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Health loss and economic burden of asthma in China: a qualitative review based on existing literature

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Abstract

Background Asthma is a significant public health issue that cannot be ignored in China and around the world, bringing a huge social burden.

Objectives To evaluate the disease burden of asthma in China, including health loss and cost of illness, and identify its influencing factors.

Methods A systematic literature review and qualitative descriptive analysis were conducted, Literature was accessed through PubMed, EMBASE, Web of Science, CNKI, Wangfang Data, and VIP databases, with a cutoff date of April 3, 2024. The analysis focused on two main aspects: health loss burden, measured by disability-adjusted life years (DALYs), including years of life lost (YLLs) and years lived with disability (YLDs); and economic burden, assessed through direct and indirect costs. The risk of bias in economic studies was assessed using an 11-item methodological checklist for cost of illness, while cross-sectional studies were evaluated using the Agency for Healthcare Research and Quality's recommendation rating tool.

Results The analysis included 50 studies, with eight focused on health loss and 42 on economic burden. The health loss studies showed a 51% decrease in asthma's age-standardized DALYs rate over 30 years, from 209.24 to 102.81 per 100,000 person-years. The health loss burden is influenced by factors such as high BMI, smoking, and occupational exposure. Economic burden studies reported annual direct costs from $348 to $1187 per capita, indirect costs from $7 to $1195, and hospitalization costs from $177 to $1547, influenced by frequency and severity of acute exacerbation, comorbidities, and treatment adherence. Quality assessment revealed moderate overall quality, with gaps in sensitivity analyses and cost data transparency.

Conclusion The health loss burden of asthma in China has significantly decreased from 1990 to 2019, with males experiencing a higher burden. However, regional disparities in the economic burden persist, highlighting the need for improved management and adherence to standardized treatment protocols to address these disparities.

Keywords Disease burden, Economic burden, DALYs, Asthma, Systematic review

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Text box 1. Contributions to the literature

- This review provides a comprehensive analysis of the health loss and economic burden of asthma in China, filling a gap in the existing literature.
- It presents the overall trends in health loss burden and regional variations in economic costs in China, with particular emphasis on the impact of high BMI, smoking, and occupational exposure on health loss.
- Given the diversity of research methods and data sources across different regions of China, this study calls for an update and integration of survey data on asthma disease burden.

Introduction

Asthma is a common chronic inflammatory airway disease characterized by a long course, recurrent episodes, and suboptimal control rates globally [1, 2]. Its lifetime prevalence ranges from 1 to 18% across different population [3]. In 2019, asthma affected 300 million people worldwide, and resulted in 461,000 asthma-related deaths [4]. In China, the prevalence among individuals over 20 years old exceeds 4.2%, corresponding to 45.7 million cases, with a rising trend annually [5]. In 2019, asthma's age-standardized disability-adjusted life years (DALYs) rate ranked eighth among 369 diseases in China [6]. These figures highlight asthma as a major global health issue, with significant social and economic implications [7].

Disease burden refers to the impact of disease on health and society, encompassing both epidemiological and economic components [8]. The epidemiological burden has evolved from traditional health metrics such as morbidity and mortality, to DALYs, which account for years of life lost (YLLs) and years lived with disability (YLDs), integrating factors such as age, time, and discount rates. The economic burden includes both direct and indirect costs associated with disease treatment and prevention, affecting individuals, families, and society [9].

In recent years, studies in China have quantified the economic burden of asthma through cross-sectional surveys, hospital data, and medical insurance databases. These aim to estimate the financial impact of asthma care. Simultaneously, research using the Global Burden of Disease (GBD) database has assessed asthma's health loss burden, including DALYs, YLLs, and YLDs. However, a systematic review of these findings is lacking. This synthesis is needed due to differences in study methodologies, regional variations, and the evolving nature of asthma's economic burden, which have led to inconsistent data and a fragmented understanding of the issue in China. This study aims to fill this gap by conducting a systematic review of the disease burden among the Chinese asthma population. By qualitatively analyzing trends and characteristics of the asthma burden, the review seeks to enhance the understanding of this pressing public health issue and to raise awareness about the disease.

Methods

This review strictly followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement. The protocol for the systematic review was registered in the PROSPERO (International prospective register of systematic overview) database (No. CRD42024552914).

Search strategy

We conducted a literature search across multiple databases, including PubMed, Web of Science, Embase, Chinese National Knowledge Infrastructure (CNKI), WANGFANG Data, and VIP databases, covering articles published from their inception up to April 3, 2024. The search terms included both subject headings and free-text terms, such as "Asthma" "bronchial asthma" "disease burden" "cost of illness" and "Disability-Adjusted Life Years (DALYs)" among others. A full list of the search terms used, along with detailed search strategies for CNKI (Chinese language) and PubMed (English language), is provided in Supplemental Appendix 1.

Study selection

Studies were included if they met the following criteria: (1) focused on the economic costs (e.g., direct and indirect costs) and/or health loss (e.g., DALYs, YLLs, YLDs) associated with asthma; (2) used a cross-sectional or retrospective study design; (3) utilized data from reliable sources, such as government health departments, medical institutions, or the Global Burden of Disease (GBD) database; (4) provided full-text availability; and (5) were published in Chinese or English. Studies were excluded if they met any of the following criteria: (1) non-original research articles, such as conference abstracts, case reports, letters, comments, editorials, or review articles; (2) economic evaluation studies focusing solely on therapies; (3) epidemiological studies examining the pathogenesis or etiology of asthma; (4) intervention studies assessing the efficacy of treatments; or (5) clinical studies unrelated to the population-level burden of asthma.

Data extraction

Two professional researchers (PZ and JX) independently screened the literature according to the search strategy, and in cases of disagreement, the decision was discussed with a third investigator (YX). The extracted data included the following: (1) Basic information: study title, first author, study period, study location, data source (e.g., surveys, medical records, insurance databases, etc.), and publication year; (2) Economic burden: (a) direct costs,

including both direct medical costs (e.g., hospitalization, outpatient visits, medications, diagnostic tests) and direct non-medical costs (e.g., transportation, accommodation, caregiving expenses); and (b) indirect costs, derived from productivity losses due to absenteeism or premature mortality, calculated in monetary terms where available; (3) Health loss: metrics such as DALYs, YLLs, and YLDs, with details on whether they were reported in aggregated or disaggregated formats by age, gender, and region.

Risk of bias evaluation

For the evaluation of disease burden studies, no specific risk of bias assessment tool was identified. However, we adopted the methodology published by Molinier et al. [10] in *PharmacoEconomics* to assess the quality of the economic cost studies included in this review. This method consists of 11 items, including disease definition, epidemiological characteristics, cost data sources, analysis methods, sensitivity analysis, and others. Each item is marked "yes" if met and "no" if not. Additionally, we assessed the risk of bias in the cross-sectional studies using the Agency for Healthcare Research and Quality (AHRQ) recommendation rating tool.

Data Analysis

Excel 2019 was used to organize and analyze the literature data. The analysis was conducted using qualitative descriptive methods, focusing on health loss burden (DALYs, YLLs, YLDs) and economic burden (direct and indirect costs) as the primary indicators. The analysis of health loss burden included overall trends and subgroup analysis based on different gender, age, and time stages, as well as identification influencing factors. For the economic burden, The analysis covered direct costs, indirect costs, and hospitalization costs, with subgroup analyses based on disease severity, management approaches, and influencing factors. All costs were converted to USD using the 2023 exchange rate.

Results

Literature search

A total of 4,995 articles were retrieved through database searches. After screening, 50 studies [11–60] were included in the final analysis, comprising 43 in Chinese and seven in English. Figure 1 outlines the selection process and results.

Characteristics of the included studies

A total of 50 studies were included in the analysis, Among these, eight studies used health loss as a measure of disease burden, all based on the GBD database. Specifically, six studies employed "DALYs", four used "YLLs", and four used "YLDs" as the disease burden indicators. In terms of economic burden, 42 studies examined the economic costs associated with asthma in 15 provinces, autonomous regions, and municipalities across China. Regarding research design, 24 studies were cross-sectional surveys, and 18 were retrospective analyses. Notably, 18 of the 42 studies focused exclusively on children.

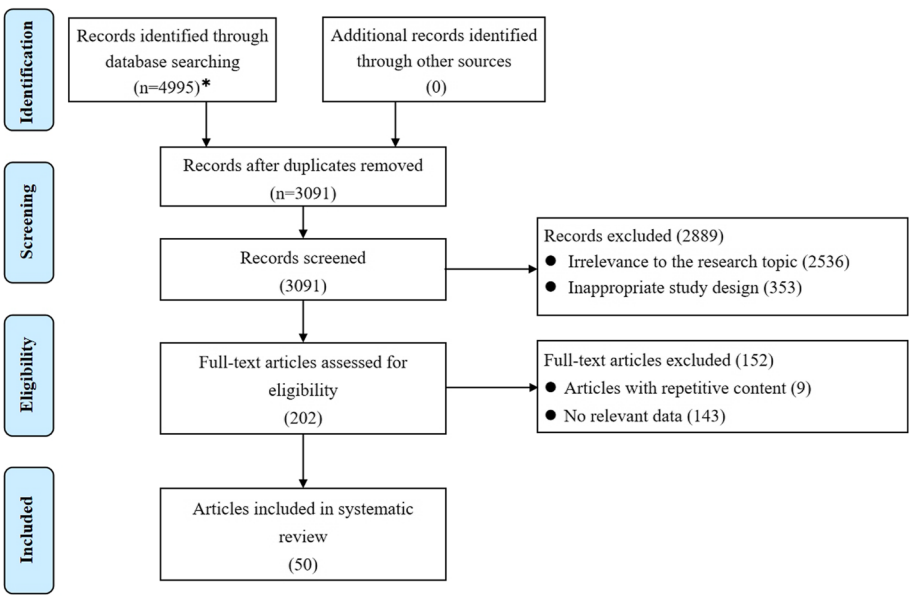

Fig. 1 The process and result of screening the articles on the disease burden of asthma in China. * Databases searched and literature detected are as follows: CNKI ($n=437$), WANGFANG ($n=2299$), VIP ($n=1278$), PubMed ($n=130$), Web of Science ($n=552$), and Embase ($n=299$)

The characteristics of these 50 studies are summarized in Table 1.

Risk of bias assessment

Based on 11 quality assessment items, 42 studies [19–60] on the economic burden of asthma were evaluated (Table S1). The findings indicate that the overall quality of these studies was moderate. Most studies performed well in terms of clearly defining the illness (Item 1), appropriately valuing unit costs (Item 7), and ensuring consistency between the study results and methodology (Item 11). However, many studies lacked adequate validation and explanation of critical assumptions, particularly in sensitivity analyses (Items 9 and 10). Additionally, deficiencies were noted in the disaggregation of direct and indirect costs (Item 3) and the detailed description of cost data sources (Item 6), with many studies failing to provide sufficient granularity in their cost breakdowns or transparency regarding the origins of the data. For the quality assessment of cross-sectional studies [19–42], detailed results are provided in the supplementary materials (Table S2), which were evaluated using the Agency for Healthcare Research and Quality (AHRQ) recommendation rating tool.

Health loss burden

The overall trend in the health loss burden

In 2019, the age-standardized rates for asthma in China were 102.81 per 100,000 for DALYs, 24.50 for YLLs, and 78.31 for YLDs [11]. From 1990 to 2019, the age-standardized DALYs rate for asthma decreased by 51%, from 209.24 to 102.81 per 100,000. This reduction ranks China seventh among G20 nations, following South Korea, the Russian Federation, Japan, Poland, Germany, and Latvia, and surpasses the global average decrease of 43% [13]. A GBD study focusing on Chinese children and adolescents (aged 1–19 years) reported a 17.91% reduction in age-standardized DALYs rate, from 145.52 per 100,000 in 1990 to 119.46 in 2019 [14]. Additionally, another study indicated a significant decline in the age-standardized DALYs rate, with an average annual percentage change (AAPC) of −5.22% from 1990 to 2019 [15].

Analysis of health loss burden by gender

According to the GBD 2019 data and Qu et al. [11], the age-standardized rates of DALYs, YLLs, and YLDs for Chinese males with asthma in 2019 were 119.43, 32.77, and 86.66 per 100,000, respectively, significantly higher than those for females. Cao et al. [12] reported a notable reduction in YLLs among asthmatic males, from 527,300 to 270,700 person-years, and among females, from 466,800 to 171,000 from 1990 to 2019. The corresponding YLLs rates dropped from 86.42 to 37.34 per 100,000 for males and from 81.39 to 24.51 per 100,000 for females, with a persistent gender disparity in mortality rates. Furthermore, an analysis of GBD 2019 data for children and adolescents showed that the age-standardized DALYs rate for males aged 1–19 years decreased from 159.53 to 134.64 per 100,000, while for females, it fell from 130.38 to 101.73 per 100,000. The reduction was more pronounced in females (21.97%) compared to males (15.60%) [14].

A gender-specific analysis by Liu et al. [13] highlighted differences in asthma-related health loss burden across age groups. Their 2019 findings revealed that males had higher age-standardized DALYs rates than females among those under 30 and over 49 years old. However, for individuals aged 30–49 years, the rates were nearly identical, representing a shift from 1990, when females in this age group had higher DALYs rates. Despite this, the DALYs rate for males remained higher than for females in both the youngest (20–24 years) and oldest (50–54 years) age groups, in both 1990 and 2019.

Analysis of health loss burden by age

Qu et al. [11] observed a subtle yet notable increase in the DALYs rate for asthma among children aged 1–5 years in 2019, contrasting with a slight decline and subsequent stabilization in the 5–10 age group. A significant surge in DALYs rate was observed in those aged 60 and above. The YLDs rate, reflecting disability burden, displayed a pronounced double-peak distribution in the 5–9 and 75–79 age groups. The YLLs rate, indicating premature mortality, showed a marked increase in the elderly, particularly in those aged 60 and older. Similarly, Liu et al. [13] identified a comparable pattern, with the age-standardized DALYs rate for asthma increasing slightly in early childhood, declining during adolescence, and then sharply rising in middle and older age, peaking in the 85–89 age group.

From 1990 to 2019, the YLLs rate consistently declined annually among asthma patients aged 40 and above. However, this trend was not observed uniformly across all age groups. The DALYs and YLDs rates decreased only in those over 65, while rates for individuals under 65 fluctuated over time [11]. A separate analysis of asthma patients aged 0–19 years, based on the GBD 2019 data, revealed a "decrease-increase–decrease" pattern in the DALYs and YLDs rates across the 1–4, 5–9, and 10–14 age groups from 1990 to 2019. The YLLs rate for the 1–4 age group consistently exceeded those of other age groups, with a notable reduction from 77.24 per 100,000 in 1999 to 2.80 per 100,000 in 2019. Across all four age groups (1–4, 5–9, 10–14, and 15–19 years), the YLLs rates showed a continuous decline, with average annual

Table 1 Characteristics of the 50 studies on asthma disease burden in China (1990–2019)

Study	Study year	Region of study	Data source	Study type	Age of population	Indicator of disease burden
Qu et al. [11]	1990–2019	China	GBD 2019	Database analysis	Unrestricted	YLL, YLD, DALY
Cao et al. [12]	1990–2019	China	GBD 2019	Database analysis	Unrestricted	YLL
Liu et al. [13]	1990–2019	Group of twenty (G20) including China	GBD 2019	Database analysis	Unrestricted	DALY
Yi et al. [15]	1990–2019	China	GBD 2019	Database analysis	1–19	DALY
Tang et al. [14]	1990–2019	China, South Korea, and Japan	GBD 2019	Database analysis	Unrestricted	DALY
Zhang et al. [16]	1990–2019	China	GBD 2019	Database analysis	1–19	YLL, YLD, DALY
Luo et al. [17]	1990–2019	Sichuan	GBD 2019	Database analysis	0–5	YLD
Liao et al. [18]	2005–2015	Southern China	GBD 2015	Database analysis	Unrestricted	YLL, YLD, DALY
Xie et al. [19]	2003	Liaoning	Survey	Cross-sectional study	Over 14	Cost
Mao et al. [20]	2010	Yunnan	Survey	Cross-sectional study	Over 18	Cost, YLL, YLD, DALY
Mao et al. [21]	2010	Yunnan	Survey	Cross-sectional study	Over 18	Cost, YLL, YLD, DALY
Zhu et al. [22]	2015	Yunnan	Survey	Cross-sectional study	Over 18	Cost
Liu et al. [23]	2011, 2021	Yunnan	Survey	Cross-sectional study	Over 35	Cost
Liu et al. [24]	2020–2021	Yunnan	Survey	Cross-sectional study	Over 35	Cost
Liu et al. [25]	2000–2001	Sichuan, Chongqing, Yunnan	Survey	Cross-sectional study	Unrestricted	Cost
Fu et al. [26]	2004	Beijing, Shanghai, Guangdong	Survey	Cross-sectional study	Unrestricted	Cost
Wang et al. [27]	2009	Shandong	Survey	Cross-sectional study	Unrestricted	Cost
Yu et al. [28]	2008	Liaoning	Survey	Cross-sectional study	Unrestricted	Cost
Li et al. [29]	2000	Sichuan	Survey	Cross-sectional study	0–14	Cost
Li et al. [30]	2002	Henan	Survey	Cross-sectional study	0–14	Cost
Feng et al. [31]	2006	Guangdong	Survey	Cross-sectional study	3–14	Cost
Huang et al. [32]	2008–2009	Guangdong	Survey	Cross-sectional study	0–14	Cost
Xu et al. [33]	2010	Beijing	Survey	Cross-sectional study	0–14	Cost
He et al. [34]	2010	Sichuan	Survey	Cross-sectional study	0–14	Cost
Tan et al. [35]	2010	Hunan	Survey	Cross-sectional study	0–14	Cost
Wang et al. [36]	2010	Hubei	Survey	Cross-sectional study	0–14	Cost
Lin et al. [37]	2010–2011	Shandong	Survey	Cross-sectional study	0–14	Cost
Zhu et al. [38]	2010–2011	Jiangsu	Survey	Cross-sectional study	0–14	Cost
Zhang et al. [39]	2012–2013	Fujian	Survey	Cross-sectional study	0–14	Cost
Zhang et al. [40]	2015	Jiangsu	Survey	Cross-sectional study	3–14	Cost
Zheng et al. [41]	2016	Guangdong	Survey	Cross-sectional study	0–14	Cost
Qi et al. [42]	2016	Yunnan	Survey	Cross-sectional study	0–14	Cost
Xiong et al. [43]	2007	Chongqing	Institutional data	Retrospective study	Unrestricted	Cost
Yang et al. [44]	2001–2010	Gansu	Institutional data	Retrospective study	Unrestricted	Cost
Li et al. [45]	2013–2019	Liaoning	Institutional data	Retrospective study	Unrestricted	Cost
Wang et al. [46]	2014	Xinjiang	Institutional data	Retrospective study	Unrestricted	Cost
Zhang et al. [47]	2014	Xinjiang	Institutional data	Retrospective study	Unrestricted	Cost
Xie et al. [48]	2009–2014	Liaoning	Institutional data	Retrospective study	Unrestricted	Cost
Xie et al. [49]	2009–2014	Liaoning	Institutional data	Retrospective study	Unrestricted	Cost
Xing et al. [50]	2013–2014	Beijing	Institutional data	Retrospective study	Over 14	Cost
Lin et al. [51]	2013–2014	China	Institutional data	Retrospective study	Over 14	Cost
Yao et al. [52]	2015	Liaoning	Institutional data	Retrospective study	Unrestricted	Cost
Xie et al. [53]	2008–2017	Liaoning	Institutional data	Retrospective study	Unrestricted	Cost
Meng et al. [54]	2008–2017	Gansu	Institutional data	Retrospective study	Unrestricted	Cost
Lin et al. [55]	2005–2006	Shandong	Institutional data	Retrospective study	2–16	Cost
Jiang et al. [56]	2013–2015	Chongqing	Institutional data	Retrospective study	0–14	Cost
Zhao et al. [57]	2017–2019	Jiangsu	Institutional data	Retrospective study	0–14	Cost
Shang et al. [58]	2011–2019	Shandong	Institutional data	Retrospective study	Unrestricted	Cost
Yang et al. [59]	2015	China	China health insurance research association	Retrospective study	Unrestricted	Cost

Table 1 (continued)

Study	Study year	Region of study	Data source	Study type	Age of population	Indicator of disease burden
Wu et al. [60]	2015	China	China health insurance research association	Retrospective study	0–14	Cost

percentage changes (AAPC) of −10.8%, −8.3%, −7.4%, and −6.6%, respectively [16].

Analysis of health loss burden by periods

Between 1990 and 2019, the crude and age-standardized DALYs rates for the asthma population in China followed a complex trajectory, initially declining, experiencing a slight resurgence from 2015, and then resuming their downward trend by 2018. The crude and age-standardized YLLs rates exhibited fluctuations but generally declined over the period. In contrast, the YLDs rate initially decreased, followed by a modest increase starting in 2014, and then declined again from 2019 onward. Notably, the age-standardized YLDs rate mirrored the crude rate in the early years but diverged to show a consistent downward trend from 2018 onward [11, 13].

Cao et al. [12] conducted a detailed analysis of the age-standardized YLLs rate for asthma, dividing the trend into five distinct periods from 1990 to 2019. The overall AAPC for this period was a decline of 5.29%. The AAPCs for the respective periods—1990–1995, 1995–2004, 2004–2007, 2007–2010, and 2010–2019—were −3.46%, −5.05%, −10.16%, −5.80%, and −4.70%, respectively. This breakdown highlights a fluctuating but generally declining trend, with the most significant reduction occurring between 2004 and 2007.

Risk factors of health loss burden

Qu et al. [11], utilizing GBD 2019 data, examined the population attributable fraction (PAF) to trace the evolution and hierarchy of risk factors for asthma. In 1990, the leading risk factors for the age-standardized DALYs rate were tobacco use (11.62%), occupational hazards (9.67%), and high BMI (4.93%). By 2019, the ranking shifted, with tobacco use rising to 14.29%, high BMI becoming the second most significant risk factor at 12.44%, and occupational hazards decreasing to 7.65%. Notably, high BMI not only ascended in rank but also showed a substantial upward trend, with an AAPC of 3.24%, highlighting the growing impact of obesity on asthma-related health outcomes.

Liu et al. [13] identified smoking, occupational asthma, and high BMI as the primary risk factors contributing to the age-standardized DALYs rate for asthma in China. In 1990, these factors accounted for 12.95%, 8.5%, and 5.22% of total DALYs, respectively. A marked gender disparity was observed, with smoking contributing significantly more to DALYs in males (23.04%) than in females (2.11%). Occupational asthma had a stronger impact on females (7.07%), while high BMI contributed 5.65%. By 2019, the order of these risk factors had shifted: high BMI (10.21%), smoking (10.08%), and occupational asthma (6.03%) led the list. In males, smoking remained the primary risk factor, though its contribution to DALYs decreased (from 23.04% to 16.9%). In females, smoking remained less significant, while high BMI became the dominant risk factor, accounting for 9.97% of the total DALYs.

Economic burden

Direct economic burden

Asthma's direct economic burden, as detailed in Table 2, includes both medical and non-medical costs. Medical costs encompass outpatient services, hospitalization, medications, and diagnostic tests, while non-medical costs include transportation, nursing, and nutrition. Our analysis of 12 cross-sectional studies (2001–2021) [19–28, 58, 59] from major regions, including Beijing, Shanghai, Guangzhou, Yunnan, Shandong, Sichuan, and Chongqing, reveals annual direct costs for adult asthma patients ranging from $348 to $1,187. Hospitalization expenses account for 47.57% to 71.72% of total costs, while outpatient costs account for 17.60% to 46.34%, and transportation and nutrition costs vary between 3.25% and 11.55%.

Our analysis also includes the direct economic burden of childhood asthma, based on 15 cross-sectional studies [30–43, 60]. While most studies focused on direct medical costs, only four studies [31, 33, 37, 40] reported annual costs ranging from $432 to $867 per child (2009–2016). A broader perspective from six studies [33, 35–37, 40, 42] (2010–2015) shows significant cost variation, with most cases falling between $284 and $710 (36.0%–71.8%). Fewer cases fell into higher cost brackets ($710-$1,419, 10.5%–30.0%), and some had costs under $284 (14.2%–31.4%). A 2015 study [60] using data from the China Medical Insurance Research Association (CHIRA) reported an average direct medical cost of $75 per child,

Table 2 Direct economic burden of asthma in 13 provinces of China: total direct costs, direct medical costs, and direct non-medical costs (2000–2019)

Study	Study Year	Region	Population Age	Sample Size	Direct Medical Costs (per capita per year, USD)	Direct Non-Medical Costs (per capita per year, USD)	Total Direct Costs (per capita per year, USD)
Liu et al. [25]	2000–2001	Sichuan, Chongqing, Yunnan	Unrestricted	108	-	-	$380
Xie et al. [19]	2003	Liaoning	Over 14	618	< $170 (48.2%) $170-$341 (2.7%) $341-$681 (0.6%) > $681 (0.3%) No expenses (48.4%)	-	-
Fu et al. [26]	2004	Beijing, Shanghai, Guangzhou	Over 7	662	Adult: $156, Child: $128	Adult: $193, Child: $219	Adult: $349, Child: $347
Yu et al. [28]	2008	Liaoning	Unrestricted	473	$140		
Wang et al. [27]	2009	Shandong	Unrestricted	152	$440	$102	$542
Mao et al. [20]	2010	Yunnan	Over 18	/	-	-	$348
Mao et al. [21]	2010	Yunnan	Over 18	60	-	-	$759
Liu et al. [23]	2011	Yunnan	Over 35	111	-	-	$394
Zhu et al. [22]	2015	Yunnan	Over 18	55	-	-	$1187 (Male: $840, Female: $1442)
Yang et al. [59]	2015	China	Unrestricted	7254	Overall Mild: $160 Moderate: $250 Severe: $962 6–14 years old Mild: $155 Moderate: $236 Severe: $429	-	-
Shang et al. [58]	2011–2019	Shandong	Over 18	8480	$474 (With acute attacks) $137 (without acute attacks)	-	-
Liu et al. [23]	2021	Yunnan	Over 35	122	-	-	$600 (Male: $498, Female: $667)
Li et al. [29]	2000	Sichuan	0–14	433	-	-	$710
Li et al. [30]	2002	Henan	0–14	128	$337 (Non standardized treatment) $93 (Standardized treatment)	-	-
Feng et al. [31]	2006	Guangdong	3–14	103	-	-	$591
Huang et al. [32]	2008–2009	Guangdong	0–14	148	$867	-	-
Xu et al. [33]	2010	Beijing	0–14	497	< $284 (31.4%) $284-$710 (41.0%) $710-$1419 (18.2%) $1419-$4257 (9.0%) > $4257 (0.4%)	-	-
He et al. [34]	2010	Sichuan	0–14	843	$504	-	-
Tan et al. [35]	2010	Hunan	0–14	482	< $284 (73.9%)	-	-
Wang et al. [36]	2010	Hubei	0–14	363	< $284 (28.7%) $284-$710 (51.0%) $710-$1419 (16.5%) $1419-$4257 (3.6%)	-	-
Lin et al. [37]	2010–2011	Shandong	0–14	315	< $284 (14.2%) $284-$710 (71.8%) $710-$1419 (10.5%)	-	-
Zhu et al. [38]	2010–2011	Jiangsu	0–14	540	$587	-	-

Table 2 (continued)

Study	Study Year	Region	Population Age	Sample Size	Direct Medical Costs (per capita per year, USD)	Direct Non-Medical Costs (per capita per year, USD)	Total Direct Costs (per capita per year, USD)
Zhang et al. [39]	2012–2013	Fujian	0–14	498	$1371 (Non standardized treatment) $620 (Standardized treatment)	-	-
Zhang et al. [40]	2015	Jiangsu	3–14	402	> $1419 (7.46%)	-	-
Wu et al. [60]	2015	China	0–14	2468	$75 (Overall) $78 (Under 3 years old) $67 (3–6 years old) $70 (7–14 years old)	-	-
Zheng et al. [41]	2016	Guangdong	0–14	317	$432	-	-
Qi et al. [42]	2016	Yunnan	0–14	150	< $284 (20.0%) $284-$710 (36.0%) $710-$1419 (30.0%) $1419-$4257 (11.33%) > $4257 (2.67%)	-	-

[$] Due to different methods of assessing economic burden, the commonly used average per person per year is used in the table. And the cost converted to USD according to the exchange rate in 2023 (7.0467 RMB = 1 USD)

primarily driven by medication ($56, 75.01%). Outpatient and diagnostic costs were lower, at $9 (11.65%). Notably, medication costs rose with age, peaking at 80.97% in children aged 7–14 years, while those aged 3–6 years had the highest relative expenditure on ancillary exams.

In China, significant regional differences exist in the direct economic burden on both pediatric and adult populations, influenced by factors such as economic development, healthcare resource allocation, and patient age characteristics. For children, medical costs are higher in economically developed regions such as Beijing (2010), Jiangsu (2010–2011), and Guangdong (2008–2009), with costs reaching $4,257, $587, and $867, respectively. These higher costs reflect abundant healthcare resources but also a higher economic burden. In contrast, regions like Sichuan (2000–2001), Yunnan (2010), and Hunan (2010) show lower costs, with Sichuan at $380, Yunnan at $348, and 73.9% of patients in Hunan incurring less than $284. In Liaoning (2003), 48.4% of children had no medical expenses, indicating a lighter burden. For adults, similar patterns are observed. In developed areas like Beijing (2010), Jiangsu (2010–2011), and Guangdong (2008–2009), medical costs range from $4257 to $867. In contrast, Sichuan (2000–2001) and Yunnan (2010) have lower costs at $380 and $348, respectively. In regions like Hubei (2010) and Hunan (2010), adult costs show more variation; in Hubei, most costs range from $284 to $710, while in Hunan, 73.9% of adults spend under $284. Overall, developed regions have higher medical costs due to better healthcare infrastructure, while less developed regions incur lower costs, likely due to limited healthcare resources and lower economic development.

Indirect economic burden

The indirect economic costs of asthma, as shown in Table 3, primarily reflect lost work productivity for patients and their caregivers. Our review of seven studies [20–24, 26, 27] from 2004 to 2021 reveals a wide range of annual per capita indirect costs, from $7 to $1,195, driven largely by regional income disparities and the number of workdays lost. Three studies [22, 26, 27] provide data on workdays lost,with a low of 3.6 days in a 2004 survey of patients from Beijing, Shanghai, and Guangzhou, and a high of 19.51 days in a 2015 study from Yunnan. A 2009 Shandong survey highlights a difference between urban and rural populations, with urban patients missing an average of 10 days, while rural families miss 15 days annually.

For pediatric asthma, indirect costs are more difficult to quantify due to factors such as medical visits and school absences. Our analysis focuses on parental work time lost, with five studies [29, 31, 34, 55, 57] documenting an average annual burden ranging from $88 to $770. Additionally, six studies [29, 31, 32, 34, 39, 55] reported an average annual loss of 18.88 to 54.28 workdays per family. Most studies [33, 35–38, 40] show that the majority of patients miss fewer than 10 days annually, accounting for 63.6% to 89.1% of cases.

Table 3 Indirect economic burden of asthma in 13 provinces of China: days of lost work, average daily salary, and total indirect costs (2000–2019)

Study	Study Year	Region	Population Age	Sample Size	Days of Lost Work (Per capita per year, days)	Average Daily Salary (USD)	Total Indirect Costs (per capita per year, USD)
Xie et al. [19]	2003	Liaoning	Over 14	618	6.<30d (6.5%) 30-60d (8.1%) 60-120d (1%) >120d (4.5%)	-	-
Fu et al. [26]	2004	Beijing, Shanghai, Guangzhou	Over 7	662	Adult: 3.6d, Child: 1.1d	$15	Adult: $55, Child: $17
Wang et al. [27]	2009	Shandong	Unrestricted	152	Urban: 10d Rural: 15d	-	$79
Mao et al. [20]	2010	Yunnan	Over 18	/	-	-	$1195 (Male: $2554, Female: $596)
Mao et al. [21]	2010	Yunnan	Over 18	60	-	-	$275 (Male: $271, Female: $278)
Liu et al. [23]	2011	Yunnan	Over 35	111	-	-	$7
Zhu et al. [22]	2015	Yunnan	Over 18	55	19.51d (Male: 23.86d, Female: 9.72d)	-	$913 (Male: $447, Female: $273)
Liu et al. [23]	2021	Yunnan	Over 35	122	-	-	$10 (Male: $8, Female: $11)
Li et al. [29]	2000	Sichuan	0–14	433	45d	$4.7	$212
Lin et al. [55]	2005–2006	Shandong	2–16	200	24.8d	$6	$149
Feng et al. [31]	2006	Guangdong	3–14	103	50.5d	$8.6	$435
Huang et al. [32]	2008–2009	Guangdong	0–14	148	18.88d	-	-
Xu et al. [33]	2010	Beijing	0–14	497	<10d (19.2%) 10-29d (12.6%) 30-59d (2.7%) >60d (1.9%)	-	-
He et al. [34]	2010	Sichuan	0–14	843	54.28d	$14.19	$770
Tan et al. [35]	2010	Hunan	0–14	482	>10d (23.2%)	-	-
Wang et al. [36]	2010	Hubei	0–14	363	<10d (63.6%) 10-29d (22.3%) 30-59d (11.6%) >60d (1.1%)	-	-
Lin et al. [37]	2010–2011	Shandong	0–14	315	<10d (75.8%) 10-29d (17.5%)	-	-
Zhu et al. [38]	2010–2011	Jiangsu	0–14	540	8d	-	-
Zhang et al. [39]	2012–2013	Fujian	0–14	498	46d	-	-
Zhang et al. [40]	2015	Jiangsu	3–14	402	10-29d (17.16%) 30-59d (5.22%) >60d (3.73%)	-	-
Zhao et al. [57]	2017–2019	Jiangsu	0–14	233	-	-	$108 (2017) $88 (2018) $106 (2019)

[$] Due to different methods of assessing economic burden, the commonly used average per person per year is used in the table. And the cost converted to USD according to the exchange rate in 2023 (7.0467 RMB = 1 USD)

Hospitalization cost

Single hospitalization cost Hospitalization costs due to acute asthma exacerbations constitute a significant portion of the disease's economic burden. Four retrospective studies [50, 51, 53, 55], utilizing hospital data, have reported on the costs associated with single hospitalizations (Table 4). Two of these studies [49, 52] provided average hospitalization costs of $1,568 for 2013–2014 and $1,591 for 2008–2017, respectively. The other two studies reported median costs. Lin et al. [50] analyzed hospitalization costs for patients over 14 years old admitted to Grade III Level A hospitals across 29 provinces, reporting a median cost of $1,284, ranging from $1,261 for general wards to $1,401

Table 4 Hospitalization expenses in tertiary hospitals across 6 provinces in China (2001–2019)

Study	Study Year	Region	Population Age	Sample Size	Hospitalization Costs (per capita per year, USD)	Average Length of Stay (days)	Cost Composition
Xiong et al. [43]	2007	Chongqing	Unrestricted	570	$811	8.16d	-
Yang et al. [44]	2001–2010	Gansu	Unrestricted	389	$177 (2001) $253 (2002) $311 (2003) $320 (2004) $191 (2005) $170 (2006) $136 (2007) $187 (2008) $205 (2009) $225 (2010)	-	-
Xie et al. [48]	2009–2014	Liaoning	Unrestricted	1327	Overall: $1803 Subgroup: $1656 (Non mechanical ventilation therapy) $6025 (Mechanical ventilation therapy)	-	-
Xing et al. [50]	2013–2014	Beijing	Over 14	99	$1568[a]	-	Drug expenses (51.7%), auxiliary examination expenses (39.5%), treatment expenses (4%), and other expenses (4.8%), including diagnosis and treatment expenses, nursing expenses, bed expenses, and material expenses
Lin et al. [51]	2013–2014	China	Over 14	3240	Overall: $1284[b] Subgroup: $1261 (Ordinary ward)[b] $1401 (ICU)[b]	-	Drug expenses (52.1%), auxiliary examination expenses (27.6%), treatment expenses (4%), and other expenses (9.6%), including diagnosis and treatment expenses, nursing expenses, bed expenses, and material expenses
Wang et al. [46]	2014	Xinjiang	Unrestricted	150	$806	13.81d	-
Zhang et al. [47]	2014	Xinjiang	Unrestricted	97	$1228	13.4d	The per capita drug expenses is $601, the per capita diagnosis and treatment expenses is $122, and the examination expenses is $151
Yao et al. [52]	2015	Liaoning	Unrestricted	292	$1041	9.02d	-
Xie et al. [49]	2008–2017	Liaoning	Unrestricted	2207	$2302 (Repeated hospitalization)[a] $1952 (Single hospitalization)[a] $1977 (Repeated hospitalization due to acute attacks)[a] $1591 (Single hospitalization due to acute attack)[a]	-	-

Table 4 (continued)

Study	Study Year	Region	Population Age	Sample Size	Hospitalization Costs (per capita per year, USD)	Average Length of Stay (days)	Cost Composition
Meng et al. [54]	2008–2017	Gansu	Unrestricted	1165	$691 (2008)[b] $768 (2009)[b] $961 (2010)[b] $801 (2011)[b] $869 (2012)[b] $892 (2013)[b] $990 (2014)[b] $1075 (2015)[b] $1167 (2016)[b] $1177 (2017)[b]	8d[c]	The highest proportion of drug expenses is 43.5%, followed by examination expenses (19.9%), testing expenses (16.8%), and treatment expenses (12.4%)
Li et al. [45]	2013–2019	Liaoning	Unrestricted	3017	$1253 (2013) $1408 (2014) $1460 (2015) $1430 (2016) $1528 (2017) $1547 (2018) $1508 (2019)	> 7d (71.13%)	The diagnostic expenses per capita increased from $138 in 2013 to $842 in 2019, ranking first; The cost of traditional Chinese and Western medicine gradually decreased from $484 per person in 2013 to $346 in 2019, ranking second; The proportion of comprehensive medical service expenses and consumables expenses is relatively low, both showing an upward trend
Jiang et al. [56]	2013–2015	Chongqing	0–14	686	$341 (2013) $343 (2014) $351 (2015)	6.87d (2013) 6.16d (2014) 5.89d (2015)	-
Zhao et al. [57]	2017–2019	Jiangsu	0–14	233	$671 (2017) $699 (2018) $743 (2019)	9.51d (2017) 8.67d (2018) 7.93d (2019)	-

[$] Due to different methods of assessing economic burden, the commonly used average per person per year is used in the table. And the cost converted to USD according to the exchange rate in 2023 (7.0467 RMB = 1 USD)

[a] Average single hospitalization cost

[b] Median single hospitalization cost

[c] Median single hospitalization days

for intensive care units. Meng et al. [54] examined hospitalization cost trends in Gansu Province from 2008 to 2017, revealing a rise in median costs from $691 in 2008 to $1,177 in 2017, a 65.2% increase over the decade.

A breakdown of the cost structure from three of the four studies [50, 51, 53] reveals that medication expenses account for the largest share of hospitalization costs, ranging from 43.5% to 52.1%. Auxiliary examination costs and treatment fees follow, accounting for 27.6% to 39.5% and 4% to 12.4%, respectively. Among medication costs, specialized asthma drugs constitute a significant portion, ranging from 22.7% to 28.6%, while the cost of antibiotics is notably higher, ranging from 44.0% to 54.8%.

Per capita annual hospitalization expenses Six retrospective hospital-based studies [43–47, 52] spanning from 2001 to 2019 have quantified the annual per capita hospitalization costs for asthma, ranging from $177 to $1,547 (Table 4). Four studies [43, 46, 47, 52] reported an average hospital stays between 8.16 and 13.81 days from 2007 to 2015. Two studies [45, 47] further dissected the cost structure. Zhang et al. [47] found that asthma patients in Xinjiang incurred an average hospitalization cost of $1,228 in 2014, with $601 for Western medicine, $151 for examinations, $122 for diagnosis and treatment, and $4 for proprietary Chinese medicine. Li et al. [45] analyzed 4,623 asthma patients in Liaoning from 2013 to 2019, showing an increase in per capita costs from $1,253 in 2013 to $1,509 in 2019, driven primarily by rising diagnostic expenses (from $138 to $842). Medication costs, however, declined from $484 to $346, while costs for comprehensive services and consumables steadily increased.

For pediatric asthma, two studies [56, 57] reported on hospitalization costs and lengths of stay (Table 4). Jiang et al. [56] observed a slight rise in hospitalization costs for children in Chongqing from $341 in 2013 to $351 in 2015, alongside a decrease in length of hospital stays from 6.87 days to 5.89 days. Zhao et al. [57] reported similar trends in Yangzhou from 2017 to 2019, with hospitalization costs increasing from $671 to $743 and hospital stays reducing from 9.51 days to 7.93 days.

Subgroup analysis of medical expenses for different disease severity and management methods

Yang et al. [59] conducted a retrospective analysis using the China Medical Insurance Research Association (CHIRA) database to assess medical expenses related to outpatient and inpatient asthma visits in 2015. The study revealed a clear correlation between asthma severity and the total cost of care, which includes outpatient, emergency, and hospitalization expenses: $160 for mild, $250 for moderate, and $962 for severe cases. Severe asthma patients had a 57.0% annual hospitalization rate, with hospitalization costs accounting for 88% of their total medical expenses, amounting to $850 per capita annually—significantly higher than the mild ($76) and moderate ($88) groups. Subgroup analysis showed that patients with frequent attacks (≥ 2 times) incurred substantially higher costs ($605 vs. $221 for fewer attacks).

Lin et al. [51] found a similar trend in hospitalization costs for acute asthma attacks in China from 2013 to 2014. The median hospitalization costs for mild, moderate, severe, and critically severe asthma were $1,205, $1,265, $1,506, and $2,844, respectively, with a ratio of 1:1.05:1.25:2.36. Xie et al. [53] analyzed clinical data from 2,207 asthma patients in Liaoning Province from 2008 to 2017, observing that patients with repeated hospitalizations faced per capita costs of $2,302, compared to $1,952 for a single hospitalization. For acute exacerbation of asthma, the cost was $1,977 for repeated hospitalizations versus $1,591 for a single episode. These findings highlight that asthma medical costs in China are largely driven by disease severity, frequency of hospitalizations, and acute exacerbation rates. Managing disease severity and complications is essential to reducing hospitalizations and alleviate the economic burden.

Yang et al. [59] also emphasized the higher costs associated with non-standardized asthma management, with patients in this group incurring $529, compared to $102 for those receiving standardized care. Li et al. [30] in 2002 reported that only 10.15% of children with asthma in Henan received step-by-step treatment according to the Global Initiative for Asthma (GINA) guidelines, resulting in an annual per capita cost of $93, compared to $337 for those not following the guidelines. Similarly, Zhang et al. [39] in 2013 found that only 33.68% of children in Fujian adhered to GINA treatment protocols, with annual per capita cost of $620 for those following guidelines versus $1,371 for those who did not. These findings underscore the critical importance of standardized asthma management and the early identification of risk factors to reduce acute attacks and mitigate the associated economic burden.

Influencing factors of economic burden

In our comprehensive review, 12 studies [20, 22, 26, 27, 30, 33, 45, 50–52, 54, 57] identified key factors influencing the economic burden (Table 5), with three studies [30, 33, 57] focusing exclusively on pediatric populations. A total of 26 factors were analyzed,categorized into five

domains: demographic characteristics, disease attributes, hospitalization indicators, clinical diagnosis and treatment markers, and miscellaneous indicators. Notably, the frequency and severity of acute exacerbation, comorbidities such as allergic rhinitis or other cardiopulmonary conditions, age, smoking status, length of hospital stays, and adherence to standardized management emerged as crucial factors contributing to the economic burden.

Table 5 Influencing factors of the economic burden of asthma in China: a review of studies from 9 provinces (2002–2019)

Influencing factors	Study number	Main conclusions
Demographic characteristics		
Age	3 [45, 52, 54]	Older patients have higher hospitalization costs than younger patients
Gender	1 [54]	Female patients have higher hospitalization costs than males
Career	1 [54]	Medical costs for individuals exposed to occupational allergens are relatively high
Patient's smoking status	3 [22, 27, 54]	Smoking and passive smokers have higher hospitalization costs compared to non-smokers
Disease characteristics		
Comorbidity	6 [27, 45, 51, 52, 54, 57]	Hospitalization costs for patients with comorbidities are higher than those without comorbidities
Number of acute exacerbation	4 [27, 33, 50, 51]	The total cost has increased since the onset of the disease with an increase in the number of previous asthma attacks
Severity of acute exacerbation	2 [50, 51]	The hospitalization cost increases with the severity of acute asthma attacks
Course of disease	1 [54]	The longer the course of the disease, the higher the hospitalization cost
Growth of the disease	1 [26]	The deterioration of the condition is a contributing factor to the increase in treatment costs
Hospitalization-related indicators		
Length of stay	4 [20, 45, 54, 57]	The more hospitalization days, the higher the direct economic burden of asthma patients; Patients who have been hospitalized for more than 7 days have higher hospitalization costs than those who have not been hospitalized for more than 7 days
With or without Hospitalization	1 [27]	Hospitalization is a factor influencing the cost of asthma treatment
Admission pathway	1 [45]	Patients admitted to the emergency department have higher hospitalization costs than those admitted to the outpatient department
Admission season	1 [45]	Winter admissions are higher
Clinical medicine-related indicators		
With or without Standardized treatment	4 [27, 30, 54, 57]	Not receiving standardized treatment is a factor affecting the cost of asthma treatment, and irregular treatment patients have higher hospitalization costs than regular treatment patients
Antibiotic usage	3 [52, 54, 57]	Those who use antibiotics are more expensive than those who do not use them, those who use two or more types of antibiotics have higher hospitalization costs than those who use one type. Antibiotics have a longer duration of use and higher hospitalization costs
Systemic use of corticosteroids	1 [54]	Those who use systemic hormones are higher than those who do not use them
length of delayed diagnosis time	1 [30]	The duration of delayed diagnosis is closely related to the cost of treatment
Other		
Patient's willingness to pay	1 [20]	The more patients find it difficult to pay for hospitalization expenses, the higher their direct economic burden of illness
Expenditure on nutritional and health products	1 [26]	The expenditure on nutritional and health products is a factor influencing the increase in direct economic burden
Medical security system	1 [26]	Patients with different medical insurance systems have differences in their annual per capita outpatient expenses. The population covered by medical insurance is greater than those covered by public funds (labor insurance) and self funded
Medical payment methods	1 [45]	Patients who are not covered by medical insurance have higher hospitalization costs than those covered by medical insurance
Drug proportion	1 [54]	The higher the proportion of drugs, the higher the hospitalization cost

Discussion

This study provides an overview of the key trends in the health loss and economic burden of asthma in China. The health loss burden has significantly decreased from 1990 to 2019, with males experiencing a higher burden than females. The burden remains relatively high among children, as well as in the middle-aged and elderly populations. Regarding the economic burden, there are notable regional differences, with economically developed areas such as Beijing, Jiangsu, and Guangdong experiencing higher burdens compared to provinces like Yunnan and Hunan.

Despite a significant reduction in asthma-related health loss in China from 1990 to 2019 compared to the global average, the country's large and growing population necessitates continued efforts for improvement. Asthma ranks second among chronic respiratory diseases, both globally and within China, surpassed only by chronic obstructive pulmonary disease (COPD) [61, 62]. While China has experienced a notable decline in age-standardized disability-adjusted life years (DALYs) for asthma over the same period, this reduction may be partially attributed to rapid population growth. Given the country's large and aging demographic, China faces substantial challenges in managing asthma, including the spread of asthma susceptibility genes, air pollution, allergen exposure, and drug abuse [63]. These factors underscore asthma's persistent role as a major public health issue, significantly affecting the quality of life and overall health of the population.

This systematic review reveals that the age-standardized DALYs rate for asthma in China peaks both in childhood, primarily between 5–9 years, and in the elderly, following an "increasing–decreasing-increasing" pattern with age. The high rate during childhood may be linked to suboptimal asthma management and treatment adherence in young children [64]. Therefore, proactive parenting strategies and a focus on symptom control and treatment adherence for children aged 5–9 are crucial. In the elderly, the second peak may reflect the natural decline in physiological functions, including impaired drug metabolism and tolerance [65, 66]. Additionally, a significant gender disparity exists, with higher age-standardized DALYs, YLLs, and YLDs rates in males compared to females in 2019. Beyond physiological factors such as genetics, sex hormones, and maternal influences, differences in smoking, obesity rates, and occupational exposure profiles likely contribute to these gender disparities in health loss [67, 68]. Clinical and experimental evidence suggests that sex hormones, particularly estrogen, play a key role in asthma presentation across different life stages (adolescence, menstruation, pregnancy, menopause, and oral contraceptive use), influencing inflammation and allergic responses [69, 70]. Targeted measures should be taken for high-risk individuals to reduce the overall disease burden.

Tobacco use, high BMI, and occupational exposure emerge as the three principal risk factors contributing to asthma-related health loss. Tobacco use, in particular, remains the most immediate risk factor, significantly affecting asthma control, treatment outcomes, and prognosis [71, 72]. With a smoking rate of 26.6% among Chinese individuals aged 15 and above, and over 300 million smokers in 2018, the impact of tobacco on asthma presents a pressing public health concern. Additionally, approximately 740 million people are exposed to secondhand smoke [73, 74]. These figures highlight the urgent need for enhanced health management strategies, including smoking cessation programs, to mitigate the incidence and impact of asthma.

High BMI is a significant contributor to asthma across all age groups [75]. Overweight and obesity rates among Chinese school-age children are alarmingly high, with 49.5% to 51.0% of boys and 47.3% of girls classified as overweight or obese, a trend that continues to rise annually [76–78]. This trend suggests that high BMI may be exacerbating the challenges in managing asthma in China. For asthmatic patients with high BMIs, targeted dietary interventions promoting weight reduction through balanced diets and regular physical activity are essential for improving asthma control and reducing inflammation. Between 1990 and 2019, the contribution of occupational exposure to asthma-related DALYs declined, likely due to improvements in industrial technology and stricter government regulations that have reduced exposure to occupational allergens [79]. In conclusion, tobacco use, high BMI, and occupational exposure are key risk factors for asthma and should be prioritized in asthma prevention and screening programs.

This economic analysis, covering 15 Chinese provinces, autonomous regions, and municipalities, reveals the annual per capita direct costs for adult asthma patients range from $348 to $1,187, with hospitalization costs accounting for the majority ($187 to $545, 47.57% to 71.72%). For pediatric asthma patients, direct medical costs range from $432 to $867. Variations in research methodologies, sample sizes, and regional factors contribute to the discrepancies in these estimates. Despite these differences, China's illness costs, even after adjusting for inflation, remain significantly lower than those in Western and certain Asian countries [80–85]. For example, a study by Nurmagambetov et al. [86] reports an average annual per capita medical cost of $3,266 for asthma patients in the United States. In comparison, Singapore and South Korea report annual per capita medical expenses of $930 and $1,324, respectively [80, 85]. The

variation in illness costs is influenced by factors such as healthcare and insurance systems, patient demographics, and economic conditions, which contribute to national disparities.

Focusing on hospitalization costs, the average annual per capita expense across six studies in four provinces ranges from $177 to $1,547. A nationwide retrospective survey conducted between 2013 and 2014 revealed that the median hospitalization cost for urban Chinese patients with acute asthma attacks was $1,335 per episode. In contrast, the annual treatment cost for a medium-dose inhaled corticosteroid (ICS) combined with a long-acting β2 receptor agonist (LABA) is approximately $426 [43]. This highlights that the hospitalization costs during acute asthma attack far exceed the cost of ongoing maintenance treatment. A similar trend is observed in the United States, where hospitalization costs for acute asthma attacks increased from $5,611 in 2001 to $7,230 in 2010 after adjusting for inflation [86].

Asthma severity is directly linked to increased hospitalization costs. Yang et al. [60] reported an annual hospitalization rate of 57.0% for severe asthma, with hospitalization costs accounting for 88% of the annual medical expenses—amounting to $850 per capita annually, significantly higher than for milder cases. These costs not only increase substantially with severity but also rise disproportionately, as corroborated by international studies [6, 80, 87–89]. For instance, a study in South Korea reported direct cost of $2,214 for severe asthma, compared to $978 for moderate and $871 for mild asthma [80]. Additionally, comorbidities, the frequency of acute attacks, and adherence to standardized treatment protocols are identified as key factors influencing increased hospitalization costs. Multiple studies have shown that patients with recurrent hospitalizations due to asthma incur significantly higher costs than those hospitalized only once. Likewise, the costs for patients with repeated acute attacks are higher than for those experiencing a single hospitalization. The annual per capita cost for patients receiving non-standard treatment exceeds that for those on standardized regimens. To mitigate the economic burden of asthma, efforts must focus on managing disease severity, reducing the frequency of acute attacks, and ensuring adherence to standardized treatment protocols.

There are several limitations to this study. First, with respect to the health loss burden, all the included literature is derived from the GBD database, and the data sources are not based on direct observations, which may lead to a conservative estimate of the results. Secondly, regarding the economic burden, the studies included are diverse in nature (e.g., cross-sectional surveys, hospital-based data) and cover only specific provinces. Additionally, the studies span a wide range of years, making it difficult to quantitatively synthesize and compare cost data. As a result, the analysis primarily provides a qualitative description. Furthermore, the overall quality of the included studies is moderate, which also limits the robustness of the conclusions. Lastly, the study does not cover asthma-related burdens in all provinces of China, which may reduce the national representativeness of the findings. It is hoped that future nationwide surveys, along with the ongoing improvements in hospital information and medical insurance coverage, will provide more comprehensive and accurate data.

Conclusion

The health loss burden of asthma patients in China has shown a significant downward trend from 1990 to 2019, with males experiencing a higher burden than females. However, The burden remains relatively high among children and the middle-aged and elderly populations. Key Risk factors include high BMI, smoking, and occupational asthma. Regarding the economic burden, although this study focuses on a limited number of provinces and spans different time periods, there are considerable regional differences. Economic burdens tend to be higher in economically developed regions such as Beijing, Jiangsu, and Guangdong, compared to provinces like Yunnan and Hunan. Comorbidities, frequency and severity of acute exacerbation, Length of stay, and whether treatment follows standardized protocols are the primary factors influencing the increase in medical costs for asthma patients.

Supplementary Information

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Supplementary Material 1.

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Authors' contributions

Study concept and design: Xie Y; Acquisition of data: Zhang P, Xu JX, and Xu BC; Analysis and interpretation of data: Zhang P, Ren JM and Xu BC; Writing-original draft preparation: Zhang P; Writing-review and editing: Zhang YY and Xie Y. All authors reviewed and approved the final version of the manuscript.

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Data availability
No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate
Not applicable.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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