Clinical & Experimental Allergy

WILEY

ORIGINAL ARTICLE

Asthma and Atopic Dermatitis in Asia, 1990–2021: The Global Burden of Disease Study 2021

GBD 2021 Asia Allergic Disorders Collaborators

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Received: 11 December 2024 | **Revised:** 13 February 2025 | **Accepted:** 19 February 2025

Funding: This study was funded by the Gates Foundation, Australian National Health and Medical Research Council, and Queensland Department of Health, Australia. This work was supported by the Yonsei Fellowship, funded by Lee Youn Jae (JIS). This research was supported by the MSIT (Ministry of Science and ICT), Korea, under the ITRC (Information Technology Research Center) support program (IITP-2024-RS-2024-00438239 to D.K.Y.) supervised by the IITP (Institute for Information & Communications Technology Planning & Evaluation; Global AI Frontier Lab, RS-2024-00509257 to D.K.Y.).

Keywords: allergy | Asia | asthma | atopic dermatitis | Global Burden of Disease Injuries and Risk Factors Study

ABSTRACT

Background: Given the diverse population and regional differences across Asia, a comprehensive analysis of allergic diseases is crucial for guiding healthcare planning, resource allocation, and prevention strategies. Therefore, utilising the Global Burden of Diseases, Injuries, and Risk Factors Study (GBD) 2021, we aimed to thoroughly investigate the burden of allergic conditions and their attributable risk factors in Asia.

Methods: Asthma and atopic dermatitis (AD) prevalence and burden estimates were calculated across various regions within Asia (Central, South, Southeast, East Asia and high-income Asia Pacific) from 1990 to 2021, covering age groups segmented into five-year intervals and analysing data separately and combined for males and females. The Bayesian meta-regression tool was employed to estimate the prevalence, incidence, and cause-specific mortality of allergic disorders. Asthma-related deaths and disability-adjusted life years (DALYs) attributable to each risk factor were estimated using relative risks, risk exposure and the theoretical minimum risk exposure level input.

Results: From 1990 to 2021, asthma in Asia showed significant declines in age-standardised prevalence, mortality, and DALYs, exceeding global trends. In 2021, an estimated 106 million (95% UI, 92–121) individuals in Asia had asthma, with age-standardised rates decreasing significantly. However, asthma-related deaths still accounted for 346,755 (278,046–464,848) cases in 2021. In contrast, the AD burden remained stable, with 68.1 million (65.4–71.0) cases in 2021, reflecting a 16.1% increase since 1990, though the age-standardised prevalence remained unchanged. AD exhibited the highest DALYs rates in high-income Asia Pacific and Central Asia, with significant gender disparities in prevalence.

Conclusion: This study showed a declining age-standardised asthma burden, mortality, and impact, along with a stable burden of AD in Asia from 1990 to 2021. This comprehensive data analysis would provide invaluable insights for making targeted health interventions and policies aimed at mitigating the burden of allergic diseases in Asia.

Abbreviations: AD, atopic dermatitis; BMI, body mass index; CODEm, Cause of Death Ensemble model; DALY, disability-adjusted life-years; DisMod-MR, Disease Modeling-Meta–regression; GATHER, Guidelines for Accurate and Transparent Health Estimates Reporting; GBD, Global Burden of Diseases, Injuries and Risk Factors Study; GHDx, Global Health Data Exchange; ICD, International Classification of Diseases; IHME, Institute for Health Metrics and Evaluation; ISAAC, International Study of Asthma and Allergies in Childhood; MR-BRT, Meta-Regression (Bayesian, Regularized, Trimmed); UI, uncertainty interval; YLL, years of life lost.

For a complete list of the GBD 2021 Asia Allergic Disorders Collaborators, see the Appendix section.

Summary

- In 2021, Asia had 106 million asthma cases, with declining age-standardised prevalence and mortality.
- The age-standardised AD burden remained stable, with 68.1 million cases in 2021.
- High BMI is the greatest asthma risk, followed by occupational exposure, smoking and NO^2.

1 | Introduction

Asthma and atopic dermatitis (AD) are common chronic allergic diseases that pose a public health problem worldwide [1]. Studies have shown that the prevalence of both conditions has increased significantly over the years, affecting approximately 10%–30% of the global population [2, 3]. Historically, North America and Europe have reported higher prevalence rates of asthma compared to Asia. However, the disability-adjusted life-years (DALYs) rates of asthma have been surpassed in Asia compared to global values [1]. According to the Global Burden of Diseases, Injuries and Risk Factors Study (GBD) 2019 studies on allergic disorders, China has been the most significant contributor to the incidence and prevalence of AD, followed by India and Indonesia [1]. These conditions can affect individuals of all ages and require continuous management and treatment to decrease the global socioeconomic burden [4, 5].

The International Study of Asthma and Allergies in Childhood (ISAAC) reported significant regional variations in allergic diseases prevalence across Asia due to factors such as ethnicity, sex, socioeconomic status and environment [6]. In countries like Bangladesh and Nepal, limited healthcare access and poor living conditions can exacerbate allergic diseases [7], while in Japan and South Korea, urban lifestyles and environmental issues still lead to high rates of allergic diseases despite better healthcare [8]. As several Asian countries have undergone a dramatic economic growth, disparities in healthcare access, treatment availability and patient education and awareness remain crucial challenges, further emphasising the need for a comprehensive analysis of allergic diseases in the region.

The GBD 2021 provides an updated, comprehensive assessment of the disease burden, with cause-specific mortality and DALYs for asthma and AD by age and sex from 1990 to 2021. A recent study utilising GBD 2021 was published; however, it was limited to presenting findings exclusively for the year 2021 on a global scale [9]. Integrating updated data, our study analysed temporal and geographical trends in the prevalence, mortality, and DALYs of asthma and AD in Asia. The objective of this study was to provide valuable insights that can inform evidence-based decision-making for future public health interventions tailored to the diverse needs of the region. This manuscript was produced as part of the GBD Collaborator Network and in accordance with the GBD Protocol.

2 | Methods

2.1 | Overview and Data Source

This study provides a comprehensive analysis of asthma and AD prevalence, mortality, incidence, years of life lost (YLLs), years of life lived with disability (YLDs) and DALYs in Asia using data from GBD 2021. The GBD 2021 provides data on 371 diseases and injuries in 204 countries or regions and more than 80 behavioural, environmental and other risk factors from 1990 to 2021 [10, 11]. For this study, the GBD 2021 data on the prevalence, deaths, and DALYs of asthma and AD for Asian countries were derived from the Global Health Data Exchange (GHDx). The detailed methods used for the estimation models closely followed those for GBD 2019 and were previously reported [10–12]. The GBD is led by the Institute for Health Metrics and Evaluation (IHME) and more than 11,000 collaborators from over 160 countries and territories. GBD 2021 complied with the Guidelines for Accurate and Transparent Health Estimates Reporting (GATHER) statement (Tables S1 and S2) [13]. Input data sources and statistical code used for GBD estimation are available online.

2.2 | Case Definition

In GBD 2021, asthma is a chronic lung disease characterised by spasms in the bronchi, resulting from an allergic reaction, hypersensitivity, viral respiratory infections, irritants in the air or exercise and causing difficulty in breathing. This definition includes allergic, non-allergic asthma, and status asthmaticus. Asthma is defined as a doctor's diagnosis and the presence of wheezing in the past year [10–12]. The International Classification of Disease 10th revision (ICD-10) codes are J45 and J46 and ICD-9 code is 493. Alternative case definitions include self-reported asthma in the past year, self-reported asthma ever, only a doctor's diagnosis in the past year, and only wheezing in the past year [10–12].

AD refers to recurring inflammation of the dermal layer of the skin, characterised by itching, erythema, vesicular lesions, and lichenification, with disruption of the epidermal barrier, which can lead to rashes [1]. It is commonly associated with elevated serum immunoglobulin E and some degree of immune dysregulation. ICD-10 code is L20 and ICD-9 code is L691 [10–12]. We define AD as a physical examination and alternatively self-reported or determined without a physical exam. The detailed case definition and sources of data for asthma and AD are available in Tables S3–S6.

2.3 | Data Processing

Multiple data types, including online research databases, government, and international organisation websites, published reports, primary data sources and contributions of datasets by GBD Collaborators, were used to capture the widest array of epidemiological information pertaining to asthma and AD [10–12]. To address known bias, asthma data reported for both sexes combined were separated by sex using Meta-Regression (Bayesian, Regularized,

Trimmed) (MR-BRT) and a cubic spline on age. Additionally, data with alternative case definitions or measurement methods were adjusted to align with the reference method using MR-BRT [10–12]. Further details are available in the Table S7–S11.

2.4 | Disease Modelling

Processed data are modelled using standardised tools to generate estimates of each quantity of interest by age, sex, location and year. The three main standardised tools are the Cause of Death Ensemble model (CODEm), Spatiotemporal Gaussian process regression and Disease Modeling-Meta–regression (DisMod-MR) 2.1 [10–12] (Supplementary Method and Table S12).

2.5 | Asthma Risk Factor Estimation

In the GBD 2021, BMI, smoking, occupational asthmagens and NO_2 pollution were identified as risk factors contributing to DALYs and deaths attributed to asthma [14]. NO_2 pollution was included for the first time in the GBD 2021 due to rising ambient air pollution, but data on deaths attributable to NO_2 pollution were unavailable [14]. The GBD 2021 database did not provide data on AD attributable risk factors. To quantify the impact of each risk factor, an extensive review integrating risks and outcomes within a comprehensive risk assessment framework was conducted. Afterward, relative risks associated with asthma were estimated based on exposure levels across various demographic variables such as age, sex, location and year utilising the DisMod-MR 2.1 model [10–12].

2.6 | Data Selection

In this study, we extracted the data on the estimates of prevalence, mortality and DALYs for asthma and AD from the GBD 2021 database. AD-related death data were not available for analysis. Our focus was specifically on each five-year age group, sex and year within the Asian continent. The countries included in the analysis were those whose region name contained 'Asia', including Central Asia, East Asia, high-income Asia Pacific, Southeast Asia and South Asia. This study incorporated data from only 34 countries in Asia even though Asia comprises 51 countries as classified by the United Nations (Supplementary Method and Table S13).

2.7 | Statistical Analyses

GBD 2021 metrics were estimated as counts, all-age and age-specific rates per 100,000 population, and age-standardised rates per 100,000 population. The standardised methods of the GBD 2019 have been extensively reported [10–12]. For all reported data, 95% uncertainty intervals (UIs) were calculated (Supplement Method). Analyses were completed with Python (version 3.6.2; Python Software Foundation, Wilmington, DE, USA) and R software (version 3.5.0; R Foundation, Vienna, Austria).

2.8 | Role of the Funding Source

The funders had no role in study design, data collection, analysis or interpretation of this manuscript. All authors actively contributed to the development of the manuscript, had access to the data, and collectively assumed responsibility for the decision to submit it for publication.

3 | Results

3.1 | Trends in Burden of Asthma in Asia

From 1990 to 2021, asthma-related mortality and DALY rates in Asia exceeded global levels, while the prevalence and incidence rates showed opposite trends to those of the world (Figure S1). In 2021, Asia had an estimated 106 million (95% UI, 92–121) asthma cases, with an age-standardised prevalence of 2350.39 per 100,000 (2035.7–2733.6), a decrease of 44% (31.9–54.0) since 1990 (Figure 1). Asthma-related mortality decreased by 50.1% (−66.6 to −25.6) from 1990 to 2021, with an age-standardised mortality rate of 7.3 (5.8–9.6) in 2021. Similarly, DALYs decreased by 48.6% (29.1–62.7), with an age-standardised DALYs rate of 261.8 per 100,000 (209.3–328.5) in 2021 (Table 1).

There were 55.6 million (48.1–65.0) prevalent cases in males and 50.6 million (44.3–57.6 million) in females in 2021, reflecting a decrease of 16.0% (−32.4 to 4.2) and 13.6% (−28.9 to 5.0), respectively, since 1990 (Figure 2). Males had higher prevalence up to 15–19 years, after which females surpassed them. DALY rates for asthma increase with age but substantially decreased in those aged over 70 years from 1990 to 2021 (Figure 3). Asthma-related deaths and DALYs peaked at ages 65–69 and 70–74, respectively, and decreased in the subsequent age groups (Figures S2 and S3). Conversely, the age-specific prevalence rate peaked slightly in the 5–9 years age group before steadily increasing. Early childhood groups, up to 14 years old, were more susceptible to asthma compared to other age groups.

3.2 | Regional and National Burden of Asthma

South Asia had the highest number of prevalent asthma cases in 2021 (39 million [33.7–45.1]), followed by East Asia with 27.1 million (22.8–32.8). However, when adjusted for population growth and ageing, High-income Asia Pacific had the highest rate of prevalent cases (3299.82 per 100,000 people [2706.15–4053.5]) (Table 1).

Age-standardised mortality rates attributed to asthma vary significantly across Asia. South Asia had the highest age-standardised asthma-related mortality and DALYs rates, with 17.68 (12.55–26.32) and 465.02 (357.17–648.94) per 100,000 people, respectively. In Central Asia, the mortality rate stands at 4.34 per 100,000 population (3.78–5.09), with a decrease of 62.2% (54.6–68.5) observed since 1990 (Figure 4). The mortality rate of high-income Asia-Pacific had remarkably declined by 90.9% (88.2–93.0) from 1990, reaching 0.66 per 100,000 population (0.53–0.84) in 2021 (Supplement Results).

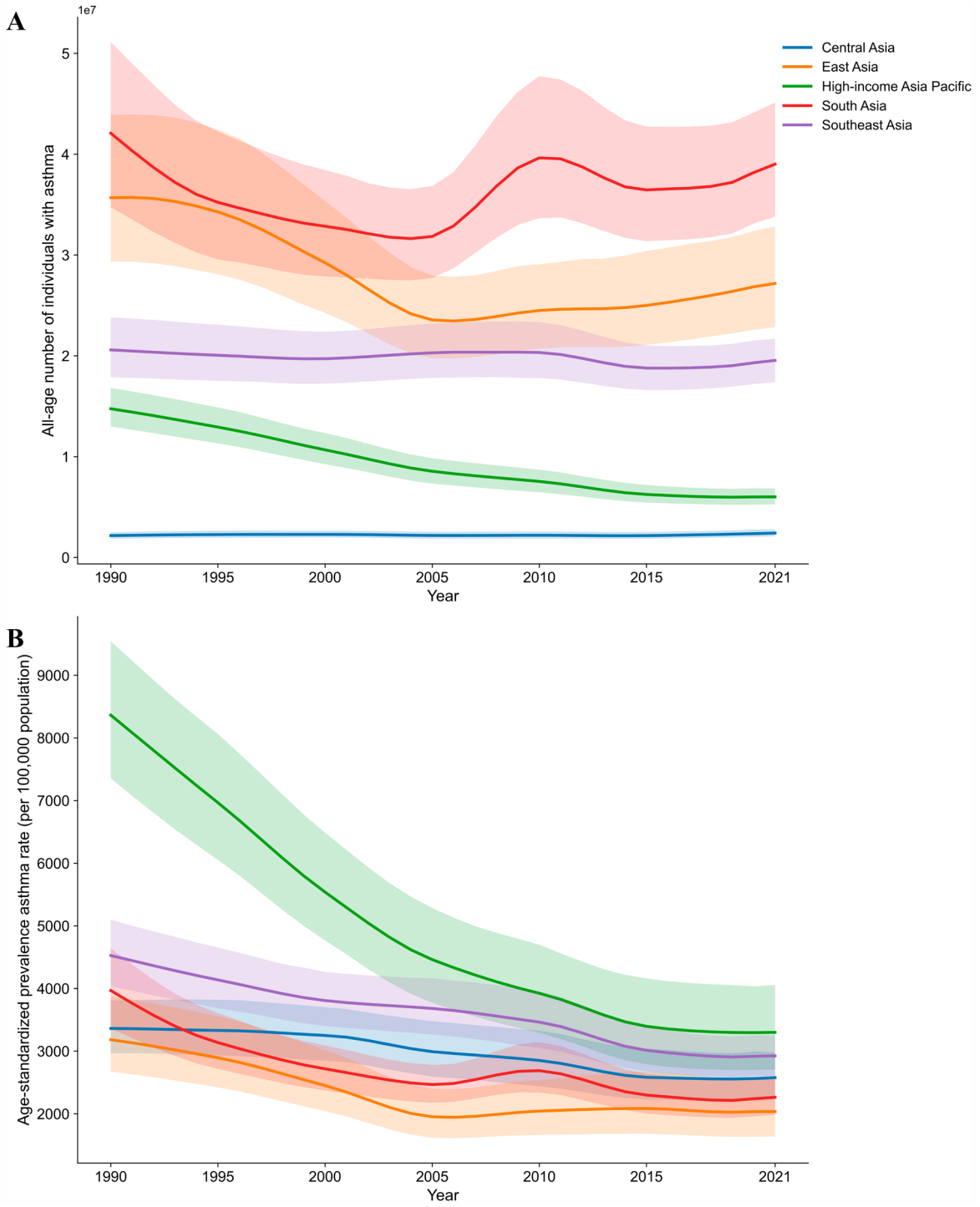

FIGURE 1 | (A) Number of prevalent asthma cases and (B) age-standardised prevalence asthma rates across Asian regions, 1990–2021, with 95% uncertainty intervals.

3.3 | Trends in Burden of AD in Asia

In 2021, Asia had an estimated 68.1 million (65.4–71.0) AD prevalence cases, with a 16.1% (9.3–23.3) increase from 1990 (Figure 5). However, age-standardised prevalent cases slightly decreased by 2.5% (−8.0 to 3.3). The age-standardised DALYs rate for AD in Asia was 71.81 per 100,000 population (36.9–119.99) (Figure 6). AD prevalence and age-standardised rates were consistently higher in females than males across all years (Figure 7). Similar to males, there was a decrease of −2.7% (−8.5 to 3.4) in age-standardised prevalent cases among females from 1990 to 2021. Contrary to asthma, DALYs rates for AD were highest in the 5–9 years age group and subsequently declined as individuals aged. Beyond 20 years, DALY rates remained relatively stable without significant sex differences. Both the total number of DALYs and prevalent cases were highest in the

TABLE 1 | Prevalence and age-standardised rate of prevalence, death, and DALYs per 100,000 people of asthma and AD, over 1990–2010 and 2010–19.

	Counts		Age-standardised prevalence rate (per 100,000 people)		Age-standardised mortality rate (per 100,000 people)		Age-standardised DALY rate (per 100,000 people)	
	Number of prevalent cases in all-age, 2021 (95% UI)	Percentage change, 1990–2021 (95% UI)	Rate of prevalent cases in age-standardised, 2021 (95% UI)	Percentage change, 1990–2021 (95% UI)	Rate of mortality cases in age-standardised, 2021 (95% UI)	Percentage change, 1990–2021 (95% UI)	Rate of DALY cases in age-standardised, 2021 (95% UI)	Percentage change, 1990–2021 (95% UI)
Asthma								
Asia (total)	106,368,080.82 (92,759,798.49–121,875,923.53)	−14.9 (−30.7 to 4.4)	2350.39 (2035.7–2733.63)	−44.0 (−54.0 to −31.9)	7.25 (5.82–9.61)	−50.1 (−66.6 to −25.6)	261.81 (209.29–328.51)	−48.6 (−62.7 to −29.1)
Region								
Central Asia	2,417,460.52 (2,087,496.7–2,802,887.49)	11.4 (−9.8 to 37.6)	2577.21 (2227.15–2979.19)	−23.3 (−36.7 to −7.1)	4.34 (3.78–5.09)	−62.2 (−68.5 to −54.6)	198.84 (158.89–245.61)	−50.6 (−62.1 to −35.6)
East Asia	27,177,785.58 (22,841,638.14–32,828,164.45)	−23.8 (−41.9 to −0.1)	2036.50 (1638.37–2582.26)	−36.0 (−52.3 to −14.2)	1.52 (1.23–1.82)	−74.9 (−82.6 to −63.9)	108.13 (75.87–150.96)	−57.1 (−72.0 to −34.3)
High income Asia Pacific	6,007,836.83 (5,267,792.96–6,854,895.69)	−59.3 (−66.1 to −51.0)	3299.82 (2706.15–4053.50)	−60.5 (−69.0 to −49.8)	0.66 (0.53–0.84)	−90.9 (−93.0 to −88.2)	143.21 (94.06–209.45)	−70.0 (−81.5 to −51.3)
South Asia	39,009,724.43 (33,789,088.17–45,116,574.80)	−7.3 (−27.2 to 18.0)	2264.21 (1980.33–2598.62)	−42.9 (−53.8 to −29.6)	17.68 (12.55–26.32)	−35.9 (−64.6 to 15.9)	465.02 (357.17–648.94)	−42.5 (−63.5 to −9.4)
Southeast Asia	19,542,629.13 (17,388,041.04–21,687,134.88)	−5.1 (−20.8 to 13.7)	2924.63 (2602.99–3254.73)	−35.4 (−45.0 to −24.1)	11.37 (10.01–12.98)	−46.4 (−56.8 to −33.4)	390.32 (340.44–453.86)	−44.9 (−56.1 to −30.8)
Sex								
Male	55,696,368.79 (48,198,792.30–65,020,795.58)	−16.0 (−32.4 to 4.2)	2454.01 (2120.84–2881.74)	−43.4 (−53.9 to −30.6)	7.31 (5.94–11.95)	−56.3 (−76.0 to −20.5)	264.85 (213.73–366.92)	−52.4 (−69.2 to −26.4)
Female	50,671,712.03 (44,350,443.36–57,695,237.24)	−13.6 (−28.9 to 5.0)	2242.67 (1950.47–2578.33)	−44.8 (−54.3 to −33.4)	7.23 (5.53–10.49)	−43.3 (−66.2 to −4.9)	259.16 (201.61–341.85)	−44.5 (−62.1 to −18.6)

(Continues)

TABLE 1 | (Continued)

	Counts		Age-standardised prevalence rate (per 100,000 people)		Age-standardised mortality rate (per 100,000 people)		Age-standardised DALY rate (per 100,000 people)	
	Number of prevalent cases in all-age, 2021 (95% UI)	Percentage change, 1990–2021 (95% UI)	Rate of prevalent cases in age-standardised, 2021 (95% UI)	Percentage change, 1990–2021 (95% UI)	Rate of mortality cases in age-standardised, 2021 (95% UI)	Percentage change, 1990–2021 (95% UI)	Rate of DALY cases in age-standardised, 2021 (95% UI)	Percentage change, 1990–2021 (95% UI)
AD								
Asia (total)	68,196,550.81 (65,487,338.16–71,039,882.62)	16.1 (9.3–23.3)	1637.44 (1571.55–1705.01)	−2.5 (−8.0,3.3)	NA	NA	71.81 (36.90–119.99)	−2.2 (−57.5to 124.8)
Region								
Central Asia	4,213,491.07 (3,987,768.27–4,445,490.41)	17.6 (8.8–27.2)	4387.01 (4148.98–4628.20)	−0.3 (−7.7 to 7.7)	NA	NA	192.37 (98.80–324.14)	−0.1 (−56.8 to 131.0)
East Asia	16,208,854.99 (15,590,596.11–16,832,433.63)	−3.2 (−8.7 to 2.5)	1369.02 (1309.83–1425.29)	−0.9 (−6.7 to 5.4)	NA	NA	60.48 (31.37–101.51)	−0.6 (−56.7 to 128.2)
High income Asia Pacific	5,749,028.88 (5,540,185.57–5,973,000.10)	−15.1 (−19.9 to −10.1)	4596.03 (4402.96–4811.08)	−0.2 (−6.3to 6.3)	NA	NA	202.07 (103.47–337.30)	−0.1 (−56.7 to 130.7)
South Asia	26,665,780.7 (25,419,589.94–27,973,135.34)	32.7 (23.6–42.4)	1467.56 (1400.88–1540.43)	0.1 (−6.4 to 7.0)	NA	NA	64.23 (33.06–106.96)	0.7 (−56.2 to 131.3)
Southeast Asia	10,720,341.96 (10,242,262.75–11,201,651.97)	20.7 (13.1–28.8)	1645.49 (1571.30–1719.24)	0 (−6.1 to 6.5)	NA	NA	72.22 (37.33–122.50)	0.4 (−56.7 to 132.7)
Sex								
Male	31,368,090.83 (30,065,106.85–32,752,435.15)	16.0 (8.9,23.5)	1467.24 (1403.60–1532.12)	−2.2 (−8.0 to 4.0)	NA	NA	64.54 (33.09–107.96)	−1.8 (−57.4 to 126.4)
Female	36,828,459.98 (35,324,428.23–38,418,494.29)	16.2 (9.2–23.6)	1819.22 (1742.78–1900.85)	−2.7 (−8.5 to 3.4)	NA	NA	79.58 (40.97–132.85)	−2.4 (−57.5 to 123.9)

Abbreviations: AD, atopic dermatitis; DALY, disability-adjusted life-years; UI, uncertainty interval.

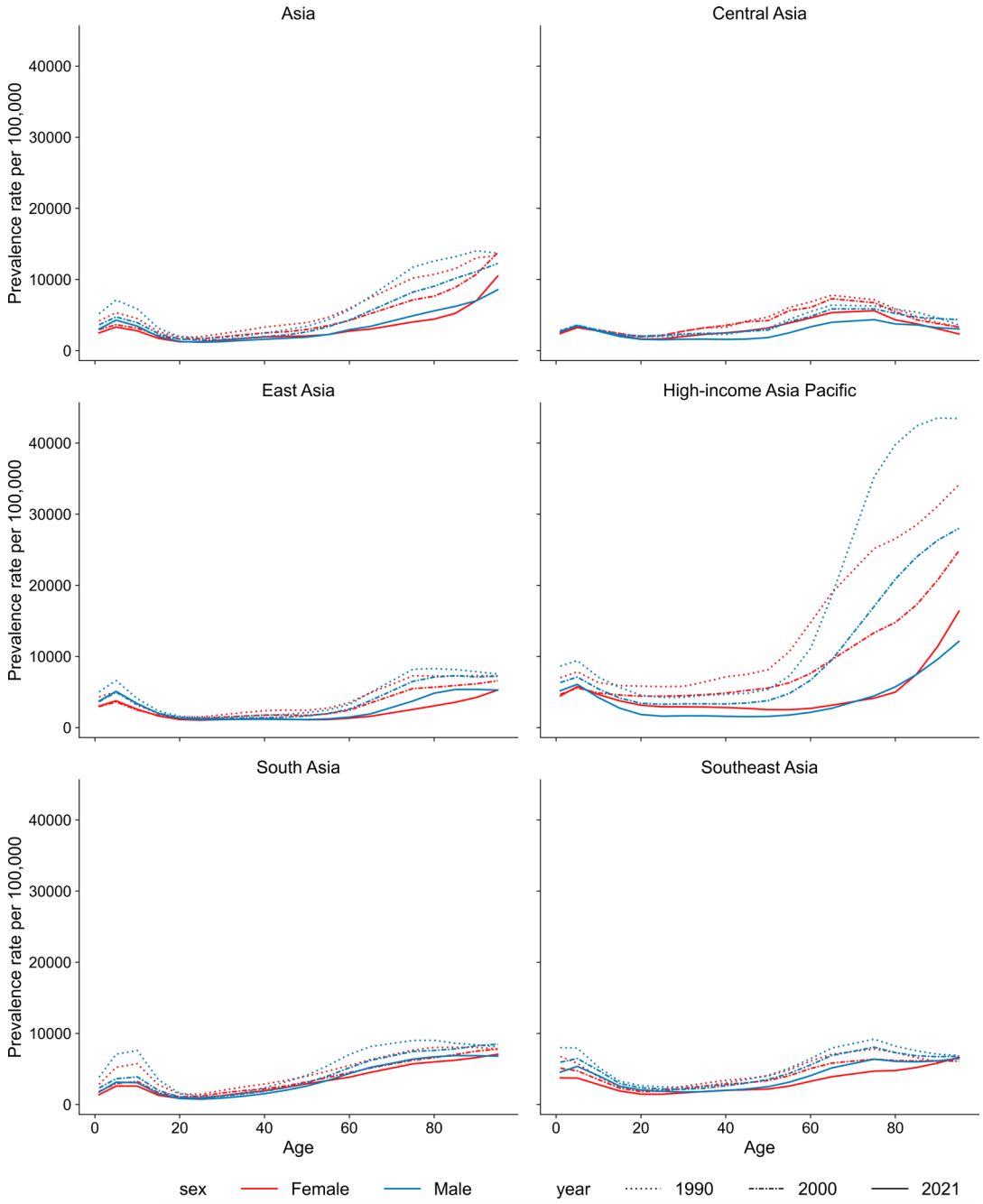

FIGURE 2 | Age-specific prevalence rates for asthma by age, sex, year, and location.

5–9 years age group, while the incidence rates were highest in the 0–4 years age group, nearly tripling by the 5–9 years age group (Figures S3 and S4).

3.4 | Regional and National Burden of AD

While the burden of AD varies significantly across different regions in Asia, some areas showed stability or slight changes over time. High-income Asia Pacific had the highest burden of AD from 1990 to 2021, with approximately 5.7 million prevalent cases (5.5–5.9) and an age-standardised DALY rate of 202.07 per 100,000 population (103.47–337.3) in 2021 (Figure 8). Similarly, Central Asia had a total AD prevalence of 4.2 million cases (3.9–4.4), with an age-standardised prevalence rate of 4387 cases per 100,000 population (4148–4628). While the total number of AD cases increased in Central Asia, the age-standardised prevalence rate has decreased, indicating a shift in the burden relative to population growth. South Asia, on the other hand, experienced the most significant increase of 32.7% (23.6–42.4) in AD prevalence from 1990 to 2021.

3.5 | Risk Factors Contribution to Asthma Burden

Four key risk factors were quantified for asthma burden: high BMI, occupational asthmagens, smoking, and NO_2 pollution (Figure 9). High BMI had the highest population-attributable

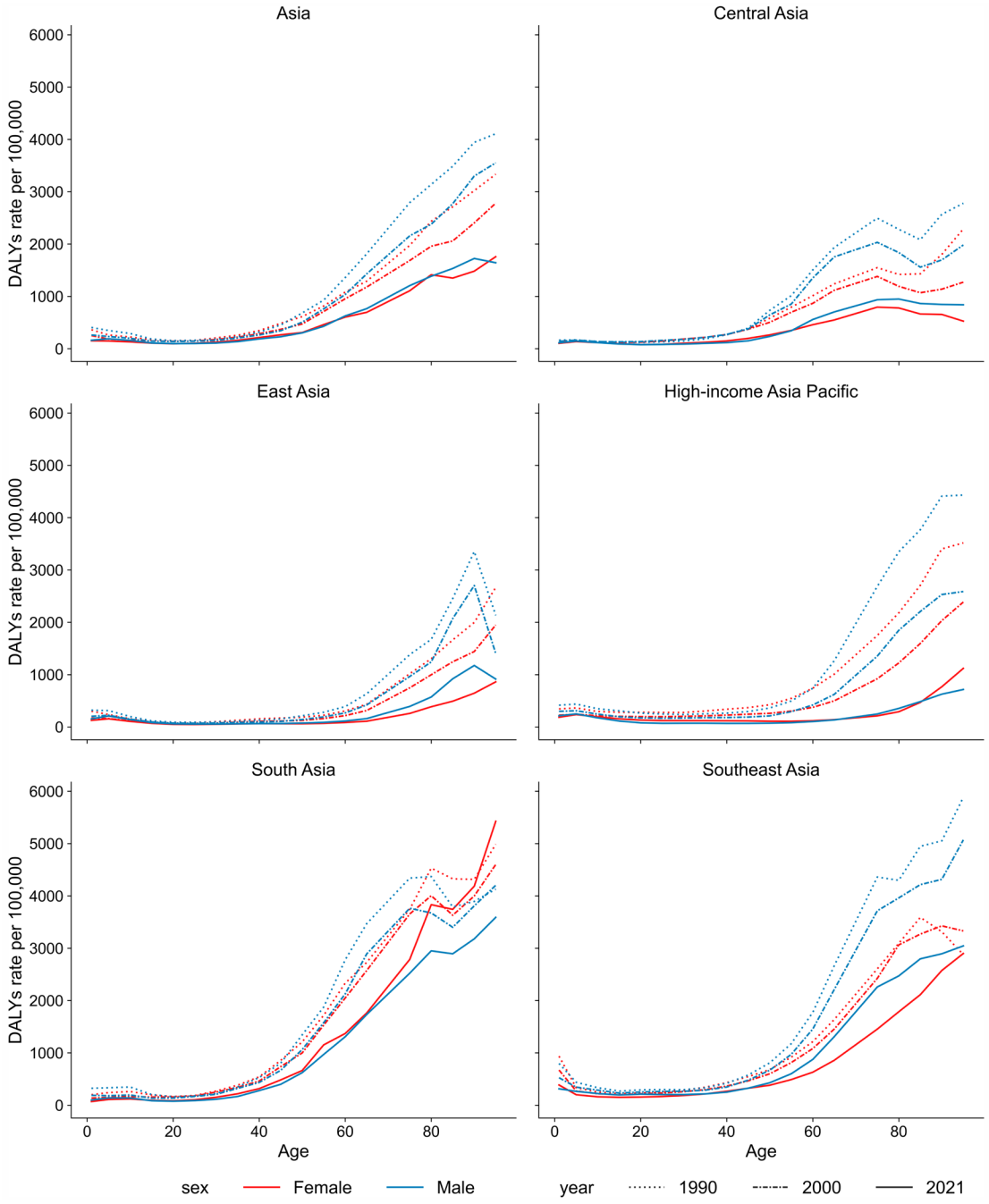

FIGURE 3 | Age-specific DALY rates for asthma by age, sex, year, and location.

DALY rate at 31.9 per 100,000 population (14.9–49.7) and was the only factor with a slightly higher DALY rate in females than in males. In high-income Asia Pacific, high BMI was a significant risk factor, with a higher age-standardised DALY in females. DALY rates associated with asthma in Asia that were attributable to smoking were almost six times higher in males (32.3 per 100,000 population [0.6–12.7]) than in females (5.8 per 100,000 population [0.6–12.7]). Southeast Asia and South Asia showed significant sex disparities in age-standardised DALY rates attributable to smoking. Since 2010, high BMI has emerged as the predominant attributable risk factor (Figures S5–S8).

4 | Discussion

This study highlights the distinct burden of asthma and AD in Asia, showing unique regional and national trends over the past three decades. Unlike most literature that focuses on individual countries over a short time frames [15–17], this study offers a comprehensive assessment utilising GBD 2021 data. The COVID-19 pandemic (2020–2021) likely influenced asthma and AD trends by impacting healthcare access, environmental exposures, and immune responses [18, 19]. Consistent with GBD 2019, the age-standardised asthma prevalence has declined, while age-standardised AD prevalence has remained relatively

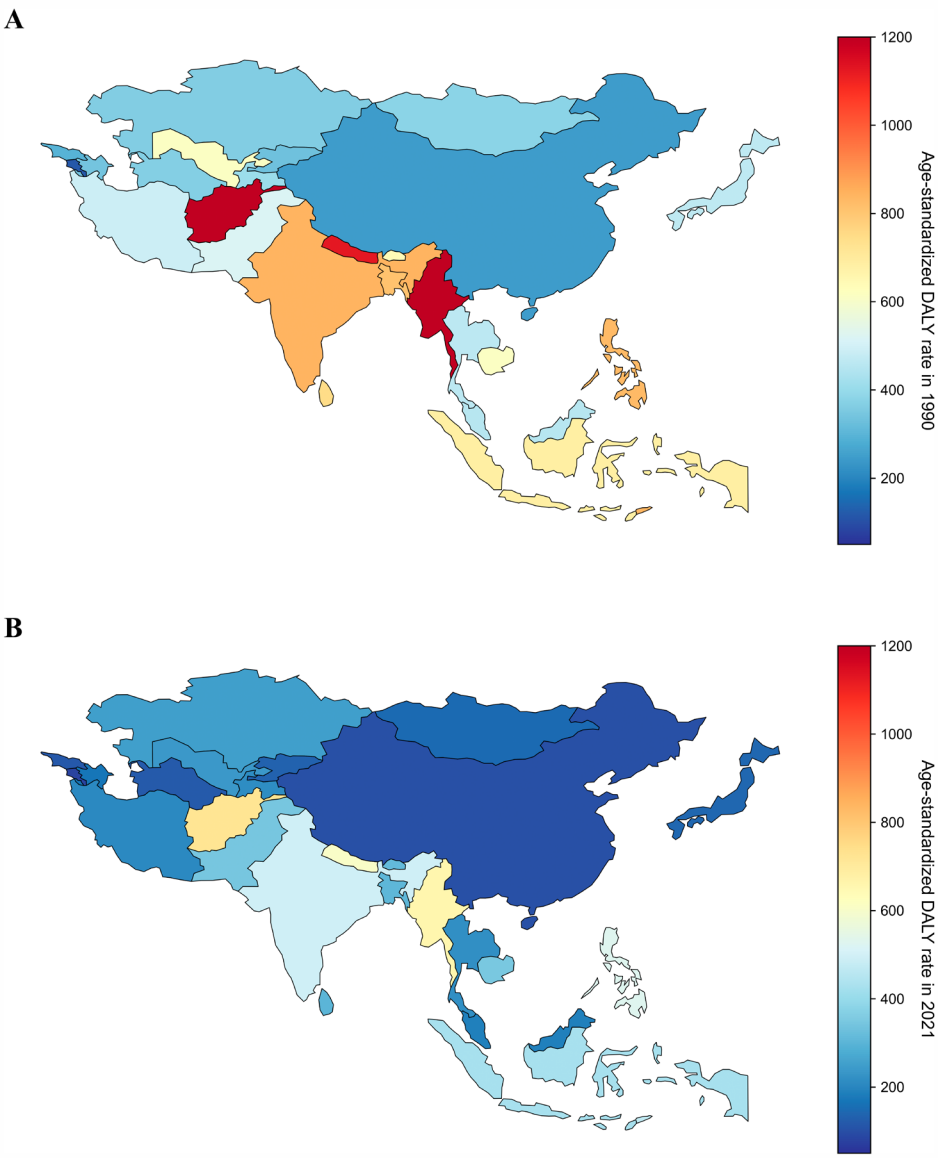

FIGURE 4 | World maps of the burden of asthma in Asia: (A) 1990 (B) 2021.

constant with a slight overall decrease [1]. Despite these declining trends, in 2021, Asia had nearly 106 million (92–121) asthma cases, causing 346,755 (278,046–464,848) deaths and 12.6 million (10.0–15.7) DALYs. In the same year, an estimated 68.1 million (65.4–71.0) cases of AD occurred in Asia, leading to 3.0 million (1.5–5.0) DALYs.

The decline in asthma prevalence by 44% from 1990 to 2021 reflects improvements in asthma management and healthcare infrastructure. However, regional disparities persist. According to the Global Initiative for Asthma, asthma remains more prevalent in developed countries, aligning with our findings in the high-income Asia Pacific region where high BMI is a major risk factor [20], consistent with national cohort studies linking obesity to asthma prevalence [21]. Sedentary lifestyles and increased consumption of processed foods may contribute to this association [22, 23]. Similarly, studies suggest that a higher carbohydrate intake is strongly linked to increased asthma prevalence and incidence [24]. These trends intensified during the pandemic, as reduced physical activity and increased stress likely influenced asthma symptoms [25, 26].

By 2021, asthma prevalence and DALY rates in high-income countries have drastically declined due to the robust healthcare systems and improved access to asthma management resources. Countries like South Korea, Japan and Singapore implemented comprehensive asthma programs, including patient education, early detection and advanced treatments such as biologics, leading to better asthma control and reduced hospitalizations [27–29]. These proactive approaches have lowered asthma prevalence and improved health outcomes in the high-income Asia Pacific region. (Supplement Discussion).

In contrast, South Asia exhibits the highest asthma prevalence and DALY rates, primarily due to high BMI, occupational exposures and air pollution. Agricultural and manufacturing workers face elevated risks, while rapid urbanisation and industrialisation have worsened air quality [30–32]. South Asia

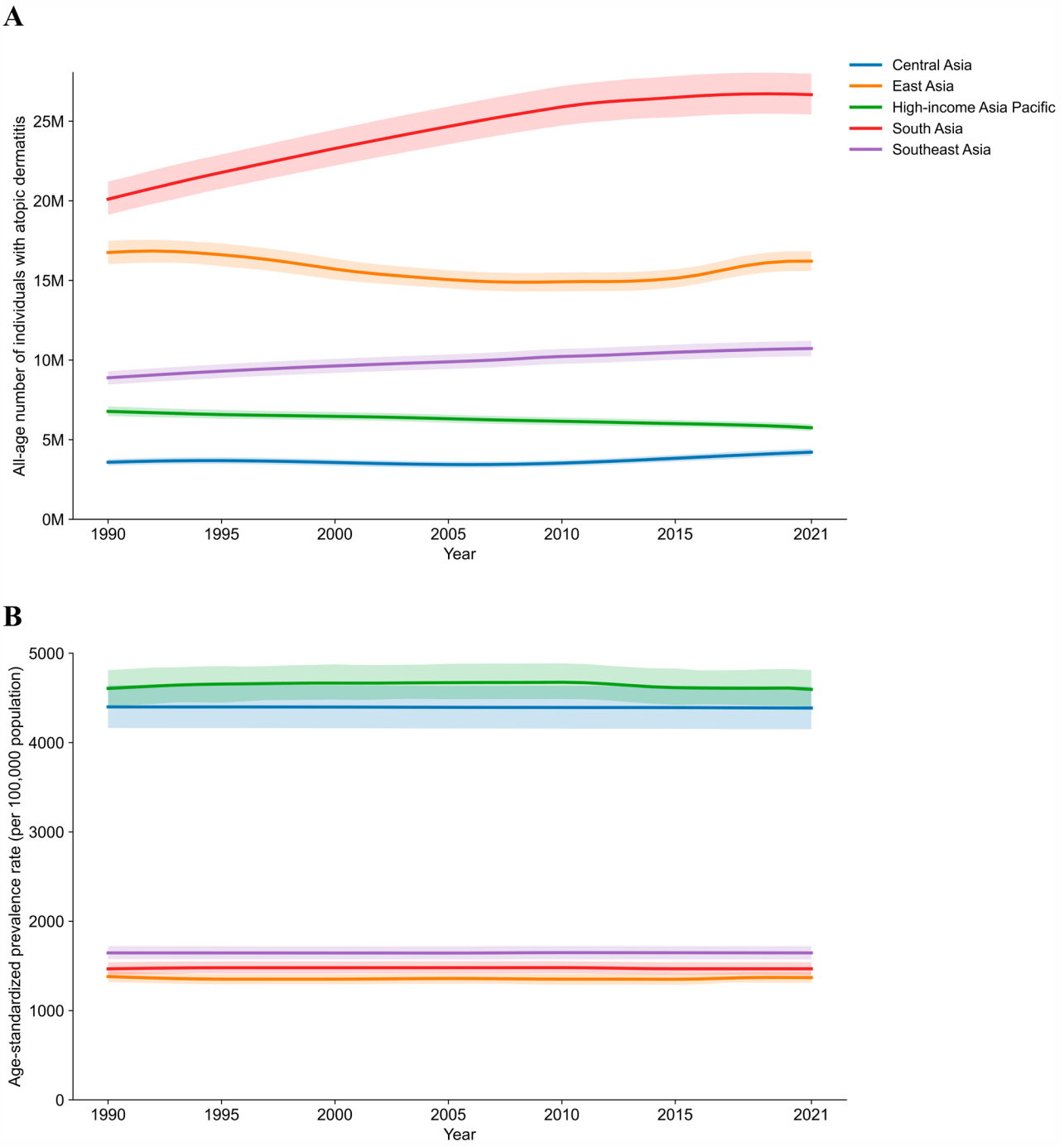

FIGURE 5 | (A) Number of prevalent AD cases and (B) age-standardised prevalence AD rates across Asian regions, 1990–2021, with 95% uncertainty intervals.

remains home to some of the world's most polluted cities, where high levels of particulate matter $\leq 2.5\,\mu m$ ($PM_{2.5}$) and rising temperatures further exacerbate asthma symptoms [33–36]. Moreover, lower-income and marginalised communities often lack access to quality healthcare, increasing the burden of asthma [4]. Even the COVID-19 pandemic disrupted healthcare access, particularly in low-income regions such as South Asia, which were already struggling with asthma management [37]. Asthma prevalence in India and China decreased until 2005 but has since risen, despite the unchanged age-standardised prevalence rates from 2005 to 2021. Population growth has increased absolute asthma cases, even if the age-standardised prevalence rates remained stable. While COVID-19 lockdowns briefly reduced pollution, the long-term effects of urbanisation, industrial emissions and coal dependence continue to impact asthma outcomes in China and India [38, 39]. Studies have indicated that air pollution exacerbates asthma severity and increases hospitalisation rates [40].

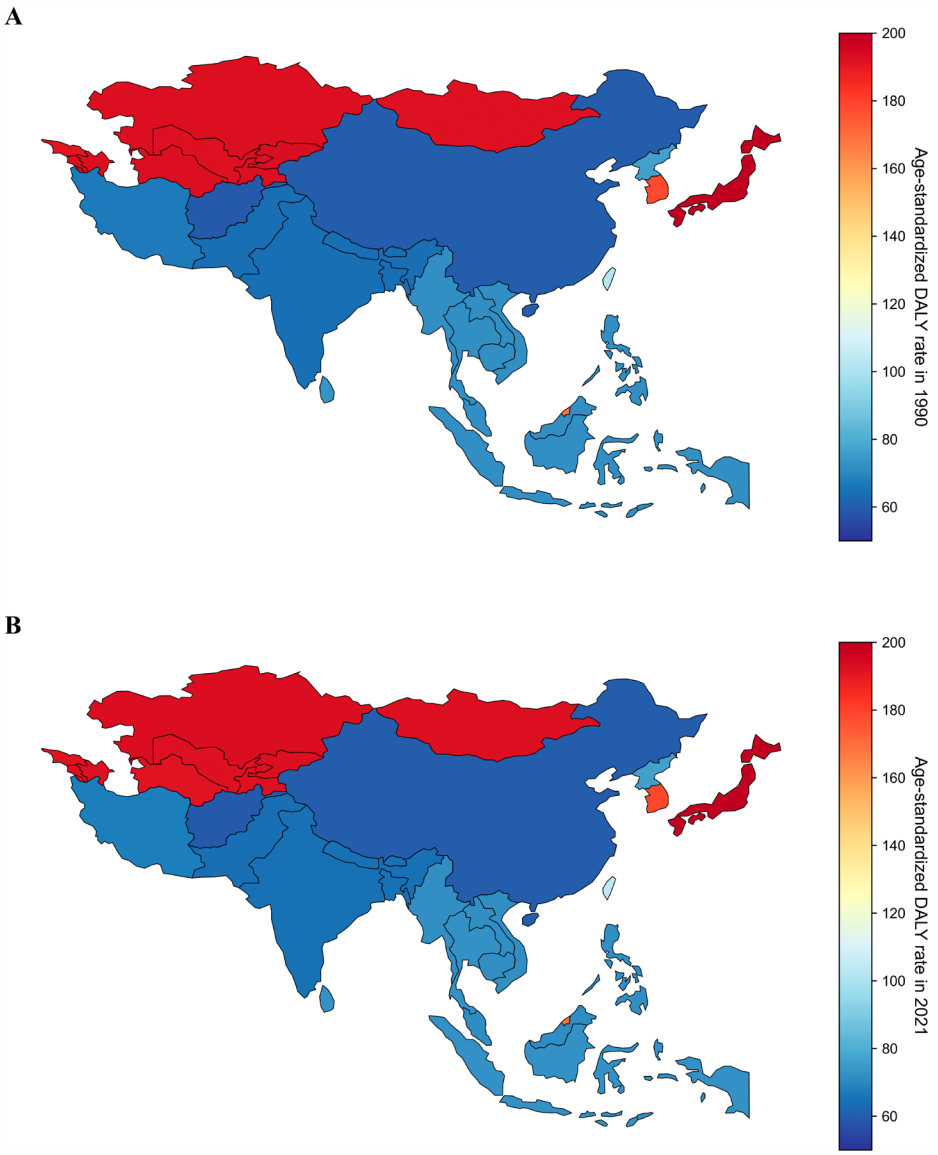

FIGURE 6 | World maps of the burden of AD in Asia: (A) 1990 (B) 2021.

Asthma is commonly perceived as a childhood condition but can develop at any age [41]. Consistent with previous studies, its incidence and prevalence are higher in children across Asia [42, 43]. However, the burden of asthma-related healthcare use and mortality is greater in adults, reflecting its cumulative impact over time. Older adults face more frequent exacerbations and complications, making asthma more severe and difficult to manage [41]. Also, natural declines in lung function contribute to reduced forced expiratory volume and heightened severe airflow restriction, contributing to higher prevalence and DALY rates in older age groups [44]. Furthermore, asthma prevalence shifts from being higher in boys during childhood to higher in women in adulthood, suggesting hormonal influences. Fluctuations in oestrogen and testosterone levels can exert profound effects on airway inflammation and reactivity.

The total number of AD cases in Asia surged to 68.1 million in 2021, though its age-standardised prevalence slightly declined, indicating population growth rather than a proportional increase in cases. Healthcare improvements may have alleviated some burden, but AD remains a persistent public health challenge [45]. AD prevalence varies widely among different countries, but there is a common perception that AD is considered one of the most common cutaneous inflammatory disorders in high-income countries [46]. With the alignment to studies, among five Asia regions, High-income Asia Pacific had the highest burden of AD from 1990 to 2021, with around 5.7 million prevalence cases. This region has undergone rapid urbanisation and economic development, leading to a more westernised lifestyle. This westernised shift in lifestyle factors has been linked to the development and exacerbation of AD [47]. Interestingly, Central Asia had the second highest prevalence rate of AD per 100,000 population. The increasing urbanisation and adoption of a more westernised lifestyle in parts of Central Asia may be contributing to the high AD prevalence in the region [48, 49].

AD is most prevalent in young children (0–5 years), aligning with its early-onset nature [50, 51]. Developing immune systems, allergen exposure and microbiome changes in urban Asian environments may contribute to the high prevalence of AD in young

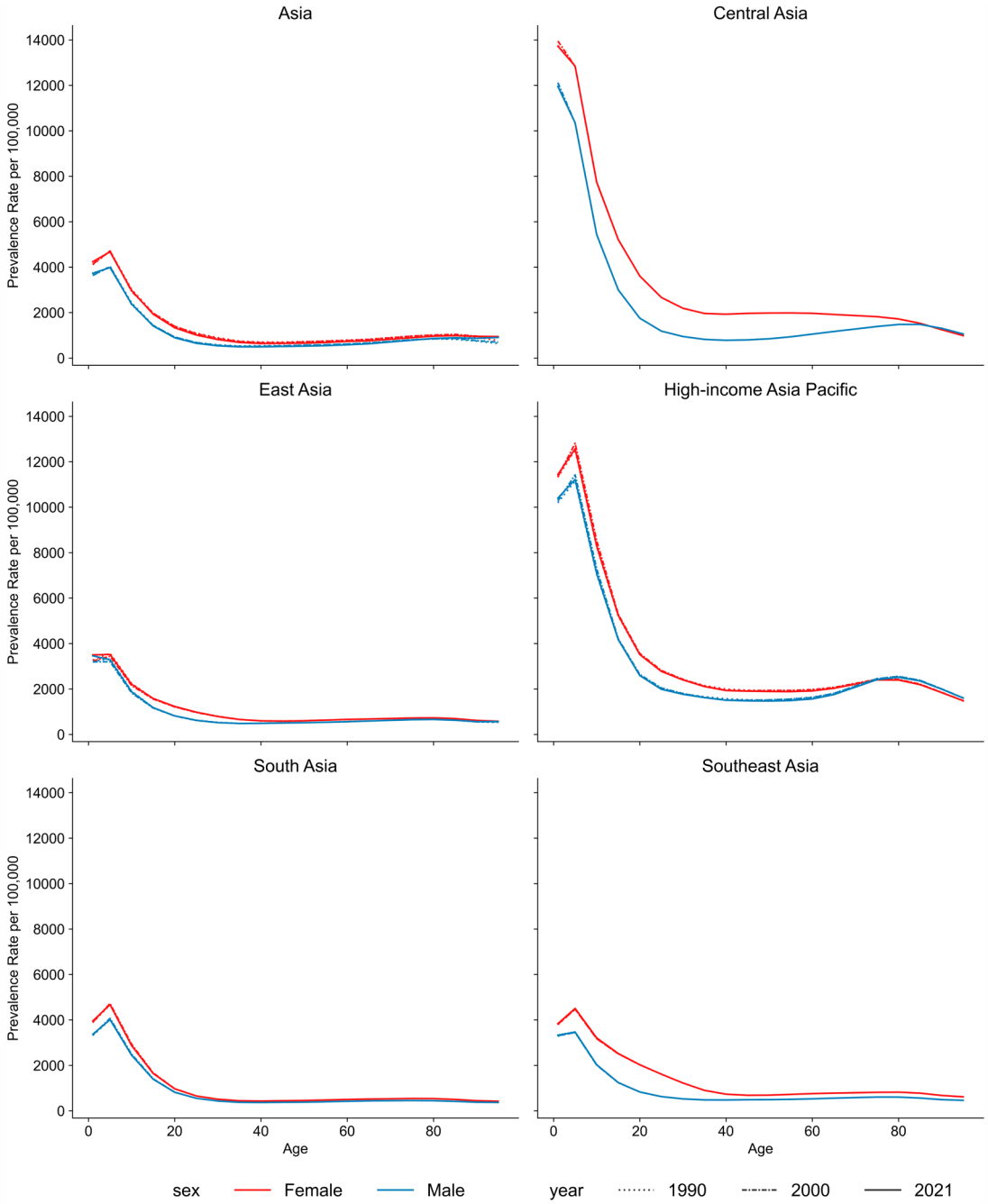

FIGURE 7 | Age-specific prevalence rates for AD by age, sex, year, and location.

children. Efforts to enhance early childhood healthcare, promote respiratory health education and implement preventive measures targeting this high-risk population may help reduce the overall AD burden in Asia. In terms of sex, AD is slightly more prevalent in females compared to males throughout all age groups. Fluctuations in female sex hormones can influence the immune system and skin barrier function, which may develop and progress with AD [52].

4.1 | Policy Implication

The cause and risk-specific insights on asthma and AD in Asia highlight the need for a multifaceted approach to address these conditions in Asia. This analysis could help to draft policies focusing on the prevention of the burden and functional loss, tailored to the unique characteristics of each Asian region. Integrated care approaches that recognise the interconnectedness of allergic diseases are crucial for managing these conditions effectively. Continued research, public health initiatives and access to quality care are essential to mitigate the impact of these allergic diseases. Furthermore, by incorporating the trends of allergic diseases for the management strategies, policymakers can proactively anticipate changes in disease burden and tailor interventions to meet the evolving needs of diverse populations in Asia.

4.2 | Strengths and Limitations of This Study

This study leverages the GBD 2021 dataset, offering a comprehensive analysis across diverse regions and populations. The

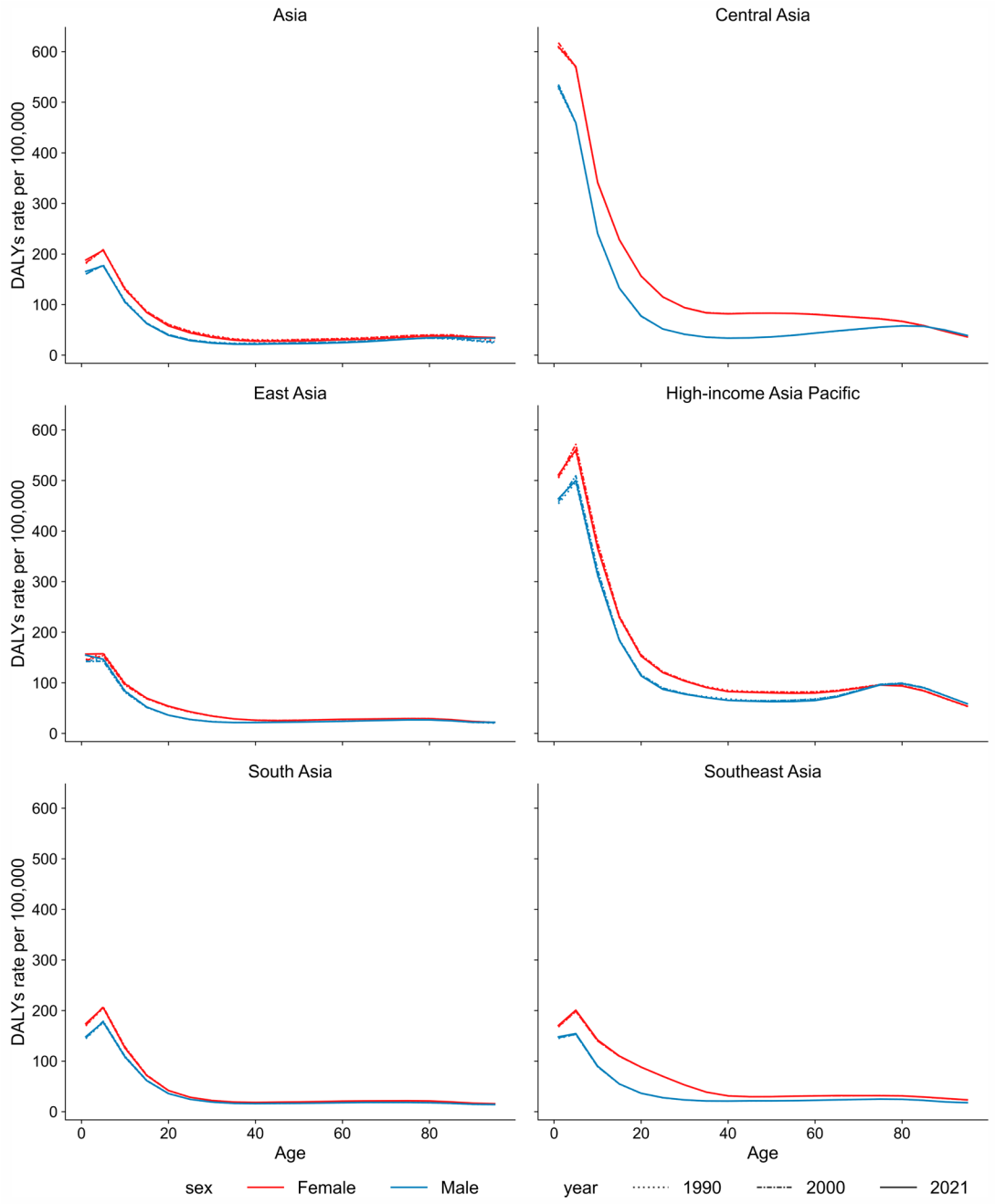

FIGURE 8 | Age-specific DALY rates for AD by age, sex, year, and location.

dataset undergoes annual systematic data collection and updates, ensuring its relevance to evolving trends. However, despite these strengths, this study is subject to the same limitations of the GBD methodology described in previous studies [1]. The major limitation lies in the variation in epidemiological data sources. It may introduce inconsistencies and biases, affecting results reliability. The GBD study addresses this through a rigorous method across regions and time periods. Secondly, in some lower-income countries and regions with inadequate health surveillance systems, data scarcity for out-of-sample modelling creates gaps in disease estimates. To mitigate biases, the GBD applies Bayesian hierarchical models to estimate and adjust for data quality issues, including incomplete or inconsistent reporting. This limitation underscores the importance of efforts to enhance data collection infrastructure in the underserved regions to improve the accuracy in future analyses. Thirdly, the discrepancies in asthma and AD definitions across countries may lead to misclassification or underestimation. Furthermore, reliance on physician diagnosis and symptoms could introduce potential heterogeneity in stringency across regions based on local practices and terminology. Fourth, the GBD dataset does not include AD-specific risk factors, limiting comprehensive burden assessment. Mortality data for AD is also absent, despite its significant impact on quality of life. Future studies should address this gap

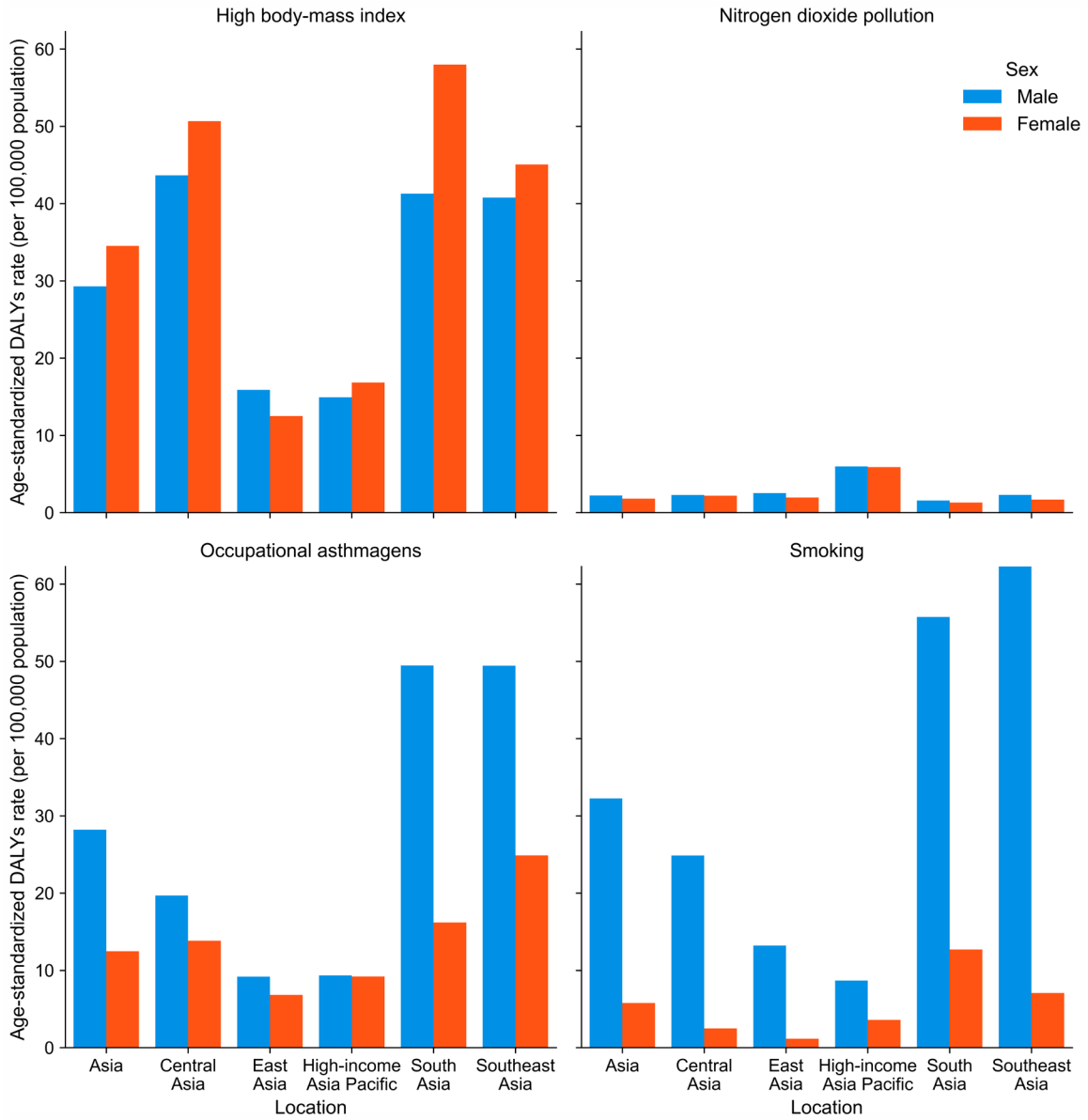

FIGURE 9 | Age-standardised DALY rate due to asthma attributable to risk factors in Asia by sex in 2021.

by incorporating comprehensive metrics for AD burden. Fifth, the study was limited by its focus on asthma and AD, excluding other allergic diseases. Finally, while asthma risk factors were analysed, the GBD 2021 may not fully capture region-specific or emerging risks, such as climate change, urbanisation and air pollution [53, 54].

5 | Conclusion

This study provided a comprehensive analysis of asthma and AD burden in Asia from 1990 to 2021. Asthma prevalence declined significantly, yet the total number of cases remained high, with 106 million cases in 2021. The age-standardised AD burden remained stable, with 68.1 million cases in 2021, reflecting its persistent impact despite medical advancements. High BMI emerged as the leading asthma risk factor, followed by occupational exposure, smoking and NO^2 pollution.

Given the substantial burden of these allergic diseases, region-wide public health strategies should focus on early prevention, risk factor reduction, and improved access to care. In addition, expanding research on the environmental and genetic factors influencing the increasing prevalence of AD is needed to mitigate its impact within the Asian context. Our findings underscore persistent regional disparities in healthcare systems for allergic diseases. This can serve as a foundation to guide future research to improve health outcomes across Asia.

Author Contributions

Please see the appendix 2 for more detailed information about individual author contributions to the research, divided into the following categories: providing data or critical feedback on data sources; developing 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 estimation or publications

process. Members of the core research team for this topic area had full access to the underlying data used to generate estimates presented in this study. All other authors had access to and reviewed estimates as part of the research evaluation process, which includes additional stages of formal review. Jae Il Shin and Dong Keon Yon contributed equally as corresponding authors. The corresponding authors (Jae Il Shin and Dong Keon Yon) had full access to the data in the study and had final responsibility for the decision to submit for publication. Contributions by the GBD 2021 Asia Allergic Disorders Collaborators are described in Appendix 1.

Acknowledgements

The authors take a neutral position with respect to territorial claims in published maps.

Disclosure

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.

Conflicts of Interest

Q E S Adnani reports grants or contracts from the Online Library Data Research funds from Universitas Padjadjaran, Bandung, Indonesia, under contract number 2152/UN6.3.1/PT.00/2024 and posed as the NIHR-Global Health Research Unit on Respiratory Health (RESPIRE) National Stakeholder Engagement Champion for Indonesia; outside the submitted work. T Fukumoto reports payment or honoraria for lectures, presentations, speakers bureaus, manuscript writing or educational events from AbbVie, Sanofi, Maruhi, Taiho, Sun Pharma, UCB, Janssen Phar, Eli Lilly, Pfizer and Novartis; outside the submitted work. N E Ismail reports leadership or fiduciary roles in board, society, committee or advocacy groups, unpaid with the Malaysian Academy of Pharmacy as Bursar and Council Member, and with the Education Chapter of the Malaysian Pharmacists Society as a Committee Member; outside the submitted work. M-C Li reports support for the present manuscript from the National Science and Technology Council, Taiwan (NSTC 113-2314-B-003-002); leadership or fiduciary roles in board, society, committee or advocacy groups, unpaid with the Journal of the American Heart Association as Technical Editor, outside the submitted work. S Saleem reports payment or honoraria for lectures, presentations, speakers bureaus, manuscript writing or educational events from the Health Services Academy (Islamabad, Pakistan); outside the submitted work. Y L Samodra reports grants or contracts from the Institute of Epidemiology and Preventive Medicine, NTU, Taiwan & NSTC; Leadership or fiduciary role in other board, society, committee or advocacy group, paid or unpaid as co-founder of Benang Merah Research Center (Indonesia); other financial or non-financial support from Jago Beasiswa as a mentor; outside the submitted work. E Upadhyay reports the following patents planned, issued or pending: A system and method of reusable filters for anti-pollution mask (published), a system and method for electricity generation through crop stubble by using microbial fuel cells (published), a system for disposed personal protection equipment (PPE) into biofuel through pyrolysis and method (published), a novel herbal pharmaceutical aid for formulation of gel and method thereof (published), herbal drug formulation for treating lung tissue degenerated by particulate matter exposure (published), a method to transform cow dung into the wall paint by using natural materials and composition thereof (filed); Leadership or fiduciary role in other board, society, committee or advocacy group, paid or unpaid as an Executive Council Member of the Indian Meteorological Society (Jaipur Chapter, India), and as Member Secretary of DSTPURSE Program; outside the submitted work.

Data Availability Statement

To download the data used in these analyses, please visit the Global Health Data Exchange GBD 2021 website at https://ghdx.healthdata.org/gbd-2021.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section.

Appendix 1

GBD 2021 Asia Allergic Disorders Collaborators

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Appendix 2

Asthma and Atopic Dermatitis in Asia, 1990–2021: The Global Burden of Disease Study 2021

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