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ORIGINAL ARTICLE

Trends in the prevalence and incidence of chronic obstructive pulmonary disease among adults aged ≥50 years in the United States, 2000–2020

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Abstract

Background: Understanding the trends of the prevalence and incidence rate of chronic obstructive pulmonary disease (COPD) is vital for improving the control and prevention of COPD. We aimed to examine the trends in the prevalence and incidence rate of COPD among adults aged 50 years or older in the United States during 2000–2020.

Methods: Utilizing data from the Health and Retirement Study, we analyzed COPD prevalence across survey waves and calculated COPD incidence rates between consecutive interview waves, stratified by gender and race. We employed joinpoint regression models to investigate trends in COPD prevalence and incidence.

Results: The individuals reporting COPD are more likely to be women and Caucasians. The age-adjusted prevalence of COPD among adults aged 50 years and over showed an increasing trend throughout the study period, spanning from 9.02% in 2000 to 9.88% in 2020 (average biennial percent change [ABPC] = 0.41, 95% confidence interval [CI]: 0.10, 0.71; $p = 0.01$). The age-adjusted incidence rate of COPD among adults aged 50 and over showed a decreasing trend throughout the study period 1031.1 per 100,000 person-years in 2000 to 700.5 per 100,000 person-years in 2020 (ABPC = –1.63, 95% CI: –2.88, –0.36; $p = 0.02$).

Conclusion: Our findings indicate a rising prevalence of COPD among older adults in the United States since 2000, while the incidence rate of COPD has shown a declining trend.

KEYWORDS

20 years trends, chronic obstructive pulmonary disease, incidence rate, older adults, race

Key points

- Our analysis reveals a significant increase trend in the prevalence of chronic obstructive pulmonary disease (COPD) among adults aged ≥50 years in the United States during the period 2000–2020, while the incidence rate experienced a decrease over the study period.
- By using the largest and most comprehensive dynamic cohort database in the United States, we explained the changing trends in COPD incidence among older adults, a topic that has been underexplored in previous research. We provided updated epidemiological insights of COPD.

1 | INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is a major public health problem of global concern and is the third leading cause of death worldwide, causing 3.23 million deaths in 2019.[1] The latest Global Initiative for Chronic Obstructive Lung Disease guidelines define COPD as a *heterogeneous lung condition characterized by chronic respiratory symptoms, resulting from abnormalities of the airways and/or alveoli, leading to persistent and often progressive airflow obstruction*.[2] Patients with COPD experience poorer quality of life and higher risks for hospitalization, death, and disease progression.[3–6] The direct and indirect economic costs associated with COPD is a considerable financial burden not only for patients but also for society.[7,8] Gaining insight into the prevalence and incidence trends of COPD is crucial for enhancing the control and prevention of the disease.

In 2013, Ford et al.[7] conducted a surveillance study on COPD among adults aged ≥25 years old in the United States from 1999 to 2011 and found a decline in the age-adjusted prevalence, mortality rate for men, and hospitalizations. Although the prevalence of COPD has been well documented in the literature, there is limited research on COPD incidence. Further studies are needed to prioritize policies focused on the prevention and management of COPD.

This study, therefore, aimed to estimate the prevalence and incidence rate of COPD among adults aged 50 years and over in the United States. It also examined the trends of the prevalence and incidence rate of COPD from 2000 to 2020, stratified by gender and race. The study utilized data collected from the Health and Retirement Study (HRS) from 1998 to 2020.

2 | METHODS

2.1 | Data resources and study participants

Data for this study were obtained from HRS, which is a dynamic cohort and one of the largest and most comprehensive nationally representative multidisciplinary panel studies in the United States and was conducted by the University of Michigan and supported by the National Institute on Aging (grant number NIA U01AG009740).[9,10] To ensure a nationally representative sample of the noninstitutionalized US civilian population, a multistage probability sampling design was used to recruit participants in HRS.[11] The HRS included adults aged over 50 years and residing in a community. Participants were recontacted every 2 years by face-to-face or telephone interview. A comprehensive description of the procedures employed in the HRS survey has been previously published.[12] For the present study, we compiled data from interviews conducted between 1998 and 2020. Additionally, we only included individuals who were at least 50 years old at the time of the interviews.

2.2 | Ascertainment of COPD

COPD cases were identified by the following question, "Has a doctor ever told you that you have chronic lung diseases such as chronic bronchitis or emphysema?" during interviews. Participants who answered "yes" were categorized as having COPD at the time of interviews. Proxy respondents were interviewed if the respondents were unable to participate.

We included several sociodemographic variables, such as age, gender, and race, to describe changes in population characteristics. In most cases, information was obtained from the respondents themselves during their first interview. In other cases, if the sample person had not been interviewed, the information may come from a spouse, partner, or other knowledgeable individuals.[13] Race was recorded as the following categories: Caucasian, African American, and other.

2.3 | Statistical analysis

Respondent characteristics were summarized for each wave of the HRS from 2000 to 2020. Then we described the age-adjusted prevalence and incidence rate of COPD in each wave, stratified by gender and race. The incidence rate of COPD between two interview waves was defined and analyzed in terms of the 2-year incidence rate of COPD using 2-year follow-up data. To address population differences among waves and groups, the prevalence was adjusted based on the age distribution of the population of the 2000 wave, and the incidence rates were adjusted to align with the population composition of the 1998–2000 wave. We utilized the χ^2 test and one-sided proportion tests to evaluate the heterogeneity of prevalence or incidence rates across groups at each time point.

In this section, we used data from the 2012 wave as an example to explain the procedures of population selection. When estimating the COPD prevalence in 2012, we first selected individuals who participated in interviews in the HRS 2012 wave. Next, we excluded participants under the age of 50. Finally, we selected individuals who answered *Yes* or *No* to the question *Has a doctor ever told you that you have chronic lung diseases such as chronic bronchitis or emphysema (not including asthma)?* for analysis (Figure 1). The estimated incidence rate from 2010 to 2012 was analyzed using baseline (2010 wave) and follow-up data (2012 wave). First, we selected individuals aged 50 years and older who provided interviews in the 2010 wave. Second, we

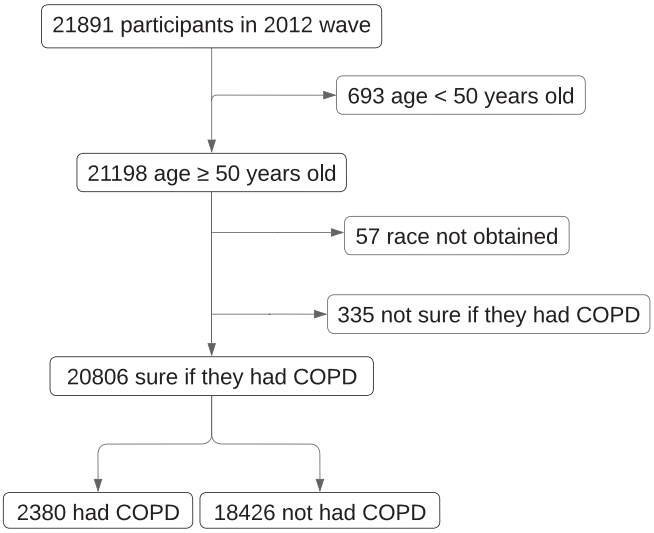

FIGURE 1 The flowchart of participants selection in the Health and Retirement Study 2012 wave for the prevalence estimate. COPD, chronic obstructive pulmonary disease.

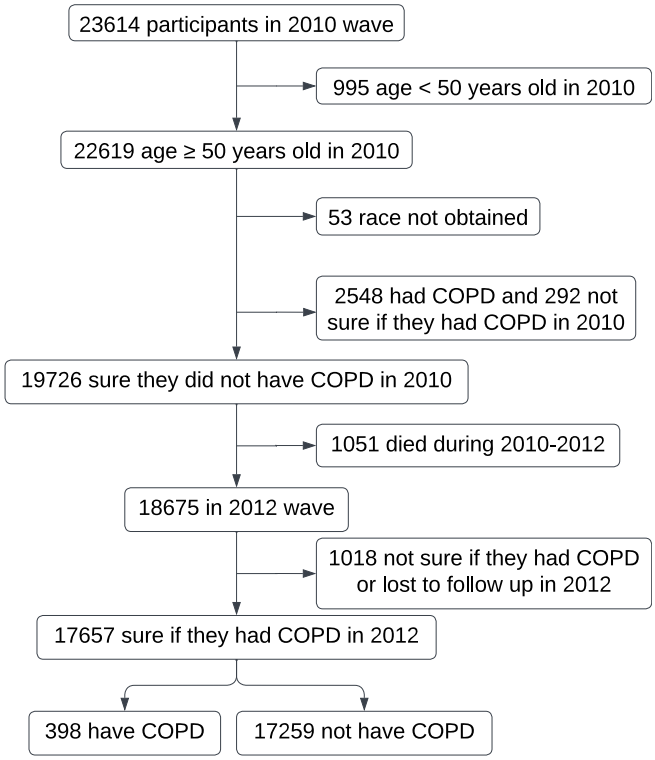

FIGURE 2 The flowchart of participants selection in the Health and Retirement Study 2010–2012 wave for the incidence rate estimate. COPD, chronic obstructive pulmonary disease.

defined the population at risk as all respondents from the 2010 wave who did not have COPD, excluding those who had COPD or were unsure if they had COPD in 2010. Third, we removed participants who died during the 2010 and 2012 waves and treated those who refused to answer or did not know if they had COPD in the 2012 wave and those who were alive but lost to follow-up in the 2012 wave as censored. The remaining participants were included in further analysis (Figure 2).

Next, we examined the trends of the age-adjusted prevalence and age-adjusted incidence rate of COPD by fitting joinpoint regression models. This was achieved through the application of the Joinpoint Regression Program, which utilizes segmented weighted least squares regression. The program iteratively adds joinpoints to the regression model and determines the optimal number of joinpoints, ranging from 0 to 3, based on the best fit to the data. For the final selected models, we reported the average biennial percent change (ABPC) and 95% confidence interval (95% CI). The prevalence and incidence rate were considered to have a significantly increasing trend if both the ABPC value and its lower limit of 95% CI were positive. The prevalence or incidence rate was considered to have a significantly decreasing trend if both the ABPC value and its upper limit of 95% CI were negative. Otherwise, the trend was considered to be stable.

Sampling weights for respondent-level characteristics were applied according to the methodology described in the HRS manual.[14] The respondent-level weight was scaled to generate weight sums corresponding to the number of individuals in the United States as measured by the March Current Population Survey for the year of data collection. Statistical analyses were performed using R 4.0, Joinpoint Regression Program version 4.9.1.0.29. This study used publicly available data and did not contain unique identifier, and thus is exempted from institutional review board approval.

3 | RESULTS

The descriptive statistics of all participants that were included in this analysis are presented in Supporting Information S1: Tables S1 and S2. The age distributions of study participants in each wave are largely comparable.

3.1 | Prevalence of COPD and 20 years trends

Overall, the age-adjusted prevalence of COPD in the United States among adults aged 50 and over showed a consistently increasing trend over the study period, spanning from 9.02% in 2000 to 9.88% in 2020 (ABPC = 0.41, 95% CI: 0.10, 0.71; $p = 0.01$) as shown in Table 1 and Figure 3. More details about the age-adjusted prevalence of COPD in each HRS wave are presented in Supporting Information S1: Table S3.

The COPD prevalence among women was higher than that of men at each study time point. Joinpoint

TABLE 1 Joinpoint regression results of age-adjusted[a] prevalence of COPD in the Health and Retirement Study, by gender and race, 2000–2020.

Characteristic	2000 P (95% CI)	2020 P (95% CI)	ABPC (95% CI)	*p* Value
Gender				
Men	8.93 (8.93, 8.94)	8.60 (8.60, 8.61)	−0.16 (−0.44, 0.12)	0.23
Women	9.22 (9.21, 9.22)	10.97 (10.97, 10.98)	0.91 (0.39, 1.43)	0.001
Race				
Caucasian	9.15 (9.14, 9.15)	10.16 (10.16, 10.16)	0.45 (0.03, 0.86)	0.03
African American	7.93 (7.92, 7.94)	10.07 (10.07, 10.09)	1.71 (1.05, 2.37)	0.0002
Other	7.96 (7.94, 7.98)	9.09 (9.08, 9.10)	1.48 (0.67, 2.29)	0.002
Overall	9.02 (9.01, 9.02)	9.88 (9.87, 9.88)	0.41 (0.10, 0.71)	0.01

Abbreviations: ABPC, the average biennial percent change; CI, confidence interval; COPD, chronic obstructive pulmonary disease; P, prevalence.
[a]Adjusted to the 2000 wave population.

regression analysis showed a significant increase in COPD prevalence in women from 9.22% in 2000 to 10.97% in 2020 (ABPC = 0.91, 95% CI: 0.39, 1.43; $p = 0.001$), while COPD prevalence among men remained stable (ABPC = −0.16, 95% CI: −0.44, 0.12; $p = 0.23$).

The prevalence of COPD among races was statistically significantly different at each study time point. The prevalence among Caucasians was higher than that of African Americans and other races during the period from 2000 to 2016. There were significantly increasing trends in COPD prevalence among African Americans from 7.93% in 2000 to 10.07% in 2020, resulting in average biennial increases of 171% (ABPC = 1.71, 95% CI: 1.05, 2.37; $p = 0.0002$). The highest prevalence for African Americans was observed in 2018. The COPD prevalence among Caucasians grew relatively slowly from 9.15% in 2000 to 10.16% in 2020 (ABPC = 0.45, 95% CI: 0.03, 0.86; $p = 0.03$).

3.2 | Incidence of COPD and 20 years trends

The age-adjusted incidence rate of COPD in the United States among adults aged 50 and over showed a significantly decreasing trend throughout the study period, ranging from 1031.1 per 100,000 person-years in 2000 to 700.5 per 100,000 person-years in 2020 (ABPC = −1.63, 95% CI: −2.88, −0.36; $p = 0.02$) (Table 2 and Figure 4). The incidence rates of COPD were substantially decreasing for both men (ABPC = −1.75, 95% CI: −3.11, −0.36; $p = 0.02$) and women (ABPC = −1.59, 95% CI: −2.90, −0.26; $p = 0.02$). There were significant decline trends among Caucasians from 1007.3 per 100,000 person-year in 2000 to 719.2 per 100,000 person-year in 2020 (ABPC = −1.59, 95% CI: −2.91, −0.24; $p = 0.03$). More details about the age-adjusted incidence rate of COPD are presented in Supporting Information S1: Table S4.

4 | DISCUSSION

In the present analysis of nationally representative data, we provided a comprehensive description of the age-adjusted prevalence and incidence rate of COPD among adults aged 50 years old and over in the United States between 2000 and 2020. Our analysis reveals notable trends in both the prevalence and incidence rate of COPD during this time period. Specifically, we observed a significant increase in the prevalence of COPD among older adults, while the incidence rate experienced a decrease over the study period.

Our findings reveal an increasing prevalence of COPD, aligning with previous research.[15] However, the age-standardized prevalence of COPD among US adults aged ≥18 years showed a decline from 1999 to 2011[7] and remained relatively stable from 2011 to 2021.[16] Globally, the prevalence of COPD rose from 10.7% in 1990 to 11.7% in 2010.[17] The trends in COPD prevalence varied across different countries. For instance, in Spain, the COPD prevalence among adults aged 40–69 years significantly decreased from 1997 to 2007.[18] Conversely, in Saudi Arabia, the prevalence of COPD has been steadily increasing from 1990 to 2019.[19]

We observed a higher prevalence of COPD among women compared to men. This pattern is also evident in developed countries like Canada, the Netherlands, and Australia.[20] However, in developing countries such as Latin America, India, and China, diagnosed COPD remains more prevalent in men than in women.[21–24] Our findings demonstrate a significant rise in COPD prevalence among women from 2000 to 2020, aligning with recent studies that indicate a

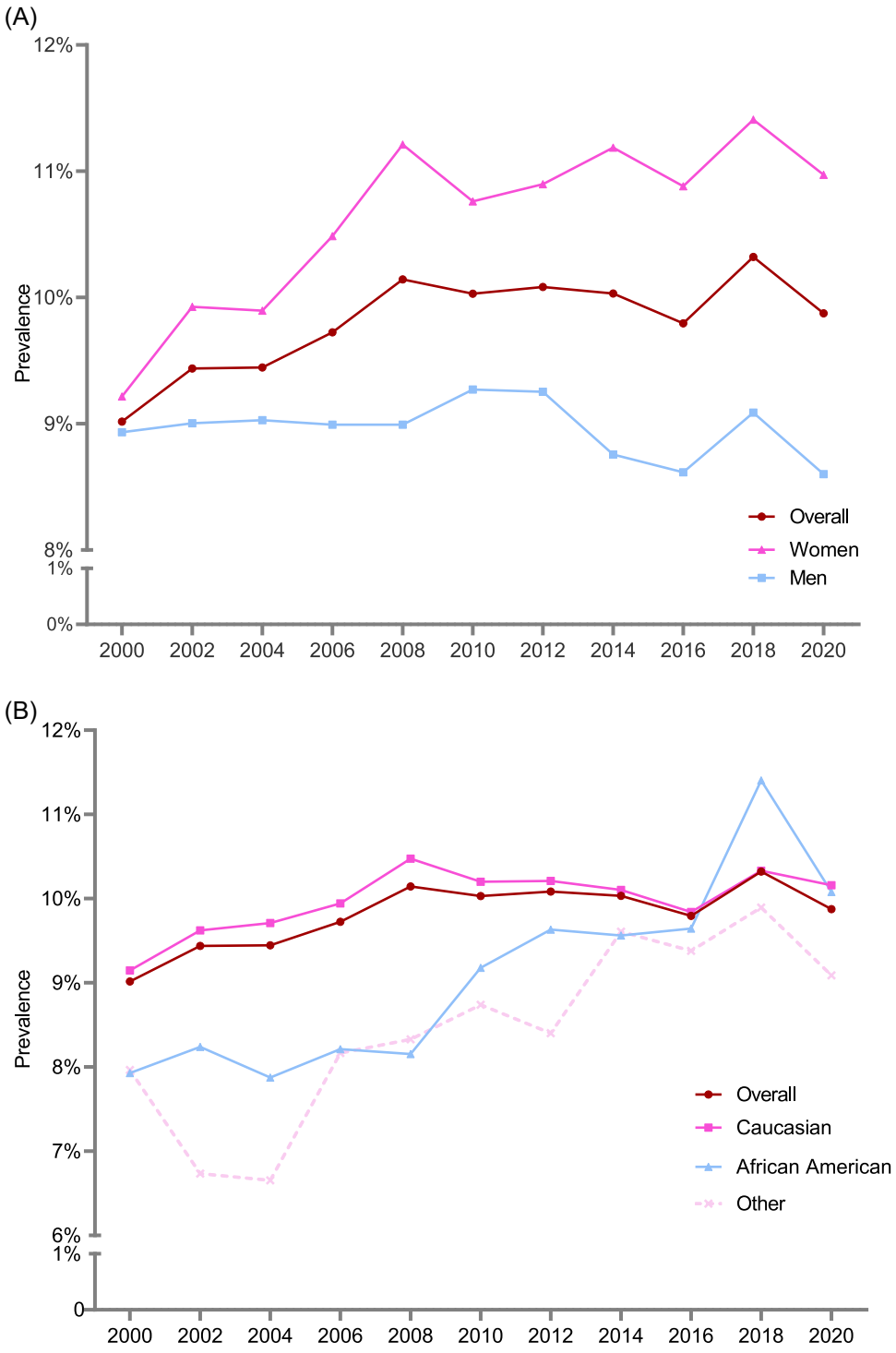

FIGURE 3 Trends in age-adjusted prevalence of chronic obstructive pulmonary disease (COPD) among adults aged ≥50 years, stratified by gender and race, the Health and Retirement Study, the United States, 2000–2020. (A) Trends in COPD prevalence by gender; (B) trends in COPD prevalence by race.

notable escalation since the 1990s.[25,26] Smoking, as an important risk factor of COPD, have contributed significantly to the changing trends in COPD epidemiology. In the past, smoking was more socially accepted for men, resulting in a delayed uptake among women due to cultural norms. Starting from the 1950s, women increasingly adopted smoking behaviors mirroring those of men, initiating smoking at younger ages and smoking more heavily.[27] Notably, smoking prevalence has generally increased among women in the United States till recent years, while smoking prevalence in men has been falling since the

TABLE 2 Joinpoint regression results of age-adjusted[a] incidence rate of COPD per 100,000 person-years in the Health and Retirement Study, by gender and race, 2000–2020.

Characteristic	1998–2000 IR (95% CI)	2018–2020 IR (95% CI)	ABPC (95% CI)	*p* Value
Gender				
Men	1004.2 (1002.8, 1005.6)	762.7 (761.6, 763.7)	−1.75 (−3.11, −0.36)	0.02
Women	1086.6 (1085.3, 1087.9)	645.1 (644.1, 646.1)	−1.59 (−2.90, −0.26)	0.02
Race				
Caucasian	1007.3 (1006.3, 1008.3)	719.2 (718.4, 720.0)	−1.59 (−2.91, −0.24)	0.03
African American	1061.8 (1058.7, 1064.8)	805.0 (802.8, 807.3)	−1.27 (−3.52, 1.03)	0.28
Other	1566.1 (1559.5, 1572.6)	895.4 (892.2, 898.5)	−1.57 (−4.23, 0.95)	0.18
Overall	1031.1 (1029.3, 1032.9)	700.5 (699.2, 701.9)	−1.63 (−2.88, −0.36)	0.02

Abbreviations: ABPC, the average biennial percent change; CI, confidence interval; COPD, chronic obstructive pulmonary disease; IR, incidence rate.
[a]Adjusted to the 1998–2000 wave population.

mid-1960s.[28,29] Women may exhibit heightened susceptibility to smoking-induced lung damage compared to men.[28] This susceptibility may stem from various factors, including potential gender-specific genetic predispositions for smoking-related lung pathology,[30] and anatomical differences leading to increased smoke exposure due to smaller airways. Additionally, hormonally mediated variations in cigarette smoke metabolism could contribute to this heightened vulnerability in women.[31] Differences in the phenotype of COPD between men and women have also been observed. For instance, a cohort study highlighted that individuals with chronic asthmatic bronchitis were more frequently females, displaying a lesser rate of decline in lung function and lower mortality compared to their male counterparts in the emphysematous group, who experienced a more rapid loss of lung function and higher mortality rates.[32] Moreover, sociologically, women are more likely to report symptoms, have a poorer self-evaluation of health, suffer from more chronic conditions, and visit physicians more frequently.[33] These factors contribute to the higher prevalence observed among women based on self-reported data. The elevated prevalence of COPD among women underscores the importance of raising awareness about COPD risk factors and symptoms in women.

Furthermore, our study revealed a higher prevalence of COPD among Caucasians compared to African Americans. Our findings align with a previous study conducted among US adults aged ≥25 years in 2011, which demonstrated a higher age-adjusted prevalence of COPD in Whites (6.9%) compared to Blacks (6.5%).[7] Genetic factors, such as α-1 antitrypsin deficiency, known as a common genetic cause of COPD, exhibit a higher frequency among Whites compared to Blacks, potentially playing a role in the observed racial disparity.[34,35] Variations in the distribution of proteases, antioxidants, detoxifying enzymes, and cytokines, which play crucial roles in COPD pathogenesis, could also differ among racial groups.[36] Discrepancies in smoke exposure may further account for the racial disparities in COPD prevalence. Studies have indicated that, compared with African Americans, Caucasians exhibit a higher prevalence of smoking behavior, smoking intensity, and early smoking initiation.[37–39] Additionally, Caucasians have been reported to have a higher prevalence of airflow obstruction across all industries and occupations.[40] Moreover, studies have shown that African Americans with COPD experience worse health outcomes and an increased risk of mortality compared to Caucasians.[41] African Americans are less likely to receive advice from physicians to quit smoking than Whites, even after a myocardial infarction.[42] Long-term oxygen therapy has demonstrated clear benefits in prolonging survival in patients with advanced COPD and chronic hypoxemia.[43,44] However, within the Medicare system, African American patients are less likely to receive ambulatory oxygen than their Caucasian counterparts.[45] Influenza vaccination has been shown to reduce the risks of influenza-related hospitalizations, acute exacerbation events, and all-cause mortality among individuals with COPD.[46,47] Nevertheless, studies indicate that African Americans with COPD are 20% less likely to receive vaccination compared to Caucasians.[48]

We observed the prevalence of COPD among African Americans has skyrocketed over the past 20 years, while the prevalence among Caucasians has increased slightly. Notably, the incidence rate of COPD among African Americans remains stable during the period from 2000 to 2020. An important reason for this could be a substantial increase in life expectancy for African Americans over the past two decades.[49] Data from 2000 to 2014 show that the age-adjusted rates of death due to COPD declined by 24.4% in Black males but increased for Black females by 4.2%.[50]

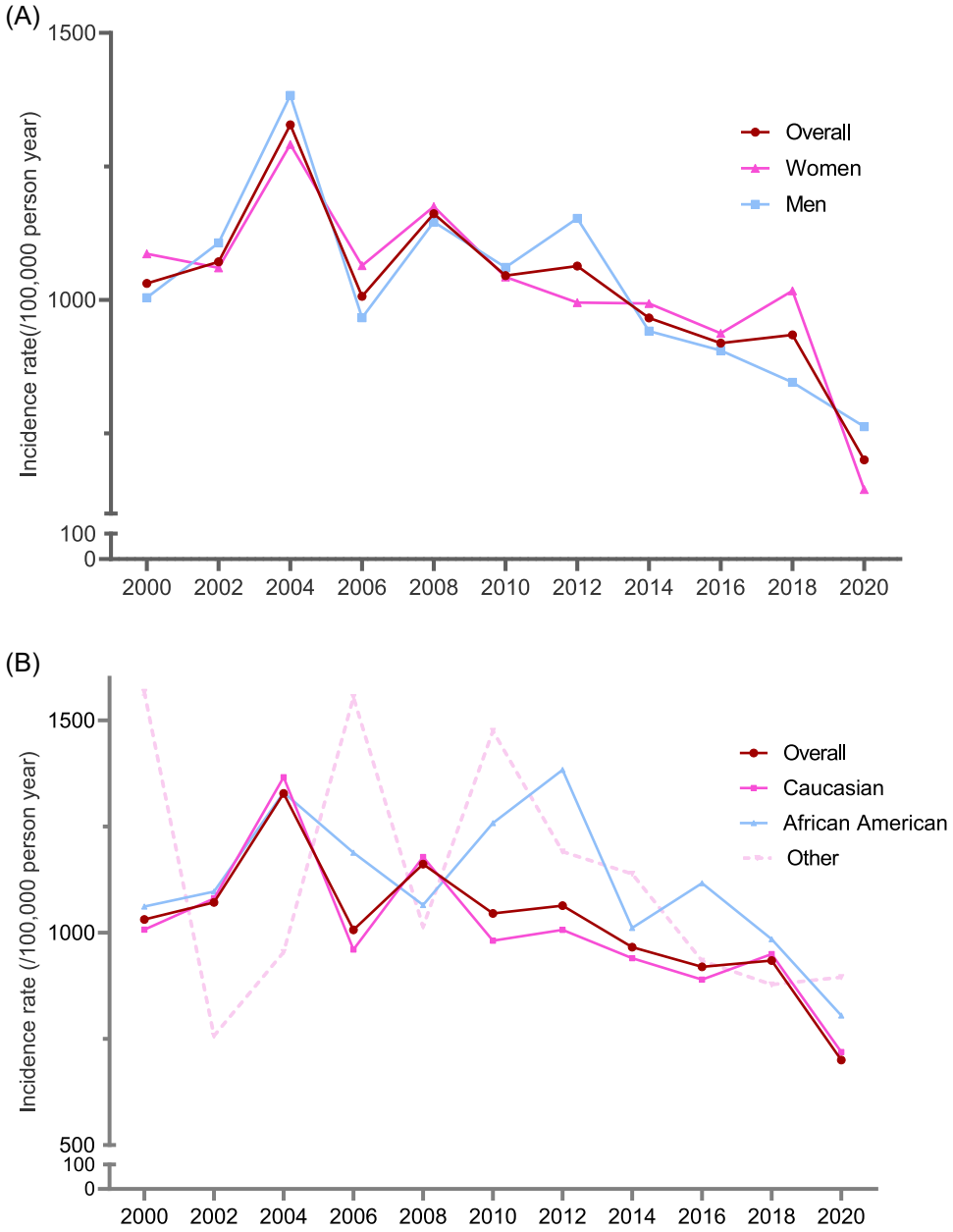

FIGURE 4 Trends in age-adjusted incidence rate of chronic obstructive pulmonary disease (COPD) among adults aged ≥50 years, stratified by gender and race, the Health and Retirement Study, the United States, 2000–2020. (A) Trends in COPD incidence rate by gender; (B) trends in COPD incidence rate by race.

Although our study found a decrease in the incidence rate of COPD among adults aged 50 years old and over in the United States, little research investigated this topic. The limited available data indicate a global age-adjusted incidence of COPD decreasing from 216.48 per 100,000 persons in 1990 to 200.49 per 100,000 persons in 2019.[51] Another study analyzed the incidence of COPD among adults aged 40–69 years from 2001 to 2006 using a community-based cohort in South Korea. It reported an overall crude incidence rate being 1447/100,000 person-years, with a higher rate in men than women.[52] The Rotterdam Study, which involved 7983 participants aged ≥55 years, reported an overall incidence rate of 920/100,000 person-years.[53] The decline in COPD incidence can be partly attributed to the reduction in smoking prevalence. As of 2015, the age-standardized global prevalence of daily smoking had decreased to 15%, reflecting a 29% overall decline since 1990.[54]

The strength of this study is its utilization of nationally representative data collected over 20 years using standardized procedures. This allows for the examination of the most current national trends and provides generalizability to older individuals in the

United States. However, the study also has several limitations. First, our measure of COPD was based on self-reported health status. Although self-reporting of health status has been recognized as a valid method in large population-based cohorts and has good consistency with medical records,[55] it may introduce some bias. Second, we excluded individuals who refused to answer questions or provided confused answers, which could potentially result in inaccurate results. Additionally, because the respondent-level weight of older adults in institutions like nursing homes was zero in the present study, the actual estimate is likely higher. Finally, we did not employ a precise definition of COPD to identify cases, which may introduce bias in the findings. It is worth noting that the prevalence of COPD can vary significantly depending on its definition.[56]

In conclusion, our study revealed an increasing prevalence of COPD among older adults over time, alongside a decrease in the incidence rate within the study period. We also observed gender and racial disparities in the trends of COPD prevalence and incidence rates, providing valuable insight into the burden of COPD among older individuals in the United States. Further research is needed to investigate the underlying factors that contribute to these disparities and to assess the effectiveness of targeted interventions and public health campaigns in reducing the impact of COPD on older adults in the United States.

AUTHOR CONTRIBUTIONS

Yiqiang Zhan had full access to all of the data in the study and took responsibility for the integrity of the data and the accuracy of the data analysis. Yaxian Meng, Qianqian Ji, and Aijie Zhang contributed to the study design, data analysis, and interpretation, and the writing of the manuscript. Yiqiang Zhan designed the study, supervised data analysis and interpretation, and manuscript writing.

ACKNOWLEDGMENTS

The authors have nothing to report.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are openly available in the Health and Retirement Study *public data* products at https://hrsdata.isr.umich.edu/data-products/public-survey-data.

ETHICS STATEMENT

This study used publicly available data and did not contain unique identifier, and thus is exempted from institutional review board approval.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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