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Global burden of asthma in young adults in 204 countries and territories, 1990–2019: Systematic analysis of the Global burden of disease study 2019

Cheng-hao Yang [a], Jia-jie Lv [a,b], Xin-yu Li [a,b], Xi-Tao Yang [c,*], Min-Yi Yin [a,d,*]

[a] Department of Vascular Surgery, Putuo People's Hospital, School of Medicine, Tongji University, Shanghai, PR China
[b] Department of Neurosurgery, Shanghai Ninth People's Hospital, Shanghai Jiao Tong University, Shanghai, PR China
[c] Department of Interventional Therapy, Multidisciplinary Team of Vascular Anomalies, Shanghai Ninth People's Hospital, Shanghai Jiao Tong University, Shanghai, PR China
[d] Department of Vascular Surgery, Shanghai Ninth People's Hospital, Shanghai Jiao Tong University, Shanghai, PR China

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ABSTRACT

Asthma is a common chronic respiratory disease, with onset usually occurring during childhood or adolescence. The aim of this study was to estimate the dynamic changes in the burden of asthma disease among adolescents (aged 15–39 years). Between 1990 and 2019, our comprehensive analysis spanned 204 nations and territories to ascertain the global prevalence of asthma. This extensive evaluation meticulously quantified the disease's burden by examining a range of critical metrics—including mortality rates, prevalence figures, and disability-adjusted life-years (DALYs)—across diverse demographics. Our investigation systematically segmented the data by age, gender, and year, as well as by geographical regions and the Socio-demographic Index (SDI), offering an in-depth perspective on the multifaceted impact of asthma worldwide. From 1990 to 2019, there was a global increase in the incidence cases of asthma among young adults, with the number rising from 6487957.18 (95 %UI: 4578735.08–8736387.55) to 7604488.39 (95 % UI:5428024.98–10177808.25). The prevalence rate of asthma among young adults exhibited a decline from 580.09 per 1,00,000 (95 %UI:481.37–757.28) to 504.28 per 1,00,000 (95 %UI:400.64–633.26). It is also noteworthy that the incidence rates in the remaining SDI regions, although lower, also showed varying degrees of increase in 2015. The age-standardized disease burden rate for asthma among young adults has exhibited a decline over the course of the previous three decades. Nevertheless, regions characterized by lower SDI demonstrate elevated age-standardized mortality rates for asthma, thereby warranting focused attention and prioritized allocation of medical resources.

1. Introduction

Asthma is a prevalent chronic respiratory ailment that impacts over 300 million individuals globally, typically manifesting in childhood or adolescence(Gray et al., 2018; Yin et al., 2018). The presence of asthma among young adults not only imposes a considerable burden on individuals, families, and society in terms of caregiving responsibilities, but also leads to substantial economic implications(Normansell et al., 2018). The global prevalence of asthma was 3.33 % in 2017, and asthma was the second leading cause of death among chronic respiratory diseases, with 4,570,100 people dying from asthma in 2017(Global burden of 369 diseases and injuries in 204 countries and territories, 2019). In addition to causing premature death, asthma is commonly associated with a variety of comorbidities such as allergic rhinitis, gastroesophageal reflux disease, obstructive sleep apnea, and anxiety(Cao et al., 2022). Prevalence rates of asthma exhibit significant variability across different countries and regions. According to a recent study, the prevalence of asthma among individuals aged over 20 years in China was found to be 4.2 %, with a total patient population of 45.7 million(Huang et al., 2019). An international study has shown that the incidence of asthma in children varies significantly by region, ranging from 4.1 % to 9.7 % in Algeria, India and Italy, to as high as 23.2 % to 32.0 % in Denmark, the United Kingdom, the United States, Estonia, Sweden, Australia, New Zealand and Ireland(Chang et al., 2015; Serebrisky and Wiznia, 2019; Mangini et al., 2019). Hence, it is imperative to possess a contemporary comprehension of the worldwide prevalence of asthma in

* Corresponding authors at: No.639 Zhizaoju Road, Huangpu District, Shanghai, China Postal Code Department of Vascular Surgery, Shanghai Putuo People's Hospital, School of Medicine, Tongji University, Shanghai, PR China.
E-mail addresses: xitao123456@126.com (X.-T. Yang), yinminyi9@126.com (M.-Y. Yin).

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the youth demographic, as this knowledge is crucial for policymakers in order to effectively execute primary prevention strategies and establish control measures.

The Global Burden of Disease (GBD) research collects epidemiological data on 369 different diseases from 204 nations and territories throughout the world(Safiri et al., 2022). This study used the burden of disease GBD 2019 data to analyze the dynamic changes in the burden of asthma disease among adolescents and assess whether there are differences in the burden of asthma disease by gender and age group in order to inform the development of prevention and control efforts.

2. Methods

This study employed the GBD 2019 data to examine the fluctuating patterns in the burden of asthma among young adults, while also evaluating potential disparities in the burden of asthma across gender and age groups. The objective of this analysis was to provide valuable insights for the formulation of effective prevention and control strategies (Global burden of 369 diseases and injuries in 204 countries and territories, 2019). The occurrence of asthma was assessed through the application of Bayesian *meta*-regression (DisMod-MR2.1), while the estimation of asthma mortality was conducted using Standard Cause of Death Ensemble Modelling (CODEm)(Zhang and Zheng, 2022; Zhou et al., 2019). Asthma mortality in GBD 2019 was estimated using vital registration and surveillance data from the cause of death database, and asthma incidence was estimated using literature reviews, survey data, and some national claims data(Global burden of 369 diseases and injuries in 204 countries and territories, 2019). Every estimate is computed 1,000 times in GBD, and each time a sample is taken from the distribution. The results are then arranged from the least significant value to the most significant value. Countries and regions have been assessed on their social development using the socio-demographic index (SDI)(Cao et al., 2019). The median household income, median level of education at age 15, and total fertility rate at age 25 are the three components that make up the SDI(Meehan et al., 2020). Countries and territories involved in the GBD 2019 were categorized into five SDI categories: high, middle-high, medium, low-middle, and low, with lower SDI values indicating poorer social development levels(Zhang et al., 2020). The Estimated Annual Percentage Change (EAPC) were computed to evaluate the time-based trend of incidence, prevalence, mortality and DALYs. The 95 % CIs for these EAPCs were established using linear modeling techniques. The trend of the age-standardized rate (ASR) can be determined by examining the EAPC and its 95 % CI. If both the EAPC value and the lower limit of the 95 % CI are positive, it indicates an increasing trend in the ASR. On the other hand, if both the EAPC value and the upper limit of the 95 % CI are negative, the ASR is deemed to be on a downward trend.

3. Joinpoint regression model

Based on the temporal characteristics of the disease distribution, a piecewise regression is constructed, and the trend is fitted and optimized for each segment(Yin et al., 2023). Annual percentage change (APC) and average annual percentage change (AAPC) are the primary indicators of trend change in the Joinpoint regression model(Tapper and Parikh, 2018). The Joinpoint Regression Program version 4.8.0.1 (Statistical Research and Application Branch, National Cancer Institute, Bethesda, Maryland, United States) was utilized for the purposes of conducting statistical analyses.

4. Results

Global burden of disease and temporal trends of asthma among young adults.

4.1. Global level

Globally,from 1990 to 2019, the number of young adults asthma incidents cases increased from 6487957.18 (95 %UI: 4578735.08–8736387.55) to 7604488.39 (95 % UI:5428024.98–10177808.25). The age-standardized incidence rate (ASIR) of young adults asthma decreased from 580.09 per 1,00,000 (95 %UI:481.37–757.28) to 504.28 per 1,00,000 (95 %UI:400.64–633.26). The EAPC for incidence of young adults asthma was decrease 0.47 % (Supplemental Table S1). From 1990 to 2019, the age-standardized deathes rate (ASDR) decreased from 11.91 per 1,00,000 (95 % UI 8.8–15.86) to 5.8 per 1,00,000 (95 % UI: 4.62–7.0) (Supplemental Table S2); the EAPC for deaths decreased by an average of 2.65 percent per year. In terms of prevalence, the prevalence cases of asthma among young adults increased from 62,962,010 cases in 1990 to 72,443,314 cases; the EAPC for prevalence decreased by an average of −1.04 percent per year (Supplemental Table S3). The age-standardized prevalence rate (ASPR) of young adults asthma decreased from 4496.93 per 1,00,000 (95 % UI: 3913.55–5224.32) to 3415.53 per 1,00,000 (95 % UI: 2898.92–4066.2); Meanwhile, DALYs decreased from 4,552,087 (95 % UI: 3427228.83–5862910.87) in 1990 to 4474740.06 (95 % UI: 3334634.69–6013932.29) (Supplemental Table S4).

4.2. SDI level

Among the five SDI regions, Middle SDI had the highest number of patients, 19,284,637 cases, and the greatest degree of change in EAPC for High-middle SDI (-2.52 %), while Low SDI had the lowest number of patients with 10,572,759 cases (95 %UI: 8511802.53–13059858.31). High SDI had the highest ASPR among the 5 SDIs with 6855.06 per 100,000 population (Supplemental Table S3). Fig. 1 shows the 30-year trends of ASIR, ASDR and DALYs for the five SDI regions. We can visually see that the incidence rate in the High SDI region is significantly higher than in other SDI regions and globally. The incidence rate in the High SDI region gradually decreased from 1990 and then increased significantly after 2005. It is also noteworthy that the incidence rate in the remaining SDI regions, although low, also showed a different degree of increase in 2015. In addition, the ASDRs of both the global and the five SDI regions show a decreasing trend year by year, but the DALYs of the High SDI region decreased year by year from 1990 and gradually leveled off around 2004.

We analyzed different age groups, by gender. We found that globally, the male-to-female ratio of adolescent asthma prevalence decreases with age, whereas High SDI shows the opposite trend: after a brief decline in the 15–24 age group, a significant increase occurs in subsequent age groups and peaks in the 30–34 age group (Fig. 2). An increase was seen in the 35–39 years in both Low-middle SDI and Low SDI, indicating an increase in the proportion of female patients.

4.3. Region level

In further observation of the GBD and temporal patterns of 21 GBD region, it was revealed that the greatest incident cases for incidence of young adults asthma are in South Asia, High-income North America, North Africa and Middle East, the highest ASIR of young adults asthma is in High-income North America, Tropical Latin America Caribbean and the steepest drop for EAPC is in High-income Asia Pacific, Eastern Europe (Supplemental Table S1). We found that in terms of mortality rates, 21 all regions showed decreases in EAPC, with High-income Asia Pacific, and Eastern Europe being the two regions with the largest decreases in EAPC (Supplemental Table S2).

The GBD of young adults asthma incidence changes for 204 nations and territories is shown in Fig. 3. We found that African countries showed a significant increase in incidence over the 30-year period, while Eastern European countries showed the greatest decrease. In terms of incidence of EAPC, most countries showed a decline, while some

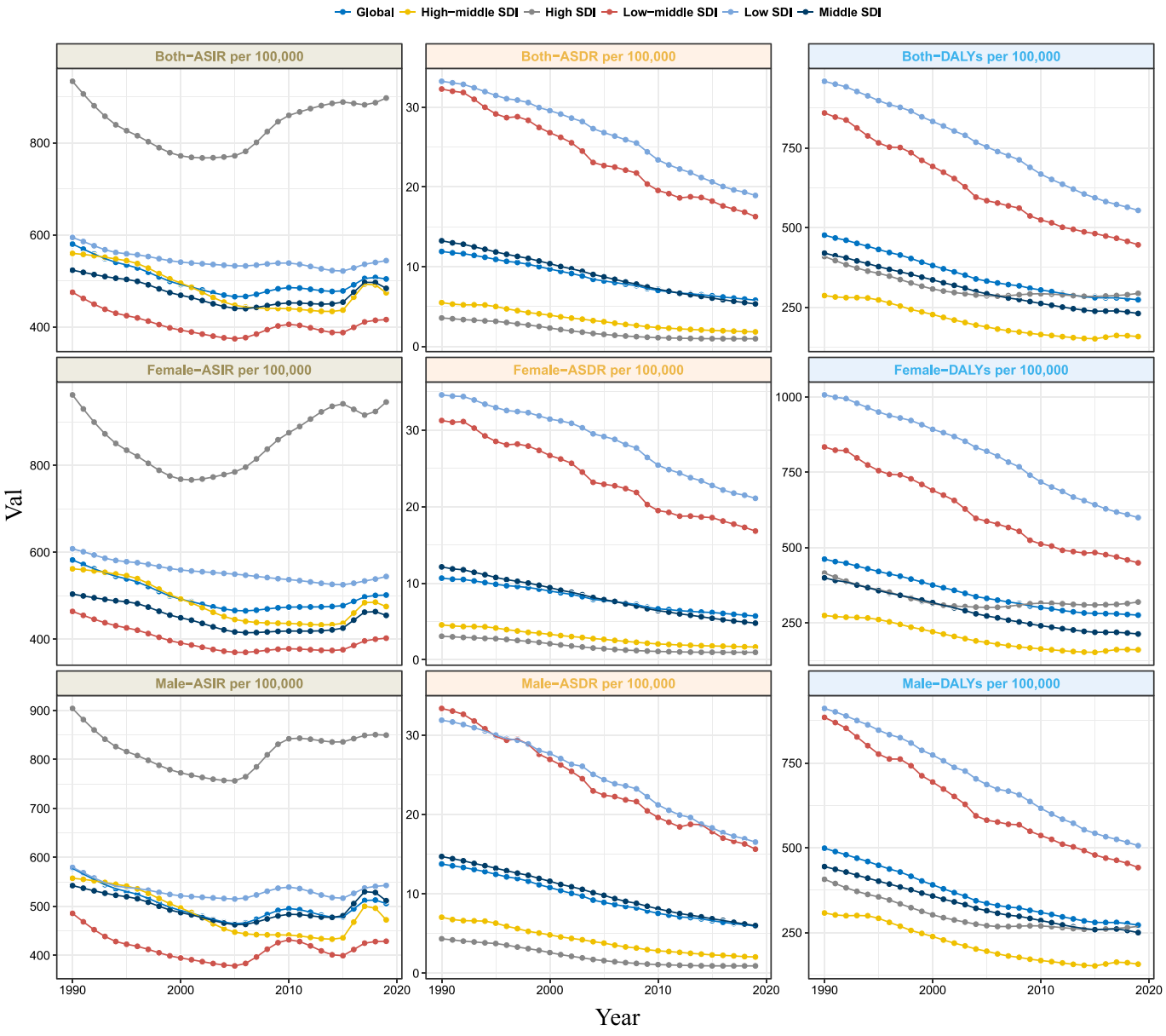

Fig. 1.

countries (e.g., the United States) showed a significant increase (Fig. 4).

4.4. Joinpoint analysis of asthma among young adults

Through the use of joinpoint analysis, the segmental trends of prevalence, incidence, and death associated with asthma among young adults were separated. The AAPC for death in the entire period was −1.84 % (Fig. 5). We found an overall decreasing trend in mortality rates, with the fastest decreasing trend from 2000 to 2015 (APC 2000–2015 = -2.66 %; Fig. 5) and a Joinpoint analysis of mortality rates by gender found that the trends were roughly the same for both, but that female mortality rates showed a significant decline from 2000 to 2012, and both are now at their lowest levels in 30 years (Fig. S1). The AAPC for prevalence in the entire period was −1.86 % (Fig. S2), and at the beginning of 2015, there was an increase in prevalence (APC2015-2019 = 2.32 %). Fig. S3 shows the results of Joinpoint analysis of prevalence by gender, both show a decreasing and then increasing trend, but the prevalence of women is higher than that of men in the same period. The AAPC for incidence in the entire period was −0.51 %, and the greatest decline in incidence occurred from 1997 to 2008 (APC1997-2008 = -1.06 %), while an increase was seen at the beginning of 2015 (APC2015-2019 = 1.50 %; Fig. S4). Notably, we found that female incidence rates began to rebound in 2010, with a further acceleration in growth starting in 2016, while male incidence rates began to rise in 2015, rising to a lesser extent than females (Fig. S5).

5. Discussion

In this study, we analyzed the burden of asthma in young adults according to the GBD database. The burden was evaluated based on the number of deaths, the prevalence, and the DALYs for each age group, gender, year, geographical region, and SDI. We found a significant decrease in age-standardized asthma prevalence, mortality and disability-adjusted years over the past 30 years, but an increase in the number of cases of asthma prevalence and morbidity. This study found that age-standardized mortality rates for asthma showed a trend toward decreasing with increasing SDI, but morbidity and prevalence did not decrease with increasing SDI, and age-standardized morbidity rates were highest in areas with high SDI. In terms of change in the number of incidence cases, the largest changes were observed in the Middle East

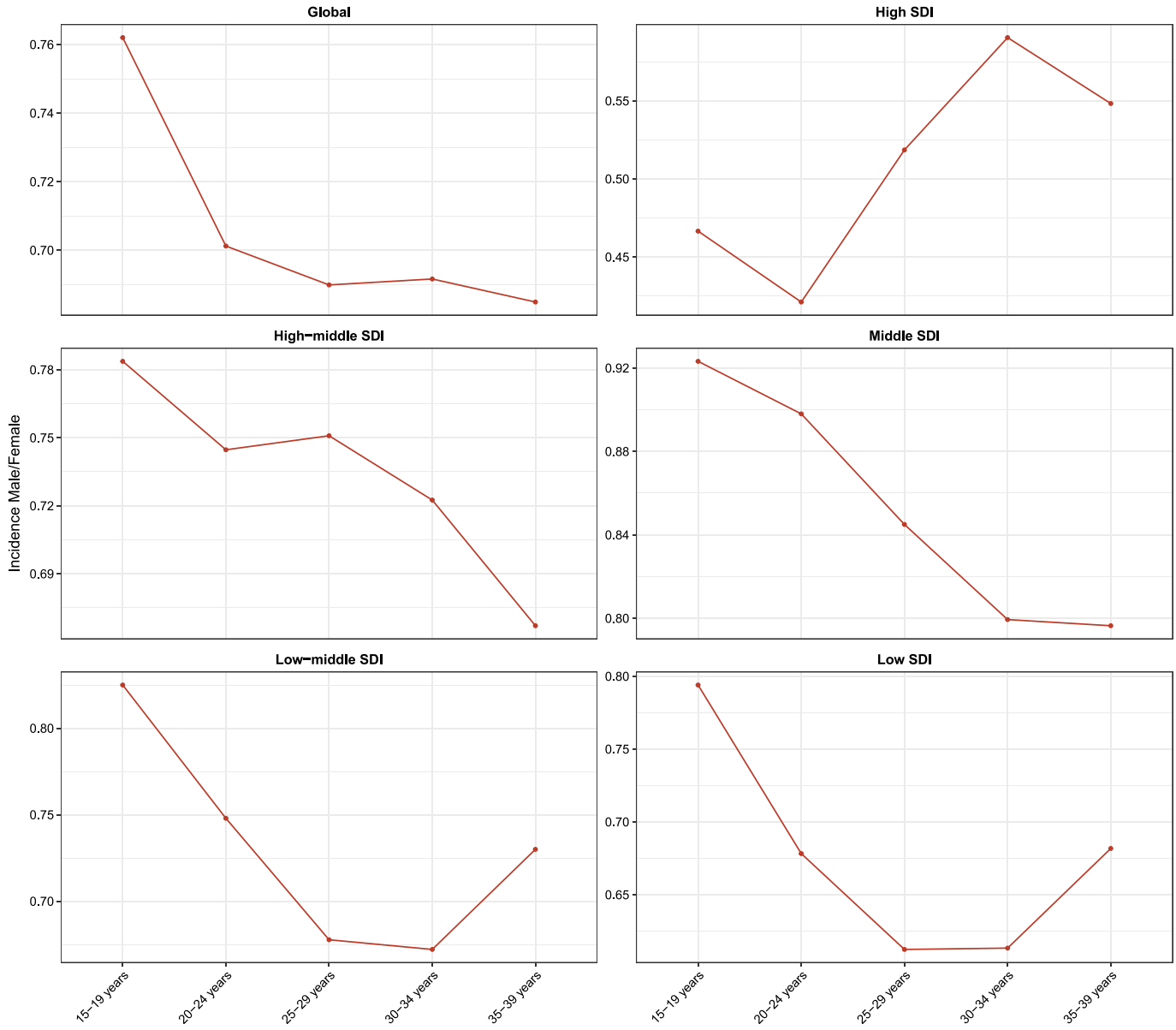

Fig. 2.

and Africa (e.g., Saudi Arabia, Afghanistan,Oman and Sudan). Previous epidemiological studies have identified a number of reasons for the high burden of asthma in Middle Eastern and Southeast Asian countries, including inadequate use of preventive asthma medications and inadequate use of pulmonary function tests to diagnose or monitor the progression of asthma(Al-Busaidi et al., 2015; Mohamed Hussain et al., 2018). In addition, it is important to raise young people awareness on asthma(Nguyen et al., 2018).It is also necessary to improve physicians' knowledge of asthma diagnosis and treatment in order to improve the effectiveness of asthma control(João et al., 2022). In addition, we also noted that 5 SDIs can have high age-standardized young asthma prevalence but low age-standardized young asthma mortality, a phenomenon that can be clearly observed in high SDI areas. It has been postulated that the observed phenomenon can be attributed to efficacious medication management and adherence to standardized care practices in affluent regions. Consequently, despite the presence of inevitable risk factors such as urbanization, which contributes to a higher prevalence of asthma, mortality rates remain comparatively low. In contrast, regions with lower SDI exhibit a lower age-standardized prevalence of young asthma, yet experience higher mortality rates associated with the condition(Babar et al., 2013; Chiang et al., 2015). The provision of effective, accessible, and affordable medications poses a significant obstacle in economically disadvantaged regions. This is exemplified by the lack of established long-term medical care standards and the scarcity of competent physicians and organizations in certain countries, resulting in suboptimal healthcare for individuals suffering from asthma(Chiang et al., 2015).

By gender, we found the highest percentage of female patients aged 15–19 years globally, and the highest percentage of females aged 30–34 years in High SDI regions. However, it is noteworthy that this trend may display variations in different countries. For example, a comprehensive survey carried out in seven major cities in China revealed a significantly higher prevalence of asthma among males aged 15 years and above in six of the surveyed cities(Zhang et al., 2016). We postulate that the observed correlation between the heightened occurrence of asthma in females after puberty may be attributed to the pathogenic influence exerted by sex hormones(Minelli et al., 2018).

Regarding joinpoint analysis, mortality in adolescent asthma has exhibited a consistent downward trend over a period of 30 years, which may be linked to improved asthma management. However, morbidity

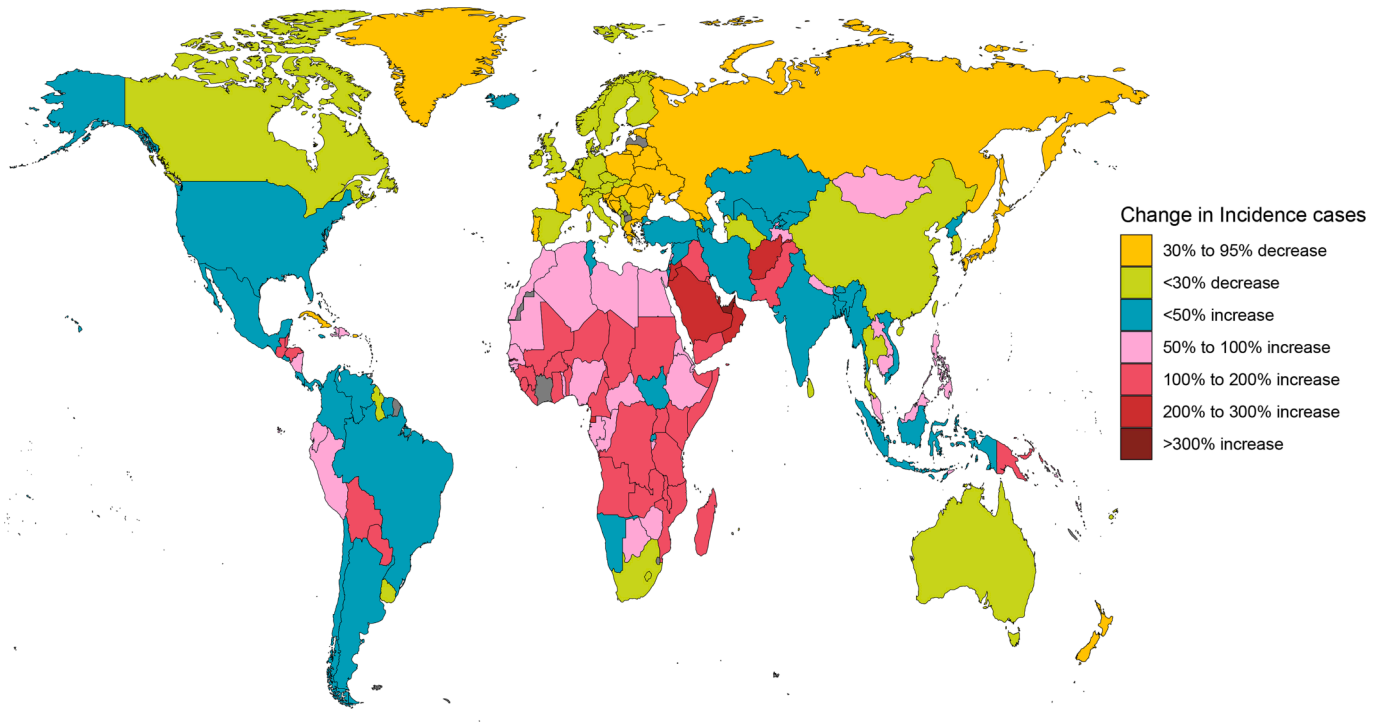

Fig. 3.

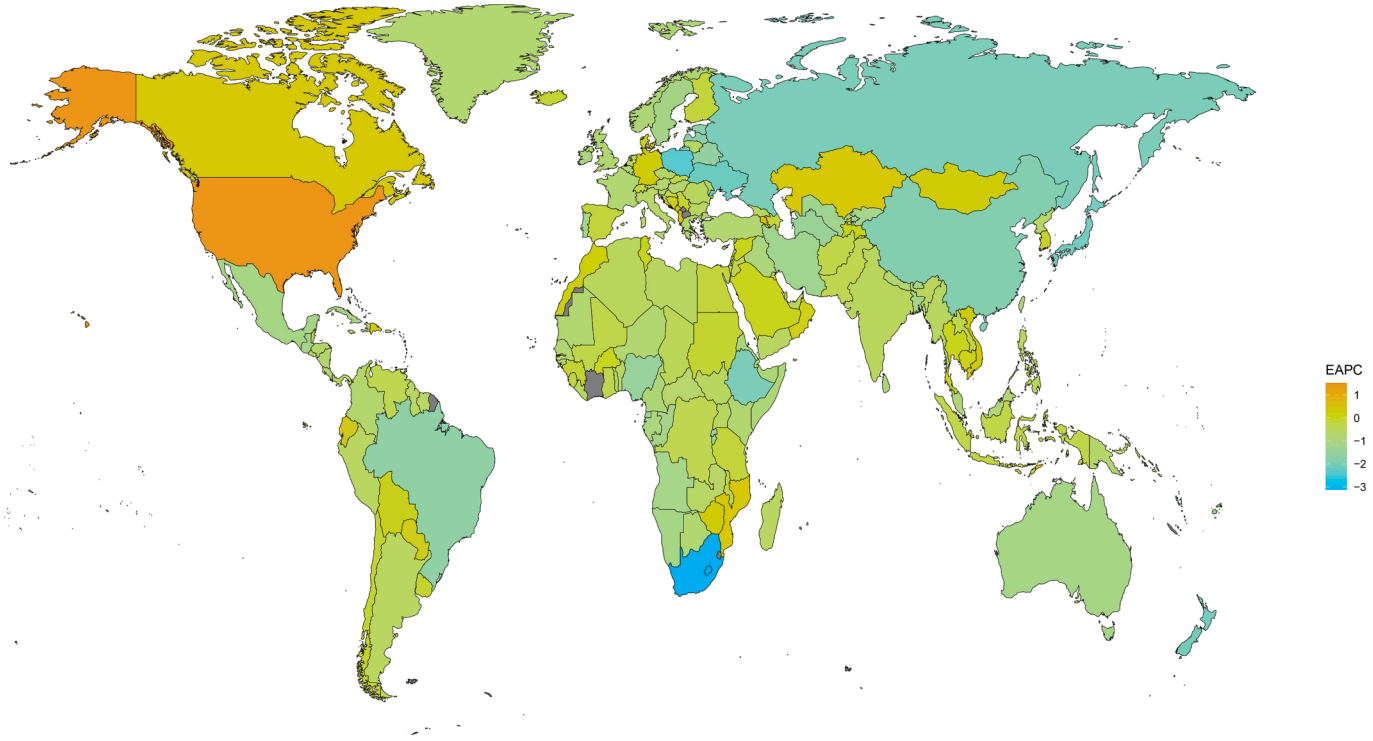

Fig. 4.

and prevalence have demonstrated a resurgence after 2015 with no evidence of a decreasing inflection point. We propose that the upsurge in incidence may be influenced by several factors, such as viral infections, air pollution, genetic susceptibility, obesity, and early immune maturation abnormalities(Zhang et al., 2010; Ho et al., 2011; Weinmayr et al., 2014; von Mutius and Smits, 2020). Nevertheless, the relationship between these factors and the pathogenesis of asthma is intricate, and further research into the underlying biological mechanisms is warranted.

This study presents a comprehensive analysis of the incidence and mortality rates of asthma in young adults, factoring in age, gender, and regional differences, covering the period from 1990 to 2019. The study's results yield significant insights for future research efforts and equip policymakers with relevant information. However, our study had some

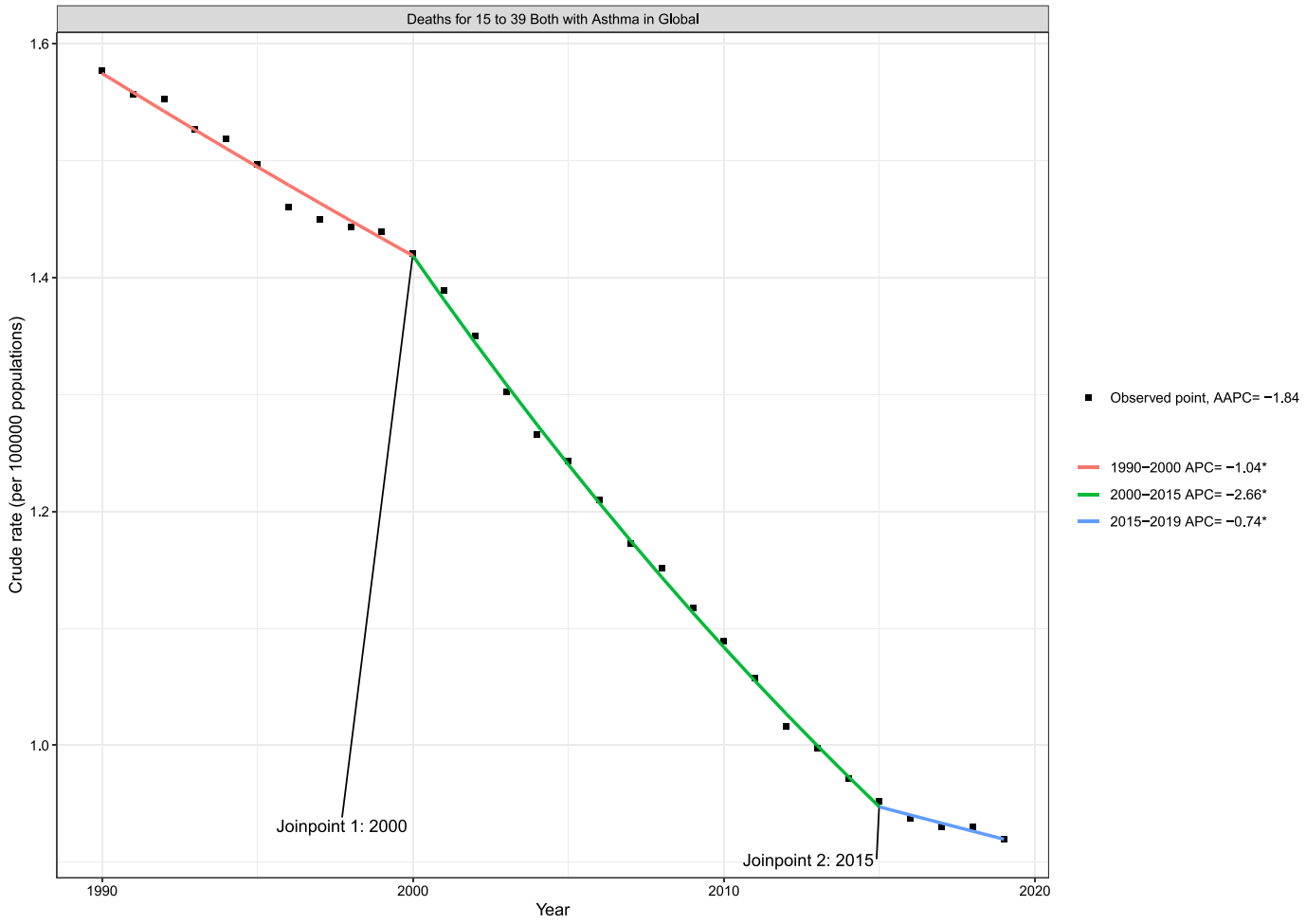

Fig. 5.

limitations. First,The findings of our study may offer limited insights into the clinical implications of asthma due to insufficient data pertaining to emergency department visits, hospital admissions, and the utilization of essential asthma medications. Furthermore, it is important to acknowledge the limitations inherent in the GBD study. The reliability and accuracy of the study's outcomes were contingent upon the quality of the population and disease data gathered. It is worth noting that numerous countries exhibited a dearth of asthma-related data, thereby creating a disparity between the study's findings and the actual state of affairs in various global regions. Thirdly, numerous countries lacked comprehensive registration systems for documenting mortality, necessitating the acquisition of estimates through autopsy investigations. Nevertheless, these studies failed to differentiate between various forms of chronic respiratory illnesses that should not be attributed to asthma-related deaths, leading to an underestimation of the true figures. Fourthly, despite employing multiple methodologies for calculation, rectification of disease misclassification, and reclassification of ambiguous codes in the GBD study, it is crucial to acknowledge the potential inaccuracies inherent in the data.

6. Conclusion

The age-standardized disease burden rate for asthma in young adults has declined somewhat over the past 30 years. However, areas with lower SDI have higher age-standardized mortality rates for asthma and deserve attention and priority support for medical resources. The joinpoint analysis suggested an increase in the prevalence of asthma in recent years.

CRediT authorship contribution statement

Cheng-hao Yang: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology. **Jia-jie Lv:** Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration. **Xin-yu Li:** Formal analysis, Funding acquisition, Investigation, Methodology, Software, Writing – original draft. **Xi-Tao Yang:** Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. **Min-Yi Yin:** Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Acknowledgments

No matter the old village doctors who are going to retire or the young who just set foot on the job, they have no regrets, no conditions and actively participated in the front-line work of epidemic prevention and control in China.

Author contributions

All authors made substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; took part in drafting the article or revising it critically for important intellectual content; agreed to submit to the current journal; gave final approval of the version to be published; and agree to be accountable for all aspects of the work.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.pmedr.2023.102531.

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