Chronic obstructive pulmonary disease (COPD) accounts for the majority of deaths from chronic lower respiratory diseases, the fourth leading cause of death in the United States in 2019.* COPD mortality rates are decreasing overall. Although rates in men remain higher than those in women, declines have occurred among men but not women (1). To examine the geographic variation in sex-specific trends in age-adjusted COPD mortality rates among adults aged ≥25 years, CDC analyzed 1999–2019 death certificate data, by urban-rural status,† U.S. Census Bureau region,§ and state. Among women, no significant change in overall COPD mortality occurred during this period; however, rates increased significantly in small metropolitan (average annual percent change [AAPC] = 0.6%), micropolitan (1.2%), and noncore (1.9%) areas and in the Midwest (0.6%). Rates decreased significantly in large central (−0.9%) and fringe metropolitan (−0.4%) areas (and in the Northeast (−0.5%) and West (−1.2%). Among men, rates decreased significantly overall (−1.3%), in all urban-rural areas (range = −1.9% [large central metropolitan] to −0.4% [noncore]) and in all regions (range = −2.0% [West] to −0.9% [Midwest]). Strategies to improve the prevention, treatment, and management of COPD are needed, especially to address geographic differences and improve the trend in women, to reduce COPD deaths.

Mortality data from the CDC National Vital Statistics System during 1999–2019 were analyzed to determine the number and rate of deaths from COPD among adults aged ≥25 years for each year by sex and by geographic characteristics.

---

* [https://www.cdc.gov/nchs/data/nvsr/nvsr70/nvsr70-08-508.pdf](https://www.cdc.gov/nchs/data/nvsr/nvsr70/nvsr70-08-508.pdf)
† As defined in the CDC National Center for Health Statistics 2013 Urban-Rural Classification Scheme for Counties with six urbanization levels: four metropolitan (large central metropolitan, large fringe metropolitan, medium metropolitan, and small metropolitan) and two nonmetropolitan (micropolitan and noncore). [https://www.cdc.gov/nchs/data/sr_02/sr02_166.pdf](https://www.cdc.gov/nchs/data/sr_02/sr02_166.pdf)
§ U.S. Census Bureau regions: Northeast: Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont. Midwest: Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin. South: Alabama, Arkansas, Delaware, District of Columbia, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, and West Virginia. West: Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming. [https://www2.census.gov/geo/pdfs/maps-data/maps/reference/us_regdiv.pdf](https://www2.census.gov/geo/pdfs/maps-data/maps/reference/us_regdiv.pdf)
Significant decrease in mortality rates among women was observed over the period 1999–2019. COPD mortality rates among women decreased significantly (AAPC = −1.3%) in the Northeast (0.8%), but increased significantly in the West (1.2%). Among men, COPD mortality rates decreased significantly from 1999 to 2019 in large central (−0.9%) and Midwest (2013–2019), but were significant in the South (0.8%) and West (−0.5%). The change in rates among women was not significant when analysis was limited to later years in the Midwest (2013–2019), but was significant in the South (0.8%) when analysis was limited to 1999–2017. Among men, significant decreases were observed from 1999 to 2019 in all regions (range = −2.0% [West] to −0.9% [Midwest]). By urban-rural status, among women, the COPD mortality rate decreased significantly from 1999 to 2019 in large central (−0.9%) and

The analysis focused on the adult population because COPD mortality is rare in the non-adult population. The analysis was restricted to adults aged ≥25 years because standard age-adjusted rates (calculated with standard populations) are only available from CDC WONDER using 10-year age groups (<1, 1–4, 5–14, 15–24, 25–34, 35–44, 45–54, 55–64, 65–74, 75–84, and ≥85 years). https://wonder.cdc.gov/

**Annual percent change (APC) for each trend segment and AAPC from 1999 to 2019 were estimated; values significantly <0 (p≤0.05) were interpreted as a significant decrease in mortality rates, and values significantly >0 were interpreted as a significant increase.** This activity was reviewed by CDC and conducted consistent with applicable federal law and CDC policy.

---

The MMWR series of publications is published by the Center for Surveillance, Epidemiology, and Laboratory Services, Centers for Disease Control and Prevention (CDC), U.S. Department of Health and Human Services, Atlanta, GA 30329-4027.

Suggested citation: [Author names; first three, then et al., if more than six.] [Report title]. MMWR Morb Mortal Wkly Rep 2022;71:[inclusive page numbers].

---

**Centers for Disease Control and Prevention**

Debra Houry, MD, MPH, Acting Principal Deputy Director
Daniel B. Jernigan, MD, MPH, Deputy Director for Public Health Science and Surveillance
Rebecca Bunnell, PhD, MEd, Director, Office of Science
Jennifer Layden, MD, PhD, Deputy Director, Office of Science
Leslie Dauphin, PhD, Director, Center for Surveillance, Epidemiology, and Laboratory Services

**MMWR Editorial Board**

Timothy F. Jones, MD, Chairman

David W. Fleming, MD
William E. Halperin, MD, DrPH, MPH
Jewel Mullen, MD, MPH, MPA
Jeff Niederdeppe, PhD
Celeste Philip, MD, MPH
Patricia Quinlisk, MD, MPH

**MMWR Editorial and Production Staff (Weekly)**

Charlotte K. Kent, PhD, MPH, Editor in Chief
Brian A. King, PhD, MPH, Executive Editor
Jacqueline Gindler, MD, Editor
Paul Z. Siegel, MD, MPH, Associate Editor
Mary Dott, MD, MPH, Online Editor
Teria F. Rutledge, Managing Editor
Teresa M. Hood, MS, Lead Technical Writer-Editor
Leigh Berdon, Glenn Damon, Sumiya Dunworth, PhD, Viana Garrett-Cherry, PhD, MPH, Sriu Sen, MA, Stacy Simon, MA, Jesse Sokolow, Morgan Thompson, Technical Writer-Editors

Martha F. Boyd, Lead Visual Information Specialist
Alexander J. Gottardy, Maureen A. Leahy, Julia C. Martinroe, Stephen R. Spriggs, Tong Yang, Visual Information Specialists
Quang M. Doan, MBA, Phyllis H. King, Terraye M. Star, Moua Yang, Information Technology Specialists

Ian Branham, MA, Acting Lead Health Communication Specialist
Shelton Bartley, MPH, Leslie Hamlin, Lowery Johnson, Amanda Ray, Health Communication Specialists
Will Yang, MA, Visual Information Specialist
### Table: Sex-specific chronic obstructive pulmonary disease related deaths and age-adjusted mortality rates* among adults aged ≥25 years and trends in mortality rates, by geographic characteristics — United States, 1999–2019

| Geographic characteristic | 1999 | 2019 |
|--------------------------|------|------|
|                          | No. of deaths | Deaths per 100,000 population (95% CI) | No. of deaths | Deaths per 100,000 population (95% CI) | AAPC† 1999–2019 (95% CI) | No. of joinpoints | Segment-specific AAPC† 1999–2019 (95% CI) |
| **Women**                |      |      |      |      |      |      |
| Overall                  | 58,040 | 54.6 (54.1 to 55.0) | 80,422 | 53.0 (52.6 to 53.4) | 0.1 (−0.1 to 0.3) | 0 | — |
| **Urban-rural status‡**  |      |      |      |      |      |      |
| Large central metropolitan | 15,833 | 52.3 (51.4 to 53.1) | 16,919 | 40.1 (39.5 to 40.7) | −0.9 (−1.2 to −0.7)** | 0 | — |
| Large fringe metropolitan  | 13,006 | 54.9 (54.0 to 55.9) | 18,337 | 48.8 (48.1 to 49.5) | −0.4 (−0.6 to −0.2)** | 0 | — |
| Medium metropolitan       | 12,334 | 56.0 (55.0 to 57.0) | 18,010 | 55.3 (54.5 to 56.1) | −0.2 (−0.9 to 0.5) | 1 | 2017–2019: −4.2 (−10.7 to 2.7) |
| Small metropolitan        | 6,067  | 58.7 (57.2 to 60.2) | 9,485  | 64.5 (63.2 to 65.9) | 0.6 (0.4 to 0.8)** | 0 | — |
| Micropolitan (nonmetropolitan) | 6,206 | 56.8 (55.4 to 58.2) | 9,924  | 71.3 (69.8 to 72.7) | 1.2 (0.7 to 1.7)** | 1 | 2015–2019: −0.5 (−2.7 to 1.8) |
| Noncore (nonmetropolitan) | 4,594  | 51.5 (50.0 to 53.3) | 7,747  | 73.8 (72.1 to 75.4) | 1.9 (1.5 to 2.4)** | 1 | 2019–2011: 2.5 (2.0 to 3.1)** |
| U.S. Census Bureau region†† |      |      |      |      |      |      |
| Northeast                | 11,163 | 48.1 (47.2 to 49.0) | 12,250 | 42.1 (41.3 to 42.8) | −0.5 (−0.7 to −0.3)** | 0 | — |
| Midwest                  | 14,028 | 54.9 (54.0 to 55.8) | 19,234 | 58.9 (58.0 to 59.7) | 0.6 (0.0 to 1.1)** | 1 | 2013–2019: −0.7 (−2.2 to 0.8) |
| South                    | 20,319 | 54.5 (53.7 to 55.2) | 33,644 | 59.3 (58.6 to 59.9) | 0.3 (−0.3 to 1.0) | 1 | 2017–2019: −3.4 (−9.4 to 3.1) |
| West                     | 12,530 | 61.6 (60.5 to 62.7) | 15,294 | 46.0 (45.3 to 46.7) | −1.2 (−1.4 to −1.0)** | 0 | — |
| **Men**                  |      |      |      |      |      |      |
| Overall                  | 60,416 | 88.2 (87.4 to 88.9) | 71,991 | 62.8 (62.3 to 63.2) | −1.3 (−1.5 to −1.1)** | 0 | — |
| **Urban-rural status‡**  |      |      |      |      |      |      |
| Large central metropolitan | 14,618 | 77.7 (76.5 to 79.0) | 14,452 | 48.0 (47.2 to 48.8) | −1.9 (−2.1 to −1.7)** | 0 | — |
| Large fringe metropolitan  | 11,981 | 79.1 (77.6 to 80.5) | 15,122 | 54.2 (53.3 to 55.1) | −1.6 (−1.8 to −1.4)** | 0 | — |
| Medium metropolitan       | 13,092 | 91.0 (89.5 to 92.6) | 16,194 | 64.8 (63.8 to 65.8) | −1.3 (−1.5 to −1.1)** | 0 | — |
| Small metropolitan        | 6,786  | 99.8 (97.4 to 102.2) | 8,706  | 75.5 (73.9 to 77.2) | −1.0 (−1.2 to −0.8)** | 0 | — |
| Micropolitan (nonmetropolitan) | 7,433 | 102.5 (100.2 to 104.9) | 9,641  | 87.0 (85.2 to 88.8) | −0.6 (−0.8 to −0.5)** | 0 | — |
| Noncore (nonmetropolitan) | 6,506  | 106.6 (104.0 to 109.2) | 7,876  | 90.2 (88.2 to 92.2) | −0.4 (−0.6 to −0.1)** | 0 | — |
| U.S. Census Bureau region†† |      |      |      |      |      |      |
| Northeast                | 10,574 | 75.6 (74.1 to 77.0) | 10,187 | 49.5 (48.6 to 50.5) | −1.8 (−2.0 to −1.5)** | 0 | — |
| Midwest                  | 14,886 | 92.3 (90.8 to 93.8) | 17,398 | 70.7 (69.6 to 71.7) | −0.9 (−1.2 to −0.7)** | 0 | — |
| South                    | 22,415 | 92.4 (91.2 to 93.7) | 29,956 | 69.0 (68.2 to 69.8) | −1.1 (−1.3 to −0.9)** | 0 | — |
| West                     | 12,541 | 88.6 (87.0 to 90.2) | 14,450 | 55.6 (54.7 to 56.5) | −2.0 (−2.2 to −1.8)** | 0 | — |

**Abbreviations:** AAPC = average annual percent change; APC = annual percent change; COPD = chronic obstructive pulmonary disease.

* Per 100,000 standard population. Age-adjusted COPD mortality rates were calculated using the 2000 U.S. Census Bureau projected population and 10-year age groups.

†† CPT trends were assessed as the AAPC from 1999 to 2019 and as the APC for segment-specific periods when a joinpoint was detected.

§ Dashes indicate that the best-fit joinpoint model did not include any trend segments.

‡ As defined in the CDC National Center for Health Statistics 2013 Urban-Rural Classification Scheme for Counties with six urbanization levels: four metropolitan (large central metropolitan, large fringe metropolitan, medium metropolitan, and small metropolitan) and two nonmetropolitan (micropolitan and noncore).

https://www.cdc.gov/nchs/data/series/sr_02/sr02_166.pdf

** Significant difference from 0 at p<0.05. For APCs and for AAPCs within one segment (e.g., no joinpoint), the t-distribution is used. For AAPCs within multiple segments (e.g., one joinpoint), the normal (z) distribution is used.

†† U.S. Census Bureau regions: **Northeast:** Connecticut; Maine, Massachusetts; New Hampshire; New Jersey; New York; Pennsylvania; Rhode Island, and Vermont. **Midwest:** Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin. **South:** Alabama, Arkansas, Delaware, District of Columbia, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, and West Virginia. **West:** Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming. https://www2.census.gov/geo/pdfs/maps-data/maps/reference/us_regdiv.pdf

---

fringe (−0.4%) metropolitan areas, did not change significantly in medium metropolitan areas, and increased significantly in small metropolitan (0.6%), micropolitan (1.2%), and noncore (1.9%) areas. The change in COPD mortality rates among women was not significant when analysis was limited to later years in medium metropolitan (2017–2019) and in micropolitan areas (2015–2019); the increase in rates slowed in noncore areas after 2011. COPD mortality rates among men decreased in all urban-rural categories (range = −1.9% [large central metropolitan] to −0.4% [noncore]).

Among women, rates decreased significantly in 17 states (AAPC range = −1.9% [California] to −0.4% [New Jersey and Arizona]) and increased significantly in 18 states (range = 0.4% [Wisconsin] to 2.9% [Arkansas]) (Figure 2) (Supplementary Table; https://stacks.cdc.gov/view/cdc/116406). Among men, rates decreased significantly in 45 states and the District of

---

**US Department of Health and Human Services/Centers for Disease Control and Prevention**

**MMWR / May 6, 2022 / Vol. 71 / No. 18**

---

**615**
FIGURE 1. Sex-specific trends in age-adjusted chronic obstructive pulmonary disease mortality rates among adults aged ≥25 years,* by urban-rural status† — United States, 1999–2019

Abbreviation: COPD = chronic obstructive pulmonary disease.
* Per 100,000 population. Age-adjusted COPD mortality rates were calculated using the 2000 U.S. Census Bureau projected population and 10-year age groups.
† As defined in the CDC National Center for Health Statistics 2013 Urban-Rural Classification Scheme for Counties with six urbanization levels: four metropolitan (large central metro, large fringe metro, medium metro, and small metro) and two nonmetropolitan (micropolitan and noncore). https://www.cdc.gov/nchs/data/series/sr_02/sr02_166.pdf
FIGURE 2. State-level changes* in sex-specific age-adjusted chronic obstructive pulmonary disease mortality rates† among adults aged ≥25 years — United States, 1999–2019

Abbreviations: AAPC = average annual percent change; COPD = chronic obstructive pulmonary disease; DC = District of Columbia.
* Statistically significant changes were determined using the estimated AAPC with all years included (1999–2019). AAPCs significantly <0 were interpreted as a significant decrease while those significantly >0 were interpreted as a significant increase.
† Per 100,000 population. Age-adjusted COPD mortality rates were calculated using the 2000 U.S. Census Bureau projected population and 10-year age groups.

Columbia (range = −4.2% [Alaska] to −0.3% [Indiana]) and increased significantly in Arkansas (0.5%). State-level mortality rates among women ranged from 24.0 (Hawaii) to 93.9 (Wyoming) in 1999 and 16.7 (Hawaii) to 89.8 (West Virginia) in 2019. Among men, rates ranged from 41.9 (Hawaii) to 143.2 (Wyoming) in 1999 and from 30.4 (District of Columbia) to 104.0 (Oklahoma) in 2019.

Discussion

Age-adjusted COPD mortality rates decreased among men from 1999 to 2019; however, rates remained higher in men than women. Among women, although overall rates exhibited no significant change, rates increased among some geographic subgroups, including women living in the Midwest and those living in small metropolitan or nonmetropolitan areas. Among both men and women, urban-rural disparities became more pronounced during this time. Efforts are needed to continue the decreasing trend in COPD mortality rates among men and improve the trend among women. Findings highlight several important geographical areas to focus COPD prevention (e.g., smoking cessation), early diagnosis, treatment (e.g., medication and oxygen therapy), and management strategies (e.g., pulmonary rehabilitation; efforts to slow declining lung function, improve exercise tolerance, and prevent exacerbations).

COPD mortality might differ by sex for several reasons. First, tobacco smoking is the main cause of COPD in the United States, and cigarette smoking declined first among men (since the 1960s) and later among women (since the 1980s) (2). Second, women might be more vulnerable to the effects of tobacco (2–4). Third, women account for most patients with COPD who have never smoked, suggesting that women might be more susceptible to secondhand smoke or nonsmoking-related factors (3,5,6). Fourth, disease presentation and rates of exacerbations might differ by sex which can result in delayed diagnosis and higher rates of exacerbations in women (3,4). Finally, women with COPD also face challenges related to their interactions with the health care system (3). Women face higher rates of misdiagnosis or delayed diagnosis that can potentially lead to suboptimal treatment (3,4). Improving understanding about the reasons for the increasing COPD mortality rates in certain subgroups of women can help guide the development and implementation of prevention, early diagnosis, treatment, and management strategies that are specifically tailored for women.

Region-specific patterns in COPD mortality in 2019 were similar among men and women (e.g., highest in the Midwest and South), and urban-rural disparities became more pronounced among both women and men during the past 20 years. For example, in 1999 there was no significant difference in rates between large central metropolitan areas and noncore areas among women, but in 2019 the rate was 84% higher in noncore areas. Similarly, for men the relative difference between these two areas increased from 37% in 1999 to 88% in 2019. These findings update previous studies that examined geographic differences in COPD prevalence and...
Continued efforts are needed to prevent COPD and support early diagnosis, treatment (e.g., medication and oxygen therapy), and management (e.g., pulmonary rehabilitation). In addition, strategies that help improve the trend among women and address geographic differences have the potential to reduce COPD mortality.

Corresponding author: Susan A. Carlson, clo3@cdc.gov, 770-488-6091.

All authors have completed and submitted the International Committee of Medical Journal Editors form for disclosure of potential conflicts of interest. No potential conflicts of interest were disclosed.

**References**

1. Zarrabian B, Mirsaedidi M. A trend analysis of chronic obstructive pulmonary disease mortality in the United States by race and sex. Ann Am Thorac Soc 2021;18:1138–46. PMID:33547376 https://doi.org/10.1513/AnnalsATS.202007-822OC
2. CDC. The health consequences of smoking—50 years of progress: a report of the Surgeon General. Atlanta, GA: US Department of Health and Human Services, CDC; 2014. https://www.ncbi.nlm.nih.gov/books/NBK179276/pdf/Bookshelf_NBK179276.pdf
3. Aryal S, Diaz-Guzman E, Mannino DM. Influence of sex on chronic obstructive pulmonary disease risk and treatment outcomes. Int J Chron Obstruct Pulmon Dis 2014;9:1145–54. PMID:25342899
4. Jenkins CR, Chapman KR, Donohue JF, Roche N, Tsiliogianni I, Han MK. Improving the management of COPD in women. Chest 2017;151:686–96. PMID:27816445 https://doi.org/10.1016/j.chest.2016.10.031
5. Salvi SS, Barnes PJ. Chronic obstructive pulmonary disease in non-smokers. Lancet 2009;374:733–43. PMID:19716966 https://doi.org/10.1016/S0140-6736(09)61303-9
6. Celi BR, Halbert RJ, Nordyke RJ, Schau B. Airway obstruction in never smokers: results from the Third National Health and Nutrition Examination Survey. Am J Med 2005;118:1364–72. PMID:16378780 https://doi.org/10.1016/j.amjmed.2005.06.041
7. Croft JB, Wheaton AG, Liu Y, et al. Urban-rural county and state differences in chronic obstructive pulmonary disease—United States, 2015. MMWR Morb Mortal Wkly Rep 2018;67:205–11. PMID:29470455 https://doi.org/10.15585/mmwr.mm6707a1
8. Wheaton AG, Liu Y, Croft JB, et al. Chronic obstructive pulmonary disease and smoking status—United States, 2017. MMWR Morb Mortal Wkly Rep 2019;68:533–8. PMID:31220055 https://doi.org/10.15585/mmwr.mm6824a1
9. Moore P, Atkins GT, Cramb S, et al. COPD and rural health: a dialogue on the National Action Plan. J Rural Health 2019;35:424–8. PMID:30677167 https://doi.org/10.1111/jrhe.12346
10. Croft JB, Lu H, Zhang X, Holt JB. Geographic accessibility of pulmonologists for adults with COPD: United States, 2013. Chest 2016;150:544–53. PMID:27221645 https://doi.org/10.1016/j.chest.2016.05.014

**Summary**

What is already known about this topic?

Chronic obstructive pulmonary disease (COPD) accounts for most deaths from chronic lower respiratory diseases, the fourth leading cause of death in 2019 in the United States. COPD mortality rates are decreasing overall.

What is added by this report?

From 1999 to 2019, overall age-adjusted COPD mortality rates among women did not change; however, rates increased among women living in the Midwest and those in small metropolitan or nonmetropolitan areas. COPD mortality rates are higher among men; however, rates decreased overall and among all regional and urban-rural subgroups.

What are the implications for public health practice?

To reduce COPD deaths, strategies to improve the prevention, treatment, and management of COPD are needed, especially strategies that address geographic differences and improve the trend among women.

Mortality (7,8). The COPD National Action Plan§§ provides a comprehensive framework for developing and implementing COPD prevention, treatment, and management strategies. Developing strategies that maximize the use of setting-specific resources (e.g., engaging existing stakeholders as well as providing patient-centric clinical guidelines to health care providers most likely to deliver COPD care within a setting) and help adults overcome setting-specific challenges are important in reducing urban-rural, regional, and state-level disparities in COPD mortality overall (9). For example, adults in rural areas might be more likely to experience challenges related to access (e.g., less access to pulmonologists and longer travel distances to health care facilities) (10) and cost (e.g., higher likelihood of being uninsured or having a lower socioeconomic status).¶¶

The findings in this report are subject to at least two limitations. First, COPD mortality might be underestimated because adults with COPD are more likely to have comorbidities (e.g., cardiovascular disease, stroke, diabetes, or cancer) (1,8) that might displace COPD as the underlying cause reported on the death certificate. Second, the 2013 CDC National Center for Health Statistics Urban-Rural Classification Scheme for Counties is well-suited to assessing and monitoring health differences across the full urbanization continuum; however, the assumption that the six urban-rural classifications reflect consistent types of distinct populations and social environments within and across each state could be an oversimplification.

§§ https://www.ruralhealthweb.org/about-nrha/about-rural-health-care

¶¶ https://www.nhlbi.nih.gov/health-topics/all-publications-and-resources/copd-national-action-plan

https://www.ruralhealthweb.org/about-nrha/about-rural-health-care

https://www.cdc.gov/mmwr/preview/mmwrhtml/mm6824a1.htm

https://www.cdc.gov/mmwr/preview/mmwrhtml/mm6824a2.htm

https://www.cdc.gov/mmwr/preview/mmwrhtml/mm6824a3.htm

https://www.cdc.gov/mmwr/preview/mmwrhtml/mm6824a4.htm