 1.08          | 53.1\(^\ddagger\) |
| Direct + Indirect      | 2.04          |      |
| Intangible             | 2.06          |      |
| Total                  | 4.11          |      |

\(^*\)In billions; \(^\ddagger\)Percentage of the sum of direct and indirect costs.
These findings suggest that some asthmatics in the Republic of Korea, although classified as mild by physicians, have an unsatisfied desire for a better QOL, matching the desire of severe asthmatics. Overall, the economic impact of impaired QOL, presented as intangible costs in this study, was tremendous and almost as large as the sum of direct and indirect costs.

The potential for cost savings based on reducing direct informal costs becomes readily apparent from our results. In this regard, the public health implications of CAMs should be viewed in the context of the limited evidence of their efficacy and their huge financial burden. In addition, considering that the economic impact of impaired QOL in asthmatics is as great as total asthma costs, improvements in QOL should be a goal of asthma control or a target of public programs for asthma care.

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REFERENCES

1. Mellis CM, Peat JK, Bauman AE, Woolcock AJ. The cost of asthma in New South Wales. Med J Aust 1991;155:522-8.
2. Krahn MD, Berka C, Langlois P, Detsky AS. Direct and indirect costs of asthma in Canada, 1990. CMAJ 1996;154:821-31.
3. Szucs TD, Anderhub H, Rutishauser M. The economic burden of asthma: direct and indirect costs in Switzerland. Eur Respir J 1999;13:281-6.
4. Chew F T, Goh DY, Lee BW. The economic cost of asthma in Singapore. Aust N Z J Med 1999;29:228-33.
5. Weiss KB, Sullivan SD, Lyttle CS. Trends in the cost of illness for asthma in the United States, 1985-1994. J Allergy Clin Immunol 2000;106:493-9.
6. Gupta R, Sheikh A, Strachan DP, Anderson HR. Burden of allergic disease in the UK: secondary analyses of national databases. Clin Exp Allergy 2004;34:520-6.
7. Poulou LM, Toelle BG, Marks GB. The burden of asthma in children: an Australian perspective. Paediatr Respir Rev 2005;6:20-7.
8. Barnes PJ, Jonsson B, Klim JB. The costs of asthma. Eur Respir J 1996;9:636-42.
9. National Heart, Lung, and Blood Institute. Expert panel report 3: guidelines for the diagnosis and management of asthma [Internet]. Bethesda (MD): U.S. Dept. of Health and Human Services, National Institutes of Health, National Heart, Lung, and Blood Institute; 2007 [updated 2007 Aug 28; cited 2010 Feb 1]. Available from: http://www.nhlbi.nih.gov/guidelines/asthma/asthgdln.pdf.
10. British Thoracic Society Scottish Intercollegiate Guidelines Network. British Guideline on the Management of Asthma. Thorax 2008;63 Suppl 4:iv1-121.
11. Bielory L. Complementary and alternative interventions in asthma, allergy, and immunology. Ann Allergy Asthma Immunol 2004;93:545-54.
12. Schäfer T. Epidemiology of complementary alternative medicine for asthma and allergy in Europe and Germany. Ann Allergy Asthma Immunol 2004;93:55-10.
13. Ernst E. Complementary therapies for asthma: what patients use. J Asthma 1998;35:667-71.
14. Senna G, Passalacqua G, Grivellaro M, Bonadonna P, Gani E, D’orizio R, Dama A, Canonicca GW, Lombardi C. Unconventional medicine: a risk of undertreatment of allergic patients. Allergy 1999;54:1117-9.
15. Kwon S. Payment system reform for health care providers in Korea. Health Policy Plan 2003;18:84-92.
16. World Health Organization. International classification of diseases [Internet]. [cited 2010 Feb 1] Available from: http://www.who.int/classifications/icd/en/.
17. Global Initiative for Asthma. GINA Workshop Report. Global strategy for asthma management and prevention [Internet]. [cited 2010 Feb 1]. Available from: http://www.ginasthma.com.
18. Park JW, Cho YS, Lee SY, Nahm DH, Kim YK, Kim DK, Sohn JW, Park JK, Jee YK, Cho YJ, Yoon HJ, Kim MK, Park HS, Choi BW, Choi IS, Park CS, Min KJ, Moon HB, Park SH, Lee YK, Kim NS, Hong CS. Multi-center study for the utilization of quality of life questionnaire for adult Korean asthmatics (QLQAKA). J Asthma Allergy Clin Immunol 2000;20:467-80.
19. Johansson M, Jonsson B, Borgquist L. Willingness to pay for antihypertensive therapy--results of a Swedish pilot study. J Health Econ 1991;10:461-73.
20. Central Intelligence Agency. The World Factbook 2010 - Korea, South [Internet]. [cited 2010 Sep 17]. Available from: https://www.cia.gov/library/publications/the-world-factbook/geos/ks.html.
21. Kim YK, Kim SH, Tak YJ, Jee YK, Lee BJ, Park HW, Jung JW, Bahn JW, Chang YS, Choi DC, Chang SI, Min KJ, Kim YY, Cho SH. High prevalence of current asthma and active smoking effect among the elderly. Clin Exp Allergy 2002;32:1706-12.
22. Peabody JW, Lee SW, Bickel SR. Health for all in the Republic of Korea: one country’s experience with implementing universal health care. Health Policy 1995;31:29-42.
23. Smith DH, Malone DC, Lawson KA, Okamoto LJ, Battista C, Saunders WB. A national estimate of the economic costs of asthma. Am J Respir Crit Care Med 1997;156:787-93.
24. Schäfer T, Riehle A, Wichmann HE, Ring J. Alternative medicine in asthma - prevalence, patterns of use, and costs. Allergy 2002;57:694-700.
25. Blumenschein K, Johansson M. Relationship between quality of life instruments, health state utilities, and willingness to pay in patients with asthma. Ann Allergy Asthma Immunol 1998;80:189-94.
26. Lundberg L, Johansson M, Silverdahl M, Hermansson C, Lindberg M. Quality of life, health-state utilities and willingness to pay in patients with psoriasis and atopic eczema. Br J Dermatol 1999;141:1067-75.
27. Zillich AJ, Blumenschein K, Johansson M, Freeman P. Assessment of the relationship between measures of disease severity, quality of life, and willingness to pay in asthma. Pharmacoeconomics 2002;20:257-65.