Global, regional, and national burden of allergic disorders and its risk factors in 204 countries and territories, 1990–2019: a systematic analysis for the Global Burden of Disease Study 2019

Running head: Global disease burden of asthma and atopic dermatitis, 1990–2019

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Funding information

Research reported in this publication was supported by the Bill and Melinda Gates Foundation. The funder of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report. All authors had full access to the study data and had final responsibility for the decision to submit for publication.

Summary

Background: Asthma and atopic dermatitis (AD) are chronic allergic conditions that constitute the "atopic march" and cause significant morbidity both to children and adults. This study aimed to describe the global, regional, national and temporal trends of the burden of asthma and AD from 1990 to 2019 and analyze their associations with geographic, demographic, social, and clinical factors.

Methods: Using data from the Global Burden of Diseases, Injuries, and Risk Factors Study (GBD) 2019, we assessed the age-standardized prevalence, incidence, mortality, and disability-adjusted life years (DALYs) of asthma and AD from 1990 to 2019, stratified by geographic region, age, sex, and socio-demographic index (SDI). DALYs were calculated as the sum of years lived with disability and years of life lost to premature mortality. Additionally, the disease burden of asthma attributable to high body mass index, occupational asthmagens, and smoking was described.

Results: In 2019, there were a total of 262 million [224–309] cases of asthma and 171 million total cases of AD globally; age-standardized prevalence rates were 3,416 and 2,277 [2.192–2.369] per 100,000 population for asthma and AD, respectively, a 24.1% [27.2–20.8] decrease for asthma and 4.3% [4.8–3.8] decrease for AD. Both asthma and AD had similar trends according to age, with age-specific prevalence rates peaking at age 5-9 and rising again in adulthood. The prevalence and incidence of asthma and AD were both higher for individuals with higher SDI; however mortality and DALYs rates of individuals with asthma had a reverse trend, with higher mortality and DALYs rates in those in the lower SDI quintiles. Of the three risk factors, high body mass index contributed to the highest DALYs and deaths due to asthma, accounting for a total of 3.65 million [2.14–5.60] asthma DALYs and 75,377 [40,615–122,841] asthma deaths.

Conclusion: Asthma and AD continue to cause significant morbidity worldwide, having increased in total prevalence and incidence worldwide, but having decreased in age-standardized prevalence rates from 1990 to 2019. Although both are more frequent in the younger ages and prevalent in high-SDI countries, each condition has distinct temporal and regional characteristics. Understanding the temporospatial trends in the disease burden of asthma and AD could guide future policies and interventions to better manage these diseases worldwide as well as to achieve equity in prevention, diagnosis and treatment.

Funding: Bill & Melinda Gates Foundation, Australian National Health and Medical Research Council, Queensland Department of Health, Australia.

Key words

Asthma; atopic dermatitis; epidemiology; mortality; disability-adjusted-life-years; global burden.

Abbreviations

AD, Atopic dermatitis; DALYs, disability-adjusted-life-years; GBD, Global Burden of Disease; ICD, International Classification of Disease; SDI, socio-demographic index; 95% UI, 95% uncertainty interval; YLD, Years of healthy life lost due to disability; YLLs, Years of life lost.

Word count: 4178

INTRODUCTION

Although frequently dismissed as diseases of childhood, allergic disorders such as asthma and atopic dermatitis (AD) are chronic diseases that can cause significant morbidity having long-term effects even into adulthood[1]. The prevalence of these physician-diagnosed allergic diseases has increased drastically over the years as reported in multiple studies[2,3], now affecting approximately 10% to 30% of the population worldwide[2,3]. Not only do asthma and AD incur great healthcare-related economic costs, they also cause significant indirect costs due to decreases in quality of life and missed work, school, and productivity[4].

Asthma and AD were once characterized as diseases being frequent in high-income countries, with affluent countries reporting higher prevalence rates and the "hygiene hypothesis" suggesting that maternal and childhood exposure to pathogens in low-resource settings could sensitize individuals to allergens[4]. However, the hypothesis that unhygienic conditions protect individuals against allergic illness has been criticized and expanded to encompass a complex interplay between genetic predisposition and the range of environmental exposures[5]. Further, on an individual level, lower socioeconomic status has been associated with higher disease burden – increased severity and poorer control of asthma and AD[6]; racial and ethnic disparities also exist[6,7]. Health equity regarding these diseases have been further accentuated recently, as novel and targeted treatment options, such as the use of biologics, has been gaining evidence and popularity, and numerous reports have called attention to disparities in access and efficacy of these emerging options[8]. As both asthma and AD are now recognized as major public health problems that greatly impact developing countries as well as developed countries[6,7], it is important to provide evidence integrating data from around the world and across sociodemographic levels.

Against this backdrop, it is critical at this time to comprehensively analyze data to paint a global picture regarding the disease burden and time trends of allergic diseases (asthma and AD). There have been isolated studies detailing the global prevalence and disease burden of asthma and AD using the Global Burden of Disease (GBD) 2017[9,10], but there has not yet been an up-to-date study encompassing both asthma and AD utilizing recently released dataset, both ends of the atopic march. Moving forward from scattered systematic reviews regarding the global distribution of these allergic diseases[11], the present study aimed to provide a bird's eye view of the global distribution of asthma and AD by analyzing data from the GBD study from 1990 to 2019 and discussing temporospatial trends in association with country-level socioeconomic development to aid future public health interventions.

METHODS

Overview

Data utilized in this paper were obtained from the GBD 2019 Results Database, provides data in 204 countries and territories from 1990 to 2019. Our analysis was performed as part of the GBD Collaborator Network and complied with the Guidelines for Accurate and Transparent Health Estimates Reporting (Supplementary Method). Comprehensive methodology for the estimation models have been published elsewhere[12]. R software version 3.6.2 (R Foundation, Vienna, Austria) was used to generate all tables.

Case Definition

In the GBD 2019 list of causes, asthma corresponds to the International Classification of Disease 10th revision (ICD-10) codes J45 and J56 and ICD-9 code 493.[10,13,14] Asthma was defined as a chronic lung disease involving bronchospasms and shortness of breath due to allergic reactions or hypersensitivity, adjudicated by physician diagnosis and wheezing in the past year. AD, consistent with ICD-10 code L20, was defined as relapsing dermatitis, either localized or widespread, associated with pruritus, elevated serum immunoglobulin E, and immune dysregulation.[1,9] Cases were selected through literature review with physical exam and claims data, then further stratified into three severity levels with different disability weights according to physical deformity and pain/itch.

Data acquisition and processing

Main data inputs for assessing the prevalence of asthma and AD were population representative surveys, limited prevalence investigations in the literature described by a systematic review of the literature, health service visits, surveillance data, survey data, and medical claims information. Estimates for prevalence, incidence, and disease burden were modeled through three main standardized tools, namely, (1) Cause of Death Ensemble model (CODEm), an optimized tool for analyzing cause of death by collecting an ensemble of different modeling methods with varying choices of covariates for high predictive validity; (2) Spatiotemporal Gaussian Process Regression (ST-GPR), a model for analyzing and comparing temporal and regional estimates between different groups; and (3) DisMod-MR 2.1, a Bayesian meta-regression tool, utilized to provide consistency between epidemiological parameters including prevalence, incidence, remission, and mortality by adjusting variations of heterogeneous datasets from various modeling methods[12].

Estimators of disease burden

For this study, we obtained the publication estimates of incidence, prevalence, mortality, years of life lost (YLLs), years lived with disability (YLDs), and disability-adjusted life years (DALYs) for asthma and AD, respectively, for each 5-year age group, sex, year, and location from GBD 2019. Briefly, age-standardized rates per 100,000 population were computed by the direct method to the GBD population standard. YLLs were defined as the product of the number of deaths and the remaining life expectancy per age group, as per the GBD standard life table; YLDs were calculated as the product of the prevalence estimate and disability weights for that specific condition, in this case asthma and AD. DALYs were computed by the summation of YLL and YLD, representing the health loss due to a specific cause; in this case, asthma and AD. Estimates for disease burden were reported with 95% uncertainty intervals (UIs), defined as the 25th and 975th values of 1,000 samples drawn for each variable.

A detailed description of the methods can be found in the literature[15].

Socio-demographic index

The development status of each country was graded based on the socio-demographic index (SDI) as defined in the GBD study since 2017, which is a composite score from 0 to 1 based on the total fertility under age 25, average education in those over age 15, and lag-distributed income per person[12,15]. In our analysis, we classified countries into quintiles of ranked SDI values as low, low-middle, middle, high-middle, and high SDI as obtained from the GBD 2019 data.

Risk factors

DALYs and deaths for asthma attributable for three risk factors: namely, high body mass index (BMI), occupational asthmagens, and smoking, as classified in GBD 2019[31], were obtained and further stratified by region and sex. Attributable risk factors for AD could not be evaluated from the current GBD database at this time.

Role of the funding source

The funders of this study had no role in study design, data collection, data analysis, data interpretation, or the writing of the report.

RESULTS

Global and regional burden of asthma

The age-standardized prevalence rates of asthma are mapped at the country level on Figure 1. Globally, the total number of patients with asthma increased slightly from 227 million [95% UI 195–270] in 1990 to 262 million [224–309] in 2019 (Figure 2 and Table S1). However, age-standardized prevalence rates had a 24.1% [20.8–27.2] decrease, from 4,497 [3,914–5,224] per 100,000 population in 1990 to 3,416 [2,899–4,066] per 100,000 population in 2019. Incidence rates of asthma showed similar trends, with total incident cases having increased from 32.2 million [25.8–40.5] to 37.0 million [29.6–45.9], whereas age-standardized incidence rates having decreased from 580.1 per 100,000 population [474.7–715.0] to 504.3 per 100,000 population [400.6–633.3] in 1990 and 2019, respectively (Table S2).

Asthma accounted for a total of 0.461 million [0.367–0.559] deaths in 2019, resulting in an age-standardized mortality rate of 5.8 per 100,000 population; this was a 51.3% decrease since 11.9 in 1990. Both the total number of DALYs and age-standardized DALYs rates due to asthma decreased from 1990 to 2019 (Figure 2 and Table S3 and S4). In particular, age-standardized DALYs rates underwent a steep dive of 42.5% [48.5–36.6] from 1990 and 2019, with DALYs rates of 476.3 per 100,000 population [378.5–579.6] in 1990 to 273.6 [216.7–343.4] per 100,000 population in 2019.

High-income North America and Australasia regions had the highest and second-highest age-standardized prevalence of asthma at 9,848 [8,624–11,312] and 8,393 [6,909–10,347] per 100,000 population, respectively, in 2019. Notably, the high-income North America region had a 9.6% [1.2–19.2] increase from 1990, with the United States contributing most of the increase at 10.9% [2.0–21.4] from 1990 to 2019; Australasia, consistent with most regions and the global trend, had a 30.6% [40.6 –18.5] decrease from its prevalence rate in 1990.

East, Central, and South Asia were the regions with the lowest age-standardized prevalence of asthma, at 2,026 [1,577–2,631], 2,277 [1,883–2,788], and 2,443 [2,030–2,910] per 100,000 population, respectively, in 2019. The lowest age-standardized prevalence rates of asthma were reported in Nepal and Bangladesh, at 1,073 [932–1,215] and 1,391 [1,217–1,574] per 100,000 population.

DALYs rates showed a somewhat different regional trend, with Oceania reporting the highest DALYs rates of 1,102 [864–1431] per 100,000 population, and East Asia reporting the lowest DALYs rates of 106.4 [75.3–152.1] per 100,000 population.

In most countries, age-standardized DALYs rates had a precipitous decrease over time, the drop in DALYs rates being as large as 72.3% [60.8–79.2] in the Republic of Korea; the only exceptions were Montenegro, the United States, and Paraguay, with 6.7% [-1.3–15.9], 4.4% [-3.4–12.9], and 3.1% [7.8–13.7] increase in DALYs from 1990 to 2019.

Global and regional burden of AD

In 2019, the number of prevalent cases of AD worldwide was 171 million [165–178], an increase from 133 million [128–138] cases in 1990; in contrast, global age-standardized rates of AD had a slight decrease of -4.3% [-4.8 to -3.8] to 2,277 [2.192–2.369] per 100,000 population in 2019 (Figure 1 and Table S5). Similarly, total incident cases rose from 19.2 million [18.3–20.2] in 1990 to 24.4 million [23.3–25.6] in 2019, but age-standardized incidence rates dropped slightly (-4.2% [-4.8 to -3.6] change; Table S6).

As there were no deaths directly attributable to AD, DALYs for AD was the same as the YLDs. DALYs rates due to AD showed the same trend as prevalence and incidence; the total number of DALYs rose steeply from 5.827 million [3.090–9.784] in 1990 to 7.480 million [3.987–12.58] in 2019, age-standardized rates had a slight drop of 4.1% [3.5–4.8] to 99.7 per 100,000 population (Table S7 and S8).

The prevalence rates of AD did not vary as drastically between regions as those of asthma, but there were still some regional trends. The highest prevalence rates of AD were reported in the High-income Asia Pacific region at 4,876 [4,639–5,113] per 100,000 population and Central Asia at 4,678 [4,210–5,192] per 100,000 population; the lowest prevalence rates of AD were reported in African countries, including Central, Eastern, Southern, and Western Sub-Saharan Africa, with 1,081 [1,009–1,162], 1,082 [1,035–1,132], 1,083 [1,027–1,140], and 1,102 [1,054–1,149] per 100,000 population. In most regions, prevalence rates of AD remained stable over 1990–2019; the steepest increase was seen in Kenya at merely 5.3% [2.0–8.2], and the largest drop was seen in the Maldives at a similar percentage of 6.6% [6.0–7.2]. DALYs rates of AD had a similar regional distribution with prevalence rates of AD, with highest DALYs rates in the High-income Asia Pacific region and lowest DALYs rates in the Sub-Saharan Africas.

Trends according to demographic factors

Consistently throughout 1990–2019, the total number of incident cases and age-standardized incidence rates of asthma were similar between females and males, whereas those of AD were substantially higher in females than males (Figure 3). Both total incidence and incidence rates of asthma down-trended slightly from 1990 to 2005, then increased from 2005 to 2019, drawing a slight V-shape over time. In contrast, the total incidence of AD increased steadily from 1990 to 2019, while age-standardized rates decreased slightly over the same period. Time trends were similar in both sexes.

Stratified by age, in 2019, the total number of prevalent cases peaked at age 5-9, down-trended to reach a plateau at age 25-69, then decreased in the older age groups (Figure 4). In contrast, the age-specific prevalence rate of asthma had an N-shaped distribution, with prevalence rates peaking in age 5-9, reaching a lowest point at age 25-29, then subsequently rising well into the oldest age group (≥95 years). Total age-specific prevalent cases and prevalence rates of asthma were higher for males up to the 15-19 age group; afterwards, the trend reversed with higher prevalence in females.

Total prevalent cases of AD according to age groups showed similar trends as that of asthma, having a distribution heavily skewed in infancy and early childhood with a high peak in the 5-9 age group and a steep decrease thereafter (Figure 4). Age-specific prevalence of AD was characterized by an earlier peak in age groups 1-4 and 5-9 and a later trough at age 35-44. For AD, both age-specific prevalence rates and total number of prevalent cases were higher for females in all age groups, with the difference almost twofold in young adulthood (ages 25-45).

Burden of asthma and AD in accordance with SDI

Age-standardized DALYs rates of asthma decreased steadily from 1990 to 2005 over all SDI quintiles, with the exception of the High SDI quintile, for which the DALYs rates increased slightly since 2005 (Figure 5). Higher SDI levels tended to have lower DALYs rates, with High, High-middle, and Middle SDI quintiles having substantially lower DALYs rates than

Low and Low-middle quintiles consistently over the study period, and with the Low SDI quintile having the highest, and the High-middle quintile having the lowest DALYs rates throughout 1990 to 2019 (553.9 [434.7–726.8] and 158.3 [114.0–220.2] per 100,000 population, respectively, in 2019). On the other hand, the High SDI quintile had the highest age-standardized prevalence, incidence, and YLDs rates of asthma across the study period, compared to lower SDI quintiles (Figure S4–S6). The highest SDI quintile had a prevalence rate of 6,855 [5,877–8,058] per 100,000 population; at the same time, the High and High-middle SDI quintiles experienced the largest decrease in asthma prevalence of 17.7% [14.2–20.9] and 26.8% [22.2–32.1], respectively, over the study period. The discrepancy in associations with SDI could be explained by the mortality rate; although the mortality rate decreased for all SDI quintiles over the study period, lower SDI was associated with higher mortality in all timeframes (Figure S3).

Age-standardized DALYs rates of AD were stagnant across time in all SDI levels, and the association between DALYs and SDI was reversed in AD. Higher SDI levels had higher DALYs rates of AD throughout 1990–2019, with the High SDI quintile having more than double the DALYs rates of the Low SDI quintile (155.5 [83.5–262.0] and 59.7 [32.0–100.1] per 100,000 population, respectively, in 2019). This trend was replicated in prevalence and incidence rates of AD; the High SDI quintile had the highest prevalence rate of 3,540 [3,376–3,685] per 100,000 population, whereas the Low SDI quintile had the lowest prevalence rate of 1,359 [1,301–1,424] per 100,000 population in 2019 (Figures S1 and S2).

Burden of asthma attributable to risk factors

We also analyzed the DALYs of asthma attributable to three different risk factors, namely

BMI, occupational asthmagens, and smoking (Figure 6).

Globally, high BMI contributed to the most DALYs and deaths due to asthma in 2019, followed by smoking and occupational asthmagens, with a total of 3.65 million [2.14–5.60], 2.12 million [1.13–3.01], and 1.90 million [1.51–2.33] asthma DALYs, and total 75,377 [40,615–122,841], 54,849 [29,149–78,006] and 34,395 [27,828–42,614] deaths attributable to each risk factor, respectively (Figure S25 and S27). In both men and women, South Asia had the highest number of asthma DALYs attributable to all three risk factors (0.910 million [0.447–1.587] for high BMI, 0.622 million [0.475–0.818] for occupational asthmagens, and 0.689 million [0.333–1.044] for smoking), mirroring the number of total DALYs due to asthma. South Asia was followed by North Africa and Middle East, High-income North America, and Southeast Asia, for highest asthma DALYs due to high BMI; the trend was slightly different for occupational asthmagens and smoking, for which the second and third-highest asthma DALYs occurred in Southeast Asia and Eastern Sub-Saharan Africa for occupational asthmagens, and Southeast Asia and East Asia for smoking, respectively (Figure S25).

Consistent with the high absolute numbers of attributable DALYs, high BMI accounted for nearly 30% of asthma DALYs in the North Africa and Middle East (27.9% [18.3–38.8]) and Southern Sub-Saharan Africa (27.7% [18.3–38.0]), but only 9.6% [5.0–6.6] in the High-income Asia Pacific. In most regions, females had a higher proportion of asthma DALYs attributable to high BMI, with the exception of the high-income Asia Pacific and East Asia regions. These two regions also had the lowest percentages of DALYs due to high BMI.

Eastern, Western, and Central Sub-Saharan Africa had a substantially higher percentage of asthma DALYs due to occupational asthmagens compared to other regions, which were 13.3% [11.8–14.8], 11.9% [10.5–13.3], and 10.8% [9.0–12.4], respectively. Further, the percentage of asthma DALYs attributable to occupational asthmagens were higher in males than in females in all regions.

The highest asthma DALYs attributable to smoking occurred in Central Europe (12.7% [7.2–17.8]) and Western Europe (12.2% [6.7–17.0]), and lowest in Andean Latin America (1.3% [0.5–2.1]). Notably, the percentage of DALYs attributable to smoking was substantially higher in males in most regions with the exception of High-income North America, Southern Latin America, and Australasia; these countries had some of the highest proportions of DALYs due to smoking in females nearing 10%.

DISCUSSION

Asthma and AD increased in total prevalent and incident cases worldwide, but have decreased in age-standardized prevalence rates from 1990 to 2019. Both have strong associations with age, being most prevalent at age 5-9 but the prevalence increasing in later adulthood. These diseases tend to have higher prevalence in countries with higher SDI, but for asthma, lower SDI was associated with higher mortality and DALYs rates; further, disease burden varied substantially across geographic region. Further epidemiologic studies of asthma and AD spanning the globe are warranted to mitigate the high disease burden due to these allergic diseases and achieve equity in prevention, diagnosis and treatment.

Asthma and AD are atopic diseases that can affect individuals throughout the life course, having major repercussions both in population health and in the global economy. However, reflecting heightened awareness from early in life, improved diagnostic resources, and perceptions that affluent populations are prone to allergic diseases, many studies have been focused on high-income countries, such as the United Kingdom, the European Union, and the United States[16,17]. Furthermore, as these diseases have been considered as pediatric conditions, most studies have leaned towards children[3]. To provide a global bird’s eye view regarding the true public health impact of these diseases across the lifespan, we investigated the most up-to-date data from the GBD 2019 study to describe the global prevalence, incidence, and disease burden of asthma and AD and analyzed their associations with geographic region, demographic characteristics, SDI, and risk factors.

In 2019, there were 262 million total cases (2.4%) of asthma globally across all ages, the percentage lower than other studies from the World Health Survey (4.3% in adults), Global Asthma Network (10.4% in adolescents and 9.9% in children), and the International

Study of Asthma and Allergies in Childhood (13.7% in age 13–14 and 11.6% in age 6–7)[2,18,19]. This discrepancy could be explained by the difference in included countries and age groups, especially considering the significant variation in asthma prevalence between countries and along the life course evident in the GBD data and in the other worldwide studies. While the total number of patients with asthma increased, age-standardized prevalence rates had a large decrease of 24.1% globally, with incident cases and incidence rates mirroring the same trend, which suggests that the increase in number was in part due to population expansion. Likewise, the prevalence rate of asthma decreased in most regions. However, few regions, such as the United States, had a rise in asthma prevalence; this increase could be attributed to increased awareness and diagnostic availability of asthma due to public health campaigns such as the National Asthma Education and Prevention Program and, in part, overdiagnosis[20].

The disease burden of asthma represented by age-standardized DALYs rates and mortality rates also underwent a steep decrease of 42.5% and 51.3% from 1990 to 2019, respectively. This could reflect the establishment of cornerstone guidelines (e.g., the National Heart, Lung, and Blood Institute guidelines, first issued in 1991, and the Global Initiative for Asthma guidelines, first published in 1995), heightened awareness and better management of asthma globally, and the development and popularization of different treatment options[21,22]. For example, the decrease in asthma DALYs were especially precipitous in some countries, reaching 72.3% in the Republic of Korea; this could reflect various initiatives and cohorts that took place since the early 2000s, such as the Cohort for Reality and Evolution of Adult Asthma, the Korea Asthma Allergy Foundation, and the Seoul Atopy-Asthma-friendly School Project[23]. However, as there still exist wide variations in DALYs and mortality rates around the globe and within regions, it is critical to continue efforts for better prevention and control of asthma, especially in under-resourced settings[6].

For AD, there were 171 million total cases globally, approximately 2.23% of the population. Although the absolute number of prevalent and incident cases rose from 1990 to 2019, age-standardized prevalence and incidence rates stayed relatively stable over time, undergoing only a slight drop of 4.3% and 4.2%, respectively. Between regions, the prevalence and DALYs rates of AD did not vary as drastically between countries and regions as those of asthma; however, the highest prevalence and DALYs rates were reported in the High-income Pacific region, and the lowest rates were reported in the Sub-Saharan Africa regions. The low reported disease burden in African countries may be partly ascribed to differences in diet and environment, but may also be a result of under-reporting, especially as AD prevalence has recently been increasing in these developing countries[24]. Therefore, additional epidemiologic studies should take place to delineate complex factors associated with the changes in different parts of the world and efforts to boost awareness and diagnostic capability in under-resourced settings should be continued.

Consistent with the literature and common perceptions, this study found that both asthma and AD peaked in the younger ages, typically ages 5-9[18,21]; however, we also found that age-standardized rates increased past adulthood well into older ages. As asthma and AD in older populations may be difficult to diagnose and treat due to their traditional misconceptions as “pediatric diseases”, different clinical presentations (i.e., phenotypes)and functional characteristics, and multiple comorbidities associated with aging, physicians should be vigilant in the recognition and multi-dimensional management of these conditions in older adults[25].

Higher SDI levels tended to have higher prevalence of asthma and AD, as reported in numerous international studies previously[3,18,26]. Notably, however, mortality and DALYs rates had the reverse trend, with lower SDI quintiles having substantially higher DALYs and higher mortality. Low-resource settings have been associated with worse outcomes of asthma, mediated by socioeconomic factors such as income and education, environmental allergens or pollutants, psychosocial stressors, and lack of access to healthcare[6,27]. Likewise, many inner-city populations in low- and middle-income countries have very high prevalence of asthma but limited access and affordability for essential medications for persistent asthma[28]; under-treatment in these countries causes significant morbidity and mortality[29]. Further, the high incidence of acute respiratory infections in low- and middle-income countries can lead to asthma exacerbations as well as under-diagnosis and thus under-treatment of asthma, leading to a relatively lower reported prevalence and higher morbidity[30]. These trends suggest a large potential for global and community initiatives to improve asthma outcomes in low-resource populations[27,31].

The present study was the first to systematically assess the disease burden of asthma and AD across regions and throughout the lifespan using the most recent GBD data. However, there are some limitations to our study. First, the definition of asthma and AD were made mainly through physician diagnosis and symptom data, the stringency of which could have been heterogeneous across regions – for example, different countries using different terms to describe symptoms of asthma or AD – and thus resulted in a discrepancy of prevalence statistics. Second, as this study was driven by data from the GBD study, it includes the limitations of the GBD dataset, mainly, that some regions had low availability and quality of data, for which statistics had to rely on predictive covariates. Furthermore, as we compared country-level aggregate data, the trends and associations we found are subject to ecological bias. Lastly, we could only assess the attributable risk for asthma on three risk factors (high BMI, occupational asthmagens, and smoking); more research is necessary to investigate associations with different demographic and clinical factors, and also for AD.

In summary, asthma and AD are both allergic diseases that have increased in total burden worldwide but have decreased in age-standardized prevalence rates from 1990 to 2019. Although both are more frequent in the younger ages and prevalent in high-SDI countries, each condition has distinct temporal and regional trends. This study will help assess regional and temporal trends regarding the distribution and disease burden of asthma and AD, and guide interventions to better manage these diseases worldwide as well as to attain equity in prevention, diagnosis and treatment.

Contributors

Please see the appendix for detailed information about individual author contributions to the research, divided into the following categories: managing the estimation or publication process; writing the first draft of the manuscript; primary responsibility for applying analytical methods to produce estimates; primary responsibility for seeking, cataloguing, extracting, or cleaning data; designing or coding figures and tables; providing data or critical feedback on data sources; development of methods or computational machinery; providing critical feedback on methods or results; drafting the manuscript or revising it critically for important intellectual content; and managing the overall research enterprise. Youn Ho Shin, Jimin Hwang, Seung Won Lee, Jae Il Shin, and Dong Keon Yon had full access to the data in the study and final responsibility for the decision to submit for publication.

Data sharing

Citations for the data used in the study can be accessed from the Global Health Data Exchange (http://internal-ghdx.healthdata.org/). Access to the data is also provided as a data use agreements permit.

Acknowledgement

We would like to express our deepest gratitude to Han Gyeol Lee, Ho Hyeok Chang, and Sungchul Choi for helping data acquisition and making tables and figures.

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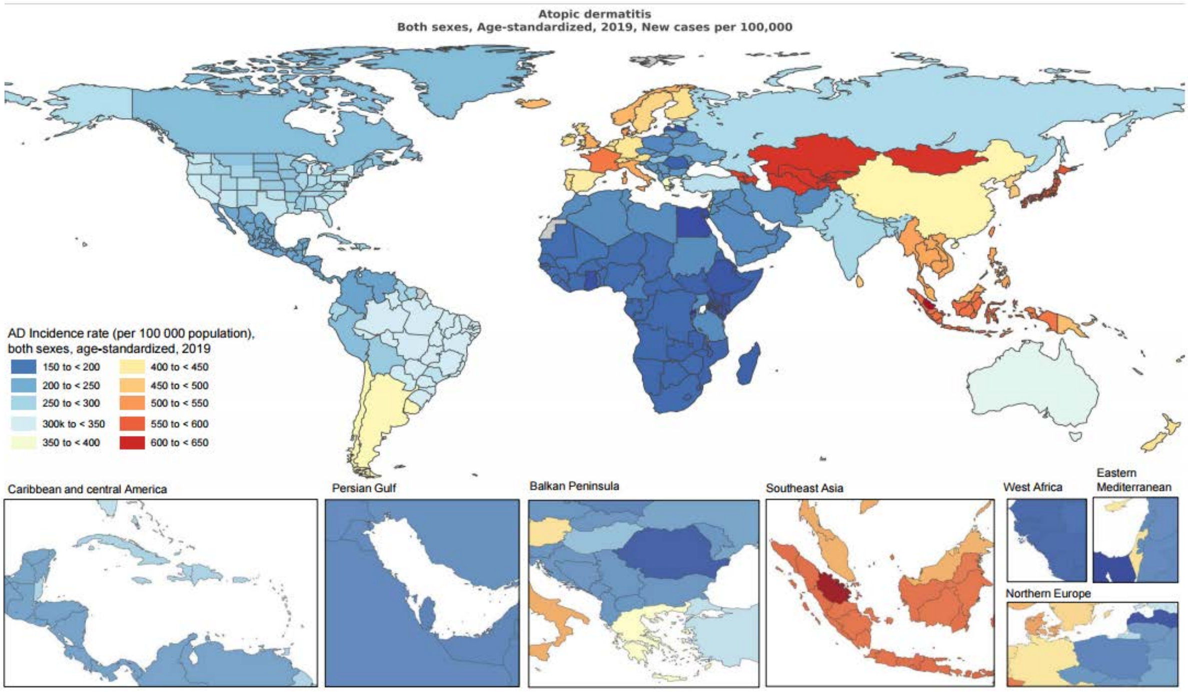
Figure 1. Global distribution of the age-standardized prevalence rates of asthma (A) and AD (B). AD, atopic dermatitis.



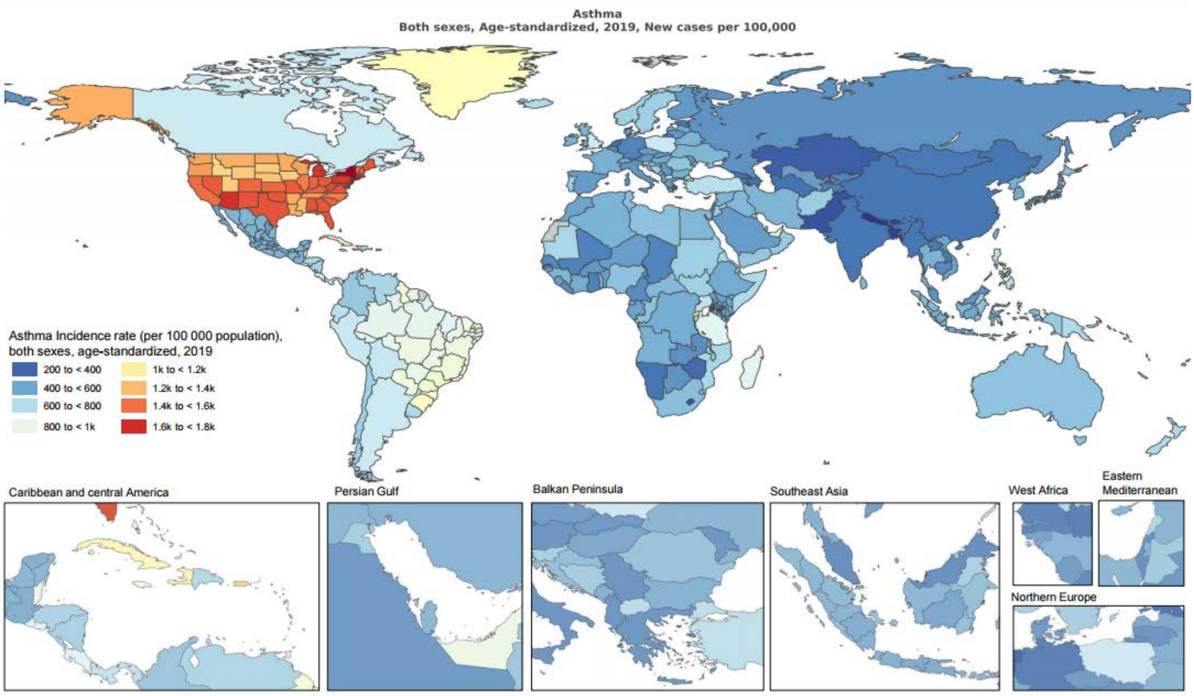


Figure 2. Global prevalence and DALYs of asthma (A and B) and AD (C and D), 1990–2019. AD, atopic dermatitis; DALY, disability-adjusted life-years.

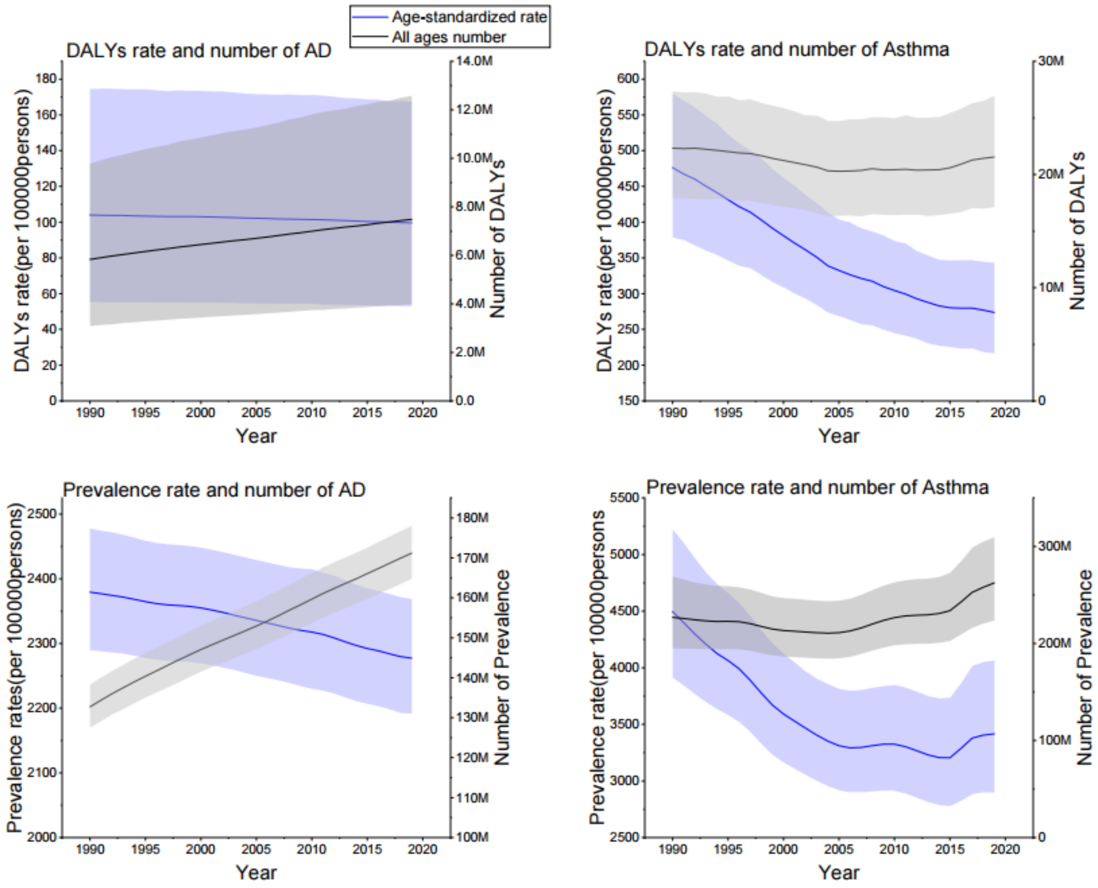


Figure 3. Total number of incident cases and global incidence rates of asthma (A) and AD (B) by sex, 1990–2019.

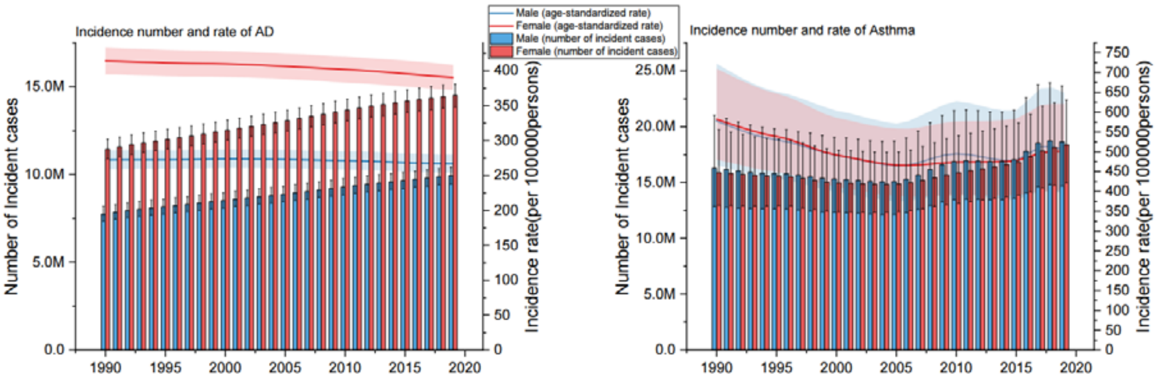


Figure 4. Total number of prevalent cases and global prevalence rates of asthma (A) and AD (B) by age, 1990–2019.

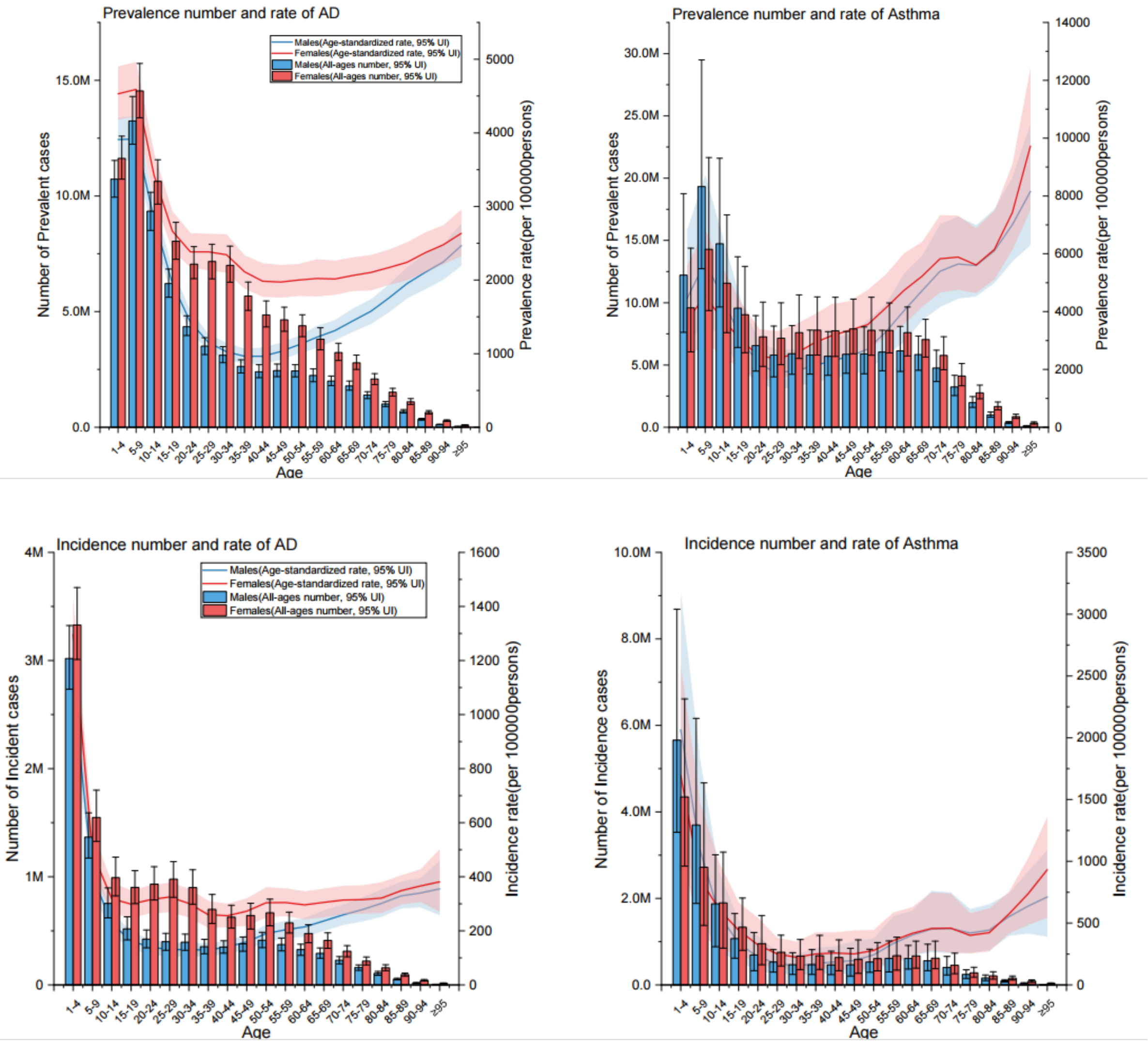


Figure 5. Age-standardized DALYs rates of asthma (A) and AD (B) according to SDI, 1990–2019. AD, atopic dermatitis; DALY, disability-adjusted life-years; SDI, socio-demographic index.

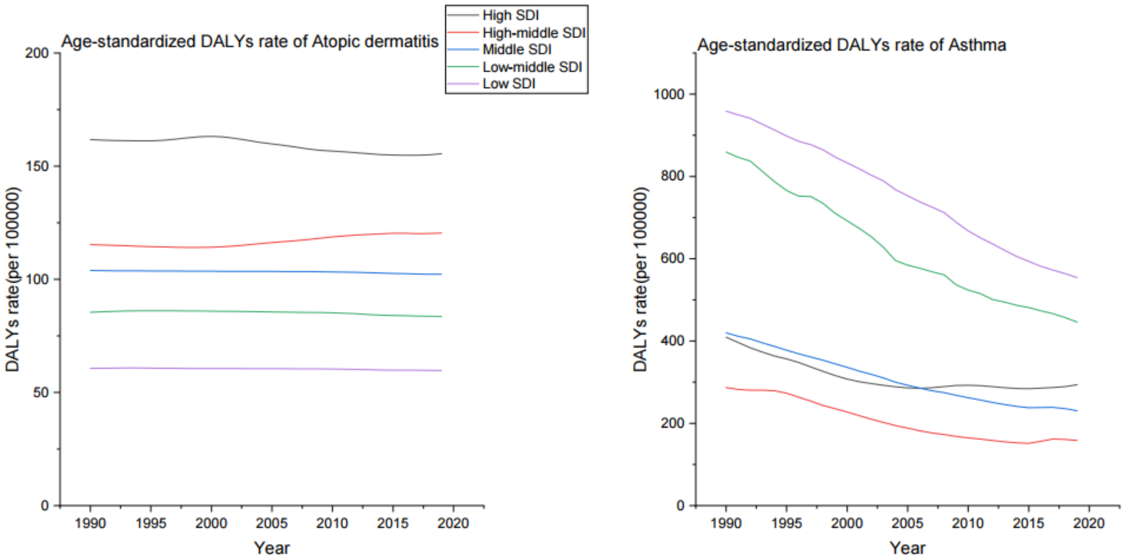


Figure 6. Percentage of age-standardized DALYs rates of asthma attributable to high BMI, occupational asthmagens, and smoking by geographic region, total (A) and sex-stratified (B). BMI, body mass index; DALY, disability-adjusted life-years.