Epidemiology of adult asthma in Asia: toward a better understanding

Woo-Jung Song1,2, Min-Gyu Kang1,2, Yoon-Seok Chang1,2,3, and Sang-Heon Cho1,2,*

1Department of Internal Medicine, Seoul National University College of Medicine, Seoul 110-799, Korea
2Institute of Allergy and Clinical Immunology, Seoul National University Medical Research Center, Seoul 110-799, Korea
3Department of Internal Medicine, Seoul National University Bundang Hospital, Seongnam 463-707, Korea

Asia is the world’s most dynamic area. Asthma is a major chronic disease in Asia, like other continents. However, unlike childhood asthma, the epidemiological burden of asthma in Asian adults has been unclear. Here we reviewed the currently available literatures on the epidemiology of adult asthma in the Asian community populations. Adult asthma prevalence was generally lower in Asian than in Europe, but the increasing trends suggested the disease burden to rise in the near future. However, for better understanding, it may be essential to prepare for the Asian multinational network for the standardization and collaboration of research.

Key words: Asthma; Epidemiology; Review; Asia

INTRODUCTION

Asia is the world’s largest and most populated continent. It covers 30% of the Earth’s land area, and hosts 60% of the world’s current population [1]. During recent decades, the Asian population has quadrupled, and the economy has enormously grown up [2]. Thus now, Asia is the world’s most ‘dynamic’ region.

Asthma is a major chronic disease in Asia, like other continents [3, 4]. The prevalence of childhood asthma has continuously increased over the decades in Asia [5]. This increasing significance has been well reflected in the activity of asthma research in Asian countries, which has doubled during the last decade [6]. However, in Asian adults, the epidemiological burden of asthma is largely unknown this lack is quite in contrast to extensive and systemic research efforts ongoing for childhood asthma epidemiology such as the International Study of Asthma and Allergies in Childhood (ISAAC) projects in Asian children [5].

How prevalent is asthma in Asian adult community populations? Is asthma increasing in Asian adults too? If we extrapolate previous findings from Asian children or the European Community...
Respiratory Health Survey (ECRHS) [7], we might simply expect that asthma is also increasing among Asian adult populations. However, factors underlying the epidemiology are not uniform across different demographic groups; and thus, there should be many questions to be directly answered in this population.

Here we aimed to review the literature on the epidemiology, and to identify tasks to improve our understanding of asthma in Asian adult populations.

**LITERATURE SEARCH**

We conducted a semisystematic literature review to identify papers reporting the prevalence of asthma among Asian adult community populations. The PubMed was searched with the term ‘asthma AND (epidemiology OR prevalence OR incidence)’ for Asian countries. The publication period was not restricted, but the language was confined to English publication. Finally, we identified 42 original studies reporting the asthma prevalence in Asian adults. Outcomes were extracted for study design, population, research questions, case definition, and asthma prevalence (Tables 1–3).

**HOW PREVALENT IS ADULT ASTHMA IN ASIA?**

Prevalence data from nationwide surveys were summarized in Table 1. A total of 14 prevalence data have been reported from 9 countries. The prevalence varied from 0.7% to 11.9%, but the asthma definitions varied widely. Only one study had utilized objective testing (bronchodilator response) to define asthma, whereas others used questionnaires. Seven studies asked the 1-year prevalence of ‘current asthma (defined by recent symptoms plus physician diagnosed asthma)’ [8-14], but their definitions also varied between studies. These nationwide findings were depicted in Fig. 1.

Local area surveys were summarized in Table 2 (28 studies from 13 countries). Specifically, local area prevalence in China was reported as 0.7–3.8% [15-19]. In two Korean local area studies, current asthma prevalence was 3.6–5.8% when defined by combination of questionnaire and methacholine challenge tests [20, 21]. In Ulaanbaatar, Mongolia, ever physician diagnosis of asthma varied from 1.1% in 1999 to 4.7% in 2009 [22, 23]. In Iran, three different local area surveys found current asthma prevalence as 1.4–6.1% [24-26]. In Al Ain, the United Arab Emirates, asthma prevalence was the highest as 12%, but the definition was not strict [27]. Four local area studies were conducted in India; the prevalence of current asthma ranged from 2.4% to 3.5% [28-31]. Other South & Southeast Asian studies found 2.4–3.9% prevalence [32-36].

Interestingly, asthma was frequently reported to increase with aging in Asia. In two different local population surveys in Korea, current asthma (defined by current wheeze and positive airway hyperresponsiveness) was consistently more prevalent among the elderly (12.7–15.3%) [20, 21]. These age-related increase were similarly observed in several questionnaire-based studies from China [15, 17], Taiwan [37], Mongolia [22], Korea [38], Iran [25], India [8, 11, 28, 31], and Bangladesh [32, 39]. In Japanese nationwide surveys using questionnaires, only wheeze but not physician diagnosed asthma increased with aging [10]. The age-specific prevalence of asthma in elderly groups (≥60–70 years old) was presented in Fig. 2.

Despite the heterogeneity in study designs and years, we presented a crude prevalence map in order to have a quick
| First author, publication year [reference] | Area | Study year | Participants (n, age) | Recruitment, dataset | Prevalence | Asthma definition |
|------------------------------------------|------|------------|----------------------|----------------------|------------|-------------------|
| Wu 2013 [19]                            | China | 2010       | n = 13,157, ≥50 yr   | Random sample, the study on global AGEing and adult health China wave 1 | Asthma: 1.9% | Have you ever been diagnosed with asthma by a healthcare professional? |
| Hwang 2010 [56]                          | Taiwan | 2000–2007  | n = 997,729, mean age, 33.8 yr | Random selection, National Health Insurance register database | Asthma: 2.9% | Diagnostic code (ICD-9-CM) |
| Makino 2005 [57]                         | Japan | 1996       | n = 11,495, adults (age not specified) | The Coordinated Research Project on Long-Term Chronic Disease | Asthma: 1.7% | Symptoms based on ATS-DLD questionnaire |
| Fukutomi 2010 [10], or Fukutomi 2012 [48] | Japan | 2006–2007  | n = 23,483, 20–79 yr | Random sample | Current asthma: 4.2% | “Have you ever had asthma?” and “Was this confirmed by a doctor?” and “Having at least one asthma-related symptom in the last 12 months.” |
| Kim 2013 [38]                            | Korea | 1998, 2008 | n = 7146 (1998), n = 4,980 (2008), 20–99 yr | Random selection, the Korean National Health and Nutrition Examination Survey (KNHANES) I and IV | Physician-diagnosed asthma: 0.7% and 2.0% | Have you ever been diagnosed with asthma by a doctor? |
| Kim 2014 [44]                            | Korea | 2007–2011  | n = 19,659, 19–64 yr | Random selection, KNHANES V | Asthma: 2.4% | Have you ever been diagnosed with asthma by a doctor? |
| Mishra 2003 [51]                         | India | 1998, 1999 | n = 38,595, ≥60 yr | Multistage cluster sample, National Family Health Survey 2 (NFHS-2) | Asthma: 10.3% | Does anyone listed (in the household) suffer from asthma? |
| Jindal 2012 [11]                         | India | 2007–2009  | n = 169,575, ≥15 yr | Random sample, the Indian Study on Epidemiology of Asthma, Respiratory Symptoms and Chronic Bronchitis | Asthma: 2.0% | Positive to at least one of the two questions on wheezing and tightness of the chest, plus one of the three questions on history of previous diagnosis of asthma, an attack of asthma and use of medication for asthma, in the past 12 months |
| Agrawal 2013 [8]                         | India | 2005, 2006 | n = 157,186, 20–49 yr | Multistage cluster sample, NFHS 3 | Asthma: 1.9% | Do you currently have asthma? |
| Dejsomritrutai 2006 [9]                  | Thailand | 2000 | n = 3,454, 20–44 yr | Multistage stratified random sample | Definite asthma: 2.9% | Reversible airway obstruction by spirometry, or any asthma symptoms within the last 12 months in addition to bronchial hyperresponsiveness |
| Hassan 2002 [39]                        | Bangladesh | 1999 | n = 5,642, mainly 15–44 yr (≥5 yr) | Random selection and face-to-face interview | Asthma (recent wheeze): 6.9% | Having the whistling sound arising from the chest and not from the nose or throat within the last 12 months |
| Ng 1994 [14]                             | Singapore | 1992 | n = 2,868, 20–74 yr | Stratified disproportionate random sample, the Singapore Adult Respiratory Health Study | Current asthma: 2.2% | Current asthma symptom (any of episodic wheeze, attack of shortness of breath, nocturnal attack of wheeze or shortness of breath within the past year) and physician diagnosed asthma |
| Lu 2013 [12]                             | Singapore | 2003–2004 | n = 2,847, 20–99 yr | Random sample, the National Mental Health Survey of Singapore | Asthma: 5.1% | “In the past 12 months, have you been told by a doctor, nurse, or other health professional that you had asthma?” and “Do you still have asthma?” |
| Mahboub 2012 [13]                        | United Arab Emirates | 2010 | n = 1,220, age 20–44 yr | Random sample | Asthma attack: 8.0% | Have you had an attack of asthma in the last 12 months? |

ICD-9-CM, The International Classification of Diseases, 9th revision, clinical modification; ATS-DLD, American Thoracic Society-Division of Lung Disease.
Table 2. Local prevalence data for adult asthma in Asian countries

| First author, publication year [reference] | Area | Study year | Participants (n, age) | Recruitment, dataset | Prevalence | Asthma definition |
|-------------------------------------------|------|------------|----------------------|----------------------|------------|------------------|
| **East Asia**                             |      |            |                      |                      |            |                  |
| Xu 1993 [52]                              | Beijing, China | 1986 | n = 3,606, 40–69 yr  | Random sample         | Asthma: 3.8% | “Have you ever had asthma?” and “Was the asthma diagnosed by a physician?” |
| Lai 1995 [58]                             | Hong Kong, China | 1991–1992 | n = 2,032, ≥70 yr | Random sampling from the old age and disability allowance list and postal survey | Asthma: 5.1% | Have you had asthma? |
| Chan-Yeung 2002 [15]                      | Beijing (rural area), China | 1996–1997 | n = 22,561, ≥15 yr | Random selection | Asthma attack: 0.7% | Have you had an attack of asthma in the last 12 months? |
| Ko 2006 [45]                              | Hong Kong, China | 2003–2004 | n = 1,524, ≥70 yr | Random sampling and telephone survey | Asthma: 5.8% | Have you had asthma? |
| Wilson 2008 [18]                          | Liaoning, China | 2002 | n = 31,704; mean age, 47.7 yr | Parents and grandparents of schoolchildren | Asthma: 1.0% | All of the following: History of a wheezing attack that caused sudden shortness of breath, history of ≥wheezing attacks. Diagnosis of asthma by a doctor |
| Shi 2012 [16]                             | Jiangsu, China | 2007 | n = 1,486, ≥20 yr | Random sample, the Chinese National Nutrition and Health Survey | Asthma: 1.4% | Have you been diagnosed with asthma by a doctor? |
| Wang 2013 [17]                            | Jinan, China | 2009 | n = 13,419, all ages | Random sample | Asthma: 0.8% | Both of (1) “Have you ever been diagnosed with asthma by a physician?” and/or “Have you ever had asthma?”, and (2) “In the past, at any time, have you experienced recurrent (more than three times) sudden attacks of at least one of the following symptoms: whistling in the chest or paroxysmal dyspnea, wheezing, chest tightness or cough?” |
| Jan 2004 [37]                             | Taipei, Taiwan | 1999 | n = 2,076, ≥18 yr | Cluster sampling | Current asthma: 4.1% | Diagnosed as asthma by physician, or “Does your chest sound wheezy or whistling when you have a cold?” or “Does your chest sound wheezy or whistling occasionally apart from when you have a cold?” |
| Fukutomi 2011 [43]                        | Fujieda, Japan | 1999 and 2006 | n = 4,187 and n = 3,985, ≥15 yr (1999) and 20–79 yr (2006) | Door-to-door survey, and postal survey | Current asthma: 1.5% (1999) and 3.4% (2006) | “Have you ever been diagnosed with asthma?” and any of asthma symptoms in the recent 2 years (1999) “Have you ever had asthma?” and “Was this confirmed by a doctor?” and having one or more asthma symptoms in the last 12 months (2006) |
| Kim 2002 [20]                             | Four cities (urban and rural), Korea | 2000 | n = 2,467, ≥20 yr | Random sample from the health service list | Current asthma: 3.6% | Wheezing within the recent 12 months and positive AHR |
Table 2. Continue

| First author, publication year (reference) | Area                      | Study year | Participants (n, age) | Recruitment, dataset                      | Prevalence | Asthma definition                                                                 |
|-------------------------------------------|---------------------------|------------|----------------------|-------------------------------------------|------------|----------------------------------------------------------------------------------|
| **Seongnam, Korea**                       | Song 2012 [49], or Song 2013 [54] | 2005–2006  | n = 994, ≥65 yr      | Random sample                             | Current asthma: 5.4% | “Have you ever been diagnosed with asthma?” and “Have you had a wheezing or whistling in the chest during the last 12 months?” |
| **Changwon and Sancheong, Korea**         | Song 2014 [21], or Choi 2011 [53] | 2007       | n = 1,080, ≥30 yr    | Community residents                       | Current asthma: 5.8% | “Have you had a wheezing or whistling in the chest during the last 12 months?” and positive methacholine AHR |
| **Ulaanbaatar, Mongolia**                 | Viinanen 2005 [23]        | 1999–2000  | n = 9,453, 10–60 yr  | Random sample from the files of family doctors | Asthma: 1.1% | Have you ever had asthma?                                                          |
| **Ulaanbaatar, Mongolia**                 | Sonomjamts 2014 [22]      | 2009       | n = 1,201, ≥20 yr    | Random selection from family clinics      | Doctor diagnosed asthma: 4.7% | Have you ever been diagnosed to have asthma?                                      |
| **Lebanon**                               | Schachter 1984 [59]       | 1978       | n = 1,303, ≥7 yr     | Community sample                          | Asthma: 6.0% | Have you ever had bronchial asthma?                                                |
| **Mashhad, Iran**                         | Boskabady 2002 [25]       | 1999       | n = 5,579, ≥20 yr    | Random sample                             | Asthma: 2.8% | (1) Two or more asthma symptoms (recurrent wheeze, recurrent cough or tightness at rest, night cough and wheeze or cough during exercise) or (2) Previously diagnosed with asthma |
| **Isfahan (rural), Iran**                 | Golshan 2002 [26]         | 2000       | n = 994, mean age, 25.2 yr | Random selection and inhabitant contact | Current asthma: 6.1% | Either any history of physician-diagnosed asthma resulting in intermittent use of antiallergic drugs or a recent history (within the past 12 months) of dyspnoeic attacks combined with wheezy breathing |
| **Urmia, Iran**                           | Rahimi-Rad 2008 [24]      | 2004       | n = 2987, 20–44 yr   | Random cluster sample                     | Current asthma: 1.4% | “Have you had an attack of asthma in the last 12 months?” or “Are you currently taking any medication (including inhalers, aerosols or tablets) for asthma?” |
| **Al Ain, United Arab Emirates**          | Alsowaidi 2010 [27]       | 2007–2008  | n = 6,543, ≥13 yr (median 30 yr, adolescents and parents) | Multistage random sample                  | Asthma: 12% | Having had wheezing in the past 12 months, or ever had asthma?                     |
| **Mumbai, India**                         | Chowgule 1998 [29]        | 1992–1995  | n = 2,213, 20–44 yr  | Random selection ECRHS phase I            | Asthma: 3.5% | (1) Have you had an attack of asthma in the last 12 months? or (2) Are you currently taking any medicine (including inhalers, aerosols, or tablets) for asthma? |
| First author, publication year [reference] | Area | Study year | Participants (n, age) | Recruitment, dataset | Prevalence | Asthma definition |
|------------------------------------------|------|------------|----------------------|----------------------|------------|------------------|
| Jindal 2000 [30]                          | Chandigarh, India | 1995–1997 | n = 2016, ≥18 yr | Home visit | Asthma: 2.8% | One or both of two questions: (1) Have you ever had wheezing or whistling sounds in your chest at any time in the last 12 months? (2) Have you woken up with a feeling of tightness in your chest first thing in the morning at any time in the last 12 months? and, one or more of three questions: (1) Have you ever had asthma? (2) Have you had an attack of asthma at any time in last 12 months? (3) Are you currently using any medicine including inhalers, aerosols, or tablets for asthma? |
| Aggarwal 2006 [28]                        | Several regions, India | 2000s? | n = 73,605, ≥15 yr | Random selection | Asthma: 2.4% | Both to (1) wheezing or whistling sound from chest, or chest tightness or breathlessness in morning, and (2) having suffered from asthma, or having an attack of asthma in past 12 months, or using inhaled or oral bronchodilators. |
| Parasuramalu 2010 [31]                   | Bangalore, India | 2008 | n = 3,194, ≥18 yr | Cluster sample | Asthma: 2.9% | (1) whistling sound from chest, or chest tightness, or breathlessness in the morning, and (2) having suffered from asthma, or having an attack of asthma in the past 12 months, or using bronchodilators |
| Bartlett 2013 [32]                       | Two rural areas (Abhoynagar and Mirsarai) and one urban area (Kamalapur), Bangladesh | 2009 | n = 32,665, >25 yr | Household visits | Asthma: 3.9% | Have you had ever been diagnosed with asthma? |
| Lam 2011 [33]                            | Northern Vietnam (urban and rural) | 2007–2008 | n = 5,782, 23–72 yr | Random sample and field survey | Physician diagnosed asthma: 3.9% | Have you been diagnosed as having asthma by a physician? |
| Sy 2007 [36]                             | Dalat, Vietnam | 2004 | n = 9984, mostly ≥15 yr | Random sample | Asthma or asthma-like symptoms: 2.4% | Have you been diagnosed as asthma by a physician? or any of 1. “Have you heard wheezing in your chest at any time in the last 12 months?” 2. “Have you felt as if you were suffocating while reclining during the day at any time in the last 12 months?” 3. “Have you been awakened by an attack of breathlessness at any time in the last 12 months?” |
| Sundaru 2005 [35]                        | Jakarta, Indonesia | Before 1990 | NA | NA | Asthma: 3.4% | Doctor diagnosed asthma |
| Sherina 2004 [34]                        | Selangor, Malaysia | 1999 | n = 223, ≥60 yr | Stratified proportionate cluster sample | Asthma: 3.1% | Diagnosed by certified doctors |

AHR, airway hyperresponsiveness; ECRHS, European Community Respiratory Health Survey; NA, not available.
A glimpse of geographical variation of asthma prevalence in Asian countries (Fig. 3). Each representative prevalence was primarily retrieved from nationwide data, if available; otherwise, the pooled estimation from available local area studies was utilized as alternatives. To summarize, currently available data indicated that crude asthma prevalence was generally less than 5% in Asian adults. The Asian prevalence estimate was lower than the European data from the ECRHS phase I surveys (median, 4.5%; range, 2.0–11.9% in stage 1; and median, 5.2%; range, 1.2–13.0% in stage 2 [7]). These geographical difference between Asian and European populations were in line with the ISAAC surveys for childhood asthma [40].

**IS ASTHMA INCREASING IN ASIAN ADULTS?**

In a recent systematic review, 48 well-designed cohort or repeated cross-sectional studies were analyzed to determine if asthma prevalence was declining recently (1990–2008) [41]. The analyses concluded that asthma prevalence recently continues to increase or remains stable in most parts of the world. However, the included studies were mostly childhood population studies, or from western populations, possibly due to lack of high quality longitudinal studies in Asian adult populations. In European adults, the ECRHS phase I and II comparison analyses (1991–1993 vs. 1998–2003) found the significant increase in ‘asthma attack’ (+0.8%; 95% confidence interval [CI], 0.2 to 1.4; \( p = 0.001 \)), ‘current asthma medication (+2.1%; 95% CI, 1.6 to 2.6; \( p < 0.001 \)) or ‘diagnosed asthma’ (+2.2%; 95% CI, 1.6 to 2.9; \( p = 0.037 \)), but no significant change in ‘current wheeze’ (−0.9%; 95% CI, −1.9 to 0.2; \( p = 0.122 \)) over the 5- to 10-year follow-ups of young adults [42].

In our review, temporal changes in Asian adult asthma prevalence were identified in three countries (Japan [43], Korea [38, 44], and Hong Kong [45]). Interestingly, the data demonstrated consistent trends for increasing prevalence, in several asthma definitions including ever asthma, current asthma, or current wheeze (Fig. 4). Statistical significance was directly calculated in the 12-year comparison studies from Hong Kong [45]; they found significant increase in current wheeze (7.5% in 1991 vs. 12.1% in 2003; \( p < 0.01 \)) but borderline significance in ever asthma (5.1% in 1991 vs. 5.8% in 2003; \( p = 0.065 \)). In a suburban area in Japan, current wheeze (4.2% in 1985 vs. 7.6% in 1999), ever asthma (5.1% in 1999 vs. 6.7% in 2006) and current asthma (1.5% in 1999 vs. 3.4% in 2006) all showed consistent increase over time [43].

It is not certain whether the adult asthma is also increasing in other Asian countries, as no other longitudinal data are currently available; however, considering the rapid urbanization in Asia, the prevalence is expected to increase in various developing countries. Within the same inherent genetic background, living areas have been associated with the risk of childhood asthma [46]. Adult asthma may be carried over from childhood disease, or newly develop by occupational or environmental irritant exposure [47].

**WHICH QUESTIONS HAVE BEEN ADDRESSED SO FAR?**

We summarized the research questions addressed in individual studies based on their study purposes (Table 3). Prevalence estimation and risk factor exploration were the most frequent topic. Otherwise, various specific factors were examined in relation to asthma risk, including lifestyle factors (obesity [48, 49] and

| Addressed questions                       | Reference                                      |
|------------------------------------------|------------------------------------------------|
| Cross-sectional prevalence               | [8-11, 13-15, 17-20, 22-37, 39, 56-59]        |
| Longitudinal prevalence trends           | [38, 43, 45]                                   |
| Association with smoking                 | [31, 33]                                       |
| Association with obesity                 | [48, 49]                                       |
| Association with socio-demographic factor| [32]                                            |
| Association with kimchi intake           | [44]                                            |
| Association with serum vitamin D level   | [50]                                            |
| Association with indoor air pollution from biomass combustion | [51] |
| Association with psychiatric disorder    | [12]                                            |
| Association with occupational dust/gas/ fume exposure | [52] |
| Association with monosodium glutamate intake or dietary pattern | [16] |
| Association with clonorchis infection   | [53]                                            |
| Association with staphylococcal enterotoxin IgE | [21] |
| Association with rhinitis               | [54]                                            |
| Risk factor exploration                 | [8, 11, 14, 17, 18, 20, 22, 24, 27, 28, 37, 39] |
| Comparison with western populations     | [15, 58]                                       |
smoking [31, 33]), dietary or nutritional factors (vitamin D level [50], kimchi [44] or monosodium glutamate intake [16]), pollutant exposure [51, 52], psychiatric disorder [12], clonorchis infection [53], rhinitis [54], or staphylococcal enterotoxin sensitization [21]. These topics of interests have reflected the ideas of Asian researchers, regarding what may underlie the adult asthma.

Fig. 3. Geographical difference of adult asthma prevalence in Asian countries. The representative prevalence was primarily retrieved from nationwide data if available. Otherwise, the summation of local area studies were utilized as alternative.

Fig. 4. Changes in the prevalence of asthma in Asian adults. Reference label indicates the first author and publication year [38, 43-45].
**TOWARD A BETTER UNDERSTANDING OF ASTHMA IN ASIANS**

Here we summarized the current status of epidemiological research on adult asthma in Asia. Overall prevalence was lower than 5% in Asian adult community populations, which appeared less prevalent than in European adult populations. Importantly, the prevalence of elderly asthma was 1.3–15.3% in Asia, which is relatively high. Because of the population aging due to rising life expectancy and/or declining birth rates in Asia, we have to pay attention to the elderly asthma in this region. However, the methodological heterogeneity was a major limitation hindering the comparison of regional prevalence, despite that the number of conducted studies was not so small in Asia. Temporal trends in prevalence suggested the recent increase of adult asthma in Hong Kong, Japan, and Korea; however, the findings warrant replication in other Asian developing countries.

For these, the utilization of standardized questionnaire tools needs to be encouraged in Asian countries. Although there is no gold standard definition for asthma in epidemiological surveys, at least the academic consensus should be made on the common framework and protocols. The ECRHS and the Global Allergy and Asthma European Network (GA2LEN) projects may be excellent examples to follow. The ECRHS project was initiated for adult respiratory diseases in 1990, consisting of 140,000 participants from 22 countries [7]; currently, the ECRHS phase III follow-up survey is undergoing. The GA2LEN project, consisting of 60 allergy centers from 20 European countries, was a more recent collaboration to integrate European research efforts and capacities for allergy and asthma, and to establish permanent international research network [55]. In each of the projects, the study protocols have been shared in every participating center. In this regard, it may be necessary to prepare for establishing the Asian network for allergy and asthma epidemiological research collaboration. The first workgroup meeting may be held in the next meeting of the Asia Pacific Association of Allergy, Asthma and Clinical Immunology.

**REFERENCES**

1. Wikipedia. Asia [Internet]. San Francisco: Wikimedia Foundation Inc.; c2014 [cited 2014 Apr. 10]. Available from: http://en.wikipedia.org/wiki/Asia.
2. Bloom DE, Canning D, Rosenberg L. Demographic change and economic growth in South Asia: The WDA – HSG discussion paper series on demographic issues. St. Gallen: World Demographic & Ageing Forum; 2011.
3. Thompson PJ, Salvi S, Lin J, Cho YJ, Eng P, Abdul Manap R, Boonsawat W, Hsu JY, Faruqui RA, Moreno-Cantu JJ, Fish JE, Ho JC. Insights, attitudes and perceptions about asthma and its treatment: findings from a multinational survey of patients from 8 Asia-Pacific countries and Hong Kong. Respiriology 2013;18:957-67.
4. Braman SS. The global burden of asthma. Chest 2006;130(1 Suppl):45S-125.
5. Wong GW, Leung TF, Ko FW. Changing prevalence of allergic diseases in the Asia-Pacific region. Allergy Asthma Immunol Res 2013;5:251-7.
6. Klaewsongkram J, Reantragoon R. Asthma research performance in Asia-Pacific: a bibliometric analysis by searching PubMed database. J Asthma 2009;46:1013-20.
7. Janson C, Anto J, Burney P, Chinn S, de Marco R, Heinrich J, Jarvis D, Kuenzli N, Leynaert B, Luczynska C, Neukirch F, Svanes C, Sunyer J, Wjst M; European Community Respiratory Health Survey II. The European Community Respiratory Health Survey: what are the main results so far? European Community Respiratory Health Survey II. Eur Respir J 2001;18:598-611.
8. Agrawal S, Peace N, Ebrahim S. Prevalence and risk factors for self-reported asthma in an adult Indian population: a cross-sectional survey. Int J Tuberc Lung Dis 2013;17:275-82.
9. Dejsomritrutai W, Nana A, Chierakul N, Sompradeekul S, Ruttanaumpawan P, Charoenratanakul S. Prevalence of bronchial hyperresponsiveness and asthma in the adult population in Thailand. Chest 2006;129:602-9.
10. Fukutomi Y, Nakamura H, Kobayashi F, Taniguchi M, Konno S, Nishimura M, Kawagishi Y, Watanabe J, Komase Y, Okada C, Tanimoto Y, Takahashi K, Kimura T, Eboshida A, Hirota R, Ikei J, Odajima H, Nakagawa T, Akasawa A, Akiyama K. Nationwide cross-sectional population-based study on the prevalences of asthma and asthma symptoms among Japanese adults. Int Arch Allergy Immunol 2010;153:280-7.
11. Jindal SK, Aggarwal AN, Gupta D, Agarwal R, Kumar R, Kaur T, Chaudhry K, Shah B. Indian study on epidemiology of asthma, respiratory symptoms and chronic bronchitis in adults (INSEARCH). Int J Tuberc Lung Dis 2012;16:1270-7.
12. Lu Y, Feng L, Lim L, Ng TP. Asthma, life events and psychiatric disorders: a population-based study. Soc Psychiatry Psychiatr Epidemiol 2013;48:1273-82.
13. Mahboub BH, Al-Hammadi S, Rafique M, Sulaiman N, Pawankar R, Al Redha AI, Mehta AC. Population prevalence of asthma and its
determinants based on European Community Respiratory Health Survey in the United Arab Emirates. BMC Pulm Med 2012;12:4.
14. Ng TQ, Hui KP, Tan WC. Prevalence of asthma and risk factors among Chinese, Malay, and Indian adults in Singapore. Thorax 1994;49:347-51.
15. Chan-Yeung M, Zhan LX, Tu DH, Li B, He GX, Kauppinen R, Nieminen M, Enarson DA. The prevalence of asthma and asthma-like symptoms among adults in rural Beijing, China. Eur Respir J 2002;19:853-8.
16. Shi Z, Yuan B, Wittert GA, Pan X, Dai Y, Adams R, Taylor AW. Monosodium glutamate intake, dietary patterns and asthma in Chinese adults. PLoS One 2012;7:e51567.
17. Wang D, Xiao W, Ma D, Zhang Y, Wang Q, Wang C, Ji X, He B, Wu X, Chen H, Zhang Y, Jiang Y, Yin J. Cross-sectional epidemiological survey of asthma in Jinan, China. Respirolgy 2013;18:313-22.
18. Wilson D, Takahashi K, Pan G, Chan CC, Zhang S, Feng Y, Hoshuyama T, Chuang KJ, Lin RT, Hwang JS. Respiratory symptoms among residents of a heavy-industry province in China: prevalence and risk factors. Respir Med 2008;102:1536-44.
19. Wu F, Guo Y, Kowal P, Jiang Y, Yu M, Li X, Zheng Y, Xu J. Prevalence of major chronic conditions among older Chinese adults: the Study on Global Ageing and adult health (SAGE) wave 1. PLoS One 2013;8:e74176.
20. 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.
21. Song WJ, Chang YS, Lim MK, Yun EH, Kim SH, Park HW, Kim YY, Cho SH, Bachert C. Staphylococcal enterotoxin sensitization in a community-based population: a potential role in adult-onset asthma. Clin Exp Allergy 2014;44:553-62.
22. Sonomjamts M, Dashdemberel S, Logii N, Nakae K, Chigusa Y, Ohhira S, Ito C, Sagara H, Makino S. Prevalence of asthma and allergic rhinitis among adult population in Ulaanbaatar, Mongolia. Asia Pac Allergy 2014;4:25-31.
23. Viinanen A, Munhbayarlah S, Zevgee T, Narantsetseg L, Naidansuren Ts, Koskenuo M, Helenius H, Terho EO. Prevalence of asthma, allergic rhinoconjunctivitis and allergic sensitization in Mongolia. Allergy 2005;60:1370-7.
24. Rahimi-Rad MH, Gaderi-Pakdel F, Salari-Lak S. Smoking and asthma in 20-44-year-old adults in Urmia, Islamic Republic of Iran. East Mediterr Health J 2008;14:6-16.
25. Baskabady MH, Kolahdzh G. Prevalence of asthma symptoms among the adult population in the city of Mashhad (north-east of Iran). Respirrology 2002;7:267-72.
26. Golshan M, Esteki B, Dadvand P. Prevalence of self-reported respiratory symptoms in rural areas of Iran in 2000. Respirology 2002;7:129-32.
27. Alsowaidi S, Abdulle A, Bernsen R. Prevalence and risk factors of asthma among adolescents and their parents in Al-Ain (United Arab Emirates). Respiration 2010;79:105-11.
28. Aggarwal AN, Chauhdry K, Chhabra SK, D’Souza GA, Gupta D, Jindal SK, Katiyar SK, Kumar R, Shah B, Vijayan VK. Asthma Epidemiology Study Group. Prevalence and risk factors for bronchial asthma in Indian adults: a multicentre study. Indian J Chest Dis Allied Sci 2006;48:13-22.
29. Chowgule RV, Shetye VM, Parmar JR, Bhosale AM, Khandagale MR, Phalnitkar SV, Gupta PC. Prevalence of respiratory symptoms, bronchial hyperreactivity, and asthma in a megacity: Results of the European community respiratory health survey in Mumbai (Bombay). Am J Respir Crit Care Med 1998;158:547-54.
30. Jindal SK, Gupta D, Aggarwal AN, Jindal RC, Singh V. Study of the prevalence of asthma in adults in North India using a standardized field questionnaire. J Asthma 2000;37:345-51.
31. Parasuramalu BG, Huliraj N, Rudraprasad BM, Prashanth Kumar SP, Gangaboriaih, Ramesh Masthi NR. Prevalence of bronchial asthma and its association with smoking habits among adult population in rural area. Indian J Public Health 2010;54:165-8.
32. Bartlett E, Parr J, Lindeboom W, Khanam MA, Koehlmoos TP. Sources and prevalence of self-reported asthma diagnoses in adults in urban and rural settings of Bangladesh. Glob Public Health 2013;8:79-89.
33. Lam HT, Ronmark E, Tuong NV, Ekerlung L, Chuc NT, Lundback B. Increase in asthma and a high prevalence of bronchitis: results from a population study among adults in urban and rural Vietnam. Respir Med 2011;105:177-85.
34. Sherina MS, Rampal L, Mustaqim A. Factors associated with chronic illness among the elderly in a rural community in Malaysia. Asia Pac J Public Health 2004;16:109-14.
35. Sundarar H. Epidemiology of asthma in Indonesia. Acta Med Indones 2005;37:51-4.
36. Sy DQ, Thanh Binh MH, Quoc NT, Hung NV, Quynh Nhu DT, Bao NQ, Khiet LQ, Hai TD, Raffard M, Aelony Y, Homasson JP. Prevalence of asthma and asthma-like symptoms in Dalat Highlands, Vietnam. Singapore Med J 2007;48:294-303.
37. Jan IS, Chou WH, Wang JD, Kuo SH. Prevalence of and major risk factors for adult bronchial asthma in Taipei city. J Formos Med Assoc 2004;103:259-63.
38. Kim SY, Jung JY, Park MS, Kang YA, Kim EY, Kim SK, Chang J, Kim YS. Increased prevalence of self-reported asthma among Korean adults: an analysis of KNHANES I and IV data. Lung 2013;191:281-8.
39. Hassan MR, Kabir AR, Mahmud AM, Rahman F, Hossain MA, Bennoor KS, Amin MR, Rahman MM. Self-reported asthma symptoms in
children and adults of Bangladesh: findings of the National Asthma Prevalence Study. Int J Epidemiol 2002;31:483-8.
40. Eder W, Ege MJ, von Mutius E. The asthma epidemic. N Engl J Med 2006;355:2226-35.
41. Anandan C, Nurmatov U, van Schayck OC, Sheikh A. Is the prevalence of asthma declining? Systematic review of epidemiological studies. Allergy 2010;65:152-67.
42. Chinn S, Jarvis D, Burney P, Luczynska C, Ackermann-Liebrich U, Anto JM, Cerveri I, De Marco R, Gislason T, Heinrich J, Janson C, Kunzli N, Leynaert B, Neukirch F, Schoute J, Sunyer J, Svanes C, Vermeire P, Wijt M. Increase in diagnosed asthma but not in symptoms in the European Community Respiratory Health Survey. Thorax 2004;59:646-51.
43. Fukutomi Y, Taniguchi M, Watanabe J, Nakamura H, Komase Y, Ohta K, Akasawa A, Nakagawa T, Miyamoto T, Akiyama K. Time trend in the prevalence of adult asthma in Japan: findings from population-based surveys in Fujieda City in 1985, 1999, and 2006. Allergol Int 2011;60:443-8.
44. Ko FW, Lai CK, Woo J, Ho SC, Ho CW, Goggins W, Hui DS. 12-year change in prevalence of respiratory symptoms in elderly Chinese living in Hong Kong. Respir Med 2014;17:172-8.
45. Wang HY, Wong GW, Chen YZ, Ferguson AC, Greene JM, Ma Y, Zhong NS, Lau CK, Sears MR. Prevalence of asthma among Chinese adolescents living in Canada and in China. CMAJ 2008;179:1133-42.
46. de Nijs SB, Venekamp LN, Bel EH. Adult-onset asthma: is it really different? Eur Respir Rev 2013;22:44-52.
47. Yokoyama N, Katoh S, Nishimura M, Nakagawa T, Miyakawa Y, Konno S. Association between body mass index and asthma among Japanese adults: risk within the normal weight range. Int Arch Allergy Immunol 2012;157:281-7.
48. Song WJ, Kim SH, Lim S, Park YJ, Kim MH, Lee SM, Lee SB, Kim KW, Chang YS. Association between obesity and asthma in the elderly population: potential roles of abdominal subcutaneous adiposity and sarcopenia. Ann Allergy Asthma Immunol 2012;109:243-8.
49. Cheng HM, Kim S, Park GH, Chang SE, Bang S, Won CH, Lee MW, Choi JH, Moon KC. Low vitamin D levels are associated with atopic dermatitis, but not allergic rhinitis, asthma, or IgE sensitization, in the adult Korean population. J Allergy Clin Immunol 2014;133:1048-55.
50. Mishra V. Effect of indoor air pollution from biomass combustion on prevalence of asthma in the elderly. Environ Health Perspect 2003;111:71-8.
51. Xu X, Christian DC. Occupational exposures and physician-diagnosed asthma. Chest 1993;104:1364-70.
52. Choi MH, Chang YS, Lim MK, Bae YM, Hong ST, Oh JK, Yun EH, Bae MJ, Kwon HS, Lee SM, Park HW, Min KU, Kim YK, Cho SH. Clonorchis sinensis infection is positively associated with atopy in endemic area. Clin Exp Allergy 2011;41:697-705.
53. Song WJ, Kim MY, Jo EJ, Kim MH, Kim TH, Kim SH, Kim KW, Cho SH, Min KU, Chang YS. Rhinitis in a community elderly population: relationships with age, atopy, and asthma. Ann Allergy Asthma Immunol 2013;111:347-51.
54. Van Cauwenberge P, Watelet JB, Van Zele T, Bousquet J, Burney P, Zuberbier T; GA2 LEN partners. Spreading excellence in allergy and asthma: the GA2 LEN (Global Allergy and Asthma European Network) project. Allergy 2005;60:858-64.
55. Hwang CY, Chen YJ, Lin MW, Chen TJ, Chu SY, Chen CC, Lee DD, Chang YT, Wang WJ, Liu NN. Prevalence of atopic dermatitis, allergic rhinitis and asthma in Taiwan: a national study 2000 to 2007. Acta Derm Venereol 2010;90:589-94.
56. Makino S, Adachi M, Aikiya K, Baba M, Egashira Y, Fujimura M, Fukuda T, Furusho K, Iikura Y, Inoue H, Ito K, Iwamoto I, Kabe J, Kamikawa Y, Kawakami Y, Kihara S, Kudo K, Mano K, Matsu T, Mikawa H, Miyagi S, Miyamoto T, Morita Y, Nagasaka Y, Nakagawa T, Nakajima S, Nakazawa T, Nishima S, Ohita K, Okubo T, Sakakibara H, Sano Y, Shinomiya K, Takagi K, Takahashi K, Tamura G, Tomikawa H, Toyoshima H, Tsuikawo K, Ueda N, Yamakido M, Hoshi S, Sagara H; Research Group for Asthma Prevention and Management Guidelines. Epidemiology of asthma. Int Arch Allergy Immunol 2005;205:153-61.
57. Lai CK, Ho SC, Lau J, Yuen YK, Ho SS, Chan CH, Woon WW. Respiratory symptoms in elderly Chinese living in Hong Kong. Eur Respir J 1995;8:505-11.
58. Schachter EN, Doyle CA, Becker NJ. A prospective study of asthma in a rural community. Chest 1984;85:623-30.