

The Burden of Childhood Asthma by Age Group, 1990-2019: A Systematic Analysis for Global Burden of Disease Study 2019 Data

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Research

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Abstract

Background: Asthma is a common respiratory disease in children. We aimed to update information about incidence of and mortality and disability adjusted life years (DALYs) due to childhood asthma and provide evidence-based recommendations for childhood asthma prevention.

Methods Data were obtained from the Global Burden of Disease (GBD) Study, which was conducted from 1990 to 2019 in 204 countries. First, we estimated the incidence, mortality and DALY rates of childhood asthma with a Bayesian meta-regression model. Second, we analyzed the relationship between the sociodemographic index (SDI) and DALYs in different age groups. Third, we studied changes in the trends of the age-standardized DALY rate between 1990 and 2019 by age group, SDI, and risk factors.

Results Globally, the numbers of deaths due to and the incidence and DALY rates of childhood asthma were 12.9 thousand (95% UI 10.6 to 15.7), 22 million (95% UI 15 to 31), and 5.1 million (95% UI 3.4 to 7.5) in 2019, representing 65.1% (95% UI 47.6 to 72.4), 5.3% (95% UI 2.6 to 8.8) and 30% (95% UI 18 to 41) decreases from those in 1990, respectively. With the exception of high-SDI regions, the age-standardized DALY rate in all age groups in all SDI regions decreased. In 2019, the age-standardized DALY rate in 1- to 4-year-olds was highest in low-SDI regions, and that of 5- to 19-year-olds was highest in high-SDI regions. In contrast to those in low-SDI regions, children, except those aged 1 to 4 years, in high-SDI regions had a higher risk of DALYs due to asthma. A high body mass index was a stronger risk factor than occupational asthmagens for childhood asthma.

Conclusion Our findings provide insights into asthma prevention and treatment through the identification of key factors related to childhood asthma. Children, especially those aged 5 to 14 years, in high-SDI regions should change their eating and lifestyle habits and exercise regularly. Data on additional chronic diseases in children need to be collected to develop better health prevention recommendations.

1. Introduction

Childhood asthma is a major common chronic respiratory illness characterized by wheezing, coughing, shortness of breath and airflow limitation, which affects daily life[1, 2]. The pathogenesis of childhood asthma involves complex interactions involving physics, chemistry, pharmacology, and immunology, resulting in excessive mucus secretion, bronchial edema and spasm, and scar remodeling[3]. Although inhaled corticosteroids can control the symptoms of asthma, some children with persistent asthma still experience severe complications and lung dysfunction[4]. Due to a lack of understanding of health care for childhood asthma, children with asthma may experience reduced treatment efficacy and incomplete control of lung damage[5]. Childhood asthma imposes the highest disability burden, causing almost 13.8 million days of absence from school in the United States in 2013. Children with asthma need to receive psychological support because asthma can lead to a lower education level and early dropout from school[6, 7]. We estimated the disability burden of childhood asthma based on disability adjusted life years (DALYs) from 1990 to 2019 by region and country and by age.

Globally, comorbidities of childhood asthma include allergic rhinitis, loss of lung function and mental illness[8, 9]. The burden of childhood asthma is substantial in high-income countries. Medical expenditures and DALYs due to severe asthma are high. Establishing a model of health care management that will reduce the number of DALYs and costs of childhood asthma is recommended[10, 11]. Children with asthma need formal monitoring and disease management to reduce the number of DALYs and control symptoms. The lack of comprehensive health care policies is likely to be one of the main reasons for the increasing incidence of and DALYs due to childhood asthma. Research on environmental factors, lifestyle behaviors, dietary habits, and other health-related risk factors will guide effective

prevention of the occurrence of childhood asthma. Improving the level of medical care requires substantial knowledge about how to prevent diseases and associated risk factors that are harmful and cause disability. The Global Burden of Diseases (GBD) Study dataset is useful for risk factor quantification, as it contains reliable data on childhood asthma from 1990-2019; the findings of data analyses can help formulate regional and national health policies[12].

In this study, we estimated the incidence, mortality and DALY rates of childhood asthma using GBD Study data from 1990 to 2019; data were stratified by age, sex, sociodemographic index (SDI), region and country. We also reveal detailed information about risk factors for DALYs due to childhood asthma and present the relationship between age group and SDI (sociodemographic index) at DALYs. The results offered evidence for healthcare management of childhood asthma.

2. Methods

2.1 Data sources

Childhood asthma is a chronic lung disease caused by allergic or hypersensitivity reactions and characterized by bronchospasms and dyspnea[13]. Childhood asthma in the GBD database was defined as a diagnosis by a doctor and the presence of International Classification of Diseases, 10th edition (ICD-10), codes J45 and J46. Detailed information on childhood asthma can be found at <http://ghdx.healthdata.org/gbd-results-tool>.

SDI is a summary measure that reflects sociodemographic development, including local income, average educational attainment, and total fertility rates[14]. SDI values range from 0 (lowest income, lowest educational attainment, and highest fertility rate) to 1 (highest income, highest educational attainment, and lowest fertility rate)[15-17]. The 204 countries and territories in the GBD Study were classified into high-, high-middle-, middle-, low-middle-, and low-SDI regions. The cutoff values used to determine quintiles for analysis were computed using country-level estimates of the SDI for 2019, excluding countries with populations less than 1 million.

2.2 Statistical analysis

The standardized methods of the GBD 2019 have been published by the GBD team and extensively reported elsewhere. Incidence, mortality, and DALY rates from childhood asthma were estimated for 204 countries and territories by age and sex from 1990 to 2019 using a Bayesian meta-regression model in DisMod-MR 2.1. During data processing, the mean of 1000 draws was generated for all reported data, and the 2.5th and 97.5th centiles of the ordered draw represent 95% uncertainty intervals (UIs).

A linear regression model was constructed to analyze the association between year and the numbers and age-standardized incidence, mortality, and DALY rates for ALL separately. Within the regression model, we scaled the numbers and age-standardized rates to make them comparable without regard to the measurement units used in the process. Then, a generalized linear model was fitted by Gaussian function, and the year coefficient was extracted to measure the strength and direction of the time trend. The corresponding 95% confidence interval (CI) of the year coefficient was acquired from this linear regression model. The associations of the age-standardized incidence, mortality, and DALY rates with the SDI for 204 countries and territories and 21 GBD regions was evaluated by smoothing spline models[18]. We used R software V.4.0.2 to estimate incidence, mortality, and DALY rates and numbers from the GBD dataset.

3. Result

3.1 Global burden

In 2019, 12.9 thousand (95% UI 10.6 to 15.7 thousand) children died from asthma. From 1990 to 2019, the age-standardized mortality rate significantly decreased by 65.1% (95% UI 47.6 to 72.4) to 0.5 per 100 000 (95% UI 0.4 to 0.6). The greatest decrease in the age-standardized mortality rate was in the high-middle-SDI group, and the number of incident childhood asthma cases was estimated to be nearly 22 million (95% UI 15 to 31 million). From 1990 to 2019, the global age-standardized incidence rate of childhood asthma decreased by 5.3% (95% UI 2.6 to 8.8%) to 876.0 per 100 000 (95% UI 599.7 to 1212.3). Rapid increases in age-standardized incidence rates were observed in the high-SDI and high-middle-SDI groups (**Tables 1, 2**). DALYs due to childhood asthma in 2019 were estimated to be 5.1 million (95% UI 3.4 to 7.5 million). Age-standardized DALY rates substantially decreased by 30% (95% UI 18 to 41%) to 196.62 (132.71 to 291.02) between 1990 and 2019. A rapid increase in the age-standardized incidence was observed in only the high-SDI group (**Tables 1, 2**).

In 2019, 6.5 thousand (95% UI 5.4 to 7.9 thousand) males and 6.3 thousand (95% UI 5.0 to 8.4 thousand) females died from childhood asthma. From 1990 to 2019, the age-standardized mortality rates were similar between males, at 0.5 per 100 000 (95% UI 0.4 to 0.6), and females, at 0.5 per 100 000 (95% UI 0.4 to 0.7). Childhood asthma affected almost 12 million (95% UI 8 to 17 million) males and almost 10 million (95% UI 7 to 14 million) females in 2019. From 1990 to 2019, the age-standardized incidence rate was higher in males, with a decrease of 4.9% (95% UI 2.0 to 8.5%) to 925.1 per 100 000 (95% UI 628.4 to 1355.7), than in females, with a decrease of 5.8% (95% UI 2.9 to 9.1) to 874.14 per 100 000 (95% UI 569.4 to 1203.6). The DALYs due to childhood asthma were higher in males, at 2.8 million (95% UI 1.8 to 4.2 million), than in females, at 2.3 million (95% UI 1.6 to 3.4 million). Similarly, from 1990 to 2019, the age-standardized DALYs were higher in males, with a decrease of 28.5% (95% UI 17.3 to 39.2%) to 208.64 per 100 000 (95% UI 138.84 to 312.52), than in females, with a decrease of 32.5% (95% UI 12.2 to 45.4%) to 183.8 per 100 000 (95% UI 124.03 to 268.95) (**Table 1, 2**).

Globally, the age-standardized DALYs were estimated to be higher than 500 per 100 000 children in some countries, such as Haiti, the United States of America, Puerto Rico and Madagascar, and lower than 100 per 100 000 children in countries such as Nepal, Bangladesh, Bhutan, Pakistan, Kazakhstan, India and Tajikistan (**Figure 1**). Regarding region, the age-standardized DALYs due to asthma in 2019 were highest in the Caribbean (584.2 (95% UI 387.7 to 824.9) per 100 000) and High-income North America (510.3 (95% UI 320.8 to 765.9) per 100 000) regions. Conversely, the age-standardized DALYs were lowest in South Asia (82.1 (95% UI 55.4 to 120.7) per 100 000) (**Figure 2**). The details of the data by country, region and the percentage change in the age-standardized incidence and DALY rates between 1990 and 2019 are shown in supplement table 1.

3.2 The burden in the 1- to 4-year-old age group

The number of deaths from childhood asthma in 2019 was highest in the 1- to 4-year-old group (6.1 thousand (95% UI 4.6 to 8.0 thousand), 47.4%). The percentage change in the age-standardized mortality rate (from 1990 to 2019) in the 1- to 4-year-old group dropped sharply by 71.8% (95% UI 49.5 to 79.6). Moreover, 10.0 million (95% UI 6.2 to 15.3 million) children aged 1 to 4 years appeared to have asthma, and almost 44.2% of the total number of children had asthma. The percentage change in the standardized incidence rate in the 1- to 4-year-old group (1990 to 2019) decreased by 7.2% (95% UI 4.0 to 11.4). The DALY rate in patients aged 1 to 4 years old was approximately 1.4 million (95% UI 1.0 to 2.1). The percentage change in the age-standardized DALY rate (from 1990 to 2019) notably declined by 50.5% (95% UI 29.0 to 63.2) (**Tables 1, 2**).

The age-standardized DALYs in the 1- to 4-year-old groups in the low-SDI regions, middle-SDI regions and low-middle-SDI regions dropped sharply from 1990 to 2019, while that in the high-SDI region increased gradually; moreover, there was no obvious decrease in the high-middle-SDI region as a whole. The highest age-standardized DALY rate in 2019 was in the low-SDI regions, and the lowest DALY rate was in the high-middle SDI regions (**Figure 3a**). At

the regional level, there was an association between age-standardized DALY rate and SDI. First, the age-standardized DALY rate was highest at an SDI of approximately 0.25, and it steadily declined until an SDI of 0.55. Second, the age-standardized DALY rates dropped sharply from an SDI of 0.55 to and SDI of 0.75. Last, the age-standardized DALY rates increased with SDIs higher than 0.75 (**Figure 4a**). At the national level, the age-standardized DALY rates declined gradually with increasing SDI (**Figure 5a**).

3.3 The burden in the 5- to 9-year-old age group

The number of deaths due to childhood asthma in the 5- to 9-year-old group in 2019 was nearly 13.2% (1.7 thousand) overall. The percentage change in the age-standardized mortality rate (from 1990 to 2019) decreased by 63.0% (95% UI 48.8 to 69.6%), and nearly 28.4% (6.4 million) of all children had asthma. The percentage change in the standardized incidence rate increased by 3.1% from 1990 to 2019. The number of DALYs were 1.5 million (95% UI 0.9 to 2.5 million). The percentage change in the age-standardized DALY rate decreased from 1990 to 2019 (**Tables 1, 2**).

In the 5- to 9-year-old group, the trend of the age-standardized DALY rate gradually declined in low-SDI, middle-SDI, high-middle-SDI and low-middle-SDI regions between 1990 and 2019; only high-SDI regions experienced a substantial increase. However, the percentage change in the age-standardized DALY rate in each SDI region was highest in the high-SDI group and lowest in the low-SDI group (**Figure 3b**). At the regional level, the age-standardized DALY rate showed intermittent increases and decreases as the SDI increased. The two peaks were at SDIs of 0.55 and 0.65 (**Figure 4b**). At the national-level, age-standardized DALY rates did not change obviously with increasing SDIs; however, the age-standardized DALY rate showed a slight decrease from an SDI of 0.55 to 0.65 (**Figure 5b**).

3.4 The burden in the 10- to 14-year-old age group

Nearly 16.4% (2.1 thousand) of children aged 10~14 years old with asthma died of asthma in 2019. The asthma incidence was approximately 16.7% (3.7 million), and the percentage change in the standardized incidence rate increased by 0.5% (95% UI -1.8 to 4.1%) from 1990 to 2019. The number of DALYs was 1.2 million (95% UI 0.8 to 1.9 million, 24.0%). The percentage change in the age-standardized DALY rate decreased from 1990 to 2019 (**Tables 1, 2**).

In children aged 10~14 years, the change trend of the age-standardized DALY rate with SDI region was similar to that in those aged 5~9 years, but the age-standardized DALY rate in the low-SDI region was higher than that in the middle-SDI region (**Figure 3c**). The age-standardized DALY rate at the regional level exhibited an upward trend from an SDI of 0.25 to 0.52, followed by a downward trend from 0.52 to 0.65 (**Figure 4c**). At the national level, the age-standardized DALY rates increased as SDI increased overall, but they decreased gradually from a low SDI until an SDI of 0.55 (**Figure 5c**).

3.5 The burden in the 15- to 19-year-old age group

In 2019, the number of deaths due to asthma among children aged 15 to 19 years was second largest. In addition, the number of incident asthma cases in individuals aged 15 to 19 years was also second largest, at close to 2.4 million. The number of DALYs in those aged 15 to 19 years was the smallest (**Tables 1,2**). Among those aged 15~19 years, there was no major decreasing trend in the low-SDI regions, and the age-standardized DALY rate in the high-SDI regions did not change obviously from 1990 to 2019 (**Figure 3d**). At the regional level, the age-standardized DALY rate decreased sharply between SDIs of 0.25 and 0.62; in contrast, it increased rapidly with increasing SDIs above 0.62 (**Figure 4d**). At the national level, when the SDI was above 0.75, the age-standardized DALY rate increased significantly, but the change was gradual when the SDI was less than 0.75 (**Figure 5d**).

3.6 DALYs attributable to risk by age group and SDI

High body mass index was an important risk factor for childhood asthma, followed by occupational asthmagens, in the GBD database. High body mass index was the independent risk factor for asthma associated with DALYs in the age groups younger than 14 years. The group aged 15 to 19 years had two risk factors: high body mass index and occupational asthmagens, and the most important risk factor was occupational asthmagens (Figure 6). In the high-SDI regions, the contribution of risk factors to DALYs was largest for high body mass index; a similar result was observed in the high-middle-SDI regions, middle-SDI regions, low-middle-SDI regions and low-SDI regions (Figure 7). Additional data can be downloaded from GBD website.

4. Discussion

Asthma is a common respiratory disease in children[19], with an age-standardized incidence rate of 1884.6 per 100 000 in those aged 1 to 4 years in 2019; this was the highest rate among the age groups aged less than 19 years. The lowest incidence rate was in the 15- to 19-year-old age group, which was nearly five times lower than that in the 1- to 4-year old age group, at 387.9 per 100 000 people in 2019. The age-standardized mortality rates of childhood asthma decreased sharply, especially in those aged 1 to 4 years. This situation greatly affected the age-standardized DALY rate, with the highest rates in individuals aged 1 to 4 years (264.6 per 100 000) and 5 to 9 years (228.2 per 100 000). Due to the substantial economic and social burdens imposed by pediatric disability along with the significant declines in incidence and mortality rates, our research mainly focused on the age-standardized DALY rate. The general understanding of asthma treatment and management and interpretation of clinical data proves that regular inhaled corticosteroids and other drugs can reduce the incidence of and mortality due to asthma in children[20].

The age group analysis showed that the age-standardized DALY rate in individuals aged 1 to 4 years decreased in all SDI regions, with the largest decrease in the low-SDI regions. However, the age-standardized DALY rate exhibited different trends in other age groups; the age-standardized DALY rate was highest in the high-SDI regions and increased from 1990 to 2019 in individuals aged 5 to 9 years, 10 to 14 years and 15 to 19 years. The results showed that largest number of DALYs in children with asthma, excluding those aged 1 to 4 years, was observed in the high-SDI regions, and the number of DALYs decreased from 1990 to 2019 in the low-SDI regions. The level of medical care in high-SDI regions allows the availability of more health services and the formation of formal drug treatment and prevention recommendations for childhood asthma[21-23]. This may explain the decreasing DALY rate in each SDI region and the lowest rate in the high-SDI regions in 2019, indicating an inverse relationship between SDI and DALYs. Even with improvements in medical care, the age-standardized DALY rate was still high in high-SDI regions among children aged more than 5 years. The GBD data analysis showed that the risks factors for asthma were high body mass index and occupational asthmagens, and the most important risk factor was high body mass index. Body mass index is calculated by dividing the child's weight (kg) by the square of height (m)[24]; it is related to food intake and an indicator of overweight and obesity. In the high-SDI regions, the increase in the age-standardized DALY rate was mainly caused by high BMI in individuals aged over 5 years.

The economic burden of childhood asthma is related to medical care, drugs and loss of productivity among families and societies[25]. Furthermore, we should raise awareness about the increasing number of DALYs due to childhood asthma[26], reduce the risk of childhood asthma and adopt formal treatment and management recommendations. In 2019, the number of DALYs due to childhood asthma was highest in the low-SDI regions, but the age-standardized DALY rate of childhood asthma was highest in the high-SDI regions, with an increase of 3% from 1990 to 2019. This difference stems from slow population growth and the change in the population age structure. Therefore, reducing high BMI is vital in high-SDI regions.

Analyses of the regional associations between SDI and the age-standardized DALY rate indicated that the age-standardized DALY rate in children in High-income North America sharply increased compared with the expected rate

from 1990 to 2019. The countries in that region should be given more attention to prevent an increase in DALYs due to childhood asthma. The detailed information for each country revealed that different countries had different age-standardized DALY rates for the target age groups, and preventive measures should be taken to reduce the age-standardized DALY rate in specific age groups. For example, Madagascar had a high age-standardized DALY rate in individuals aged 10 to 19 years; therefore, prevention and treatment recommendations need to be more extensive for individuals aged 10 to 19 years.

Another risk factor for childhood asthma was occupational asthmagens; regrettably, information about occupational asthmagens was missing for children under 15 years of age. According to the available data, the contribution of occupational asthmagens to the age-standardized DALY rate decreased but remained high; simultaneously, the proportion of children with high BMI increased quickly from 1990 to 2019, indicating that the effect of high BMI may be greater than that of occupational asthmagens one day. These results show the importance of high BMI in DALYs in children. The highest age-standardized DALY rate was in the high-SDI regions, and we estimated the incidence rates of risk factors for childhood asthma from the GBD database as follows: 23.5 per 100 000 for high BMI and 16.3 per 100 000 for occupational asthmagens. Research has indicated that BMI is related to the incidence of childhood asthma via DNA methylation[27]. Epidemiological studies[2, 7, 28, 29] have proposed assumptions about the causes of childhood asthma, including environmental exposures, gene interactions, sensitivity to multiple foods and inhalation of allergens. People with the same ethnic background who live in diverse environments with different environmental conditions have very different incidences. However, whether the incidence is related to DALYs has not been reported. The analysis of childhood asthma data in the GBD database by age group showed a relationship between DALYs and high BMI. In high-SDI regions, weight control and healthy diets are the main methods to reduce DALYs due to childhood asthma.

The estimates of the age-standardized DALY rates in each SDI region in all age groups implied a slow increase in those aged 1 to 4 years and a sharp increase in those aged 5 to 19 years in high-SDI regions. Even though the incidence of high BMI increased sharply in children aged 1 to 4 years from 1990 to 2019, the DALY rate may be influenced by low BMI for the first 4 years of life[27, 30]. The age-standardized mortality rate in the low-SDI regions declined by 66.4% but was still higher than those in the other regions from 1990 to 2019. The age-standardized DALY rate declined significantly in all age groups, and the estimated incidence of risk factors was 18.6 per 100 000 for high BMI and 16.7 per 100 000 for occupational asthmagens. Formal treatment and management, effective drug use and improved clinical care are considered essential ways to reduce DALYs due to childhood asthma in low-SDI regions[31, 32], but information about risk factors for childhood asthma is limited.

High BMI, which is related to eating habits, lifestyle and food intake, leads to obesity in children[33]. Current research has demonstrated that children's diets and lifestyle behaviors are associated with a high BMI[33-35]. Childhood obesity is an increasing public health problem worldwide.

5. Conclusions

Childhood asthma is a widespread chronic disease, and the associated medical and economic burdens remain high. We need to establish recommendations for prevention and treatment, as childhood asthma has received less attention than other chronic diseases, such as childhood leukemia and cardiovascular or other childhood cancers. Critical and correct intervention policies require information about childhood asthma cases. Based on the current information, children in high-SDI regions, such as the United States and Canada, should change their diet and lifestyle habits and exercise regularly. Data on additional childhood chronic diseases need to be collected to formulate improved health prevention recommendations, especially regarding risk factors.

Declarations

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Tables

Table 1: The burden of childhood asthma by age groups, sex and SDI in 1990 and 2019.

	Deaths(95%UI)		Incidence(95%UI)		DALYs(95%UI)	
	1990 cases (thousands)	2019 cases (thousands)	1990 cases (millions)	2019 cases (millions)	1990 cases (millions)	2019 cases (millions)
Age (years)						
1~4	20.44(11.75 to 26.60)	6.10(4.62 to 7.98)	10.16(6.46 to 15.38)	10.00(6.28 to 15.28)	2.67(1.76 to 3.57)	1.40(0.95 to 2.10)
5~9	4.10(3.19 to 4.85)	1.70(1.40 to 2.05)	5.56(2.81 to 9.36)	6.42(3.27 to 10.83)	1.60(1.03 to 2.51)	1.49(0.88 to 2.48)
10~14	3.41(2.90 to 3.82)	2.11(1.79 to 2.51)	3.13(1.42 to 5.00)	3.77(1.73 to 6.00)	1.16(0.77 to 1.70)	1.22(0.76 to 1.86)
15~19	4.56(3.76 to 5.21)	2.97(2.54 to 3.43)	2.17(1.27 to 3.32)	2.40(1.41 to 3.66)	0.99(0.69 to 1.41)	0.95(0.63 to 1.44)
Sex						
Male	16.48(12.06 to 20.65)	6.54(5.45 to 7.94)	11.33(7.79 to 15.79)	12.30(8.35 to 17.21)	3.40(2.49 to 4.72)	2.77(1.85 to 4.15)
Female	16.02(8.91 to 21.00)	6.34(4.97 to 8.40)	9.69(6.80 to 13.35)	10.30(7.12 to 14.01)	3.02(2.04 to 4.16)	2.30(1.55 to 3.36)
Socio-demographic factor						
Global	32.51(22.79 to 39.65)	12.88(10.59 to 15.68)	21.03(14.58 to 29.22)	22.59(15.47 to 31.27)	6.42(4.62 to 8.86)	5.07(3.42 to 7.51)
High SDI	0.86(0.79 to 0.91)	0.31(0.28 to 0.34)	3.55(2.47 to 4.92)	3.63(2.57 to 4.78)	0.77(0.49 to 1.19)	0.75(0.47 to 1.15)
High-middle SDI	1.71(1.30 to 2.03)	0.29(0.25 to 0.36)	3.56(2.42 to 5.06)	12.62(8.64 to 17.91)	0.76(0.50 to 1.15)	0.53(0.32 to 0.86)
Middle SDI	10.14(7.29 to 12.11)	2.87(2.40 to 3.34)	7.02(4.79 to 9.82)	6.37(4.31 to 8.89)	2.06(1.48 to 2.87)	1.39(0.90 to 2.12)
Low-middle SDI	10.76(7.42 to 13.43)	3.28(2.69 to 3.98)	3.92(2.78 to 5.38)	4.01(2.72 to 5.58)	1.57(1.14 to 2.05)	0.99(0.68 to 1.45)
Low SDI	8.98(5.40 to 11.98)	6.10(4.58 to 8.18)	2.95(2.14 to 4.01)	5.03(3.50 to 6.87)	1.25(0.87 to 1.63)	1.41(1.00 to 1.97)

UI, uncertainty interval; SDI, socio-demographic index.

Table2: Percentage change in age-standardized rates of childhood asthma by age groups, sex and SDI, 1990-2019.

	Deaths(95%UI)		Incidence(95%UI)		DALYs(95%UI)	
	2019 age-standardized rates (per 100,000)	Percentage change in age-standardized rates, 1990-2019	2019 age-standardized rates (per 100,000)	Percentage change in age-standardized rates, 1990-2019	2019 age-standardized rates (per 100,000)	Percentage change in age-standardized rates, 1990-2019
Age						
(years)						
1~4	1.2(0.9 to 1.5)	-71.8(-79.6 to -49.5)	1884.6(1183.7 to 2879.0)	-7.2(-11.4 to -4)	264.6(179.1 to 394.6)	-50.5(-63.2 to -29)
5~9	0.3(0.2 to 0.3)	-63.0(-69.6 to -48.8)	980.3(500.0 to 1654.7)	3.1(7.1 to -14.1))	228.2(134.9 to 379.3)	-16.6(-24.9 to -9.9)
10~14	0.3(0.3 to 0.4)	-48.3(-55.1 to -37.5)	587.0(268.8 to 934.6)	0.5(4.1 to -1.8)	189.6(118.6 to 290.2)	-12.1(-18.4 to -7.1)
15~19	0.5(0.4 to 0.6)	-45.3(-52.0 to -35.4)	387.9(227.9 to 590.7)	-7.1(-3.5 to -10.8)	154.1(102.3 to 231.7)	-18.8(-25.9 to -13.2)
Sex						
Male	0.5(0.4 to 0.6)	-65.2(-72.0 to -49.2)	925.1(628.4 to 1355.7)	-4.9(-8.5 to -2.0)	208.64(138.84 to 312.52)	-28.5(-39.2 to -17.3)
Female	0.5(0.4 to 0.7)	-64.9(-75.0 to -26.7)	874.14(569.38 to 1203.57)	-5.8(-9.1 to -2.9)	183.84(124.03 to 268.95)	-32.5(-45.4 to -12.2)
Socio-demographic factor						
Global	0.5(0.4 to 0.6)	-65.1(-72.4 to -47.6)	876.01(599.68 to 1212.28)	-5.3(-8.8 to -2.6)	196.62(132.71 to 291.02)	-30(-41 to -18)
High SDI	0.14(0.12 to 0.15)	-62.5(-65.3 to -57.2)	1642.81(1165.5 to 2163.38)	8(1 to 16)	338.46(212.04 to 520.44)	3(-3 to 9)
High-middle SDI	0.09(0.08 to 0.11)	-79.0(-83.3 to -70.5)	873.41 (583 to 1230.22)	1(-4 to 5)	162.21(97.71 to 261.99)	-13(-23 to -6)
Middle SDI	0.39(0.45 to 0.33)	-70.5(-76.5 to -58.8)	864.82(584.92 to 1206.9)	-6(-9 to -3)	188.38(122.36 to 287.65)	-30(-42 to -18)
Low-middle SDI	0.47(0.39 to 0.57)	-75.0(-80.8 to -61.6)	577.19(391.49 to 803.14)	-16(-22 to -11)	142.23(97.48 to 208.99)	-48(-59 to -34)
Low SDI	1.02(0.77 to 1.37)	-66.4(-76.1 to -66.4)	842.9(585.72 to 1150.93)	-16(-21 to -11)	236.12(167.92 to 329.67)	-44(-56 to -34)

UI, uncertainty interval; SDI, socio-demographic index.

Figures

Figure1

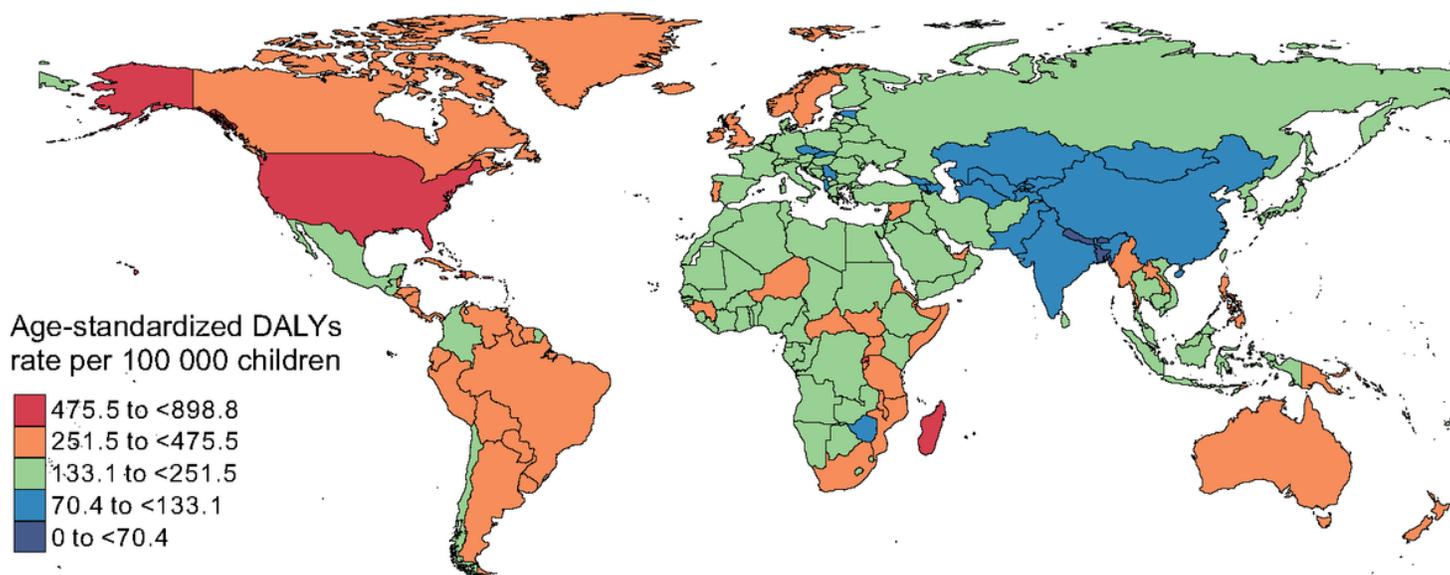


Figure 1

Age-standardized DALYs due to childhood asthma per 100 000 children by country, both sexes, 2019 DALYs= disability adjusted life years

Figure2

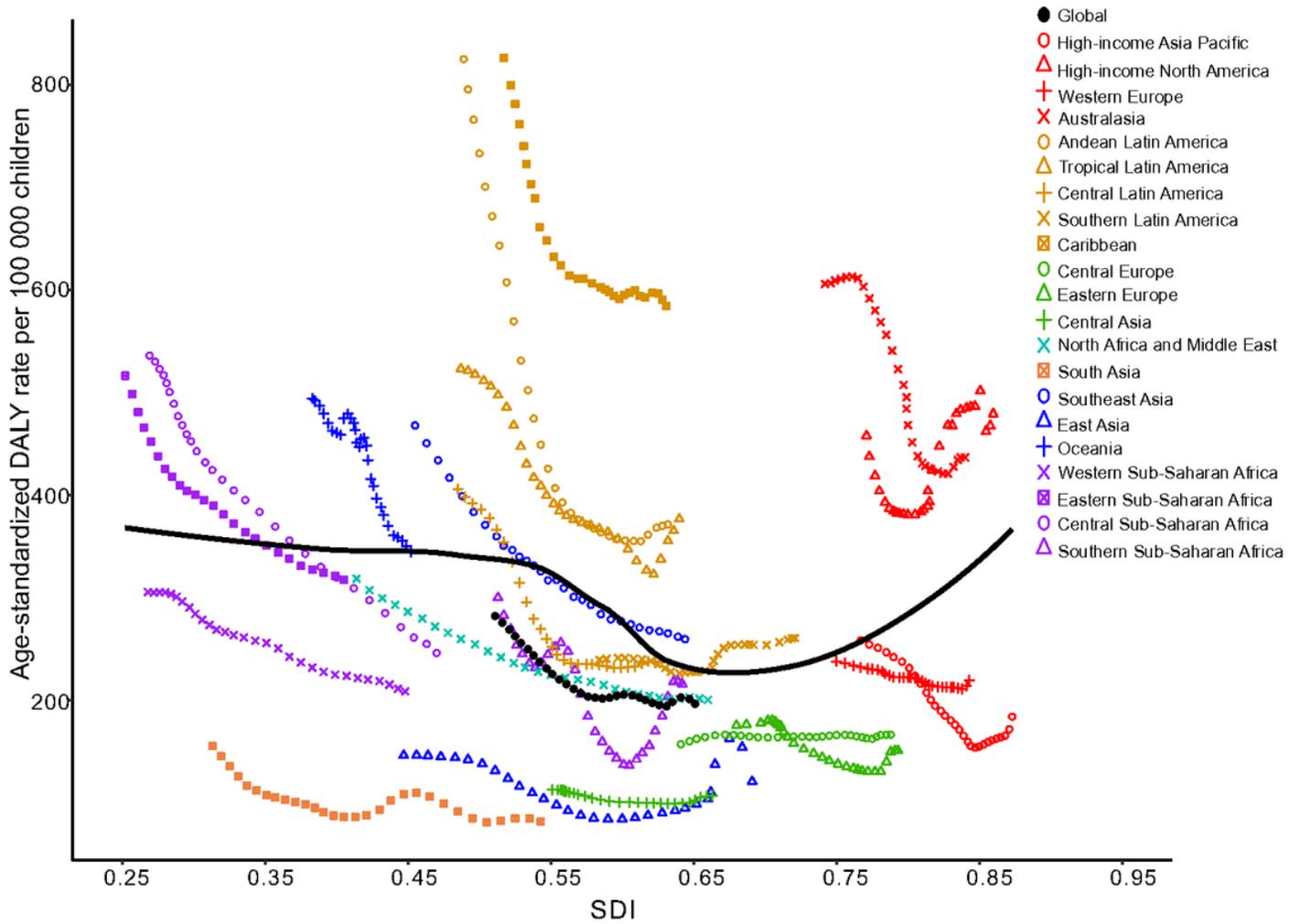


Figure 2

Age-standardized DALYs due to childhood asthma by 21 GBD regions and expected values by SDI, 1990-2019 DALYs= disability adjusted life years, SDI= sociodemographic index

Figure3

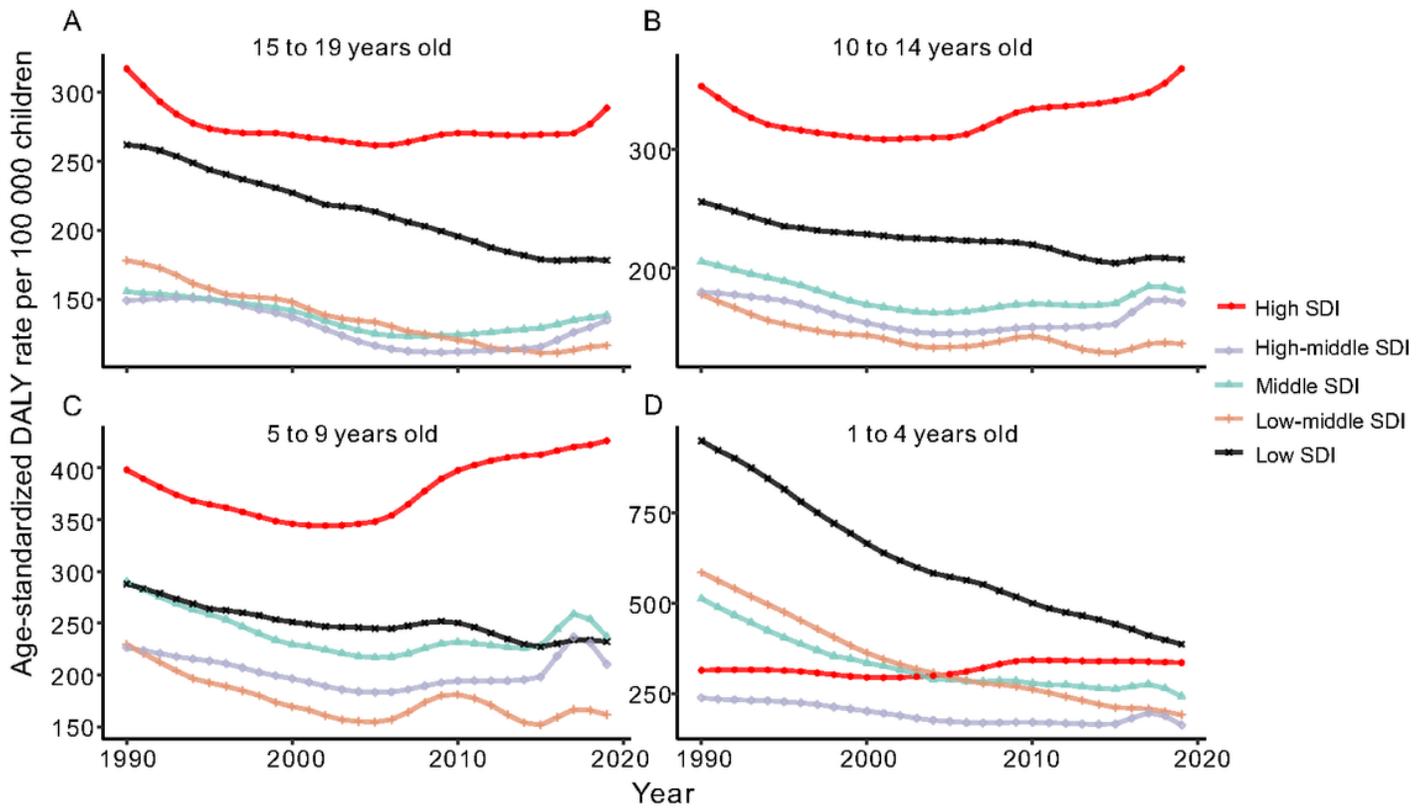


Figure 3

Change trends of age-standardized DALYs due to childhood asthma by age group from 1990 to 2019. A The change trends of age-standardized DALYs in those 15 to 19 years old, B The change trends of age-standardized DALYs in those 10 to 14 years old, C The change trends of age-standardized DALYs in those 5 to 9 years old, D The change trends of age-standardized DALYs in those 1 to 4 years old. DALYs= disability adjusted life years

Figure4

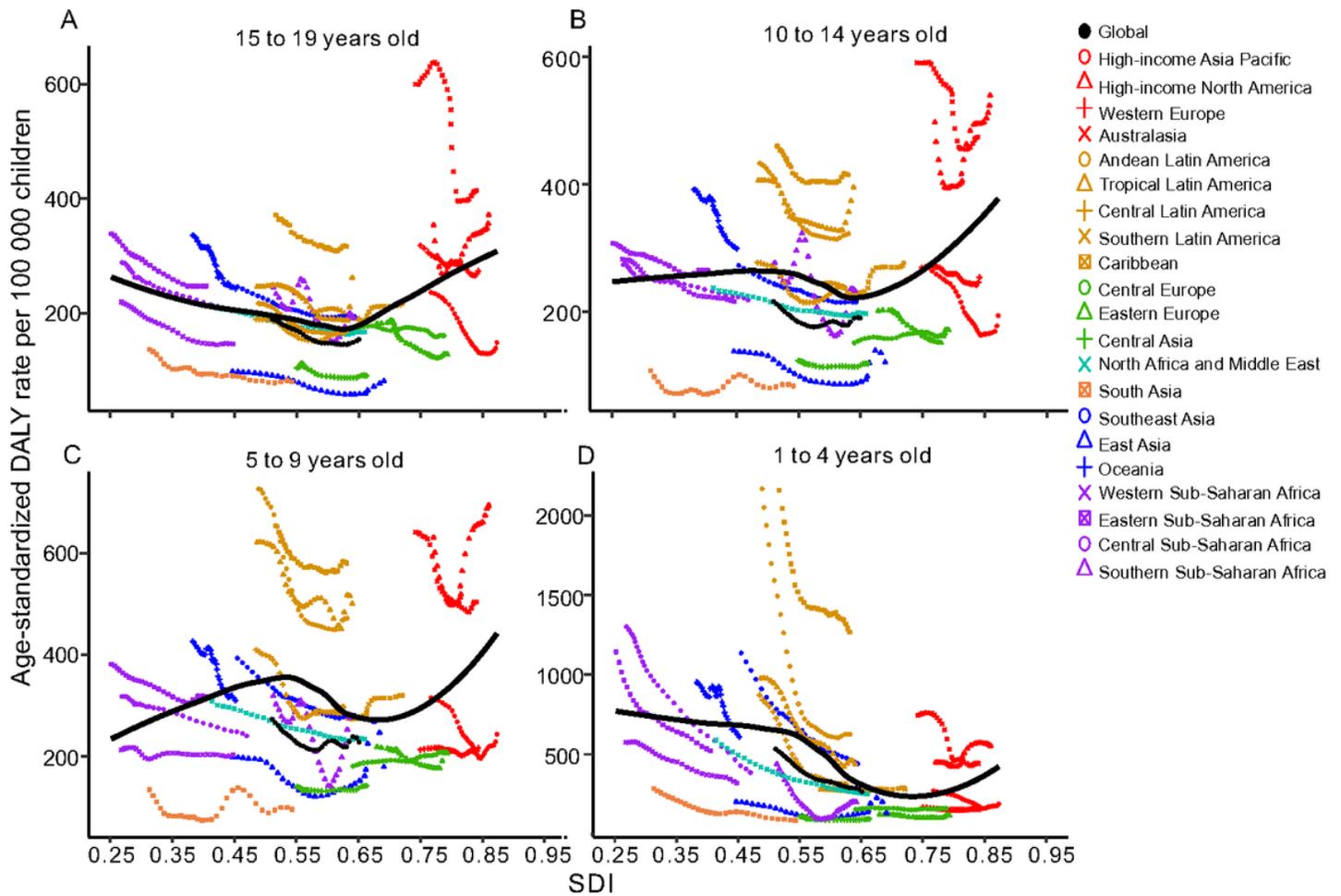


Figure 4

Age-standardized DALYs due to childhood asthma by 21 GBD regions and different age groups, 1990-2019; the black line represents the expected values by SDI. A The change trends of age-standardized DALYs for regions by SDI in those 15 to 19 years old, B The change trends of age-standardized DALYs for regions by SDI in those 10 to 14 years old, C The change trends of age-standardized DALYs for regions by SDI in those 5 to 9 years old, D The change trends of age-standardized DALYs for regions by SDI in those 1 to 4 years old. DALYs= disability adjusted life years, SDI= sociodemographic index

Figure 5

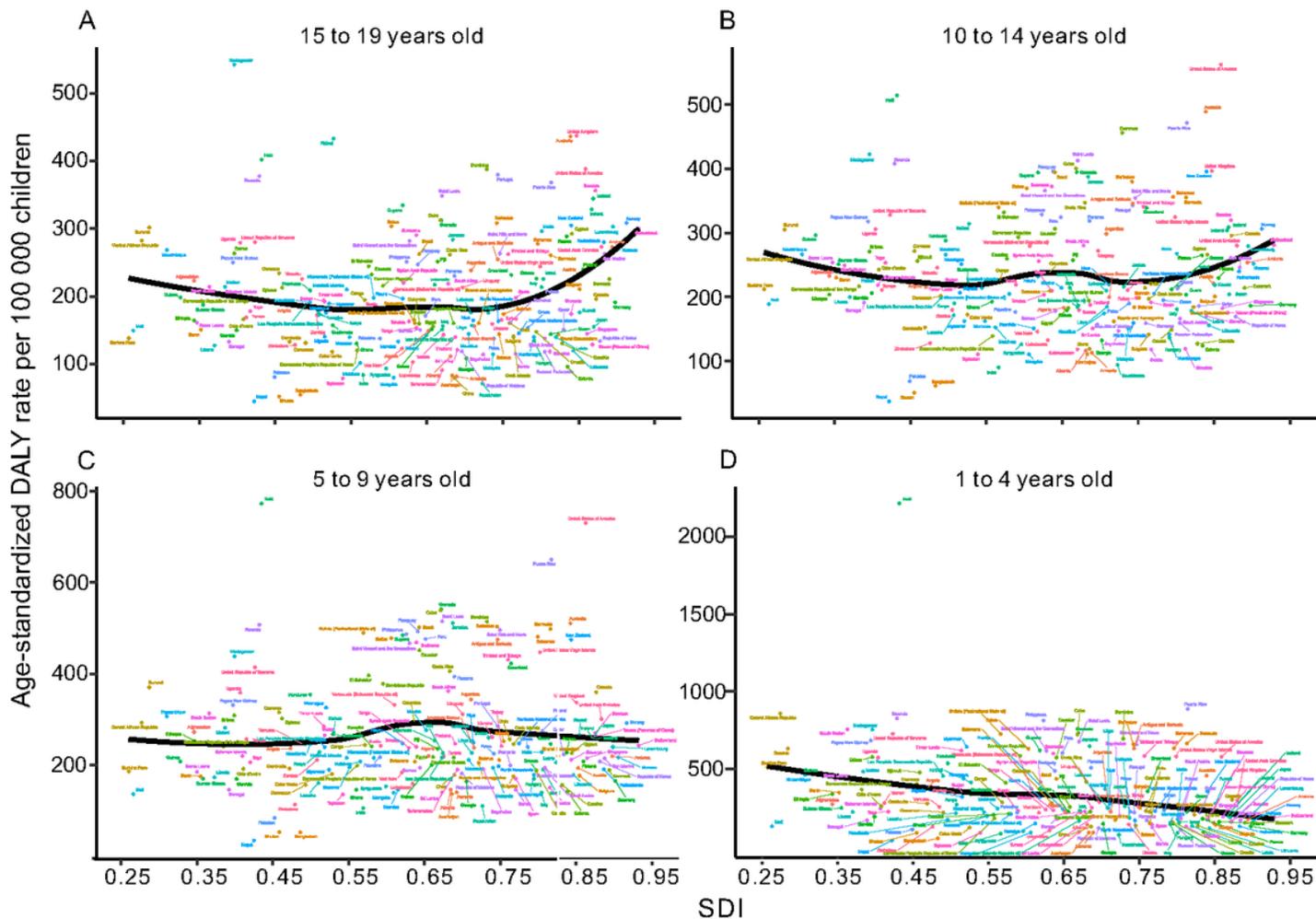


Figure 5

Age-standardized DALYs due to childhood asthma by country and SDI, 2019; the black line represents the expected values. A The change trends of age-standardized DALYs by country and SDI in those 15 to 19 years old, B The change trends of age-standardized DALYs by country and SDI in those 10 to 14 years old, C The change trends of age-standardized DALYs by country and SDI in those 5 to 9 years old, D The change trends of age-standardized DALYs by country and SDI in those 1 to 4 years old. DALYs= disability adjusted life years, SDI= sociodemographic index.

Figure6

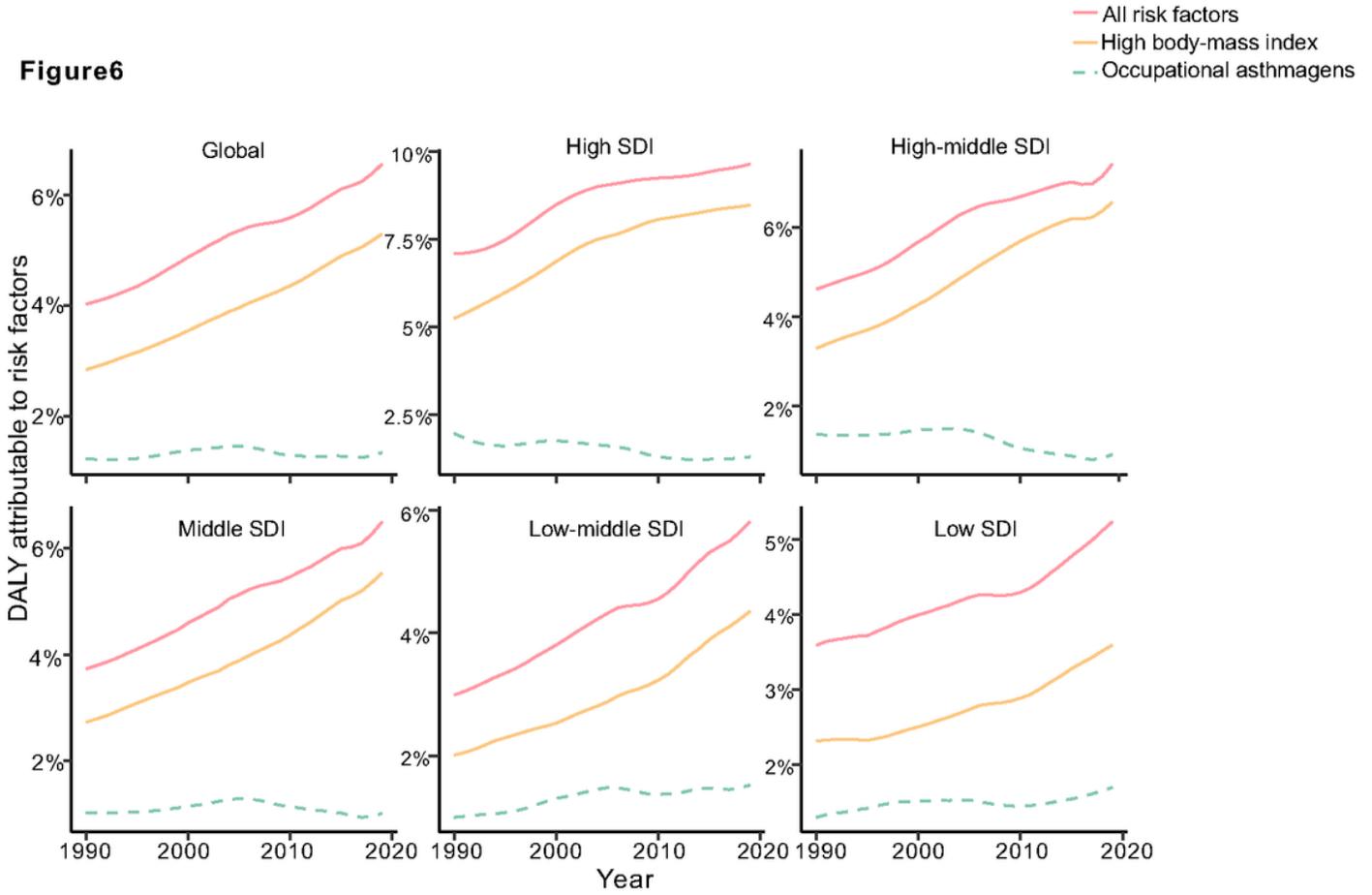


Figure 6

Fraction of age-standardized DALYs attributable to high BMI and occupational asthmagens in childhood asthma by SDI region, 1990-2019. DALYs= disability adjusted life years, SDI= sociodemographic index, BMI= high body mass index.

— All risk factors
— High body-mass index
- - - Occupational asthmagens

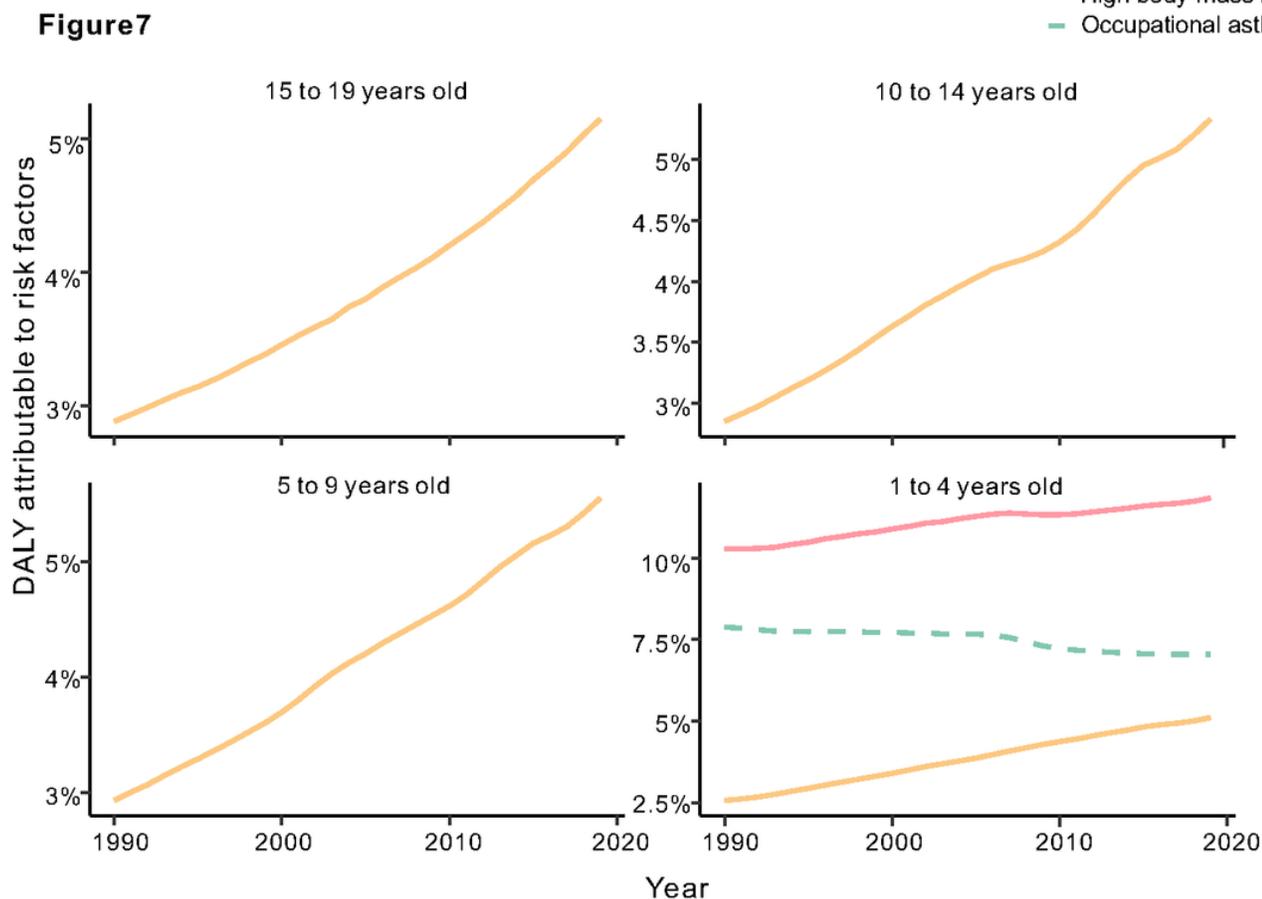


Figure 7

Fraction of age-standardized DALYs attributable to high BMI and occupational asthmagens in childhood asthma by age group, 1990-2019. DALYs= disability adjusted life years, BMI= high body mass index.

Supplementary Files

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