

Divergent Trajectories and Risk Factor Attribution of Chronic Obstructive Pulmonary Disease Burden in China and the United States, 1990–2023: An Age-Period-Cohort Analysis with Projections to 2035 Based on the Global Burden of Disease Study 2023

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Background: Chronic obstructive pulmonary disease (COPD) remains a leading cause of global mortality. China and the United States, the world's two largest economies accounting for 40% of global COPD burden, lack comprehensive comparative analyses of long-term trends and risk factor attribution.

Objective: This study aimed to compare COPD burden trends, decompose age-period-cohort effects, quantify risk factor contributions, and project future trajectories in China and the United States from 1990 to 2023 with forecasts to 2035.

Methods: We analyzed Global Burden of Disease Study 2023 data for China and the United States, examining incidence, prevalence, mortality, and disability-adjusted life years (DALYs) stratified by sex and 17 age groups. Joinpoint regression identified temporal inflection points. Age-period-cohort models decomposed burden into independent effects. Risk factor attribution analyzed eight major exposures. Bayesian methods projected burden to 2035.

Results: China demonstrated remarkable declines in age-standardized mortality (58.68% decrease to 46.60 per 100,000) and DALY rates (61.12% decrease to 777.86 per 100,000), with dramatic risk factor reductions: particulate matter pollution declined 82.21%, smoking 68.48%. Conversely, the United States exhibited increasing age-standardized mortality (8.90% increase to 28.89 per 100,000), with female mortality rising 45.64% and smoking-attributable burden declining only 14.09%. Period effects deteriorated in the United States (relative risk: 0.67 to 1.34) while improving in China (1.20 to 0.83). Projections indicated Chinese deaths would surge 135.9% by 2035 despite declining age-standardized rates, while American deaths would increase 30.1% with rising age-standardized rates.

Conclusion: Substantial COPD burden reductions are achievable through comprehensive risk factor control as demonstrated by China's success, while persistent deterioration in the United States highlights critical prevention gaps requiring urgent intervention to avert projected burden escalation.

Keywords: chronic obstructive pulmonary disease, global burden of disease, age-period-cohort analysis, risk factors, epidemiological trends

Introduction

Chronic obstructive pulmonary disease (COPD) represents one of the most pressing global health challenges, ranking as the third leading cause of death worldwide and affecting over 400 million individuals.¹ The disease imposes a staggering economic burden, projected to cost \$4.326 trillion between 2020 and 2050, equivalent to 0.111% annual tax on global GDP.² Despite therapeutic advances and public health initiatives over three decades, COPD continues exacting enormous tolls, with 212.3 million prevalent cases and 3.3 million deaths reported in 2019.³ The burden is particularly pronounced in low- and middle-income countries, where 95% of cases remain undiagnosed and access to interventions is severely limited.⁴ This persistent burden, coupled with demographic shifts and evolving risk factor profiles, underscores urgent needs for comprehensive epidemiological analyses to inform targeted prevention strategies.

Substantial progress has been made in understanding COPD epidemiology. Global Burden of Disease (GBD) studies documented declining age-standardized mortality rates, with global reductions of 41.7% between 1990 and 2019.⁵ Recent genetic studies identified variants associated with lung function and COPD susceptibility, enhancing understanding of disease mechanisms.⁶ Risk factor attribution reveals smoking remains the predominant contributor globally, accounting for 46.0% of disability-adjusted life years (DALYs), followed by ambient particulate matter pollution (20.7%) and occupational exposures (15.6%).³ However, risk factor contributions vary dramatically across countries, with household air pollution from solid fuels disproportionately affecting low- and middle-income nations while tobacco smoking dominates high-income countries. Gender-specific analyses uncovered striking disparities, with COPD prevalence among women projected to increase while male prevalence decreases, possibly reflecting slower tobacco reduction and greater exposure to household air pollution from biomass fuel combustion (eg, wood, crop residues, and coal used for cooking and heating) among women.¹ Regional studies documented dramatic improvements in certain countries, with China experiencing 68% decline in age-standardized mortality between 1990 and 2021,⁷ while other nations witnessed concerning upward trends, particularly among females.⁸

Despite these advances, critical knowledge gaps limit our ability to develop effective, geographically tailored interventions. First, while most studies focused on overall trends, comprehensive age-stratified analyses examining burden shifts across the entire life course remain scarce, particularly for understanding paradoxical patterns in different age groups. Second, the complex interplay between age, period, and cohort effects has not been adequately disentangled, leaving uncertainty about whether trends reflect true epidemiological changes or demographic shifts. Third, direct comparative analyses between high-income and middle-income countries with contrasting healthcare systems and risk factor profiles are lacking, limiting understanding of how socioeconomic contexts influence disease trajectories. Fourth, systematic examination of differential risk factor contributions—particularly smoking, air pollution, and occupational exposures—between nations with divergent trends remains absent. Fifth, while projections suggest continued increases in absolute burden due to population aging,⁹ quantitative forecasts incorporating age-period-cohort dynamics through 2035 remain absent for major affected nations.¹⁰ Finally, the stark disparity between China and the United States—the world's two largest economies collectively accounting for approximately 40% of global COPD burden with fundamentally different trajectories—has not been systematically examined to identify modifiable factors underlying these divergent patterns.¹¹

To address these gaps, we conducted comprehensive analysis of COPD burden in China and the United States from 1990 to 2023, with projections to 2035, using GBD 2023 data. We employed joinpoint regression to identify temporal inflection points, age-period-cohort modeling to decompose independent contributions of age, period, and birth cohort effects, and risk factor attribution analysis to quantify contributions of eight major exposures including smoking, particulate matter pollution, and occupational factors. Bayesian age-period-cohort methods generated future projections. By stratifying analyses by sex and detailed age groups across the adult life span, we characterized heterogeneous patterns of disease burden evolution and identified critical demographic and epidemiological transitions. This comparative approach between two nations with the highest absolute COPD burdens but markedly different trajectories provides unique insights into effectiveness of different public health strategies and healthcare system responses, with implications for global COPD prevention and control efforts.

Materials and Methods

Data Source and Study Design

This retrospective observational study utilized data from the Global Burden of Disease Study 2023 (GBD 2023), accessed through the Institute for Health Metrics and Evaluation (IHME) database (<http://ghdx.healthdata.org/gbd-results-tool>)¹². The GBD 2023 provides comprehensive estimates of mortality, morbidity, and disability for 292 causes of death across 204 countries and territories from 1990 to 2023. For this analysis, we extracted data on chronic obstructive pulmonary disease (COPD), defined according to the International Classification of Diseases codes J41-J42.4 and J43-J44.9. The study focused on comparing disease burden trends between China and the United States of America over the 34-year period from 1990 to 2023. The study was conducted in accordance with the principles of the Declaration of Helsinki and reported following the Transparent Reporting of a multivariable prediction model for Individual Prognosis or Diagnosis (TRIPOD) guidelines where applicable.

Outcome Measures

Four primary disease burden indicators were analyzed: incidence (new cases per 100,000 population), prevalence (existing cases per 100,000 population), mortality (deaths per 100,000 population), and disability-adjusted life years (DALYs, per 100,000 population). Age-standardized rates (ASR) were calculated using the GBD 2023 world standard population to enable valid comparisons across populations with different age structures. Age-specific rates were examined for 17 age groups ranging from 15 years to 95 years and above, with 5-year intervals. All metrics included point estimates with 95% uncertainty intervals (UI) derived from the GBD modeling framework. Data were stratified by sex (male, female, and both sexes combined), age group, year, and geographic location (China and United States of America).

Statistical Analysis

Temporal trend analyses were conducted using three complementary methodologies to provide comprehensive insights into disease burden evolution. First, the estimated annual percentage change (EAPC) was calculated using a log-linear regression model, where the natural logarithm of age-standardized rates was regressed on calendar year. The EAPC and its 95% confidence interval (CI) were derived from the regression coefficient, with statistical significance determined at $p < 0.05$. An EAPC significantly greater than zero indicated an increasing trend, while an EAPC significantly less than zero indicated a decreasing trend. Second, joinpoint regression analysis was performed using the Joinpoint Regression Program methodology implemented in R to identify significant changes in temporal trends. This approach fits a series of joined straight lines on a log scale to the trend data, with the joinpoints representing years when significant changes in the slope occurred. The annual percentage change (APC) for each segment between joinpoints and the average annual percentage change (AAPC) over the entire study period were calculated with 95% CI. A maximum of five joinpoints was allowed, and the optimal number was determined using the permutation test. Models were fitted using the logarithmic transformation with constant variance assumption. Statistical significance was assessed using Monte Carlo permutation tests ($p < 0.05$). Third, age-period-cohort (APC) analysis using the intrinsic estimator method was conducted to disentangle the independent effects of age, time period, and birth cohort on disease burden. The APC model decomposed the temporal trends into age effects (risk variation across different age groups), period effects (factors affecting all age groups simultaneously in specific time periods), and cohort effects (influences on individuals born in the same time period). The intrinsic estimator approach was applied to address the identification problem inherent in APC models. Relative risks (RR) with 95% CI were estimated for each age group (15–19 to 95+ years), time period (1994–1998 to 2019–2023 in 5-year intervals), and birth cohort (1899–1903 to 2004–2008). The analysis required age-specific data in 5-year intervals, with starting age of 15 years and ending age of 95 years, covering the period from 1994 to 2023.

Projection Analysis

Future disease burden projections to 2035 were generated using Bayesian age-period-cohort (BAPC) models. The BAPC approach integrates Bayesian inference with age-period-cohort methodology to account for parameter uncertainty in

predictions. Models were stratified by sex and fitted separately for each disease burden indicator (incidence, prevalence, mortality, and DALYs). Population projections were obtained from GBD demographic estimates to calculate future age-standardized rates. The models incorporated age-specific rates for individuals aged 15 years and above, with predictions extending from 2024 to 2035. Both the number of cases and age-standardized rates were projected with 95% credible intervals. Model validation was performed using historical data from 1990 to 2018 to predict the period 2019–2023, and prediction accuracy was assessed by comparing predicted values with observed data.

Data Preprocessing and Quality Control

All analyses were preceded by rigorous data quality checks. Duplicate records were identified and removed. Age groups with any rate values less than or equal to zero were excluded from analysis to ensure logarithmic transformations in trend analyses were mathematically valid. The final dataset included 17 age-specific groups (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 plus years), along with age-standardized and all-ages aggregated data. Variables were systematically checked for consistency, and measure names were standardized (eg, “DALYs (Disability-Adjusted Life Years)” was abbreviated to “DALYs” for clarity). Data spanning 34 consecutive years (1990–2023) were utilized to ensure adequate statistical power for temporal trend detection.

Results

Overall Trends in COPD Burden, 1990–2023

Between 1990 and 2023, COPD burden exhibited divergent patterns between China and the United States ([Table 1](#), [Figure 1](#)). In China, incident cases doubled (98.32% increase to 4,440,422) while age-standardized incidence declined 28.23% (to 197.76 per 100,000). Prevalent cases increased 116.72% (to 52,490,910) with age-standardized prevalence decreasing 17.53% (to 2367.20 per 100,000). Deaths rose 46.86% (to 998,237) but age-standardized mortality plummeted 58.68% (to 46.60 per 100,000). DALYs increased 18.90% (to 17,281,133) while age-standardized DALY rates declined 61.12% (to 777.86 per 100,000). Conversely, the United States showed concurrent increases in both absolute numbers and age-standardized rates. Incident cases doubled (102.45% increase to 1,341,405) with age-standardized incidence rising 10.07% (to 236.37 per 100,000). Prevalent cases doubled (100.03% increase to 19,751,607) with age-standardized prevalence increasing 6.66% (to 3315.38 per 100,000). Deaths more than doubled (108.97% increase to 186,785) with age-standardized mortality rising 8.90% (to 28.89 per 100,000). DALYs increased 90.99% (to 4,395,947) with age-standardized rates rising 1.12% (to 719.09 per 100,000).

Sex-stratified analyses revealed substantial disparities ([Supplementary Figures 1–2](#)). Chinese males experienced steeper declines in age-standardized mortality (68.77% decrease to 55.91 per 100,000) than females (42.83% decrease to 38.86 per 100,000), with DALY reductions of 69.49% versus 45.98%. In the United States, females exhibited concerning increases in age-standardized mortality (45.64% increase to 27.40 per 100,000) and DALYs (22.12% increase to 702.29 per 100,000), while males demonstrated improvements with mortality declining 21.94% (to 30.92 per 100,000) and DALYs decreasing 19.32% (to 742.54 per 100,000).

Joinpoint Regression Analysis of Temporal Trends

Joinpoint analysis revealed complex non-linear patterns ([Figure 2](#), [Supplementary Figures 3–4](#)). In China, age-standardized incidence declined consistently (AAPC: -1.02% , 95% CI: -1.03 to -1.00 , $p < 0.001$), steepest from 2011–2020 (APC: -1.73%). Prevalence showed modest decline (AAPC: -0.59% , $p < 0.001$) with notable reduction from 2015–2020 (APC: -2.12%) before recent upturn in 2020–2023 (APC: 0.28%). Mortality improved dramatically (AAPC: -2.62% , $p < 0.001$), with sharpest decline from 2017–2020 (APC: -6.43%) followed by concerning reversal in 2020–2023 (APC: 2.50%). DALYs declined substantially (AAPC: -2.81% , $p < 0.001$), accelerating from 2017–2020 (APC: -6.08%) before recent upturn in 2020–2023 (APC: 1.99%). The United States demonstrated contrasting patterns: incidence increased overall (AAPC: 0.29% , $p < 0.001$) with recent decline from 2020–2023 (APC: -0.78%). Prevalence increased modestly (AAPC: 0.20% , $p < 0.001$) with recent decline (APC: -1.06%). Mortality showed slight overall increase (AAPC: 0.19% ,

Table 1 Overall Trends and Percentage Changes in COPD Burden in China and the United States, 1990–2023

Location	Gender	Indicator	Cases in 1990 (n)	Cases in 2023 (n)	Change in Cases (%)	Age-Standardized Rate in 1990 (per 100,000)	Age-Standardized Rate in 2023 (per 100,000)	Change in Age-Standardized Rate (%)	EAPC (95% CI)	AAPC (95% CI)	AAPC P-value
China	Both	Incidence	2238998	4,440,422	98.32	275.52	197.76	−28.23	−1.16 (−1.25 to −1.08)	−1.02 (−1.03 to −1.00)	<0.001
China	Female	Incidence	1151273	2,159,727	87.59	272.95	184.11	−32.55	−1.32 (−1.38 to −1.27)	−1.20 (−1.22 to −1.19)	<0.001
China	Male	Incidence	1087724	2,280,695	109.68	279.64	212.46	−24.02	−1.01 (−1.14 to −0.88)	−0.84 (−0.85 to −0.82)	<0.001
China	Both	Prevalence	24220063	52,490,910	116.72	2870.24	2367.2	−17.53	−0.65 (−0.75 to −0.55)	−0.59 (−0.61 to −0.58)	<0.001
China	Female	Prevalence	12777518	26,372,624	106.4	2944.32	2277.22	−22.66	−0.77 (−0.83 to −0.72)	−0.78 (−0.80 to −0.76)	<0.001
China	Male	Prevalence	11442545	26,118,286	128.26	2765.85	2454.52	−11.26	−0.51 (−0.68 to −0.34)	−0.37 (−0.39 to −0.36)	<0.001
China	Both	Deaths	679718	998,237	46.86	112.79	46.6	−58.68	−3.26 (−3.72 to −2.8)	−2.62 (−2.71 to −2.54)	<0.001
China	Female	Deaths	217538	463,139	112.9	67.96	38.86	−42.83	−2.33 (−2.89 to −1.77)	−1.62 (−1.75 to −1.50)	<0.001
China	Male	Deaths	462180	535,098	15.78	179	55.91	−68.77	−4.07 (−4.47 to −3.68)	−3.46 (−3.56 to −3.37)	<0.001
China	Both	DALYs	14534512	17,281,133	18.9	2000.61	777.86	−61.12	−3.45 (−3.88 to −3.01)	−2.81 (−2.88 to −2.74)	<0.001
China	Female	DALYs	4498226	7,673,186	70.58	1190.22	643	−45.98	−2.48 (−2.99 to −1.97)	−1.81 (−1.90 to −1.73)	<0.001
China	Male	DALYs	10036286	9,607,946	−4.27	3050.49	930.79	−69.49	−4.16 (−4.54 to −3.78)	−3.54 (−3.62 to −3.46)	<0.001
United States of America	Both	Incidence	662581	1,341,405	102.45	214.74	236.37	10.07	0.4 (0.24 to 0.55)	0.29 (0.28 to 0.30)	<0.001
United States of America	Female	Incidence	337896	687,019	103.32	198.92	231.38	16.32	0.58 (0.4 to 0.76)	0.46 (0.44 to 0.48)	<0.001
United States of America	Male	Incidence	324685	654,386	101.54	240.2	243.29	1.29	0.12 (0 to 0.23)	0.04 (0.03 to 0.05)	<0.001
United States of America	Both	Prevalence	9874435	19,751,607	100.03	3108.48	3315.38	6.66	0.33 (0.18 to 0.47)	0.20 (0.19 to 0.21)	<0.001
United States of America	Female	Prevalence	5534013	10,660,768	92.64	3019.77	3307.9	9.54	0.41 (0.25 to 0.56)	0.27 (0.26 to 0.29)	<0.001
United States of America	Male	Prevalence	4340422	9,090,839	109.45	3278.56	3338.39	1.82	0.18 (0.06 to 0.31)	0.06 (0.05 to 0.08)	<0.001
United States of America	Both	Deaths	89384	186,785	108.97	26.53	28.89	8.9	0.33 (0.09 to 0.57)	0.19 (0.09 to 0.28)	<0.001
United States of America	Female	Deaths	37927	100,591	165.22	18.81	27.4	45.64	1.11 (0.79 to 1.44)	1.06 (0.96 to 1.15)	<0.001
United States of America	Male	Deaths	51457	86,193	67.51	39.62	30.92	−21.94	−0.63 (−0.8 to −0.46)	−0.79 (−0.88 to −0.72)	<0.001
United States of America	Both	DALYs	2301711	4,395,947	90.99	711.13	719.09	1.12	0.12 (−0.07 to 0.31)	−0.01 (−0.07 to 0.05)	0.709
United States of America	Female	DALYs	1064344	2,333,897	119.28	575.11	702.29	22.12	0.64 (0.41 to 0.88)	0.55 (0.48 to 0.62)	<0.001
United States of America	Male	DALYs	1237367	2,062,049	66.65	920.39	742.54	−19.32	−0.53 (−0.68 to −0.39)	−0.68 (−0.74 to −0.62)	<0.001

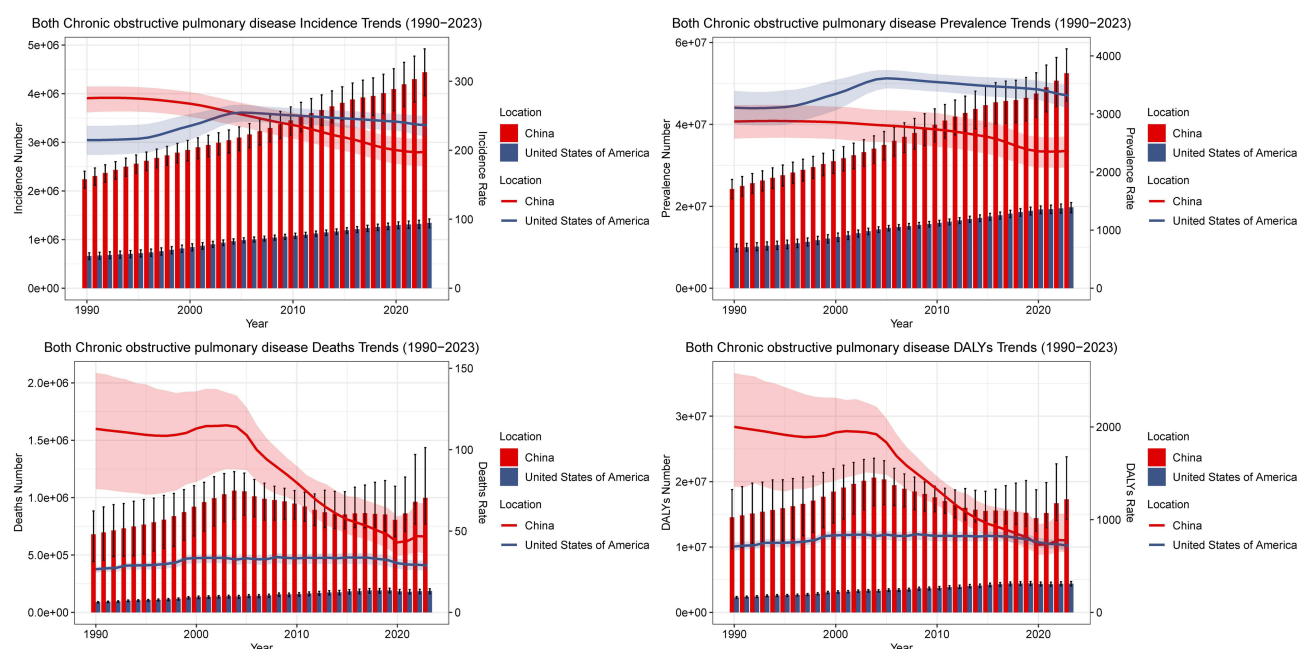


Figure 1 Temporal Trends in COPD Incidence, Prevalence, Mortality, and DALYs in China and the United States, 1990–2023 (Both Sexes Combined). This figure displays the temporal evolution of four key disease burden indicators for chronic obstructive pulmonary disease (COPD) in China (red) and the United States (blue) from 1990 to 2023, combining data for both sexes. Each panel presents a dual-axis visualization: the left y-axis and bar charts represent the absolute number of cases (incidence, prevalence, deaths) or DALYs, while the right y-axis and line graphs represent the corresponding age-standardized rates per 100,000 population. Error bars on the bar charts and shaded ribbons around the line graphs indicate 95% uncertainty intervals.

$p < 0.001$) with significant recent decline from 2017–2023 (APC: -2.72%). DALY rates remained stable (AAPC: -0.01% , $p = 0.709$) with recent decrease from 2017–2023 (APC: -2.28%).

Sex-stratified analyses revealed marked disparities ([Supplementary Figures 3–4](#)). Chinese males exhibited steeper declining trends than females: incidence (AAPC: -1.20% vs -0.84%), prevalence (AAPC: -0.78% vs -0.37%), mortality (AAPC: -3.46% vs -1.62%), and DALYs (AAPC: -3.54% vs -1.81%). Both sexes showed concerning recent reversals from 2020–2023 in DALY rates (males: 1.26% , females: 2.65%). In the United States, females demonstrated significant increases in incidence (AAPC: 0.46% vs 0.04%), prevalence (AAPC: 0.27% vs 0.06%), mortality (AAPC: 1.06% vs -0.79%), and DALYs (AAPC: 0.55% vs -0.68%), with particularly pronounced mortality rises from 1990–2001 (APC: 3.79%).

Age-Specific Patterns of COPD Burden

Age-stratified analyses revealed profound heterogeneity ([Table 2](#), [Figure 3](#), [Supplementary Figure 5](#)). In China, younger groups (15–39 years) experienced dramatic declines in incidence cases (44.24–62.47% decrease) and rates (21.22–29.79% decrease, AAPC: -0.73% to -1.10%). Middle-aged groups (40–64 years) demonstrated substantial rate reductions: incidence declined 16.91–41.82% (AAPC: -0.57% to -1.66%), mortality decreased 73.16–75.31% (AAPC: -3.92% to -5.22%), and DALYs fell 65.38–70.81% (AAPC: -3.10% to -4.51%). Older groups (≥ 65 years) exhibited paradoxical patterns: while mortality (AAPC: -1.19% to -3.70%) and DALYs (AAPC: -1.14% to -3.69%) declined significantly, prevalence rates surged in the oldest groups—increasing 9.68% (ages 85–89), 27.08% (ages 90–94), and 50.93% (ages 95+), with absolute prevalence cases rising 585.31%, 1428.21%, and 2761.90%, respectively.

In the United States, younger groups (15–39 years) experienced substantial declines in incidence (cases: 13.14–46.69% decrease, rates: 3.43–56.14% decrease, AAPC: -0.11% to -2.53%) and prevalence (cases: 16.48–37.76% decrease, rates: 29.77–38.40% decrease, AAPC: -1.08% to -1.48%). Middle-aged groups (40–64 years) showed increasing trends in incidence (cases: 34.29–134.25% increase, rates: 2.55–17.12% increase, AAPC: 0.08% – 0.49%) and prevalence (cases: 35.39–106.83% increase, AAPC: -0.13% to 0.29%), while mortality remained stable or declined modestly (AAPC: -0.18% to -0.56%). Older groups (≥ 65 years) exhibited alarming increases: prevalence cases rose

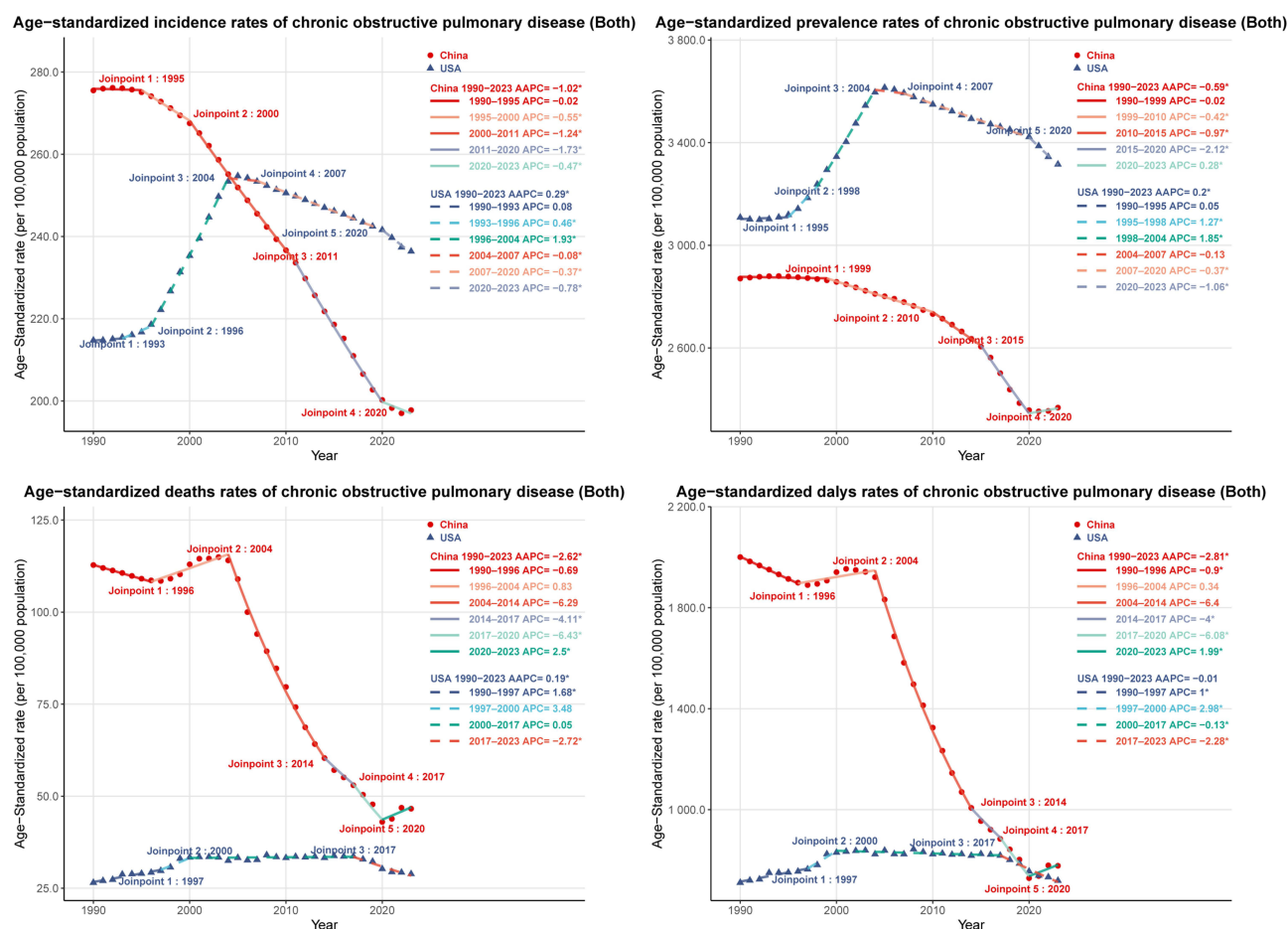


Figure 2 Jointpoint Regression Analysis of Age-Standardized COPD Burden in China and the United States, 1990–2023 (Both Sexes Combined). This figure presents the results of jointpoint regression analysis for age-standardized rates of COPD incidence, prevalence, mortality, and DALYs in China (solid lines and circles) and the United States (dashed lines and triangles) from 1990 to 2023, combining data for both sexes. Each panel corresponds to one disease burden indicator. Observed data points are overlaid on model-fitted segmented lines, with different colors representing different time segments identified by the jointpoint analysis. Vertical text annotations mark jointpoint years where significant changes in trends occurred. The legend provides the average annual percentage change (AAPC) for the entire period (1990–2023) and the annual percentage change (APC) for each segment, with asterisks (*) indicating statistical significance ($p < 0.05$).

109.25–199.55% with rates increasing 6.31–20.21% (AAPC: 0.17–0.56%). Mortality escalated dramatically in the oldest groups, with deaths increasing 192.28–540.36% and rates rising 56.03–127.27% (ages 85+, AAPC: 1.29–2.49%). DALYs mirrored mortality, with younger groups declining (AAPC: -0.35% to -1.02%) while the oldest groups increased substantially (AAPC: 1.08–1.93%).

Age-Period-Cohort Decomposition

Age-period-cohort analysis revealed distinct patterns (Figure 4, Supplementary Figure 6). Age effects demonstrated exponential increases with advancing age in both countries. In China, age-specific relative risk (RR) increased from 0.080 (ages 15–19) to 8.44 (ages 90–94), with steepest escalation between ages 50–54 (RR: 0.75) and 60–64 (RR: 1.73). The United States showed similar patterns with lower peaks (RR: 0.091 to 5.34).

Period effects revealed divergent dynamics. In China, period RR initially increased from 1.00 (1994–1998) to 1.20 (1999–2003), then declined consistently to 0.83 (2019–2023), with males showing more pronounced improvements. Conversely, the United States demonstrated deteriorating period effects, with RR increasing from 0.67 (1994–1998) to 1.34 (2019–2023), more dramatic in females (0.64 to 1.39) than males (0.72 to 1.27).

Cohort effects exhibited striking generational gradients. In China, earlier cohorts (1899–1903) demonstrated highest RR (3.69), declining progressively to 0.23 (2004–2008 cohort), representing 16-fold reduction. The inflection occurred around the 1949–1953 cohort (RR: 1.10). In the United States, cohort RR declined from 3.10 (1899–1903) to 0.19 (2004–

Table 2 Age-Specific Trends and Percentage Changes in COPD Burden in China and the United States, 1990–2023

Location	Gender	Indicator	Age Group	Cases in 1990 (n)	Cases in 2023 (n)	Change in Cases (%)	Rate in 1990 (per 100,000)	Rate in 2023 (per 100,000)	Change in Rate (%)	EAPC (95% CI)	AAPC (95% CI)	AAPC P-value
China	Both	Incidence	15 to 19	33,671	15,243	-54.73	26.51	18.92	-28.63	-1.18 (-1.29 to -1.08)	-1.02 (-1.04 to -1.01)	<0.001
China	Both	Incidence	20 to 24	48,967	18,378	-62.47	36.99	25.97	-29.79	-1.29 (-1.4 to -1.19)	-1.10 (-1.11 to -1.08)	<0.001
China	Both	Incidence	25 to 29	43,358	24,178	-44.24	39.35	31	-21.22	-0.92 (-1.02 to -0.83)	-0.73 (-0.74 to -0.71)	<0.001
China	Both	Incidence	30 to 34	35,654	37,292	4.6	40.29	34.72	-13.83	-0.57 (-0.63 to -0.51)	-0.45 (-0.46 to -0.44)	<0.001
China	Both	Incidence	35 to 39	38,897	46,468	19.47	42.48	39.31	-7.47	-0.28 (-0.31 to -0.25)	-0.24 (-0.25 to -0.24)	<0.001
China	Both	Incidence	40 to 44	93,359	73,411	-21.37	138.74	80.72	-41.82	-1.93 (-2.12 to -1.73)	-1.66 (-1.68 to -1.63)	<0.001
China	Both	Incidence	45 to 49	159,524	172,739	8.28	308.22	173.18	-43.81	-1.99 (-2.17 to -1.82)	-1.75 (-1.78 to -1.72)	<0.001
China	Both	Incidence	50 to 54	184,435	312,992	69.7	385.54	264.36	-31.43	-1.32 (-1.44 to -1.2)	-1.15 (-1.17 to -1.13)	<0.001
China	Both	Incidence	55 to 59	176,813	399,302	125.83	406.48	337.75	-16.91	-0.64 (-0.71 to -0.57)	-0.57 (-0.58 to -0.56)	<0.001
China	Both	Incidence	60 to 64	291,145	433,832	49.01	821.24	532.78	-35.12	-1.49 (-1.62 to -1.37)	-1.32 (-1.34 to -1.30)	<0.001
China	Both	Incidence	65 to 69	364,690	655,569	79.76	1330.43	859.05	-35.43	-1.44 (-1.57 to -1.32)	-1.33 (-1.35 to -1.31)	<0.001
China	Both	Incidence	70 to 74	324,395	746,984	130.27	1718.5	1223.46	-28.81	-1.12 (-1.21 to -1.03)	-1.03 (-1.05 to -1.02)	<0.001
China	Both	Incidence	75 to 79	226,265	580,590	156.6	1980.12	1578.22	-20.3	-0.79 (-0.84 to -0.74)	-0.70 (-0.71 to -0.69)	<0.001
China	Both	Incidence	80 to 84	139,712	460,923	229.91	2501.94	2051.79	-17.99	-0.77 (-0.82 to -0.71)	-0.61 (-0.62 to -0.60)	<0.001
China	Both	Incidence	85 to 89	60,844	302,703	397.51	3048.19	2427.02	-20.38	-0.88 (-0.96 to -0.81)	-0.70 (-0.72 to -0.69)	<0.001
China	Both	Incidence	90 to 94	14,011	122,386	773.48	3720.75	2702.59	-27.36	-1.26 (-1.36 to -1.15)	-0.99 (-1.01 to -0.96)	<0.001
China	Both	Incidence	95 plus	3256	37,433	1049.67	4972.5	3014.9	-39.37	-1.95 (-2.1 to -1.8)	-1.55 (-1.58 to -1.52)	<0.001
China	Both	Prevalence	15 to 19	378,357	188,584	-50.16	297.92	234.09	-21.42	-0.83 (-0.91 to -0.75)	-0.73 (-0.74 to -0.72)	<0.001
China	Both	Prevalence	20 to 24	608,223	246,542	-59.47	459.48	348.44	-24.17	-1.08 (-1.12 to -0.92)	-0.84 (-0.85 to -0.83)	<0.001
China	Both	Prevalence	25 to 29	706,915	383,302	-45.78	641.64	491.48	-23.4	-1.02 (-1.12 to -0.92)	-0.82 (-0.83 to -0.80)	<0.001
China	Both	Prevalence	30 to 34	734,313	695,769	-5.25	829.73	647.72	-21.94	-0.94 (-1.05 to -0.83)	-0.75 (-0.77 to -0.74)	<0.001
China	Both	Prevalence	35 to 39	939,219	972,813	3.58	1025.74	822.89	-19.78	-0.8 (-0.89 to -0.7)	-0.68 (-0.69 to -0.67)	<0.001
China	Both	Prevalence	40 to 44	930,186	987,080	6.12	1382.39	1085.35	-21.49	-0.86 (-0.95 to -0.77)	-0.74 (-0.76 to -0.73)	<0.001
China	Both	Prevalence	45 to 49	1,274,796	1,691,580	32.69	2463.05	1695.91	-31.15	-1.33 (-1.45 to -1.21)	-1.14 (-1.16 to -1.12)	<0.001
China	Both	Prevalence	50 to 54	1,965,624	3,288,194	67.29	4108.89	2777.26	-32.41	-1.43 (-1.56 to -1.29)	-1.19 (-1.21 to -1.17)	<0.001
China	Both	Prevalence	55 to 59	2,513,580	4,947,895	96.85	5778.57	4185.23	-27.57	-1.17 (-1.31 to -1.03)	-0.99 (-1.01 to -0.98)	<0.001
China	Both	Prevalence	60 to 64	2,827,285	4,943,701	74.86	7974.97	6071.23	-23.87	-0.94 (-1.08 to -0.81)	-0.83 (-0.85 to -0.82)	<0.001
China	Both	Prevalence	65 to 69	3,388,261	7,039,551	107.76	12,360.77	9224.59	-25.37	-0.97 (-1.1 to -0.84)	-0.89 (-0.91 to -0.88)	<0.001
China	Both	Prevalence	70 to 74	3,290,992	8,385,847	154.81	17,434.19	13,734.9	-21.22	-0.76 (-0.88 to -0.64)	-0.73 (-0.75 to -0.72)	<0.001
China	Both	Prevalence	75 to 79	2,543,338	7,075,737	178.21	22,257.54	19,234.04	-13.58	-0.45 (-0.54 to -0.35)	-0.45 (-0.46 to -0.44)	<0.001
China	Both	Prevalence	80 to 84	1,430,163	5,633,200	293.89	25,611.06	25,076.06	-2.09	-0.02 (-0.1 to 0.07)	-0.06 (-0.07 to -0.05)	<0.001
China	Both	Prevalence	85 to 89	563,693	3,863,071	585.31	28,240.31	30,973.49	9.68	0.39 (0.31 to 0.47)	0.29 (0.27 to 0.30)	<0.001
China	Both	Prevalence	90 to 94	107,428	1,641,721	1428.21	28,527.85	36,253.41	27.08	0.94 (0.85 to 1.03)	0.74 (0.72 to 0.76)	<0.001
China	Both	Prevalence	95 plus	17692	506,320	2761.9	27,018.89	40,779.88	50.93	1.61 (1.49 to 1.73)	1.27 (1.25 to 1.30)	<0.001
China	Both	Deaths	15 to 19	645	102	-84.19	0.51	0.13	-75.08	-4.99 (-5.27 to -4.7)	-4.06 (-4.19 to -3.96)	<0.001

China	Both	Deaths	20 to 24	840	125	-85.11	0.63	0.18	-72.15	-4.92 (-5.33 to -4.51)	-3.73 (-3.87 to -3.62)	<0.001
China	Both	Deaths	25 to 29	1004	210	-79.09	0.91	0.27	-70.46	-4.97 (-5.47 to -4.48)	-3.56 (-3.71 to -3.44)	<0.001
China	Both	Deaths	30 to 34	1516	538	-64.49	1.71	0.5	-70.74	-4.76 (-5.26 to -4.25)	-3.60 (-3.80 to -3.44)	<0.001
China	Both	Deaths	35 to 39	2686	909	-66.15	2.93	0.77	-73.79	-5 (-5.53 to -4.47)	-3.95 (-4.11 to -3.84)	<0.001
China	Both	Deaths	40 to 44	4357	1509	-65.36	6.47	1.66	-74.37	-4.84 (-5.26 to -4.41)	-3.98 (-4.14 to -3.88)	<0.001
China	Both	Deaths	45 to 49	7262	3756	-48.28	14.03	3.77	-73.16	-4.64 (-5.01 to -4.27)	-3.92 (-4.03 to -3.82)	<0.001
China	Both	Deaths	50 to 54	15,819	10,191	-35.58	33.07	8.61	-73.97	-4.82 (-5.23 to -4.41)	-3.93 (-4.09 to -3.83)	<0.001
China	Both	Deaths	55 to 59	27,802	18,656	-32.9	63.92	15.78	-75.31	-5.22 (-5.75 to -4.69)	-4.07 (-4.15 to -3.98)	<0.001
China	Both	Deaths	60 to 64	54,574	31,774	-41.78	153.94	39.02	-74.65	-4.83 (-5.33 to -4.33)	-4.06 (-4.20 to -3.94)	<0.001
China	Both	Deaths	65 to 69	89,352	64,772	-27.51	325.97	84.88	-73.96	-4.71 (-5.23 to -4.18)	-3.95 (-4.07 to -3.85)	<0.001
China	Both	Deaths	70 to 74	133,190	123,793	-7.06	705.58	202.76	-71.26	-4.45 (-4.98 to -3.92)	-3.70 (-3.79 to -3.63)	<0.001
China	Both	Deaths	75 to 79	143,531	162,849	13.46	1256.08	442.67	-64.76	-3.77 (-4.26 to -3.28)	-3.10 (-3.19 to -3.02)	<0.001
China	Both	Deaths	80 to 84	117,252	214,716	83.12	2099.72	955.8	-54.48	-2.99 (-3.45 to -2.52)	-2.28 (-2.42 to -2.19)	<0.001
China	Both	Deaths	85 to 89	61,744	209,191	238.8	3093.3	1677.26	-45.78	-2.32 (-2.76 to -1.88)	-1.76 (-1.91 to -1.64)	<0.001
China	Both	Deaths	90 to 94	15,101	116,460	671.21	4010.13	2571.74	-35.87	-1.81 (-2.3 to -1.32)	-1.31 (-1.42 to -1.22)	<0.001
China	Both	Deaths	95 plus	3042	38,686	1171.54	4646.44	3115.84	-32.94	-1.63 (-2.06 to -1.19)	-1.19 (-1.26 to -1.12)	<0.001
China	Both	DALYs	15 to 19	65,981	16,849	-74.46	51.95	20.91	-59.74	-3.19 (-3.35 to -3.03)	-2.72 (-2.78 to -2.68)	<0.001
China	Both	DALYs	20 to 24	87,336	20,560	-76.46	65.98	29.06	-55.96	-3.08 (-3.31 to -2.85)	-2.44 (-2.50 to -2.39)	<0.001
China	Both	DALYs	25 to 29	98,456	31,767	-67.74	89.36	40.73	-54.42	-3.15 (-3.45 to -2.85)	-2.34 (-2.41 to -2.28)	<0.001
China	Both	DALYs	30 to 34	123,740	64,492	-47.88	139.82	60.04	-57.06	-3.25 (-3.58 to -2.92)	-2.50 (-2.62 to -2.40)	<0.001
China	Both	DALYs	35 to 39	188,410	94,598	-49.79	205.77	80.02	-61.11	-3.53 (-3.89 to -3.16)	-2.84 (-2.90 to -2.78)	<0.001
China	Both	DALYs	40 to 44	254,079	118,873	-53.21	377.6	130.71	-65.38	-3.78 (-4.1 to -3.46)	-3.10 (-3.19 to -3.03)	<0.001
China	Both	DALYs	45 to 49	373,099	240,168	-35.63	720.87	240.78	-66.6	-3.88 (-4.18 to -3.58)	-3.27 (-3.37 to -3.19)	<0.001
China	Both	DALYs	50 to 54	696,570	541,046	-22.33	1456.09	456.98	-68.62	-4.16 (-4.5 to -3.82)	-3.41 (-3.53 to -3.34)	<0.001
China	Both	DALYs	55 to 59	1,048,273	850,407	-18.88	2409.92	719.33	-70.15	-4.51 (-4.96 to -4.06)	-3.53 (-3.60 to -3.47)	<0.001
China	Both	DALYs	60 to 64	1,705,531	1,143,314	-32.96	4810.82	1404.08	-70.81	-4.37 (-4.82 to -3.92)	-3.65 (-3.77 to -3.55)	<0.001
China	Both	DALYs	65 to 69	2,327,464	1,877,546	-19.33	8490.86	2460.33	-71.02	-4.33 (-4.8 to -3.85)	-3.69 (-3.77 to -3.63)	<0.001
China	Both	DALYs	70 to 74	2,811,989	2,839,450	0.98	14,896.65	4650.64	-68.78	-4.16 (-4.65 to -3.67)	-3.47 (-3.55 to -3.40)	<0.001
China	Both	DALYs	75 to 79	2,415,076	2,902,653	20.19	21,135.08	7890.31	-62.67	-3.57 (-4.03 to -3.11)	-2.94 (-3.03 to -2.86)	<0.001
China	Both	DALYs	80 to 84	1,536,045	2,910,571	89.48	27,507.17	12,956.34	-52.9	-2.87 (-3.31 to -2.42)	-2.19 (-2.31 to -2.11)	<0.001
China	Both	DALYs	85 to 89	642,079	2,229,126	247.17	32,167.31	17,872.77	-44.44	-2.22 (-2.64 to -1.8)	-1.69 (-1.84 to -1.57)	<0.001
China	Both	DALYs	90 to 94	134,965	1,070,586	693.23	35,840.41	23,641.27	-34.04	-1.71 (-2.18 to -1.24)	-1.23 (-1.34 to -1.14)	<0.001
China	Both	DALYs	95 plus	25419	329,127	1194.83	38,819.33	26,508.43	-31.71	-1.56 (-1.98 to -1.14)	-1.14 (-1.21 to -1.07)	<0.001
United States of America	Both	Incidence	15 to 19	3091	1648	-46.69	17.02	7.46	-56.14	-3.11 (-3.38 to -2.83)	-2.53 (-2.57 to -2.49)	<0.001
United States of America	Both	Incidence	20 to 24	4704	2696	-42.7	23.98	12.41	-48.26	-2.34 (-2.53 to -2.15)	-2.01 (-2.04 to -1.98)	<0.001

(Continued)

Table 2 (Continued).

Location	Gender	Indicator	Age Group	Cases in 1990 (n)	Cases in 2023 (n)	Change in Cases (%)	Rate in 1990 (per 100,000)	Rate in 2023 (per 100,000)	Change in Rate (%)	EAPC (95% CI)	AAPC (95% CI)	AAPC P-value
United States of America	Both	Incidence	25 to 29	6881	4576	-33.5	31.64	20.83	-34.18	-1.35 (-1.46 to -1.25)	-1.27 (-1.29 to -1.25)	<0.001
United States of America	Both	Incidence	30 to 34	8312	7219	-13.14	37.22	30.59	-17.81	-0.59 (-0.66 to -0.53)	-0.59 (-0.61 to -0.58)	<0.001
United States of America	Both	Incidence	35 to 39	8565	9162	6.97	42.04	40.6	-3.43	-0.09 (-0.12 to -0.05)	-0.11 (-0.11 to -0.10)	<0.001
United States of America	Both	Incidence	40 to 44	28,189	37,855	34.29	156.02	172.75	10.73	0.61 (0.32 to 0.9)	0.32 (0.30 to 0.35)	<0.001
United States of America	Both	Incidence	45 to 49	46,998	70,466	49.93	335.75	354.99	5.73	0.37 (0.18 to 0.55)	0.18 (0.16 to 0.20)	<0.001
United States of America	Both	Incidence	50 to 54	46,042	85,473	85.64	401.35	411.58	2.55	0.17 (0.09 to 0.24)	0.08 (0.07 to 0.09)	<0.001
United States of America	Both	Incidence	55 to 59	43,117	87,226	102.3	410.24	421.65	2.78	0.15 (0.11 to 0.19)	0.08 (0.08 to 0.09)	<0.001
United States of America	Both	Incidence	60 to 64	85,665	200,668	134.25	803.95	941.58	17.12	0.75 (0.56 to 0.94)	0.49 (0.47 to 0.51)	<0.001
United States of America	Both	Incidence	65 to 69	124,329	275,113	121.28	1233.69	1431.9	16.07	0.65 (0.49 to 0.81)	0.46 (0.45 to 0.47)	<0.001
United States of America	Both	Incidence	70 to 74	106,401	247,852	132.94	1315.77	1597.37	21.4	0.71 (0.53 to 0.88)	0.58 (0.57 to 0.60)	<0.001
United States of America	Both	Incidence	75 to 79	75,112	174,599	132.45	1224.87	1539.02	25.65	0.74 (0.5 to 0.99)	0.71 (0.68 to 0.73)	<0.001
United States of America	Both	Incidence	80 to 84	43,283	82,599	90.84	1099.26	1189.88	8.24	0.05 (-0.2 to 0.31)	0.23 (0.18 to 0.28)	<0.001
United States of America	Both	Incidence	85 to 89	21,482	35,049	63.16	1055.34	919.21	-12.9	-0.79 (-1.01 to -0.58)	-0.43 (-0.47 to -0.40)	<0.001
United States of America	Both	Incidence	90 to 94	7848	14,063	79.18	1083.9	817.07	-24.62	-1.23 (-1.41 to -1.06)	-0.89 (-0.92 to -0.85)	<0.001
United States of America	Both	Incidence	95 plus	2562	5140	100.62	1148.48	817.72	-28.8	-1.29 (-1.45 to -1.12)	-1.06 (-1.10 to -1.03)	<0.001
United States of America	Both	Prevalence	15 to 19	45,565	38,057	-16.48	250.88	172.4	-31.28	-1.32 (-1.41 to -1.22)	-1.15 (-1.16 to -1.13)	<0.001
United States of America	Both	Prevalence	20 to 24	68,958	47,661	-30.88	351.51	219.34	-37.6	-1.69 (-1.83 to -1.56)	-1.42 (-1.44 to -1.40)	<0.001

United States of America	Both	Prevalence	25 to 29	106,420	66,238	-37.76	489.36	301.46	-38.4	-1.71 (-1.85 to -1.58)	-1.48 (-1.50 to -1.46)	<0.001
United States of America	Both	Prevalence	30 to 34	147,981	100,830	-31.86	662.65	427.24	-35.53	-1.52 (-1.63 to -1.41)	-1.34 (-1.36 to -1.32)	<0.001
United States of America	Both	Prevalence	35 to 39	174,876	136,029	-22.21	858.28	602.74	-29.77	-1.21 (-1.29 to -1.12)	-1.08 (-1.09 to -1.06)	<0.001
United States of America	Both	Prevalence	40 to 44	228,256	226,430	-0.8	1263.34	1033.31	-18.21	-0.61 (-0.68 to -0.53)	-0.61 (-0.62 to -0.60)	<0.001
United States of America	Both	Prevalence	45 to 49	352,097	476,706	35.39	2515.33	2401.56	-4.52	0.02 (-0.15 to 0.19)	-0.13 (-0.15 to -0.12)	<0.001
United States of America	Both	Prevalence	50 to 54	503,304	901,524	79.12	4387.34	4341.11	-1.05	0.11 (-0.03 to 0.25)	-0.03 (-0.04 to -0.01)	0.002
United States of America	Both	Prevalence	55 to 59	664,390	1,312,549	97.56	6321.35	6344.86	0.37	0.14 (0.02 to 0.25)	0.02 (0.00 to 0.03)	0.029
United States of America	Both	Prevalence	60 to 64	945,395	1,955,350	106.83	8872.39	9175	3.41	0.24 (0.12 to 0.36)	0.11 (0.09 to 0.13)	<0.001
United States of America	Both	Prevalence	65 to 69	1,391,516	2,911,713	109.25	13,807.69	15,154.82	9.76	0.48 (0.33 to 0.63)	0.29 (0.27 to 0.31)	<0.001
United States of America	Both	Prevalence	70 to 74	1,579,491	3,424,399	116.8	19,532.12	22,069.72	12.99	0.56 (0.41 to 0.72)	0.38 (0.36 to 0.39)	<0.001
United States of America	Both	Prevalence	75 to 79	1,524,929	3,327,528	118.21	24,867.26	29,330.69	17.95	0.68 (0.5 to 0.86)	0.51 (0.49 to 0.52)	<0.001
United States of America	Both	Prevalence	80 to 84	1,143,067	2,422,606	111.94	29,030.82	34,898.92	20.21	0.7 (0.51 to 0.9)	0.56 (0.54 to 0.58)	<0.001
United States of America	Both	Prevalence	85 to 89	657,851	1,460,729	122.05	32,318.85	38,309.34	18.54	0.6 (0.4 to 0.81)	0.51 (0.49 to 0.54)	<0.001
United States of America	Both	Prevalence	90 to 94	254,996	687,616	169.66	35,217.07	39,951.73	13.44	0.41 (0.21 to 0.61)	0.37 (0.34 to 0.41)	<0.001
United States of America	Both	Prevalence	95 plus	85341	255,642	199.55	38,254.18	40,669.26	6.31	0.16 (-0.03 to 0.35)	0.17 (0.15 to 0.18)	<0.001
United States of America	Both	Deaths	15 to 19	10	15	40.43	0.06	0.07	15.54	0.02 (-0.3 to 0.34)	0.20 (-0.06 to 0.51)	0.124
United States of America	Both	Deaths	20 to 24	15	19	30.1	0.08	0.09	17.46	0.76 (0.39 to 1.12)	0.97 (0.59 to 1.44)	0.002
United States of America	Both	Deaths	25 to 29	24	29	21.35	0.11	0.13	20.1	1.21 (0.86 to 1.57)	0.89 (0.59 to 1.14)	<0.001

(Continued)

Table 2 (Continued).

Location	Gender	Indicator	Age Group	Cases in 1990 (n)	Cases in 2023 (n)	Change in Cases (%)	Rate in 1990 (per 100,000)	Rate in 2023 (per 100,000)	Change in Rate (%)	EAPC (95% CI)	AAPC (95% CI)	AAPC P-value
United States of America	Both	Deaths	30 to 34	46	69	50.97	0.21	0.29	42.85	1.32 (1.02 to 1.61)	1.32 (1.02 to 1.66)	<0.001
United States of America	Both	Deaths	35 to 39	93	143	53.75	0.46	0.63	38.81	0.78 (0.38 to 1.18)	0.87 (0.73 to 1.04)	<0.001
United States of America	Both	Deaths	40 to 44	229	366	59.99	1.27	1.67	31.92	0.63 (0.14 to 1.12)	0.87 (0.64 to 1.07)	<0.001
United States of America	Both	Deaths	45 to 49	559	824	47.31	4	4.15	3.88	0.59 (0.13 to 1.05)	0.17 (0.06 to 0.28)	0.002
United States of America	Both	Deaths	50 to 54	1395	2371	69.92	12.16	11.42	-6.14	0.58 (0.27 to 0.9)	-0.18 (-0.28 to -0.09)	<0.001
United States of America	Both	Deaths	55 to 59	3227	5575	72.77	30.7	26.95	-12.22	0.16 (-0.02 to 0.35)	-0.39 (-0.51 to -0.26)	<0.001
United States of America	Both	Deaths	60 to 64	7173	12,812	78.62	67.31	60.12	-10.69	-0.36 (-0.49 to -0.23)	-0.32 (-0.40 to -0.24)	<0.001
United States of America	Both	Deaths	65 to 69	12,162	19,674	61.77	120.68	102.4	-15.15	-0.72 (-0.88 to -0.56)	-0.55 (-0.62 to -0.47)	<0.001
United States of America	Both	Deaths	70 to 74	16,508	26,554	60.85	204.14	171.14	-16.17	-0.5 (-0.75 to -0.25)	-0.56 (-0.67 to -0.47)	<0.001
United States of America	Both	Deaths	75 to 79	18,742	33,556	79.05	305.62	295.78	-3.22	-0.03 (-0.29 to 0.22)	-0.19 (-0.28 to -0.10)	<0.001
United States of America	Both	Deaths	80 to 84	14,959	32,040	114.19	379.91	461.56	21.49	0.57 (0.25 to 0.89)	0.61 (0.44 to 0.72)	<0.001
United States of America	Both	Deaths	85 to 89	9018	26,357	192.28	443.02	691.24	56.03	1.37 (0.98 to 1.76)	1.29 (1.15 to 1.42)	<0.001
United States of America	Both	Deaths	90 to 94	3860	17,641	357.06	533.06	1024.98	92.28	2.26 (1.87 to 2.64)	2.00 (1.92 to 2.07)	<0.001
United States of America	Both	Deaths	95 plus	1364	8738	540.36	611.63	1390.06	127.27	2.85 (2.46 to 3.25)	2.49 (2.39 to 2.57)	<0.001
United States of America	Both	DALYs	15 to 19	4163	3930	-5.59	22.92	17.8	-22.33	-1.02 (-1.13 to -0.92)	-0.84 (-0.90 to -0.77)	<0.001
United States of America	Both	DALYs	20 to 24	6116	4796	-21.58	31.17	22.07	-29.2	-1.16 (-1.28 to -1.04)	-1.02 (-1.06 to -0.97)	<0.001
United States of America	Both	DALYs	25 to 29	9293	6653	-28.41	42.73	30.28	-29.14	-1.07 (-1.19 to -0.95)	-1.01 (-1.05 to -0.96)	<0.001

United States of America	Both	DALYs	30 to 34	13,396	11,326	-15.45	59.99	47.99	-20	-0.74 (-0.85 to -0.63)	-0.65 (-0.71 to -0.59)	<0.001
United States of America	Both	DALYs	35 to 39	17,509	17,317	-1.09	85.93	76.73	-10.71	-0.5 (-0.67 to -0.33)	-0.35 (-0.41 to -0.30)	<0.001
United States of America	Both	DALYs	40 to 44	27,208	33,659	23.71	150.59	153.61	2	-0.05 (-0.32 to 0.23)	0.01 (-0.08 to 0.09)	0.947
United States of America	Both	DALYs	45 to 49	48,774	68,980	41.43	348.44	347.51	-0.27	0.29 (-0.03 to 0.62)	0.06 (0.01 to 0.11)	0.025
United States of America	Both	DALYs	50 to 54	88,104	152,781	73.41	768.01	735.69	-4.21	0.38 (0.14 to 0.62)	-0.11 (-0.16 to -0.06)	<0.001
United States of America	Both	DALYs	55 to 59	153,128	275,332	79.8	1456.94	1330.96	-8.65	0.14 (0.01 to 0.26)	-0.27 (-0.35 to -0.20)	<0.001
United States of America	Both	DALYs	60 to 64	269,789	499,127	85.01	2531.93	2342.03	-7.5	-0.22 (-0.31 to -0.13)	-0.21 (-0.28 to -0.15)	<0.001
United States of America	Both	DALYs	65 to 69	386,827	666,814	72.38	3838.4	3470.62	-9.58	-0.43 (-0.58 to -0.27)	-0.32 (-0.38 to -0.26)	<0.001
United States of America	Both	DALYs	70 to 74	431,523	746,177	72.92	5336.25	4808.99	-9.88	-0.25 (-0.48 to -0.03)	-0.33 (-0.40 to -0.26)	<0.001
United States of America	Both	DALYs	75 to 79	395,156	741,606	87.67	6443.88	6536.93	1.44	0.11 (-0.12 to 0.35)	-0.04 (-0.11 to 0.03)	0.255
United States of America	Both	DALYs	80 to 84	257,322	544,888	111.75	6535.28	7849.4	20.11	0.56 (0.27 to 0.84)	0.55 (0.46 to 0.62)	<0.001
United States of America	Both	DALYs	85 to 89	129,010	345,711	167.97	6337.98	9066.67	43.05	1.12 (0.78 to 1.46)	1.08 (0.99 to 1.16)	<0.001
United States of America	Both	DALYs	90 to 94	48,346	191,583	296.28	6676.99	11,131.32	66.71	1.77 (1.43 to 2.1)	1.57 (1.51 to 1.62)	<0.001
United States of America	Both	DALYs	95 plus	16047	85,266	431.35	7193.1	13,564.65	88.58	2.21 (1.88 to 2.55)	1.93 (1.86 to 1.99)	<0.001

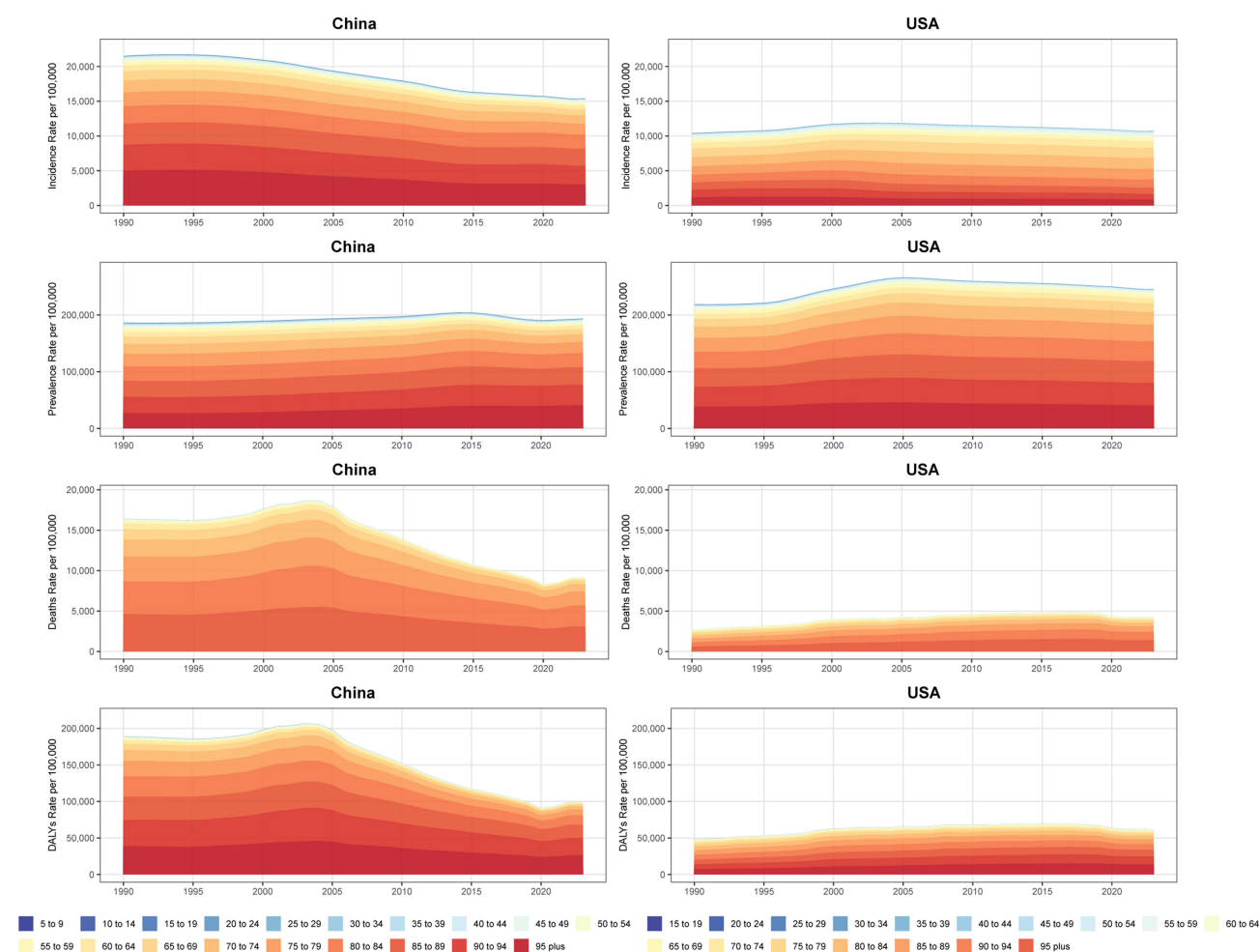


Figure 3 Age-Specific Contribution to COPD Burden in China and the United States, 1990–2023 (Both Sexes Combined, Rates). This figure presents stacked area charts depicting the age-specific contribution to total COPD burden (incidence, prevalence, mortality, and DALYs rates per 100,000 population) in China and the United States from 1990 to 2023, for both sexes combined.

2008), with less pronounced magnitude than China. Females exhibited less favorable cohort effects, with earlier cohorts showing lower RR values than males.

Risk Factor Attribution of COPD Burden

Risk factor attribution analyses revealed substantial reductions in COPD DALY burden associated with most exposures in China, contrasting with more modest changes in the United States (Table 3). In China, age-standardized DALY rates declined dramatically across all major risk factors between 1990 and 2023. Particulate matter pollution demonstrated the steepest absolute decline (82.21% reduction, from 1403.08 to 249.68 per 100,000), followed by smoking (68.48% reduction, from 1027.10 to 323.78 per 100,000), low temperature (67.24% reduction, from 229.07 to 75.04 per 100,000), secondhand smoke (60.89% reduction, from 248.89 to 97.35 per 100,000), ambient ozone pollution (65.33% reduction, from 182.54 to 63.29 per 100,000), and occupational exposures (63.66% reduction, from 179.60 to 65.28 per 100,000). High temperature remained a negligible contributor (declining from 7.90 to 4.63 per 100,000). Conversely, the United States exhibited more modest improvements: particulate matter pollution decreased 72.12% (from 91.72 to 25.57 per 100,000), secondhand smoke declined 33.88% (from 55.19 to 36.49 per 100,000), and ambient ozone pollution decreased 40.16% (from 57.56 to 34.44 per 100,000). However, smoking-attributable burden declined only 14.09% (from 342.35 to 294.10 per 100,000), remaining the dominant risk factor in 2023. Low temperature and occupational exposures showed

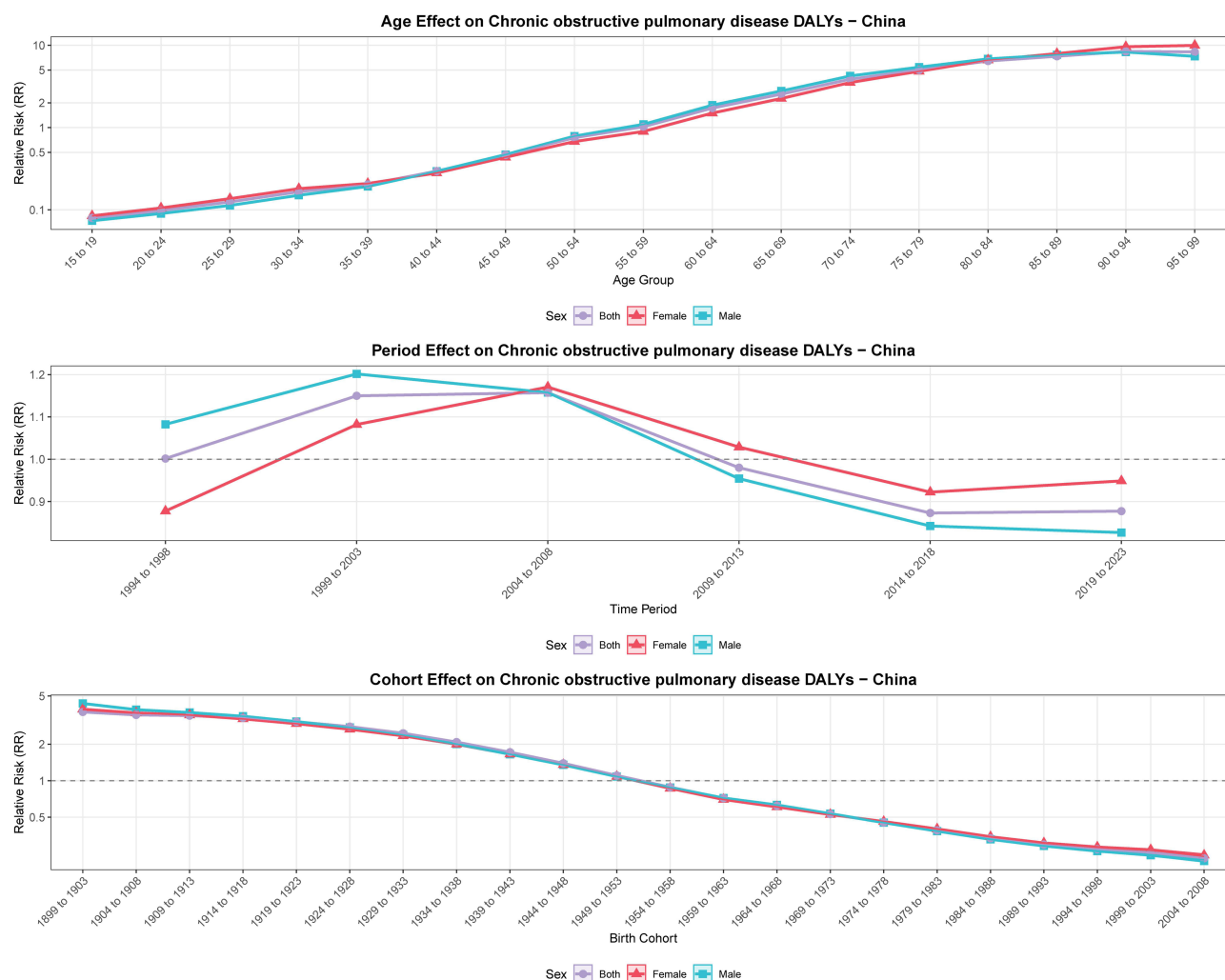


Figure 4 Age-Period-Cohort Analysis of COPD DALYs in China, 1994–2023. This figure presents the results of age-period-cohort (APC) analysis using the intrinsic estimator method for COPD disability-adjusted life years (DALYs) in China from 1994 to 2023. The figure consists of three vertically arranged panels representing the three independent temporal effects: (1) Age effects (top panel) show how relative risk (RR) varies across different age groups (15–19 to 95+ years), plotted on a logarithmic scale; (2) Period effects (middle panel) display how RR changes across successive 5-year time periods (1994–1998 to 2019–2023), with a horizontal reference line at $RR = 1$; (3) Cohort effects (bottom panel) illustrate how RR differs among birth cohorts (1899–1903 to 2004–2008), also plotted on a logarithmic scale with a reference line at $RR = 1$.

minimal changes (4.75% and 10.21% reductions, respectively), while high temperature burden increased 2.4-fold (from 1.44 to 3.50 per 100,000), suggesting emerging climate-related challenges.

Projected Future COPD Burden to 2035

Bayesian projections to 2035 revealed divergent trajectories (Figures 5–6). In China, age-standardized incidence rates are projected to increase 30.0% (to 256.98 per 100,000) with absolute cases rising 23.6% (to 5,486,115). Prevalence rates will rise 39.8% (to 3310.97 per 100,000) with cases expanding 32.3% (to 69,464,505), adding 16.97 million individuals. Mortality rates will increase 120.0% (to 102.54 per 100,000) with absolute deaths surging 135.9% (to 2,354,092). DALY rates will rise 92.0% (to 1493.52 per 100,000) with absolute DALYs increasing 95.9% (to 33,856,856), nearly doubling total burden.

In the United States, age-standardized incidence rates will increase 36.6% (to 322.98 per 100,000) with cases rising 15.4% (to 1,547,402). Prevalence rates will escalate 28.2% (to 4251.48 per 100,000) with cases expanding 20.1% (to 23,715,229). Mortality rates will rise 32.0% (to 38.14 per 100,000) with deaths increasing 30.1% (to 243,058). DALY rates will increase 24.1% (to 892.24 per 100,000) with absolute DALYs rising 13.4% (to 4,986,368). Female mortality

Table 3 Age-Standardized DALY Rates Attributable to Major Risk Factors for COPD in China and the United States, 1990 and 2023

Measure	Metric	Risk	Cause	Location	Age	Sex	Year	Value	Upper	Lower
DALYs	Rate	Occupational particulate matter, gases, and fumes	Chronic obstructive pulmonary disease	China	Age-standardized	Both sexes	1990	179.6	365.31	64.15
DALYs	Rate	Occupational particulate matter, gases, and fumes	Chronic obstructive pulmonary disease	China	Age-standardized	Both sexes	2023	65.28	133.67	19.7
DALYs	Rate	Ambient ozone pollution	Chronic obstructive pulmonary disease	China	Age-standardized	Both sexes	1990	182.54	353.08	44.98
DALYs	Rate	Ambient ozone pollution	Chronic obstructive pulmonary disease	China	Age-standardized	Both sexes	2023	63.29	120.56	14.59
DALYs	Rate	Secondhand smoke	Chronic obstructive pulmonary disease	China	Age-standardized	Both sexes	1990	248.89	416.12	118.53
DALYs	Rate	Secondhand smoke	Chronic obstructive pulmonary disease	China	Age-standardized	Both sexes	2023	97.35	163.08	46.73
DALYs	Rate	Smoking	Chronic obstructive pulmonary disease	China	Age-standardized	Both sexes	1990	1,027.10	1,418.37	629.55
DALYs	Rate	Smoking	Chronic obstructive pulmonary disease	China	Age-standardized	Both sexes	2023	323.78	438.01	246.35
DALYs	Rate	Low temperature	Chronic obstructive pulmonary disease	China	Age-standardized	Both sexes	1990	229.07	306.78	150.77
DALYs	Rate	Low temperature	Chronic obstructive pulmonary disease	China	Age-standardized	Both sexes	2023	75.04	108.64	57.49
DALYs	Rate	High temperature	Chronic obstructive pulmonary disease	China	Age-standardized	Both sexes	1990	7.9	31.76	-5.9
DALYs	Rate	High temperature	Chronic obstructive pulmonary disease	China	Age-standardized	Both sexes	2023	4.63	14.68	-2.31
DALYs	Rate	Particulate matter pollution	Chronic obstructive pulmonary disease	China	Age-standardized	Both sexes	1990	1,403.08	1,843.86	965.57
DALYs	Rate	Particulate matter pollution	Chronic obstructive pulmonary disease	China	Age-standardized	Both sexes	2023	249.68	365.97	170.39
DALYs	Rate	Ambient ozone pollution	Chronic obstructive pulmonary disease	United States of America	Age-standardized	Both sexes	1990	57.56	101.23	13.75
DALYs	Rate	Ambient ozone pollution	Chronic obstructive pulmonary disease	United States of America	Age-standardized	Both sexes	2023	34.44	61.71	8.27
DALYs	Rate	Occupational particulate matter, gases, and fumes	Chronic obstructive pulmonary disease	United States of America	Age-standardized	Both sexes	1990	28.02	47.83	11.71
DALYs	Rate	Occupational particulate matter, gases, and fumes	Chronic obstructive pulmonary disease	United States of America	Age-standardized	Both sexes	2023	25.16	43.59	10.15

DALYs	Rate	Secondhand smoke	Chronic obstructive pulmonary disease	United States of America	Age-standardized	Both sexes	1990	55.19	84.36	27.78
DALYs	Rate	Secondhand smoke	Chronic obstructive pulmonary disease	United States of America	Age-standardized	Both sexes	2023	36.49	55.13	18.53
DALYs	Rate	Smoking	Chronic obstructive pulmonary disease	United States of America	Age-standardized	Both sexes	1990	342.35	412.23	279.58
DALYs	Rate	Smoking	Chronic obstructive pulmonary disease	United States of America	Age-standardized	Both sexes	2023	294.1	368.41	227.25
DALYs	Rate	Low temperature	Chronic obstructive pulmonary disease	United States of America	Age-standardized	Both sexes	1990	59.15	65.01	49.58
DALYs	Rate	Low temperature	Chronic obstructive pulmonary disease	United States of America	Age-standardized	Both sexes	2023	56.34	63.35	48.02
DALYs	Rate	High temperature	Chronic obstructive pulmonary disease	United States of America	Age-standardized	Both sexes	1990	1.44	8.31	-4.02
DALYs	Rate	High temperature	Chronic obstructive pulmonary disease	United States of America	Age-standardized	Both sexes	2023	3.5	12.51	-2.66
DALYs	Rate	Particulate matter pollution	Chronic obstructive pulmonary disease	United States of America	Age-standardized	Both sexes	1990	91.72	165.21	36.4
DALYs	Rate	Particulate matter pollution	Chronic obstructive pulmonary disease	United States of America	Age-standardized	Both sexes	2023	25.57	39.99	13.46

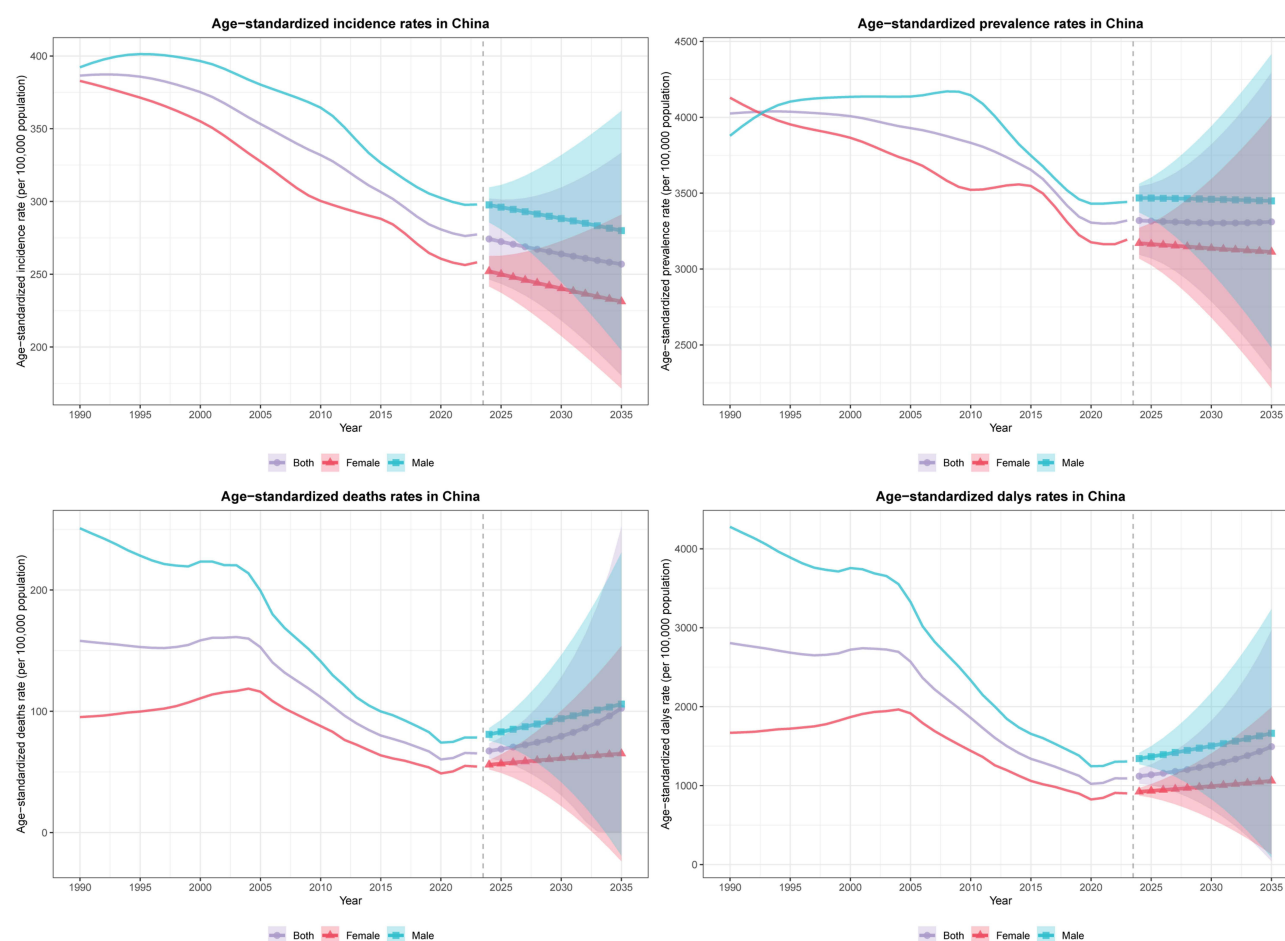


Figure 5 Projected COPD Burden in China, 2024–2035. This figure presents Bayesian age-period-cohort (BAPC) model projections of COPD burden in China from 1990 to 2035, combining historical data (1990–2023) with future projections (2024–2035). Four panels display age-standardized rates for incidence, prevalence, mortality, and DALYs (per 100,000 population), stratified by sex (both, female, male). Historical data are shown with thin solid lines without markers, while projected data (2024–2035) are displayed with thicker solid lines and distinct point markers (circles for both sexes, triangles for females, squares for males). Shaded regions around the projected lines represent 95% credible intervals, indicating prediction uncertainty. A vertical dashed line at year.

rates (34.77 per 100,000) are projected to converge with male rates (34.23 per 100,000) by 2035, reflecting concerning continuation of rising female COPD mortality trends.

These contrasting trajectories underscore fundamental differences: China demonstrates declining age-standardized mortality and DALY rates yet faces escalating absolute burden due to population aging, while the United States confronts simultaneous increases in both age-adjusted rates and absolute numbers, highlighting persistent challenges in both nations despite vastly different healthcare systems and risk factor profiles.

Discussion

This comprehensive analysis of COPD burden in China and the United States from 1990 to 2023 revealed markedly divergent epidemiological trajectories. China experienced substantial improvements in age-standardized mortality rates (declining 58.68% from 112.79 to 46.60 per 100,000) and DALY rates (decreasing 61.12% from 2000.61 to 777.86 per 100,000), despite a 116.72% increase in absolute prevalent cases driven by population aging. Conversely, the United States exhibited increasing trends, with mortality rates rising 8.90% (from 26.53 to 28.89 per 100,000) and DALY rates remaining essentially stable (1.12% increase). Joinpoint analyses identified critical inflection points: China demonstrated dramatic mortality declines from 2017–2020 (APC: -6.43%) followed by concerning reversals from 2020–2023 (APC: 2.50%), while the United States showed recent improvements from 2017–2023 (mortality APC: -2.72%). Age-period-cohort decomposition revealed that period effects in China declined from 1.20 (1999–2003) to 0.83 (2019–2023),

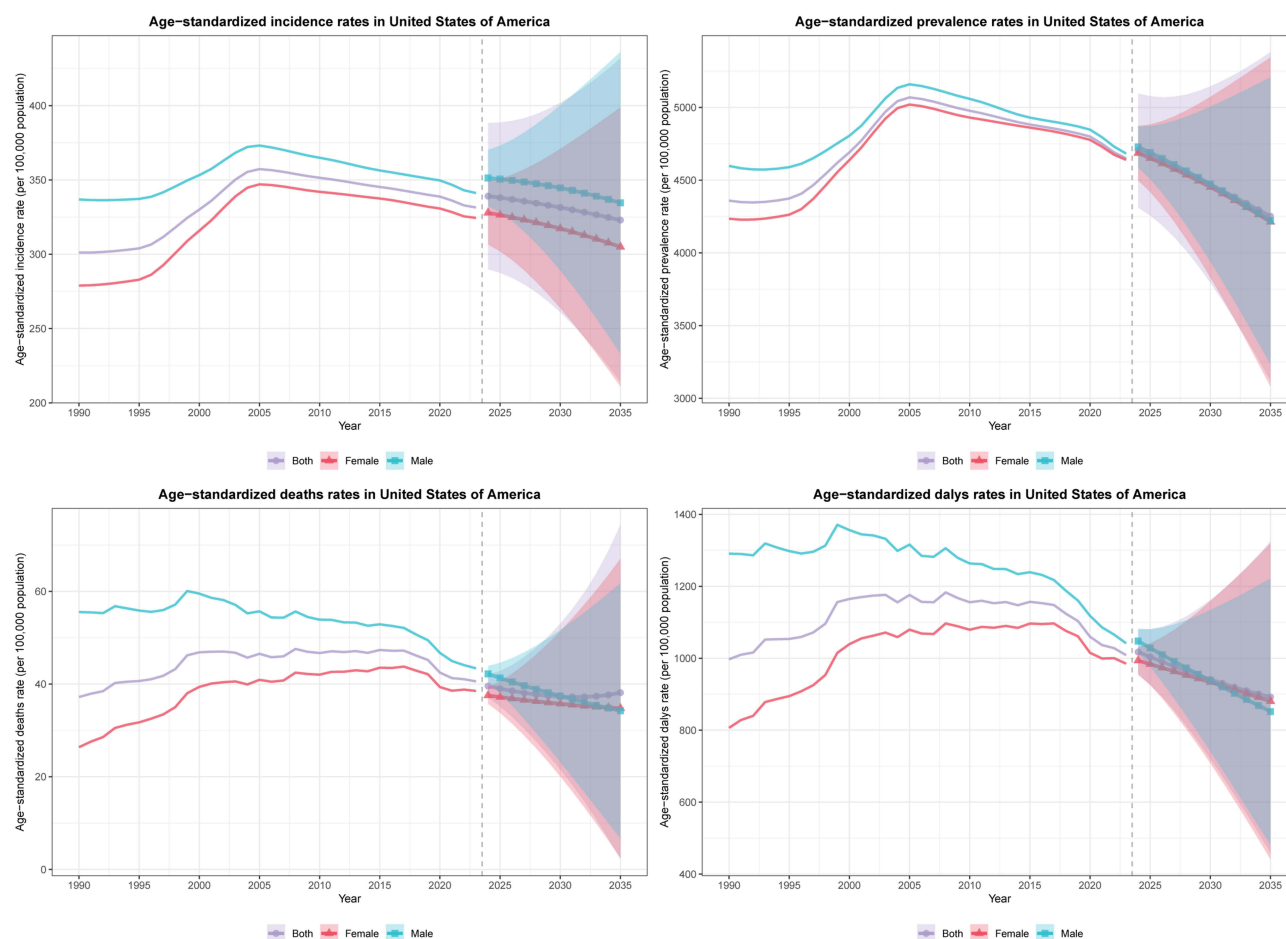


Figure 6 Projected COPD Burden in the United States, 2024–2035. This figure presents BAPC model projections for the United States, using the same structure, time frame, and visualization approach as Figure 5.

whereas American period effects deteriorated from 0.67 (1994–1998) to 1.34 (2019–2023). Projections to 2035 indicated dramatic increases in absolute burden: China's mortality would surge 135.9% with age-standardized rates rising 120.0%, while the United States would experience 30.1% increase in deaths and 32.0% rise in age-standardized mortality.

Risk factor attribution analyses revealed fundamental differences in exposure control between countries. In China, age-standardized DALY rates declined dramatically across all major risk factors: particulate matter pollution decreased 82.21% (from 1403.08 to 249.68 per 100,000), smoking declined 68.48% (from 1027.10 to 323.78 per 100,000), low temperature decreased 67.24% (from 229.07 to 75.04 per 100,000), ambient ozone pollution declined 65.33% (from 182.54 to 63.29 per 100,000), occupational exposures decreased 63.66% (from 179.60 to 65.28 per 100,000), and secondhand smoke declined 60.89% (from 248.89 to 97.35 per 100,000). These reductions align with previous GBD analyses reporting 68.2% and 71.5% reductions in age-standardized death and DALY rates between 1990 and 2021, corroborating earlier documentation of 70% decreases in mortality from 1990–2019.^{7,13,14} This progress reflects aggressive tobacco control reducing male smoking from 63% in 1996 to 50% in 2018, substantial reductions in household air pollution from solid fuels, and improved healthcare access following reforms.^{9,14} The dramatic decline in ozone pollution-attributable mortality from 71.2 to 22.8 per 100,000 between 1990 and 2021 further supports environmental protection impacts.⁷ However, the mortality reversal from 2020–2023 warrants attention, potentially reflecting COVID-19 pandemic disruptions in healthcare delivery and chronic disease management.

Conversely, the United States demonstrated more modest risk factor improvements: particulate matter pollution decreased 72.12% (from 91.72 to 25.57 per 100,000), secondhand smoke declined 33.88% (from 55.19 to 36.49 per 100,000), and ambient ozone pollution decreased 40.16% (from 57.56 to 34.44 per 100,000). Critically, smoking-

attributable burden declined only 14.09% (from 342.35 to 294.10 per 100,000), remaining the dominant risk factor in 2023. Low temperature and occupational exposures showed minimal changes (4.75% and 10.21% reductions), while high temperature burden increased 2.4-fold (from 1.44 to 3.50 per 100,000), suggesting emerging climate-related challenges. The increasing burden, particularly among females, aligns with concerning trends: our finding of 45.64% increase in female age-standardized mortality (from 18.81 to 27.40 per 100,000) is consistent with 2010–2019 analyses showing continued deterioration.⁸ The striking gender disparity—males demonstrating 21.94% mortality decrease while females experienced dramatic increases—mirrors global patterns of slower tobacco reduction among women and reflects historical increases in female smoking now manifesting as elevated COPD burden.^{1,8} Age-period-cohort analysis revealing deteriorating period effects (RR: 0.67 to 1.34) indicates that temporal factors beyond demographic aging—including persistent smoking, rising obesity, and environmental exposures—drive the American epidemic. The economic burden exceeding \$45,532 per patient annually further emphasizes crisis severity.^{15,16}

Age-stratified analyses revealed profound heterogeneity. In China, dramatically declining mortality rates across all ages (32.94–75.31% reductions) combined with prevalence increases in oldest groups (50.93% for ages ≥ 95 years, AAPC: 1.27%) reflects improved survival with population aging, consistent with global patterns of increasing absolute burden despite declining age-standardized rates.^{5,17} The 585.31%, 1428.21%, and 2761.90% increases in absolute prevalence among ages 85–89, 90–94, and ≥ 95 years underscore China's demographic shift, with life expectancy increasing from 69 to 78 years (1990–2019). In the United States, alarming increases in both prevalence and mortality among oldest groups (rates rising 56.03–127.27% for ages ≥ 85 , AAPC: 1.29–2.49%) contrast sharply with China's improving survival, suggesting inadequate disease management in advanced age. The concentration of American burden in middle-aged groups (50–69 years) differs markedly from China's shift toward older populations, potentially reflecting earlier disease onset associated with higher obesity and earlier smoking initiation.^{8,9}

Cohort effects provide crucial insights into long-term secular trends. In China, the 16-fold reduction in cohort-specific DALY risk from 1899–1903 (RR: 3.69) to 2004–2008 (RR: 0.23), with inflection around 1949–1953, reflects dramatic improvements including substantial reductions in indoor air pollution from solid fuels, improved nutrition, and decreasing occupational exposures.^{7,14} The steeper decline compared to the United States, despite earlier American transition to below-baseline cohort risk (1954–1958 versus 1949–1953), suggests more rapid risk factor modification in China. Less favorable American female cohort effects may reflect historical gender differences in smoking uptake, with women's prevalence peaking later than men's.^{1,8} These findings align with GBD analyses demonstrating smoking and ambient particulate matter remain predominant risk factors globally, accounting for 46.0% and 20.7% of COPD DALYs, respectively.^{3,5}

Our study possesses notable strengths: comprehensive GBD 2023 data ensuring comparability, extended 33-year time series with projections to 2035,^{9,18,19} multiple advanced analytical methods (joinpoint regression, age-period-cohort modeling, Bayesian projections), and detailed age-sex stratification revealing heterogeneous patterns.^{17,19} Compared with a recent similar study analyzing COPD burden in China and the United States based on GBD 2021 data (1990–2021),²⁰ our study provides updated estimates using GBD 2023 data extending to 2023, offers more comprehensive risk factor attribution analysis quantifying seven major risk factors, and includes detailed age-stratified analysis across 17 age groups to better characterize burden evolution across the life course. However, limitations warrant consideration: reliance on statistical modeling introducing uncertainty, potential diagnostic variations and misclassification in death certification, projection assumptions not accounting for future changes, inability to examine urban-rural differences or COPD phenotypes, the inability of GBD data to capture critical social and healthcare determinants such as treatment adherence, medication access, and health insurance coverage, and cautious interpretation required for 2020–2023 trends given COVID-19 disruptions.^{20–22} Additionally, the GBD database does not include data on cannabis smoking, which is the second most widely smoked substance after tobacco in the United States. While cannabis smoke contains many components similar to tobacco smoke that are injurious to lung tissue, it also contains cannabinoid compounds including delta-9-tetrahydrocannabinol (THC) with potential immunosuppressive and anti-inflammatory properties.²³ Current evidence regarding the association between cannabis smoking and COPD remains mixed. A recent state-of-the-art review found no association between cannabis smoking and the development of COPD, although cannabis smoking was strongly associated with chronic bronchitis symptoms and airway inflammation.²⁴ However, studies in patients with

established COPD have shown that combined cannabis and tobacco smokers demonstrated higher rates of bullous emphysema compared to tobacco-only smokers.²⁵ Given the increasing legalization and use of cannabis in many countries, future research should investigate the independent and combined effects of cannabis and tobacco smoking on COPD development and progression.

Our findings have important implications. Divergent trajectories demonstrate that substantial burden reductions are achievable through comprehensive interventions, as evidenced by China's 60% mortality decline, which may be attributed to tobacco control, air quality improvements, and healthcare strengthening.^{14,22} However, these findings should be interpreted with caution, as alternative explanations cannot be excluded, including potential underreporting, changes in case detection and screening practices, revisions in diagnostic criteria, and methodological adjustments in epidemiological modeling over time. Furthermore, while China's comprehensive COPD countermeasures may serve as a model for developing countries, the trends observed in the United States may represent the future trajectory for developed nations and potentially for China as well. As China continues its epidemiological transition with population aging and lifestyle changes, current successful interventions may face increasing challenges, and mortality rates could rise in the future, similar to patterns observed in the United States. Our projections indicating a 135.9% surge in Chinese deaths and 120.0% increase in age-standardized mortality by 2035 support this concern. Cost-effectiveness analyses showing population-based screening could achieve \$8,034-\$13,209 per QALY suggest case-finding benefits.²² Persistently high American burden highlights needs for smoking cessation, particularly among women, addressing obesity, and ensuring equitable therapy access.^{1,4} These dramatic projected increases underscore urgent healthcare system preparation needs, including pulmonary rehabilitation expansion, respiratory professional training, and sustainable financing.^{2,4} Age-specific patterns suggest tailored strategies: intensive risk reduction for younger populations preventing onset, while ensuring screening and management for older adults bearing current burden.^{1,18} Future research priorities include: prospective cohorts validating estimates and characterizing phenotypes; evaluating novel interventions including pharmacotherapies and digital health technologies; examining COPD intersection with comorbidities, particularly cardiovascular disease and diabetes; and investigating social determinants informing equity-oriented interventions.^{21,26}

Conclusions

This comprehensive 33-year analysis reveals fundamentally divergent COPD trajectories between China and the United States. China achieved remarkable 58.68% and 61.12% reductions in age-standardized mortality and DALY rates through successful tobacco control, environmental interventions, and dramatic risk factor reductions—particulate matter pollution declining 82.21%, smoking 68.48%, and occupational exposures 63.66%—while the United States experienced concerning increases particularly among females and older adults, with mortality rising 8.90%, female mortality escalating 45.64%, and smoking-attributable burden declining only 14.09%. Despite contrasting epidemiological patterns, both nations face dramatic projected increases in absolute burden by 2035: Chinese deaths increasing 135.9%, American deaths 30.1%, driven predominantly by population aging. Age-period-cohort analyses revealed deteriorating American period effects (RR: 0.67 to 1.34) versus improving Chinese effects (RR: 1.20 to 0.83), reflecting fundamental differences in risk factor control. Profound age-specific heterogeneity—Chinese prevalence increasing 50.93% among ages ≥ 95 years alongside mortality declines, versus American mortality rising 127.27% in oldest groups—underscores needs for age-tailored strategies. These findings demonstrate substantial burden reductions are achievable through comprehensive interventions as evidenced by China's success, while persistent American trends despite greater resources highlight critical prevention and management gaps requiring urgent attention to avert projected escalation.

Data Sharing Statement

All data used in this study are publicly available from the Global Burden of Disease Study 2023 database through the Institute for Health Metrics and Evaluation (IHME) Global Health Data Exchange (<http://ghdx.healthdata.org/gbd-results-tool>). The analytical code and [supplementary materials](#) are available from the corresponding author upon reasonable request.

Ethics Statement

This study was conducted in accordance with the principles of the Declaration of Helsinki. All data were obtained from the Global Burden of Disease Study 2023 database, which is publicly accessible through the Institute for Health Metrics and Evaluation (IHME) and contains aggregated, de-identified population-level estimates that do not involve individual patient data. According to Articles 32(1) and 32(2) of the “Measures for Ethical Review of Life Science and Medical Research Involving Human Subjects” issued by the National Health Commission of the People’s Republic of China on February 18, 2023, research using legally obtained publicly available data or data that cannot identify specific individuals through information technology is exempt from ethical review. Therefore, this study did not require ethical approval. The authors have completed the Introduction to GBD Online Course certified by the Institute for Health Metrics and Evaluation at the University of Washington, demonstrating proficiency in GBD data, methods, findings, and implications.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors declare that they have no competing interests.

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