



The prevalence and year lived with disability of atopic dermatitis in China: Findings from the global burden of disease study 2019

Wen-lan Dong, MD^{a,#}, Jing An, MM^{b,#}, Miao Yu, MS^c, Peng Yin, MD^a, Ting-ling Xu, MM^a, Bo Liu, MD^c, Torsten Zuberbier, MD, PhD^{d***,†}, Zuo-tao Zhao, MD, PhD^{c***,†} and Mai-geng Zhou, MD, PhD^{a*,†}

ABSTRACT

Background: Atopic dermatitis (AD) is a chronic disease with growing prevalence and has become a global public health problem. However, little is known about the burden caused by AD in China.

Objective: To assess the prevalence and burden of AD in China.

Methods: We estimated the prevalence and year lived with disability (YLD) of AD in China, by different age and sex groups. We also compared the burden of AD in China with other countries in the Group of Twenty (G20). We analyzed the changes in the number of AD patients and their YLDs by cause decomposition from 1990 to 2019.

Results: AD was the twenty-fourth leading cause of the burden of 369 diseases in China in 2019. From 1990 to 2019, the age-standardized prevalence and YLD rate of AD in China increased by 1.04% and 1.43% respectively, which were the second and the largest increase among the G20 and both higher than the global average (−4.29% and −4.14%). The number of patients with AD increased by 25.65%, of which 20.16% was due to population growth, 3.85% due to population aging, and 1.64% due to age-specific prevalence. Both the prevalence and YLD rate of AD were higher in 1 to 4 year-olds and 95+ years age group. Before the age of 10, the prevalence and YLD rate of AD in males were higher than those in females, while there was a marked sex shift at the ages of 10 to 14.

Conclusion: AD is a serious public health problem in China. Substantial variations exist in burden due to AD between male and female, and in age groups. Considering these findings will be important for developing preventive strategies and treatments to reduce the burden of AD.

Keywords: Atopic dermatitis, Prevalence, Years lived with disability, Burden, GBD 2019

^aNational Center for Chronic and Noncommunicable Disease Control and Prevention, Beijing 100050, People's Republic of China

*Corresponding author. E-mail: zhoumaigeng@ncncd.chinacdc.cn

**Corresponding author. Email: zhaozuotaotao@163.com

***Corresponding author. Email: torsten.zuberbier@charite.de

[#] Wen-lan Dong and Jing An contributed equally to this study and are the joint first authors

[†] Mai-geng Zhou, Zuo-tao Zhao and Torsten Zuberbier contributed equally to this study and are the joint corresponding authors

Full list of author information is available at the end of the article

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INTRODUCTION

Atopic dermatitis (AD) is a chronic inflammatory skin condition,¹ which has become a serious public health problem because of its worldwide increasing prevalence, and places a heavy burden on patient quality of life.^{2,3} According to the Global Burden of Disease Study 2019 (GBD 2019),⁴ there were 171.17 million (95% uncertainty interval [UI]: 164.82–178.10 million) individuals and 7.48 million (95% uncertainty interval [UI]: 3.98–12.58 million) YLDs (years lived with disability) due to AD in the world in 2019 respectively. The percentage of YLDs due to AD (in 369 diseases) was 0.87%, and AD ranked as the twenty-eighth leading cause in 369 diseases.⁵

However, little is known about the burden of AD in China at the national level. The previous epidemiological studies on AD were based on regional data or specific age groups.^{6–9} Data from GBD 2019 provide an updated and comprehensive assessment of the epidemiological characteristics of major diseases in China, including the YLD for AD. This study describes how the diseases changed from 1990 to 2019.¹⁰ The study of the current status and trend of disease burden is helpful to determine the focus and direction of public health efforts and to provide data-based information for policy decision-makers to allocate scarce health care resources precisely and efficiently.¹¹ Therefore, the present study aims to access the prevalence and burden of AD in China using GBD 2019.

METHODS

Data source

Using a unified and comparable method, GBD 2019 comprehensively analyzed the incidence, prevalence, mortality, year of life lost (YLL), YLD and disability-adjusted life-year (DALY) due to 369 diseases, injuries, and 3473 sequela, and covered males and females in 204 countries and territories from 1990 to 2019. Source data were extracted from censuses, household surveys, and civil registration, as well as vital statistics, disease registries, health service utilization, air pollution monitors, satellite imaging, disease notifications, and so on. Detailed description of the background and

overview of this study can be found in GBD 2019 Diseases and Injuries Collaborators (2020).¹⁰

Data on AD came from 313 sources which were compiled from 113 countries, and could be divided into 2 categories. One was reference, which included literature with physical exam and market scan of the United States. Another was alternative case definition, which included administrative data, MEPS (Medical Expenditure Panel Surveys, [the United States]), no physical exam, and market scan of the United States 2000. The data for AD were expanded by skin expert group based on recommendations of research articles and reviews. Data which were found to violate the established age patterns and regional trends were excluded.¹⁰ AD was defined as a relapsing dermatitis associated with elevated serum immunoglobulin E and some degree of immune dysregulation, which can be localised or widespread and is commonly characterized by itching that can be extreme (ICD-10: L20).

GBD 2019 China Study used the global burden of disease methodology to systematically analyze all demographic and epidemiological data available in China, and used DisMod-MR 2.1, a Bayesian meta-regression tool, as the main estimation method to ensure the consistency between incidence, prevalence, and mortality for various conditions.⁵ We used the GBD 2019 appointed results for prevalence and YLD to estimate the burden due to AD in China. The step-by-step estimation of the point prevalence and YLD of AD is summarized in [Figure S1](#).

YLD measures the burden of living with a disease or disability and is estimated as the product of prevalence and disability weight for all mutually exclusive sequela, corrected for comorbidity and aggregated to the cause level. $YLD_{sequela} = Prev_{sequela} \times DW_{health\ state}$ (Prev: prevalent number, and DW: disability weights). Disability weights (DWs) from the GBD Study (2019) were used to represent the magnitude of health loss associated with AD. DWs were measured on a scale from 0 to 1 (in which “0” represents a state of full health and “1” represents a state equivalent to death). The basis of the GBD disability weight survey assessments is the lay descriptions of sequelae highlighting major functional consequences and symptoms. Severity was

split into 3 levels of disfigurement with pain/itch. See below for lay descriptions of the severity levels:

- (I). Mild atopic dermatitis (DW: 0.027; 95% CI: 0.015-0.042): Disfigurement, level 1 with itch/pain; The person has a slight, visible physical deformity that is sometimes sore or itchy. Others notice the deformity, which causes some worry and discomfort.
- (II). Moderate atopic dermatitis (DW: 0.188; 95% CI: 0.124-0.267): Disfigurement, level 2, with itch/pain; The person has a visible physical deformity that is sore and itchy. Other people stare and comment, which causes the person to worry. The person has trouble in sleeping and concentrating.
- (III). Severe atopic dermatitis (DW: 0.576, 95% CI: 0.401-0.731): Disfigurement, level 3, with itch/pain; The person has an obvious physical deformity that is very painful and itchy. The physical deformity makes others uncomfortable, which causes the person to avoid social contact, feel worried, sleep poorly, and think about suicide.

Statistical analysis

The quantity of prevalence and YLD in this report included number, rate, and percent. The age-standardized rates for prevalence and YLD were computed with an average world population age-structure for the period 2000–2025 constructed by the World Health Organization (WHO). The values of the prevalence and YLD rate were shown as mean rate and 95% uncertainty intervals (UIs). We estimated the uncertainty by running each model until convergence, then taking the ninety-fifth and twenty-fifth ordered draw from 1000 posterior model runs as 95% uncertainty intervals (UIs) for each point estimate. Microsoft office excel 2007 was used to organize the 1990 and 2019 data into tables and charts.

We analyzed the prevalence and YLD of AD in China in 1990 and 2019, and compared them with the age-standardized prevalence and YLD rate of AD across G20 (Group of 20, an international economic cooperation forum composed of 20 major economies; we excluded the EU from analysis due to lack of data and compared only 19

countries), and with the global average trends from 1990 to 2019. We used UIs to compare prevalence rate and YLD rate among different countries. If 95% UIs of these estimates did not overlap, these estimates were considered different from each other at the $\alpha = 0.05$ significance level. We then assessed the AD prevalence and YLD by age and sex in China in 1990 and 2019. The age was divided into 20 groups: 1–4, 5–9, 10–14, 15–19, 20–24, 25–29, 30–34, 35–39, 40–44, 45–49, 50–54, 55–59, 60–64, 65–69, 70–74, 75–79, 80–84, 85–89, 90–94, and 95+.

By cause decomposition,¹² we analyzed the change of the individual number or YLDs due to AD between 1990 and 2019, which could be attributable to population growth, age-specific population structure changing, and age-specific prevalence changing. The observed change in the total number of patients or YLDs equaled the net change of these 3 aspects. We took prevalence as an example to illustrate cause decomposition. Two counterfactual scenarios were used to calculate the number of patients. The first scenario assumed that the total population grew as observed from 1990 to 2019, while the population structure and age-specific prevalence were the same in 2019 as in 1990. In the second scenario, total population and age-specific prevalence changed from 1990 to 2019 as observed, but the population age structure was the same in 2019 as in 1990. The difference between the number of patients observed in 1990 and the first scenario was the change in the number of patients exclusively from population growth. The difference between the second scenario and the number of patients observed in 2019 was the change in the number of patients exclusively attributable to population ageing. The difference between the first and the second scenarios was the change in the number of patients exclusively attributable to age-specific prevalence.

RESULTS

There were 35.58 million (95% uncertainty interval [UI]: 34.25–36.94 million) individuals and 1.54 million (95% uncertainty interval [UI]: 0.82–2.56 million) YLDs due to AD in China in 2019. The percentage of YLDs due to AD was 1.00% and AD

Country	Prevalence rate			YLD rate		
	1990 (/per 100,000)	2019 (per 100,000)	Change (%)	1990 (/per 100,000)	2019 (/per 100,000)	Change (%)
China	2434.96 (2342.91,2519.90)	2460.18 (2366.59,2548.51)	1.04 (-1.15,3.20)	105.96 (56.58,176.97)	107.47 (57.80,178.08)	1.43 (-1.01,3.95)
Global	2379.29 (2289.61,2478.07)	2277.22 (2192.00,2369.06)	-4.29 (-4.77, -3.79)	103.99 (55.32,174.57)	99.69 (53.09,167.43)	-4.14 (-4.75, -3.50)
Argentina	3058.23 (2871.86,3260.31)	3053.69 (2867.93,3255.30)	-0.15 (-0.17, -0.13)	134.77 (72.66,226.58)	134.66 (73.05,226.19)	-0.08 (-4.17,4.37)
Australia	2506.29 (2336.77,2696.09)	2503.21 (2322.34,2689.61)	-0.12 (-4.25,4.54)	110.53 (59.76,190.92)	110.48 (59.00,186.99)	-0.05 (-5.83,6.46)
Brazil	2366.27 (2261.85,2470.83)	2361.51 (2262.68,2468.06)	-0.20 (-2.79,2.27)	103.64 (55.82,173.53)	103.68 (55.40,173.00)	0.04 (-3.00,2.91)
Canada	1983.99 (1904.53,2072.73)	1984.46 (1904.91,2073.12)	0.02 (0.01,0.04)	87.60 (46.70,146.52)	87.54 (46.70,147.93)	-0.07 (-4.89,5.20)
France	5086.78 (4680.98,5531.27)	5087.17 (4681.43,5531.23)	0.01 (-0.01,0.03)	224.51 (119.25,376.4)	224.54 (118.38,380.84)	0.01 (-3.19,3.30)
Germany	3586.51 (3423.67,3750.48)	3624.47 (3439.87,3816.18)	1.06 (-2.37,4.71)	158.45 (86.04,266.74)	160.05 (84.81,268.06)	1.01 (-3.93,5.94)
India	1816.32 (1726.50,1914.10)	1818.39 (1728.65,1916.29)	0.11 (0.10,0.13)	79.60 (42.76,131.94)	80.11 (42.98,134.11)	0.64 (-0.65,2.03)
Indonesia	3720.85 (3591.06,3865.05)	3733.89 (3595.68,3877.01)	0.35 (-1.87,2.53)	160.66 (86.08,267.47)	162.00 (86.70,271.73)	0.83 (-1.68,3.31)
Italy	4284.73 (4074.23,4487.33)	4276.30 (4066.19,4479.54)	-0.20 (-0.22, -0.18)	189.03 (100.26,320.37)	188.91 (100.35,320.18)	-0.06 (-1.20,1.04)
Japan	5328.11 (5087.53,5579.18)	5324.33 (5072.16,5571.07)	-0.07 (-3.09,2.78)	235.86 (126.72,396.46)	236.15 (126.31,396.93)	0.12 (-3.25,3.12)
Mexico	1455.86 (1386.00,1524.94)	1454.61 (1384.79,1523.55)	-0.09 (-0.11, -0.06)	64.44 (34.74,108.27)	64.47 (34.94,108.04)	0.04 (-1.43,1.61)
Republic of Korea	4010.99 (3775.71,4252.66)	4036.29 (3801.42,4273.94)	0.63 (-3.34,4.91)	177.09 (93.71,295.72)	178.79 (96.70,302.53)	0.96 (-4.06,6.62)

Russian Federation	3474.80 (3331.45,3609.04)	3454.29 (3324.14,3584.15)	-0.59 (-1.73,0.41)	154.33 (82.31,261.23)	153.7 (81.75,259.87)	-0.41 (-1.94,1.00)
Saudi Arabia	1323.32 (1251.79,1404.10)	1321.70 (1250.36,1402.58)	-0.12 (-0.19, -0.06)	58.38 (31.91,99.00)	58.36 (31.55,99.82)	-0.04 (-6.33,6.18)
South Africa	1084.72 (1033.26,1138.78)	1082.49 (1031.25,1136.46)	-0.21 (-0.26, -0.15)	47.92 (25.74,81.04)	47.85 (25.36,80.80)	-0.15 (-2.71,2.62)
Turkey	2455.52 (2296.61,2641.08)	2458.30 (2281.00,2630.27)	0.11 (-3.39,3.95)	107.90 (57.75,182.03)	108.25 (57.41,181.53)	0.33 (-5.64,6.42)
United Kingdom	4344.63 (4144.96,4541.18)	4250.15 (4066.39,4444.79)	-2.17 (-4.47,0.45)	191.47 (102.40,319.59)	187.31 (100.41,313.98)	-2.17 (-4.48,0.45)
United States of America	3274.36 (3152.00,3398.17)	3131.79 (3017.99,3240.72)	-4.35 (-5.07, -3.63)	143.65 (77.08,240.97)	137.17 (73.15,230.15)	-4.51 (-5.71, -3.36)

Table 1. Age-standardized prevalence, YLD rate, and their changes of atopic dermatitis, 19 member countries of the G20 (the 20th member is the European Union) and the world, 1990 and 2019. YLDs: years lived with disability

was twenty-fourth of the burden of 369 diseases in China in 2019.

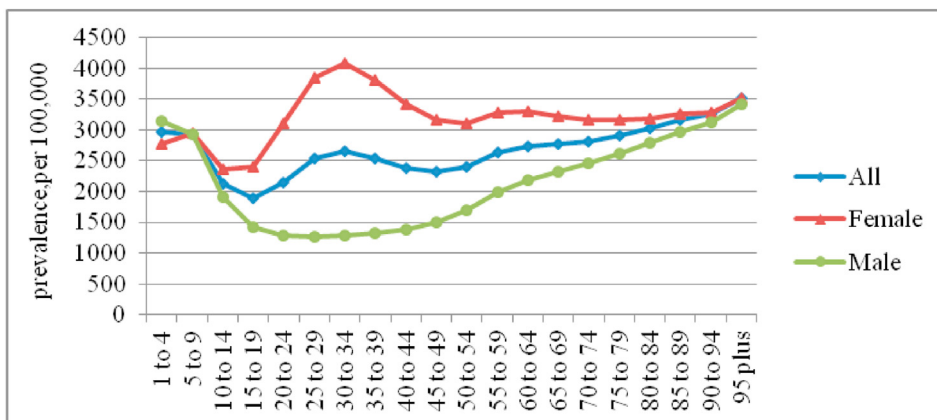
We compared the age-standardized prevalence and YLD rate of AD in China with the global average, as well as those in the other 18 member countries of the G20. In 2019, the age-standardized prevalence and YLD rate of AD in China were similar to those in the world [2460.18 per 100,000 (2366.59-2548.51) vs. 2277.22 per 100,000 (2192.00-2369.06); 107.47 per 100,000 (57.80-178.08) vs. 99.69 per 100,000 (53.09-167.43)] (Table 1).

From 1990 to 2019, the age-standardized prevalence of AD in China increased by 1.04% (95% CI, -1.15%-3.20%), which was the second largest increase among the G20, following Germany's 1.06% (95% CI, -2.37%-4.71%), and was higher than the global average [-4.29%, (95% CI, -4.77% to -3.79%)]. The age-standardized YLD rate of AD in China increased by 1.43% (95% CI, -1.01%-3.95%), which was the largest increase among the G20, and was higher than the global average [-4.14%, (95% CI, -4.75% to -3.50%)] (Table 1).

In the overall population, the prevalence of AD was higher in 1-4 year-olds, with a drop in older childhood and adolescence but showing a wave trend with the increase of age, and a small peak appeared at age 30-34. In the age 50-59 group, it showed an obvious upward trend with the increase of age, and reached the highest value in the 95+ years age group (in both 1990 and 2019) (Fig. 1). The YLD rate of AD was the highest at age 1-4. With the increase of age, it showed a wave trend change, and a small peak appeared at age 30-34. In the age 50-59 group, the upward trend was not obvious with the increase of age (in both 1990 and 2019) (Fig. 2).

From the perspective of gender, the prevalence and YLD rate of AD of females showed a wave trend with the increase of age, with higher value at the childbearing age (15-49), and a peak at age 30-34. With the increase of age, the prevalence and YLD rate of AD of male first decreased and then showed an upward trend, the highest value appeared at age 1-4, followed by age 95+. Before the 5-9 year interval, the prevalence and YLD rate of AD of male were both higher than those of female, and there was a marked sex shift at the age

A



B

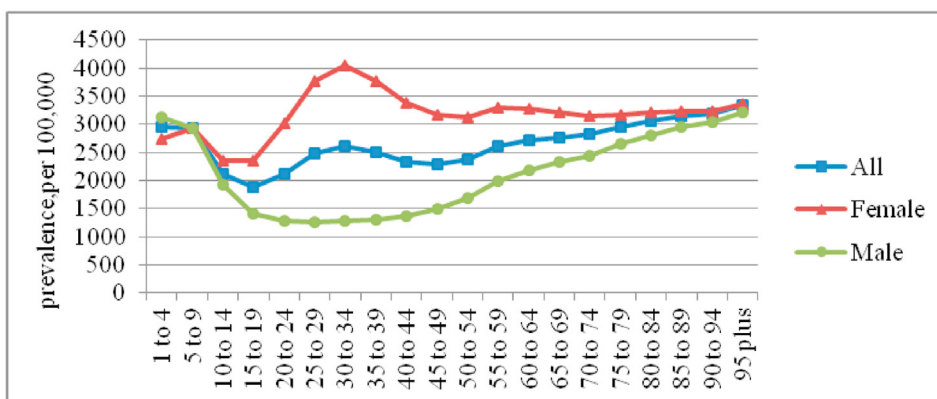


Fig. 1 A. The atopic dermatitis prevalence rate of male and female of different ages in China in 1990. B. The atopic dermatitis prevalence rate of male and female of different ages in China in 2019

of 10–14 (in both 1990 and 2019) (Figs. 1 and 2). The data of Figs. 1 and 2 were showed in Table S1.

The changes in the number of AD could be mostly explained by population growth, population aging, and changes in age-specific prevalence (Table 2). From 1990 to 2019, the number of patients with AD increased by 25.65%, of which 20.16% was due to population growth, 3.85% due to population aging, and 1.64% due to the increase in age-specific prevalence. And the YLDs of AD increased by 24.26%, of which 20.16% was due to population growth, 2.00% due to population aging, and 2.10% due to the increase in age-specific YLD rate (Table 2).

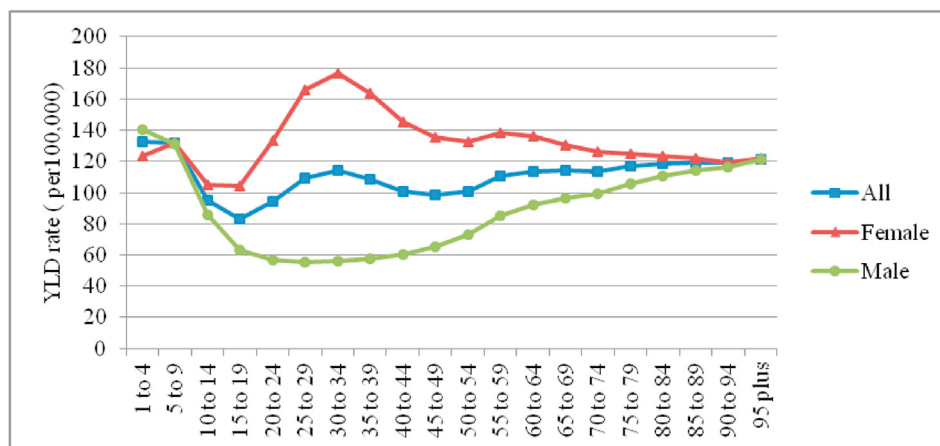
DISCUSSION

YLD reflects not only the morbidity of the disease but also the degree of disability due to the disease. Therefore, it reflects the epidemic severity

of the disease better. AD, being in a chronic condition, has a high impact on the economy as it affects children and young adults, and potentially impairs productivity. YLD is more suitable for estimating the burden of AD in case of nonfatal diseases.^{13,14} This study was the first to clarify the prevalence and YLD of AD in China.

Compared with the global average, the burden of AD in China is more severe; it is also the case among the G20. Firstly, AD was the twenty-fourth leading cause among 369 diseases, after ischemic heart disease, edentulism, and neonatal sepsis. Secondly, China is one of the few countries with both the prevalence and YLD rate being on the rise from 1990 to 2019, and the age-standardized YLD rate of AD in China has the largest increase among the G20 and is much larger than the global average. Finally, the number of patients and YLDs of AD mainly increased due to population growth and population aging, which indicates an ongoing

A



B

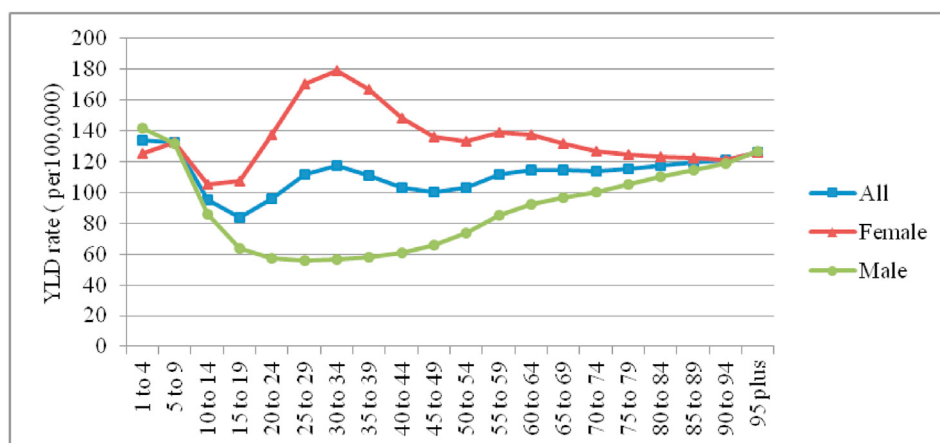


Fig. 2 A. The atopic dermatitis YLD rate of male and female of different ages in China in 1990. B. The atopic dermatitis YLD rate of male and female of different ages in China in 2019. YLD: years lived with disability

challenge given China’s huge population base and rapidly aging population. Furthermore, the age-specific prevalence and YLD rate increasing of AD have always been attributed to factors such as rapid urbanization, increasingly Westernized lifestyles, improved living and education standards, increased exposure to various environmental factors, and so on.¹⁵⁻¹⁷ In China, AD remains a serious public health problem which needs more attention.

Our findings indicated that the prevalence and the YLD rate of AD both were high at age 1-4, which was consistent with a previous study.⁶ AD occurs predominantly in childhood, with over half of the cases presenting in the first year of life,¹⁸ and probably as many as 85% of the patients experienced an onset under 5 years old.¹⁹ About 50-70% of children with AD are

sensitive to 1 or more kinds of allergens,¹⁹ such as food, mold, and pets.^{20,21} The high prevalence and YLD of AD in children could be explained by environment factors and prenatal exposure.^{22,23} Prevention and control measures should be taken in the perinatal period, targeting the skin barrier, immune/allergy and environmental aspects.¹⁹

AD is also a part of process called the atopic march, which is generally characterized by the progression of AD to allergic rhinitis and asthma.²⁴ The present study indicated that the prevalence and YLD rate of AD of males were both higher than those of females before the 5-9 year interval. The prevalence of males and females changed dramatically at the age of 10-14. Gender differences were also observed in the prevalence of other atopic symptoms and

Prevalence

Observed number of people in 1990	28.32
Number expected with 2019 population, 1990 population age structure, and 1990 prevalence	34.03
Number expected with 2019 population, 1990 population age structure, and 2019 prevalence	34.49
Observed number of people in 2019	35.58
Percentage change from 1990 due to population growth	20.16%
Percentage change from 1990 due to population aging	3.85%
Percentage change from 1990 due to change in age-specific prevalence	1.64%
Percentage change from 1990 to 2019	25.65%

YLD

Observed number of people in 1990	1.24
Number expected with 2019 population, 1990 population age structure, and 1990 YLD rate	1.49
Number expected with 2019 population, 1990 population age structure, and 2019 YLD rate	1.51
Observed number of people in 2019	1.54
Percentage change from 1990 due to population growth	20.16%
Percentage change from 1990 due to population aging	2.00%
Percentage change from 1990 due to change in age-specific YLD rate	2.10%
Percentage change from 1990 to 2019	24.26%

Table 2. Attribution analysis of changes in the number of individuals (in millions) with atopic dermatitis and YLDs (in millions) due to atopic dermatitis in China, 1990 and 2019. YLD: years lived with disability

diseases such as asthma and hay fever. Among children, boys have a larger prevalence of asthma compared to girls. The frequency of asthma started to change around puberty from being higher in males to higher in females instead.^{25,26} Hay fever and eczema in females were more often reported than in males.^{27,28}

Our study found that females have a higher prevalence of AD than males after the age of 5-9, which was possibly related to the effects of sex hormones on immune responses and skin permeability barrier.²⁹ In the study, we found that the prevalence and YLD rate of AD were higher in females of reproductive age (15-49 years old). Because women at this age have more access to

water at workplace and housework, which may possibly damage the skin barrier.³⁰

The pathogenesis of AD is complex and multifactorial, with genetic predisposition, skin barrier dysfunction, altered immune responses, and environmental and lifestyle factors.³¹ We further observed an upward trend in prevalence of AD among those aged 50+. Age-related immune skewing with decreased TH2/TH22 and increased TH1/TH17 activation were supposed to play an important role in the pathogenesis of elderly AD.³² In the meantime the skin is less moisturized and with the genetic barrier dysfunction of AD with age increasing, which plays another important role in the pathogenesis of elderly AD. The rate

of burden of AD (that is the YLD rate per 100,000 people) was substantial and increased progressively. The stunning growth of AD in the elderly demands special attention from clinicians, especially for those who cannot use moisturizers properly and cannot reach their body parts such as backs.

LIMITATIONS

Although the GBD made every effort to collect published and unpublished data, the quantity and quality of data available are still limited, which could affect the accuracy of the estimated burden. First, the model was used to estimate prevalence by age, sex, year, and geography (subnational, country, region, super-region) for AD. Model input data for AD from Chinese scientific literatures were little. The lack of relevant data in China may lead to bias in estimating the models. Second, GBD studies used secondary data to estimate the disease burden of different populations, such as literatures, Medical Expenditure Panel Surveys, self-reported data, administrative data, which may lead to bias in estimating the results. Third, there may be an underreporting. As the type of AD often gets less inflammatory in older patients, they might worry more about rhinitis and asthma problems than AD. Patients with mild-to-moderate AD especially in rural areas are less likely to visit physicians. Fourth, the burden of AD at the provincial level was not mentioned in the paper, which may affect the representativeness of the materials for the whole of China. However, we would like to analyze them when the representativeness of the burden of AD at the provincial level is good enough in GBD study in the future.

CONCLUSIONS

Our study is the most comprehensive summary of AD prevalence and YLD in China. The age-standardized YLD rate of AD ranked as the twenty-fourth leading cause in 369 diseases in China. The number of patients and YLDs due to AD increased rapidly with population growing and aging in China from 1990 to 2019. Substantial variations exist between males and females and in age groups in prevalence and YLD due to AD. Considering these findings will be important for

developing preventive strategies and treatments to reduce the burden of AD.

Abbreviations

YLDs: Years lived with disability; GBD 2019: Global Burden of Diseases, Injuries, and Risk Factors Study 2019; DW: disability weights; AD: Atopic dermatitis.

Authors' contributions

Mai-geng Zhou, Zuo-tao Zhao and Torsten Zuberbier conceived the study and are guarantors of the paper. Wenlan Dong and Jing An prepared the first draft and finalized the manuscript, based on comments from all other authors. Miao Yu, Peng Ying, Ting-ling Xu and Bo Liu participated in the data preparation and analysis. Zuberbier Torsten provided comments on the manuscript. All authors have approved the final version of the manuscript and agree to submission.

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Availability of data and materials

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Ethics statement

The authors declare that this manuscript complies with the ethics in publishing guidelines. The ethics approval and consent to participate is not applicable here.

Submission declaration

We confirm that the manuscript is original, has not been published before, is not currently being considered for publication elsewhere. All authors have approved the final version of the manuscript and agree to submission.

Declaration of competing interest

The authors declare that they have no competing interests.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.waojou.2021.100604>.

Author details

^aNational Center for Chronic and Noncommunicable Disease Control and Prevention, Beijing 100050, People's Republic of China. ^bBeijing Xicheng District Maternal and Child Health Hospital, Beijing 100054, People's Republic of China. ^cPeking University First Hospital, Beijing 100034, People's Republic of China. ^dCharité - Universitätsmedizin Berlin Hindenburgdamm 30, Haus II D-10117, Berlin, UK.

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