CHEST

Prevalence, Deaths, and Disability-Adjusted Life-Years Due to Asthma and Its Attributable Risk Factors in 204 Countries and Territories, 1990-2019

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BACKGROUND: Understanding global trends in the point prevalence, deaths, and disability-adjusted life-years (DALYs) for asthma will facilitate evidence-based decision-making.

RESEARCH QUESTION: What are the global, regional, and national burdens of asthma in 204 countries and territories between 1990 and 2019 by age, sex, and sociodemographic index (SDI)?

STUDY DESIGN AND METHODS: Publicly available data from the Global Burden of Disease study from 1990 through 2019 were used. All estimates were presented as counts and age-standardized rates per 100,000, along with their associated uncertainty intervals.

RESULTS: In 2019, the global age-standardized point prevalence and death rates for asthma were 3,415.5 and 5.8 per 100,000, which represent a 24% and 51.3% decrease since 1990, respectively. Moreover, in 2019, the global age-standardized DALY rate was 273.6 and the global point prevalence of asthma was highest in the group 5 to 9 years of age. Also in 2019, the United States (10,399.3) showed the highest age-standardized point prevalence rate of asthma. Generally, the burden of asthma decreased with increasing SDI. Globally, high BMI (16.9%), smoking (9.9%), and occupational asthmagens (8.8%) contributed to the 2019 asthma DALYs.

INTERPRETATION: Asthma remains an important public health issue, particularly in regions with low socioeconomic development. Future research is needed to examine thoroughly the associations asthma has with its risk factors and the factors impeding optimal self-management. Further research also is needed to understand and implement better the interventions that have reduced the burden of asthma. CHEST 2022; 161(2):318-329

KEY WORDS: asthma; burden; epidemiology; global; mortality; prevalence; risk factors

ABBREVIATIONS: DALY = disability-adjusted life-year; GBD = Global Burden of Disease; SDI = sociodemographic index

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Take-home Points

Study Question: What are the global, regional, and national burdens of asthma by age, sex, and sociodemographic index (SDI) and how have these changed between 1990 and 2019?

Results: Despite a reduction in the global burden of asthma between 1990 and 2019, the prevalence remains high, as do deaths and DALYs.

Interpretation: Large intercountry variations in the burden of asthma were found. Nevertheless, asthma remains a substantial public health issue requiring emergent health actions, especially in countries with a lower SDI.

Asthma is a common chronic noncommunicable disease affecting approximately 358 million people worldwide.[1,2] The negative impacts are reported most commonly among children and young adults, largely because asthma develops in one in four individuals before 40 years of age.[3] In 2019, asthma ranked eighth of 369 diseases and injuries to impact those 20 years of age and younger, as measured by years lived with disability.[4]

Asthma causes a substantial economic burden, with a US study reporting the per-person incremental medical cost to be $3,266 per year.[5] Furthermore, the authors estimated that asthma cost the economy more than $80 billion annually through direct medical expenditure, absenteeism, and mortality.[5] Moreover, severe asthma can affect an individual's social life, physical activity, work, and education substantially.

No recent studies have reported the global epidemiologic patterns of asthma,[6,7] and none using the most current data from the Global Burden of Disease (GBD) project.[6-8] Nevertheless, the global burden of all respiratory diseases were reported in 2015 and 2017 using GBD data, but no recent study focused on asthma alone.[2,9] The latest evidence regarding the burden of asthma is required to inform clinical care guidelines and public policy, with the aim to prevent disease development and to reduce the societal and individual burden of asthma. Therefore, the current study reports the prevalence, deaths, and disability-adjusted life-years (DALYs) resulting from asthma and its attributable risk factors in 204 countries and territories from 1990 through 2019 by age, sex, and sociodemographic index (SDI).

Methods

Data used in this study were sourced from the GBD 2019 project. Information about the case definition, data sources, disease model, severity and years lived with disability, compilation of the results, and risk factors was presented in previous publications.[4,10,11] A synopsis of these methods are reported herein, with detailed methodology available in e-Appendix 1.

Case Definition

Asthma was defined by doctor diagnosis and wheezing in the past year, with alternative case definitions presented in e-Appendix 1.[4]

Disease Model

The standard Cause of Death Ensemble modelling approach was used to estimate asthma mortality, with DisMod-MR 2.1 used as the main asthma modelling tool. The list of covariates used in the Cause of Death Ensemble modelling are shown in e-Table 1.

Severity and Years Lived With Disability

The International Classification of Diseases, Ninth Revision (code 493) and Tenth Revision (codes J45 and J46), were used for asthma, with four sequelae (severity levels) (e-Table 2). Information from the Medical Expenditure Panel Surveys was used to determine the proportion of each asthma severity level.

Compilation of Results

The years of life lost were calculated by multiplying the number of deaths in an age group by the remaining life expectancy in that age group, as per the GBD standard life table. DALYs then were calculated as the sum of the years of life lost and years lived with disability.

Results

Global Level

In 2019, there were 262.4 million (95% uncertainty interval) (Table 1) prevalent cases of asthma globally, with an age-standardized point prevalence of 3,415.5 per

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DISCLAIMER: This study is based on publicly available data and solely reflects the opinion of its authors and not that of the Institute for Health Metrics and Evaluation.

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TABLE 1] Prevalent Cases, Deaths, and DALYs for Asthma in 2019 and the Percentage Change in the Age-Standardized Rates per 100,000 People by GBD Region From 1990 Through 2019

	Prevalence (95% UI)			Deaths (95% UI)			DALYs (95% UI)		
GBD Region	No. (95% UI)	ASRs per 100,000 (95% UI)	Percentage Change in ASRs Between 1990 and 2019	No. (95% UI)	ASRs per 100,000 (95% UI)	Percentage Change in ASRs Between 1990 and 2019	No. (95% UI)	ASRs per 100,000 (95% UI)	Percentage Change in ASRs Between 1990 and 2019
Global	262,405,182 (224,047,914-309,452,681)	3,415.5 (2,898.9-4,066.2)	−24 (−27.2 to −20.8)	461,069 (366,580-559,006)	5.8 (4.6-7)	−51.3 (−59.1 to −43.7)	21,550,977 (17,141,587-26,971,997)	273.6 (216.7-343.4)	−42.5 (−48.5 to −36.6)
High-income Asia Pacific	7,250,096 (6,115,953-8,632,440)	3,744.9 (3,032.3-4,726.2)	−48.7 (−54.3 to −42.8)	4,948 (3,761-6,267)	0.8 (0.7-1)	−88.2 (−90.3 to −83)	335,832 (237,183-464,856)	160.3 (105.9-237.6)	−60.9 (−66.9 to −54.8)
High-income North America	35,609,106 (31,843,996-39,983,534)	9,848.1 (8,624.3-11,312.1)	9.6 (1.2-19.2)	4,373 (3,593-4,701)	0.8 (0.7-0.9)	−49.9 (−58.8 to −47.1)	1,484,598 (1,021,841-2,057,307)	413 (282.5-584.4)	2.8 (−4.4 to 10.6)
Western Europe	27,043,663 (22,873,450-31,920,142)	5,893.4 (4,900.3-7,117.7)	−29.3 (−35.1 to −23.6)	6,902 (5,733-7,827)	0.7 (0.6-0.8)	−77.3 (−79.5 to −74.7)	1,150,103 (785,822-1,641,190)	245.6 (162.9-361.9)	−38 (−44.3 to −32.3)
Australasia	2,317,311 (1,958,150-2,773,621)	8,393.3 (6,908.8-10,347.1)	−30.6 (−40.6 to −18.5)	545 (448-636)	1.1 (1-1.3)	−73.8 (−77 to −70)	101,067 (69,220-144,907)	360 (239-527.6)	−39.3 (−48.2 to −29.4)
Andean Latin America	2,688,039 (2,008,863-3,586,171)	4,215.4 (3,152.4-5,621.4)	−22.8 (−34 to −11.2)	521 (404-660)	0.9 (0.7-1.2)	−77.1 (−83.1 to −68.8)	121,611 (78,553-185,551)	192.3 (124.9-291.9)	−51.5 (−62.1 to −39.5)
Tropical Latin America	9,896,164 (7,738,019-12,694,179)	4,907.3 (3,771.5-6,383.3)	−18.3 (−24.5 to −12.6)	2,940 (2,613-3,448)	1.3 (1.1-1.5)	−62.8 (−67.4 to −56)	465,996 (321,847-685,484)	227.3 (154.5-339.9)	−33.2 (−40.7 to −26.5)
Central Latin America	7,921,211 (6,215,577-10,048,175)	3,244.4 (2,546.2-4,160.4)	−26.2 (−32.4 to −19.8)	3,419 (2,810-4,047)	1.5 (1.2-1.8)	−77.2 (−81.6 to −72.8)	403,923 (283,108-574,650)	166.1 (116.3-237.5)	−50.8 (−58.7 to −43.1)
Southern Latin America	4,431,281 (3,786,071-5,243,875)	6,450.2 (5,427.8-7,800.4)	−3.7 (−12.1 to 5.4)	884 (731-1,006)	1.1 (0.9-1.2)	−61.8 (−68.2 to −55.4)	190,578 (130,424-271,189)	275.8 (188.2-399.4)	−17.4 (−26.2 to −8.5)
Caribbean	2,736,600 (2,297,598-3,292,308)	6,072.6 (5,048.5-7,345.1)	−14.6 (−18.4 to −10.3)	2,233 (1,693-2,832)	4.5 (3.4-5.8)	−43.6 (−54.7 to −30.6)	192,996 (146,202-249,879)	422.8 (315.7-553.5)	−30.5 (−39.2 to −21.2)
Central Europe	5,066,122 (4,218,455-6,051,251)	4,203.6 (3,452.8-5,155.5)	−27.4 (−32.9 to −21.9)	1,776 (1,509-2,139)	0.8 (0.7-1)	−82.5 (−85.2 to −78.9)	226,328 (157,240-318,448)	180.5 (119.9-263.9)	−43.2 (−50.5 to −36.8)
Eastern Europe	5,363,011 (4,377,809-6,458,925)	2,712 (2,160.8-3,412.6)	−42.6 (−48.2 to −37.1)	2,326 (1,964-3,410)	0.7 (0.6-1)	−83.4 (−86.3 to −73)	260,765 (184,395-363,884)	124.1 (84.1-182.6)	−57 (−63.6 to −50.2)

(Continued)

TABLE 1] *(Continued)*

GBD Region	Prevalence (95% UI)			Deaths (95% UI)			DALYs (95% UI)		
	No. (95% UI)	ASRs per 100,000 (95% UI)	Percentage Change in ASRs Between 1990 and 2019	No. (95% UI)	ASRs per 100,000 (95% UI)	Percentage Change in ASRs Between 1990 and 2019	No. (95% UI)	ASRs per 100,000 (95% UI)	Percentage Change in ASRs Between 1990 and 2019
Central Asia	2,072,070 (1,692,605-2,559,339)	2,277.4 (1,883.3-2,787.8)	−15.4 (−21.8 to −9.4)	3,342 (2,869-4,053)	5.4 (4.7-6.5)	−47.1 (−58 to −28.7)	160,741 (126,601-204,693)	198 (160-246)	−38.9 (−48.1 to −27.4)
North Africa and Middle East	2,2132,734 (18,619,787-26,444,040)	3,819.3 (3,262.5-4,512.7)	−7.9 (−12.4 to −3.2)	32,076 (26,201-38,345)	8.4 (6.9-9.9)	−59 (−68.2 to −49.3)	1,677,783 (1,318,052-2,122,631)	324.2 (259.2-397.5)	−47.6 (−56 to −39.1)
South Asia	39,871,689 (33,201,510-47,765,389)	2,443.4 (2,029.8-2,909.8)	−10.9 (−17 to −7.7)	232,188 (160,834-316,297)	18.9 (12.9-26.4)	−51.2 (−62.1 to −39.8)	6,907,586 (5,205,633-8,695,263)	472 (350.5-601.2)	−49.6 (−59.1 to −39.4)
Southeast Asia	22,359,243 (19,257,485-26,371,311)	3,431.8 (2,926.7-4,059.8)	−8.2 (−11 to −5.1)	72,055 (61,159-81,555)	13.8 (11.6-15.6)	−55.4 (−65.3 to −43.7)	2,678,719 (2,252,869-3,164,506)	433.2 (365.4-509.7)	−49.7 (−56.8 to −41.3)
East Asia	26,502,559 (21,606,395-32,719,373)	2,025.5 (1,577.4-2,631.4)	−14.1 (−18.5 to −10.3)	27,211 (22,727-33,033)	1.6 (1.3-1.9)	−75.9 (−85 to −64.1)	1,528,079 (1,141,964-2,062,500)	106.4 (75.3-152.1)	−50.7 (−63.6 to −38.8)
Oceania	529,213 (467,646-599,363)	4,265.2 (3,835-4731.9)	−21.7 (−24.6 to −18.8)	2,556 (1,891-3,446)	46.8 (34.4-63.6)	−31.2 (−46.9 to −13.2)	95,043 (74,135-122,199)	1,102.2 (863.7-1,431.3)	−31.6 (−45 to −15.7)
Western Sub-Saharan Africa	14,052,637 (11,321,219-17,960,481)	3,087.3 (2,629-3,669.7)	−18.1 (−21 to −15)	24,108 (19,908-29,110)	13.1 (11-15.7)	−43 (−52 to −31.5)	1,340,150 (1,080,864-1,670,430)	425.2 (354-508.8)	−39.6 (−48.1 to −29.7)
Eastern Sub-Saharan Africa	17,781,817 (14,422,770-22,250,549)	4,151.2 (3,582.1-4,898.7)	−19.1 (−22.6 to −15.2)	19,765 (15,361-28,237)	11.3 (8.5-17.5)	−45.6 (−54 to −34)	1,450,564 (1,120,595-1,856,696)	450.9 (356.4-582.8)	−43 (−50.8 to −31.8)
Central Sub-Saharan Africa	4,117,823 (3,355,827-5,095,414)	3,081.7 (2,653.8-3,633.4)	−15.9 (−19.9 to −11.2)	9,792 (6,176-17,107)	20.6 (12-41.6)	−33.9 (−50.2 to −13)	479,544 (341,410-658,749)	572.9 (389.2-908)	−37.7 (−51.2 to −21.3)
Southern Sub-Saharan Africa	2,662,794 (1,922,876-3,414,012)	3,476.2 (2,532.4-4,396.6)	−15.9 (−22.5 to −10)	7,109 (6,295-8,293)	13.8 (12.1-16.1)	−39.3 (−53.5 to −27.2)	298,971 (249,019-366,217)	446.5 (378.5-530.7)	−40.1 (−48.9 to −31.6)

Table generated from data available from http://ghdx.healthdata.org/gbd-results-tool. ASRs = age-standardized rates; DALY = disability-adjusted life-year; GBD = Global Burden of Disease; UI = uncertainty interval.

100,000 people, a 24% decrease since 1990. Asthma accounted for 461.1 thousand deaths in 2019, with an age-standardized rate of 5.8 per 100,000 people, a 51.3% reduction since 1990. In 2019, the number of global DALYs resulting from asthma was 21.6 million, with an age-standardized rate of 273.6 DALYs per 100,000 people, a 42.5% decrease since 1990 (Table 1).

Regional Level

In 2019, the age-standardized point prevalence of asthma (per 100,000 people) was highest in high-income North America (9,848.1), but lowest in East Asia (2,025.5) (Table 1). Oceania (46.8) showed the highest age-standardized death rates resulting from asthma, with the lowest rates being in Eastern Europe (0.7) and Western Europe (0.7).

In 2019, Oceania (1,102.2) showed the highest age-standardized DALY rates (per 100,000 people), whereas East Asia (106.4) showed the lowest (Table 1). The age-standardized point prevalence, deaths, and DALY rates of asthma are presented for all GBD regions in 2019 in e-Figures 1-3, respectively.

The age-standardized point prevalence of asthma decreased from 1990 through 2019 in all regions except high-income North America (9.6%). High-income Asia-Pacific (–48.7%) showed the largest decreases during the measurement period. In the same period, all regions showed a decrease in the age-standardized death rates resulting from asthma, with the largest decreases being in high-income Asia-Pacific (–88.2%) (Table 1). Furthermore, the age-standardized DALY rates decreased in all regions from 1990 through 2019, with the greatest decreases being in high-income Asia-Pacific (–60.9%) (Table 1). The percentage change, from 1990 through 2019, in the age-standardized point prevalence, death, and DALY rates for asthma are presented in e-Figures 4-6, respectively.

The number of prevalent cases of asthma increased from 226.9 million in 1990 to 262.4 million in 2019. South Asia and high-income North America showed the largest number of prevalent cases in 2019 (e-Table 3). The number of deaths resulting from asthma increased marginally from 460.0 thousand in 1990 to 461.0 thousand in 2019, with South Asia and Southeast Asia showing the highest number of deaths in 2019 (e-Table 4). Moreover, the number of DALYs decreased from 22.3 million in 1990 to 21.6 million in 2019, with South Asia and Southeast Asia showing the highest numbers of DALYs in 2019 (e-Table 5).

National Level

In 2019, the national age-standardized point prevalence of asthma ranged from 1,072.5 to 10399.3 cases per 100,000 people. The United States (10,399.3) showed the highest age-standardized point prevalence rates of

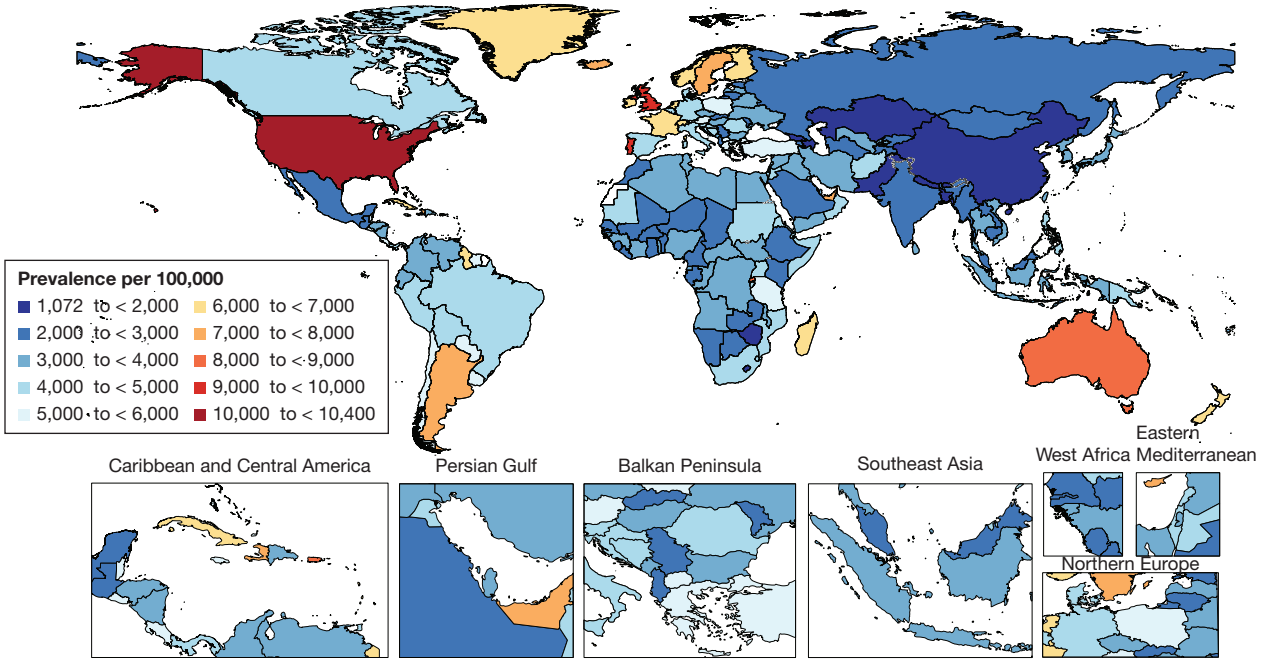

Figure 1 – *Map showing age-standardized point prevalence of asthma per 100,000 population in 2019 by country. (Generated from data available at http://ghdx.healthdata.org/gbd-results-tool.)*

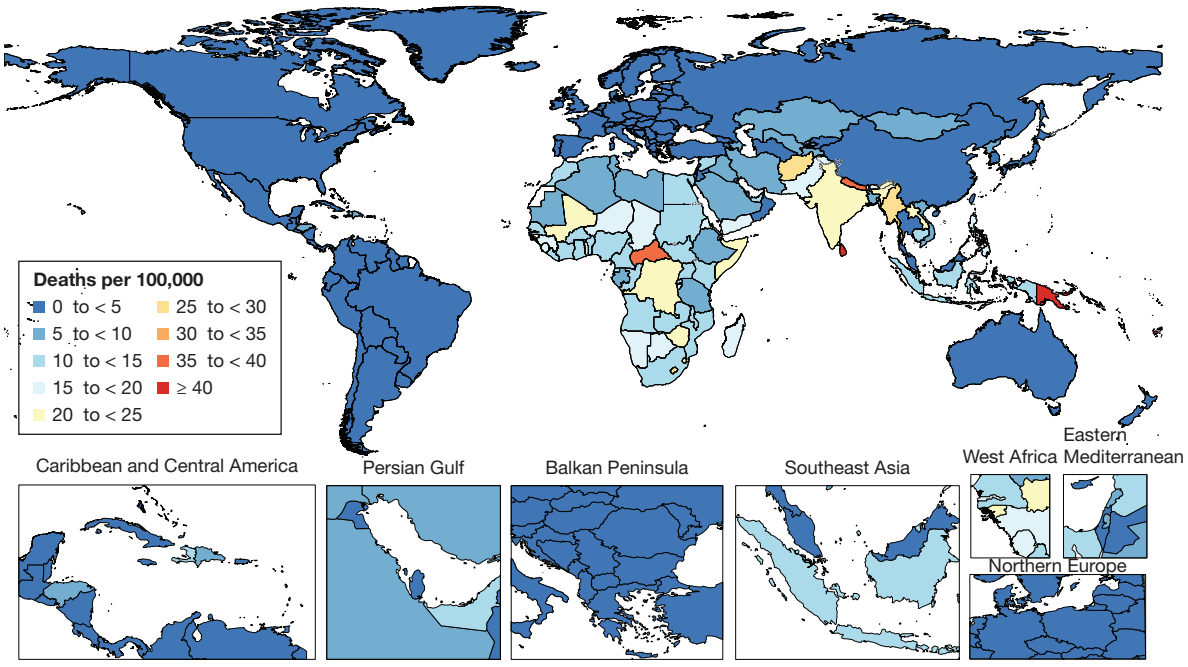

Figure 2 – *Map showing age-standardized death rate resulting from asthma per 100,000 population in 2019 by country. (Generated from data available at http://ghdx.healthdata.org/gbd-results-tool.)*

asthma, with Nepal (1,072.5) having the lowest (Fig 1, e-Table 3). The national age-standardized death rates of asthma in 2019 varied from 0.3 to 80.5 cases per 100,000 people. The highest rates were observed in Kiribati (80.5), whereas the lowest rates were found in Greece (0.3), Italy (0.3), and Montenegro (0.3) (Fig 2, e-Table 4). In 2019, the national age-standardized DALY rate of asthma ranged from 91.1 to 1,795.1 cases per 100,000 people. The highest rates were observed in Kiribati (1,795.1), whereas the lowest rates were in Armenia (91.1) (e-Fig 7, e-Table 5). The percentage change in the age-standardized point prevalence, from 1990 through 2019, differed substantially between countries, with Oman (31.4%) showing the largest increases. In contrast, New Zealand (–55.1%) showed the largest decreases (e-Table 3).

No country showed an increase in the age-standardized death or DALY rates over the last 30 years. The Republic of Korea (–90.2%) showed the largest decreases in the age-standardized death rates of asthma (e-Table 4), whereas the Maldives (–75.6%) showed the largest decreases in DALYs over the measurement period (e-Table 5).

Age and Sex Patterns

In 2019, the global point prevalence of asthma was very high in the group 5 to 9 years of age, but decreased from there to the group 25 to 29 years of age, before increasing again up to the oldest age group (95 years of age or older). Similarly, the number of prevalent cases was highest in the groups 1 to 14 years of age, which then decreased with increasing age. Furthermore, the global point prevalence and number of prevalent cases of asthma were higher in men and boys up to the 15 to 19 years of age group, after which asthma was more common among women and girls (Fig 3).

In 2019, the global death rate of asthma was highest in those 95 years of age or older, with no substantial sex differences. The number of deaths reached its highest in the 75 to 79 years of age and 80 to 84 years of age groups for men and women, respectively, after which they declined with increasing age (e-Fig 8).

A clear decrease was found in the global DALY rate of asthma up to the 25 to 29 years of age and 20 to 24 years of age groups, for men and women, respectively, followed by an increase up to the 80 to 84 years of age group. No substantial sex differences were found. In addition, the number of DALYs was highest in the 5 to 9 years of age and 60 to 64 years of age groups, for men and boy and for women and girls, respectively. The number of DALYs were higher among men and boys in the 1 to 19 years of age groups, but were higher for women in all older age groups (e-Fig 9).

Association With SDI

At the regional level, a negative association was found between SDI and the age-standardized DALY rate of

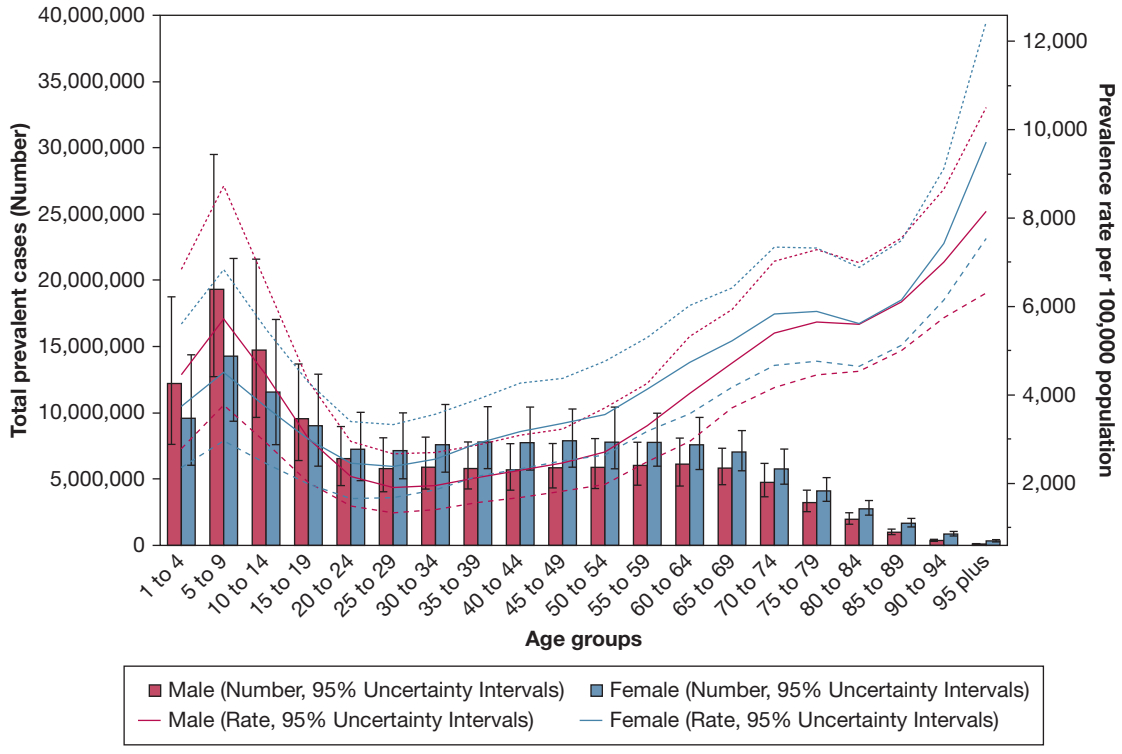

Figure 3 – *Graph showing global number of prevalent cases and prevalence of asthma per 100,000 people by age and sex in 2019. Dotted and dashed lines indicate 95% upper and lower uncertainty intervals, respectively. (Generated from data available from http://ghdx.healthdata.org/gbd-results-tool.)*

asthma, suggesting that the burden of asthma is higher in regions with lower socioeconomic development. Oceania, Southeast Asia, Southern Sub-Saharan Africa, the Caribbean, and Australasia showed higher than expected DALY rates, based on SDI, from 1990 through 2019. In contrast, Eastern Sub-Saharan Africa, Western Sub-Saharan Africa, East Asia, Andean Latin America, Tropical Latin America, Central Latin America, and Central Asia showed lower than expected burdens from 1990 through 2019 (Fig 4).

At the country level, in 2019 the burden of asthma decreased with increasing socioeconomic development, up to an SDI of around 0.8, but then increased as SDI increased (e-Fig 10). Countries and territories such as Kiribati, Papua New Guinea, Fiji, the Central African Republic, Lesotho, Sri Lanka, and the United Arab Emirates showed much higher than expected burdens, whereas Armenia, Turkmenistan, Bolivia, and Singapore showed much lower than expected burdens (e-Fig 10).

Risk Factors

Although the proportion of asthma DALYs attributable to the individual risk factors differed across the GBD regions, globally high BMI, smoking, and occupational asthmagens contributed 16.9%, 9.9%, and 8.8% of the DALYs, respectively. The proportion of asthma DALYs that were attributable to smoking and occupational asthmagens were higher in men and boys than in women and girls, whereas high BMI was higher among women and girls (Fig 5).

The proportion of asthma DALYs attributable to the individual risk factors also differed by age group. The highest proportions of attributable DALYs were in the 45 to 49 years of age group for high BMI, in the 60 to 65 years of age group for smoking, and in the 35 to 39 years of age group for occupational asthmagens (e-Fig 11).

Discussion

This study provided the most up-to-date assessment of the global burden of asthma, with approximately 262.4 million prevalent cases and 461.1 thousand deaths reported in 2019. Although the global burden of asthma decreased over the study period, this was primarily the result of a reduction in deaths, rather than reduced prevalence. Importantly, for some countries such as Oman, Saudi Arabia, and Vietnam, asthma prevalence continues to increase. Currently, no treatments exist that

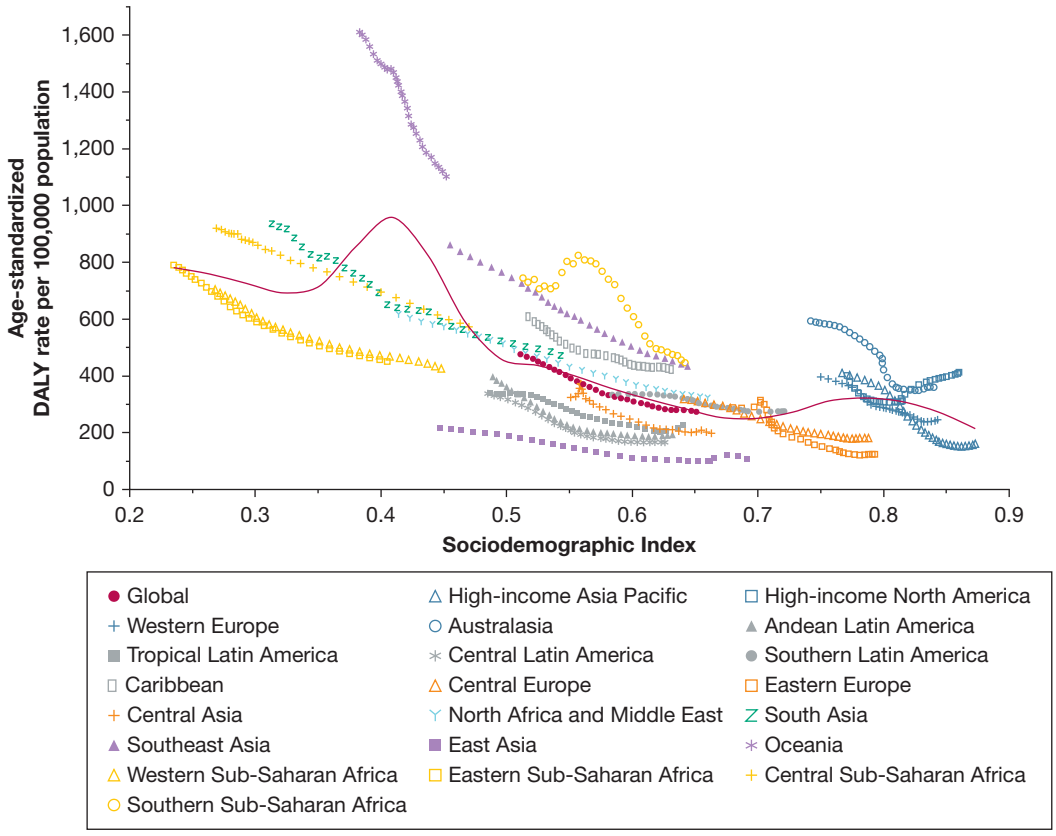

Figure 4 – *Graph showing age-standardized disability-adjusted life-year (DALY) rates of asthma for the 21 Global Burden of Disease (GBD) regions by sociodemographic index (SDI) from 1990 through 2019. Thirty points are plotted for each GBD region and show the observed age-standardized DALY rates from 1990 through 2019 for that region. Expected values based on SDI and disease rates in all locations are shown as the black line. Regions above the solid black line represent higher than expected burden (eg, Oceania), and regions below the line show lower than expected burden (eg, East Asia). (Generated from data available from http://ghdx.healthdata.org/gbd-results-tool.)*

can cure asthma, meaning that the asthma burden will continue to be driven mostly by increasing prevalence.

Although several risk factors are linked to asthma,[12,13] establishing causality is difficult in observational studies, and few risk factors have been examined in primary prevention studies. Thus far, none of the primary prevention interventions studied, using randomized controlled trials, have enough evidence to warrant widespread implementation in clinical practice.[12] Even when evidence is considered sufficient to justify the use of an intervention, the widespread and sustained adoption into clinical care, policy, or practice remains a substantial barrier to reducing the burden of asthma at the population level. Therefore, investigating the causal relationships asthma has with the different risk factors is needed urgently to help policy-makers in developing public health and pharmacologic primary prevention measures to decrease the prevalence and incidence of asthma.[12] Being overweight or obese (BMI $>$ 25 kg/m^2) is one of the greatest risk factors for many diseases, with studies reporting a global increase over the past few decades, particularly among children.[14] Our study found that the global burden of asthma could be decreased by 16.9% at the population level via the use of weight control interventions. Strategies such as mass media campaigns, food and menu labeling, and food pricing strategies (subsidies and taxation) also could be used to decrease the overweight and obesity burden. However, the effectiveness of these strategies have not been examined adequately.[15] The consequences of weight reduction on asthma management also should be considered, because obesity has important implications for asthma treatment in terms of pharmacologic therapy, physiologic changes to the lungs, and societal implications.[16]

Smoking is the second greatest risk factor, contributing approximately 9.9% of the asthma burden. The burden of smoking was much higher in men (15.4%) than among women (4.7%), which corresponds with global tobacco prevalence estimates showing that men are three

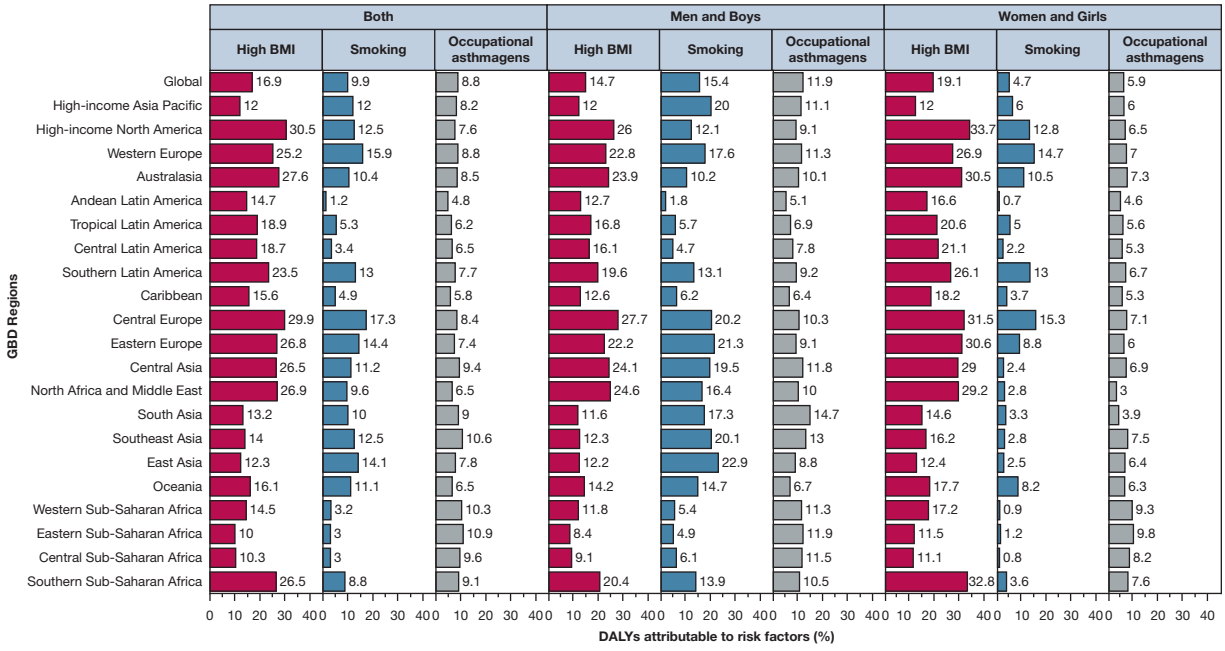

Figure 5 – *Graph showing the percentage of DALYs resulting from asthma attributable to risk factors for 21 Global Burden of Disease regions in 2019. DALY = disability-adjusted life-year. (Generated from data available from http://ghdx.healthdata.org/gbd-results-tool.)*

times more likely to use tobacco than women.[17] Although studies indicate that the global prevalence of smoking has decreased recently (from 1990 through 2015),[18] further reductions in smoking prevalence, using effective smoking preventive programs, still should lead to a reduction in the burden of asthma.[18] Strategies may include the taxation of tobacco products, bans on smoking in public places, smoke-free zones, restrictions on the marketing and promotion of cigarettes, plain packaging laws, community-wide and nationwide smoking cessation interventions, and the enforcement of both text and pictorial warning labels on tobacco products. These policies are the norm for some countries like Australia,[19] but these interventions could be implemented to great effect in countries with few public health policies. The impact would be particularly great in Central, Western, and Eastern Europe, where the attributable burden could be decreased by 17.3%, 15.9%, and 14.4%, respectively.

Occupational asthma also was assessed in the GBD project, with a slight decrease in exposure to asthmagens being reported in previous publications.[11,20] The present study found no remarkable interregional variations in the burden attributable to occupational asthmagens, so preventive measures should be implemented in all regions. Unlike cigarette smoking and obesity, the health implications of exposure to occupational asthmagens is a relatively new area that has not been researched fully because of poor documentation of the diseases directly linked to workplace exposure and the absence of workplace exposure standards.[21] Therefore, a substantial opportunity exists for preventing the development of asthma using industrial and occupational health regulations.[12]

At the regional level, a marked drop in DALYs was found in all regions, whereas high-income North America showed stable DALY rates between 1990 and 2019. Similarly, high-income North America showed a rise in prevalence between 1990 and 2019, whereas all other regions showed a moderate-marked fall in prevalence. Better socioeconomic status and access to primary health care and diagnostic facilities, in addition to heightened awareness as a result of public health campaigns, may have lead to an overdiagnosis of asthma in this region.[22-24]

We found strong age-related patterns in the burden of asthma in 2019. The highest number of prevalent cases was among 5- to 9-year-olds, but then the prevalence decreased and remained relatively stable until approximately 69 years of age, when it started to fall. Although the specific risk factors and their mechanisms for the development of childhood asthma have not yet been determined, genetic and environmental factors, like intrauterine exposures, perinatal period and postnatal phase, and especially allergens, influence the incidence of asthma.[25] Therefore, the prevalence of asthma would

be higher in children younger than 10 years, then it would decrease in adolescences, perhaps because of a modification of their immune responses, before increasing again in the elderly, as nonallergic asthma.[26] A recent review showed that asthma prevalence and mortality patterns are not the same, with higher mortality rates in adult-onset asthma, compared with childhood-onset asthma.[27] In addition, most of the remissions occur between 14 and 21 years of age.[28] Studies also have found that, among children who wheezed before 3 years of age, > 50% had stopped wheezing by 6 years of age[29] or by 12 years of age.[30] Furthermore, remission rates for childhood asthma have been reported as being between 16% and 60% by early adulthood, whereas a low remission rate has been reported for adult-onset asthma.[27]

The present study also found that the country-level burden of asthma decreased proportionally with increases in SDI up to about 0.8, which also was reported previously.[2] Improved access to health care in developed countries is one factor contributing to the observed decrease in asthma mortality. However, the increase after 0.8 indicates that factors other than the provision of substantial government and private-sector resources are contributing to the increasing burden. It is probable that lifestyle factors in wealthy countries, such as poor diet, low levels of physical activity, and exposure to occupational asthmagens, from a well-developed industrial sector are causing the observed rise in the disease burden. Improving population-wide awareness could have very important public health and policy implications, because the impact of poor lifestyle choices, particularly around obesity, are undervalued as modifiable risk factors for asthma. In addition, a better understanding about the role obesity plays in the development of asthma could have a substantial flow-on effect for public policy health interventions.

Strengths and Limitations of the Study

This study provided the most recent information on the global burden of asthma and its attributable risk factors. Improvements in the GBD 2019 data allowed for more accurate estimates with: (1) age differences being taken into account, with data points for both sexes adjusted to their equivalent value for men and boys and for women and girls, separately, to mirror the higher prevalence in men younger than 20 years and then in women; and (2) adjustments for alternative case definitions were made before the DisMod-MR. These adjustments lowered survey estimates based on nonstandard case definitions (eg, wheezing or doctor's diagnosis only), but raised estimates for the US claims data.

This study has several limitations. First, a comparison with previous studies could not be made because of the differing methodologies, selected age groups, and countries included.[6,31,32] The present study also lacked physiologic measures, which is the gold standard in asthma diagnosis. Our asthma definition was based on a clinical assessment, self-report, or both, which resulted in a high degree of variance.[1] Hence, the prevalence of asthma could be affected by recall bias, access to health services, and different interpretations of survey questions. Access to health care is an important challenge, especially in resource-poor countries where basic asthma medications are not available.[1] Moreover, considerable heterogeneity exists in the definition of asthma, which could be based on signs and symptoms or on clinical parameters.[33] For instance, Toelle et al[34] defined asthma as "bronchial hyperresponsiveness . . . plus recent wheeze (in the 12 months prior to study)," which showed better specificity and worse sensitivity than symptom questionnaires.[35,36] Also, different symptomatic questionnaires, like the European Community Respiratory Health Study and the International Study of Asthma and Allergies in Childhood, range in their validity, which is largely dependant on the number of required items for an asthma diagnosis.[36] To improve validity, various definitions of asthma were adjusted in the model, but measurement bias could not be accounted for comprehensively within these estimates. In addition, asthma severity was determined based on the Medical Expenditure Panel Surveys data, and therefore the same distribution was assumed for every location, year, age, and sex. This assumption is highly unlikely to be accurate because the severity of asthma could be affected largely by the treatments available. Furthermore, in some countries, no data were available and the burden of asthma was estimated using the GBD modelling process, meaning that these estimates should be interpreted with caution. In addition, comparing two data points 29 years apart provides little understanding of more recent trends (eg, the last 5-10 years), which are important for understanding the effects of recent interventions or policy improvements. Finally, the attributable risk factors of asthma were assumed to be independent and joint distributions were not considered, which could inflate the estimated burden attributable to each risk factor. Also, the general limitations of the GBD 2019 study, which have been described elsewhere, should be taken into account.[4,10,11]

Interpretation

The burden of asthma decreased between 1990 and 2019, primarily because of a reduction in mortality, but large intercountry variations were found. A higher level of socioeconomic development was correlated with a decreased burden of disease. However, for regions with low socioeconomic development, the growing prevalence of asthma remains a substantial public health issue. Studies are needed to understand more clearly the relationship the different risk factors have with the development of asthma. Nevertheless, evidence from the present study suggests that obesity, tobacco use, and exposure to occupational asthmagens would be appropriate targets for public health interventions.

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Additional information: The e-Appendix, e-Figures, and e-Tables can be found in the Supplemental Materials section of the online article.

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