

## The Current Status of Asthma in Korea

A systematic review of English and Korean articles published between 1990 and 2004 and a search of database and various online resources was conducted to determine the prevalences, mortality rates, socioeconomic burden, quality of life, and treatment pattern of asthma in Korean adults and children. Asthma morbidity and mortality in Korea are steadily increasing. The prevalence of asthma in Korea is estimated to be 3.9% and its severity is often underestimated by both physicians and patients. Mortality resulting from chronic lower respiratory diseases including asthma increased from 12.9 to 22.6 deaths per 100,000 of the population between 1992 and 2002. Disease severity, level of control, and symptom state were all found to negatively impact the quality of life of asthmatics. Although international and Korean asthma management guidelines are available, familiarity with and implementation of these guidelines by primary care physicians remain poor.

Key Words : Asthma; Prevalence; Mortality; Cost of Illness; Quality of Life; Korea

Sang-Heon Cho, Heung-Woo Park,  
Daniel M Rosenberg\*

Department of Internal Medicine, Seoul National University College of Medicine, Seoul, Korea; Director, Asia Pacific Epidemiology\*, GlaxoSmithKline Asia Pacific, Singapore

Received : 31 August 2005  
Accepted : 17 November 2005

### Address for correspondence

Sang Heon Cho, M.D.  
Department of Internal Medicine, Seoul National University College of Medicine, 28 Yongon-dong, Chongno-gu, Seoul 110-744, Korea  
Tel : +82.2-2072-2971, Fax : +82.2-742-2912  
E-mail : shcho@plaza.snu.ac.kr

\*This work was supported by grants from GlaxoSmithKline Korea.

## INTRODUCTION

Asthma is a chronic inflammatory disorder of the airways characterized by bronchial hyperresponsiveness, reversible airflow limitation, and respiratory symptoms (1, 2). Internationally, the prevalence of asthma has increased over the last 3 decades (3-5), and in the Asia-Pacific region asthma causes considerable morbidity, with 15% of teenagers troubled by exercise-induced symptoms during the past 12 months (6). Furthermore, asthma mortality rates in more affluent areas, such as Hong Kong and Japan, are similar to those reported in Western countries (6). Studies in Korea also bear witness to these increasing trends (7, 8). The reported prevalence of asthma in Korea ranges from 2 to 13% (9-18). However, its prevalence in the elderly has been reported to be very high, at 12.7% in those aged 65 or more (15). Indeed, with a population estimated at more than 48 million, and a life expectancy of 72.0 yr for males and 79.5 yr for females (19), Korea faces an important public health challenge in terms of dealing with chronic diseases such as asthma.

In addition to its increasing prevalence, the economic impact of asthma is also substantial and continues to grow. The total cost of the disease in the United States was estimated to be US\$4.5 billion in the mid-1980s, whereas in the first half of the 1990s, this estimate had increased to between US\$6.2 and US\$10.7 billion (20-22). In Korea, where health insurance is mandatory and the cost of medical care is only covered in part by health insurance, the importance of economic out-

comes also continues to grow although little data is currently available.

The purpose of this review is to present an overview of the current disease status with respect to the prevalence, mortality rate, socioeconomic burden, quality of life and the treatment patterns of asthma in Korea, to identify barriers to improvements in asthma care and to provide recommendations for action at the national, organizational and individual levels. For this, all relevant English and Korean language articles were retrieved using PubMed ([www.ncbi.nlm.nih.gov/entrez/query.fcgi](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi)) and KoreaMed ([www.koreamed.com](http://www.koreamed.com)) from November 2004 to January 2005. Results were limited to the articles published between 1990 and 2004. In addition, various online resources through internet search engines were used.

## PREVALENCE AND ASSOCIATED RISK FACTORS

Recently, several large-scale studies of different population in Korea (9-17) have reported asthma prevalence ranging from 2 to 13% (Table 1). These differences are probably ascribable to different case definitions, methodologies, and a tendency to survey children rather than adults due to the relative ease of implementing studies in a school environment. According to the latest summary issued by the global burden of asthma by the Global Initiative for Asthma (GINA) program, the prevalence of clinical asthma in Korea is esti-

mated to be 3.9% (23). The prevalence of asthma tended to be higher in children than in adults and was found to depend significantly on their place of residence, for example, it was found to be higher in Seoul than in provincial cities (7). According to 1998 data (11), childhood asthma was less prevalent in Korea than in other developed countries. However, among the elderly (aged 65 yr or older), its prevalence was found to be high at 12.7% in 2001 (15), which is about three times higher than among English or US elderly (24, 25). Although estimations of asthma prevalence in older age groups differ greatly between countries because of overlapping diagnoses, and poor patient perception of symptoms (24), this rate is unexpectedly high. In the elderly, asthma is an important problem because it is usually underdiagnosed and hence inadequately treated (24-26). Interestingly, Korean adults and children appear to have a later average age of asthma onset than other Asian populations (12) (Fig. 1). This is likely to be due to the underdiagnosis of early stage asthma by general physicians. Some investigators have reported that an underdiagnosis rate by general physicians was 21% (27). Another contributable factor may be that a high proportion of Kore-

an people, at least initially, turn to traditional medicine for medical help (28-30), which delays the diagnosis until they are referred to hospitals or emergency department with severe symptoms. Finally, racial differences may be a consideration.

Age, sex, affluence, genetic predisposition, climate, outdoor air quality and cigarette smoking have all been found to be associated with asthma (7, 12, 15, 31-33). Studies suggest a higher incidence of asthma in children than in adults (9-15, 17, 34), and male asthmatic patients were found to be more often hospitalized or treated at a tertiary medical centers than their female counterparts (34, 35). In a regression analysis of the Asthma Insights and Reality in Asia-Pacific (AIRIAP) data for the eight areas of Asia-Pacific countries including Korea, it was found that a low household income is significantly associated with the likelihood of having moderate or severe persistent asthma symptoms ( $p=0.002$  compared with a high income status) (12).

It has been reported that the genetic variations of the chemokine (C-X-C motif) receptor 3 (CXCR3) (36), the signal transducer and activator of transcription 4 (STAT4) (37), a disintegrin and metalloprotease 33 (ADAM33) (38), and Tumor

**Table 1.** Summary of studies documenting the prevalence of asthma and wheeze in Korea

Study	Number	Population	Methodology/Criterion for asthma	Prevalence
<b>Children and adolescents</b>				
Son BK et al. 1997 (17)	2,850	Primary school-aged	Self-reported by parents using questionnaire, with lung function testing of children: asthma	10.3%
Lee SI et al. 2001 (7)	27,405	6-12 yr	Self-reported by parents using ISAAC questionnaire: wheeze ever 12-months asthma (wheeze) severe attack of wheezing	15.9% 8.7% 1.9%
Lee SI et al. 2001 (7)	15,481	12-15 yr	Self-reported using ISAAC questionnaire: wheeze ever 12-months asthma (wheeze) severe attack of wheezing	13.4% 8.2% 3.0%
Lee JG et al. 2001 (10)	13,160	School children and adolescents, rural	Self-reported by a questionnaire: ever had asthma current asthma	11.1% 2.2%
ISSAC 1998 (11)	9,983	Seoul and provincial	Self-reported asthma: written questionnaire Self-reported asthma: video questionnaire	8.0% 3-5%
Kim YY et al. 1997 (9)	3,219	7-19 yr	Modified American Thoracic Society questionnaires and bronchial challenge: current asthma wheeze	4.6% 8.2%
<b>Adults</b>				
Kim SH et al. 2001 (14)	718	Adults, urban Seoul	Self-reported questionnaire and bronchial challenge: current asthma	3.4%
Kim JJ et al. 1998 (13)	17,877	Adult Physician	Self-reported questionnaire: asthma under treatment in the past 5 yr males females	0.55% 0.39%
Kim YK et al. 2002 (15)	2,467	Adult, urban, rural and non-metropolitan urban	Current asthma: questionnaire and bronchial challenge <40 yr 40-54 yr 55-64 yr >65 yr	2.0% 3.8% 7.7% 12.7%

necrosis factor-alpha (TNF- $\alpha$ ) (39) are associated with the susceptibilities to the development of asthma and its intermediate phenotypes in the Korean population. The IL-4 cytokine gene cluster and/or the T cell receptor  $\alpha/\delta$  gene complex are believed to be associated with the expression of bronchial responsiveness to methacholone in nuclear families (40), and a polymorphism in exon 7 of chromosome 11q13 was found to be significantly associated with histamine release from basophile to anti-IgE stimuli in 80 randomly recruited asthmatic children (41). Specific environmental allergens also play important roles in asthma development in Koreans. Spider mites (*Citrus red mite*) (42, 43), the European red mite (*Panonychus ulmi*), (44) and the two-spotted spider mite (*Tetranychus urticae*) (44), have been identified as important allergens in the development of work-related asthma and rhinitis symptoms and toluene diisocyanate has been most commonly implicated allergen in occupational asthma in Korea (45). A number of studies have documented an association between air pollution and asthma-related morbidity in Korean cities and have linked active smoking with asthma prevalence and severity (15, 28, 29, 46-48).

**MORTALITY**

The accurate determination of the asthma mortality in Korea is difficult. Because large-scale medical databases tend to group asthma data along with those of other disease states, or to group it with less specific group diagnoses such as 'Chronic lower respiratory diseases' (49). According to the Korea National Statistical Office data, the death rate from chronic lower respiratory diseases (including asthma) between 1992 and 2002 increased from 12.9 to 22.6 deaths per 100,000 of the population (50). In 1992, chronic lower respiratory diseases were ranked as the eighth leading cause of death in

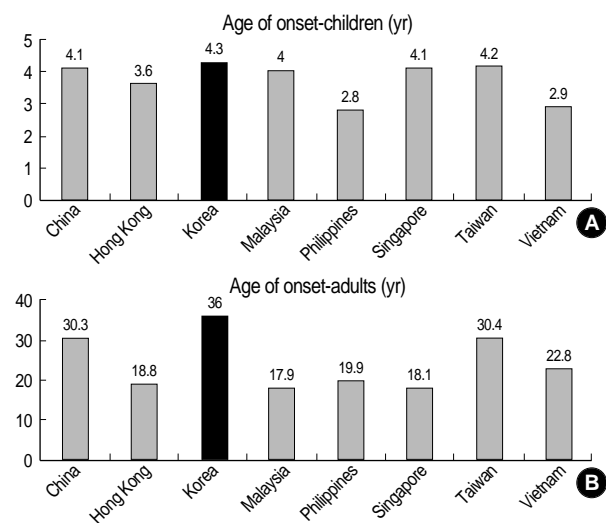


Fig. 1. Age of onset of asthma in children (A) and adults (B) in eight urban areas in the Asia-Pacific region, including Korea (12).

Korea, and in 2002, this had risen to fifth place preceded only by diabetes mellitus, heart disease, cerebrovascular disease, and cancer (50) (Fig. 2). According to the latest GINA estimates, there are 4.9 asthma related deaths per 100,000 asthmatics each year in Korea (23). Globally, respiratory diseases are responsible for 6.3% of all death and asthma for 0.4% (51). Several risk factors of asthma mortality have been identified in the Korean population. These include cigarette smoking, chronic asthma severity, frequent hospitalization, the duration of recent asthma exacerbations, age and a female sex (28, 52, 53).

**COST OF ILLNESS**

At present, little data is available on the economic burden posed by asthma in Korea. However, indirect estimates may be made based on the market shares of asthma medications in Korea. According to the data from the pharmaceutical industry (54), from 2001 to 2004, the annual gross value of drugs sold in Korea increased by nearly 50% (from U\$3.48 to U\$5.21 billion) and the proportion shared by drugs for asthma treatment in respiratory drug market increased by approximately 36% (from U\$51.8 to U\$70.6 million). Research in this area is underway, with a large-scale analysis being performed using data from Health Insurance Review Agency (HIRA), the 1998 National Survey on Health and Nutrition in Korea, and an ongoing patient survey. Results are expected to be published soon.

**QUALITY OF LIFE**

To adequately account for cultural and behavioral factors, a quality of life questionnaire for adult Korean asthmatics (QLQAKA) was developed (55), and in a multicenter study using QLQAKS, it was found that dyspnea (87%), difficul-

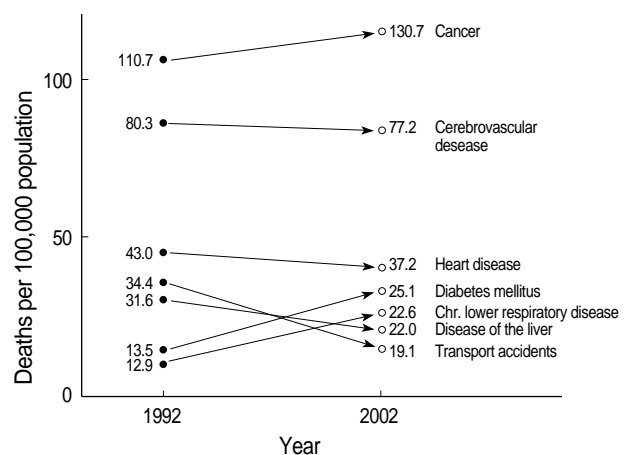


Fig. 2. Comparison of leading causes of death in 1992 and 2002 in Korea (50).

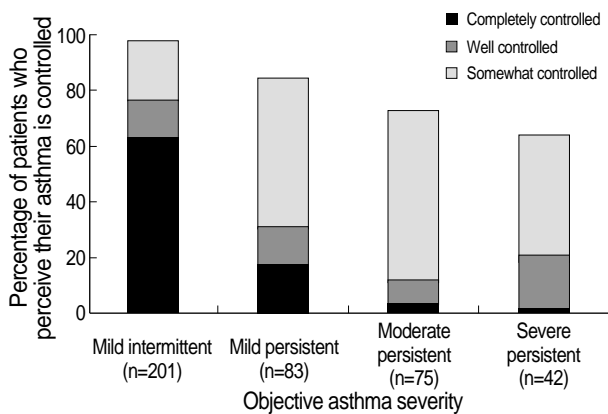


Fig. 3. Patients' perception of adequate disease control versus their objective severity assessment results, according to the AIRIAP study (12).

ty in sputum discharge or throat clearing (87%), strenuous activity limitation (84%), and coughing (82.4%) were most frequently complained about by adult asthmatics (55). The AIRIAP study revealed that approximately one-third of all Korean asthmatic patients felt restricted in terms of their abilities to perform the routine activities of daily living such as, exercise, social activities, or sleeping (12). This survey also reported that 52% of asthmatic patients had experienced daytime symptoms during 4 weeks prior to completing the questionnaires, and that 41% of patients with asthma had been woken at night by their symptoms (12). Another study conducted to assess the quality of life of 189 patients showed that running, walking, and hurried movements appeared to be the most impaired daily activities (56). The characteristics that significantly impaired an individual's quality of life score were disease severity, level of asthma control and symptom attacks during the previous 3 months (all  $p < 0.001$ ) (56). Interestingly, a discrepancy was identified between perceived and actual asthma control in a substantial number of asthma patients. According to AIRIAP data, about one-fifth of Korean asthmatic patients with severe persistent symptoms considered that their asthma was adequately controlled, despite their current symptoms suggesting otherwise (12) (Fig. 3). This is due in part to the fact that some asthmatics have poor symptom perception (57-59) and partly because asthmatics in Korea are not adequately educated about the practical and theoretical aspects of asthma management (60, 61).

## TREATMENT PATTERNS

No national guidelines concerning best management practice of asthma have been issued in Korea, although three academic associations have published separate guidelines (62-64). However, almost half of the physicians (43%) in 325 Korean clinics surveyed by the HIRA either did not use or were unfamiliar with these guidelines (65). Therefore, few

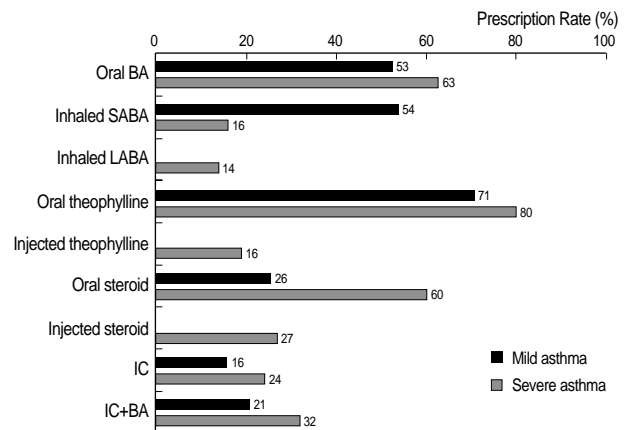


Fig. 4. Prescription patterns reported by 325 internal medicine clinics in Seoul, for patients with mild or severe asthma (65). BA,  $\beta 2$  agonist; LABA, Long acting  $\beta 2$  agonist; SABA, Short acting  $\beta 2$  agonist; IC, Inhaled corticosteroids.

asthma patients used or were prescribed inhaled corticosteroid by their physicians to prevent symptoms (65) (Fig. 4). The reasons for this reluctance to prescribing inhaled corticosteroid as cited by physicians in the HIRA survey were, in decreasing order; lack of patient education concerning inhaler use, high cost, patient refusal to use, and side effects (65). In addition, according to the AIRIAP survey, 65% of patients with asthma in Korea have never undergone a lung function test, and only 32% of patients reported that they had undergone a lung function test during the previous year (12). Moreover, although 6% of patients owned a peak flow meter for self-monitoring, only 20% of them used it daily, whereas another 20% used it on a symptomatic basis (12). Another survey found that patients who used a nebulizer at home were not properly instructed as to how to use it, and did not follow equipment maintenance procedures (66). However, paradoxically, most Korean asthmatics were satisfied with their treatment, although many expressed a need for more information on the disease (12). This 'disconnect' from the guidelines by physicians has had a major impact on the management of asthma patients. To reduce this gap, an 'Easy Asthma Management' study is currently underway in Korea. The purpose of this study may provide a simple stereotyped algorithm using a computer based program to allow clinicians to easily diagnose asthma and implement its correct management.

In December 2004, it was estimated that 11.9 million Koreans had access to the World Wide Web (WWW) and the number of allocated IP addresses allocated in Korea ranked eighth worldwide (67). Nowadays, computer-based educational programs available on the WWW are believed to be an effective alternative as they overcome the cost and time barriers that prevent implementation of education programs for asthmatics (68). However studies have shown that asthma educational material on the web sites is highly variable in quality and content, lacks detail of the core concepts essen-

tial for asthma education, and fails to meet patients needs (69, 70).

## SUMMARY

This review showed that the prevalence of asthma in Korea ranges from 2 to 13%, and that physicians and patients often underestimate its severity. Mortality from chronic lower respiratory diseases including asthma increased from 12.9 to 22.6 deaths per 100,000 of the population between 1992 and 2002. Disease severity, level of control, and symptom state were all found to negatively impact the quality of life of asthmatics. Moreover, although international and Korean asthma management guidelines are available, primary care physicians are largely unfamiliar with or fail to implement them.

## REFERENCES

- Sugita M, Kuribayashi K, Nakagomi T, Miyata S, Matsuyama T, Kitada O. *Allergic bronchial asthma: airway inflammation and hyperresponsiveness. Intern Med* 2003; 42: 636-43.
- Global Strategy for Asthma Management and Prevention. *GINA Workshop Report*. Available at: [www.ginasthma.com](http://www.ginasthma.com) [accessed 7 Jan 2005].
- Upton MN, McConnachie A, McSharry C, Hart CL, Smith GD, Gillis CR, Watt GC. *Intergenerational 20 year trends in the prevalence of asthma and hay fever in adults: the Midspan family study surveys of parents and offspring. BMJ* 2000; 321: 88-92.
- Ninan TK, Russell G. *Respiratory symptoms and atopy in Aberdeen schoolchildren: evidences from two survey 25 years apart. BMJ* 1992; 304: 873-75.
- Yunginger JW, Reed CE, O'Connell EJ, Melton LJ III, O'Fallon WM, Silverstein MD. *A community-based study of the epidemiology of asthma. Incidence rates, 1964-1983. Am Rev Respir Dis* 1992; 146: 888-94.
- Lai CK, de Guia TS, Kim YY, Kuo SH, Mukhopadhyay A, Soriano JB, Trung PL, Zhong NS, Zainudin N, Zainudin BM. *Asthma control in the Asia-Pacific region: The asthma insight and reality in Asia-Pacific study. J Allergy Clin Immunol* 2003; 111: 263-8.
- Lee SI, Shin MH, Lee HB, Son BK, Koh YY, Kim KE, Ahn YO. *Prevalence of symptoms of asthma and other allergic diseases in Korean children: a nationwide questionnaire survey. J Korean Med Sci* 2001; 16: 155-64.
- Lee MH, Hong SC, Kim SH, Bahn JW, Kim TB, Kim YK, Cho SH, Min KU, Kim YY. *Prevalence of asthma and atopy in children living in rural area of Cheju Island for an interval of three years. J Asthma Allergy Clin Immunol* 2002; 22: 85-91.
- Kim YY, Cho SH, Kim WK, Park JK, Song SH, Kim YK, Jee YK, Ha MN, Ahn YO, Lee SI, Min KU. *Prevalence of childhood asthma based on questionnaires and methacholine bronchial provocation test in Korea. Clin Exp Allergy* 1997; 27: 761-8.
- Lee JG, Moon HJ, Kim KS, Yoon JH, Kim SS, Park IY. *Epidemiological study for allergic disease of school-aged children and adolescence in rural area of Korea. Korean J Otolaryngol-Head Neck Surg* 1998; 41: 1156-63.
- International Study of Asthma and Allergies in Childhood (ISAAC) Steering Committee. *Worldwide variation in prevalence of symptoms of asthma, allergic rhinoconjunctivitis and atopic eczema: ISAAC. Lancet* 1998; 351: 1225-32.
- Isis Research/GlaxoSmithKline. *Asthma Insights and Reality in Asia Pacific (AIRIAP) Korea: Executive Summary* 2002.
- Kim JJ, Kim SD, Meng KH, Ahn YO, Yum YT, Oh HC, Lee DB, Lee SI, Chun BY, Choi JS. *Prevalence and disease experience rates in Korean physicians. J Korean Med Sci* 1998; 13: 247-62.
- Kim SH, Lee JY, Son SW, Chang YS, Jung JW, Kim YK, Cho SH, Min KU, Kim YY. *Prevalence of adult asthma based on questionnaires and methacholine bronchial provocation test in Seoul. J Asthma Allergy Clin Immunol* 2001; 21: 618-27.
- Kim YK, Kim SH, Tak YJ, Jee YK, Lee BJ, Kim SH, Park HW, Jung JW, Bahn JW, Chang YS, Choi DC, Chang SI, Min KU, Kim YY, Cho SH. *High prevalence of current asthma and active smoking effect among the elderly. Clin Exp Allergy* 2002; 32: 1706-12.
- Korea Institute for Health and Social Affairs (KIHASA). *Prevalence of asthma like symptoms in Korean adult population. Korean J Med* 2001; 60: 196-205.
- Son BK, Lim DH, Kim JH, Jun YH, Kim SK. *Prevalence of allergic disease and asthma related conditions in primary school-aged children and comparison of pulmonary function test between normal and children with condition related with asthma. Pediatr Allergy Respir Dis* 1997; 7: 198-206.
- International Study of Asthma and Allergies in Childhood (ISAAC) Steering Committee. *Worldwide variations in the prevalence of asthma symptom: International Study of Asthma and Allergies in Childhood (ISAAC) Eur Respir J* 1998; 12: 315-35.
- Central Intelligence Agency. *The World Factbook 2004 - Korea, South*. Available at: [www.cia.gov/cia/publications/factbook/geos/ks.html](http://www.cia.gov/cia/publications/factbook/geos/ks.html) [accessed: 15 Jan 2005].
- Weiss KB, Gergen PJ, Hodgson TA. *An economic evaluation of asthma in the United States. N Engl J Med* 1992; 326: 862-6.
- 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.
- 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.
- Masoli M, Fabian D, Holt S, Beasley R; Global Initiative for Asthma (GINA) Program. *The global burden of asthma: executive summary of the GINA Dissemination Committee report. Allergy* 2004; 59: 469-78.
- Enright PL, McClelland R, Newman AB, Gottlieb DJ, Lebowitz MD. *Underdiagnosis and undertreatment of asthma in the elderly. Cardiovascular Health Study Research Group. Chest* 1999; 116: 603-13.
- Parameswaran K, Hildreth AJ, Chadha D, Keaney NP, Taylor IK, Bansal SK. *Asthma in the elderly: underperceived, underdiagnosed, and undertreated: a community survey. Respir Med* 1998; 92: 573-7.

26. Enlight PL. *The diagnosis and management of asthma is much tougher in older patients. Curr Opin Allergy Clin Immunol* 2002; 2: 175-81.
27. Van Schayck CP, van Der Heijden FM, van Den Boom G, Tirimanna PR, van Herwaarden CL. *Underdiagnosis of asthma: is the doctor or the patient to blame? The DIMCA project. Thorax* 2000; 55: 562-5.
28. Kim OJ, Hoon CS. *A clinical analysis on the patients of orient-medical therapies in emergency department. J Korean Soc Emerg Med* 1997; 8: 553-8.
29. Kang SD, Jeong JW, Moon BS, Kim JM. *Current epidemiological status of cerebrovascular disease. J Korean Neurosurg Soc* 1999; 28: 509-3.
30. Cho HJ, Shim JY, Lee HR, Lee SH. *Factors associated with possession of regular doctor in Korea. J Korean Acad Fam Med* 2001; 22: 1612-21.
31. Choi H, Lim DH, Kim JH, Son BK, Lim JW. *Study on the interrelationship of air pollution and respiratory diseases in Incheon City via children who visited the emergency room of Inha University Hospital. J Korean Pediatr Soc* 2000; 43: 1372-9.
32. Kim KW, Choi IS, Park SC, Jang AS, Lim H. *Risk factors of near-fatal asthma. Korean J Med* 1999; 57: 52-9.
33. Koh YY, Lee MH, Kim CK, Min YG, Kim YK, Min KU, Kim YY. *A familial predisposition in bronchial hyperresponsiveness among patients with allergic rhinitis. J Allergy Clin Immunol* 1998; 102: 921-6.
34. Jeong MG, Kim TS, Son BH, Kim SW. *Clinical characteristics of hospitalized cases due to asthma attack combined with pneumonic infiltrates. Pediatr Allergy Respir Dis* 1999; 9: 290-300.
35. Yoon HS, Cha JK, Lee HR. *A survey of current trends in the management of childhood asthma in practical fields. Pediatr Allergy Respir Dis* 1998; 8: 167-78.
36. Cheong HS, Park CS, Kim LH, Park BL, Uh ST, Kim YH, Lym GI, Lee JY, Lee JK, Kim HT, Ryu HJ, Han BG, Kim JW, Park C, Kimm K, Shin HD, Oh B. *CXCR3 polymorphisms associated with risk of asthma. Biochem Biophys Res Commun* 2005; 334: 1219-25.
37. Park BL, Cheong HS, Kim LH, Choi YH, Namgoong S, Park HS, Hong SJ, Choi BW, Lee JH, Park CS, Shin HD. *Association analysis of signal transducer and activator of transcription 4 (STAT4) polymorphisms with asthma. J Hum Genet* 2005; 50: 133-8.
38. Lee JH, Park HS, Park SW, Jang AS, Uh ST, Rhim T, Park CS, Hong SJ, Holgate ST, Holloway JW, Shin HD. *ADAM33 polymorphism: association with bronchial hyper-responsiveness in Korean asthmatics. Clin Exp Allergy* 2004; 34: 860-5.
39. Shin HD, Park BL, Kim LH, Jung JH, Wang HJ, Kim YJ, Park HS, Hong SJ, Choi BW, Kim DJ, Park CS. *Association of tumor necrosis factor polymorphisms with asthma and serum total IgE. Hum Mol Genet* 2004; 13: 397-403.
40. Cho SH, Son JW, Koh YY, Min KU, Kim YY, Kim YK. *Linkage between bronchial responsiveness to methacholine and gene markers of IL-4 cytokine gene cluster and T cell receptor alpha/delta gene complex in Korean nuclear families. Clin Exp Allergy* 2001; 31: 103-9.
41. Kim YK, Oh SY, Oh HB, Chun SY, Cho SH, Koh YY, Min KU, Kim YY. *Coding single nucleotide polymorphism in the high-affinity immunoglobulin E receptor b chain (Fc epsilon RI-beta) gene is associated with immunoglobulin E receptor-mediated histamine release from basophile. Clin Exp Allergy* 2002; 32: 751-5.
42. Kim YK, Park HS, Kim HY, Jee YK, Son JW, Bae JM, Lee MH, Cho SH, Min KU, Kim YY. *Citrus red mite (Panonychus citri) may be an important allergen in the development of asthma among exposed children. Clin Exp Allergy* 2001; 31: 582-9.
43. Kim YK, Son JW, Kim HY, Park HS, Lee MH, Cho SH, Min KU, Kim YY. *Citrus red mite (Panonychus citri) is the most common sensitizing allergen in citrus farmers with asthma and rhinitis. Clin Exp Allergy* 1999; 29: 1102-9.
44. Kim YK, Lee MH, Jee YK, Hong SC, Bae JM, Chang YS, Jung JW, Lee BJ, Son JW, Cho SH, Min KU, Kim YY. *Spider mite allergy in apple-cultivating farmers: European red mite (Panonychus ulmi) and two-spotted spider mite (Tetranychus urticae) may be important allergens in the development of work-related asthma and rhinitis symptoms. J Allergy Clin Immunol* 1999; 104: 1285-92.
45. Kang SK, Jee YK, Nahm DH, Min KU, Park JW, Park HS, Son CH, Cho SH, Choi I, Choi SW, Hong CS, Kim KS, Kim YY. *A status of occupational asthma in Korea through the cases reported to the Occupational Asthma Surveillance Center. J Asthma Allergy Clin Immunol* 2000; 20: 906-15.
46. Ju YS, Cho SH. *Effect of air pollution on emergency room visits for asthma: a time series analysis. Korean J Prev Med* 2001; 34: 61-72.
47. Lee JT, Kim H, Song H. *Air pollution and asthma among children in Seoul, Korea. Epidemiology* 2002; 13: 481-4.
48. Song HI. *Effect of air pollution on childhood asthma living in Seoul. J Asthma Allergy Clin Immunol* 2001; 21: 28-39.
49. Park KA. *Recent trends and patterns of mortality in Korea. Dev Soc* 1998; 27: 67-81.
50. Korea National Statistical Office (KNSO). *News release: Summary report of the cause of death statistics in 2003. Available at: kosis.nso.go.kr/Magazine/YD/VD0002.xls [accessed: 3 Jan 2005].*
51. Mathers CD, Stein C, Fat DM, Rao C, Inoue M, Tomijima N, Bernard C, Lopez AD, Murray CJL. *Global burden of disease 2000: Version 2 methods and results. Global programme on evidence for health policy discussion paper No. 50. World Health Organization, October 2002.*
52. Kim JS, Wen Y. *A comparative study on mortality patterns among Koreans, Korean-Chinese and Chinese. J Korean Med Sci* 1999; 14: 365-72.
53. World Health Organization Statistical Information Service. *WHO mortality database. Available at: www3.who.int/whosis/menu.cfm [accessed: 7 Jan 2005].*
54. Korea Pharmaceutical Manufactures Association. *Drug market statistics in 2004. Available at: http://www.kpma.or.kr/kpma [accessed: 23 Jan 2005].*
55. 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 KU, Moon HB, Park SH, Lee YK, Kim NS, Hong CS. *Multi-center study of the utilization of quality of life questionnaire for adult Korean asthmatics (QLQAKA). J Asthma Allergy Clin Immunol* 2000; 20: 467-80.
56. Rho HJ, Park MS, Park CW, Yun YY, Park JW, Hong CS, Suh JY, Kim DK. *Factors influencing quality of life asthmatic patients in Korea. J Asthma Allergy Clin Immunol* 2000; 20: 209-21.

57. Kikuchi Y, Okabe S, Tamaura G, Hinda W, Homma M, Shirato K, Takishima T. *Chemosensitivity and perception of dyspnea in patients with a history of near fatal asthma. N Engl J Med* 1994; 330: 1329-34.
58. Fritz G K, McQuaid EL, Spirito A, Klein RB. *Symptom perception in pediatric asthma: relationship to functional morbidity and psychological factors. J Am Acad Child Adolesc Psychiatry* 1996; 35: 1033-41.
59. Chetta A, Gerra G, Foresi A, Zaimovic A, Del Donno M, Chittoloni B, Malorgio R, Castagnaro A, Olivieri D. *Personality profiles and breathlessness perception in outpatients with different gradings of asthma. Am J Respir Crit Care Med* 1998; 157: 116-22.
60. Kim SG, Jang AS, Kim YK, Lee S, Seo JP, Yang SW, Choi SI, Park SH, Lee KR, Park JH. *The effect of patient education on correct use of metered dose inhalers in patients with asthma. J Asthma Allergy Clin Immunol* 2000; 20: 695-701.
61. Lim JY, Chung SM, Choung JT. *The role of patient and parents education in the management of pediatric asthma. Pediatr Allergy Respir Dis* 2000; 10: 51-60.
62. Korean Society of Allergology. *National guideline for the management of asthma. J Asthma Allergy Clin Immunol* 1998; 18: 338-90.
63. Pyun BY. *2003 Guideline for the management of childhood asthma. Pediatr Allergy Respir Dis* 2003; 13: 65-71.
64. Korean Academy of Tuberculosis and Respiratory Disease. *Guideline of chronic obstructive pulmonary disease (COPD) and asthma. Available at: www.lungkorea.com [accessed: 27 Dec 2004].*
65. Korea Institute for Health and Social Affairs (KIHASA). *Analysis of data from Health Insurance Review Agency (HIRA). Available at: www.kihasa.re.kr/html/jsp/sub04\_01.jsp [accessed: 16 Jan 2005].*
66. Rhee SE, Kim CH, Choi JY, Son MH, Kim KE, Lee KY. *The study of home nebulizer use in asthmatic children. Pediatr Allergy Respir Dis* 2000; 10: 141-52.
67. Internet statistics information system. *Internet usage statistics. Available at: isis.nic.or.kr/english [accessed: 8 Jan 2005].*
68. Peterson MW, Strommer-Pace L, Dayton C. *Asthma patient education: current utilization in pulmonary training programs. J Asthma* 2001; 38: 261-7.
69. Park HW, Min KU, Kim YY, Cho SH. *Assessing the quality and contents of asthma-related information on the Korean internet as an educational material for patients. J Korean Med Sci* 2004; 19: 364-8.
70. Song DJ, Kim HJ, Hong SH, Choung JT. *Bronchial asthma education and the internet: The present situation and future direction. J Asthma Allergy Clin Immunol* 2004; 24: 224-8.