Chinese Medical Journal Pulmonary and Critical Care Medicine 3 (2025) 300–307

Contents lists available at ScienceDirect

Chinese Medical Journal Pulmonary and Critical Care Medicine

journal homepage: www.elsevier.com/locate/pccm

Original Article

Global, regional, and national burden of interstitial lung disease and pulmonary sarcoidosis from 1990 to 2023, and projections to 2050: A systematic analysis for the Global Burden of Disease Study 2023

Xiaoqian Ma[a,1], Lili Zhu[b,1], Huijuan Xiao[c], Yushan He[d], Huaping Dai[b,*]

[a] Department of Respiratory Disease, Thoracic Disease Center, The First Affiliated Hospital, College of Medicine, Zhejiang University, Hangzhou, Zhejiang 310002, China
[b] National Center for Respiratory Medicine; State Key Laboratory of Respiratory Health and Multimorbidity; National Clinical Research Center for Respiratory Diseases; Institute of Respiratory Medicine, Chinese Academy of Medical Sciences; Department of Pulmonary and Critical Care Medicine, Center of Respiratory Medicine, China-Japan Friendship Hospital, Beijing 100029, China
[c] Department of Respiratory and Critical Care Medicine, The Affiliated Hospital of Qingdao University, Qingdao, Shandong 266000, China
[d] Guangzhou Institute of Respiratory Health, State Key Laboratory of Respiratory Disease, National Clinical Research Center for Respiratory Disease, National Center for Respiratory Medicine, the First Affiliated Hospital, Guangzhou Medical University, Guangzhou, Guangdong 510030, China

ARTICLE INFO

Edited by: Peifang Wei

Keywords:
Interstitial lung diseases
Sarcoidosis
Global burden of disease 2023

ABSTRACT

Background: Interstitial lung disease (ILD) and pulmonary sarcoidosis are a group of complex respiratory conditions imposing a significant and growing global health burden. A comprehensive, up-to-date assessment of their epidemiological trends is crucial for informing policy. This study analyzes the global, regional, and national burden of ILD and pulmonary sarcoidosis from 1990 to 2023, with projections to 2050, using data from the Global Burden of Diseases (GBD) 2023 study.

Methods: We extracted data on incidence, prevalence, deaths, and disability-adjusted life years (DALYs) across 204 countries and territories from the GBD 2023 database. We analyzed temporal trends using absolute numbers and age-standardized rates, examining the relationship between disease burden and the socio-demographic index (SDI). Future burden to 2050 was also forecast.

Results: Globally, the absolute burden of ILD and pulmonary sarcoidosis increased substantially from 1990 to 2023, with incident cases rising to 428.16 (95 % UI: 385.88–484.19) thousand, prevalent cases to 4581.13 (95 % UI: 4092.82–5166.99) thousand, deaths to 112.65 (95 % UI: 90.85–141.59) thousand, and DALYs to 4.46 (95% UI: 3.74–5.65) million in 2023, which were 1.57, 1.22, 1.45, and 2.40 times higher than their respective 1990 levels. From 1990 to 2023, the global age-standardized incidence rate (ASIR, average annual percentage change [AAPC] 0.60%) and age-standardized prevalence rate (ASPR, AAPC 0.32%) of ILD and sarcoidosis increased modestly, whereas age-standardized death rate (ASDR, AAPC 1.97%) and age-standardized DALY rate (AAPC 1.34%) rose more steeply. Significant regional disparities were observed in 2023, with Andean Latin America and High-income Asia Pacific recording the highest burdens, and Southeast Asia the lowest. Nationally, Peru reported the highest ASIR, ASDR and age-standardized DALY rate, while Mauritius reported the highest ASPR. Burden levels were generally positively correlated with SDI. The age group with the highest global ILD and pulmonary sarcoidosis incident cases in 2023 was observed in individuals aged 70–74 years. For individuals aged 60 and above, males consistently had higher incidence rates than females across all age groups. In 2023, the estimated burden of ILD and pulmonary sarcoidosis in China was substantial, with 45,154.35 incident cases, 627,044.96 prevalent cases, 10,278.66 deaths, and 267,349.11 DALYs. Correspondingly, the age-standardized rates were 2.12 per 100,000 for incidence, 27.98 per 100,000 for prevalence, 0.46 per 100,000 for death, and 12.02 per 100,000 for DALYs. Forecasts indicate that by 2050, the global crude death and DALY rates will increase by approximately 83.53 % and 60.43 %, respectively. This rise is primarily attributable to population growth and aging, particularly in high-income regions.

* Corresponding author at: National Center for Respiratory Medicine; State Key Laboratory of Respiratory Health and Multimorbidity; National Clinical Research Center for Respiratory Diseases; Institute of Respiratory Medicine, Chinese Academy of Medical Sciences; Department of Pulmonary and Critical Care Medicine, Center of Respiratory Medicine, China-Japan Friendship Hospital, Beijing 100029, China.
E-mail address: daihuaping@ccmu.edu.cn (H. Dai)

[1] Xiaoqian Ma and Lili Zhu contributed equally to this work.

https://doi.org/10.1016/j.pccm.2025.11.008
Received 7 March 2025; Available online 12 December 2025
2097-1982/© 2025 Published by Elsevier B.V. on behalf of Chinese Medical Association. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/)

Conclusions: The global burden of ILD and pulmonary sarcoidosis has significantly increased, marked by persistent disparities across regions and demographics, with projections indicating that population aging will intensify this pressure, especially in high-SDI and rapidly developing areas. Addressing this challenge requires urgent, hierarchical strategies focusing on high-risk groups and strengthening multi-disciplinary disease management to mitigate future impact.

Introduction

Interstitial lung disease (ILD) represents a heterogeneous group of over 200 pulmonary disorders characterized by inflammation and/or fibrosis of the pulmonary parenchyma. These diseases are broadly categorized into four subgroups: ILD of known cause, idiopathic interstitial pneumonia (IIP), granulomatous ILD (e.g., pulmonary sarcoidosis), and other forms of ILD.[1,2] Despite advancements in diagnostic modalities, ILD remains challenging to diagnose and manage, necessitating a multidisciplinary approach.[3,4] Fibrotic ILD has emerged as a significant component of global health problems, primarily attributable to the incomplete knowledge of underlying pathogenic pathways and natural disease progression, the absence of fully validated predictive biomarkers for disease behavior, and the paucity of disease-modifying therapeutic strategies.[5] Idiopathic pulmonary fibrosis (IPF) represents the prototypical progressive fibrotic ILD, characterized by relentless decline in lung function and a median survival of merely 3–5 years after diagnosis without treatment.[6] Recent clinical investigations have demonstrated that pirfenidone and nintedanib exhibit modest therapeutic efficacy in attenuating the decline of pulmonary function in patients with IPF and other progressive pulmonary fibrosis (PPF).[7-12] However, lung transplantation remains the only therapeutic intervention to improve survival rates and quality of life in these patients, which is unfortunately limited by substantial costs and restricted accessibility.[6]

The objective of the establishment of the World Health Organization (WHO) Global Alliance against Chronic Respiratory Diseases is to alleviate the burden of chronic respiratory diseases and to realize a world where everyone can breathe freely, with a particular focus on addressing the needs of individuals suffering from chronic respiratory diseases in low-income and middle-income countries.[13] As an important part of chronic respiratory diseases, ILD imposes a significant health burden globally, necessitating comprehensive statistical analysis of integrated epidemiological data encompassing ILD incidence, prevalence, mortality, and disability-adjusted life years (DALYs) trends at a global, national and regional level. Unlike other chronic respiratory diseases, the global age-standardized mortality rate due to ILD and pulmonary sarcoidosis increased at an average of 0.97 % (0.92–1.03 %) a year from 1990 to 2017. The mortality rate of ILD and pulmonary sarcoidosis was positively associated with the socio-demographic index (SDI), and these diseases are consequently expected to impose increasing burdens on individuals and societies due to the global rise in SDI.[14] Furthermore, our previous study indicated that from 1990 to 2019, the global incidence, deaths and DALYs due to ILD and pulmonary sarcoidosis increased by 118.6 %, 166.63 % and 122.87 % respectively. Since 2006, high-SDI regions had higher age-standardized incidence rates (ASIRs) but lower age-standardized death rates (ASDRs) compared to the low-SDI regions, which showed significant regional differences in the disease burden of ILD and pulmonary sarcoidosis.[15]

The Global Burden of Diseases, Injuries, and Risk Factors Study is a comprehensive database to provide annual data on the prevalence and associated levels of disability associated with 371 diseases and injuries, as well as 88 risk factors. This study provides the analysis of ILD and pulmonary sarcoidosis burden across 204 countries and territories from 1990 to 2023, utilizing data from the Global Burden of Disease (GBD) 2023. Our findings aim to inform targeted prevention strategies by delineating temporal and geographical trends of incidence, prevalence, death, and DALYs of ILD and pulmonary sarcoidosis, by sex, region, and regional SDI globally from 1990 to 2023 using the latest data from GBD 2023 study.

Methods

Overview

This study analyzed the global burden of ILD and pulmonary sarcoidosis from 1990 to 2023 using data from the GBD 2023 study,[16] encompassing 204 countries and territories. The GBD 2023 study employed a standardized methodological framework to systematically assess population, morbidity, and mortality trends, ensuring rigorous and transparent reporting practices in alignment with the Guidelines for Accurate and Transparent Health Estimates Reporting (GATHER).[17] Ethical approval was not required for this study, as it utilized publicly available data from the GBD 2023 dataset. Detailed methodologies are documented in prior publications.[18]

Case definition

ILD comprises over 200 heterogeneous disorders characterized by alveolar and interstitial involvement. Pulmonary sarcoidosis is clinically recognized as a form of ILD, characterized by granulomatous inflammation. However, within the GBD study's methodological framework, which aims for mutually exclusive cause categories for burden estimation, pulmonary sarcoidosis is modeled and analyzed as a distinct entity separate from the main "ILD" category. In GBD 2023, the category "ILD and pulmonary sarcoidosis" was restricted to conditions corresponding to specific International Classification of Diseases (ICD) codes: D86–D86.2, D86.9, J84–J84.9 (ICD-10); and 135–135.9, 515, 515.9–516.9 (ICD-9).

Data source

The GBD 2023 study, led by the Institute for Health Metrics and Evaluation (IHME), synthesizes epidemiological data to enable comparative analyses of health losses attributable to diverse conditions and risk factors. All data are publicly accessible through the Global Health Data Exchange (GHDx) platform, with detailed documentation on data sources, statistical methods, and methodologies. Informed patient consent was not required for data use. In this study, we extracted annual case counts and age-standardized rates (ASRs) for incidence, prevalence, mortality, and DALYs of ILD and pulmonary sarcoidosis from 1990 to 2023, stratified by sex, age, geographic region, and country and territory.

Data analysis

The GBD 2023 methodology for estimating sex- and age-specific incidence, prevalence, mortality, and DALYs has been previously described.[16] Key methods include DisMod-MR 2.1 for modeling prevalence, incidence, and mortality; Cause of Death Ensemble modeling (CODEm) for cause-specific mortality estimation; Spatiotemporal Gaussian Process Regression (ST-GPR) to address data gaps and smooth estimates; age-standardization for cross-population comparisons; and uncertainty quantification using 95 % uncertainty intervals (UIs). GBD 2023 study combines sophisticated modeling (DisMod-MR), data standardization Meta-Regression—Bayesian, Regularized, Trimmed (MR-BRT), pattern-based splitting, and targeted imputation techniques to create a complete and consistent dataset despite gaps in the original source data.

To evaluate trends in incidence, prevalence, mortality, and DALYs, we calculated ASRs and their average annual percentage changes (AAPCs). The AAPC, derived from the Joinpoint regression model, summarizes trends over time as a weighted average of annual percentage

Table 1
Incidence cases and ASIRs of ILD and pulmonary sarcoidosis globally and stratified by sex, SDI and regions in 1990 and 2023, and their temporal trend from 1990 to 2023.

Characteristics	1990		2023		AAPC in 1990–2023 (%), No. (95 % CI)
	Incidence cases (thousand), No. (95 % UI)	ASIR per 100,000, No. (95 % UI)	Incidence cases (thousand), No. (95 % UI)	ASIR per 100,000, No. (95 % UI)	
Overall	166.73 (145.17–194.23)	3.95 (3.48–4.58)	428.16 (385.88–484.19)	4.75 (4.29–5.36)	0.60 (0.56–0.63)
Sex					
Male	87.25 (75.28–101.85)	4.46 (3.93–5.17)	233.92 (210.34–265.72)	5.63 (5.08–6.38)	1.03 (0.90–1.15)
Female	79.48 (69.91–92.42)	3.58 (3.17–4.16)	194.24 (175.62–219.08)	4.07 (3.68–4.56)	0.40 (0.35–0.45)
SDI					
High-middle	23.64 (20.38–27.45)	3.04 (2.67–3.52)	73.86 (66.33–83.63)	3.73 (3.37–4.19)	0.69 (0.60–0.77)
Middle	7.76 (6.70–8.96)	2.01 (1.76–2.32)	16.32 (14.54–18.59)	1.81 (1.62–2.04)	−0.24 (−0.30 to −0.18)
Low-middle	18.39 (15.66–21.93)	4.28 (3.69–5.06)	35.28 (31.05–40.37)	3.65 (3.23–4.18)	−0.46 (−0.48 to −0.43)
Low	16.92 (14.36–20.20)	4.10 (3.53–4.86)	34.01 (30.06–39.07)	3.35 (2.96–3.85)	−0.60 (−0.62 to −0.59)
Region					
Andean Latin America	2.58 (2.37–2.81)	12.90 (11.76–14.08)	14.17 (13.45–14.95)	22.60 (21.42–23.85)	1.74 (1.72–1.76)
Australasia	0.77 (0.71–0.84)	3.37 (3.11–3.67)	4.37 (4.17–4.60)	7.51 (7.16–7.88)	2.44 (2.42–2.46)
Caribbean	0.48 (0.43–0.54)	1.70 (1.53–1.93)	1.36 (1.28–1.46)	2.46 (2.31–2.65)	1.13 (1.11–1.14)
Central Asia	1.72 (1.57–1.88)	3.36 (3.11–3.62)	2.30 (2.12–2.51)	2.55 (2.37–2.75)	−0.86 (−0.89 to −0.84)
Central Europe	3.54 (3.16–3.96)	2.51 (2.25–2.82)	4.73 (4.33–5.17)	2.69 (2.45–2.95)	0.25 (0.22–0.28)
Central Latin America	3.47 (3.07–4.00)	3.70 (3.30–4.26)	15.44 (13.99–17.33)	5.73 (5.20–6.41)	1.33 (1.32–1.35)
Central Sub-Saharan Africa	0.58 (0.49–0.68)	2.18 (1.85–2.58)	1.47 (1.29–1.70)	1.95 (1.70–2.24)	−0.35 (−0.36 to −0.34)
East Asia	21.06 (17.89–25.21)	2.02 (1.73–2.38)	46.90 (40.77–55.03)	2.12 (1.86–2.46)	0.28 (0.09–0.46)
Eastern Europe	7.41 (6.43–8.58)	2.85 (2.50–3.29)	3.05 (2.61–3.58)	1.16 (1.01–1.35)	−2.67 (−2.71 to −2.64)
Eastern Sub-Saharan Africa	2.85 (2.43–3.36)	3.34 (2.88–3.97)	5.75 (5.05–6.59)	2.59 (2.28–2.95)	−0.77 (−0.79 to −0.76)
High-income Asia Pacific	24.36 (20.82–29.40)	12.01 (10.31–14.40)	65.08 (54.80–77.68)	14.56 (12.80–17.02)	0.59 (0.58–0.60)
High-income North America	28.38 (24.56–33.97)	8.51 (7.39–10.02)	78.05 (67.76–92.29)	12.22 (10.81–14.15)	1.13 (1.11–1.14)
North Africa and Middle East	5.98 (5.24–6.89)	3.10 (2.74–3.58)	16.67 (15.00–18.50)	3.11 (2.85–3.42)	0.00 (−0.05 to 0.05)
Oceania	0.04 (0.04–0.05)	1.07 (0.93–1.25)	0.09 (0.08–0.11)	0.85 (0.74–0.96)	−0.70 (−0.71 to −0.69)
South Asia	34.58 (29.37–41.53)	5.44 (4.67–6.50)	74.58 (65.45–86.25)	4.70 (4.13–5.43)	−0.41 (−0.44 to −0.37)
Southeast Asia	2.11 (1.76–2.53)	0.69 (0.58–0.83)	5.77 (5.05–6.70)	0.78 (0.69–0.90)	0.40 (0.39–0.42)
Southern Latin America	2.71 (2.54–2.88)	5.91 (5.54–6.24)	9.70 (9.36–10.04)	10.46 (10.07–10.86)	1.76 (1.74–1.77)
Southern Sub-Saharan Africa	1.27 (1.09–1.49)	4.12 (3.53–4.93)	2.74 (2.40–3.17)	3.78 (3.31–4.38)	−0.26 (−0.29 to −0.23)
Tropical Latin America	2.74 (2.35–3.22)	2.53 (2.19–2.99)	8.48 (7.42–9.78)	3.22 (2.81–3.70)	0.71 (0.65–0.77)
Western Europe	17.67 (16.15–19.34)	3.52 (3.21–3.90)	62.44 (58.29–67.78)	7.15 (6.70–7.71)	2.19 (2.16–2.21)
Western Sub-Saharan Africa	2.40 (2.03–2.82)	2.44 (2.10–2.86)	5.00 (4.36–5.69)	1.87 (1.64–2.13)	−0.82 (−0.83 to −0.80)

AAPC: Average annual percentage change; ASIR: Age-standardized incidence rate; CI: Confidence interval; ILD: Interstitial lung disease; SDI: Sociodemographic index; UI: Uncertainty interval.

changes (APCs), with weights corresponding to the length of each APC interval. Calculations were performed using the Joinpoint Regression Program, Version 5.3.0 (Surveillance Research Program, National Cancer Institute, Bethesda, MD, USA),[19] which also provides the 95 % confidence intervals (CIs) for the AAPC estimates based on the model's standard errors. All statistical analyses and visualizations, excluding APC and AAPC calculations, were performed using R version 4.4.1 (R Foundation for Statistical Computing, Vienna, Austria).

Results

Global level

Globally, ILD and sarcoidosis accounted for 428.16 (95 % UI: 385.88–484.19) thousand incident cases, 4581.13 (95 % UI: 4092.82–5166.99) thousand prevalent cases, 112.65 (95 % UI: 90.85–141.59) thousand deaths, and 4.46 (95 % UI: 3.74–5.65) million DALYs in 2023. In 2023, the absolute number of incident cases, prevalent cases, deaths, and DALYs were 1.57, 1.22, 1.45, and 2.40 times higher than their respective 1990 levels, respectively. After adjusting for demographic factors, however, the trends in age-standardized rates varied. The global ASIR in 2023 was 4.75 per 100,000 population. While the global ASIR showed a consistent increase over the entire period (AAPC, 0.60 %; 95 % CI, 0.56 % to 0.63 %), Joinpoint analysis revealed an accelerated increase of 0.77 % per year from 2008 to 2023. The global ASPR in 2023 was 50.41 per 100,000 population, and the AAPC of ASPR between year 1990 and 2023 was 0.32 % (95 % CI, 0.21 % to 0.43 %). The global ASDR in 2023 was 2.40 (95 % CI, 1.98–2.93) per 100,000 population. From 1990 to 2023, the global ASDR demonstrated a steady increase, with an AAPC of 1.97 % (95 % CI, 1.91 % to 2.03 %). The ASR of DALY in 2023 was 49.55 per 100,000 population. The global age-standardized DALY rate kept an increasing trend over the 34-year period, with an AAPC of 1.34 % (95 % CI, 1.24 % to 1.43 %) (Tables 1–4).

Regional levels

At the regional level, the burden of ILD and sarcoidosis showed substantial heterogeneity in 2023. Andean Latin America recorded the highest age-standardized rates for incidence (22.60 per 100,000), deaths (16.56 per 100,000), and DALYs (285.58 per 100,000). The highest ASPR was observed in High-income Asia Pacific (155.12 per 100,000). Conversely, Southeast Asia had the lowest age-standardized rates for incidence (0.78 per 100,000), prevalence (9.31 per 100,000), deaths (0.41 per 100,000) and DALYs (10.43 per 100,000) (Tables 1–4).

From 1990 to 2023, the temporal trends also varied widely across regions. Australasia experienced the most significant increase in ASIR (AAPC, 2.44 %; 95 % CI, 2.42 % to 2.46 %), whereas East Europe saw the greatest decline (AAPC, −2.67 %; 95 % CI, −2.71 % to −2.64 %). For prevalence, Australasia recorded the steepest rise in ASPR (AAPC, 2.22 %; 95 % CI, 2.19 % to 2.25 %), while Eastern Europe again showed the sharpest decrease (AAPC, −2.20 %; 95 % CI, −2.24 % to −2.17 %). For mortality, the ASDR demonstrated the steepest rise in Australasia (AAPC, 3.26 %; 95 % CI, 3.09 % to 3.42 %) and the sharpest fall in Eastern Europe (AAPC, −1.72 %; 95 % CI, −2.03 % to −1.40 %). In terms of disease burden, Australasia saw the largest increase in the age-standardized DALY rate (AAPC, 2.86 %; 95 % CI, 2.68 % to 3.05 %), while Eastern Europe experienced the greatest reduction (AAPC, −1.67 %; 95 % CI, −1.91 % to −1.42 %). The relationship between age-standardized rates and SDI was complex. In most high-income regions, such as High-income North America and Western Eu-

Table 2
Prevalence cases and ASPRs of ILD and pulmonary sarcoidosis globally and stratified by sex, SDI and regions in 1990 and 2023, and their temporal trend from 1990 to 2023.

Characteristics	1990		2023		AAPC in 1990–2023 (%), No. (95 % CI)
	Prevalent cases (thousand), No. (95 % UI)	ASPR per 100,000, No. (95 % UI)	Prevalent cases (thousand), No. (95 % UI)	ASPR per 100,000, No. (95 % UI)	
Overall	2063.48 (1773.83–2400.60)	49.76 (43.10–57.37)	4581.13 (4092.82–5166.99)	50.41 (45.03–56.71)	0.32 (0.21–0.43)
Sex					
Male	983.04 (845.02–1137.97)	50.67 (44.08–58.39)	2271.70 (2023.54–2579.53)	53.67 (47.98–60.58)	0.21 (0.16–0.26)
Female	1080.44 (925.85–1262.63)	49.40 (42.32–57.58)	2309.43 (2058.36–2599.98)	48.09 (42.79–53.97)	−0.03 (−0.07 to 0.02)
SDI					
High-middle	258.99 (219.53–308.19)	33.12 (28.15–39.05)	734.36 (644.85–839.26)	36.07 (31.85–40.93)	0.32 (0.26–0.38)
Middle	85.70 (72.42–101.37)	22.56 (19.04–26.46)	185.94 (159.99–214.77)	19.79 (17.20–22.64)	−0.32 (−0.39 to −0.25)
Low-middle	174.02 (147.43–203.55)	40.11 (34.15–47.14)	329.93 (288.50–376.34)	32.90 (28.90–37.47)	−0.55 (−0.59 to −0.51)
Low	154.27 (130.01–180.19)	37.03 (31.43–43.90)	322.68 (281.62–367.95)	31.14 (27.39–35.84)	−0.50 (−0.53 to −0.48)
Region					
Andean Latin America	16.75 (15.20–18.47)	79.92 (72.21–88.14)	86.47 (81.56–92.12)	134.84 (127.01–143.76)	2.07 (1.89–2.24)
Australasia	8.19 (7.27–9.29)	35.03 (31.01–39.86)	37.77 (35.40–40.56)	65.66 (60.97–71.05)	2.22 (2.19–2.25)
Caribbean	4.95 (4.20–5.77)	17.75 (15.15–20.57)	14.25 (12.88–15.79)	25.80 (23.22–28.80)	1.14 (1.13–1.16)
Central Asia	19.27 (17.00–21.95)	38.40 (34.27–43.44)	27.73 (24.46–32.01)	29.18 (26.04–33.22)	−0.86 (−0.88 to −0.83)
Central Europe	56.68 (49.12–67.13)	38.50 (33.24–45.85)	75.31 (67.20–84.60)	39.70 (34.77–45.93)	0.14 (0.10–0.19)
Central Latin America	34.78 (29.64–40.02)	38.45 (33.21–44.82)	144.62 (129.76–163.88)	53.22 (47.74–60.35)	0.99 (0.95–1.04)
Central Sub-Saharan Africa	5.59 (4.66–6.65)	20.72 (17.58–24.62)	15.37 (13.02–18.21)	20.61 (17.82–23.64)	−0.02 (−0.03 to −0.01)
East Asia	287.30 (238.56–348.56)	29.61 (24.59–35.89)	648.74 (552.62–759.81)	27.96 (23.92–32.74)	−0.08 (−0.23 to 0.06)
Eastern Europe	117.05 (100.50–138.47)	42.87 (36.78–50.96)	62.81 (53.51–75.44)	20.41 (16.92–24.54)	−2.20 (−2.24 to −2.17)
Eastern Sub-Saharan Africa	24.44 (20.76–29.02)	28.28 (23.94–33.88)	51.92 (44.39–60.39)	23.20 (20.19–26.78)	−0.60 (−0.61 to −0.58)
High-income Asia Pacific	327.97 (279.42–388.08)	161.35 (138.10–190.89)	694.63 (608.18–810.93)	155.12 (137.23–179.54)	−0.07 (−0.10 to −0.03)
High-income North America	393.92 (341.65–464.22)	116.77 (101.00–136.72)	852.18 (754.42–977.14)	133.27 (117.54–150.98)	0.42 (0.40–0.44)
North Africa and Middle East	66.61 (56.68–78.93)	34.35 (29.56–39.85)	209.54 (182.04–244.35)	38.08 (33.51–43.34)	0.32 (0.31–0.33)
Oceania	0.53 (0.44–0.63)	13.61 (11.52–15.92)	1.22 (1.02–1.47)	11.78 (10.01–13.71)	−0.43 (−0.44 to −0.43)
South Asia	319.78 (270.34–376.94)	49.88 (42.35–58.82)	685.81 (597.02–787.21)	41.60 (36.42–47.65)	−0.49 (−0.54 to −0.43)
Southeast Asia	23.78 (19.16–29.63)	8.06 (6.55–9.82)	69.86 (58.49–83.41)	9.31 (7.86–10.98)	0.46 (0.45–0.48)
Southern Latin America	28.41 (25.76–30.99)	60.59 (54.88–66.08)	92.72 (87.37–98.36)	100.34 (94.40–106.77)	1.55 (1.53–1.56)
Southern Sub-Saharan Africa	12.72 (10.73–14.92)	41.33 (34.88–48.41)	28.23 (24.30–32.56)	38.50 (33.36–44.34)	−0.21 (−0.25 to −0.18)
Tropical Latin America	29.84 (24.61–35.85)	27.72 (23.30–32.99)	63.67 (55.67–73.60)	23.80 (20.68–27.38)	−0.52 (−0.63 to −0.42)
Western Europe	261.72 (230.89–299.94)	50.00 (43.63–58.06)	666.42 (611.23–725.43)	77.29 (70.16–85.21)	1.32 (1.30–1.34)
Western Sub-Saharan Africa	23.21 (19.52–27.30)	23.44 (19.93–27.38)	51.86 (43.59–61.06)	19.64 (16.96–22.42)	−0.54 (−0.55 to −0.53)

AAPC: Average annual percentage change; ASPR: Age-standardized prevalence rate; CI: Confidence interval; ILD: Interstitial lung disease; SDI: Sociodemographic index; UI: Uncertainty interval.

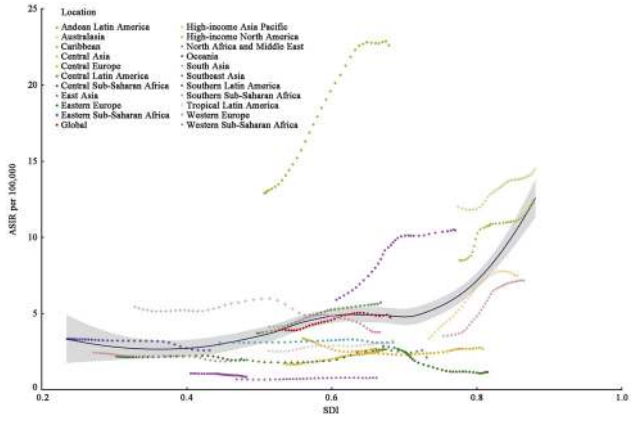

Fig. 1. ASIRs of ILD and pulmonary sarcoidosis per 100,000 individuals across regions based on the SDI of each year. ASIR: Age-standardized incidence rate; ILD: Interstitial lung disease; SDI: Sociodemographic index.

rope, rates generally increased with rising SDI. However, some regions, like East Asia, exhibited a distinct inverted U-shaped pattern, where rates first rose and then fell as SDI improved (Fig. 1, Supplementary Fig. 1).

National/territorial level

At the national level, striking disparities in disease burden were observed in 2023. Peru reported the highest age-standardized rates for incidence (27.09 per 100,000), mortality (22.23 per 100,000), and DALY rate (373.89 per 100,000). Mauritius reported the highest ASPR (188.27 per 100,000). In contrast, the lowest burdens were recorded in the Philippines for incidence (ASIR, 0.38 per 100,000), prevalence (ASPR, 5.20 per 100,000) and ASR of DALY (2.48 per 100,000), and in the Republic of Moldova for mortality (ASDR, 0.04 per 100,000).

The temporal trends from 1990 to 2023 also showed marked heterogeneity. Mauritius experienced the most rapid increase in incidence (AAPC, 3.85 %) and prevalence (AAPC, 3.97 %), while Italy saw the fastest rises in mortality (AAPC, 7.48 %). Conversely, the most substantial declines were observed in Latvia for incidence (AAPC, –4.38 %) and in Ukraine for prevalence (AAPC, –3.25 %), and in the Republic of Moldova for mortality (AAPC, –7.57 %). For DALYs, Saint Vincent and the Grenadines had the largest increase (AAPC, 6.00 %), whereas Estonia recorded the steepest decrease (AAPC, –4.90 %). These patterns underscore the heterogeneous national trajectories in ILD and sarcoidosis burden worldwide (Supplementary Table 1).

In 2023, the estimated burden of ILD and pulmonary sarcoidosis in China was substantial, with 45,154.35 incident cases, 627,044.96 prevalent cases, 10,278.66 deaths, and 267,349.11 DALYs. Correspondingly, the age-standardized rates were 2.12 per 100,000 for incidence, 27.98 per 100,000 for prevalence, 0.46 per 100,000 for death, and 12.02 per 100,000 for DALYs (Supplementary Table 1).

Age and sex pattern

The burden of ILD and pulmonary sarcoidosis exhibited distinct age and sex patterns. Age-specific incidence rates increased consistently with age. The age group with the highest global ILD and pulmonary sarcoidosis incident cases in 2023 was observed in individuals aged 70–

Table 3
Death cases and ASDRs of ILD and pulmonary sarcoidosis globally and stratified by sex, SDI and regions in 1990 and 2023, and their temporal trend from 1990 to 2023.

Characteristics	1990		2023		AAPC in 1990–2023 (%), No. (95 % CI)
	Death cases (thousand), No. (95 % UI)	ASDR per 100,000, No. (95 % UI)	Death cases (thousand), No. (95 % UI)	ASDR per 100,000, No. (95 % UI)	
Overall	46.05 (35.84–76.17)	1.27 (1.00–2.04)	112.65 (90.85–141.59)	2.40 (1.98–2.93)	1.97 (1.91–2.03)
Sex					
Male	24.97 (19.58–40.37)	1.62 (1.28–2.52)	100.58 (77.85–146.99)	2.93 (2.36–3.63)	1.84 (1.78–1.90)
Female	21.09 (14.91–40.58)	1.03 (0.73–1.93)	213.23 (176.15–261.21)	2.01 (1.55–2.95)	1.99 (1.88–2.09)
SDI					
High-middle	5.31 (3.63–7.90)	0.92 (0.62–1.35)	39.98 (31.47–52.82)	2.08 (1.63–2.75)	2.41 (2.20–2.63)
Middle	1.61 (0.94–2.61)	0.55 (0.32–0.88)	7.27 (4.60–11.70)	0.94 (0.59–1.51)	1.60 (1.53–1.68)
Low-middle	5.76 (2.38–17.61)	1.68 (0.71–5.09)	22.62 (12.62–37.85)	2.68 (1.48–4.54)	1.51 (1.41–1.61)
Low	6.42 (2.20–20.32)	1.93 (0.67–6.05)	19.97 (10.96–39.29)	2.47 (1.33–4.96)	0.72 (0.64–0.79)
Region					
Andean Latin America	1.11 (0.75–1.59)	5.94 (3.97–8.65)	10.09 (7.50–12.04)	16.56 (12.29–19.80)	2.99 (2.85–3.13)
Australasia	0.26 (0.24–0.29)	1.14 (1.03–1.25)	2.24 (1.96–2.49)	3.40 (3.00–3.76)	3.26 (3.09–3.42)
Caribbean	0.16 (0.13–0.22)	0.59 (0.48–0.82)	0.73 (0.62–0.90)	1.31 (1.11–1.63)	2.38 (2.19–2.57)
Central Asia	0.50 (0.40–0.60)	1.16 (0.93–1.40)	1.53 (1.26–1.83)	2.03 (1.66–2.44)	2.05 (1.67–2.44)
Central Europe	1.47 (1.27–1.68)	1.01 (0.88–1.16)	2.43 (2.19–2.66)	1.06 (0.96–1.16)	0.16 (0.05–0.27)
Central Latin America	1.10 (1.00–1.23)	1.38 (1.26–1.53)	7.49 (6.75–8.43)	2.91 (2.62–3.28)	2.31 (2.21–2.41)
Central Sub-Saharan Africa	0.24 (0.05–0.69)	1.28 (0.26–3.56)	0.72 (0.21–1.43)	1.37 (0.40–2.73)	0.19 (0.15–0.23)
East Asia	1.42 (0.82–2.51)	0.19 (0.11–0.32)	10.84 (7.11–16.12)	0.47 (0.31–0.70)	2.91 (2.84–2.98)
Eastern Europe	2.26 (1.87–2.70)	0.87 (0.72–1.04)	1.75 (1.45–2.07)	0.49 (0.40–0.58)	−1.72 (−2.03 to −1.40)
Eastern Sub-Saharan Africa	0.83 (0.14–2.10)	1.19 (0.20–3.02)	2.47 (0.77–4.78)	1.43 (0.45–2.77)	0.55 (0.52–0.59)
High-income Asia Pacific	5.20 (4.58–5.81)	2.73 (2.39–3.06)	35.14 (28.14–42.06)	5.48 (4.46–6.53)	2.17 (2.02–2.32)
High-income North America	8.01 (7.23–8.61)	2.23 (2.01–2.40)	30.72 (26.54–34.48)	4.25 (3.70–4.75)	2.00 (1.92–2.07)
North Africa and Middle East	1.53 (0.78–2.89)	1.07 (0.55–2.00)	6.31 (4.42–9.33)	1.57 (1.09–2.35)	1.09 (1.01–1.17)
Oceania	0.04 (0.02–0.08)	1.25 (0.71–2.31)	0.11 (0.05–0.18)	1.18 (0.61–1.98)	−0.18 (−0.25 to −0.11)
South Asia	11.60 (4.65–37.27)	2.33 (0.94–7.44)	51.95 (28.73–89.19)	3.79 (2.08–6.50)	1.60 (1.48–1.72)
Southeast Asia	0.46 (0.18–1.00)	0.19 (0.07–0.42)	2.64 (0.97–5.86)	0.41 (0.15–0.91)	2.29 (2.20–2.38)
Southern Latin America	1.13 (0.96–1.32)	2.60 (2.18–3.03)	5.04 (4.27–6.10)	5.06 (4.29–6.12)	2.20 (2.00–2.39)
Southern Sub-Saharan Africa	0.38 (0.20–0.58)	1.47 (0.79–2.27)	1.14 (0.77–1.67)	1.87 (1.27–2.76)	0.13 (−0.16 to 0.43)
Tropical Latin America	0.80 (0.72–0.89)	0.92 (0.82–1.03)	4.82 (4.30–5.22)	1.85 (1.65–2.00)	2.17 (2.04–2.30)
Western Europe	6.50 (5.86–7.12)	1.08 (0.97–1.18)	32.62 (28.48–36.59)	2.89 (2.56–3.23)	3.08 (2.97–3.18)
Western Sub-Saharan Africa	1.04 (0.25–2.40)	1.35 (0.32–3.12)	2.44 (0.98–4.39)	1.28 (0.52–2.35)	−0.17 (−0.21 to −0.14)

AAPC: Average annual percentage change; ASDR: Age-standardized death rate; CI: Confidence interval; ILD: Interstitial lung disease; SDI: Sociodemographic index; UI: Uncertainty interval.

74 years and the lowest in those aged 0–14 years. For individuals aged 60 and above, males consistently had higher incidence rates than females across all age groups. The age group with the highest global ILD and pulmonary sarcoidosis prevalent cases in 2023 was observed in individuals aged 70–74 years and the lowest in those aged 0–14 years. For individuals aged 65 and above, males consistently had higher prevalence rates than females across all age groups. Similar patterns were observed for mortality and DALYs, with males experiencing higher death and DALY rates than females. ILD and pulmonary sarcoidosis-related deaths in 2023 were predominantly concentrated among those aged 65–89 years. The age group with the highest number of ILD and pulmonary sarcoidosis-related deaths among both males and females was 80–84 years, while the age group with the highest number of DALYs among both genders was 70–74 years (Fig. 2, Supplementary Fig. 2).

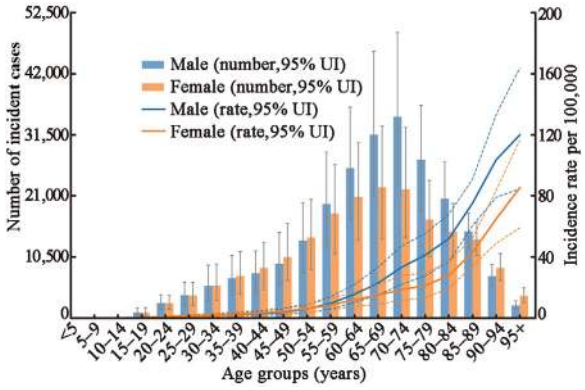

Fig. 2. Number of incident cases and incidence rate of ILD and pulmonary sarcoidosis per 100,000 population, by age and sex in 2023 globally. Bar chart represents the number of incident cases with 95 % UIs (error bars) for males and females. Line chart represents incidence rates with 95 % UIs (dashed line) for males and females. ILD: Interstitial lung disease; UI: Uncertainty interval.

Forecasts to 2050

Looking toward 2050, the global burden of ILD and sarcoidosis is projected to continue rising in terms of all-age death and DALY rates. According to GBD model projections, the global all-age death rate is expected to increase from 2.49 (95 % UI: 2.12–2.82) per 100,000 in 2023 to 4.57 (3.74–5.47) per 100,000 by 2050—an 83.53 % rise. Similarly, the global all-age DALY rate is forecast to grow from 52.97 (44.70–60.34) per 100,000 to 84.98 (69.03–101.16) per 100,000, up by about 60.43 %. Regional disparities are anticipated to widen further: High-income Asia Pacific is projected to see its death rate climb from 14.85 to 23.57 per 100,000, and its DALY rate from 241.68 to 337.22 per 100,000. Andean Latin America is expected to show a similar trend, with the death rate rising from 9.87 to 23.15 per 100,000 and the DALY rate from 187.44 to 367.22 per 100,000 by 2050. In contrast, Southeast Asia's all-age death and DALY rates are projected to remain among the lowest globally (death rate, 0.29 to 0.61 per 100,000; DALY rate, 8.85 to 14.84 per 100,000) (Fig. 3). It is important to emphasize that these projections are for crude (all-age) rates, and thus largely reflect the impact of global population growth and accelerated population aging. These shifting demographics—especially the rapidly increasing proportion of older adults in high-income regions—are likely to account for much of the anticipated rise in future burden, rather than substantive changes in disease risk among age groups. Overall, these findings highlight the

Table 4
DALYs and ASR of DALYs of ILD and pulmonary sarcoidosis globally and stratified by sex, SDI and regions in 1990 and 2023, and their temporal trend from 1990 to 2023.

Characteristic	1990		2023		AAPC in 1990–2023 (%), No. (95 % CI)
	DALYs (million), No. (95 % UI)	ASR of DALYs per 100,000, No. (95 % UI)	DALYs (million), No. (95 % UI)	ASR of DALYs per 100,000, No. (95 % UI)	
Overall	1.31 (1.01–2.15)	32.13 (24.94–51.94)	4.46 (3.74–5.65)	49.55 (41.61–62.75)	1.34 (1.24–1.43)
Sex					
Male	0.71 (0.55–1.16)	38.43 (30.06–61.44)	2.36 (1.91–2.94)	57.35 (46.67–71.44)	1.23 (1.16–1.30)
Female	0.60 (0.42–1.12)	27.31 (19.39–50.99)	2.10 (1.60–3.00)	43.56 (33.01–62.40)	1.45 (1.35–1.55)
SDI					
High-middle	0.16 (0.12–0.24)	22.36 (16.05–32.13)	0.90 (0.71–1.18)	45.23 (36.25–59.49)	2.24 (2.16–2.32)
Middle	0.17 (0.08–0.48)	14.55 (9.61–21.81)	0.19 (0.12–0.29)	21.47 (14.17–33.72)	1.23 (1.17–1.29)
Low-middle	0.05 (0.04–0.08)	41.29 (19.44–116.82)	0.56 (0.33–0.93)	59.25 (34.93–97.38)	1.19 (1.10–1.28)
Low	0.19 (0.08–0.59)	47.17 (18.79–142.04)	0.53 (0.31–0.98)	54.27 (31.06–102.71)	0.40 (0.33–0.48)
Region					
Andean Latin America	0.03 (0.02–0.04)	122.32 (85.22–168.49)	0.18 (0.14–0.21)	285.58 (221.31–330.36)	2.65 (2.46–2.84)
Australasia	0.01 (0.01–0.01)	23.94 (21.96–26.28)	0.04 (0.03–0.04)	62.56 (55.96–68.78)	2.86 (2.68–3.05)
Caribbean	0.00 (0.00–0.01)	16.22 (13.00–23.39)	0.02 (0.01–0.02)	31.49 (26.39–41.04)	2.03 (1.88–2.19)
Central Asia	0.02 (0.01–0.02)	32.64 (26.43–37.95)	0.04 (0.03–0.05)	44.45 (36.71–52.56)	0.27 (−0.28 to 0.83)
Central Europe	0.04 (0.04–0.05)	30.22 (26.38–34.30)	0.06 (0.05–0.06)	28.46 (26.03–31.19)	−0.16 (−0.25 to −0.07)
Central Latin America	0.03 (0.03–0.04)	34.86 (31.73–39.06)	0.18 (0.16–0.20)	66.80 (60.54–74.66)	1.99 (1.91–2.07)
Central Sub-Saharan Africa	0.01 (0.00–0.02)	30.01 (7.52–82.74)	0.02 (0.01–0.04)	31.47 (10.72–59.95)	0.12 (0.08–0.16)
East Asia	0.07 (0.05–0.11)	7.35 (5.17–11.16)	0.28 (0.21–0.39)	12.18 (9.06–16.64)	1.62 (1.54–1.70)
Eastern Europe	0.07 (0.06–0.08)	25.37 (21.23–30.09)	0.05 (0.04–0.06)	14.42 (12.11–16.61)	−1.67 (−1.91 to −1.42)
Eastern Sub-Saharan Africa	0.03 (0.01–0.06)	28.98 (7.17–69.25)	0.07 (0.02–0.13)	31.93 (11.80–59.86)	0.31 (0.28–0.33)
High-income Asia Pacific	0.14 (0.12–0.16)	69.35 (61.41–78.47)	0.55 (0.46–0.64)	102.28 (88.74–118.76)	0.72 (0.56–0.87)
High-income North America	0.21 (0.19–0.23)	61.39 (55.90–68.11)	0.59 (0.53–0.66)	89.29 (80.24–98.57)	1.16 (1.09–1.23)
North Africa and Middle East	0.05 (0.03–0.09)	26.35 (14.86–46.34)	0.17 (0.12–0.23)	34.52 (25.55–48.46)	0.76 (0.68–0.84)
Oceania	0.00 (0.00–0.00)	40.71 (22.32–74.97)	0.00 (0.00–0.01)	39.55 (20.41–66.20)	−0.06 (−0.12 to −0.00)
South Asia	0.34 (0.16–1.02)	56.68 (25.71–168.33)	1.26 (0.73–2.08)	81.67 (47.13–135.27)	1.21 (1.13–1.30)
Southeast Asia	0.02 (0.01–0.03)	5.58 (2.60–11.18)	0.07 (0.03–0.16)	10.43 (4.34–21.65)	1.90 (1.81–1.99)
Southern Latin America	0.03 (0.02–0.03)	59.54 (50.75–68.70)	0.10 (0.09–0.12)	105.67 (91.45–126.05)	1.89 (1.69–2.10)
Southern Sub-Saharan Africa	0.01 (0.01–0.02)	35.74 (21.73–52.79)	0.03 (0.02–0.04)	42.95 (30.01–60.82)	0.63 (0.51–0.75)
Tropical Latin America	0.03 (0.02–0.03)	25.25 (22.65–27.97)	0.11 (0.10–0.11)	40.65 (37.23–43.79)	1.60 (1.37–1.83)
Western Europe	0.15 (0.14–0.17)	27.32 (24.01–30.70)	0.57 (0.52–0.63)	59.68 (54.16–65.85)	2.43 (2.34–2.52)
Western Sub-Saharan Africa	0.03 (0.01–0.07)	31.04 (9.13–67.71)	0.07 (0.03–0.13)	28.97 (12.71–49.84)	−0.23 (−0.26 to −0.19)

AAPC: Average annual percentage change; ASR: Age-standardized rate; CI: Confidence interval; DALYs: Disability-adjusted life-years; ILD: Interstitial lung disease; SDI: Sociodemographic index; UI: Uncertainty interval.

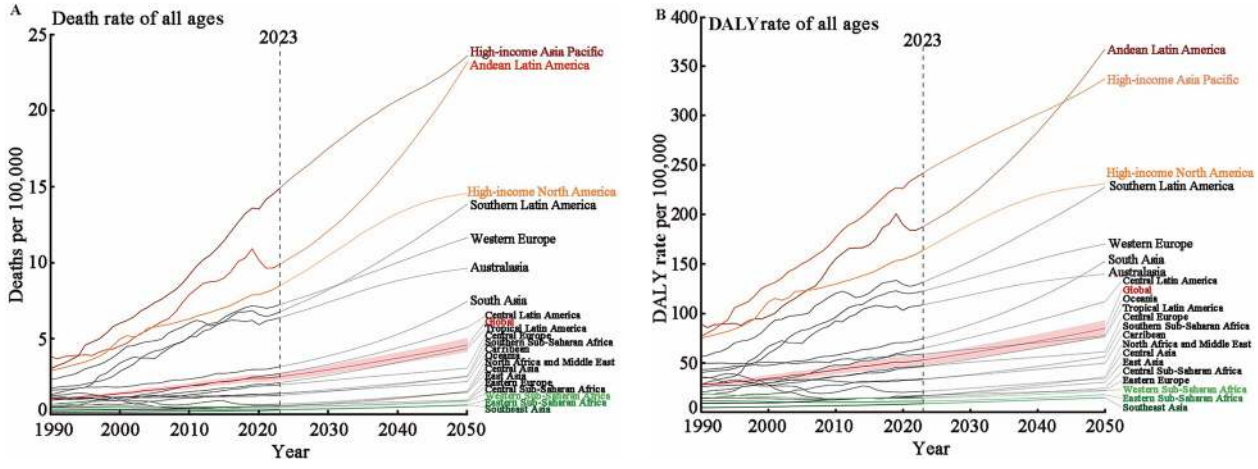

Fig. 3. Trends and forecasts in all-age death (A) and DALY rates (B) for interstitial lung disease and pulmonary sarcoidosis from 1990 to 2050, by GBD region. Historical data from 1990 to 2023 are shown as darker, solid lines. Forecasted trends from 2024 to 2050 are indicated by the lighter lines following the vertical dashed line at 2023. Shaded areas around the lines represent the 95 % uncertainty intervals (UI). The vertical dashed line marks the transition from historical data to forecasted data in 2023. Key regions with high and low burdens are highlighted. DALY: Disability-adjusted life year; GBD: Global Burden of Disease.

urgent need for enhanced health system preparedness to address the consequences of ongoing demographic changes.

Discussion

Based on the GBD 2023 data, this study analyzed the incidence, prevalence, mortality, and DALY burden of ILD and pulmonary sarcoidosis across 204 countries and territories (1990–2023) and projected trends to 2050. Key findings included accelerated global burden growth, regional heterogeneity, and age-sex disparities, providing critical epidemiological evidence for targeted interventions.

From 1990 to 2023, global ILD and pulmonary sarcoidosis burden increased substantially: incident cases (1.57 times), prevalence (1.22

times), deaths (1.45 times), and DALYs (2.40 times). The ASIR rose annually by 0.60 % (0.77 % post-2008), and ASPR rose annually by 0.32 %. Additionally, the ASDR and age-standardized DALY rate increased annually by 1.97 % and 1.34 %, respectively. Multifactorial drivers included: (1) population aging[20] with the 80–84 age group having the highest mortality; (2) improved detection via chest computed tompgraphy (CT) scanning,[21] especially in high SDI regions; (3) environmental exposures (fine particulate matter [PM2.5], occupational dust, biofuels),[22] linked to pulmonary fibrosis progression, exacerbated by industrialization in developing countries; (4) increased diagnosis of progressive fibrosing subtypes[23]; (5) pre-existing ILD, through its synergy with coronavirus disease 2019 (COVID-19), which increased the risk of severe disease, leading to a higher ASDR from COVID-19-related deaths.[24,25]

Age-sex disparities were evident: incidence increased with age (peak 70–74 years), mortality concentrated at 65–89 years. Men over 65 years had significantly higher incidence, prevalence, death and DALY rates than women, linked to pathophysiology and risk exposure. IPF and connective tissue disease-associated ILD (CTD-ILD) are the most common forms of ILD.[26-28] Notably, the GBD 2023 dataset explicitly excludes CTD-ILD, and this exclusion directly results in the predominance of IPF in the ILD disease spectrum captured by the dataset. IPF has well-documented demographic characteristics—its incidence is significantly higher in elderly males.[29,30] This inherent epidemiological feature of IPF is highly consistent with our finding from the GBD 2023 data: males aged over 65 years exhibit substantially higher ASIR, ASPR, ASDR, and age-standardized DALY rates. Given this consistency, we hypothesize that the observed high ILD disease burden in males aged over 65 years in the GBD 2023 data may be closely associated with the growing global IPF population. However, this hypothesis requires further verification. While occupational exposures and smoking history may contribute to this pattern, genetic and hormonal factors likely play significant roles.[31,32]

From 2023 to 2050, the global all-age mortality rate and DALY rate of ILD and pulmonary sarcoidosis will increase by 83.53 % and 60.43 %, respectively. Regional variations are significant: High-income Asia-Pacific and Andean Latin America will see substantial growth while Southeast Asia's all-age death and DALY rates are projected to remain among the lowest globally. This is consistent with the progressive pulmonary fibrosis treatment market forecast which emphasizes aging-driven epidemiological trends. Accelerated global population aging is the core driver, so demographic structure changes will directly promote the growth of absolute disease burden. Two distinct trends will emerge across regions. First, in high-SDI regions, despite abundant medical resources, the proportion of the elderly population will reach 30 % by 2050, and the demand for diagnosis and treatment of progressive ILD will surge, potentially leading to medical resource strain. Second, in low-SDI regions, due to delayed improvement in diagnostic capabilities, the underdiagnosis rate remains high, and the actual burden may be underestimated. These regions will face dual pressures of "improved diagnosis rate plus population aging". A hierarchical prevention and control system should be established. In high-SDI regions, efforts should focus on strengthening the construction of ILD specialist centers, promoting telemedicine to improve primary care capabilities, and increasing investment in research and development of new drugs. In low-SDI regions, the approach must prioritize the allocation of basic diagnostic equipment (e.g., high resolution CT), deliver standardized training on ILD diagnosis and treatment for medical staff, and strengthen environmental governance and occupational protection to reduce disease incidence from the source.

In conclusion, ILD and pulmonary sarcoidosis burden accelerated globally (1990–2023), with persistent disparities across regions, SDI levels, and between sex-age groups. 2050 projections highlight aging-related pressure, especially in high-SDI and rapidly aging developing regions. Hierarchical strategies, high-risk population focus (men over 65 years), and multi-disciplinary collaboration in disease management are critical for global burden control.

Data availability

All data used in this study are publicly available from the Global Burden of Disease (GBD) study. Detailed access procedures and documentation can be found at: https://www.healthdata.org/gbd.

Funding

This work was supported by National Key Technologies Research & Development Program Precision Medicine Research (No. 2021YFC2500700), and Young Scientists Fund of the National Natural Science Foundation of China (No. 82300087).

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.

CRediT authorship contribution statement

Xiaoqian Ma: Writing – original draft, Software, Visualization, Funding acquisition. **Lili Zhu:** Writing – original draft, Investigation. **Huijuan Xiao:** Investigation, Writing – original draft, Data curation. **Yushan He:** Data curation, Software. **Huaping Dai:** Writing – review & editing, Project administration, Conceptualization, Supervision, Funding acquisition.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.pccm.2025.11.008.

References

1. Wijsenbeek M, Suzuki A, Maher TM. Interstitial lung diseases. *Lancet*. 2022;400:769–786. doi:10.1016/S0140-6736(22)01052-2.
2. Wijsenbeek M, Cottin V. Spectrum of fibrotic lung diseases. *N Engl J Med*. 2020;383:958–968. doi:10.1056/NEJMra2005230.
3. Travis WD, Costabel U, Hansell DM, et al. An official American Thoracic Society/European Respiratory Society statement: Update of the international multidisciplinary classification of the idiopathic interstitial pneumonias. *Am J Respir Crit Care Med*. 2013;188:733–748. doi:10.1164/rccm.201308-1483ST.
4. Grewal JS, Morisset J, Fisher JH, et al. Role of a regional multidisciplinary conference in the diagnosis of interstitial lung disease. *Ann Am Thorac Soc*. 2019;16:455–462. doi:10.1513/AnnalsATS.201811-794OC.
5. Spagnolo P, Ryerson CJ, Putman R, et al. Early diagnosis of fibrotic interstitial lung disease: Challenges and opportunities. *Lancet Respir Med*. 2021;9:1065–1076. doi:10.1016/S2213-2600(21)00017-5.
6. Lederer DJ, Martinez FJ. Idiopathic pulmonary fibrosis. *N Engl J Med*. 2018;378 1811–1123. doi:10.1056/NEJMra1705751.
7. Crestani B, Huggins JT, Kaye M, et al. Long-term safety and tolerability of nintedanib in patients with idiopathic pulmonary fibrosis: Results from the open-label extension study, INPULSIS-ON. *Lancet Respir Med*. 2019;7:60–68. doi:10.1016/S2213-2600(18)30339-4.
8. King TE Jr, Bradford WZ, Castro-Bernardini S, et al. A phase 3 trial of pirfenidone in patients with idiopathic pulmonary fibrosis. *N Engl J Med*. 2014;370:2083–2092. doi:10.1056/NEJMoa1402582.
9. Maher TM, Corte TJ, Fischer A, et al. Pirfenidone in patients with unclassifiable progressive fibrosing interstitial lung disease: A double-blind, randomised, placebo-controlled, phase 2 trial. *Lancet Respir Med*. 2020;8:147–157. doi:10.1016/S2213-2600(19)30341-8.
10. Behr J, Prasse A, Kreuter M, et al. Pirfenidone in patients with progressive fibrotic interstitial lung diseases other than idiopathic pulmonary fibrosis (RELIEF): A double-blind, randomised, placebo-controlled, phase 2b trial. *Lancet Respir Med*. 2021;9:476–486. doi:10.1016/S2213-2600(20)30554-3.
11. Flaherty KR, Wells AU, Cottin V, et al. Nintedanib in progressive fibrosing interstitial lung diseases. *N Engl J Med*. 2019;381:1718–1727. doi:10.1056/NEJMoa1908681.
12. Distler O, Highland KB, Gahlemann M, et al. Nintedanib for systemic sclerosis-associated interstitial lung disease. *N Engl J Med*. 2019;380:2518–2528. doi:10.1056/NEJMoa1903076.
13. World Health Organization. *Global Alliance against chronic respiratory disease (GARD)*. Available from: https://www.who.int/groups/global-alliance-against-chronic-respiratory-diseases-(gard). [Accessed on November 20, 2025].

14. Li X, Cao X, Guo M, Xie M, Liu X. Trends and risk factors of mortality and disability adjusted life years for chronic respiratory diseases from 1990 to 2017: Systematic analysis for the Global Burden of Disease Study 2017. *BMJ*. 2020;368:m234. doi:10.1136/bmj.m234.
15. Ma X, Zhu L, Kurche JS, Xiao H, Dai H, Wang C. Global and regional burden of interstitial lung disease and pulmonary sarcoidosis from 1990 to 2019: Results from the Global Burden of Disease study 2019. *Thorax*. 2022;77:596–605. doi:10.1136/thoraxjnl-2020-216732.
16. GBD 2023 Causes of Death Collaborators. Global burden of 292 causes of death in 204 countries and territories and 660 subnational locations, 1990-2023: A systematic analysis for the Global Burden of Disease Study 2023. *Lancet*. 2025;406:1811–1872. doi:10.1016/S0140-6736(25)01917-8.
17. Stevens GA, Alkema L, Black RE, et al. Guidelines for accurate and transparent health estimates reporting: The GATHER statement. *PLoS Med*. 2016;13:e1002056. doi:10.1371/journal.pmed.1002056.
18. GBD 2023 Demographics Collaborators. Global age-sex-specific all-cause mortality and life expectancy estimates for 204 countries and territories and 660 subnational locations, 1950-2023: A demographic analysis for the Global Burden of Disease Study 2023. *Lancet*. 2025;406:1731–1810. doi:10.1016/S0140-6736(25)01330-3.
19. Kim HJ, Chen HS, Byrne J, Wheeler B, Feuer EJ. Twenty years since Joinpoint 1.0: Two major enhancements, their justification, and impact. *Stat Med*. 2022;41:3102–3130. doi:10.1002/sim.9407.
20. World Health Organization. *Ageing and health*. Available from https://www.who.int/news-room/fact-sheets/detail/ageing-and-health. [Accessed on November 20, 2025].
21. Lee JE, Chae KJ, Suh YJ, et al. Prevalence and long-term outcomes of CT interstitial lung abnormalities in a health screening cohort. *Radiology*. 2023;306:e221172. doi:10.1148/radiol.221172.
22. Sack C, Vedal S, Sheppard L, et al. Air pollution and subclinical interstitial lung disease: The Multi-Ethnic Study of Atherosclerosis (MESA) air-lung study. *Eur Respir J*. 2017;50:1700559. doi:10.1183/13993003.00559-2017.
23. Rajan SK, Cottin V, Dhar R, et al. Progressive pulmonary fibrosis: An expert group consensus statement. *Eur Respir J*. 2023;61:2103187. doi:10.1183/13993003.03187-2021.
24. Valenzuela C, Waterer G, Raghu G. Interstitial lung disease before and after COVID-19: A double threat? *Eur Respir J*. 2021;58:2101956. doi:10.1183/13993003.01956-2021.
25. Zheng Z, Peng F, Zhou Y. Pulmonary fibrosis: A short- or long-term sequelae of severe COVID-19? *Chin Med J Pulm Crit Care Med*. 2023;1:77–83. doi:10.1016/j.pccm.2022.12.002.
26. Ley B, Collard HR. Epidemiology of idiopathic pulmonary fibrosis. *Clin Epidemiol*. 2013;5:483–492. doi:10.2147/CLEP.S54815.
27. Raghu G, Remy-Jardin M, Richeldi L, et al. Idiopathic pulmonary fibrosis (an update) and progressive pulmonary fibrosis in adults: An official ATS/ERS/JRS/ALAT clinical practice guideline. *Am J Respir Crit Care Med*. 2022;205:e18–e47. doi:10.1164/rccm.202202-0399ST.
28. Cao Z, He L, Luo Y, et al. Burden of chronic respiratory diseases and their attributable risk factors in 204 countries and territories, 1990-2021: Results from the global burden of disease study 2021. *Chin Med J Pulm Crit Care Med*. 2025;3:100–110. doi:10.1016/j.pccm.2025.05.005.
29. Raghu G, Weycker D, Edelsberg J, Bradford WZ, Oster G. Incidence and prevalence of idiopathic pulmonary fibrosis. *Am J Respir Crit Care Med*. 2006;174:810–816. doi:10.1164/rccm.200602-163OC.
30. Hutchinson J, Fogarty A, Hubbard R, McKeever T. Global incidence and mortality of idiopathic pulmonary fibrosis: A systematic review. *Eur Respir J*. 2015;46:795–806. doi:10.1183/09031936.00185114.
31. Fang C, Huang H, Zhang Q, et al. Relation between sex hormones and leucocyte telomere length in men with idiopathic pulmonary fibrosis. *Respirology*. 2020;25:1265–1273. doi:10.1111/resp.13871.
32. Chen Y, Zhong J, Cai Z, et al. Meta-analysis of the association between sex hormones and pulmonary fibrosis. *Postgrad Med*. 2024;136:567–576. doi:10.1080/00325481.2024.2373683.