University of Alberta

International Prevalence of Asthma and Wheeze in Adults: Results from the WHS

by

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A thesis submitted to the Faculty of Graduate Studies and Research
in partial fulfillment of the requirements for the degree of

Master of Science
in
Epidemiology

Department of Public Health Sciences

Fall 2009
Edmonton, Alberta

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Dedication

~ To Dr. A. Senthilselvan, who provided this valuable opportunity and continuous guidance ~

Acknowledgements

I hereby sincerely express my deepest gratitude to my graduate committee, Dr. A. Senthilselvan, Dr. B.H. Rowe, Dr. J. Douwes, and Dr. J. Beach for their expertise and support for this academic endeavor. This research thesis was funded by the Sir Frederick Banting and Charles Best Canada Graduate Scholarship by the CIHR and the Walter H. Johns Graduate Fellowship by the University of Alberta. I would like to give special thanks to Dr. L. Laing to be the chair of the thesis defense and to Ms. Nirmala Naidoo for providing guidance and data information on the World Health Survey. The research and analysis are based on the World Health Survey data conducted by the World Health Organization; however, the opinions expressed in this thesis do not represent the views of the World Health Organization.

Abstract

International prevalence of ever asthma and current wheeze in adults were examined in 55 countries participating in the World Health Survey. The prevalence of ever asthma ranged from 1.1-7.9% in Asia, 2.4-7.6% in Africa, 3.4-7.9% in Middle East, 2.4-12.1% in America, 3.9-6.8% in Eastern Europe, 4.2-17.1% in Western Europe, and 18.5% in Australia. Anxiety and ever depression were strong and consistent risk factors for ever asthma (Odds ratios (ORs) ranged from 0.64-4.08 and 1.42-18.49, respectively) and current wheeze (ORs ranged from 1.57-3.56 and from 1.72-16.23, respectively). Female and older age appeared to be risk factors, while higher education appeared to be a protective factor for both outcomes. In conclusion, large variations in ever asthma and current wheeze prevalence were observed both within and among geographic regions, with the highest prevalence generally found in Western Europe, Brazil, and Australia, and the lowest prevalence found in Asia and Africa.

Keywords: Asthma, international comparison, prevalence, protective factors, risk factors, wheeze, World Health Survey.

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Chapter 1

Introduction

Asthma is a very common chronic disease. Due to the insufficient understanding of asthma etiology and the vast spectrum of clinical presentations, defining asthma has not been easy for both clinicians and medical researchers. Nonetheless, advancing knowledge regarding the pathophysiology of asthma has helped to refine the definition:

> *Asthma is a chronic inflammatory disorder of the airways in which many cells and cellular elements play a role. The chronic inflammation is associated with airway hyperresponsiveness that leads to recurrent episodes of wheezing, breathlessness, chest tightness, and coughing, particularly at night or in the early morning. These episodes are usually associated with widespread, but variable, airflow obstruction within the lung that is often reversible either spontaneously or with treatment (FitzGerald et al., 2008).*

This definition emphasized asthma as a single disorder, rather than a collection of multiple conditions and syndromes. The major distinguishing characteristic of asthma pertains to the underlying chronic inflammation of the lower airways. As a result of inflammation, the airways became hyperresponsive and narrowed easily in response to a wide range of stimuli, resulting in symptoms such as wheezing. The airway obstruction and underlying inflammation might lead to recurrent episodes of acute exacerbations, or asthma attacks, manifested by worsening symptoms. The partial reversibility of airway obstruction helps to diagnostically differentiate asthma from other obstructive respiratory diseases in which airways obstruction is predominately non-reversible including chronic bronchitis and emphysema, collectively known as chronic obstructive pulmonary disease or COPD (Chung and Adcock, 2000).

Different asthma classifications are needed to account for the vast number of asthma phenotypes. One classification was based on allergic status. Allergic (or atopic) asthma referred to asthmatics with a known allergy, which is usually verified by skin test or serum immunoglobulin (Ig)-E level. Exacerbations in persons with allergic asthma might be triggered by exposing to an allergen: pollen, animal dander, or house dust mite. Non-allergic (or non-atopic) asthma referred to asthmatics without an allergy. Their exacerbations might be triggered by exposing to an allergy-unrelated agent or event such as physical exercise, infections, stress, emotional excitement, hyperventilation, or inhalation of cold air (Chung and Adcock, 2000). Allergy is a very common comorbidity in asthma with approximately 70% of asthmatics also having an allergy (WHO, 2007). However, the proportion of asthma cases attributable to atopy is only about 50%, because many non-asthmatics are also allergic (Pearce et al., 1999). Other asthma classifications were based on provoking factors, treatment response, intensity of exacerbations, and others (Chung, 2002). They included pollen-induced, exercise-induced, aspirin-induced, childhood-onset, adult-onset, fixed irreversible, cough-variant, nocturnal, occupational, steroid-dependent, and steroid-resistant asthma. According to the severity and frequency of exacerbations, asthma has been classified as grade 1 (mild, intermittent), grade 2 (mild, persistent), grade 3 (moderate, persistent) and grade 4 (severe, persistent) (Yawn, 2008).

Asthma is a serious international health concern, yet many aspects regarding the etiology, diagnosis, treatment and prevention of this disease remain largely unknown. By examining possible geographic patterns, a better understanding regarding asthma etiology and risk/protective factors may emerge. Thus, the intent of this research thesis was to examine the prevalence of asthma and asthma-related outcomes in different countries worldwide. Comparisons within and among geographic regions would be made to determine any possible geographical patterns. In addition, risk and protective factors would be identified from a predetermined set of potential factors.

Chapter 2

Literature review

2.1 Identification of related literature

Various approaches were used to identify articles related to this study. First, the relevant peer-reviewed journals were identified from MEDLINE using combinations of the following keywords:

- Geography: International, global, Asia, Africa, America, Europe, Middle East, US, Canada
- Article type: Epidemiology, prevalence, incidence, rate, trend, pattern, cause, etiology, risk, exposure, review, summary, overview
- Exposure: Gene, sex, age, occupation, farming, SES, education, income, environment, pollutant, fuel, allergen, psychological, anxiety, depression
- Outcome: Asthma, wheeze

Secondly, in order to obtain the potentially relevant articles in grey literature, search using the GOOGLE scholar engine and government websites were conducted. Thirdly, hand search from the bibliographies from highly relevant articles was carried out. Lastly, additional journals and textbooks were identified through personal communication with the thesis committee members.

The initial MEDLINE search yielded approximately 700 results (on January 2009), and 221 deemed relevant after screening based on titles and abstracts. Other sources including hand search, GOOGLE scholar, and referred literature added 30 more articles. From the 251 included literatures, 106 have been used on the bibliography in this study. These referenced articles consisted of one randomized control trial, one systematic review, two simulation studies, three comment responses, five cohort studies, five case-control studies, 42 reviews, and 47 cross-sectional studies.

2.2 International prevalence of asthma

Asthma is a worldwide problem. The prevalence of asthma has increased substantially across the world between 1980s and mid 1990s (Pearce et al., 1998). This uptrend has occurred in both developed and developing countries of widely different lifestyles and ethnic groups, including Canada (ASC, 2005), USA (Mannino et al., 1998), and China (Chen, 2004). Since the mid 1990s, however, converging evidence from regional cross-sectional surveys conducted in multiple time points suggested that the rising trend of asthma might have stopped in many areas in the world, including Nijmegen and Limburg in the Netherlands (van Schayck and Smit, 2005), Zurich and Montana in Switzerland (Braun-Fahrlander et al., 2004), Belmont in Australia (Toelle et al., 2004), Hong Kong in China (Wong et al., 2004), Aberdeen in Scotland (Devenny et al., 2004), and Saskatchewan in Canada (Senthilselvan et al., 2003). In contrast, the asthma trend continued rising in Africa, Latin American regions, and parts of Asia (FitzGerald et al., 2008). About 300 million people worldwide have reported having asthma (Masoli et al., 2004), ranging from 1% to 18% of the population in different countries (FitzGerald et al., 2008).

2.3 Burden of asthma

Due to its high prevalence and chronic nature, asthma lead to a heavy financial, psychological, and physical burden on society and individuals through school/work absenteeism, lost productivity, use of medications, hospitalizations, physician visits, reduced quality of life, and increased stress and anxiety. Approximately, 1 in every 250 deaths in the world was attributable to asthma (Masoli et al., 2004). Many of these deaths could have been prevented with appropriate asthma treatment and management. The major economic burden was largely due to the asthma medication and management. The total cost of asthma could be divided into direct cost (e.g. hospital admissions and medications) and indirect cost (e.g. reduced work productivity and time spent on doctor visits). The direct cost of asthma represented roughly 1-3% of the total medical expenditure in many countries while the indirect cost might consume as much as 50% of the total cost (Bousquet et al., 2005). The number of disability-adjusted life years (DALYs) lost due to asthma worldwide is similar to that for diabetes, liver cirrhosis, and Schizophrenia. Patients with suboptimally-controlled or severe asthma utilize a disproportionately large segment of the total asthma resource (Bootman et al., 2004). A cross-sectional survey conducted in northern California showed that the total per-person annual costs of asthma averaged $4,912, with direct and indirect costs accounting for $3,180 and $1,732, respectively (Cisternas et al., 2003). The direct cost primarily consisted of medications ($1,605), hospital admissions ($463), and non-emergency department ambulatory visits ($342), whereas, the indirect cost primarily consisted of cessation of work ($1,062) and the loss of entire work days among those remaining employed ($486). Total per-person costs were $2,646, $4,530, and $12,813 for persons self-reporting mild, moderate, and severe asthma, respectively (Cisternas et al., 2003). Every day, 40,000 Americans miss school or work, 30,000 experience an asthma attack, 5,000 visit the emergency room, 1,000 are admitted to the hospital, and 11 die due to asthma (AAAAI, 2005; NCHS, 2001).

2.4 Asthma etiology

Although the etiology of asthma remains largely unknown, it is believed that asthma develops through a complex and multi-faceted interplay of genetic and environmental factors. Individuals with a hereditary tendency of asthma or allergy were more likely to develop asthma upon contact with specific airborne allergens (e.g., house dust mites, pollen, cockroaches, and cat dander) in infancy or in early childhood when the immune system was maturing (NHLBI, 2008). These allergens were called sensitizers because exposure caused previous-healthy individuals to become sensitized to the allergen. After patients have developed asthma, their symptoms might episodically worsen upon encounter with an asthma trigger, resulting in a full-blown asthma attack called an exacerbation. As much as 80% of exacerbations are associated with respiratory viral infections, with rhinoviral infection responsible for about two thirds of cases (Sykes and Johnston, 2008). Certain allergens (e.g., pollen and house dust mite), environmental agents (e.g., cigarette smoke, perfume, and air pollutant) and bacterial infections (e.g., *C. pneumoniae*) are also identified as triggers.

A well known theory attempted to explain the increased prevalence of asthma between 1980-90s was the hygiene hypothesis. Westernized life styles have led to an increased use of antibiotics, decreased helminth infection, decreased physical proximity to farm animals, changed exposure to mycobacteria that were commonly found in soil, changed bacterial colonization of the gut, and decreased infection with hepatitis A virus (Platts-Mills et al., 2005). The hygiene hypothesis proposed that this "excessively" hygienic environment led to the overstimulation of the T-helper cells type-2 (Th2) branch of the immune system. Subsequently, an overly stimulated Th2 branch increased the likelihood of developing inflammatory diseases including asthma and hay fever. This theory is in accord with the relatively consistent observations of higher allergic diseases, including allergic asthma, in developed countries than developing countries. However, the non-allergic asthmatic cases, approximately 50% of all cases, could not be explained by this theory (Douwes and Pearce, 2008).

2.5 Risk and protective factors for asthma

Many risk and protective factors were found to be associated with asthma. They could generally be categorized into the following categories.

2.5.1 Biological and demographic factors

A range of demographic factors have been associated with asthma risk, including age, sex, birth order, season of birth, birth weight, ethnicity, region, and country (Pearce et al., 1998). Before the age of 15, asthma is more prevalent in boys than girls (Sunyer et al., 1997); however, this pattern is reversed once puberty is reached and beyond (Arif et al., 2003). Prevalence of asthma and asthma symptoms increase with age in both males and females (Chan-Yeung et al., 2002). Obesity and lower physical activity were associated with increased risk of developing asthma and exacerbations (Garcia-Aymerich et al., 2009; Ronmark et al., 2005). The prevalence of both asthma and obesity has significantly increased over the past 20 years (Moorman et al., 2007). A recent meta-analysis summarizing 7 prospective studies on white adult populations indicated that obesity was significantly associated with increased risk of asthma (Odds ratio (OR): 1.92, CI: 1.43-2.59) (Beuther and Sutherland, 2007). It was proposed that obesity could deteriorate lung functions which might subsequently lead to a higher susceptibility to exacerbations (Redd, 2002). It was also suggested that obesity might modulate immune responses via genetic mechanisms and hormonal changes (Tantisira and Weiss, 2001).

2.5.2 Genetic factors

There was a familial component to the etiology of asthma (Horwood et al., 1985); however, this might be due to both shared genetics and physical environment. Twin studies have estimated the proportion of phenotypic variations attributable to genetic variations, or heritability, is approximately 60% in asthma (Moffatt, 2008; Sanford et al., 1996). The magnitude of heritability might, however, vary based on the degree of environmental variations in these studies. To date, over 100 candidate genes have been reported to be associated with asthma, and 10 of them (e.g., IL4, IL4RA, IL13, ADRB2, TNF, HLA-DRB1, HLA-DQB1, FCER1B, CD14 and ADAM33) were found to be linked to asthma or atopy in more than 10 studies each (Ober and Hoffjan, 2006). The overall clinical effects of a particular gene might be immensely amplified or attenuated by its interactions with other genes, protein products, or environmental stimuli. However, since no major influence on asthma was found solely by a single or a small number of predisposing genes, it was generally believed that the increasing prevalence of asthma in the 1980-90s was mainly due to environmental, and not genetic, factors (McCunney, 2005).

2.5.3 Occupational factors

In a population-based incidence study, metal and forestry manufacturing positions were associated with higher adult-onset asthma risk in males, whereas, an increased risk was demonstrated in waitresses, cleaners, and dental workers in females (Jaakkola et al., 2003). An increasing number of studies conducted in Europe, North America, and Australia have reported a reduced risk of atopy, hay fever, and asthma in farmers' children (Braun-Fahrlander et al., 1999; Downs et al., 2001; Ernst and Cormier, 2000; Midodzi et al., 2007; Riedler et al., 2000). Several studies have also shown a low prevalence among adult or adolescent farmers and people living in rural areas of allergic symptoms and atopic sensitization, both in developing and developed countries (Mugusi et al., 2004; Portengen et al., 2005; Portengen et al., 2002). It was speculated that these protective effects in adults could be due to microbial exposure during childhood; however, one study further illustrated a decreased prevalence among adolescent farmers who were not raised on a farm (Portengen et al., 2002), thus suggesting farming by itself might protect against asthma and allergic diseases.

2.5.4 Socioeconomic factors

Low socioeconomic status (SES) was associated with reduced lung functions, increased asthma hospital admissions, and poorer asthma severity (Littlejohns and Macdonald, 1993; Steinberg and Becklake, 1986; Watson et al., 1996). However, evidence from a prospective cohort study on SES and asthma prevalence have been mixed (Hancox et al., 2004). This inconsistency might be partly explained by the phenomenon that a small number of SES indicators (e.g. education, income, and occupation) were used to represent such a broad and abstract concept. Thus, it has been suggested that prospective studies should consider applying multiple SES indicators in an attempt to effectively capture the major essential domains within SES (Corvalán et al., 2005). In addition, different physician diagnosis criteria and patient reporting, as well as perception of signs of asthma symptoms might differ among social classes (Franksa et al., 2003; Leeder et al., 1976; Mielck et al., 1996; Phankingthongkum et al., 2002), hence further obscuring the underlying relational pathways.

2.5.5 Environmental factors

Environmental factors could be broadly divided into indoor and outdoor factors. Residents living in developed countries mainly spend their time indoors, thus, exposure to indoor air pollutants might have a more potent effect on childhood asthma risk than exposure to outdoor air pollutants in these areas (Etzel, 2003). The well-established, air pollutants associated with asthma exacerbations included biologic allergens (house dust mites, cockroaches, pet dander, and mold), environmental toxins (tobacco smoke), irritant chemicals, fumes, and combustion byproducts (cooking stove, oil heater, and fireplace). In terms of their roles in asthma development, house dust mites allergen (Peat and Li, 1999; Platts-Mills et al., 1997), cockroach allergen (Etzel, 2003), and pre- and post-natal exposure to environmental cigarette smoke (Pearce et al., 1998; Wang and Pinkerton, 2008) appeared to link to asthma development. On the contrary, exposure to dander from certain pets in early childhood were found to be protective against future asthma development (Murray et al., 2001).

In the last few decades, high levels of outdoor air pollution have been linked to the corresponding short-term increases in asthma morbidity and mortality (Kim, 1993; Ostro et al., 2001). Some, though limited, evidence suggested that outdoor air pollutants were associated with the increased asthma incidences at population levels (D’Amato et al., 2005; Salvi, 2001). Air pollutants that might affect asthmatic patients included ozone, sulfur dioxide, nitrogen dioxide, carbon monoxide, lead, and inhalable particulate matters (D’Amato et al., 2005). Furthermore, in a number of regions, ambient hazardous air pollutants and industrial disposals of aldehydes, certain metals, isocyanates, and others have been shown to trigger asthma (Leikauf et al., 1995).

2.5.6 Psychological factors

Psychological aspects have been shown to be important for asthma severity, exacerbations, and quality of life (Lehrer et al., 2002). Stress alone could trigger asthma attacks (Affleck et al., 2000; Ritz et al., 2000). Asthmatics, particularly children, were more prone to psychological problems, especially anxiety disorders (Bussing et al., 1996; Vila et al., 1999). Persons with asthma and comorbid psychiatric disorders such as depression and anxiety had more impairment in asthma control and general health care utilization than persons with either disease alone (Feldman et al., 2000; Schneider et al., 2008; ten Brinke et al., 2001). This association might occur either through disorganization of self-care behavior or by direct physiological effects of anxiety on the autonomic and immune systems (Lehrer et al., 2002). Elevated anxiety and depression have been found to be positively associated with asthma severity in children (Mrazek, 1992), but not in adults (Afari et al., 2001). Asthmatics, especially children, were more likely to experience negative emotions without expressing them (Silverglade et al., 1994).

Some recent studies have suggested depression and anxiety might be predisposing risk factors for later asthma development. Childhood adversities and early-onset depressive and anxiety disorders predicted adult-onset asthma (Scott et al., 2008). A prospective cohort study has explained a dose-response relationship between the level of maternal anxiety and the likelihood of developing asthma at 7.5 years old (Cookson et al., 2009).

2.6 The role of international prevalence studies

Despite enormous research efforts, the exact etiology of asthma remains largely unknown. The major contributing factors responsible for asthma development and exacerbations might differ significantly at the individual, regional, and international levels. Historically, the causal relationships of many diseases were first revealed by international or regional prevalence comparisons.

This was especially true for a number of cancers, such as human papilloma virus and cervical cancer, dietary factors and colon cancer, and hepatitis B and liver cancer (Doll et al., 1971). Population prevalence studies were frequently conducted to validate or refute hypothesized risk factors. For instance, from the lack of significant difference in prevalence of asthma between Eastern and Western Germany, it was indicated that long-term exposure to sulfur dioxide and inhalable particulate matters in Eastern Germany did not play a major role on population prevalence of asthma in Germany (von Mutius et al., 1992).

Many local studies on asthma prevalence have been conducted throughout the world; however, the differences in methodology, survey tools, characteristics of respondents, and time frame made international comparisons unwarranted. Thus, initiatives on conducting high quality, global cross-sectional studies using the same methodology have emerged. Three major international prevalence studies have been conducted within the last two decades: the International Study of Asthma and Allergies in Childhood (ISAAC), the European Community Respiratory Health Survey (ECRHS), and the World Health Survey (WHS).

2.6.1 Results from ISAAC

Initiated in 1991, ISAAC was developed to collect data on childhood asthma, allergic rhinitis and atopic eczema using simple standardized methods allowing for systematic international comparisons. ISAAC consisted of three phases. Phase I was achieved by 1997, two groups (13-14 year old and 6-7 year old) were measured using either simple written questionnaire or video questionnaire. More than 750,000 children from 156 centres in 56 countries have completed the surveys (Beasley et al., 2003). The authors have summarized the findings as the followings:

- Asthma was less prevalent in developing countries (e.g., Southeast Asia).

- The highest asthma prevalence were found in English-speaking countries (e.g., the UK, USA, Canada, and Australia).
- Asthma prevalence was higher in northwest Europe than southeast Europe.
- The asthma prevalence patterns at population levels could not be explained by genetic components alone (e.g., higher prevalence in HK than mainland China despites a shared genetic similarity).
- Asthma prevalence patterns at population levels cannot be explained by known risk factors alone (e.g., higher prevalence in HK than mainland China despite higher smoking rates and air pollution levels in the latter).

Beginning in 1998, ISAAC phase II was completed, involving 30 centres from 22 countries using intensive investigations to further examine the potential role of risk factors that might contribute to the international differences observed in Phase I. Phase II added more objective laboratory measures including hypertonic saline aerosol challenge, skin prick tests for atopy, total and specific serum IgE, and storage of blood samples for genetic analyses. Phase III was conducted after 5-10 years of the previous survey administration. This phase applied the same standardized data collection method as used in Phase I, thus allowing for examining a temporal change. In 2006, the ISAAC Phase III studies were completed involving 66 centres from 37 countries in the 6-7 years old group and involving 106 centres from 56 countries in the 13-14 years old group (Asher et al., 2006). For 6-7 year age-group, prevalence of asthma symptoms increased in 25 centres and decreased in 14. For the 13-14 year age-group, the prevalence of asthma symptoms increased in 42 centres and decreased in 40.

2.6.2 Results from ECRHS

In response to the increased mortality rates due to asthma in many parts of Europe in mid 1970s, the ECRHS, funded by the European Commission, started collecting information on asthma prevalence, risk factors, and medical management since 1990. The Phase I of ECRHS was conducted between 1990 and 1993 to determine the variations in prevalence and risk factors associated with asthma and symptoms among adults aged 20 to 44 years (Burney et al., 1994). Phase I of ECRHS collected data from about 18,000 adults in 56 centres from 25 countries (mainly in Western Europe). The prevalence of wheeze in the previous 12 months varied between 4.1% and 32.0%. The highest prevalence was found in the UK, New Zealand, Australia, and Canada, while the lowest in developing countries including China, India, and Algiers (Chan-Yeung et al., 2002; ECRHS, 1996; Manfreda et al., 2001). The prevalence of asthma attacks varied between 1.3% and 9.7% and the prevalence of diagnosed asthma (based indirectly on asthma attack and medication) varied between 2.1% and 11.9%.

The ECRHS II, involving 29 centres from 14 countries and 11,169 respondents was completed in 1999-2001. It represented a follow-up study (after at least 7 years) of the ECRHS I. While ECRHS I recruited a random sample (expectedly 1,500 males and 1,500 females) using a short self-complete questionnaire, the Phase II followed up these same patients participated in Phase I for a more detailed questionnaire, collected blood samples for IgE, and carried out lung function tests and bronchial responsiveness tests (Jarvis, 2002). In Phase II, there was a net significant increase in asthma attack, current medication, and diagnosed asthma (Chinn et al., 2004). The changes varied widely between different centres within and among countries. Although not directly comparable due to the different age cohorts examined, the ISAAC and the ECRHS appeared to have good agreement in many outcomes including ever-diagnosed asthma and 12-month wheeze (Pearce et al., 2000).

2.6.3 The World Health Survey

The World Health Survey (WHS) was conducted by the World Health Organization (WHO) in 2002, which was about a decade after ISAAC and ECRHS studies initially collected their information. Contrary to the ISAAC and ECRHS which were respiratory and allergy surveys, the WHS was a comprehensive survey examining all the chief domains of health. While the ISAAC studied a population entirely composed of children and the ECRHS studied adults aged 20-44 years old, the WHS examined an adult population of age 18 years and above. The WHS study covered geographically many more non-European countries than the ECRHS study. More details on the WHS will be discussed in the Methods section.

2.7 Summary of literature review

The WHS provide the most recent international data on asthma prevalence, and contained a broader age and geographic coverage than the ISAAC and ECRHS studies. It would be of immense value to explore international prevalence and risk/protective factors for asthma and asthma-related symptoms. To the best of our knowledge, no research group has conducted a project using the WHS data source for this purpose. Consequently, this specific research was undertaken.

2.8.1 Objectives

The objectives for this thesis were:

- to determine the overall, sex-specific, and age-specific prevalence of ever asthma and current wheeze in countries which participated in the WHS;
- to make continental and cross-continental comparisons of the prevalence of ever asthma and current wheeze;
- to determine the risk factors for ever asthma and current wheeze in individual countries;
- to examine the variation in risk factors between countries and continents, and assess whether these differences are associated with the international prevalence patterns of ever asthma and current wheeze.

2.8.2 Hypotheses

The hypotheses to be examined in this thesis were:

- the prevalence of ever asthma and current wheeze will be higher in developed countries comparing to developing countries;
- the prevalence of ever asthma and current wheeze will be higher in Western Europe comparing to Eastern Europe;
- the prevalence of ever asthma and current wheeze will be higher in adult females comparing to adult males;
- the prevalence of ever asthma and current wheeze will be higher in older age groups comparing to younger age groups;
- risk factors associated with ever asthma and current wheeze will be different among countries.

Chapter 3

Methods

This chapter describes the design and data collection of the WHS and the statistical analysis used in this study. Between 2002 and 2004, the WHO launched the WHS in 70 countries worldwide. It used a common survey instrument in nationally representative population for assessing a broad spectrum of health domains. The main goals of WHS were (Üstün et al., 2001):

- to develop a means of providing low-cost, valid, reliable, and comparable information;
- to build the evidence base which allows the evaluation of the performance of health systems, programs, and interventions;
- to provide policy-makers with the evidence they need to adjust their policies, strategies, and programs as necessary.

3.1 Sampling

The WHS sampling frame covered 100% of the eligible population living in the country, including all citizens, as well as guest workers, immigrants, and refugees. Thus, the eligible population was comprised of all adult members from the general population aged 18 years or older. A stratified, multistage-cluster random sampling design was used to select the final respondents. Stratification was carried out by dividing each country into small subgroups, known as strata, in which sampling will then be conducted separately in each strata (WHS, 2002). The choice of subgroup varied by country depending on the local conditions and available evidence indicating that they were related to the outcomes (e.g., mortality and coverage). Examples of stratification included geography (e.g., North, Central, South) and level of urbanization (e.g., urban, rural). Next, in multistage cluster sampling, a number of clusters were being randomly selected from a list of naturally-occurring units within a population, called clusters (WHS, 2002). The difference between stratified sampling and cluster sampling was that the former required sampling in all strata while the latter required sampling in only the selected clusters. Thus, the cluster sampling lowered the cost of the survey by eliminating an exhaustive list of every member in the sampling frame.

The complex survey design enabled every eligible person in the sampling frame to have a known and non-zero probability of being selected into the survey sample. Household was selected using a random, stratified sampling procedure based on an up-to-date registry of all persons residing in the country or registries providing postal coverage if the former was unavailable. Then, one adult within the household was chosen randomly using the Kish table (WHS, 2002). Based on the stratification, clustering, and the number of eligible persons in household, a normalized design weight for each respondent would be calculated to statistically account for the complex design features.

3.2 Sample size

The pool of respondents selected into the final survey sample represented the entire national population of age 18 years or older. Depending on the needs of each country, sample size might vary between 1,000 and 10,000. Overall, the obtained sample size per country ranged from 700 (Luxembourg) to 38,746 (Mexico) (Table 4.1).

3.3 Survey implementation

Several methodologies of data collection were developed and pre-tested for the WHS. Depending on the available human and monetary resources, size of the country, and total population, each participating country had to make an individual decision regarding which method or a combination of methods to use. The data collection options were:

- Household Face-to-Face Surveys: randomly selected houses were contacted, and a person from that house was selected randomly and interviewed by a trained interviewer;
- Computer Assisted Telephone Interview (CATI): surveys were conducted via phone using computerized systems when there was good coverage of the telephone network;
- Computer Assisted Personal Interview (CAPI): computer assisted data collection method for replacing paper-and-pencil methods of data collection using a portable personal computer.

3.4 Survey contents

The WHS covered a broad spectrum of health related issues. There was a menu of choices of modules for various health and disease related components in the WHS. Each country was allowed to choose from these core modules or might add additional ones. The modules covered the following topics:

- Health status of populations: measuring health in multiple domains;
- Potential risk factors (e.g., tobacco, alcohol, pollution) and their association with health states;
- Responsiveness of health systems: whether health systems met the legitimate expectations of people;
- Coverage, access, and utilization of key health services (e.g., immunization, treatment of childhood illness, STD, and HIV/AIDS);
- Health care expenditures: how much household spending contributed to health care.

The WHS included household and individual level questionnaires. The household questionnaire included questions on house members, long-term care and institutionalization, household health coverage, insurance, indicator of permanent income, health expenditure, and health occupants. The individual questionnaire included questions on socio-demographics, health state description, health state valuation, risk factors, mortality, coverage, health system responsiveness, health system goals, and social capital. There were two types of individual questionnaire: short and long. The long individual questionnaire contained additional questions and took longer to complete. Forty six countries have used the long questionnaire and 9 countries have used the short questionnaire (Table 4.1).

3.5 Independent variables

For the purpose of this study, eleven explanatory factors were derived from the WHS questions (Appendix A). These factors could be categorized into 4 general groups (Appendix B):

- Demographics: sex, age group, obesity, and urban/rural,
- Socioeconomic (SES) indicators: household spending and highest education accomplished,
- Psychological factors: anxiety and ever depression,
- Environmental factors: current smoking status, floor type, and cooking fuel type.

Except for the categorized 'age group' variable which had three levels, all other independent variables were dichotomized into binary variable. Information on anxiety, current smoking status, floor type, and cooking fuel type were only available in the long individual questionnaire. Therefore, these variables were considered as potential risk or protective factors in those countries where the long questionnaire was employed.

3.6.1 Dependent variables

The WHS included 8 questions on asthma and asthma-related symptoms in both the short and long individual questionnaires. The response choices for all these questions were dichotomous (Y/N). The questions were:

(1) Have you ever been diagnosed with asthma?
(2) Have you ever been treated for it?
(3) Have you been taking any medications or other treatment for asthma during the last 2 weeks?
(4) During the last 12 months, have you experienced attacks of wheezing or whistling breathing?
(5) During the last 12 months, have you experienced any attack of wheezing that came on after you stopped exercising or some other physical activity?
(6) During the last 12 months, have you experienced a feeling of tightness in your chest?
(7) During the last 12 months, have you woken up with a feeling of tightness in your chest in the morning or any other time?
(8) During the last 12 months, have you had an attack of shortness of breath that came on without obvious cause when you were not exercising or doing some physical activity?

3.6.2 Primary outcomes

The primary outcomes of this study were ever asthma and current wheeze. Both outcomes are dichotomous. The determination of the status of ever asthma was based exclusively on the response of question (1), *have you ever been diagnosed with asthma?* Likewise, current wheeze was based exclusively and directly on the response for question (4), *during the last 12 months, have you experienced attacks of wheezing or whistling breathing?*

3.7 Country exclusion criteria

Because of the presence of missing data for the outcomes and/or design variables, not all the 70 WHS-participated countries were included in this study. Countries were excluded from this study if:

- Information on individual design weight was missing; and/or
- Information on primary sampling unit (PSU) was missing; and/or
- Missing ≥25% responses on both ever asthma- and current wheeze-derived questions

Of the 70 WHS-participated countries, 15 (21%) were excluded. The reasons for exclusion are provided in Appendix C.

3.8 Statistical methods

3.8.1 Asthma and wheeze prevalence

The prevalence of asthma-related outcomes including ever asthma and current wheeze, as well as the proportions on baseline characteristics, were described with 95% confidence intervals (CI) using the Taylor linearization method (Chaudhuri and Stenger, 2005). Normalized individual design weights were applied to account for the complex sampling design. Since Mexico provided adequate information only for ever asthma but not current wheeze, it was analyzed for ever asthma only. In total, fifty five countries were included in the analysis related to ever asthma, while 54 countries were examined for analysis related to current wheeze.

3.8.2 Risk/protective factors

Multivariate logistic regression analysis with Taylor linearization was used to identify significant risk and protective factors for ever asthma and current wheeze. Only respondents from the countries that employed the long questionnaire and those had adequate information on both explanatory and outcome variables were included in the analysis. In the multivariate analysis, respondents from 43 (42) countries were included for ever asthma (current wheeze). The purposeful selection method was used to generate the final model (Bursac et al., 2008).

3.8.3 Purposeful selection method

- The steps followed in this method were:

  Step 1: The univariate logistic regression was fitted to each independent variable.

  Step 2: Any variable which was significant at the 20% level was selected for the multivariate model.

  Step 3: A multivariable model was developed. Clinically important variables (age and sex) were always retained in the model.

  Step 4: Variables (except age and sex) which failed at the 5% significance level were excluded.

  Step 5: A reduced multivariable model was developed and the likelihood test was performed.

  Step 6: Confounders changing the parameters of any already-included variable by more than 15% due were retained. Re-try was applied if previously non-significant variables had a p-value of less than 0.05.

  Step 7: A reduced multivariable model including the clinically important, statistically significant, and confounding variables was developed.

  Step 8: The model fit was assessed using the Archer and Lemeshow method for survey design (Archer and Lemeshow, 2006).

- Building the 1st-order interaction model

Step 9: For the multivariate model developed in Step 7, interaction effect between the significant main effect variables was tested one at a time.

Step 10: All interaction terms, which were significant at the 5% level in the multivariate model in Step 9, were identified.

Step 11: A final model including main effects and significant interactions was developed.

Step 12: The model fit was tested using the Archer and Lemeshow method for survey design.

Chapter 4

Results

4.1 Participant response rates

A total of 258,550 subjects from 55 countries were considered. The long version of the WHS questionnaire was used in 46 countries, and the short questionnaire was used in 9 countries, mostly but not exclusively in Western Europe (Table 4.1). The total number of respondents in each country ranged from 700 (Luxembourg) to 38,746 (Mexico). The median sample size per country was approximately 4,292. Overall, the household response rate ranged from 24% to 100%, with a median of 93%. The individual response rate ranged from 63% to 100%, with a median of 99%. Five countries, including China, Comoros, Cote d'Ivoire, India, and Russia, have not used a nationally representative sampling frame.

4.2 Demographic characteristics

Tables 4.2.1 to 4.2.7 summarize the baseline demographic characteristic for the included countries grouped by continent. Countries generally contained a larger proportion of young adult group (18-34 years old) than the old adult group (35-54 years old) which, in terms, was typically larger than the older adult group (≥55 years old). The proportion of male and female was similar for all countries. The proportions of education level, urban/rural, obesity, ever depression, anxiety, current smoker, and cooking fuel varied widely worldwide. The proportion of respondents having completed secondary school or beyond ranged from 4.9% (Burkina Faso) to 98.5% (Kazakhstan). The education level was generally higher in the Middle East, Eastern and Western European countries, and Australia comparing to American, Asian, and especially African countries. The proportion of respondents living in urban areas ranged from 10.5% (India) to 100% (Luxembourg), and was generally lower in African and Asian countries comparing to other regions. The prevalence of obesity (BMI ≥ 30 kg/m^2) ranged from 1.3% (Laos) to 19.1% (Luxembourg); however, obesity data were missing in many non-European countries. From the available data, obesity appeared to be more prevalent in Europe than America and the Middle East, which in turn, were more prevalent than Asia and Africa. The prevalence of ever depression ranged from 0.1% (Vietnam) to 33.6% (Nepal). Ever depression was the least prevalent in Asia and African countries, and most prevalent in the Western European countries. The proportion of respondents who reported having experienced some level of anxiety in the previous month ranged from 18.4% (Vietnam) to 89.4% (Kazakhstan). The proportion was slightly lower in Asia, Africa, and the Middle East comparing to America and Europe. The proportion of current smoking ranged from 3.9% (Ethiopia) to 44.6% (Bangladesh). The prevalence of current smoking was the lowest in Africa, higher in America, and highest in Asia, Middle East, and Europe. The proportion of household using hydrocarbon cooking fuel ranged from 0.7% (Zimbabwe) to 98.9% (Malaysia). The proportion was relatively low in Asia and Africa, higher in the Middle East and Western Europe, and highest in America and Eastern Europe. Unlike other independent variables, the proportion of household with hard floor ranged considerably only in Asia and Africa. Globally, it ranged from 10.7% (Ethiopia) to 100% (Mauritius), whereas in the Middle East, America, and Europe, dwelling with earth floor was virtually non-existing. Information on anxiety, current smoking status, floor type, and cooking fuel type were unavailable in many Western European countries because of the use of short questionnaire.

4.3 Prevalence of asthma-related outcomes

Tables 4.3.1 to 4.3.7 indicate the prevalence of asthma and asthma-related outcomes for the included countries grouped by continent. The prevalence of all these asthma-related outcomes varied considerably worldwide. The prevalence of ever asthma ranged from 1.1% (Vietnam) to 18.5% (Australia). The prevalence of ever-treated asthma ranged from 1.1% (Vietnam) to 18.2% (Australia). The prevalence of ever asthma and current wheeze were generally lower in Asia and Africa; higher in America, Middle East, and Eastern Europe; and highest in

Western Europe and Australia. The prevalence of current wheeze ranged from 2.1% (Vietnam) to 17.9% (Nepal). It was generally higher in Europe and Australia compared to other regions. The prevalence of chest tightness ranged from 3.2% (Vietnam) to 21.9% (Nepal). It was generally lower in Asia and Africa; higher in America and Western Europe; and highest in the Middle East, Eastern Europe, and Australia. The prevalence of shortness of breath ranged from 1.2% (China) to 14.2% (Morocco). It was the lowest in Asia; higher in Africa, America, Middle East, and Western Europe; and highest in Eastern Europe and Australia. The proportion of the respondents who received asthma intervention in the last 2 weeks varied modestly worldwide, ranging from 0.01% (Vietnam) to 9.0% (Australia). This prevalence was generally higher in Western Europe and Australia than other regions.

4.4 Detailed analyses of prevalence of ever asthma and current wheeze by country

The prevalence of ever asthma in adults of all included countries (N=55) is shown in Figure 4.1.1, ranging from 1.1% (Vietnam) to 18.5% (Australia) or a 16.8-fold difference. The 25^{th}, 50^{th}, and 75^{th} percentiles of the distribution of ever asthma prevalence were 3.5%, 4.4%, and 7.6%, respectively. The five countries with the lowest prevalence of ever asthma were Vietnam, Kazakhstan, China, Burkina Faso, and Ecuador. And the five countries with the highest prevalence of ever asthma were Australia, Sweden, Norway, Brazil, and France. These results are further depicted by country in the world map (Figure 4.1.2). Australia, most part of Western Europe, and some part of America had relatively high prevalence. In general, Asia and Africa had lower prevalence (Figures 4.1.2 and 4.3.1).

The prevalence of current wheeze in adults of all included countries (N=54) is shown in Figure 4.2.1, ranging from 2.1% (Vietnam) to 17.9% (Nepal) or an 8.5-fold difference (Figure 4.1.2). The 25^{th}, 50^{th}, and 75^{th} percentiles of the distribution of current wheeze prevalence were 5.7%, 8.6%, and 11.0%, respectively. The five countries with the lowest prevalence of current wheeze were Vietnam, China, Myanmar, Ecuador, and Ghana. The five countries with the highest prevalence were Nepal, Sweden, Australia, Finland, and Brazil. These results are further depicted by country in the world map (Figure 4.2.2). Australia, Nepal, Brazil, some countries in Europe and Africa had relatively high prevalence. In general, Asia and Africa had lower prevalence (Figures 4.2.2 and 4.3.2).

4.5 Sex-specific prevalence of ever asthma and current wheeze

Figure 4.4.1 indicates the sex-specific prevalence of ever asthma in adults by country and continent. Adult females having higher ever asthma prevalence compared to adult males were observed in 36 of the 55 countries: Asia (6 out of 12), Africa (12 out of 17), Middle East (3 out of 4), America (6 out of 6), Eastern Europe (2 out of 5), Western Europe (6 out of 10), and South Pacific (1 out of 1). Figure 4.4.2 indicates the sex-specific prevalence of current wheeze in adults by country and continent. Adult females having higher current wheeze prevalence compared to adult males were observed in 33 of the 54 countries: Asia (5 out of 12), Africa (13 out of 17), Middle East (2 out of 4), America (4 out of 5), Eastern Europe (4 out of 5), Western Europe (4 out of 10), and South Pacific (1 out of 1).

4.6 Age-specific prevalence of ever asthma and current wheeze

Figure 4.5.1 indicates the age-specific prevalence of ever asthma in adults by country and continent. Overall, older age groups tended to have higher prevalence. Twenty nine of the 55 countries showed higher prevalence in the older adult group (≥55 year old) than the old adult group (35-54 year old) which in terms had higher prevalence than the young adult group (18-34 year old). Nine countries showed the highest prevalence of ever asthma in young adult group compared to the two older age groups: Asia (0 out of 12), Africa (0 out of 17), Middle East (1 out of 4), America (3 out of 6), Eastern Europe (1 out of 5), Western Europe (3 out of 10), and South Pacific (1 out of 1). These countries also tended to be the ones with high prevalence of ever asthma.

Figure 4.5.2 indicates age-specific prevalence of current wheeze in adults by country and continent. Overall, older age groups tended to have higher prevalence. Forty six of the 54 countries demonstrated higher prevalence in the late adult group (≥55 year old) than the old adult group (35-54 year old) which in turn had higher prevalence than the young adult group (18-34 year old). Only two countries (Australia and Uruguay) showed higher prevalence of current wheeze in the young adult group than the two older age groups.

4.7 Significant risk/protective factors from multivariate logistic regression analysis

4.7.1 Risk/protective factors for ever asthma

Table 4.4.1 shows the multivariate logistic regression analyses of ever asthma in Asian and Middle East countries. Age group (ORs range: 1.48-7.61), female gender (ORs range: 0.64-2.21), higher household spending (ORs range: 0.44-2.52), higher education (OR: 0.23), urban (ORs range: 0.48-2.05), obesity (OR: 2.26), anxiety (ORs range: 0.64-4.08), ever depression (ORs range: 1.89-7.11), and hydrocarbon cooking fuel (OR: 8.38) were found to be significant risk or protective factors for ever asthma in one or more countries from these regions. Both anxiety and ever depression were fairly consistent risk factors across these countries, except anxiety was found to be protective against ever asthma in Sri Lanka. Higher education and anxiety was a confounder for China and Georgia, respectively.

Table 4.4.2 shows the multivariate logistic regression analyses of ever asthma in African countries. Age group (ORs range: 1.66-4.15), female gender (ORs range: 1.74-3.37), higher household spending (OR: 1.59), higher education (ORs range: 0.60-2.16), urban (ORs range: 0.53-2.19), obesity (OR: 2.13), anxiety (ORs range: 1.38-2.53), ever depression (ORs range: 2.15-18.49), current smoker (ORs range: 0.36-1.97), and hard floor (OR: 4.35) were found to be significant risk or protective factors for ever asthma in one or more countries from these regions. Ever depression was a fairly consistent risk factor cross these countries. Higher household spending was a confounder in Chad and Cote d'Ivoire; obesity was a confounder in Comoros and Tunisia; and hard floor was a confounder in Ethiopia and Mauritania.

Table 4.4.3 shows the multivariate logistic regression of ever asthma in American countries. Age group (ORs range: 0.75-1.23), female gender (ORs range: 1.38-1.53), higher household spending (ORs range: 1.29-1.43), urban (OR: 1.48), anxiety (ORs range: 1.38-2.51), ever depression (ORs range: 1.85-2.36), and current smoker (OR: 0.64) were found to be significant risk or protective factors for ever asthma in one or more countries from these regions. Anxiety and ever depression were fairly consistent risk factors cross these countries.

Table 4.4.4 shows the multivariate logistic regression of ever asthma in European countries. Age group (ORs range: 0.52-3.79), higher education (OR: 0.42), obesity (OR: 3.06), anxiety (ORs range: 1.87-1.90), ever depression (ORs range: 1.42-10.95), and current smoker (OR: 0.71) were found to be significant risk or protective factors for even asthma in one or more countries from these regions. Neither anxiety nor ever depression appeared to be a consistent risk factor throughout these regions. Current smoker was a confounder in Russia.

Table 4.4.5 summarizes information from Tables 4.4.1 to 4.4.4 by depicting the frequency count of each explanatory variable of the number of times having found significant for ever asthma. On a global perspective, ever depression was a strong and consistent risk factor for ever asthma. Older age, female gender, and anxiety appeared to be fairly consistent risk factors for ever asthma except a number of countries finding them to be protective.

On the continental perspective (Table 4.4.5), older age was a consistent risk factor for ever asthma in Asia/Middle East and Africa; female gender was a consistent risk factor in America; anxiety was a consistent risk factor in Asia/Middle East (except Sri Lanka), Africa, and America; ever depression was a consistent risk factor in Asia/Middle East, Africa and America. Continental patterns for other explanatory variables could not be derived.

4.7.2 Risk/protective factors for current wheeze

Table 4.5.1 shows the multivariate logistic regression analyses of current wheeze for Asian and Middle East countries. Age group (ORs range: 1.51-6.47), female gender (OR: 0.69), higher household spending (ORs range: 0.44-1.86), higher education (ORs range: 0.57-0.75), urban (OR: 2.06), obesity (ORs range: 1.82-2.42), anxiety (ORs range: 1.57-3.56), ever depression (ORs range: 1.72-12.62), current smoker (OR: 1.50), hard floor (ORs range: 0.31-1.8), and hydrocarbon cooking fuel (ORs range: 0.36-2.45) were found to be significant risk or protective factors for current wheeze in one or more countries from these regions. Both Anxiety and Ever depression were fairly consistent risk factors across these countries.

Table 4.5.2 shows the multivariate logistic regression analyses of current wheeze for African countries. Age group (ORs range: 1.44-2.65), female gender (ORs range: 0.70-2.50), higher household spending (OR: 1.55), higher education (ORs range: 0.08-0.55), urban (OR: 0.50), obesity (ORs range: 1.90-2.12), anxiety (ORs range: 1.58-3.09), ever depression (ORs range: 1.98-16.23), current smoker (ORs range: 1.59-2.26), hard floor (OR: 0.65), and hydrocarbon cooking fuel (OR: 1.76) were found to be significant risk or protective factors for current wheeze in one or more countries from these regions. Both Anxiety and Ever depression were fairly consistent risk factors across these countries. Higher household spending and obesity was a confounder in Senegal and Malawi, respectively.

Table 4.5.3 shows the multivariate logistic regression analyses of current wheeze for American countries. Age group (OR: 0.69), female gender (ORs range: 1.38-1.70), higher education (ORs range: 0.76-1.90), anxiety (ORs range: 1.75-2.42), ever depression (ORs range: 2.06-2.47), current smoker (ORs range: 1.52-1.33) were found to be significant risk or protective factors for current wheeze in one or more countries from these regions. Anxiety was consistent risk factor across these countries.

Table 4.5.4 shows the multivariate logistic regression analyses of current wheeze for European countries. Age group (ORs range: 1.88-6.10), female gender (ORs range: 0.75-2.12), higher household spending (OR: 0.45), higher education (ORs range: 0.47-0.55), obesity (ORs range: 1.50-3.87), anxiety (ORs range: 1.82-3.31), ever depression (ORs range: 1.78-8.44), current smoker (ORs range: 1.63-4.54), and hydrocarbon cooking fuel (OR: 0.52) were found to be significant risk or protective factors for current wheeze in one or more countries from these regions. Older age group, anxiety, ever depression, and current smoker were fairly consistent risk factors across these countries.

Table 4.5.5 summarizes information from Tables 4.5.1 to 4.5.4 by depicting the frequency count of each explanatory variable of the number of times having found significant for current wheeze. On a global perspective, ever depression, anxiety, obesity, and current smoker were consistent risk factors for current wheeze. Older age also tended to be a consistent risk factor for current wheeze with the exception of old adult group being protective comparing to young adult group.

On the continental perspective (Table 4.5.5), older age was a consistent risk factor for current wheeze in Asia/Middle East, Africa, and Europe; higher education was a consistent risk factor in Asia/Middle East and Africa; anxiety and ever depression were consistent risk factors in all regions; current smoking was a consistent risk factor in Africa and Europe. Continental patterns for other explanatory variables could not be derived.

Table 4.1: Summary and response rate of WHS questionnaire by country

Country	Household response rate* (%)	Individual response rate† (%)	Type of survey used	Participants
Australia	n/a	n/a	short	1846
Bangladesh	91	94	long	5942
Brazil	70	100	long	5000
Burkina Faso	98	99	long	4948
Chad	95	97	long	4875
China	93	100	long	3994
Comoros	98	97	long	1836
Cote D'Ivoire	81	99	long	3251
Croatia	72	100	long	993
Czech Rep.	24	99	long	949
Dominican	82	94	long	5027
Ecuador	76	82	long	5677
Estonia	87	99	long	1021
Ethiopia	96	99	long	5090
Finland	100	100	short	1013
France	99	99	short	1008
Georgia	92	99	long	2950
Ghana	73	97	long	4165
Hungary	72	100	long	1419
India	96	97	long	10692
Ireland	100	100	short	1014
Israel	56	63	short	1536
Kazakhstan	100	100	long	4499
Kenya	81	96	long	4640
Laos	83	100	long	4989
Latvia	100	94	long	929
Luxembourg	100	100	short	700
Malawi	93	96	long	5551
Malaysia	81	99	long	6145
Mali	94	85	long	5209
Mauritania	95	99	long	3907
Mauritius	90	98	long	3968
Mexico	96	100	long	38746
Morocco	75	89	long	5000
Myanmar	100	100	long	6045
Namibia	93	99	long	4379
Nepal	100	98	long	8822
Norway	n/a	n/a	short	984
Pakistan	91	94	long	6502
Paraguay	82	97	long	5288
Philippines	100	100	long	10083
Portugal	100	100	short	1030
Russian Fed.	100	100	long	4427
Senegal	69	90	long	3465
South Africa	80	90	long	2629
Spain	52	98	long	6373
Sri Lanka	94	99	long	6805
Sweden	100	100	short	1000
Tunisia	98	99	long	5203
Turkey	99	98	long	11481
UAE	79	100	long	1183
Ukraine	61	89	long	2860
Uruguay	99	100	long	2996
Vietnam	100	84	long	4174
Zimbabwe	89	99	long	4292
Mean‡	87	96		4701
Median	93	99		4292

*Household response rate $= \left(\frac{\text{\# of households responded}}{\text{total \# of households selected}}\right) * 100\%$. †Individual response rate $= \left(\frac{\text{\# of individuals responded}}{\text{total \# of individuals selected}}\right) * 100\%$; n/a = data not available. ‡Unweighted mean

Table 4.2.1: Baseline demographics of Asian countries*

	Age				Female	Finished			Ever		Current	Hard	Hydrocarbon
	Mean (SE†)	18-34	35-54	≥55	gender	2° school	Urban	Obese	depression	Anxiety	smoker	floor	Cooking fuel
Bangladesh	36.3 (.24)	52.7	34.3	13.0	48.5	16.5	24.3	—‡	1.3	65.5	44.6	20.4	13.6
China	45.1 (.69)	29.5	43.3	27.3	51.0	55.1	30.8	1.6	0.3	28.1	30.0	92.0	77.1
India	38.4 (.32)	47.4	33.4	19.2	47.2	34.7	10.5	—	12.8	46.2	35.8	39.8	20.7
Kazakhstan	41.4 (1.11)	38.1	42.6	19.3	52.1	98.5	55.9	10.0	1.6	89.4	30.0	97.0	92.6
Laos	36.8 (.28)	52.2	33.2	14.5	50.7	21.3	20.3	1.3	1.9	23.2	40.5	91.7	18.0
Malaysia	38.8 (.34)	45.4	38.6	16.1	49.6	62.8	64.0	—	2.6	29.8	28.1	100	98.9
Myanmar	38.4 (.27)	47.4	36.3	16.3	51.1	28.1	29.1	—	0.5	33.7	30.9	98.1	23.1
Nepal	37.0 (.19)	50.0	34.1	15.9	49.5	20.0	15.2	—	33.6	50.9	41.1	23.4	19.5
Pakistan	36.6 (.32)	51.0	32.9	16.0	49.6	24.7	33.9	—	2.5	32.9	20.2	42.3	23.2
Philippines	37.2 (.23)	51.1	34.4	14.5	50.4	54.1	61.4	—	3.7	47.8	35.0	93.2	65.0
Sri Lanka	40.5 (.37)	41.9	38.7	19.5	47.9	72.4	20.6	—	1.1	72.5	22.2	88.9	28.0
Vietnam	38.4 (.52)	46.7	37.2	16.2	51.3	57.2	25.8	—	0.1	18.4	26.2	81.2	61.3

*Numbers indicate percentages unless stated otherwise. †Linearized standard error. ‡Missing data ≥25%

Table 4.2.2: Baseline demographics of African countries[*]

	Age				Female	Finished			Ever		Current	Hard	Hydrocarbon
	Mean (SE[†])	18-34	35-54	≥55	gender	2° school	Urban	Obese	depression	Anxiety	smoker	floor	Cooking fuel
Burkina Faso	34.6 (.42)	59.6	28.0	12.3	52.8	4.9	17.8	—[‡]	2.6	43.1	17.4	25.8	4.4
Chad	35.8 (.31)	55.0	31.1	14.0	51.1	7.5	25.3	15.0	2.2	58.9	11.0	10.9	24.8
Comoros	40.7 (.51)	44.3	30.4	25.3	50.8	18.2	30.9	3.8	1.5	64.5	22.5	82.5	23.6
Cote d'Ivoire	34.7 (.40)	58.8	29.6	11.5	42.2	31.0	71.7	4.9	1.7	51.6	13.3	84.2	50.7
Ethiopia	35.5 (.28)	55.2	30.7	14.1	51.0	24.7	15.7	—	4.4	40.8	3.9	10.7	9.7
Ghana	36.1 (.31)	54.3	31.9	13.9	50.9	12.9	45.6	5.0	1.5	36.7	5.6	77.6	38.5
Kenya	33.4 (.39)	64.6	25.6	9.7	51.1	40.6	39.9	6.1	5.5	37.0	14.3	54.9	46.2
Malawi	35.8 (.48)	58.1	28.0	14.0	51.2	6.6	15.5	6.7	1.3	34.9	15.6	24.1	6.9
Mali	34.2 (.28)	—	—	—	52.1	6.1	32.0	—	—	36.7	13.3	—	13.0
Mauritania	35.8 (.33)	54.0	32.0	13.9	51.1	25.8	62.4	13.5	2.8	38.2	17.0	50.5	74.1
Mauritius	40.6 (.36)	39.9	41.2	18.9	50.8	35.9	43.0	—	6.3	41.1	22.4	100	98.4
Morocco	37.7 (.46)	49.7	34.8	15.6	50.5	28.3	57.5	—	3.0	—	16.2	87.6	94.5
Namibia	37.0 (.42)	54.5	30.0	15.4	53.0	22.4	33.2	9.8	7.7	38.6	19.9	47.2	10.2
Senegal	35.3 (.34)	55.3	33.2	11.5	50.9	14.2	49.9	—	1.7	50.1	12.7	55.6	60.6
South Africa	37.4 (.48)	50.1	35.4	14.4	52.0	56.4	56.3	—	9.0	51.5	25.3	89.5	18.7
Tunisia	38.6 (.28)	46.9	36.1	17.1	50.1	40.0	63.8	7.9	5.0	37.4	27.5	95.3	97.0
Zimbabwe	35.2 (.44)	60.3	24.5	15.2	51.4	41.3	36.3	—	6.5	39.7	14.4	73.3	0.7

[*]Numbers indicate percentages unless stated otherwise. [†]Linearized standard error. [‡]Missing data ≥25%

Table 4.2.3: Baseline demographics of Middle East countries*

	Age				Female	Finished			Ever		Current	Hard	Hydrocarbon
	Mean (SE†)	18-34	35-54	≥55	gender	2° school	Urban	Obese	depression	Anxiety	smoker	floor	cooking fuel
Georgia	45.2 (.39)	33.4	36.1	30.5	53.3	95.4	51.5	11.1	5.4	44.5	31.4	99.6	41.9
Israel	43.0 (.59)	38.8	34.9	26.2	51.6	92.3	91.7	11.9	7.6	n/a	n/a	n/a	n/a
Turkey	38.8 (.26)	47.1	35.3	17.5	49.9	—‡	66.3	—	6.7	47.7	35.8	—	—
UAE	37.6 (.46)	40.2	51.4	8.4	47.7	80.0	88.1	—	3.4	31.6	24.1	99.4	96.7

*Numbers indicate percentages unless stated otherwise. †Linearized standard error. ‡Missing data ≥25%. n/a = questions not available in short version of WHS questionnaire

Table 4.2.4: Baseline demographics of American countries*

	Age				Female	Finished			Ever		Current	Hard	Hydrocarbon
	Mean (SE†)	18-34	35-54	≥55	gender	2° school	Urban	Obese	depression	Anxiety	smoker	floor	cooking fuel
Brazil	39.1 (.33)	44.7	37.6	17.7	51.5	47.0	83.0	9.9	18.9	70.5	22.4	97.2	88.5
Dominican	38.5 (.35)	47.6	35.7	16.7	49.1	23.0	58.5	—‡	8.5	46.2	15.0	94.6	85.1
Ecuador	38.3 (.36)	48.5	35.0	16.5	48.9	35.6	61.8	—	5.8	53.0	—	—	—
Mexico	38.3 (.16)	48.9	34.3	16.9	52.0	88.1	75.4	—	4.8	32.8	25.3	90.8	86.6
Paraguay	37.1 (.26)	50.9	50.9	14.4	50.4	28.8	56.7	11.9	6.7	55.4	27.3	81.9	58.4
Uruguay	45.0 (.56)	36.2	32.8	31.0	52.5	57.8	92.8	14.0	10.5	56.2	33.4	100	95.1

*Numbers indicate percentages unless stated otherwise. †Linearized standard error. ‡Missing data ≥25%

Table 4.2.5: Baseline demographics of Eastern European countries*

	Age				Female	Finished			Ever		Current	Hard	Hydrocarbon
	Mean (SE†)	18-34	35-54	≥55	gender	2° school	Urban	Obese	depression	Anxiety	smoker	floor	cooking fuel
Croatia	49.5 (.66)	20.6	40.6	38.8	58.1	68.5	67.3	16.1	5.3	56.7	26.6	99.8	78.1
Czech Rep.	45.8 (.88)	34.4	32.5	33.1	52.1	81.3	73.0	19.1	5.8	51.0	31.8	100	69.8
Hungary	46.5 (.51)	31.2	35.0	33.8	53.2	93.0	64.9	18.9	8.4	44.4	36.8	—	—
Russia	51.4 (.68)	20.0	37.2	42.8	64.4	91.4	87.6	17.0	3.4	57.4	27.5	99.6	82.2
Ukraine	46.1 (.59)	30.5	36.8	32.7	54.5	94.7	66.7	—‡	3.7	61.2	30.3	99.7	91.9

*Numbers indicate percentages unless stated otherwise. †Linearized standard error. ‡Missing data ≥25%

Table 4.2.6: Baseline demographics of Western European countries*

	Age				Female	Finished			Ever		Current	Hard	Hydrocarbon
	Mean (SE†)	18-34	35-54	≥55	gender	2° school	Urban	Obese	depression	Anxiety	smoker	floor	cooking fuel
Estonia	47.1 (.46)	29.9	35.1	35.0	55.4	78.9	69.7	17.4	8.8	50.3	39.1	99.9	34.9
Finland	48.2 (.75)	25.3	37.0	37.7	51.7	88.2	61.9	14.7	13.6	n/a	n/a	n/a	n/a
France	47.4 (1.11)	28.6	37.6	33.8	52.0	77.2	76.3	9.3	16.8	n/a	n/a	n/a	n/a
Ireland	43.5 (.80)	35.9	37.8	26.3	50.9	70.1	60.3	16.0	5.5	n/a	n/a	n/a	n/a
Latvia	46.5 (.90)	32.7	32.2	35.1	55.4	75.6	66.5	17.6	5.9	68.7	42.1	—	85.6
Luxembourg	46.0 (.70)	29.1	40.0	30.8	51.3	73.2	100	14.1	11.8	n/a	n/a	n/a	n/a
Norway	47.3 (.23)	29.1	36.9	34.0	51.0	38.5	—‡	8.5	9.6	n/a	n/a	n/a	n/a
Portugal	46.1 (.76)	30.8	35.8	33.4	53.2	37.2	53.5	15.0	22.1	n/a	n/a	n/a	n/a
Spain	46.8 (.33)	29.8	36.7	33.5	51.5	72.2	76.8	14.7	13.8	35.8	33.6	99.9	66.5
Sweden	48.8 (1.27)	25.1	32.8	42.1	47.2	91.5	84.3	11.4	16.0	n/a	n/a	n/a	n/a

*Numbers indicate percentages unless stated otherwise. †Linearized standard error. ‡Missing data ≥25%. n/a = questions not available in short version of WHS questionnaire

Table 4.2.7: Baseline demographics of Australia*

	Age				Female	Finished			Ever		Current	Hard	Hydrocarbon
	Mean (SE†)	18-34	35-54	≥55	gender	2° school	Urban	Obese	depression	Anxiety	smoker	floor	cooking fuel
Australia	45.6 (.53)	29.0	40.3	30.6	55.1	89.3	—‡	—	12.1	n/a	n/a	n/a	n/a

*Numbers indicate percentages unless stated otherwise. †Linearized standard error. ‡Missing data ≥25%. n/a = questions not available in short version of WHS questionnaire

Table 4.3.1: Prevalence of asthma-related outcomes of Asian countries*

	Lifetime prevalence		12-month prevalence			Last 2 weeks
	Diagnosed asthma	Treated asthma	Wheezing	Chest tightness	Shortness of breath	Asthma intervention
Bangladesh	4.4	4.1	9.8	11.7	5.8	2.2
China	2.1	1.7	2.4	3.6	1.2	1.9
India	5.9	4.9	11.6	10.4	7.1	3.1
Kazakhstan	1.8	1.6	4.2	8.9	5.8	1.1
Laos	3.4	2.3	4.4	5.1	4.0	1.0
Malaysia	5.9	5.1	5.5	7.5	2.6	2.5
Myanmar	2.8	2.6	2.7	3.8	1.9	1.1
Nepal	3.9	—†	17.9	21.9	10.6	—
Pakistan	4.1	3.4	5.1	6.1	3.2	1.9
Philippines	7.9	6.0	9.0	15.6	5.1	2.9
Sri Lanka	3.7	3.9	9.0	6.2	5.2	2.8
Vietnam	1.1	1.1	2.1	3.2	2.7	0.01

*Numbers indicate percentages. †Missing data ≥25%

Table 4.3.2: Prevalence of asthma-related outcomes of African countries*

	Lifetime prevalence		12-month prevalence			Last 2 weeks
	Diagnosed asthma	Treated asthma	Wheezing	Chest tightness	Shortness of breath	Asthma intervention
Burkina Faso	2.4	1.9	5.0	7.5	5.8	0.7
Chad	4.0	2.4	5.9	6.9	4.8	1.4
Comoros	7.5	6.2	10.2	11.2	5.1	2.2
Cote d'Ivoire	4.2	4.1	5.4	7.3	6.7	2.0
Ethiopia	2.7	—†	6.7	8.0	5.2	—
Ghana	4.2	3.5	3.0	3.5	3.0	1.3
Kenya	2.9	3.4	5.7	7.5	4.6	2.0
Malawi	5.1	4.5	6.5	9.1	5.8	1.4
Mali	2.8	—	3.3	—	—	—
Mauritania	7.6	5.7	9.7	9.0	7.3	4.9
Mauritius	4.6	4.3	7.2	5.3	3.3	2.3
Morocco	3.4	3.0	12.5	16.3	14.2	1.3
Namibia	3.6	3.4	8.0	11.3	5.6	2.4
Senegal	3.8	—	7.0	9.4	9.0	—
South Africa	6.3	6.4	12.2	12.5	8.0	2.9
Tunisia	3.7	3.4	8.1	9.0	4.9	1.8
Zimbabwe	2.9	3.0	5.7	8.7	5.6	1.3

*Numbers indicate percentages. †Missing data ≥25%

Table 4.3.3: Prevalence of asthma-related outcomes of Middle East countries[*]

	Lifetime prevalence		12-month prevalence			Last 2 weeks
	Diagnosed asthma	Treated asthma	Wheezing	Chest tightness	Shortness of breath	Asthma intervention
Georgia	3.8	3.5	6.5	15.7	9.2	2.4
Israel	7.9	7.8	12.0	21.2	9.7	—[†]
Turkey	3.4	3.3	13.3	16.8	5.2	1.9
UAE	5.7	5.4	5.0	6.7	4.1	3.2

[*]Numbers indicate percentages. [†]Missing data ≥25%

Table 4.3.4: Prevalence of asthma-related outcomes of American countries[*]

	Lifetime prevalence		12-month prevalence			Last 2 weeks
	Diagnosed asthma	Treated asthma	Wheezing	Chest tightness	Shortness of breath	Asthma intervention
Brazil	12.1	11.7	15.6	20.6	11.6	3.5
Dominican	9.6	6.4	5.8	9.1	3.8	1.1
Ecuador	2.4	2.2	2.9	5.6	4.4	0.9
Mexico	2.7	—[†]	—	—	—	—
Paraguay	5.9	5.5	9.9	12.4	7.8	1.3
Uruguay	8.7	8.0	6.4	6.4	4.5	4.6

[*]Numbers indicate percentages. [†]Missing data ≥25%

Table 4.3.5: Prevalence of asthma-related outcomes of Eastern European countries*

	Lifetime prevalence		12-month prevalence			Last 2 weeks
	Diagnosed asthma	Treated asthma	Wheezing	Chest tightness	Shortness of breath	Asthma intervention
Croatia	6.0	5.6	10.9	20.4	12.6	4.0
Czech Rep.	4.7	4.9	8.2	12.8	4.2	1.7
Hungary	6.8	—†	15.0	16.5	13.3	—
Russia	3.9	3.9	9.3	21.0	12.9	3.0
Ukraine	4.4	3.8	13.5	16.5	9.3	2.7

*Numbers indicate percentages. †Missing data ≥25%

Table 4.3.6: Prevalence of asthma-related outcomes of Western European countries*

	Lifetime prevalence		12-month prevalence			Last 2 weeks
	Diagnosed asthma	Treated asthma	Wheezing	Chest tightness	Shortness of breath	Asthma intervention
Estonia	4.7	4.6	11.0	15.5	7.1	2.0
Finland	10.1	10.6	15.9	10.2	6.0	6.3
France	11.8	11.4	10.7	10.6	7.7	5.1
Ireland	9.8	9.2	11.0	9.5	7.5	5.6
Latvia	4.2	3.8	9.4	21.4	10.5	2.1
Luxembourg	8.7	7.8	11.8	10.1	6.3	3.3
Norway	12.2	13.4	9.5	14.1	3.3	5.2
Portugal	8.3	7.4	6.6	11.4	8.0	4.5
Spain	7.2	6.5	10.9	9.2	6.3	4.2
Sweden	17.1	—†	17.2	13.6	10.5	—

*Numbers indicate percentages. †Missing data ≥25%

Table 4.3.7: Prevalence of asthma-related outcomes of Australia*

	Lifetime prevalence		12-month prevalence			Last 2 weeks
	Diagnosed asthma	Treated asthma	Wheezing	Chest tightness	Shortness of breath	Asthma intervention
Australia	18.5	18.2	16.7	19.4	11.1	9.0

*Numbers indicate percentages.

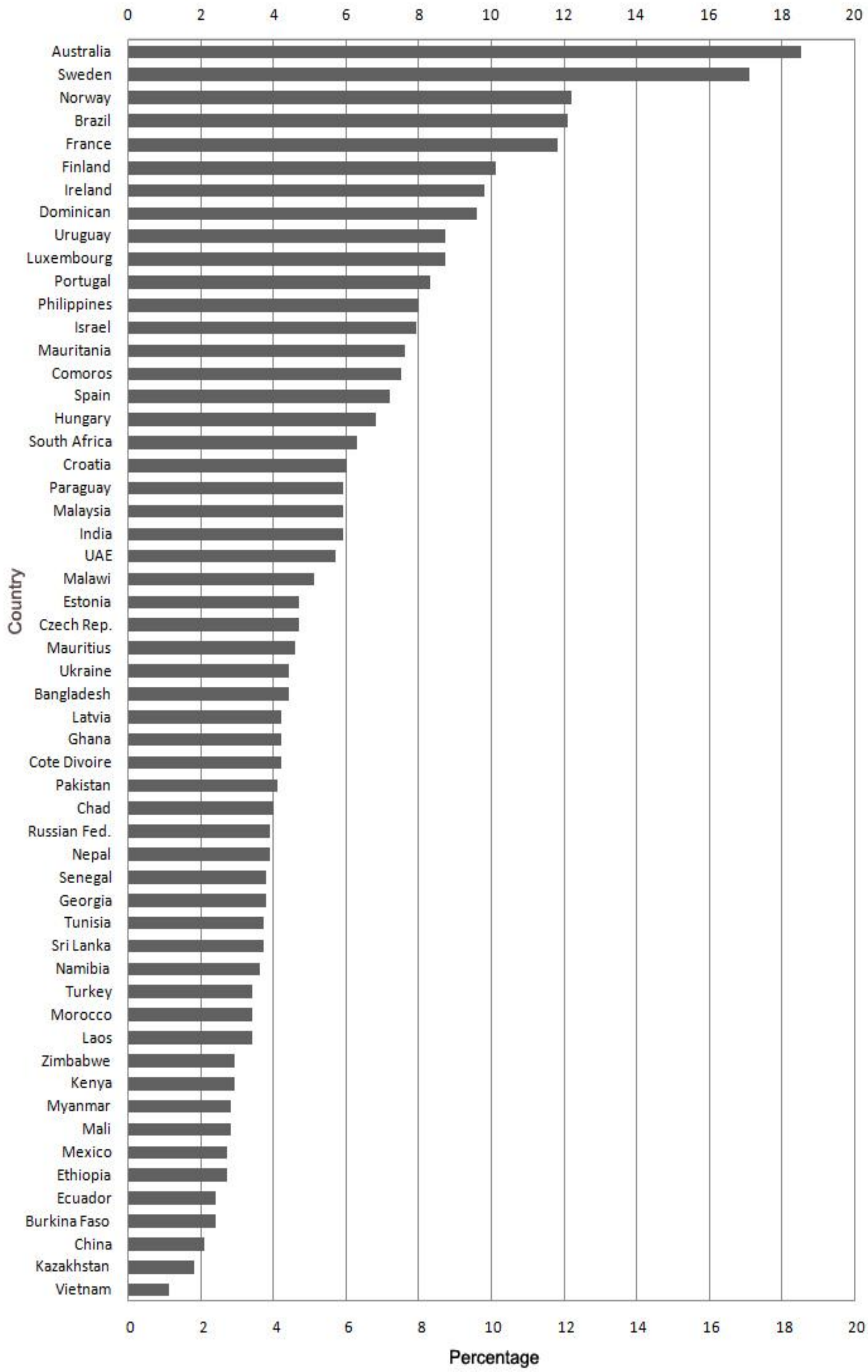

Fig 4.1.1: Prevalence of ever asthma in adults aged 18 years and above by countries from the World Healh Survey

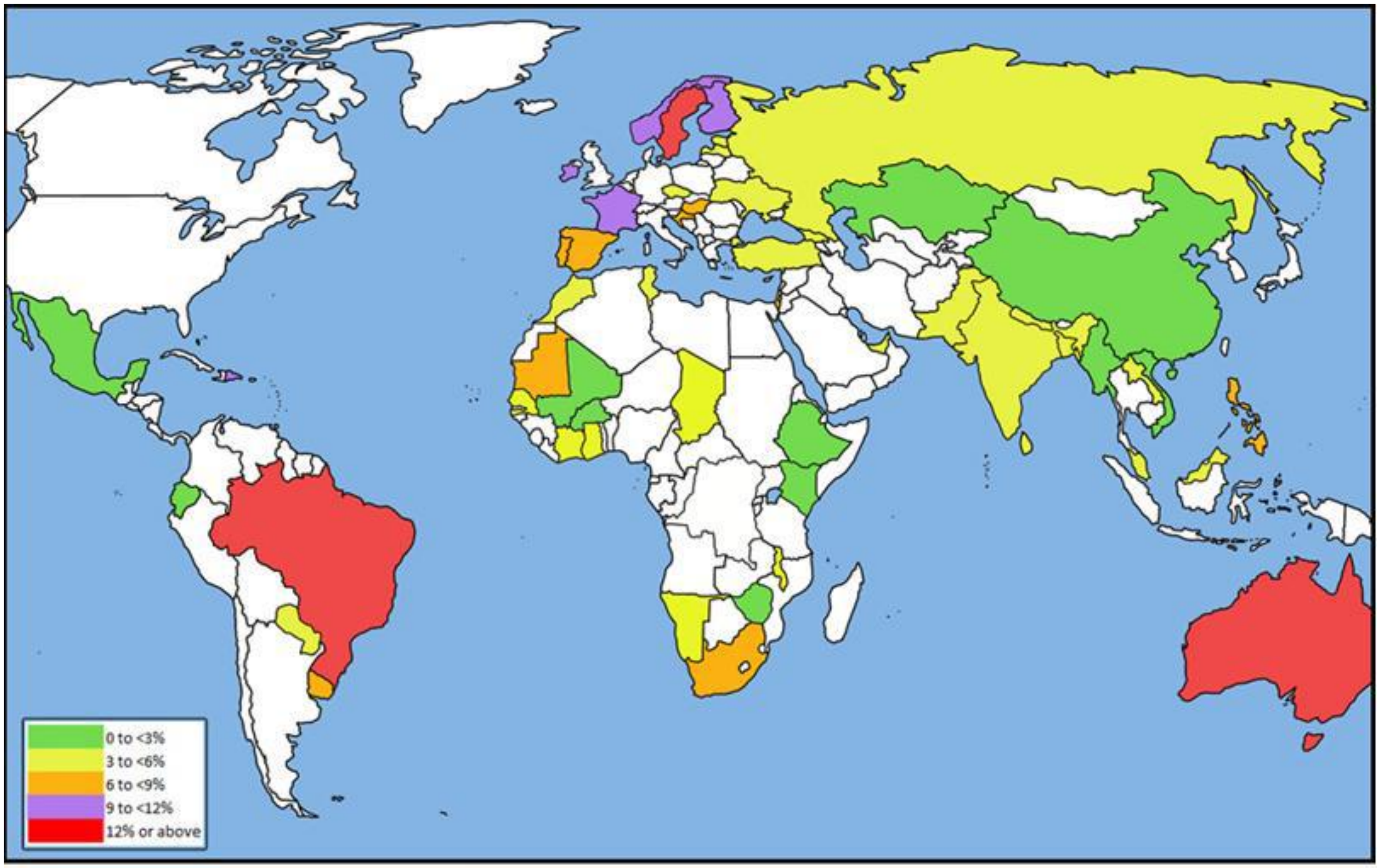

Fig 4.1.2: World map of prevalence of ever asthma in adults aged 18 years and above from the World Health Survey

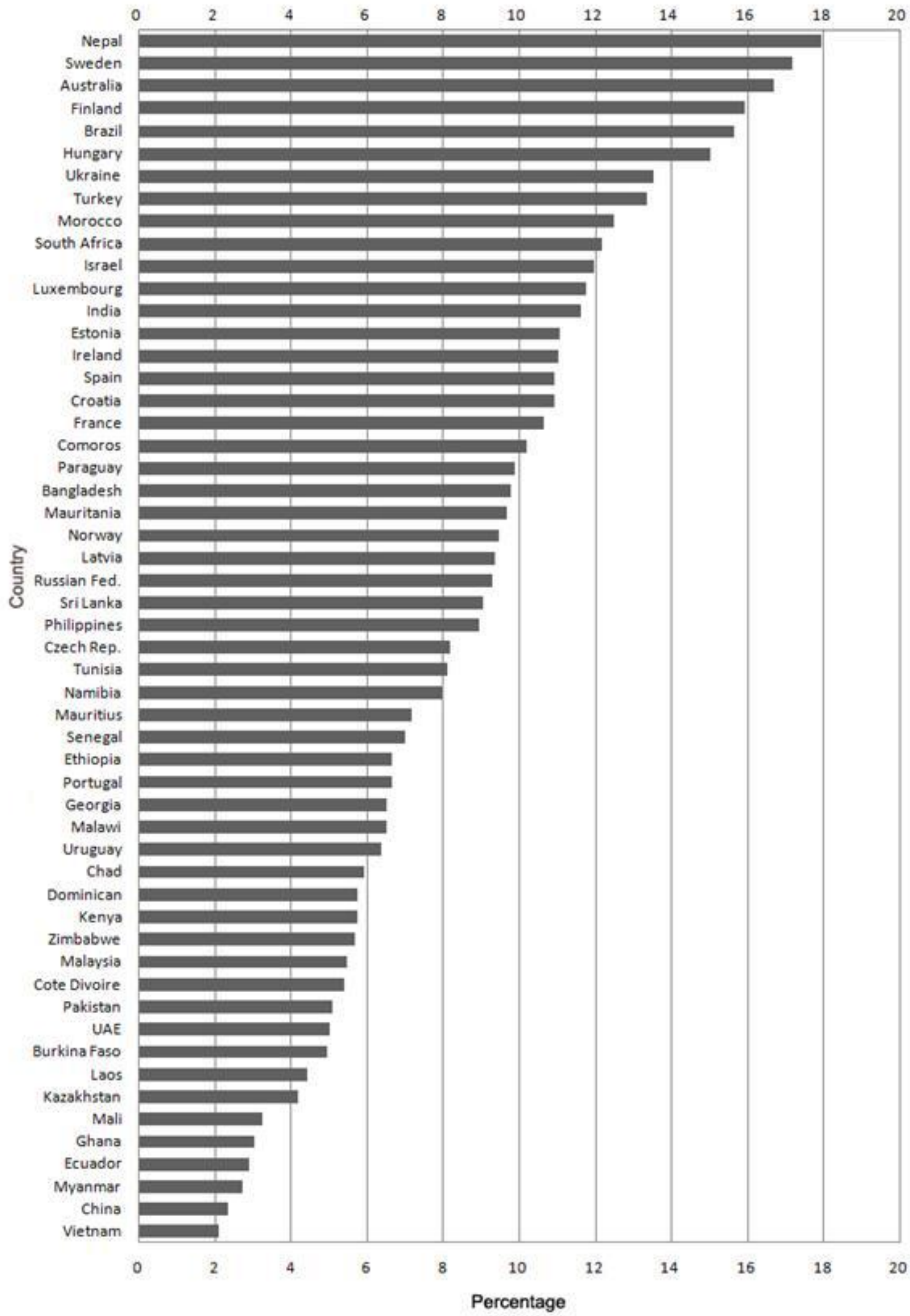

Figure 4.2.1: Prevalence of current wheeze in adults aged 18 years and above by countries from the World Health Survey

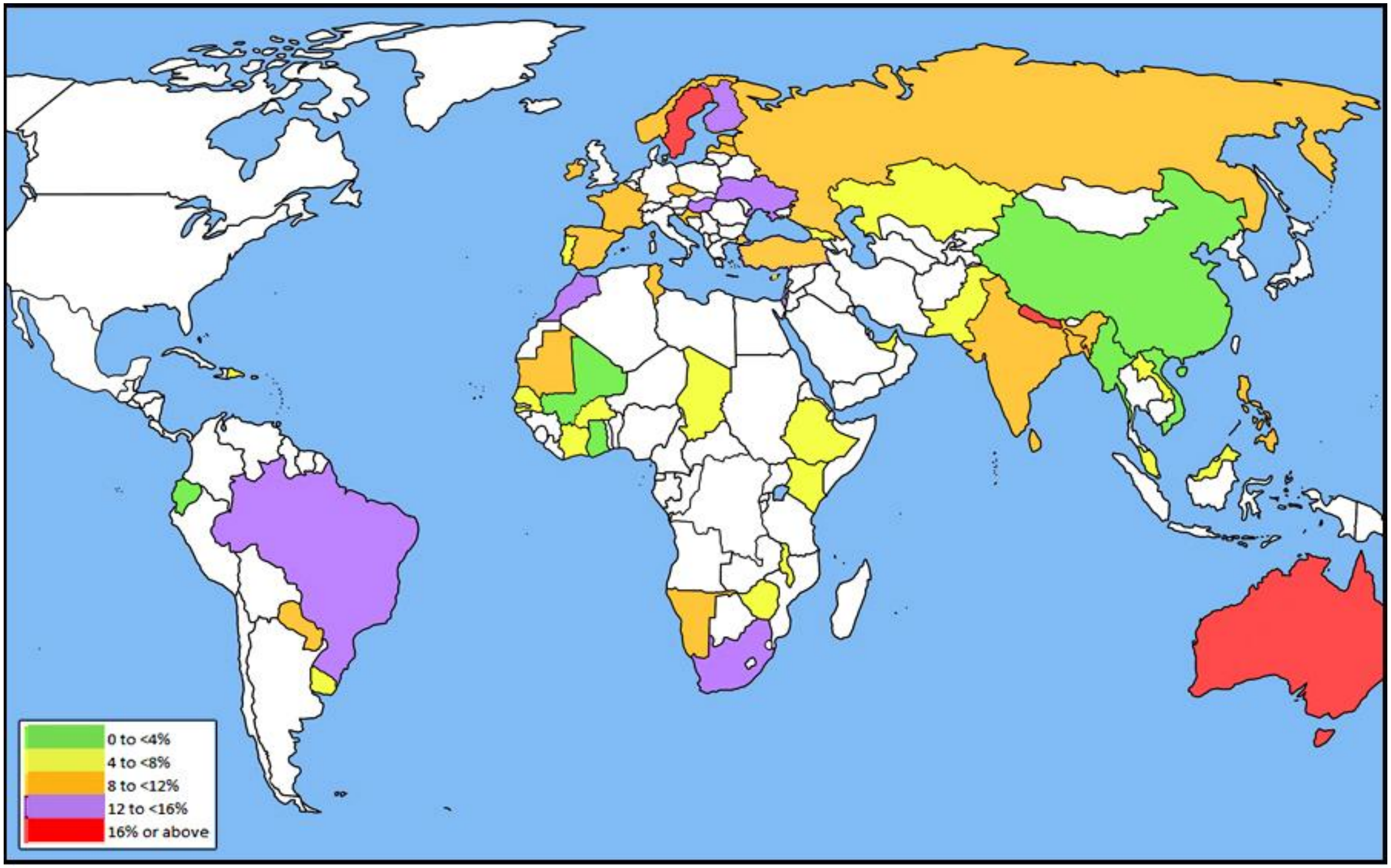

Figure 4.2.2: World map of prevalence of current wheeze in adults aged 18 years and above from the World Health Survey

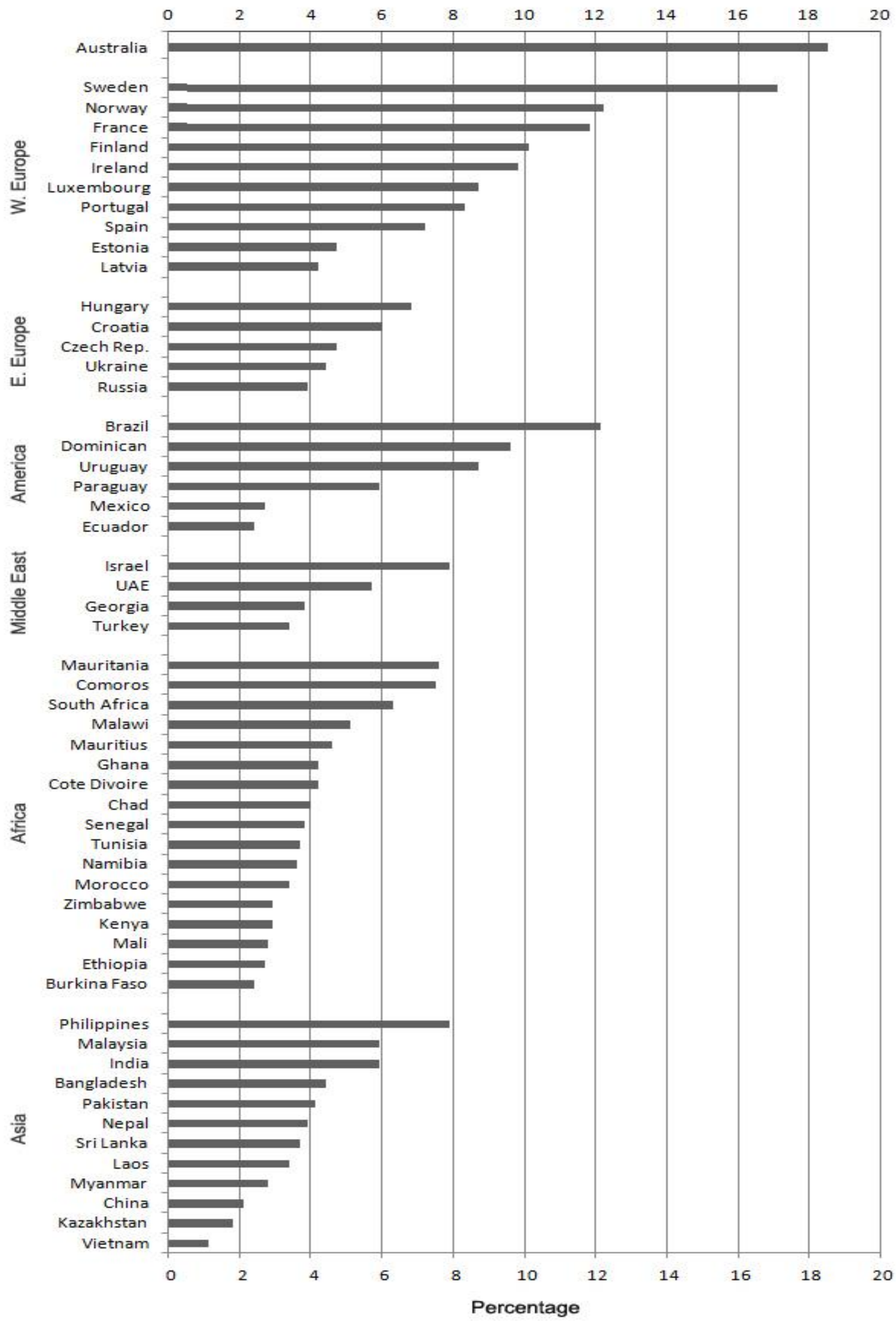

Figure 4.3.1: Prevalence of ever asthma in adults aged 18 years and above by geographic regions from the World Health Survey

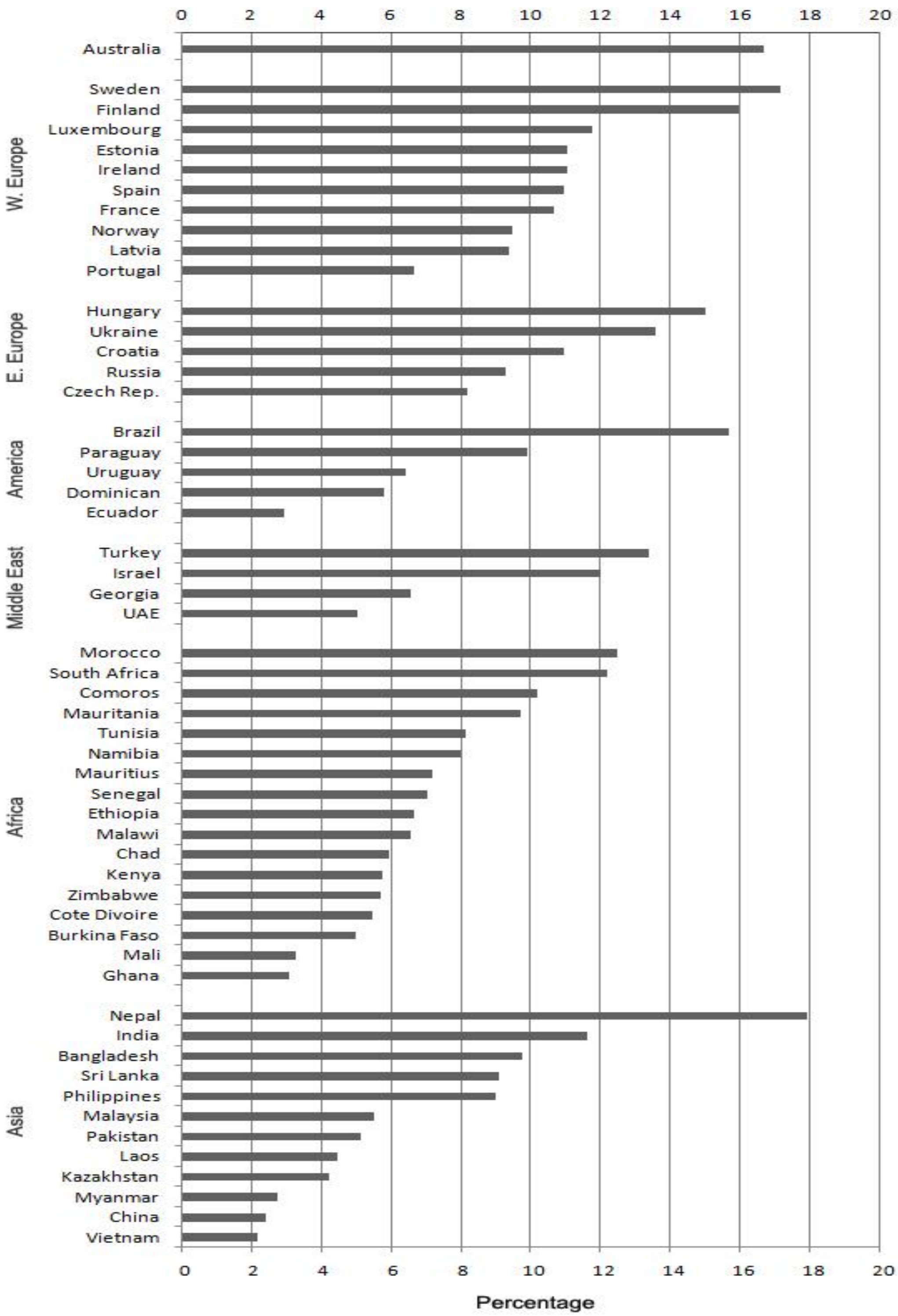

Figure 4.3.2: Prevalence of current wheeze in adults aged 18 years and above by geographic regions from the World Health Survey

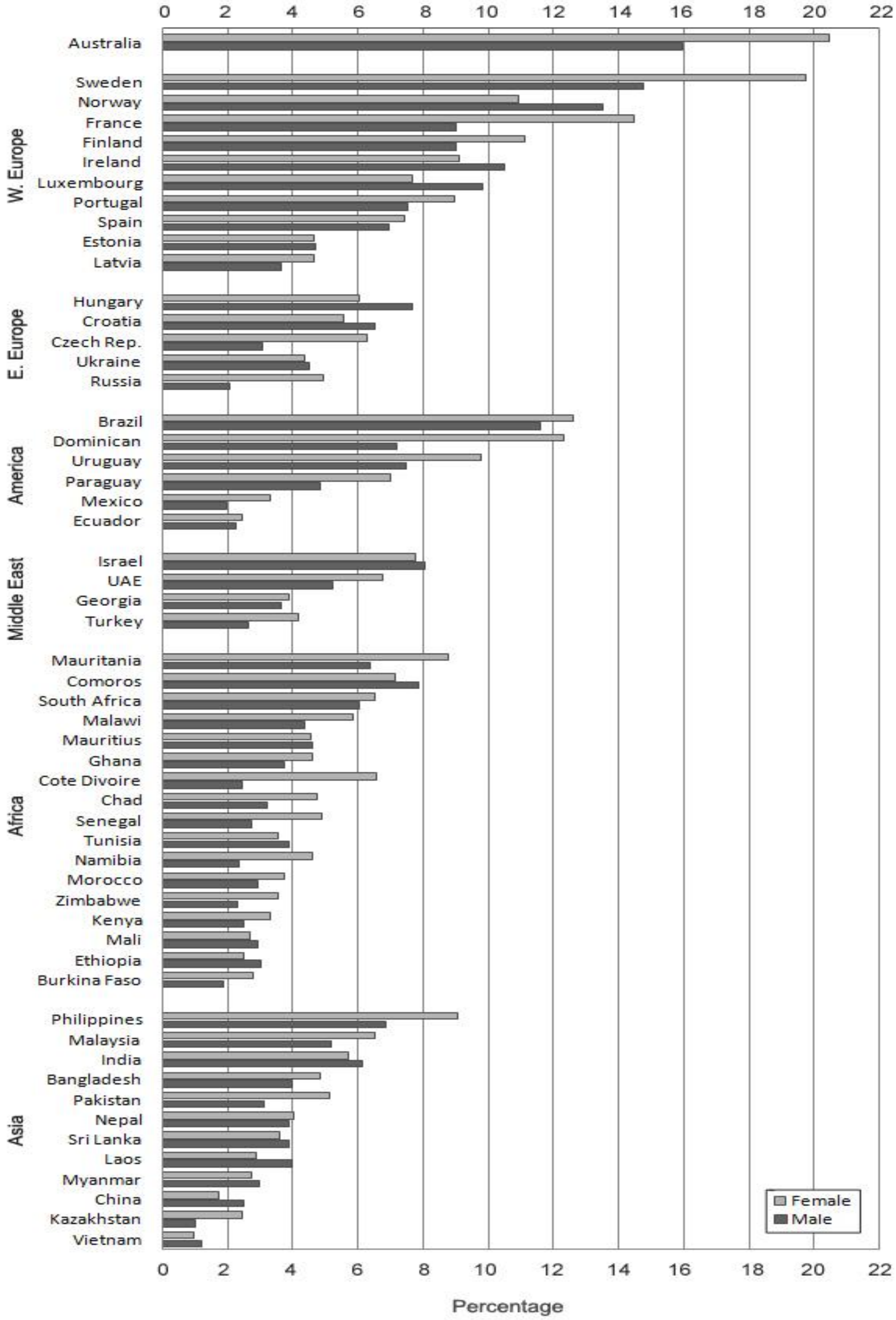

Figure 4.4.1: Sex-specific prevalence of ever asthma in adults aged 18 years and above by geographic regions from the World Health Survey

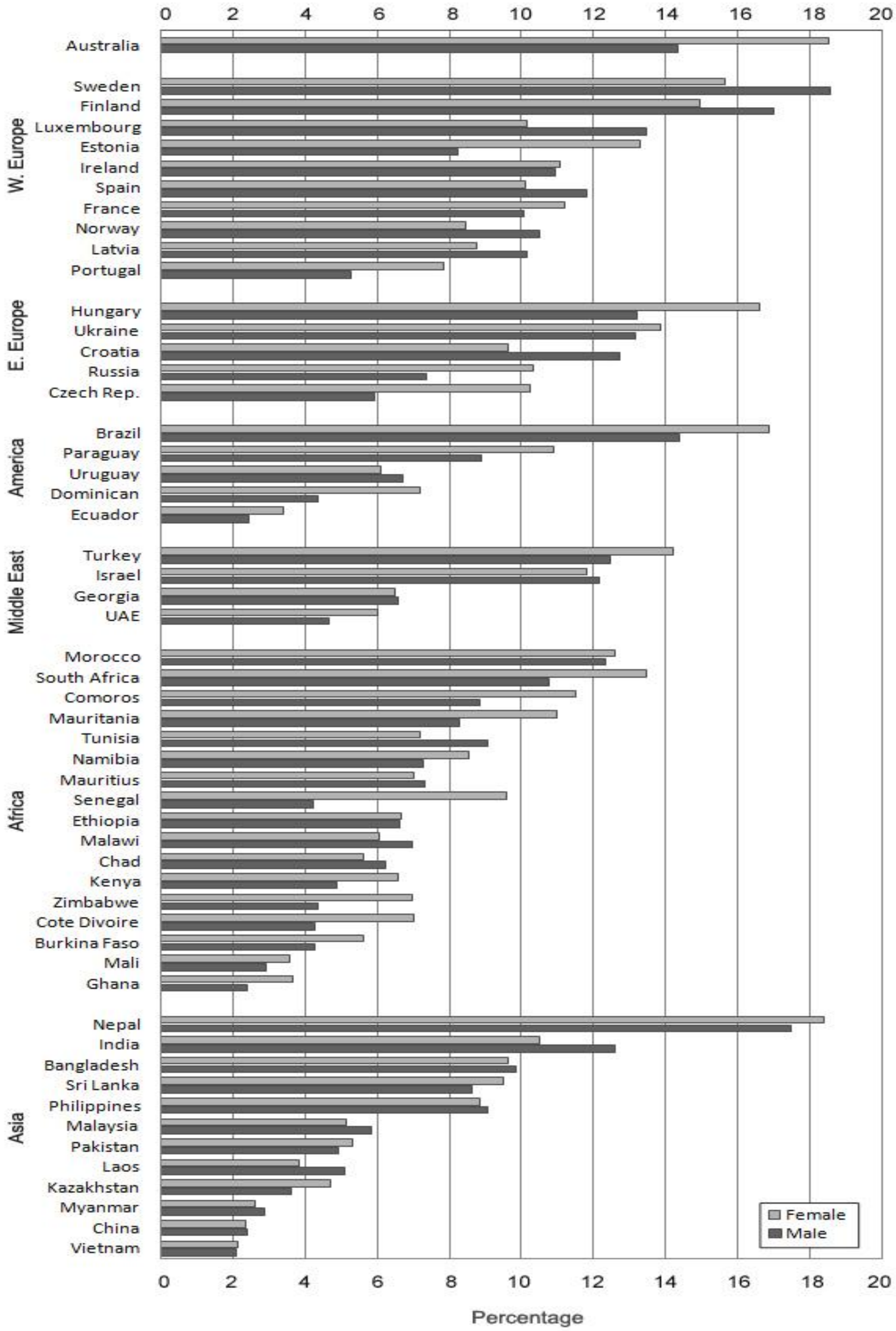

Figure 4.4.2: Sex-specific prevalence of current wheeze in adults aged 18 years and above by geographic regions from the World Health Survey

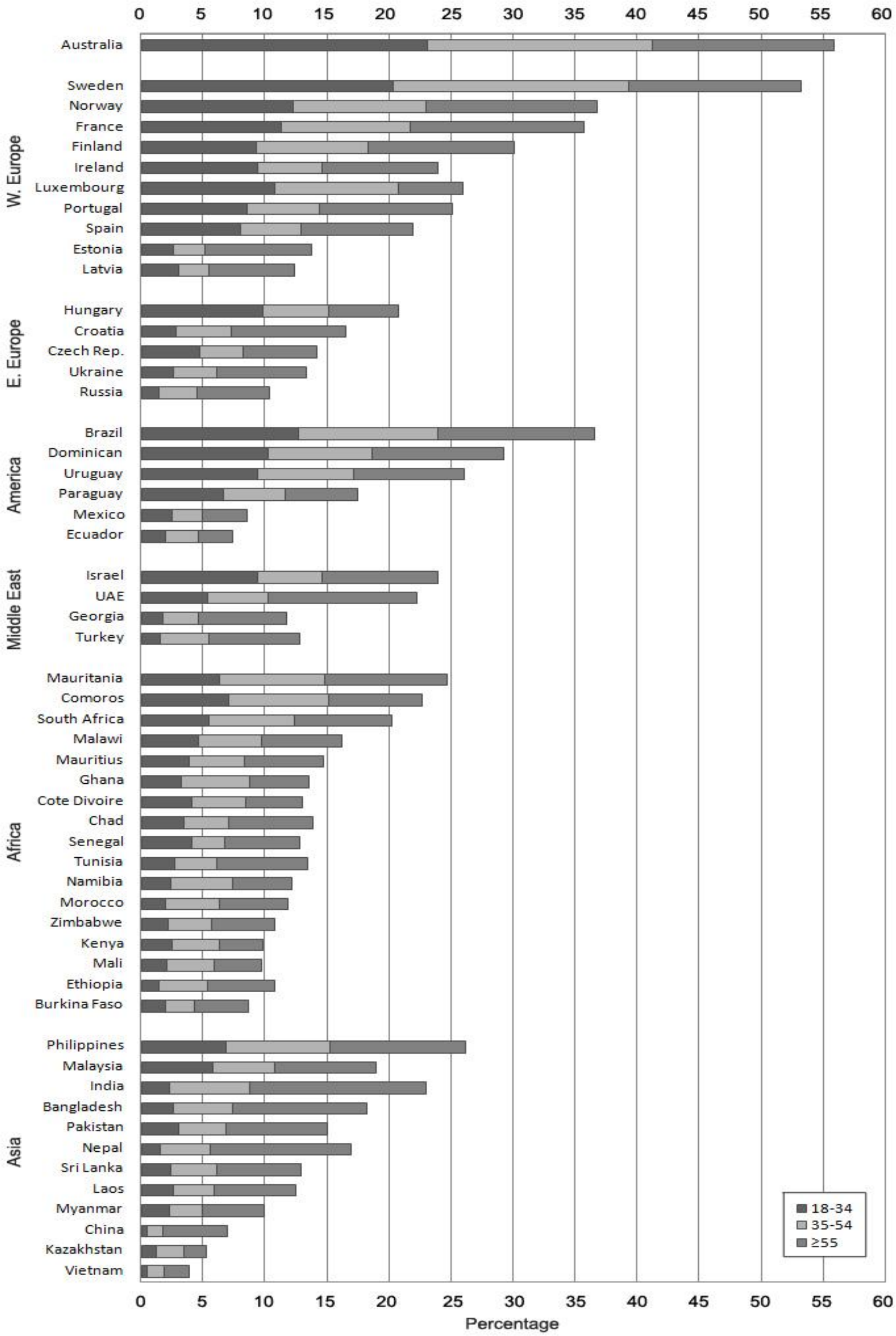

Figure 4.5.1: Age-specific prevalence of ever asthma in adults aged 18 years and above by geographic regions from the World Health Survey

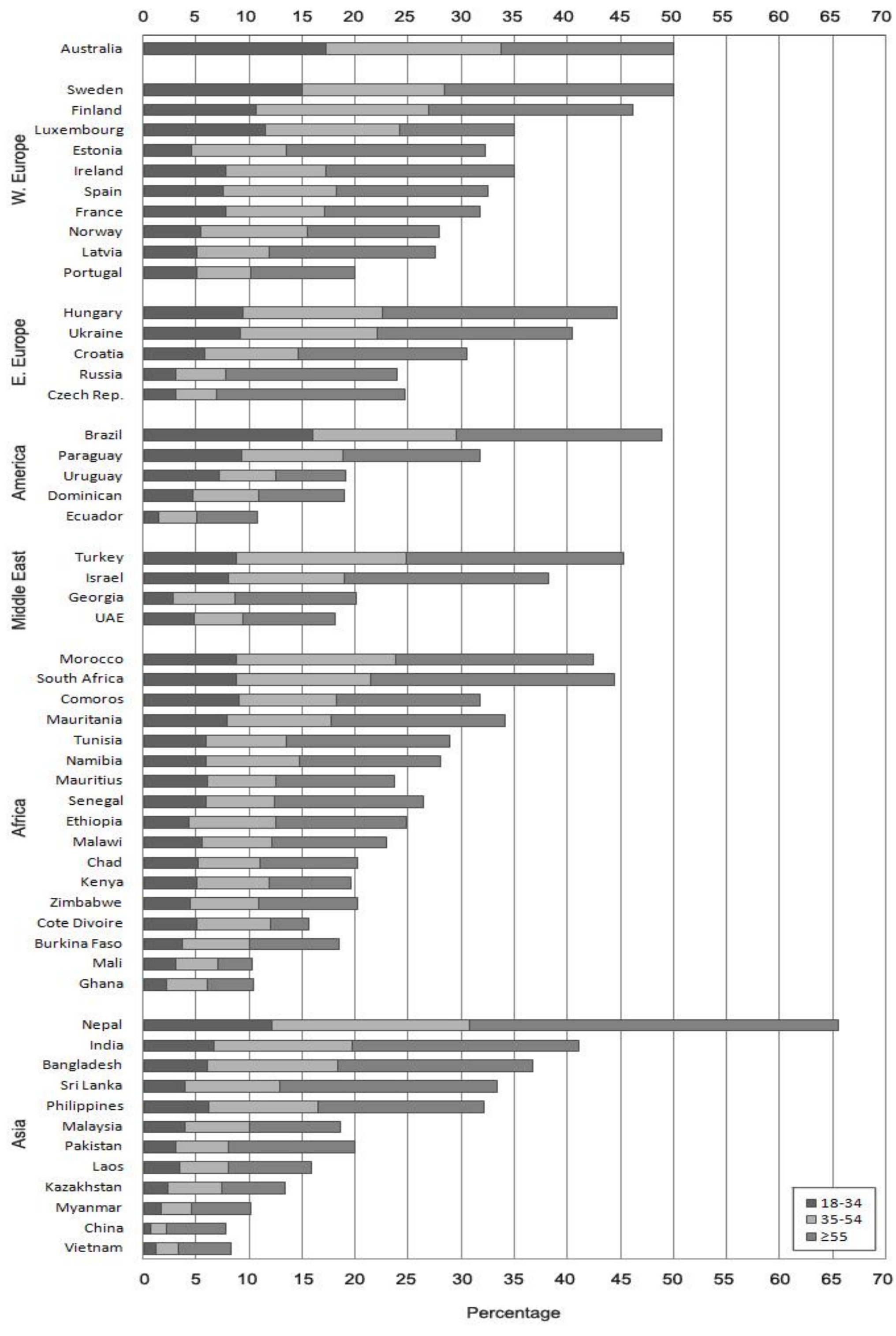

Figure 4.5.2: Age-specific prevalence of current wheeze in adults aged 18 years and above by geographic regions from the World Health Survey

Table 4.4.1: Multivariate logistic regression analysis of ever asthma for Asian and Middle East countries*

Country (N analyzed)		Age group		Sex	Household spending	Education
		"35-54" vs ref. "18-34"	"≥55" vs ref. "18-34"	female vs ref. male	upper vs. lower ref. 50%ile	finished 2° vs ref. lower
Bangladesh	OR (95% CI)	1.76 (1.14-2.70)	3.9 (2.54-6.01)	1.06 (0.76-1.49)		
(5448)	p-value	**<0.05**	**<0.0005**	0.73		
China†	OR (95% CI)	2.19 (0.71-6.74)	6.5 (3.2-13.19)	0.58 (0.24-1.39)	0.44 (0.24-0.82)	0.59 (0.32-1.08)
(3976)	p-value	0.16	**<0.0005**	0.21	**<0.05**	0.09
Georgia	OR (95% CI)	1.43 (0.54-3.75)	3.42 (1.22-9.58)	0.94 (0.57-1.55)		
(2728)	p-value	0.46	**<0.05**	0.80		
India	OR (95% CI)	2.59 (1.89-3.56)	5.66 (4.00-8.01)	0.84 (0.68-1.05)		
(9273)	p-value	**<0.0005**	**<0.0005**	0.12		
Kazakhstan	OR (95% CI)	1.70 (0.68-4.25)	1.39 (0.67-2.90)	2.21 (1.05-4.62)		
(4108)	p-value	0.25	0.38	**<0.05**		
Laos	OR (95% CI)	1.2 (0.78-1.83)	2.34 (1.45-3.78)	0.64 (0.44-0.94)		0.23 (0.11-0.50)
(4690)	p-value	0.41	**<0.005**	**<0.05**		**<0.0005**
Malaysia	OR (95% CI)	0.89 (0.66-1.20)	1.48 (1.08-2.02)	1.18 (0.91-1.53)		
(5968)	p-value	0.45	**<0.05**	0.21		
Myanmar	OR (95% CI)	1.06 (0.73-1.56)	1.89 (1.20-2.99)	0.84 (0.60-1.18)		
(5886)	p-value	0.75	**<0.05**	0.31		
Nepal†	OR (95% CI)	2.77 (1.89-4.06)	7.61 (5.26-11.01)	0.93 (0.72-1.22)		
(8343)	p-value	**<0.0005**	**<0.0005**	0.62		
Pakistan	OR (95% CI)	1.07 (0.72-1.60)	2.32 (1.64-3.29)	1.42 (1.05-1.90)	1.58 (1.06-2.36)	
(5894)	p-value	0.74	**<0.0005**	**<0.05**	**<0.05**	
Philippines†	OR (95% CI)	1.21 (0.99-1.48)	1.53 (1.16-2.03)	1.30 (1.08-1.58)		
(9888)	p-value	0.06	**<0.005**	**<0.05**		
Sri Lanka	OR (95% CI)	1.55 (0.97-2.49)	2.99 (1.82-4.91)	0.92 (0.60-1.39)		
(6169)	p-value	0.07	**<0.0005**	0.68		
UAE	OR (95% CI)	0.96 (0.48-1.90)	2.83 (1.13-7.06)	1.22 (0.62-2.40)	2.52 (1.06-6.00)	
(1146)	p-value	0.90	**<0.05**	0.55	**<0.05**	
Vietnam†	OR (95% CI)	2.39 (0.96-6.00)	2.94 (0.98-8.83)	0.64 (0.32-1.28)		
(3459)	p-value	0.06	0.05	0.21		

*Only main effects are listed. †Countries with significant 1st-order interaction, see Appendix D for details. Variables *Current smoking* and *Floor type* are not significant in any of these countries. ‡Variable excluded due to ≥20% data missing. §Not applicable due to zero cell count

(Table 4.4.1 continued)

Country		Urban/rural	Obesity	Anxiety	Ever depression	Cooking fuel	Model fit
		urban vs ref. rural	obese vs ref. non-obese	"yes" vs ref. "no"	"yes" vs ref. "no"	hydrocarbon vs ref. non HC.	
Bangladesh	OR (95% CI)	0.68 (0.49-0.95)	-[‡]	2.03 (1.29-3.22)	2.11 (1.08-4.11)		
	p-value	**<0.05**		**<0.005**	**<0.05**		0.08
China[†]	OR (95% CI)	2.05 (1.15-3.64)		3.43 (1.95-6.05)			
	p-value	**<0.05**		**<0.0005**			**<0.0005**
Georgia	OR (95% CI)			1.66 (0.77-3.57)			
	p-value			0.19			0.70
India	OR (95% CI)		-	1.91 (1.41-2.60)	2.05 (1.54-2.74)		
	p-value			**<0.0005**	**<0.0005**		0.09
Kazakhstan	OR (95% CI)		2.26 (1.33-3.84)				
	p-value		**<0.005**				0.82
Laos	OR (95% CI)	0.48 (0.29-0.81)	/[§]		3.71 (1.73-7.98)		
	p-value	**<0.05**			**<0.005**		0.83
Malaysia	OR (95% CI)		-	2.48 (1.92-3.19)		8.38 (1.11-63.51)	
	p-value			**<0.0005**		**<0.05**	0.99
Myanmar	OR (95% CI)		-	2.51 (1.69-3.72)			
	p-value			**<0.0005**			0.97
Nepal[†]	OR (95% CI)	1.70 (1.27-2.28)	-		1.89 (1.42-2.53)		
	p-value	**<0.0005**			**<0.0005**		0.35
Pakistan	OR (95% CI)		-	2.40 (1.75-3.29)	2.73 (1.36-5.51)		
	p-value			**<0.0005**	**<0.05**		0.56
Philippines[†]	OR (95% CI)		-		4.60 (3.31-6.39)		
	p-value				**<0.005**		0.14
Sri Lanka	OR (95% CI)		-	0.64 (0.45-0.90)	7.11 (3.15-16.02)		
	p-value			**<0.05**	**<0.0005**		0.54
UAE	OR (95% CI)		-		3.10 (1.23-7.82)		
	p-value				**<0.05**		0.99
Vietnam†	OR (95% CI)		/	4.08 (2.00-8.31)	/		
	p-value			**<0.0005**			0.27

[*]Only main effects are listed. [†]Countries with significant 1st-order interaction, see Appendix D for details. Variables *Current smoking* and *Floor type* are not significant in any of these countries. [‡]Variable excluded due to ≥20% data missing. [§]Not applicable due to zero cell count

Table 4.4.2: Multivariate logistic regression analysis of ever asthma for African countries*

Country (N analyzed)		Age group "35-54" vs ref. "18-34"	Age group "≥55" vs ref. "18-34"	Sex female vs ref. male	Household spending upper vs. lower ref. 50%ile	Education finished 2° vs ref. lower	Urban/rural urban vs ref. rural
Burkina Faso†	OR (95% CI)	1.03 (0.59-1.82)	1.64 (0.53-3.84)	1.41 (0.87-2.27)			
(4753)	p-value	0.90	0.25	0.16			
Chad	OR (95% CI)	0.78 (0.48-1.29)	1.49 (0.85-2.59)	1.31 (0.86-1.99)	0.99 (0.63-1.56)		
(3830)	p-value	0.34	0.16	0.21	0.98		
Comoros†	OR (95% CI)	1.02 (0.62-1.67)	0.84 (0.57-1.22)	0.93 (0.58-1.50)	1.59 (1.03-2.44)		0.53 (0.28-1.01)
(1690)	p-value	0.94	0.35	0.77	**<0.05**		**<0.05**
Cote d'Ivoire	OR (95% CI)	1.11 (0.71-1.74)	1.37 (0.65-2.89)	3.37 (2.12-5.36)	1.23 (0.79-1.92)	2.16 (1.23-3.79)	
(2868)	p-value	0.65	0.40	**<0.0005**	0.35	**<0.05**	
Ethiopia	OR (95% CI)	3.33 (2.10-5.30)	4.15 (2.31-7.46)	0.80 (0.52-1.23)	-‡		2.19 (1.19-4.04)
(4409)	p-value	**<0.0005**	**<0.0005**	0.30			**<0.05**
Ghana	OR (95% CI)	1.74 (1.14-2.67)	1.50 (0.88-2.55)	1.24 (0.85-1.80)			
(3896)	p-value	**<0.05**	0.14	0.26			
Kenya	OR (95% CI)	1.66 (0.96-2.89)	1.48 (0.69-3.16)	1.11 (0.67-1.84)			
(4316)	p-value	0.07	0.31	0.68			
Malawi	OR (95% CI)	1.10 (0.68-1.80)	1.36 (0.92-2.00)	1.29 (0.86-1.93)			
(5164)	p-value	0.68	0.12	0.22			
Mauritania	OR (95% CI)	1.37 (0.96-1.96)	1.34 (0.89-2.01)	1.18 (0.81-1.72)			
(3129)	p-value	0.08	0.16	0.39			
Mauritius	OR (95% CI)	0.98 (0.66-1.45)	1.90 (0.73-1.97)	0.82 (0.58-1.18)		0.60 (0.41-0.88)	
(3857)	p-value	0.92	0.47	0.29		**<0.05**	
Morocco	OR (95% CI)	2.18 (1.19-4.00)	2.71 (1.34-5.49)	1.21 (0.74-1.99)			
(4467)	p-value	**<0.05**	**<0.05**	0.44			
Namibia	OR (95% CI)	2.06 (1.21-3.50)	1.54 (0.81-2.95)	1.57 (0.90-2.74)			
(3731)	p-value	**<0.05**	0.19	0.12			
Senegal	OR (95% CI)	0.60 (0.34-1.05)	1.34 (0.59-3.04)	1.74 (1.01-2.98)			
(2617)	p-value	0.07	0.49	**<0.05**			
South Africa	OR (95% CI)	1.14 (0.69-1.86)	1.35 (0.74-2.49)	1.22 (0.79-1.88)			
(2233)	p-value	0.61	0.33	0.36			
Tunisia	OR (95% CI)	0.96 (0.54-1.70)	1.98 (1.11-3.54)	0.65 (0.42-1.01)			
(4098)	p-value	0.89	0.89	0.06			
Zimbabwe†	OR (95% CI)	1.66 (1.02-2.70)	2.38 (1.38-4.12)	1.47 (0.89-2.41)			
(3921)	p-value	**<0.05**	**<0.005**	0.13			

*Only main effects are listed. †Countries with significant 1st-order interaction, see Appendix D for details. Variable *Cooking fuel* is not significant in any of these countries. ‡Variable excluded due to ≥20% data missing. §Not applicable due to zero cell count

(Table 4.4.2 continued)

Country		Obesity obese vs ref. non-obese	Anxiety "yes" vs ref. "no"	Ever depression "yes" vs ref. "no"	Current smoking "yes" vs ref. "no"	Floor type hard vs ref. earth	Model fit
Burkina Faso[†]	OR (95% CI)	-	2.05 (1.15-3.64)	13.01 (5.63-30.06)			
	p-value		**<0.05**	**<0.0005**			**<0.05**
Chad	OR (95% CI)	-		9.06 (3.89-21.12)		-	
	p-value			**<0.0005**			0.97
Comoros[†]	OR (95% CI)	1.41 (0.51-3.92)		18.49 (5.13-66.66)	1.97 (1.04-3.74)		
	p-value	0.50		**<0.0005**	**<0.05**		0.28
Cote D'Ivoire	OR (95% CI)			6.49 (2.59-16.29)			
	p-value			**<0.0005**			0.50
Ethiopia	OR (95% CI)	-		5.79 (3.17-10.56)		1.64 (0.82-3.28)	
	p-value			**<0.0005**		0.16	0.98
Ghana	OR (95% CI)	-					
	p-value						0.99
Kenya	OR (95% CI)	-			0.36 (0.14-0.90)		
	p-value				**<0.05**		0.99
Malawi	OR (95% CI)		1.38 (1.02-1.89)	5.47 (2.70-11.08)			
	p-value		**<0.05**	**<0.0005**			0.75
Mauritania	OR (95% CI)			7.26 (3.40-15.48)		0.71 (0.49-1.05)	
	p-value			**<0.0005**		0.08	0.90
Mauritius	OR (95% CI)	-	1.84 (1.21-2.80)	2.15 (1.35-3.42)		/[§]	
	p-value		**<0.0005**	**<0.0005**			0.32
Morocco	OR (95% CI)	-	-	2.94 (1.38-6.23)			
	p-value			**<0.05**			0.92
Namibia	OR (95% CI)	2.13 (1.19-3.80)		3.90 (2.24-6.80)			
	p-value	**<0.05**		**<0.0005**			0.14
Senegal	OR (95% CI)	-	1.91 (1.11-3.29)				
	p-value		**<0.05**				0.92
South Africa	OR (95% CI)	-		3.62 (1.64-7.97)	1.88 (1.11-3.21)		
	p-value			**<0.005**	**<0.05**		0.49
Tunisia	OR (95% CI)	1.33 (0.70-2.52)	2.53 (1.61-3.98)	4.46 (2.58-7.70)		4.35 (1.43-13.22)	
	p-value	0.38	**<0.0005**	**<0.0005**		**<0.05**	0.15
Zimbabwe[†]	OR (95% CI)	-		2.56 (1.12-5.86)			
	p-value			**<0.05**			0.99

[*]Only main effects are listed. [†]Countries with significant 1st-order interaction, see Appendix D for details. Variable *Cooking fuel* is not significant in any of these countries. [‡]Variable excluded due to ≥20% data missing. [§]Not applicable due to zero cell count

Table 4.4.3: Multivariate logistic regression analysis of ever asthma for American countries*

Country (N analyzed)		Age group: "35-54" vs ref. "18-34"	Age group: "≥55" vs ref. "18-34"	Sex: female vs ref. male	Household spending: upper vs. lower ref. 50%ile	Urban/rural: urban vs ref. rural
Brazil	OR (95% CI)	0.82 (0.64-1.04)	0.94 (0.73-1.21)	1.01 (0.81-1.26)		
(4965)	p-value	0.10	0.63	0.96		
Dominican†	OR (95% CI)	0.76 (0.50-1.15)	1.00 (0.69-1.44)	1.53 (1.07-2.19)		
(4474)	p-value	0.19	1.00	**<0.05**		
Mexico†	OR (95% CI)	0.85 (0.70-1.03)	1.23 (1.01-1.50)	1.41 (1.15-1.73)	1.29 (1.08-1.55)	
(37605)	p-value	0.09	**<0.05**	**<0.005**	**<0.05**	
Paraguay	OR (95% CI)	0.75 (0.55-1.04)	0.89 (0.61-1.28)	1.38 (1.01-1.89)	1.43 (1.03-1.97)	1.48 (1.10-1.98)
(5102)	p-value	0.08	0.52	**<0.05**	**<0.05**	**<0.05**
Uruguay	OR (95% CI)	0.75 (0.57-0.98)	0.81 (0.43-1.52)	1.24 (0.96-1.61)		
(2963)	p-value	**<0.05**	0.50	0.09		

*Only main effects are listed. †Countries with significant 1st-order interaction, see Appendix D for details. Variables *Education*, *Obesity*, *Floor type*, and *Cooking fuel* are not significant in any of these countries

(Table 4.4.3 continued)

Country		Anxiety	Ever depression	Current smoking	Model fit
		"yes" vs ref. "no"	"yes" vs ref. "no"	"yes" vs ref. "no"	
Brazil	OR (95% CI)		1.85 (1.48-2.32)		
	p-value		**<0.0005**		0.99
Dominican†	OR (95% CI)	1.38 (1.03-1.86)	2.02 (1.31-3.12)		
	p-value	**<0.05**	**<0.005**		0.99
Mexico†	OR (95% CI)	2.51 (2.09-3.02)	1.88 (1.43-2.47)		
	p-value	**<0.0005**	**<0.0005**		0.71
Paraguay	OR (95% CI)		2.36 (1.53-3.62)		
	p-value		**<0.0005**		0.84
Uruguay	OR (95% CI)	2.05 (1.61-2.61)		0.64 (0.46-0.89)	
	p-value	**<0.0005**		**<0.05**	0.34

*Only main effects are listed. †Countries with significant 1st-order interaction, see Appendix D for details. Variables *Education*, *Obesity*, *Floor type*, and *Cooking fuel* are not significant in any of these countries

Table 4.4.4: Multivariate logistic regression analysis of ever asthma for European countries[*]

Country (N analyzed)		Age group "35-54" vs ref. "18-34"	Age group "≥55" vs ref. "18-34"	Sex female vs ref. male	Education finished 2° vs ref. lower	Obesity obese vs ref. non-obese
Croatia	OR (95% CI)	1.32 (0.38-4.56)	2.86 (0.94-8.72)	0.84 (0.45-1.56)		3.06 (1.50-6.23)
(975)	p-value	0.66	0.07	0.58		**<0.005**
Czech Rep.[†]	OR (95% CI)	0.70 (0.28-1.74)	1.03 (0.42-2.53)	1.91 (0.88-4.16)	0.42 (0.19-0.94)	
(917)	p-value	0.44	0.94	0.10	**<0.05**	
Estonia	OR (95% CI)	0.95 (0.22-4.09)	3.36 (1.4207.97)	0.78 (0.35-1.71)		
(1001)	p-value	0.94	**<0.05**	0.52		
Hungary	OR (95% CI)	0.52 (0.32-1.00)	0.56 (0.32-1.00)	0.81 (0.50-1.33)		
(1419)	p-value	**<0.05**	0.05	0.41		
Latvia	OR (95% CI)	0.77 (0.18-3.27)	2.26 (0.80-6.37)	1.19 (0.51-2.74)		-[‡]
(836)	p-value	0.73	0.12	0.69		
Russia	OR (95% CI)	1.99 (0.96-4.12)	3.79 (1.78-8.07)	1.49 (0.75-2.98)		-
(4134)	p-value	0.07	**<0.0005**	0.25		
Spain	OR (95% CI)	0.52 (0.35-0.78)	0.83 (0.59-1.17)	0.87 (0.65-1.18)		
(6150)	p-value	**<0.005**	0.29	0.37		
Ukraine	OR (95% CI)	1.27 (0.60-2.65)	2.68 (1.24-5.81)	0.78 (0.48-1.27)		-
(2470)	p-value	0.53	**<0.05**	0.32		

[*]Only main effects are listed. [†]Analysis done without PSU variable. [‡]Variable excluded due to ≥20% data missing. [§]Unavailable due to missing values. Variables *Household spending*, *Urban/rural*, *Floor type*, and *Cooking fuel* are not significant in any of these countries

(Table 4.4.4 continued)

Country		Anxiety	Ever depression	Current smoke	Model fit
		"yes" vs ref. "no"	"yes" vs ref. "no"	"yes" vs ref. "no"	
Croatia	OR (95% CI)				
	p-value				/[§]
Czech Rep.[†]	OR (95% CI)				
	p-value				0.95
Estonia	OR (95% CI)		3.60 (1.87-6.93)		
	p-value		**<0.0005**		0.15
Hungary	OR (95% CI)				
	p-value				0.99
Latvia	OR (95% CI)				
	p-value				0.99
Russia	OR (95% CI)		10.95 (2.12-56.55)	0.62 (0.25-1.55)	
	p-value		**<0.05**	0.30	0.76
Spain	OR (95% CI)	1.90 (1.44-2.51)	1.42 (1.01-1.99)	0.71 (0.52-0.98)	
	p-value	**<0.0005**	**<0.05**	**<0.05**	0.83
Ukraine	OR (95% CI)	1.87 (1.05-3.34)			
	p-value	**<0.05**			0.90

[*]Only main effects are listed. [†]Analysis done without PSU variable. [‡]Variable excluded due to ≥20% data missing. [§]Unavailable due to missing values. Variables *Household spending*, *Urban/rural*, *Floor type,* and *Cooking fuel* are not significant in any of these countries

Table 4.4.5: Summary of risk and protective factors for ever asthma

	No. of country	Age	Sex	Urban	Obesity	HHSpend[†]	Edu	Anxiety	Depress	Smoke	Floor	Fuel
Asia/Middle East	14	12(0)[*]	3(1)	2(2)	1(0)	2(1)	0(2)	7(1)	8(0)	0(0)	0(0)	1(0)
Africa	16	5(0)	2(0)	1(1)	1(0)	1(0)	1(1)	5(0)	13(0)	2(1)	1(0)	0(0)
America	5	1(1)	3(0)	1(0)	0(0)	2(0)	0(0)	3(0)	4(0)	0(1)	0(0)	0(0)
Europe	8	3(2)	0(0)	0(0)	1(0)	0(0)	0(1)	2(0)	3(0)	0(1)	0(0)	0(0)
Overall	43	21(3)	8(1)	4(3)	3(0)	5(1)	1(4)	17(1)	28(0)	2(3)	1(0)	1(0)

[*]Total number of country indicating the variable as risk factor (total number of country indicating the variable as protective factor). [†]HHSpend = *Household spending* variable

Table 4.5.1: Multivariate logistic regression analysis of current wheeze for Asian and Middle East countries*

Country (N analyzed)		Age group "35-54" vs ref. "18-34"	Age group "≥55" vs ref. "18-34"	Sex: female vs ref. male	Household spending: upper vs. lower ref. 50%ile	Education: finished 2° vs ref. lower	Urban/rural: urban vs ref. rural
Bangladesh	OR (95% CI)	2.03 (1.54-2.68)	3.18 (2.34-4.32)	0.88 (0.69-1.12)			
(5454)	p-value	**<0.0005**	**<0.0005**	0.30			
China†	OR (95% CI)	1.92 (0.71-5.19)	6.47 (3.2-13.08)	0.94 (0.51-1.75)	0.44 (0.27-0.71)		2.06 (1.15-3.66)
(3986)	p-value	0.19	**<0.0005**	0.85	**<0.005**		**<0.05**
Georgia	OR (95% CI)	1.53 (0.92-2.54)	2.68 (1.38-5.21)	0.79 (0.56-1.11)			
(2738)	p-value	0.10	**<0.05**	0.17			
India†	OR (95% CI)	1.68 (1.10-2.58)	2.7 (1.58-4.61)	0.84 (0.71-1.01)			
(9218)	p-value	**<0.05**	**<0.0005**	0.06			
Kazakhstan	OR (95% CI)	2.06 (1.27-3.36)	2.45 (1.27-4.70)	1.14 (0.70-1.86)			
(4114)	p-value	**<0.005**	**<0.05**	0.59			
Laos†	OR (95% CI)	1.33 (0.95-1.86)	2.20 (1.46-3.31)	0.69 (0.51-0.94)			
(4711)	p-value	0.09	**<0.0005**	**<0.05**			
Malaysia	OR (95% CI)	1.66 (1.2-2.31)	2.5 (1.73-3.61)	0.8 (0.61-1.05)			
(5969)	p-value	**<0.005**	**<0.0005**	0.11			
Myanmar	OR (95% CI)	1.63 (1.02-2.59)	3.03 (1.89-4.86)	0.82 (0.58-1.16)			
(5876)	p-value	**<0.05**	**<0.0005**	0.26			
Nepal	OR (95% CI)	1.51 (1.28-1.77)	3.1 (2.61-3.68)	0.95 (0.82-1.12)		0.67 (0.52-0.87)	
(8397)	p-value	**<0.0005**	**<0.0005**	0.55		**<0.005**	
Pakistan†	OR (95% CI)	1.30 (0.86-1.97)	3.23 (2.10-4.97)	0.85 (0.61-0.18)	1.86 (1.30-2.66)	0.57 (0.36-0.91)	
(5914)	p-value	0.21	**<0.0005**	0.33	**<0.005**	**<0.05**	
Philippines	OR (95% CI)	1.52 (1.26-1.84)	2.05 (1.60-2.64)	0.92 (0.76-1.10)		0.75 (0.62-0.91)	
(9932)	p-value	**<0.0005**	**<0.0005**	0.35		**<0.005**	
Sri Lanka	OR (95% CI)	2.46 (1.68-3.61)	5.85 (3.94-8.69)	1.12 (0.85-1.48)			
(6277)	p-value	**<0.0005**	**<0.0005**	0.41			
UAE	OR (95% CI)	0.95 (0.45-2.01)	2.27 (0.66-7.75)	1.38 (0.78-2.42)	0.52 (0.29-0.92)		
(1153)	p-value	0.89	0.19	0.26	**<0.05**		
Vietnam	OR (95% CI)	1.58 (0.80-3.10)	3.55 (1.83-6.88)	0.92 (0.64-1.31)			
(3458)	p-value	0.18	**<0.0005**	0.63			

*Only main effects are listed. †Countries with significant 1st-order interaction, see Appendix E for details. ‡Variable excluded due to ≥20% data missing. §Unavailable due to missing values.

(Table 4.5.1 continued)

Country		Obesity	Anxiety	Ever depression	Current smoking	Floor type	Cooking fuel	Model fit
		obese vs ref. non-obese	"yes" vs ref. "no"	"yes" vs ref. "no"	"yes" vs ref. earth	hard vs ref. earth	hydrocarbon vs ref. non HC.	
Bangladesh	OR (95% CI)	-‡	2.14 (1.55-2.96)	2.23 (1.27-3.92)				
	p-value		**<0.0005**	**<0.05**				0.94
China†	OR (95% CI)		3.56 (2.35-5.39)			0.31 (0.13-0.74)		
	p-value		**<0.0005**			**<0.05**		**<0.0005**
Georgia	OR (95% CI)	2.42 (1.47-3.98)	3.01 (1.87-4.83)					
	p-value	**<0.005**	**<0.0005**					**<0.05**
India†	OR (95% CI)	-	2.15 (1.60-2.90)	1.72 (1.35-2.19)	1.50 (1.15-1.94)	0.72 (0.60-0.87)		
	p-value		**<0.0005**	**<0.0005**	**<0.005**	**<0.005**		0.38
Kazakhstan	OR (95% CI)	1.82 (1.15-2.87)					0.41 (0.26-0.65)	
	p-value	**<0.05**					**<0.0005**	0.97
Laos†	OR (95% CI)		2.27 (1.59-3.22)	3.56 (1.84-6.89)		1.8 (1.02-3.18)	0.36 (0.21-0.64)	
	p-value		**<0.0005**	**<0.0005**		**<0.05**	**<0.0005**	0.85
Malaysia	OR (95% CI)	-	2.6 (2.03-3.33)			/	2.45 (1.50-4.02)	
	p-value		**<0.0005**				**<0.0005**	0.89
Myanmar	OR (95% CI)	-		5.43 (1.92-15.37)				
	p-value			**<0.005**				0.83
Nepal	OR (95% CI)	-	1.73 (1.49-2.01)	1.76 (1.53-2.020)			1.38 (1.12-1.69)	
	p-value		**<0.0005**	**<0.0005**			**<0.005**	0.43
Pakistan†	OR (95% CI)	-	2.18 (1.58-3.01)	5.98 (3.22-11.10)				
	p-value		**<0.0005**	**<0.0005**				0.06
Philippines	OR (95% CI)	-	1.57 (1.28-1.93)	7.2 (5.29-9.79)		0.6 (0.44-0.83)		
	p-value		**<0.0005**	**<0.0005**		**<0.005**		0.11
Sri Lanka	OR (95% CI)	-		12.61 (6.84-23.25)			0.57 (0.42-0.78)	
	p-value			**<0.0005**			**<0.005**	0.75
UAE	OR (95% CI)	-		5.79 (1.46-23.01)		/		
	p-value			**<0.05**				0.93
Vietnam	OR (95% CI)	/§	3.30 (1.99-5.48)	/		0.49 (0.31-0.79)		
	p-value		**<0.0005**			**<0.005**		/

*Only main effects are listed. †Countries with significant 1st-order interaction, see Appendix E for details. ‡Variable excluded due to ≥20% data missing. §Unavailable due to missing values.

Table 4.5.2: Multivariate logistic regression analysis of current wheeze for African countries[*]

Country (N analyzed)		Age group "35-54" vs ref. "18-34"	Age group "≥55" vs ref. "18-34"	Sex female vs ref. male	Household spending upper vs. lower ref. 50%ile	Education finished 2° vs ref. lower	Urban/rural urban vs ref. rural
Burkina Faso[†]	OR (95% CI)	1.56 (1.10-2.21)	1.88 (1.08-3.26)	1.21 (0.84-1.72)			
(4768)	p-value	**<0.05**	**<0.05**	0.30			
Chad	OR (95% CI)	1.04 (0.71-1.52)	1.36 (0.82-2.26)	0.83 (0.61-1.12)			
(4277)	p-value	0.85	0.23	0.21			
Comoros	OR (95% CI)	1.04 (0.63-1.72)	1.54 (1.06-2.23)	1.25 (0.85-1.86)			
(1707)	p-value	0.86	**<0.05**	0.25			
Cote d'Ivoire	OR (95% CI)	1.37 (0.87-2.16)	0.66 (0.34-1.29)	1.65 (1.06-2.58)			
(3009)	p-value	0.17	0.23	**<0.05**			
Ethiopia	OR (95% CI)	1.90 (1.45-2.48)	2.54 (1.81-3.56)	0.94 (0.68-1.30)	-[‡]		
(4583)	p-value	**<0.0005**	**<0.0005**	0.70			
Ghana	OR (95% CI)	1.84 (1.10-3.09)	1.97 (1.08-3.59)	1.50 (0.91-2.47)			
(3870)	p-value	**<0.05**	**<0.05**	0.11			
Kenya	OR (95% CI)	1.28 (0.80-2.05)	1.28 (0.78-2.13)	1.26 (0.85-1.88)			
(4317)	p-value	0.30	0.33	0.25			
Malawi	OR (95% CI)	1.07 (0.77-1.47)	1.64 (0.97-2.76)	0.86 (0.57-1.29)		0.08 (0.02-0.30)	
(4655)	p-value	0.69	0.06	0.46		**<0.0005**	
Mauritania[†]	OR (95% CI)	1.44 (1.04-2.01)	2.29 (1.59-3.30)	1.22 (0.83-1.79)			
(3167)	p-value	**<0.05**	**<0.0005**	0.32			
Mauritius[†]	OR (95% CI)	0.85 (0.62-1.17)	1.27 (0.87-1.85)	0.70 (0.51-0.95)		0.54 (0.36-0.79)	
(3856)	p-value	0.32	0.21	**<0.05**		**<0.005**	
Morocco	OR (95% CI)	1.72 (1.28-2.32)	2.51 (1.80-3.52)	1.34 (0.96-1.88)			
(4468)	p-value	**<0.0005**	**<0.0005**	0.08			
Namibia	OR (95% CI)	1.49 (0.99-2.25)	2.15 (1.46-3.16)	1.07 (0.78-1.47)			
(3851)	p-value	0.06	**<0.0005**	0.68			
Senegal	OR (95% CI)	1.21 (0.73-2.01)	2.65 (1.40-5.04)	2.50 (1.61-3.88)	1.27 (0.83-1.96)		
(2177)	p-value	0.46	**<0.005**	**<0.0005**	0.27		
South Africa[†]	OR (95% CI)	1.22 (0.84-1.78)	2.66 (1.78-3.96)	1.35 (0.96-1.89)	1.55 (1.13-2.11)		0.50 (0.33-0.75)
(2117)	p-value	0.30	**<0.0005**	0.09	**<0.05**		**<0.005**
Tunisia[†]	p-value	0.93 (0.66-1.30)	1.68 (1.13-2.48)	0.83 (0.55-1.24)		0.55 (0.38-0.78)	
(4162)	OR (95% CI)	0.66	**<0.05**	0.36		**<0.005**	
Zimbabwe	p-value	1.11 (0.74-1.66)	1.43 (0.87-2.34)	1.38 (0.94-2.04)		0.49 (0.30-0.79)	
(3909)	OR (95% CI)	0.61	0.16	0.10		**<0.005**	

[*]Only main effects are listed. [†]Countries with significant 1st-order interaction, see Appendix E for details. [‡]Variable excluded due to ≥20% data missing. [§]Unavailable due to missing values

(Table 4.5.2 continued)

Country		Obesity	Anxiety	Ever depression	Current smoking	Floor type	Cooking fuel	Model fit
		obese vs ref. non-obese	"yes" vs ref. "no"	"yes" vs ref. "no"	"yes" vs ref. "no"	hard vs ref. earth	hydrocarbon vs ref. non HC.	
Burkina Faso[†]	OR (95% CI)	-	2.22 (1.40-3.52)	7.26 (3.34-15.77)				
	p-value		**<0.005**	**<0.0005**				0.96
Chad	OR (95% CI)	-	2.39 (1.59-3.60)	12.78 (6.63-24.64)		-		
	p-value		**<0.0005**	**<0.0005**				0.96
Comoros	OR (95% CI)	2.12 (1.04-4.31)		16.23 (5.49-48.00)				
	p-value	**<0.05**		**<0.0005**				0.73
Cote D'Ivoire	OR (95% CI)		1.90 (1.24-2.92)	10.03 (5.19-19.41)				
	p-value		**<0.005**	**<0.0005**				0.91
Ethiopia	OR (95% CI)	-	1.81 (1.30-2.52)	4.76 (3.06-7.40)				
	p-value		**<0.005**	**<0.0005**				0.70
Ghana	OR (95% CI)	-		4.33 (1.49-12.55)				
	p-value			**<0.05**				0.99
Kenya	OR (95% CI)	-	2.46 (1.49-4.05)					
	p-value		**<0.0005**					**<0.05**
Malawi	OR (95% CI)	1.21 (0.51-2.87)	2.27 (1.65-3.11)	4.45 (2.08-9.52)	1.59 (1.12-2.28)			
	p-value	0.66	**<0.005**	**<0.0005**	**<0.05**			0.44
Mauritania[†]	OR (95% CI)			5.59 (2.85-10.96)		0.65 (0.46-0.90)		
	p-value			**<0.0005**		**<0.05**		0.69
Mauritius[†]	OR (95% CI)	-	2.33 (1.67-3.25)	3.27 (2.13-5.01)		/[§]		
	p-value		**<0.0005**	**<0.0005**				0.18
Morocco	OR (95% CI)	-	-	1.98 (1.05-3.76)	2.26 (1.52-3.38)			
	p-value			**<0.05**	**<0.0005**			0.97
Namibia	OR (95% CI)		1.88 (1.36-2.59)	2.90 (1.90-4.42)			1.76 (1.12-2.77)	
	p-value		**<0.0005**	**<0.0005**			**<0.05**	0.84
Senegal	OR (95% CI)	-	2.72 (1.63-4.54)	5.87 (1.96-17.61)			-	
	p-value		**<0.0005**	**<0.005**				**<0.005**
South Africa[†]	OR (95% CI)	-	2.36 (1.65-3.37)	4.10 (2.50-6.72)	1.95 (1.38-2.76)			
	p-value		**<0.0005**	**<0.0005**	**<0.0005**			**<0.05**
Tunisia[†]	p-value	1.90 (1.19-3.03)	3.09 (2.24-4.28)	2.21 (1.30-3.74)	2.01 (1.37-2.96)			
	OR (95% CI)	**<0.05**	**<0.0005**	**<0.005**	**<0.0005**			0.99
Zimbabwe	p-value	-	1.58 (1.12-2.23)	2.71 (1.55-4.73)			/	
	OR (95% CI)		**<0.05**	**<0.005**				0.34

[*]Only main effects are listed. [†]Countries with significant 1st-order interaction, see Appendix E for details. [‡]Variable excluded due to ≥20% data missing.
[§]Unavailable due to missing values

Table 4.5.3: Multivariate logistic regression analysis of current wheeze for American countries*

Country (N analyzed)		Age group "35-54" vs ref. "18-34"	Age group "≥55" vs ref. "18-34"	Sex female vs ref. male	Education finished 2° vs ref. lower
Brazil	OR (95% CI)	0.69 (0.57-0.85)	1.05 (0.83-1.32)	1.04 (0.86-1.26)	0.76 (0.63-0.91)
(4972)	p-value	**<0.0005**	0.70	0.66	**<0.005**
Dominican	OR (95% CI)	1.25 (0.80-1.93)	1.70 (1.12-2.57)	1.32 (0.91-1.93)	
(4477)	p-value	0.32	**<0.05**	0.14	
Paraguay†	OR (95% CI)	0.97 (0.75-1.24)	1.38 (1.03-1.85)	1.25 (0.97-1.61)	
(5104)	p-value	0.80	**<0.05**	0.08	
Uruguay†	OR (95% CI)	0.72 (0.50-1.04)	1.13 (0.74-1.72)	0.77 (0.60-1.01)	1.90 (1.46-2.48)
(2967)	p-value	0.08	0.55	0.06	**<0.0005**

*Only main effects are listed. †Countries with significant 1st-order interaction, see Appendix E for details. Variables *Household spending*, *Urban/rural*, *Obesity*, *Floor type* and *Cooking fuel* are not significant in any of these countries

(Table 4.5.3 continued)

Country		Anxiety	Ever depression	Current smoking	Model fit
		"yes" vs ref. "no"	"yes" vs ref. "no"	"yes" vs ref. "no"	
Brazil	OR (95% CI)	1.75 (1.40-2.18)	2.06 (1.67-2.55)	1.52 (1.23-1.87)	
	p-value	**<0.0005**	**<0.0005**	**<0.0005**	0.53
Dominican	OR (95% CI)	1.77 (1.13-2.79)	2.47 (1.45-4.22)		
	p-value	**<0.05**	**<0.005**		0.80
Paraguay[†]	OR (95% CI)	1.82 (1.42-2.33)		1.33 (1.03-1.72)	
	p-value	**<0.0005**		**<0.05**	0.21
Uruguay[†]	OR (95% CI)	2.42 (1.67-3.50)			
	p-value	**<0.0005**			**<0.05**

[*]Only main effects are listed. [†]Countries with significant 1st-order interaction, see Appendix E for details. Variables *Household spending*, *Urban/rural*, *Obesity*, *Floor type* and *Cooking fuel* are not significant in any of these countries

Table 4.5.4: Multivariate logistic regression analysis of current wheeze for European countries*

Country		Age group		Sex	Household spending	Education
(N analyzed)		"35-54" vs ref. "18-34"	"≥55" vs ref. "18-34"	female vs ref. male	upper vs. lower ref. 50%ile	finished 2° vs ref. lower
Croatia	OR (95% CI)	1.37 (0.52-3.62)	3.32 (1.29-8.53)	0.72 (0.42-1.22)	0.45 (0.25-0.80)	
(961)	p-value	0.53	**<0.05**	0.22	**<0.05**	
Czech Rep.‡	OR (95% CI)	0.88 (0.30-2.58)	6.10 (2.53-14.71)	2.12 (1.08-4.14)	-‡	
(905)	p-value	0.82	**<0.0005**	**<0.05**		
Estonia	OR (95% CI)	1.88 (1.06-3.34)	4.03 (2.24-7.25)	1.25 (0.77-2.03)		
(995)	p-value	**<0.05**	**<0.0005**	0.35		
Hungary	OR (95% CI)	1.17 (0.70-1.94)	2.55 (1.61-4.03)	1.12 (0.83-1.51)	-	
(1384)	p-value	0.55	**<0.0005**	0.46		
Latvia†	OR (95% CI)	1.19 (0.51-2.81)	3.35 (1.57-7.17)	0.90 (0.46-1.77)		0.47 (0.26-0.85)
(818)	p-value	0.68	**<0.005**	0.77		**<0.05**
Russia	OR (95% CI)	1.41 (0.78-2.56)	5.25 (2.72-10.11)	1.02 (0.63-1.65)		
(4140)	p-value	0.25	**<0.0005**	0.92		
Spain	OR (95% CI)	1.21 (0.871.67)	1.94 (1.41-2.67)	0.75 (0.57-0.98)		
(6155)	p-value	0.26	**<0.0005**	**<0.05**		
Ukraine†	OR (95% CI)	1.43 (0.91-2.23)	2.14 (1.36-3.36)	1.11 (0.76-1.63)		0.55 (0.32-0.96)
(2356)	p-value	0.12	**<0.005**	0.59		**<0.05**

*Only main effects are listed. †Countries with significant 1st-order interaction, see Appendix E for details. ‡Variable excluded due to ≥20% data missing. Variables *Urban/rural* and *Floor type* are not significant in any of these countries

(Table 4.5.4 continued)

Country		Obesity obese vs ref. non-obese	Anxiety "yes" vs ref. "no"	Ever depression "yes" vs ref. "no"	Current smoking "yes" vs ref. earth	Cooking fuel hydrocarbon vs ref. non HC.	Model fit
Croatia	OR (95% CI)	3.24 (1.81-5.81)	1.92 (1.08-3.38)		4.54 (2.53-8.15)		
	p-value	**<0.0005**	**<0.05**		**<0.0005**		0.54
Czech Rep.[‡]	OR (95% CI)	3.87 (1.99-7.50)	3.31 (1.57-7.01)		4.05 (2.12-7.71)		
	p-value	**<0.0005**	**<0.005**		**<0.0005**		0.87
Estonia	OR (95% CI)		2.17 (1.27-3.71)	1.84 (1.08-3.12)			
	p-value		**<0.05**	**<0.05**			0.28
Hungary	OR (95% CI)	1.50 (1.03-2.19)	1.82 (1.31-2.55)	2.49 (1.64-3.77)	1.63 (1.07-2.49)	-	
	p-value	**<0.05**	**<0.005**	**<0.0005**	**<0.05**		0.68
Latvia[†]	OR (95% CI)	-	2.42 (1.13-5.19)	4.02 (1.78-9.09)	2.25 (1.10-4.61)		
	p-value		**<0.05**	**<0.005**	**<0.05**		0.97
Russia	OR (95% CI)	-	1.91 (1.02-3.57)	8.44 (3.11-22.88)			
	p-value		**<0.05**	**<0.0005**			**<0.05**
Spain	OR (95% CI)		2.40 (1.87-3.07)	1.78 (1.33-2.36)	2.13 (1.62-2.79)		
	p-value		**<0.0005**	**<0.0005**	**<0.0005**		0.40
Ukraine[†]	OR (95% CI)	-	2.93 (2.00-4.28)	3.26 (1.78-5.98)	2.05 (1.37-3.08)	0.52 (0.30-0.90)	
	p-value		**<0.0005**	**<0.0005**	**<0.005**	**<0.05**	0.75

[*]Only main effects are listed. [†]Countries with significant 1st-order interaction, see Appendix E for details. [‡]Variable excluded due to ≥20% data missing. Variables *Urban/rural* and *Floor type* are not significant in any of these countries

Table 4.5.5: Summary of risk and protective factors for current wheeze

	No. of country	Age	Sex	Urban	Obesity	HHSpend[†]	Edu	Anxiety	Depress	Smoke	Floor	Fuel
Asia/Middle East	14	13(0)[*]	0(1)	1(0)	2(0)	1(2)	0(3)	10(0)	9(0)	1(0)	1(4)	2(3)
Africa	16	10(0)	2(1)	0(1)	2(0)	1(0)	0(4)	12(0)	15(0)	4(0)	0(1)	1(0)
America	4	2(1)	0(0)	0(0)	0(0)	0(0)	1(1)	4(0)	2(0)	2(0)	0(0)	0(0)
Europe	8	8(0)	1(1)	0(0)	3(0)	0(1)	0(2)	8(0)	6(0)	6(0)	0(0)	0(1)
Overall	42	33(1)	3(3)	1(1)	7(0)	2(3)	1(10)	34(0)	32(0)	13(0)	1(5)	3(4)

[*]Total number of country indicating the variable as risk factor (total number of country indicating the variable as protective factor). [†]HHSpend = *Household spending* variable

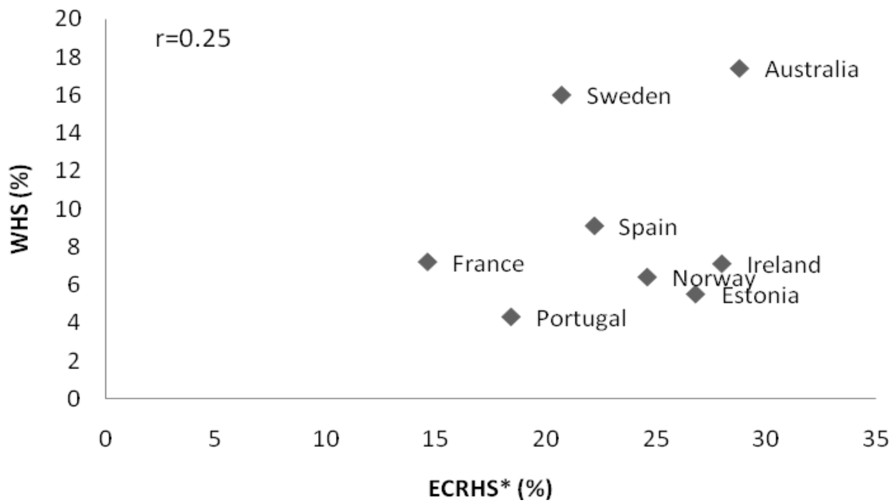

Fig 4.6.1: Prevalence of 12-month wheeze in adults aged 20-44 years in both European Community Respiratory Health Survey (ECRHS) and World Health Survey (WHS)

* Since original data was unavailable, the prevalence rates of ECRHS were only rough estimates using data presented from ECRHS (1996) article

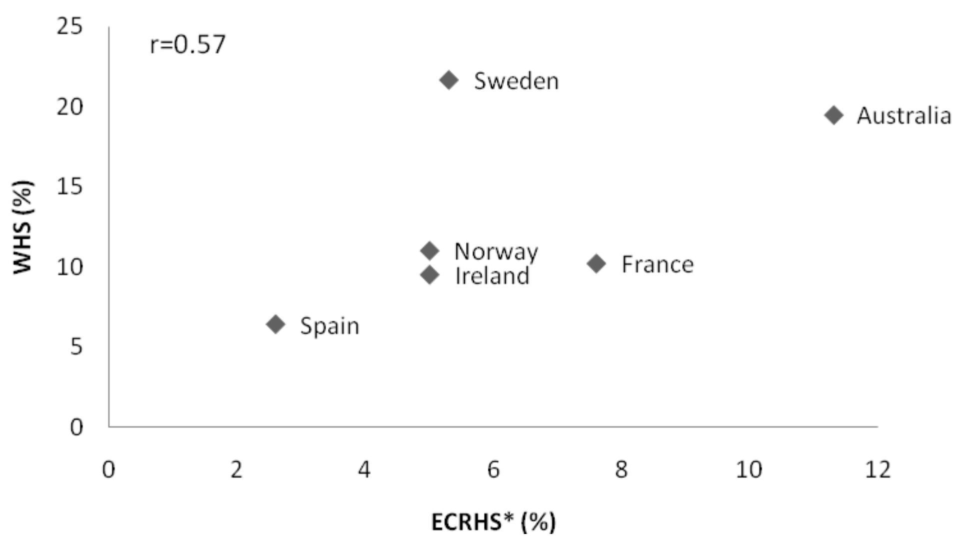

Fig 4.6.2: Prevalence of ever-diagnosed asthma in adults aged 20-44 years in both European Community Respiratory Health Survey (ECRHS) and World Health Survey (WHS)

* Since original data was unavailable, the prevalence rates of ECRHS were only rough estimates using data presented from Janson (1997) article

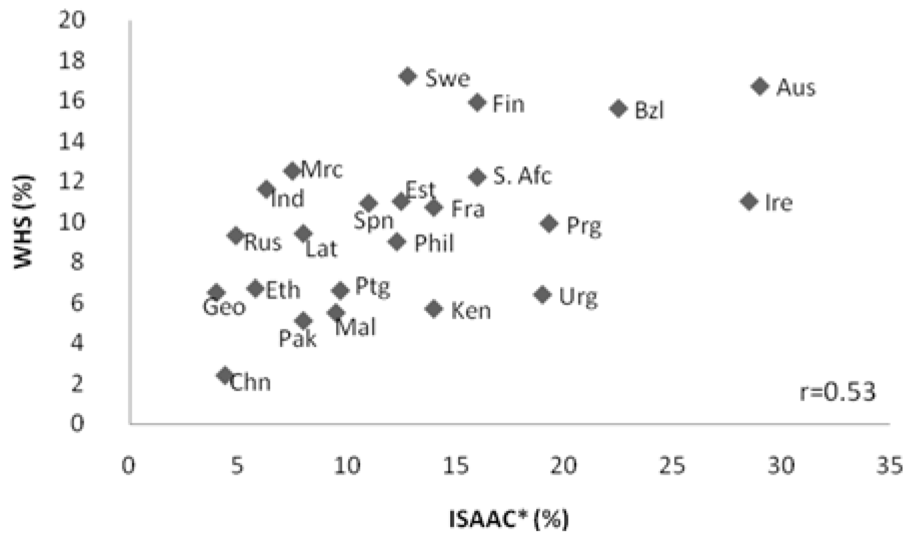

Fig 4.6.3: Prevalence of 12-month wheeze in children aged 13-14 years in International Study of Asthma and Allergies in Childhood (ISAAC) and in adults (aged 18 years and above) in World Health Survey (WHS)

* Since original data was unavailable, the prevalence rates of ISAAC were only rough estimates using data presented from Beasley (2003) article

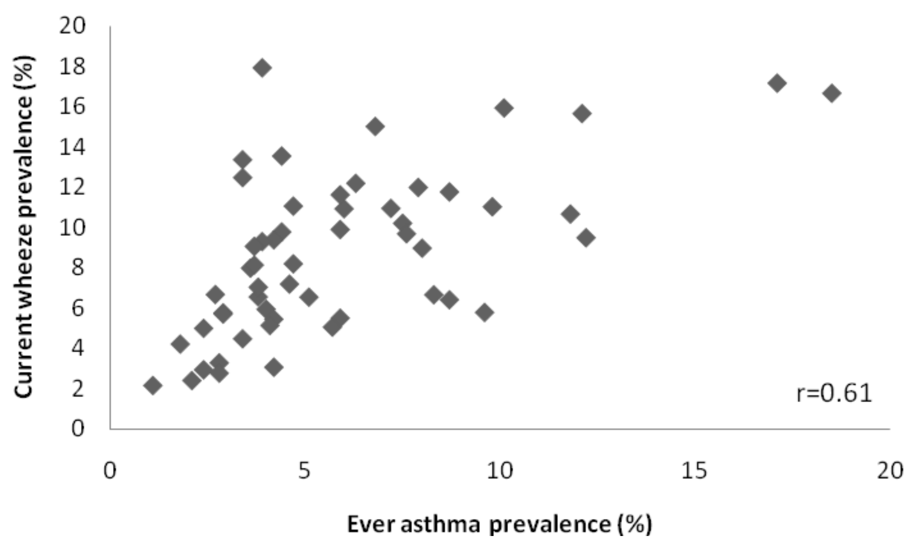

Fig 4.6.4: Prevalence of ever asthma and current wheeze in adults (aged 18 years and above) in World Health Survey (WHS)

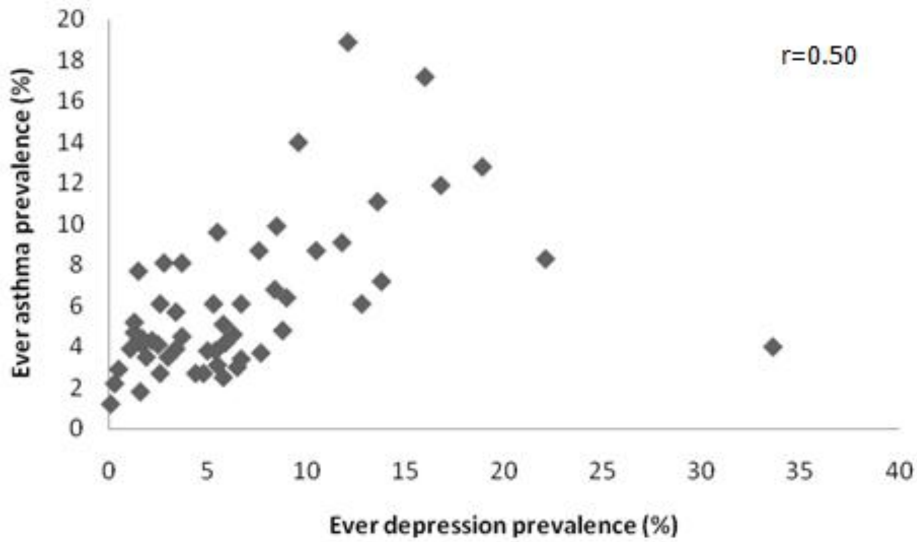

Fig 4.6.5: Prevalece of ever depression and ever asthma in adults (aged 18 years and above) in World Health Survey (WHS)

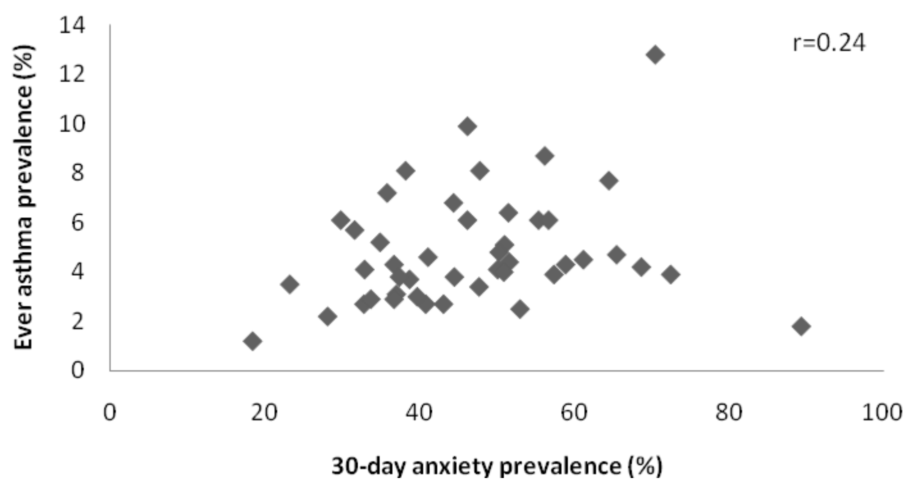

Fig 4.6.6: Prevalece of 30-day anxiety and ever asthma in adults (aged 18 years and above) in World Health Survey (WHS)

Chapter 5

Discussion

5.1 Summary of study findings

Large variations in prevalence of ever asthma and current wheeze were observed both within and among continents (Figures 4.1.1 and 4.2.1). The prevalence of the two primary outcomes appeared to vary greater among continents than within each continent (Figures 4.1.2 and 4.2.2). Summing up with all the analyzed countries, the prevalence between the two primary outcomes had moderate correlation (Fig 4.6.4), with the exceptions of a number of countries (e.g., Nepal and Turkey) having high current wheeze prevalence but low ever asthma prevalence (Figures 4.1.2 and 4.2.2). Australia, Brazil, and countries in Western Europe had higher prevalence in both primary outcomes, while Asian and African countries were generally lower. An apparent distinction between the global patterns of ever asthma and current wheeze was that countries with high current wheeze prevalence tended to be more widespread over the world than countries with high ever asthma prevalence (Figures 4.2.1-4.2.2). The pattern of risk and protective factors were primarily country-specific. However, a number of continental and global patterns was observed (Table 4.4.5 and 4.5.5).

5.2 Clinically important factors

Using a retrospective method to assess the age of onset, de Marco et al. (2000) observed that girls had a lower incidence of asthma than boys; the pattern was crossing over during puberty, and female tended to have higher rate than male at age 15 years and older. Overall, the expected higher rate of asthma in adult females than males was observed in our study population. Female gender was a risk factor for ever asthma in eight or the nine analyzed countries (Table 4.4.5). This suggests that hormonal factors might play an important role in explaining this difference (de Marco et al., 2000).

In a large cross-sectional study (N=22,561) on residents of Beijing aged 15 years and older, Chan-Yeung et al. (2002) found that older age tended to be associated with a greater prevalence of wheeze and other asthma-related symptoms in both men and women. Similar patterns were also observed in this study. The prevalence of ever asthma and current wheeze were generally greater in older age groups. Older age group was a risk factor for ever asthma (current wheeze) in 21 (33) countries, and a protective factor in three (one) countries. Caution must be taken, however, when interpreting the higher rates in the old adult group (35-54) and older adult group (≥55 year old). A study recruited both American and British adults aged 40 years and older found that COPD tended to be misdiagnosed as asthma in this age group (Tinkerman et al., 2006). However, information available to this study was unable to discern the scope of misdiagnosis between asthma and COPD.

5.3 Asthma and psychological factors

An important finding from the study reported in this thesis was the relative consistency and strong magnitude of association between the psychological factors and both primary outcomes. Ever depression and 30-day anxiety were risk factors for ever asthma and current wheeze in many countries throughout the world (Tables 4.4.5 and 4.5.5). A moderate global pattern was observed between ever asthma prevalence and ever depression prevalence (Fig 4.6.5), while no such pattern was observed between ever asthma prevalence and 30-day anxiety prevalence (Fig 4.6.6).

A review on asthma and depression indicated that the prevalence of depression in asthmatics could range from 1-45%, and results from a number of cross-sectional studies investigating whether depression was a risk factor for asthma deemed inconclusive (Opolski and Wilson, 2005). These divergent results might be the result of different methodologies, sampling frames and techniques, and clinical definitions used. On the other hand, a review on asthma and anxiety disorders by concluded that children and adults with asthma tended to have high prevalence of anxiety disorders, with asthmatic adults experienced a rate between 6.5-24% of also having an anxiety disorder (Katon et al., 2004). A prospective cohort study on 5231 adults found that high levels of baseline anxiety and depression were associated with an increased incidence of asthma amongst those who had healthy pulmonary functions in baseline (Jonas et al., 1999).

Despite the large odds ratios obtained, the cross-sectional nature of the WHS questionnaire precluded the knowledge regarding the directionality of pathway between psychiatric disorders and asthma. Other studies have theorized different possible mechanisms for this association including: 1) the stress of chronic asthma led to the development of mental illnesses, 2) mental illnesses physiologically modified the respiratory track which led to the development of asthma, 3) both complex chronic illnesses were influenced by a third external factor (e.g. common susceptibility genes or obesity), and 4) spurious (e.g., people with either condition were more likely to seek medical attention; or “yea-saying” in survey response) (Mannino, 2008). Although evidence indicating the direction of depression and anxiety remained insufficient, results from recent longitudinal studies (Cookson et al., 2009; Scott et al., 2008) have hinted the possibility of depression and anxiety being the predisposing risk factors for later asthma development.

5.4 Comparisons with ISAAC and ECRHS

It is interesting to compare the results from the current study with those from the ECRHS and ISAAC. The interpretation of the comparison, however, must be undertaken cautiously because both ECRHS and ISAAC are respiratory health surveys while the WHS was not limited to respiratory diseases. Major factors that limit a direct comparison among the three surveys include major differences in survey tools, methodologies, geographic coverage, time frame, and age of the cohort. Despites these differences, the three surveys have used very similar questions in assessing the status of ever asthma and current wheeze, as indicated in the followings (Pearce et al., 2000):

	WHS	ISAAC*	ECRHS
Ever asthma	Have you ever been diagnosed with asthma?	Have you ever had asthma?	Have you ever had asthma?
Current wheeze	During the last 12 months, have you experienced attacks of wheezing or whistling breathing?	Have you had wheezing or whistling in the chest in the last 12 months	Have you had wheezing or whistling in your chest at any time in the last 12 months?

*For 6-7 year group, the wording of "*Have you…*" was replaced by "*Has your child…*"

The ECRHS (1996) and WHS have both examined current wheeze in the following countries: Norway, Sweden, Estonia, France, Ireland, Spain, Portugal, and Australia. Considerable differences in current wheeze prevalence were observed between the two surveys for most countries. The WHS prevalence were systematically lower than the ECRHS, and the agreement between the two surveys appeared poor (Fig 4.6.1). The systematic difference and the poor agreement might be due to the following reasons: i) the source of sample in the ECRHS was centre-specific, thus less generalizable to the entire national population compared to WHS, ii) only a few available European countries were compared, thus, it might lack the comprehensiveness to depict any meaningful patterns, and iii) an approximately 10-year time lag between the two surveys in which the prevalence or diagnostic practice might have changed. On the other hand, the ECRHS (Janson et al., 1997) and WHS have both examined ever-diagnosed asthma in the following countries: Norway, Sweden, Ireland, France, Spain, and Australia. The WHS prevalence were systematically higher than ECRHS (Fig 4.6.2), which was likely to be due to the more stringent ever-diagnosed asthma definition in ECRHS (Janson et al., 1997): Ever asthma was defined as i) having asthma confirmed by a doctor, and ii) having experienced asthma-related symptoms in the last 12 months. The agreement between the two surveys appeared to be fair.

Comparisons have been made on the prevalence of asthma and asthma-related symptoms between ECRHS and ISAAC (Pearce et al., 2000). They observed that although there were differences in the absolute levels of prevalence possibly due to the age of inclusion between the two surveys, a good overall agreement in asthma-related outcomes between the two surveys was observed. They found that 64% (74%) of the variation at the country level in the prevalence of current wheeze (self-reported asthma) in the ECRHS phase I data being explained by the variation in the ISAAC Phase I data. The major international patterns identified by both ISAAC and ECRHS studies included the followings (Beasley et al., 2003): Large variations among and within geographic regions; asthma being less prevalent in developing countries; a northwest-to-southeast gradient in asthma prevalence exists in Europe; the international patterns of asthma prevalence in children are similar to those observed in adults.

Our study results were in agreement with these patterns. First, 16.8-fold and 8.5-fold worldwide differences were found in ever asthma and current wheeze, respectively. The continental variations in prevalence for each of the two outcomes were also high. Second, countries from the developing regions (e.g., Burkina Faso in Africa and China in Asia) generally had lower prevalence comparing to other more developed regions (e.g., Australia). Third, our study also illustrated the northwest-to-southeast prevalence gradient in Europe, with Norway, Sweden, and Finland being the highest in asthma and wheeze prevalence comparing to southeast European regions. Lastly, there was a generally fair agreement between the international patterns of asthma prevalence found in ISAAC and WHS surveys (Fig 4.6.3). Regions with high prevalence of asthma for adults (WHS) were likely to be regions with high prevalence for children (ISAAC).

5.5 Limitations

Although the WHS has been vigorously validated and the methodology was carried out relatively consistently among the participating countries, there were inherent weaknesses. There was no definitive diagnostic test on asthma-related outcomes. The statuses of ever asthma and current wheeze were based on participants' self report, thus, recall bias and the accompanying misclassification of disease status were possible. On the other hand, ever asthma which was based on physicians' diagnosis, the degree of underdiagnosis might be substantial and varied widely among countries. Thus, this could underestimate the true prevalence rates, as well as reducing the comparability between countries. For example, physicians failed to diagnose 35-75% of asthma cases at five primary health care centres in United Arab Emirates (Al-Shadi et al., 2001). On the other hand, the willingness and actual frequency of physician visits could vary from culture to culture depending on a number of factors including the accessibility of primary health services, perceived benefits of seeking medical consultation, and general health practices.

Although the WHS had ambitiously recruited as many as 70 countries, certain geographic locations, such as North America and central Africa, were underrepresented. Canada and the U.S. generally had higher prevalence in both adult and childhood asthma (Manfreda et al., 2001; Rose et al., 2006), thus data from these countries could prove valuable in completing the whole notion of global asthma prevalence. Three countries (China, Cote d'Ivoire, and India) did not apply a nationally representative sampling frame and 3 other countries (Czech Republic, Israel, and Spain) had household response rates lower than 60%. The response rates of individual variables were generally high except obesity, and Mexico was unable to provide sufficient information on all but one asthma-related outcome. Also, misdiagnosis was likely to partially explain the high prevalence in older age group. Extra caution was needed to interpret these areas for potential bias and non-representativeness.

Many countries from Western Europe chose not to use the long questionnaire, thus they were excluded from the multivariate analysis. Since many of these countries had high prevalence in both ever asthma and current wheeze, their non-participation from the multivariate analysis might lead to an inability to explore all possible cross-continental trends regarding risk factors. Also, since the WHS was intended to be a comprehensive approach of covering many areas of health, it was not meant to be asthma-specific. Thus, questions on environmental pollutant and allergen exposure were very broad and nonspecific. For instance, since there was no question directly assessing house dust mite exposure, a surrogate question of floor type was used instead. Thus, the preciseness and appropriateness of the risk factors chosen were compromised to a certain degree.

5.6 Conclusions

In conclusion, this study provided, for the first time, the prevalence of asthma and wheeze for a large diversity of countries and a complete inclusion of all adult ages. Despite the differences in study elements, the findings from the current study were in good agreement with previous international surveys. Large variations in ever asthma and current wheeze prevalence were found both within and among continental regions. Developing countries generally had lower prevalence in both outcomes than developed countries. A northwest-to-southeast prevalence gradient was observed in Europe. The high prevalence in some countries such as Australia, Sweden, Finland, Brazil and others post serious concerns at individual and national levels.

Several risk factors were found to be associated with ever asthma and/or current wheeze. Ever depression and 30-day anxiety stood out as consistent risk factors for both outcomes throughout large geographic regions worldwide. This helped consolidating the validity of the association between asthma and psychological factors. It also facilitated academic interests and needs for determining the direction of the association for future studies. Overall, the results from our study will enhance the understanding of epidemiology of asthma in adults on a global scale. High generalizability from this study is reasonably grounded. Information derived from this study should contribute to decision making by health policymakers for more effective resource allocation, prevention, intervention, and management for asthma.

Reference

AAAAI. 2005. Asthma Statistics. Milwaukee: American Academy of Allergy Asthma and Immunology.

Afari N, Schmaling K, Barnhart S, Buchwald D. 2001. Psychiatric comorbidity and functional status in adult patients with asthma. Journal of Clinical Psychology in Medical Settings 8:245-252.

Affleck G, Apter A, Tennen H, Reisine S, Barrows E, Willard A. 2000. Mood states associated with transitory changes in asthma symptoms and peak expiratory flow. Psychosomatic Medicine 62:61-68.

Al-Shadi A, Bener A, Brebner J, Dunn E. 2001. Asthma diagnosis and management in adults: Is the risk of underdiagnosis and undertreatment related to patients' education levels? Journal of Asthma 38(2):121-126.

Archer K, Lemeshow S. 2006. Goodness-of-fit test for a logistic regression model fitted using survey sample data. The Stata Journal 6:97-105.

Arif A, Delclos G, Lee E, et al. 2003. Prevalence and risk factors of asthma and wheezing among US adults: an analysis of the NHANES III data. Eur Respir J 21:827-833.

ASC. 2005. Asthma Society of Canada: Asthma facts and statistics.

Asher M, Montefort S, Bjorksten B, Lai C, Strachan D. 2006. Worldwide time trends in the prevalence of symptoms of asthma, allergic rhinoconjunctivitis, and eczema in childhood: ISAAC Phases One and Three repeat multicountry cross-sectional surveys. Lancet 370(9537):733-743.

Beasley R, Ellwood P, Asher I. 2003. International patterns of the prevalence of pediatric asthma: the ISAAC program. Pediatr Clin N Am 50:539– 553.

Beuther D, Sutherland E. 2007. Overweight, obesity, and incident asthma: a meta-analysis of prospective epidemiologic studies. Am J Respir Crit Care Med 175:661-666.

Bootman J, Crown W, Luskin A. 2004. Clinical and economic effects of suboptimally controlled asthma. Managed Care Interface 17:31-36.

Bousquet J, Bousquet P, Godard P, et al. 2005. The public health implications of asthma. Bulletin of the World Health Organization 83(7).

Braun-Fahrlander C, Gassner M, Grize L, et al. 1999. Prevalence of hay fever and allergic sensitization in farmer's children and their peers living in the same rural community. Clin Exp Allergy 29:28-34.

Braun-Fahrlander C, Gassner M, Grize L, et al. 2004. No further increase in asthma, hay fever and atopic sensitisation in adolescents in Switzerland. Eur Respir J 23:407–413.

Burney P, Luczynska C, Chinn S, et al. 1994. The European Community Respiratory Health Survey. European Respiratory Journal 7:954–960.

Bursac Z, Gauss C, Williams D, Hosmer D. 2008. Purposeful selection of variables in logistic regression. Source Code for Biology and Medicine 3(17):1-8.

Bussing R, Burket R, Kelleher E. 1996. Prevalence of anxiety disorders in a clinic-based sample of pediatric asthma patients. Psychosomatics 37:108-115.

Chan-Yeung M, Zhan L, Tu D, et al. 2002. The prevalence of asthma and asthma-like symptoms among adults in rural Beijing, China. Eur Respir J 19:853-858.

Chaudhuri A, Stenger H, editors. 2005. Survey sampling: Theory and methods. 2 ed: Chapman & Hall/CRC.

Chen Y. 2004. Comparative analysis of the state of asthma prevalence in children from two nation-wide surveys in 1990 and 2000 year. National Cooperation Group On Childhood Asthma, China. Zhonghua Yi Wue Ke Xue Za Zhi 27:112-116.

Chinn S, Burney P, Luczynska C, et al. 2004. Increase in diagnosed asthma but not in symptoms in the European Community Respiratory Health Survey. Thorax 59:646–651.

Chung F, Adcock I. 2000. Application of cell and molecular biology techniques to unravel causes and pathophysiological mechanisms. Methods in Molecular Medicine Asthma: Mechanisms and protocols: Humana Press.

Chung K, editor. 2002. Clinicians' guide to asthma. New York: Arnold.

Cisternas M, Blanc P, Yen I, Katz P. 2003. A comprehensive study of the direct and indirect costs of adult asthma. J Allergy Clin Immunol 111(12):12-18.

Cookson H, Granell R, Joinson C. 2009. Mother's anxiety during pregnancy is associated with asthma in their children. J Allergy Clin Immunol 123:847-853.

Corvalán C, Amigo H, Bustos P, Rona R. 2005. Socioeconomic Risk Factors for Asthma in Chilean Young Adults. American Journal of Public Health 95(8):1375-1381.

D'Amato G, Liccardi G, D'Amato M, et al. 2005. Environmental risk factors and allergic bronchial asthma. Clin Exp Allergy 35:1113–1124.

de Marco R, Locatelli F, Sunyer J, Burney P. 2000. Differences in incidence of reported asthma related to age in men and women: A retrospective analysis of the data of the European Respiratory Health Survey. Am J Respir Crit Care Med 162:68-74.

Devenny A, Wassall H, Ninan T, et al. 2004. Respiratory symptoms and atopy in children in Aberdeen: questionnaire studies of a defined school population repeated over 35 years. BMJ 329:489–490.

Doll R, Payne P, Waterhouse J, editors. 1971. Cancer Incidence in Five Continents: Berlin: Springer-Verlag.

Douwes J, Pearce N. 2008. Authors' response: 'Hygiene hypothesis: Wanted - dead or alive'. Int J Epidemiol:1-3.

Downs S, Marks G, Mitakakis T, et al. 2001. Having lived on a farm and protection against allergic diseases in Australia. Clin Exp Allergy 31:570-575.

ECRHS. 1996. Variations in prevalence of respiratory symptoms, self-reported asthma attacks, and use of asthma medication in the European Community Respiratory Health Survey (ECRHS). Eur Respir J 7:954-960.

Ernst P, Cormier Y. 2000. Relative scarcity of asthma and atopy among rural adolescents raised on a farm. Am J Respir Crit Care Med 161:1563-1566.

Etzel R. 2003. How environmental exposures influence the development and exacerbation of asthma. Pediatrics 112(233–239).

Feldman J, Siddique M, Morales E, Kaminski B, Lu S, Lehrer P. 2000. Psychiatric disorders and asthma outcomes among high-risk inner-city patients. Psychosomatic Medicine 67(6):989-996.

FitzGerald M, Barnes P, Bateman E, Becker A. 2008. GINA. Methodology and summary of new recommendations global strategy for asthma management and prevention: 2008 update.

Franksa P, Goldb M, Fiscellac K. 2003. Sociodemographics, self-rated health, and mortality in the US. Soc Sci Med 56:2505–2514.

Garcia-Aymerich J, Varraso R, Antó J, Camargo C. 2009. Prospective study of physical activity and risk of asthma exacerbations in older women. Am J Respir Crit Care Med:doi:10.1164/rccm.200812-201929OC.

Hancox R, Milne B, Taylor D, et al. 2004. Relationship between socioeconomic status and asthma: a longitudinal cohort study. Thorax 59:376–380.

Horwood L, Fergusson D, Shannon F. 1985. Social and familial factors in the development of early childhood asthma. Pediatrics 75:859-868.

Jaakkola J, Piipari R, Jaakkola M. 2003. Occupation and asthma: a population-based incident case-control study. Am J Epidemiol 158:981-987.

Janson C, Chinn S, Jarvis D, Burney P. 1997. Physician-diagnosed asthma and drug utilization in the European Community Respiratory Health Survey. Eur Respir J 10:1795-1802.

Jarvis D. 2002. The European Community Respiratory Health Survey II. Eur Respir J 20:1071–1079.

Jonas B, Wagener D, Lando J, Feldman J. 1999. Symptoms of anxiety and depression as risk factors for development of asthma. J Applied Biobeh Respir Med 4:91-119.

Katon W, Richardson L, Lozano P, et al. 2004. The relationship of asthma and anxiety disorders. Psychosomatic Medicine 66:349–355.

Kim J. 1993. Ambient air pollution: respiratory hazards to children. Pediatrics 91:1210–1213.

Leeder S, Corkhill R, Irwig L, al e. 1976. Influence of family factors on asthma and wheezing during the first five years of life. Br J Prev Soc Med 30:213–218.

Lehrer P, Feldman J, Giardino N, Song H, Schmaling K. 2002. Psychological Aspects of Asthma. Journal of Consulting and Clinical Psychology 70(3):691–711.

Leikauf G, Kline S, Albert R, Baxter C, Bernstein D, Buncher C. 1995. Evaluation of a possible association of urban air toxics and asthma. Environ Health Perspect 103(6):253–271.

Littlejohns R, Macdonald L. 1993. The relationship between severe asthma and social class. Respir Med 87:139-143.

Manfreda J, Sears M, Becklake M. 2001. Prevalence of asthma symptoms among adults aged 20-44 years in Canada. CMAJ 164:995-1001.

Mannino D. 2008. Doc, my asthma (depression) has gotten me down (wheezing). Chest 134:1116-1117.

Mannino D, Homa D, Pertowski C, Ashizawa A, Nixon L. 1998. Surveillance for asthma - United States, 1960-1995. In: CDC Surveillance Summaries, April 24, 1998. MMWR 47:1-27.

Masoli M, Fabian D, Holt S, Beasley R. 2004. The global burden of asthma: executive summary of the GINA dissemination Committee Report. Allergy 59:469-478.

McCunney R. 2005. Asthma, genes, and air pollution. JOEM 47(12):1285-1291.

Midodzi W, Rowe B, Majaesic C, Senthilselvan A. 2007. Reduced risk of physician-diagnosed asthma among children dwelling in a farming environment. Respirology 12(5):692-699.

Mielck A, Reitmeir P, Wjst M. 1996. Severity of childhood asthma by socioeconomic status. Int J Epidemiol 25:388-393.

Moffatt M. 2008. Genes in asthma: new genes and new ways. Curr Opin Allergy Clin Immunol 8:411-417.

Moorman J, Rudd R, Johnson C, King M, Minor P, Bailey C, al e. 2007. National surveillance for asthma-United States, 1980-2004. MMWR Surveill Summ 56:1-54.

Mrazek D. 1992. Psychiatric complications of pediatric asthma. Annals of Allergy 69:285-290.

Mugusi F, Edwards R, Hayes L, et al. 2004. Prevalence of wheeze and self-reported asthma and asthma care in an urban and rural area of Tanzania and Cameroon. Tro Doct 34:209-214.

Murray C, Woodcock A, Custovic A. 2001. The role of indoor allergen exposure in the development of sensitization and asthma. Curr Opin Allergy Clin Immunol 1:407-412.

NCHS. 2001. New asthma estimates: tracking prevalence, health care and mortality.

NHLBI. 2008. What causes asthma? In: Institute NHLaB, editor.

Ober C, Hoffjan S. 2006. Asthma genetics 2006: the long and winding road to gene discovery. Genes Immun 7:95–100.

Opolski M, Wilson I. 2005. Asthma and depression: A pragmatic review of the literature and recommendations for future research. Clinical Practice and Epidemiology in Mental Health 1(18):1-7.

Ostro B, Lipsett M, Mann J, Braxton-Owens H. 2001. Air pollution and exacerbation of asthma in African-American children in Los Angeles. Epidemiology 12:200–208.

Pearce N, Beasley R, Burgess C, Crane J, editors. 1998. Asthma epidemiology: principles and methods , 1st ed.: Oxford University Press.

Pearce N, Pekkanen J, Beasley R. 1999. How much asthma is really attributable to atopy? Thorax 54:268-272.

Pearce N, Sunyer J, Cheng C, et al. 2000. Comparison of asthma prevalence in the ISAAC and the ECRHS. Eur Respir J 16:420-426.

Peat J, Li J. 1999. Reversing the trend: reducing the prevalence of asthma. J Allergy Clin Immunol 103(1):1-10.

Phankingthongkum S, Daengsuwan T, Visitsunthorn N, et al. 2002. How do Thai children and adolescents describe asthma symptoms? Pediatr Allergy Immunol 13:119–124.

Platts-Mills T, Erwin E, Heymann P, Woodfolk J. 2005. Is the hygiene hypothesis still a viable explanation for the increased prevalence of asthma? Allergy 60:25–31.

Platts-Mills T, Sporik R, Chapman M, et al. 1997. The role of domestic allergens. The rising trends in asthma Ciba Foundation Symposium 206:173-189.

Portengen L, Preller L, Tielen M, et al. 2005. Endotoxin exposure and atopic sensitization in adult pig farmers. J Allergy Clin Immunol 115:797-802.

Portengen L, Sigsgaard T, Omland O, et al. 2002. Low prevalence of atopy in young Danish farmers and farming studies born and raised on a farm. Clin Exp Allergy 32:247-253.

Redd S. 2002. Asthma in the United States: burden and current theories. Environ Health Perspect 110:557–560.

Riedler J, Eder W, Oberfeld G, et al. 2000. Austrian children living in a farm have less hay fever, asthma and allergic sensitization. Clin Exp Allergy 30:194-200.

Ritz T, Steptoe A, DeWilde S, Costa M. 2000. Emotions and stress increase respiratory resistance in asthma. Psychosomatic Medicine 62:401-412.

Ronmark E, Andersson C, Norrman E, et al. 2005. Obesity increases risk of incident asthma among adults. Eur Respir J 25:282-288.

Rose D, Mannino D, Leaderer B. 2006. Asthma prevalence among US adults, 1998-2000: Role of Puerto Rican ethnicity and behavioral and geographic factors. American Journal of Public Health 96(5):880-888.

Salvi S. 2001. Pollution and allergic airways disease. Curr Opin Allergy Clin Immunol 1(1):35–41.

Sanford A, Weir T, Pare P. 1996. The genetics of asthma. Am Rev Respir Crit Care Med 153:1749-1765.

Schneider A, Lowe B, Meyer F, Szecsenyi J. 2008. Depression and panic disorder as predictors of health outcomes for patients with asthma in primary care. Respiratory medicine 102:359-366.

Scott K, Korff M, Alonso J, Posada-Villa J. 2008. Childhood adversity, early-onset depressive/anxiety disorders, and adult-onset asthma. Psychosomatic Medicine 70:1035-1043.

Senthilselvan A, Lawson J, Rennie D, et al. 2003. Stabilization of an increasing trend in physcian-diagnosed asthma prevalence in Saskatchewan, 1991 to 1998. Chest 124:438-448.

Silverglade L, Tosi D, Wise P, D'Costa A. 1994. Irrational beliefs and emotionality in adolescents with and without bronchial asthma. Journal of General Psychology 121:199-207.

Steinberg M, Becklake M. 1986. Socio-environmental factors and lung function: a review of the literature. S Af Med J 70:2704.

Sunyer J, Anto J, Kogevinas M, et al. 1997. Risk factors for asthma in young adults. Spanish Group of the European Community Respiratory Health Survey. Eur Respir J 10:2490-2494.

Sykes A, Johnston S. 2008. Etiology of asthma exacerbations. J Allergy Clin Immunol 122(4):685-688.

Tantisira K, Weiss S. 2001. Complex interactions in complex traits: obesity and asthma. Thorax 56:64–74.

ten Brinke A, Ouwerkerk M, Zwinderman A, Spinhoven P, Bel E. 2001. Psychopathology in patients with severe asthma is associated with increased health care utilization. American Journal of Respiratory & Critical Care Medicine 163:1093-1096.

Tinkerman D, Price D, Nordyke R, Halbert A. 2006. Misdiagnosis of COPD and asthma in primary care patients 40 years of age and over. Journal of Asthma 43:75-80.

Toelle B, Ng K, Belousova E, Salome C, Peat J, Marks G. 2004. Prevalence of asthma and allergy in schoolchildren in Belmont, Australia: three cross-sectional surveys over 20 years. BMJ 328:386–387.

Üstün T, Chatterji S, Villanueva M, Bendib L, Celik C. 2001. WHO multi-country survey study on health and responsiveness: GPE discussion paper 37.

van Schayck C, Smit H. 2005. The prevalence of asthma in children: a reversing trend. Eur Respir J 26:647–650.

Vila G, Nollet-Clemencon C, de Blic J, Falissard B, Mouren-Simeoni M, Scheinmann P. 1999. Assessment of anxiety disorders in asthmatic children. Psychosomatics 40:404-413.

von Mutius E, Fritzsch C, Weiland S, et al. 1992. Prevalence of asthma and allergic disorders among children in united Germany: a descriptive comparison. BMJ 305:1395-1399.

Wang L, Pinkerton K. 2008. Detrimental effects of tobacco smoke exposure during development on postnatal lung function and asthma. Birth Defects Research 84:54–60.

Watson J, Cowen P, Lewis P. 1996. The relationships between asthma admission rates, routes of admission, and socioeconomic deprivation. Eur Respir J 9:2087-2093.

WHO. 2007. Global surveillance, prevention and control of chronic respiratory diseases: a comprehensive approach.

WHS. 2002. The World Health Survey (WHS): Sampling guidelines for participating countries.

Wong G, Leung T, Ko F. 2004. Declining asthma prevalence in Hong Kong Chinese schoolchildren. Clin Exp Allergy 34:1550–1555.

Yawn B. 2008. Factors accounting for asthma variability: Achieving optimal symptom control for individual patients. Primary Care Respiratory Journal 17(3):138-147.

Appendix A: Original WHS questions and response for each risk factor

Variable	Question #	Questions presented from the WHS
Sex	Q1001	Recoded sex as observed by on-site interviewer
Age group	Q1002	Q: "How old are you?" R: 1.Female 2.Male
Obesity	Q1004, Q1006	Q1: "Your height in cm's?" Q2: "Your weight in kilos?"
Rural/urban	Q0104	Recorded region setting by on-site interviewer
Household spending	Q0800	Q: "In the last 4 weeks, how much did your household spend in total?"
Education	Q1009	Q: "What is the highest level of education that you have completed?" R: 1.No formal schooling 2.Less than primary school 3.Primary school completed 4.Secondary school completed 5.High school completed 6.University completed 7.Post graduate degree completed
Current anxiety	Q2091	Q: "Overall in the last 30 days, how much of a problem did you have with worry or anxiety?" R: 1.None 2.Mild 3.Moderate 4.Severe 5.Extreme
Ever depression	Q6025	Q: "Have you ever been diagnosed with depression?" R: 1.Yes 2.No
Current smoking	Q4000	Q: "Do you currently smoke any tobacco products such as cigarettes, cigars, or pipes?" R: 1.Daily 2.Yes, but not daily 3.No, not at all
Floor type	Q4040	Q: "What type of floor does your dwelling/house have?" R: 1.Hard floor (cement, tile, brick, wood) 2.Earth
Cooking fuel	Q4047	Q: "What type of fuel does your household mainly use for cooking?" R: 1.Gas 2.Electricity 3.Kerosene 4.Coal 5.Charcoal 6.Wood 7.Agriculture/crop 8.Animal dung 9.Shrub/grass 10.Other

Appendix B: Summary of exposure and outcome variables

	Variable	Recoded responses*
Demographic		
	Sex	i) Male ii) Female
	Age group	i) 18-34 years i) 35-54 years ii) $\geq$ 55 years
	Obesity	i) BMI < 30 ii) BMI $\geq$ 30
	Rural/urban	i) Rural setting, residence ii) Urban setting, residence
SES indicator		
	Household spending	i) Lower 50%ile, survey sample ii) Upper 50%ile, survey sample
	Education	i) Before the completion of secondary school ii) Secondary school completed or beyond
Psychological		
	Current anxiety	i) Did not experience anxiety at all in last month ii) Experienced at least some anxiety in last month
	Ever- diagnosed depression	i) No ii) Yes
Environmental		
	Current smoking	i) No ii) Yes
	Floor type	i) Earth floor, dwelling ii) Hard floor, dwelling
	Cooking fuel	i) Other ii) Hydrocarbon (gas, kerosene, coal, and charcoal)
Primary Outcome		
	Ever asthma	i) No ii) Yes
	Current wheeze	i) No ii) Yes

*Reference groups are listed as '*i)*

Appendix C: Reasons for country exclusion

Reasons for exclusion	Countries
A) Missing individual weight data	Austria, Belgium, Denmark, Germany, Greece, Italy, Netherland, Slovenia, UK, Guatemala
B) Missing primary sampling unit data	Bosnia, Zambia
C) Missing ≥ 25% for both ever asthma and current wheeze	Congo, Slovakia, Swaziland

AppendixD: Multivariate models of countries with significant interactions for ever asthma

Country		Old adult vs. young adult	Older adult vs. young adult	Female vs. male	Higher HHSpend† vs. lower	Higher edu. vs. lower edu.	Urban vs. rural	Obese vs. not obese	Anxiety vs. no anxiety	Ever depress vs. no ever depress	Current smoker vs nonsmoker	Interaction‡		Model fit
China	OR (p-value)	1.31 (0.68)	4.51 (<0.0005)	0.58 (0.21)	0.45 (<0.05)	0.57 (0.06)	0.57 (0.18)		0.57 (<0.0005)			Age.1*Urban	13.42 (0.06)	0.38
	OR (p-value)											Age.2*Urban	8.96 (0.06)	
Philippines	OR (p-value)	1.63 (<0.005)	2.67 (<0.0005)	1.92 (<0.0005)						4.60 (<0.0005)		Age.1*Female	0.60 (<0.05)	0.99
	OR (p-value)											Age.2*Female	0.35 (<0.0005)	
Nepal	OR (p-value)	2.76 (<0.0005)	7.63 (<0.0005)	0.93 (0.59)			2.49 (<0.0005)		1.52 (<0.05)	2.23 (<0.0005)		Urban*EverDep	0.44 (<0.05)	0.25
Vietnam	OR (p-value)	1.01 (0.99)	2.26 (0.24)	0.65 (0.22)					0.20 (0.15)			Age.1*Anxiety	45.44 (<0.005)	0.23
	OR (p-value)											Age.2*Anxiety	16.1 (<0.05)	
Burkina Faso	OR (p-value)	0.91 (0.75)	1.42 (0.35)	1.32 (0.23)					3.12 (<0.0005)	52.18 (<0.0005)		Anxiety*EverDep	0.13 (<0.005)	0.83
Comoros	OR (p-value)	1.01 (0.97)	0.83 (0.34)	0.93 (0.75)	1.32 (0.23)		0.13 (<0.005)	1.47 (0.44)		17.36 (<0.0005)	1.97 (<0.05)	HHSpend*Urban	5.30 (<0.05)	0.76
Zimbabwe	OR (p-value)	1.95 (<0.05)	3.01 (<0.0005)	1.45 (0.14)						4.81 (<0.05)		Age.1*EverDep	0.35 (0.18)	0.99
	OR (p-value)											Age.2*EverDep	0.19 (<0.05)	
Dominican	OR (p-value)	0.76 (0.18)	1.00 (0.99)	1.38 (0.10)					1.39 (<0.05)	0.51 (0.26)		Female*EverDep	4.85 (<0.05)	0.99
Mexico	OR (p-value)	0.85 (0.10)	1.22 (0.05)	1.51 (<0.0005)	1.30 (<0.005)				2.51 (<0.0005)	3.40 (<0.0005)		Female*EverDep	0.46 (<0.05)	0.68

†HHSpend = household spending; ‡Age.1 = old age group, Age.2 = older age group

Appendix E: Multivariate models of countries with significant interactions for current wheeze

Country		Old adult vs. young adult	Older adult vs. young adult	Female vs. male	Higher HHSpend† vs. lower	Higher edu. vs. lower edu.	Urban vs. rural	Obese vs. not	Anxiety vs. not	EverDep vs. not	Current smoker vs nonsmoker	Hard floor vs earth floor	Hydrocarbon fuel vs. other	Interaction‡		Model fit
China	OR (p-value)	1.92 (0.18)	6.23 (<0.0005)	1.01 (0.98)	0.18 (<0.0005)		1.19 (0.61)		3.38 (<0.0005)			0.36 (<0.05)		HHSpend*Urban	4.75 (<0.005)	<0.0005
Burkina Faso	OR (p-value)	1.46 (<0.05)	1.73 (<0.05)	1.17 (0.40)					2.72 (<0.0005)	24.03 (<0.0005)				Anxiety*EverDep	0.18 (<0.05)	0.99
India	OR (p-value)	2.39 (<0.0005)	4.39 (<0.005)	0.86 (0.08)					3.34 (<0.0005)	1.74 (<0.0001)	1.51 (<0.005)	0.73 (<0.005)		Age.1*Anxiety	0.56 (<0.05)	0.48
	OR (p-value)													Age.2*Anxiety	0.47 (<0.05)	
Laos	OR (p-value)	1.66 (<0.05)	3.60 (<0.0005)	0.68 (<0.05)					3.70 (<0.0005)	3.41 (<0.0005)		1.78 (<0.05)	0.35 (<0.0005)	Age.1*Anxiety	0.57 (0.15)	0.85
	OR (p-value)													Age.2*Anxiety	0.32 (<0.05)	
Pakistan	OR (p-value)	1.33 (0.17)	3.29 (<0.0005)	0.83 (0.28)	1.85 (<0.005)	1.07 (0.80)			2.79 (<0.0005)	6.49 (<0.0005)				Edu*Anxiety	0.17 (<0.0005)	0.08
Mauritania	OR (p-value)	1.13 (0.54)	1.74 (<0.05)	1.23 (0.29)						5.49 (<0.0005)		0.45 (<0.0005)		Age.1*Hardfloor	1.81 (0.08)	0.93
	OR (p-value)													Age.2*Hardfloor	1.99 (0.07)	
S. Africa	OR (p-value)	1.86 (<0.05)	5.28 (<0.0005)	1.34 (0.09)	1.53 (<0.05)		0.35 (<0.05)		1.54 (0.08)	8.49 (<0.0005)	1.96 (<0.0005)			Age.1*Urban	0.79 (0.52)	0.87
	OR (p-value)													Age.2*Urban	0.26 (<0.005)	
	OR (p-value)													Age.1*EverDep	0.26 (<0.005)	
	OR (p-value)													Age.2*EverDep	0.45 (0.20)	
	OR (p-value)													Urban*Anxiety	2.82 (<0.005)	
Tunisia	OR (p-value)	0.91 (0.58)	1.64 (<0.05)	0.84 (0.39)		0.54 (<0.005)		1.94 (<0.05)	3.48 (<0.0005)	7.48 (<0.0005)	2.04 (<0.0005)			Anxiety*EverDep	0.21 (<0.005)	0.99
Paraguay	OR (p-value)	0.98 (0.90)	1.40 (<0.05)	1.25 (0.08)					1.43 (<0.05)		0.75 (0.22)			Anxiety*CurrSmok	2.30 (<0.005)	0.99
Uruguay	OR (p-value)	0.74 (0.09)	1.15 (0.52)	0.76 (<0.05)		2.40 (<0.0005)			2.42 (<0.0005)	2.54 (<0.0005)				Edu*EverDep	0.42 (<0.005)	<0.005
Latvia	OR (p-value)	1.18 (0.70)	3.43 (<0.005)	0.91 (0.79)		0.39 (<0.005)			2.43 (<0.05)	1.15 (0.82)	2.19 (<0.05)			Edu*EverDep	5.84 (<0.05)	0.97
Ukraine	OR (p-value)	1.47 (0.08)	2.20 (<0.005)	1.07 (0.72)		0.56 (<0.05)			3.25 (<0.0005)	23.96 (<0.0005)	2.05 (<0.005)		0.52 (0.05)	Anxiety*EverDep	0.11 (<0.05)	0.46

†HHSpend = household spending; ‡Age.1 = old age group, Age.2 = older age group

Appendix F: Ethics approval documents

Re-Approval Form

Study ID:	MS1_Pro00003716
Study Title:	International prevalence and risk factors for asthma and wheeze in adults: Analyses of the WHO world health survey
Long Title:	International prevalence and risk factors for asthma and wheeze in adults: Analyses of the WHO world health survey
Study Investigator:	Ambikaipakan Senthilselvan

The Health Research Ethics Board (HREB) has reviewed the renewal request and file for this project and found it to be acceptable within the limitations of human research.

The re-approval for the study as presented is valid for one year. It may be extended following completion of the annual renewal request. Beginning at 60 days prior to expiration, you will receive notices that the study is about to expire. Once the study has expired you will have to resubmit. Any proposed changes to the study must be submitted to the HREB for approval prior to implementation.

For studies where investigators must obtain informed consent, signed copies of the consent forms must be retained, as should all study related documents, so as to be available to the HREB upon request. They should be kept for the duration of the project and for at least seven years following study completion.

Sincerely,

Glenn Griener, Ph.D.
Chair, Health Research Ethics Board - Panel B

Note: This correspondence includes an electronic signature (validation and approval via an online system).

Health Research Ethics Board

213 Heritage Medical Research Centre
University of Alberta, Edmonton, Alberta T6G 2S2
p.780.492.9724 (Biomedical Panel)
p.780.492.0302 (Health Panel)
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HEALTH RESEARCH ETHICS APPROVAL FORM

Date: December 2007

Name of Applicant: **Dr. Sentil Senthilsevan**

Organization: **U of A**

Department: **Public Health Sciences**

Project Title: **International prevalence and risk factors for asthma and wheeze in adults: Analyses of the WHO world health survey**

The Health Research Ethics Board (HREB) has reviewed the protocol for this project and found it to be acceptable within the limitations of human experimentation.

The approval for the study as presented is valid for one year. It may be extended following completion of the yearly report form. Any proposed changes to the study must be submitted to the Health Research Ethics Board for approval. Written notification must be sent to the HREB when the project is complete or terminated.

Special Comments:

Dr. Glenn Griener, PhD
Chair of the Health Research Ethics Board
(B: Health Research)

JAN - 9 2008
Date of Approval Release

File Number: B-110108

UNIVERSITY OF ALBERTA   Capital Health Edmonton and area   CARITAS HEALTH GROUP