

REVIEW ARTICLE

Coronary artery disease-related mortality among older adults with essential hypertension in the United States, 1999-2020: a retrospective CDC WONDER analysis

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ABSTRACT

Background: Coronary artery disease (CAD) and essential hypertension (HTN) frequently coexist in late life and remain dominant drivers of cardiovascular mortality in the United States. We evaluated national trends and demographic disparities in CAD related mortality among older adults (≥65 years) with essential HTN from 1999 to 2020.

Methods: We queried the Centers for Disease Control and Prevention Wide ranging Online Data for Epidemiologic Research Multiple Cause of Death files. Deaths listing essential HTN (ICD 10 I10) and ischemic heart disease/CAD (ICD 10 I20-I25) as underlying or contributing causes were included. We calculated annual age adjusted mortality rates (AAMRs) per 100,000 using the 2000 U.S. standard population and estimated annual percent change (APC) and average APC (AAPC) with Joinpoint regression (Version 5.1.0). Analyses were stratified by sex, race/ethnicity, U.S. Census region, urbanization, place of death, and state.

Results: We identified 1,878,811 deaths in older adults with coexisting essential HTN and CAD from 1999 to 2020. The overall AAMR rose sharply between 1999 and 2001 (APC, 67.81%; 95% CI, 13.99-123.72) and then declined modestly from 2001 to 2020 (APC, −1.22%; 95% CI, −2.50 to −0.20); overall AAPC was 3.89% (95% CI, 1.16-6.60). Men had consistently higher AAMRs than women across all years (period means, 244.9 vs. 172.3 per 100,000). Non Hispanic (NH) Black older adults experienced the highest mean AAMR (271.1), followed by NH White (200.0), Hispanic (181.6), American Indian/Alaska Native (195.8), and Asian (149.2) populations. Regional rates were highest in the Midwest and South during the early 2000s, with declines thereafter; non metropolitan counties exhibited persistently higher AAMRs than metropolitan counties. Home and hospice deaths increased substantially over time, with a marked surge in 2020. State level AAMRs ranged from 104.7 (Utah) to 310.9 (Oklahoma).

Conclusions: Among U.S. older adults with essential HTN and CAD, mortality surged around the turn of the millennium and then declined slowly through 2020, with substantial and persistent disparities by sex, race/ethnicity, geography, and urbanization. These findings underscore the need for renewed, equity focused strategies to improve blood pressure control, secondary prevention of CAD, and access to high-quality cardiovascular care, particularly for NH Black and rural populations.

Keywords: Coronary Artery Disease, Mortality, Essential Hypertension, United States, CDC WONDER

Introduction

Essential hypertension (HTN) remains highly prevalent in the aging U.S. population and is a principal modifiable risk factor for coronary artery disease (CAD), heart failure, stroke, and premature death [1]. Persistent elevation of blood pressure accelerates atherosclerosis, left ventricular hypertrophy, and endothelial dysfunction, thereby compounding CAD risk and severity in older adults [2]. National survey and claims–linked data show

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a very high burden of HTN among older adults and substantial treatment intensity, yet blood pressure control has worsened in the past decade, threatening progress against coronary deaths [1,3].

After decades of decline, U.S. coronary mortality experienced stagnation beginning in the early 2010s, with widening demographic and geographic gaps [4,5]. Rural counties, in particular, have faced slower improvements and higher mortality than urban counties, reflecting differences in cardiovascular risk profiles, care access, and socioeconomic context [5].

Population-level studies using the Centers for Disease Control and Prevention (CDC) Wide-ranging Online Data for Epidemiologic Research (WONDER) Multiple Cause of Death (MCD) resource enable reproducible assessment of temporal trends and disparities across sex, race/ethnicity, regions, and urbanization classes [6]. Building on this approach, we tested the hypothesis that, among older adults, CAD-related mortality in those with essential HTN displays distinct temporal trends with sizeable disparities by demographic and geographic strata.

Methods

Study setting and population

We conducted a retrospective, population-based analysis using CDC WONDER MCD files for 1999–2020, which compile physician-certified death certificate data from all 50 states and the District of Columbia. This national vital statistics system captures underlying and contributing causes of death codified with ICD-10 and is widely used for cardiovascular surveillance [7]. In accordance with the TITAN Guidelines 2025 for transparent use of AI in scholarly communication, no AI tools were used in the research design, data collection, analysis, or interpretation; AI assistance was limited solely to language refinement during manuscript preparation [8]. Institutional review board approval was not required because the data are publicly available and de-identified. Reporting followed STROBE guidelines [9].

We included deaths in persons aged ≥65 years in which essential (primary) HTN (ICD-10 I10) and ischemic heart disease/CAD (ICD-10 I20-I25) appeared anywhere on the death certificate (underlying or contributing). Use of these code groups to represent HTN and ischemic heart disease is consistent with prior validation and surveillance studies [10,11].

Variables and stratifications

We abstracted annual counts and annual age-adjusted mortality rates (AAMRs) (per 100,000) overall and by sex (men, women); race/ethnicity [Non-Hispanic (NH) White, NH Black, NH American Indian/Alaska Native, NH Asian/Pacific Islander, Hispanic/Latino]; U.S. Census region (Northeast, Midwest, South, West); urbanization (metropolitan *vs.* non-metropolitan) using the 2013 NCHS Urban-Rural Classification Scheme for Counties; place of death (medical facility, nursing home/long-term care, hospice facility, home); and state [12].

Outcomes

The primary outcome was the AAMR per 100,000 U.S. population aged ≥65 years. AAMRs were directly standardized to the 2000 U.S. standard population in accordance with National Center for Health Statistics guidance.

Statistical analysis

Temporal trends in AAMRs from 1999 to 2020 were modeled with Joinpoint regression (Joinpoint Regression Program, Version 5.1.0; National Cancer Institute) [13]. We estimated annual percent change (APC) for each linear segment and average APC (AAPC) across the full period, with 95% confidence intervals calculated via the permutation test and grid-search approach. Statistical significance was defined as two-sided $p \leq 0.05$. Analyses were stratified by all variables specified above.

Results

Overall burden and time trends

From 1999 to 2020, there were 1,878,811 deaths among older adults with coexisting essential HTN and CAD in the United States. The overall AAMR climbed abruptly between 1999 and 2001 (APC, 67.81%; 95% CI, 13.99-123.72) and then declined between 2001 and 2020 (APC, −1.22%; 95% CI, −2.50 to −0.20). Across the full interval, the AAPC was 3.89% (95% CI, 1.16-6.60). Deaths at home and in hospice facilities rose steadily, with a dramatic increase in 2020 (home, 45,785 deaths; hospice, 5,397), while medical-facility deaths also increased in 2020. Cumulative deaths over 1999–2020 were 561,207 at home, 496,872 in nursing homes/long-term care, 471,189 in medical facilities, and 49,739 in hospice facilities (Figure 1, Supp lementary tables 1-3).

Sex

Men consistently exhibited higher AAMRs than women throughout the study period (period means, 244.88 *vs.* 172.31 per 100,000). In 2020, AAMRs were 293.6 in men and 169.2 in women. Joinpoint analysis showed a significant early increase for both sexes (1999-2001), followed by a larger decline among women (2001-2020 APC, −2.10%) than men (APC, −0.25%, not significant) (Figure 1, Supplementary tables 1, 3, and 4).

Race and ethnicity

Among American Indian or Alaska Native individuals, there was a statistically significant increase in rates from 1999 to 2005 with an APC of 11.81% (95% CI: 2.90-72.97, $p = 0.0028$), followed by a significant decline from 2005 to 2020 with an APC of −1.98% (95% CI: −4.98 to −0.34, $p = 0.0176$). The Asian or Pacific Islander group showed a non-significant increase from 1999 to 2001 (APC: 46.31%, 95% CI: −0.61 to 96.35, $p = 0.0644$), but a significant decline thereafter from 2001 to 2020 (APC: −2.38%, 95% CI: −4.26 to −1.32, $p = 0.0212$).

For the Black or African American population, there was an initial non-significant increase between 1999 and 2001 (APC: 54.93%, 95% CI: −0.04 to 121.36, $p = 0.0512$), followed by a significant decrease from 2001 to 2020 (APC: −2.61%, 95% CI: −5.13 to −1.42, $p = 0.0164$). The White population experienced a significant rise between 1999 and 2001 (APC: 49.97%, 95% CI: 2.30-105.55, $p = 0.0164$), but the decline from 2001 to 2020 was not statistically significant (APC: −0.80%, 95% CI: −2.37 to 0.14, $p = 0.0904$).

The Hispanic or Latino group showed the most complex trend with two joinpoints. From 1999 to 2001, there was a sharp significant increase (APC: 61.21%, 95% CI: 11.73-110.21, $p = 0.0028$), followed by a significant decline from 2001 to 2018 (APC: −2.27%, 95% CI: −6.23 to −1.42, $p = 0.0028$), and a subsequent significant rise from 2018 to 2020 (APC: 14.70%, 95% CI: 0.09-25.42, $p = 0.0456$). These results demonstrate dynamic and divergent trends among racial and ethnic groups, with some experiencing recent improvements while others show concerning reversals (Figure 2, Supplementary tables 1, 3, and 5).

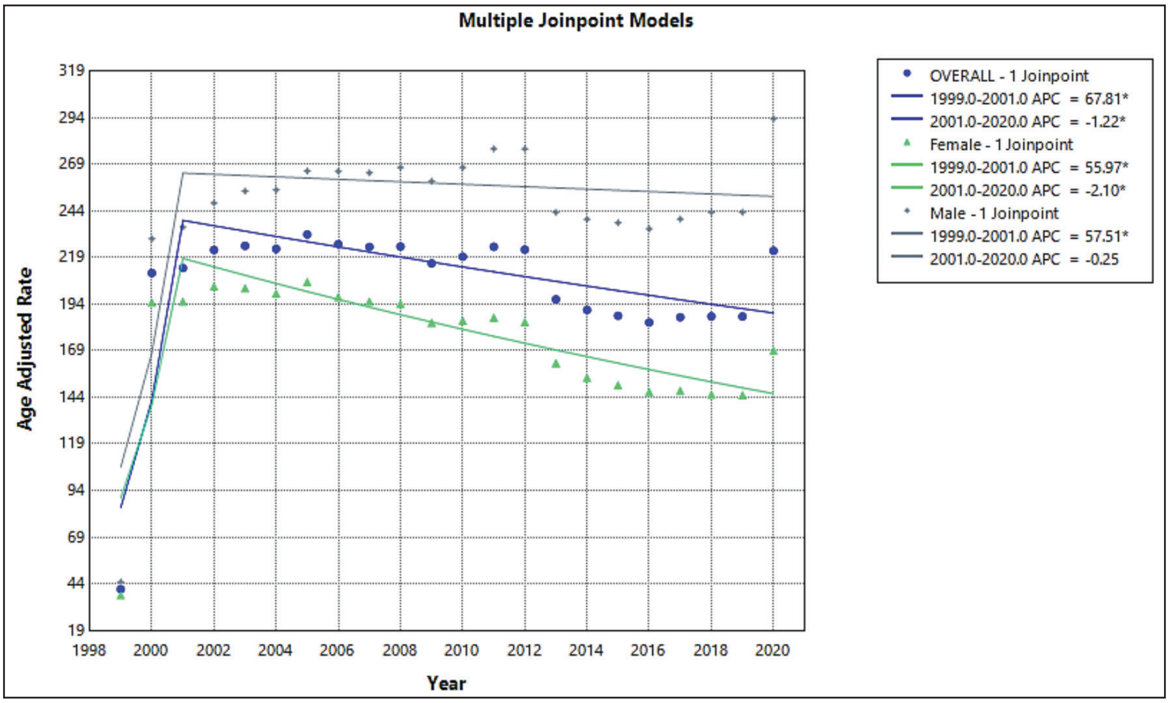


Figure 1. *Trends and disparities in mortalities rates among U.S. Older adults (>64) based on sex, from 1999 to 2020.*

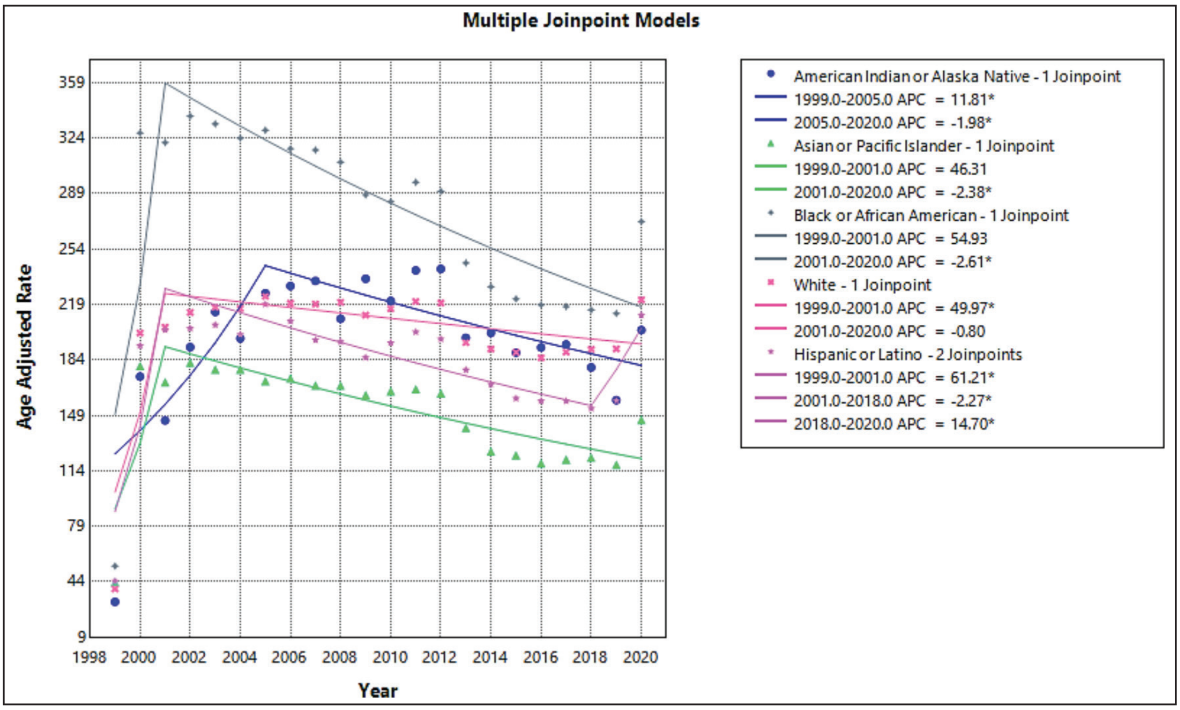


Figure 2. *Trends and disparities in mortalities rates among U.S. Older adults (>64) based on race, from 1999 to 2020.*

Census region

During the initial segment (1999-2001), all regions showed a sharp and significant increase in rates: the Midwest had the steepest rise with an APC of +57.89% (95% CI: 7.22-109.25, $p = 0.008$), followed by the South with an APC of +54.47% (95% CI: −0.80 to 147.97, $p = 0.070$), Northeast with +53.42% (95% CI: 5.37-104.29, $p = 0.012$), and West with +51.25% (95% CI: 15.98-82.02, $p = 0.0008$). However, post-2001 (2001-2020), all regions experienced a statistically significant decline except the South. The West had the most marked decrease (APC: −1.67%, 95% CI: −2.56 to −0.92, $p = 0.0008$), followed by the Northeast (−1.30%, 95% CI: −2.79 to −0.33, $p = 0.016$) and the Midwest (−1.22%, 95% CI: −2.67 to −0.22, $p = 0.022$). In contrast, the South showed a non-significant and minimal decrease (APC: −0.71%, 95% CI: −10.05 to 1.42, $p = 0.228$). These findings suggest an early sharp rise followed by a gradual, regionally varied decline in age-adjusted rates after 2001, with the South lagging in improvement (Figure 3, Supplementary tables 3 and 6).

Urbanization

Non-metropolitan counties had higher period-mean AAMRs than metropolitan counties (228.2 *vs.* 197.9

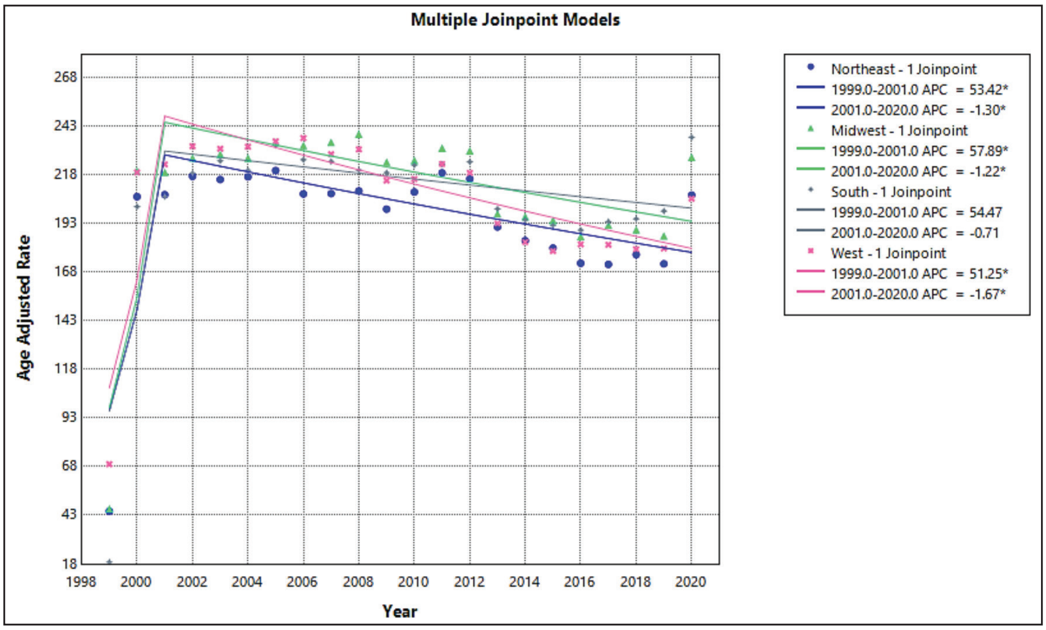


Figure 3. *Trends and disparities in mortalities rates among U.S. Older adults (>64) based on census, from 1999 to 2020.*

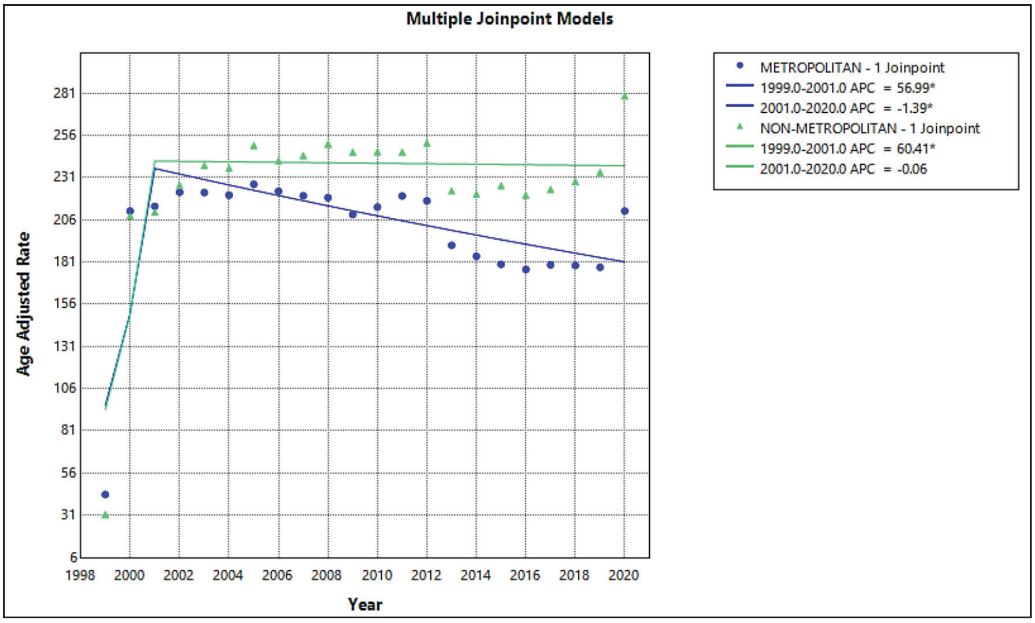
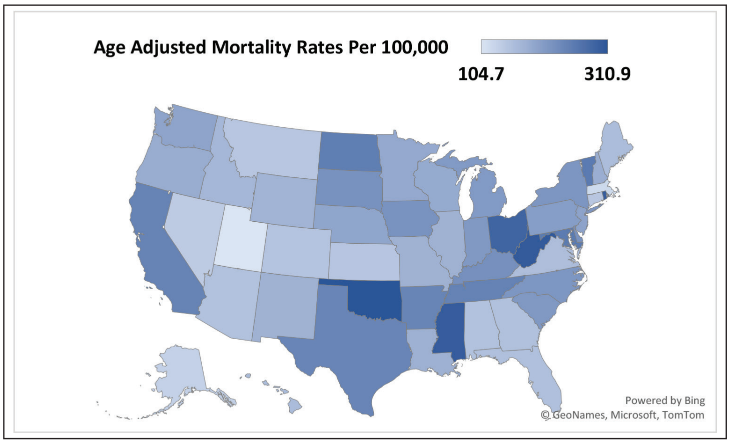


Figure 4. *Trends and disparities in mortalities rates among U.S. Older adults (>64) based on urbanization, from 1999 to 2020.*



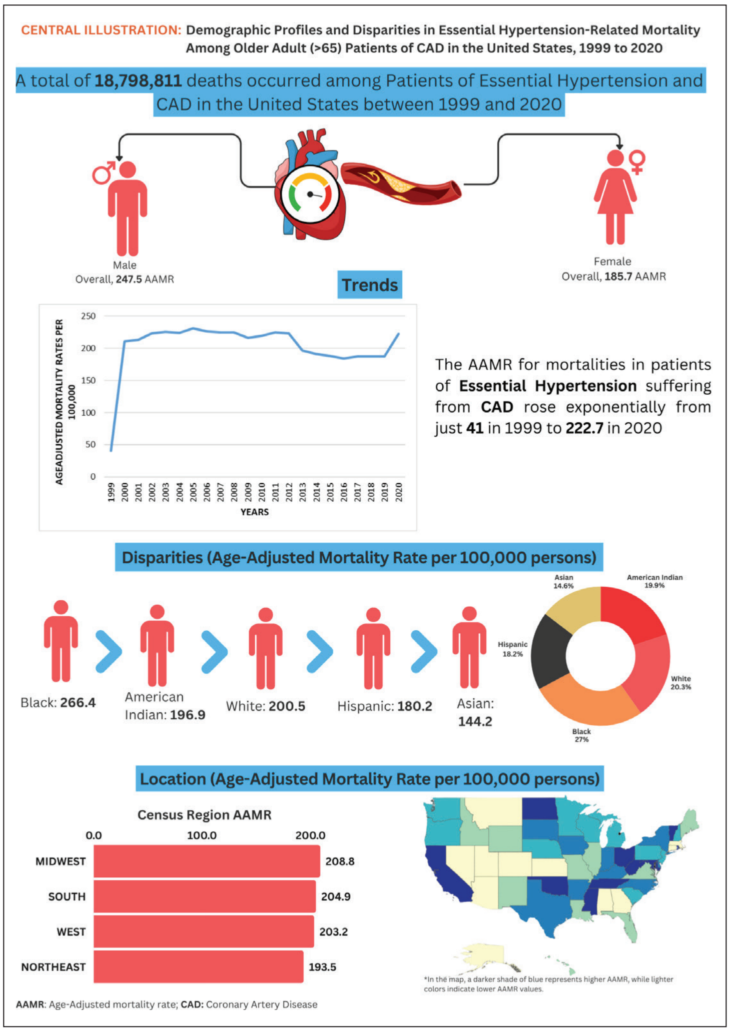


Figure 5. *Trends and disparities in mortalities rates among U.S. Older adults (>64) based on states.*

per 100,000). Metropolitan areas showed a significant decline from 2001 to 2020 (APC, −1.39%), whereas non-metropolitan areas were approximately flat (APC, −0.06%, $p = 0.84$) (Figure 4, Supplementary tables 3 and 7).

States

State AAMRs varied widely. The highest rates were observed in Oklahoma (310.9), West Virginia (303.7), Mississippi (300.8), Rhode Island (298.7), and Ohio (288.2). The lowest rates were in Utah (104.7), Massachusetts (119.8), Alaska (130.8), Nevada (137.8), and Kansas (146.1) (Figure 5, Supplementary table 8).

Discussion

In this nationwide analysis of more than 1.87 million deaths among older U.S. adults with essential HTN and CAD, we observed a sharp surge in mortality around 1999-2001 followed by a prolonged, modest decline through 2020. Despite this overall improvement, large and persistent disparities were evident men, NH Black individuals, residents of non-metropolitan counties, and several states in the South and Appalachian regions bore disproportionate burdens. These patterns align with and extend prior observations of stalled progress in coronary mortality and widening inequities in cardiovascular outcomes across the United States [14,15] (Central Illustration).

Sex differences

Men had substantially higher AAMRs than women throughout the period. Biological differences in atherosclerotic progression, cumulative exposure to risk factors, and lower rates of preventive care and risk-factor control among men likely contribute to the gap. Moreover, men historically demonstrate lower primary-care engagement and medication adherence, which may blunt the benefits of antihypertensive therapy and secondary CAD prevention [16,17].

Race/ethnicity

NH Black older adults experienced the highest average mortality despite significant declines after 2001. This pattern mirrors entrenched disparities in HTN prevalence, earlier onset and severity of high blood pressure, suboptimal control, and reduced access to specialty cardiovascular care. Structural and place-based determinants, including differential access to high-quality primary care, healthy food, safe spaces for physical activity, and income/wealth gaps, further amplify risk and impede optimal secondary prevention [2,18]

The excess burden in non-metropolitan counties is consistent with reports of slower gains in cardiovascular mortality in rural America, attributable to higher prevalence of cardiometabolic risk, shortages of clinicians (particularly cardiology and cardiac rehabilitation), longer travel times for emergency care, limited procedural capability, and socioeconomic disadvantage. Interventions that expand team-based HTN management, telecardiology, home BP monitoring, cardiac rehabilitation participation, and timely revascularization, where indicated may help narrow these gaps [1,15]. The early spike followed by a drift downward likely reflects the transition to the Year-2000 age standard (which increases absolute age-adjusted rates relative to the 1940 standard) and rapid diffusion of evidence-based CAD therapies and antihypertensive regimens in the early 2000s, offset by subsequent headwinds including worsening national BP control, obesity, diabetes, and social risk [19,20].

Recent perturbations

Although our series ends in 2020, we observed a marked rise in home and facility deaths that year. Multiple studies have documented excess cardiovascular mortality during the first pandemic year, driven by infection-related events, care avoidance, strained emergency systems, and delays in time-sensitive care. Sustained surveillance is warranted to characterize post-2020 trajectories in this high-risk population [18,21].

Implications

Our findings support multilevel strategies: 1) restore national blood-pressure control through guideline-concordant combination therapy, team-based care, and home monitoring; 2) strengthen secondary prevention for CAD (statins, antiplatelet therapy as appropriate, cardiac rehabilitation); 3) resource rural and safety-net systems to improve access to cardiology and advanced therapies; and 4) implement culturally tailored, community-engaged programs to reduce inequities among NH Black and other underserved groups [18,22].

Limitations

This study is subject to limitations inherent to death-certificate research. Misclassification can occur when HTN or CAD are under-documented or miscoded on certificates, potentially biasing rates downward or differentially across groups. ICD-10 coding captures presence but not severity, duration, treatment, or control of HTN and CAD; nor does WONDER include granular socioeconomic variables. The Year-2000 age standard alters absolute AAMR magnitudes relative to older reports; however, temporal patterns are robust when a single standard is applied over time. Finally, our period ends in 2020; subsequent pandemic waves and recovery could further modify trends.

Conclusions

Among U.S. adults aged ≥65 years with essential HTN and coexisting CAD, mortality surged at the start of the study era and then declined modestly through 2020, with persistent excess in men, NH Black individuals, non-metropolitan counties, and several high-burden states. Reversing these inequities will require renewed national focus on blood-pressure control, comprehensive secondary prevention, and equitable access to high-quality cardiovascular care, especially in rural and historically marginalized communities.

Conflict of interests

The authors declare that there is no conflict of interest regarding the publication of this article.

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Ethical approval

Not applicable.

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Supplementary content (If any) is available online.

References:

1. Tsao CW, Aday AW, Almarzooq ZI, et al. Heart Disease and Stroke Statistics—2023 update: a report from the American Heart Association. Circulation. 2023;147(8):e93–621. https://doi.org/10.1161/CIR.0000000000001137
2. Glazier JJ. Pathophysiology, diagnosis, and management of hypertension in the elderly. Int J Angiol. 2022;31(4):222–8. https://doi.org/10.1055/s-0042-1759486
3. Yu Q, Lin S, Wu J. Hypertension prevalence rates among urban and rural older adults of China, 1991-2015: a standardization and decomposition analysis. Front Public Health. 2021;9:713730. https://doi.org/10.3389/fpubh.2021.713730
4. Wilmot KA, O'Flaherty M, Capewell S, et al. Coronary heart disease mortality declines in the United States from 1979 through 2011: evidence for stagnation in young adults, especially women. Circulation. 2015;132(11):997–1002. https://doi.org/10.1161/CIRCULATIONAHA.115.015293
5. Liu M, Marinacci LX, Joynt Maddox KE, et al. Cardiovascular health among rural and urban US adults – healthcare, lifestyle, and social factors. JAMA Cardiol. 2025;10(6):538. https://doi.org/10.1001/jamacardio.2025.0538
6. Abdullah AB, Siddiqui MR, Shaikh S, et al. Depression leading to suicide in United States: a retrospective analysis of CDC WONDER from 1999 to 2022. J Psychiatr Res. 2025;186:235–43. https://doi.org/10.1016/j.jpsychires.2025.04.016
7. Azeem B, Khurram L, Sharaf B, et al. Unmasking arrhythmia mortality: a 25-year analysis of trends and disparities in the United States (1999–2023). Clin Cardiol. 2025;48(3):e70109. https://doi.org/10.1002/clc.70109
8. Agha R, Mathew G, Rashid R, et al. Transparency in the reporting of artificial intelligence – the TITAN guideline. Premier J Sci. 2025;2025:100082. https://doi.org/10.70389/PJS.100082
9. von Elm E, Altman DG, Egger M, et al. The strengthening the reporting of observational studies in epidemiology (STROBE) statement: guidelines for reporting observational studies. J Clin Epidemiol. 2008;61(4):344–9. https://doi.org/10.1016/j.jclinepi.2007.11.008
10. Lix LM, Sobhan S, St-Jean A, et al. Validity of an algorithm to identify cardiovascular deaths from administrative health records: a multi-database population-based cohort study. BMC Health Serv Res. 2021;21(1):758. https://doi.org/10.1186/s12913-021-06762-0
11. U.S. Census Bureau. Older Population and Aging [Internet]. Available from: https://www.census.gov/topics/population/older-aging.html (Accessed 2 July 2025).
12. U.S. Census Bureau. U.S. Census Bureau QuickFacts: United States [Internet]. Available from: https://www.census.gov/quickfacts/fact/table/US/PST045224 (Accessed 2 July 2025).
13. National Cancer Institute. Joinpoint Regression Program [Internet]. Available from: https://surveillance.cancer.gov/joinpoint/ (Accessed 2 July 2025).
14. Banerjee A, Chen S, Pasea L, et al. Excess deaths in people with cardiovascular diseases during the COVID-19 pandemic. Eur J Prev Cardiol. 2021;28(14):1599–609. https://doi.org/10.1093/eurjpc/zwaa155
15. Furuse Y. Estimation of excess cardiovascular deaths after COVID-19 in 2020. J Infect. 2023;87(1):e5. https://doi.org/10.1016/j.jinf.2023.04.014
16. Kim HL. Sex differences in coronary atherogenesis: a narrative review. Ewha Med J. 2024;47(2):e15. https://doi.org/10.12771/emj.2024.e15
17. Banks E, Welsh J, Joshy G, et al. Comparison of cardiovascular disease risk factors, assessment and management in men and women, including consideration of absolute risk: a nationally representative cross-sectional study. BMJ Open. 2020;10(12):e038761. https://doi.org/10.1136/bmjopen-2020-038761
18. Oliveros E, Patel H, Kyung S, et al. Hypertension in older adults: assessment, management, and challenges. Clin Cardiol. 2019;43(2):99–108. https://doi.org/10.1002/clc.23303
19. Li J, Zhang J, Somers VK, et al. Trends and disparities in treatment and control of atherosclerotic cardiovascular disease in US adults, 1999 to 2018. J Am Heart Assoc. 2024;13(9):32527. https://doi.org/10.1161/JAHA.123.032527
20. Wijeysundera HC, Machado M, Farahati F, et al. Association of temporal trends in risk factors and treatment uptake with coronary heart disease mortality, 1994–2005. JAMA. 2010;303(18):1841–7. https://doi.org/10.1001/jama.2010.580
21. Egan BM, Mattix-Kramer HJ, Basile JN, et al. Managing hypertension in older adults. Curr Hypertens Rep. 2023;26(4):157. https://doi.org/10.1007/s11906-023-01289-7
22. Kramer MR, Valderrama AL, Casper ML. Decomposing Black-White disparities in heart disease mortality in the United States, 1973–2010: an age-period-cohort analysis. Am J Epidemiol. 2015;182(4):302–10. https://doi.org/10.1093/aje/kwv050