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Persistent Disparities in the Face of Decline: A Two-Decade Population-Based Study of Cancer Deaths Involving Renal Failure in the United States

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Research Article

Keywords: Cancer mortality, Renal failure, Multiple cause of death, Trends, Disparities, CDC WONDER

Posted Date: April 2nd, 2026

DOI: https://doi.org/10.21203/rs.3.rs-9087623/v1

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Additional Declarations: No competing interests reported.

Abstract

Background:

Cancer and renal failure often occur together in clinical practice, but national patterns of cancer deaths that also involve renal failure have not been well described.

Objectives:

To assess long term trends in cancer deaths that list renal failure as a contributing cause among U.S. adults aged 45 years and older from 1999 to 2020, and to identify key demographic and geographic differences.

Methods:

We used CDC WONDER multiple cause of death data. Cancer deaths (ICD 10 C00 to C97) that also listed renal failure anywhere on the death certificate were included. Age adjusted mortality rates were calculated, and trends were evaluated across age, sex, race, region, and urban rural status.

Results:

From 1999 to 2020, 483,738 cancer deaths involved renal failure. The national age adjusted mortality rate declined slightly over time. Higher rates were consistently seen in men, Black individuals, older adults, non-metropolitan areas, and residents of the West and Midwest. Genitourinary and hematologic cancers showed the highest mortality levels.

Conclusion:

Cancer deaths involving renal failure have decreased modestly but show clear and persistent disparities. These findings highlight the need to address gaps in cancer and kidney care, especially in high burden demographic and geographic groups.

1.Introduction

Renal failure (RF) imposes a substantial and growing burden in the United States, consistently featuring among the leading causes of mortality. In the US, diseases of the kidney, which include nephritis, nephrotic syndrome, and nephrosis, accounted for more than 55,000 deaths in recent years, placing them among the top 10 causes of death overall (1). The age-adjusted mortality rate for renal failure has exhibited complex temporal patterns over the past two decades, with some periods of decline and resurgence (2). Meanwhile, cancer remains the second leading cause of death nationally, accounting for over 600,000 fatalities annually (3)(4). In clinical and epidemiologic practice, patients with renal failure frequently harbor malignancies, whether as antecedent, concomitant, or complicating diagnoses, yet the joint mortality patterns involving renal failure due to malignant neoplasm remain understudied.

Prior investigations have explored mortality trends in chronic kidney disease and cancer separately, as well as the clinical outcomes of patients with both conditions (5). However, few studies have quantified how cancers co-occur on death certificates alongside renal failure, how those patterns have shifted over time, and how they vary by demographic variables such as age, sex, and race. Understanding these patterns could illuminate the burden of comorbidity, enhance cause-of-death surveillance, and encourage hypothesis generation on pathophysiologic or treatment interactions. Therefore, in the present study, we analyze national multiple-cause mortality data from 1999 to 2020, among adults ≥ 45 years of age within the United States, to evaluate demographic and regional differences.

2. Methodology

We analyzed U.S. death certificate data from the Centers for Disease Control and Prevention (CDC) Wide-Ranging Online Data for Epidemiologic Research (WONDER) Multiple Cause-of-Death database (6). Mortality data were extracted for individuals aged 45 years or older between January 1, 1999, and December 31, 2020. The primary outcome was deaths due to Malignant Neoplasms (MN), defined as International Classification of Diseases, 10th Revision (ICD-10) codes (C00-C97) listed as an Underlying Cause of Death (UCD) and Renal Failure (RF) (N17-N19) listed anywhere in the death certificate as a contributing factor or Multiple Cause of Death (MCD). ICD-10 definitions were applied in accordance with international and U.S. coding standards (7). Since CDC WONDER contains de-identified data, this study was exempt from the Institutional Review Board (IRB) approval and complies with Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines.

2.1 Stratification:

Analyses were stratified by calendar year (1999–2020), sex (male, female), race (American Indian or Alaska Native; Asian or Pacific Islander; Black or African American; White), ethnicity (Hispanic or Latino; non-Hispanic or Latino), 2013 National Center for Health Statistics (NCHS) urban–rural classification (Metropolitan and Non-metropolitan), and US Census region (Northeast, Midwest, South, West). Age groups were defined as 20-year age groups: 45–64, 65–84, and 85 + years, since such complications are often rare in younger demographics, our study excluded individuals below the age of 45 to avoid noise in the analysis. in alignment with CDC WONDER standards to ensure stable mortality estimates. Race and ethnicity categories reflect those recorded on death certificates in accordance with Office of Management and Budget (OMB) standards (8). Place of death (medical facility, home, hospice, nursing home/long-term care) was obtained for descriptive reporting only. To assess variation across cancer types, sites were stratified by anatomical region (digestive, respiratory/intrathoracic, genitourinary, and lymphoid/hematopoietic) to identify regions with the highest mortality burden.

2.2 Statistical Analysis:

Age-adjusted mortality rates (AAMRs) were calculated per 100,000 populations by the direct method, standardized to the 2000 U.S. standard population, with 95% confidence intervals provided by WONDER (9). RF and Cancer related mortality trends were examined for yearly changes, age, demographics, and geographical locations. Temporal trends in AAMR were evaluated using the Joinpoint Regression Program (v4.9.0.0, National Cancer Institute) (10). Log-linear segmented regression models estimated annual percent change (APC) and detected inflection points where slopes changed significantly. To categorize APCs as increasing or decreasing,

we evaluated their statistical deviation from the null hypothesis of zero change. Statistical significance was determined using a two-tailed t-test with a threshold of $p < 0.05$. CDC WONDER suppresses cells with counts < 10; suppressed estimates were excluded or aggregated.

3. Results

A total of 483,738 deaths from malignant neoplasms with renal failure as a multiple cause occurred in the United States between 1999 and 2020 among adults aged ≥ 45 years. Of these, 40.5% were women and 59.5% were men (Supplemental Table 1). Information on the place of death was available for 482,669 deaths. Among these, 56.4% occurred in medical facilities, 21.5% in homes, 13.5% in nursing homes or long-term care facilities, 5.2% in hospices, and 3.1% in other settings, while 0.2% were of unknown location (Supplemental Table 2).

3.1 Annual Trend

The AAMR for malignant neoplasm deaths with renal failure as a multiple cause was 18.5 (95% CI: 18.3 to 18.8) in 1999 and 16.7 (95% CI: 16.5 to16.9) in 2020 (Fig. 1, Supplemental Table 3, 10). The overall AAMR showed a slight increase from 1999 to 2012 [APC: 0.71 (95% CI: − 0.01 to 1.43)], followed by a steep yet non-significant decline from 2012 to 2015 [APC: − 8.09 (95% CI: − 21.44 to 7.53)], and then a modest rise from 2015 to 2020 [APC: 0.71 (95% CI: − 2.86 to 4.42)].

3.2 Sex

Men consistently exhibited higher AAMRs than women throughout the study period.

Among men, the AAMR increased from 1999 to 2005 [APC: 1.47 (95% CI: -2.20 to 5.28), followed by a significant decline from 2005 to 2020 [APC: − 2.28 (95% CI: -3.07 to -1.47). Among women, the AAMR rose non-significantly from 1999 to 2005 [APC: 2.02 (95% CI: -1.46 to 5.63), followed by a significant decline from 2005 to 2020 [APC: − 1.26 (95% CI: -1.89 to -0.62) (Fig. 1, Supplemental Table 1, 3, 10).

3.3 Race/Ethnicity

Ethno-racial analysis revealed, Black or African American individuals had the highest overall AAMR, followed by White, Hispanics, American Indian or Alaska Native, and Asian or Pacific Islander individuals.

Among Black or African American individuals, the AAMR decreased non-significantly from 1999 to 2012 [APC: -0.38 (95% CI: -1.28 to 0.53)], followed by a steep but non-significant decrease until 2015 [APC: -10.33 (95% CI: -24.52 to 6.53)], and then decreased non-significantly from 2015 to 2020 [APC: -0.05 (95% CI: -3.66 to 3.70)].

Among White individuals, the AAMR increased non-significantly from 1999 to 2011 [APC: 0.72 (95% CI: -0.33 to 1.77)] and then decreased significantly from 2011 to 2020 [APC: -2.76 (95% CI: -4.34 to -1.16)].

Among Hispanic individuals, the AAMR increased non-significantly from 1999 to 2007 [APC: 1.30 (95% CI: -1.63 to 4.32)] followed by a significant decline until 2020 [APC: -2.45 (95% CI: -3.53 to -1.36)].

Among American Indian or Alaska Native individuals, the AAMR decreased significantly from 1999 to 2020 [APC: -1.94 (95% CI: -2.97 to -0.91)].

Among Asian or Pacific Islander individuals, the AAMR increased non-significantly from 1999 to 2012 [APC: 0.31 (95% CI: -0.76 to 1.39)], decreased steeply from 2012 to 2015 [APC: -11.91 (95% CI: -26.63 to 5.77)], and then increased slightly from 2015 to 2020 [APC: 0.61 (95% CI: -2.99 to 4.35)] (Fig. 2, Supplemental Table 1, 4, 10).

3.4 Age Group

When stratified by age group, the 85 + individuals had the highest mean crude rate, followed by 65–84 years, and 45–64 years (Fig. 3, Supplemental Table 5).

The 85 + age group showed a significant decrease from 1999 to 2020 [APC: -0.75 (95% CI: -1.45 to -0.05)]. 65–84 year old individuals showed a modest increase in mortality from 1999 to 2012 [APC: 0.51 (95% CI: -0.25 to 1.28)], followed by a non-significant decline until 2015 [APC: -9.92 (95% CI: -24.25 to 7.13)], followed yet by another non-significant increase from 2015 to 2020 [APC: 0.57 (95% CI: -2.77 to 4.01)].

The age group 45–64 showed an essentially statistically non-significant mortality from 1999 to 2020 [APC: 0.05 (95% CI: -0.31 to 0.41)] (Fig. 3, Supplemental Table 5, 10).

3.5 Urbanization

Non-metropolitan regions showed a higher AAMR than metropolitan regions.

Metropolitan regions showed a non-significant decrease in AAMR from 1999 to 2012 [APC: 0.49 (95% CI: -0.28 to 1.3)], followed by a steep but non-significant decline until 2015 [APC: − 7.35 (95% CI: -16.3 to 2.6)], followed by a non-significant increase from 2015 to 2020 [APC: 0.35 (95% CI: − 2.0 to 2.8)].

Nonmetropolitan regions showed a significant increase from 1999 to 2012 [APC: 1.11(95% CI: 0.29 to 1.94)], followed by a steep yet non-significant decline until 2015 [APC: − 7.68 (95% CI: -22.70 to 10.26)], followed by a moderate increase from 2015 to 2020 [APC: 1.44 (95% CI: − 2.41 to 5.4)] (Fig. 4, Supplemental Table 6,10).

3.6 Census Region

Across regions, the West had the highest overall AAMR throughout the study period, followed by the Midwest, South, and Northeast, which consistently showed the lowest rates. Overall, most regions showed modest declines in AAMR over time, with some periods of non-significant increases or sharp declines.

The West showed a significant increase from 1999 to 2011 [APC: 1.21 (95% CI: 0.02 to 2.41)], followed by a significant decline until 2020 [APC: − 2.84 (95% CI: − 4.27 to − 1.39)].

The Midwest showed a non-significant increase from 1999 to 2012 [APC: 0.75 (95% CI: − 0.06 to 1.58)], followed by a non-significant decline until 2015 [APC: − 8.49 (95% CI: − 23.61 to 9.63)], followed by a non-significant increase from 2015 to 2020 [APC: 1.07 (95% CI: − 1.64 to 3.86)].

The South showed a significant increase from 1999 to 2012 [APC: 0.72 (95% CI: 0.10 to 1.35)], followed by a steep decline until 2015 [APC: – 7.68 (95% CI: − 19.29 to 5.60)], followed by a non-significant increase from 2015 to 2020 [APC: 1.23 (95% CI: − 1.81 to 4.37)].

The Northeast showed a period of stability from 1999 to 2012 [APC: − 0.03 (95% CI: − 0.76 to 0.70)], followed by a sharp yet statistically non-significant decline from 2012 to 2015 [APC: − 9.02 (95% CI: − 23.07 to 7.59)],

followed by a non-significant decrease from 2015 to 2020 [APC: – 0.84 (95% CI: – 3.94 to 2.36)] (Fig. 5, Supplemental Table 7, 10).

3.7 States

Upon subgroup analysis after stratification by 51 U.S. states, a significant difference in Age-Adjusted Mortality Rates (AAMRs) were observed between states, with AAMR being 28.2 (95% CI: 26.7 to 29.7) in District of Columbia and 12.3 (95% CI: 12.0 to 12.6) in Arizona. States that fell in the top 90th percentile were District of Columbia [AAMR: 28.2 (95% CI: 26.7 to 29.7)], North Dakota [AAMR: 25.4 (95% CI: 24.2 to 26.7)], West Virginia [AAMR: 22.7 (95% CI: 22.0 to 23.4)], and California [AAMR: 22.3 (95% CI: 22.1 to 22.4)], which had AAMRs nearly twice as high as the states that fell into the lower 10th percentile, including Montana [AAMR: 14.3 (95% CI: 13.5 to 15.1)], New Mexico [AAMR: 14.3 (95% CI: 13.7 to 14.8)], Florida [AAMR : 13 (95% CI: 12.9 to 13.2)] and Arizona [AAMR: 12.3 (95% CI: 12.0 to 12.6)] (Fig. 7, Supplemental Table 8).

3.8 Cancer Region

Across the United States, Genitourinary system Cancers had the highest AAMR, followed by Lymphoid/Hematopoietic/related tissue cancer, Digestive organs cancers, and Respiratory and Intrathoracic organs.

The AAMR for Digestive organs cancers increased from 3.6 (95% CI: 3.5 to 3.7) in 1999 to 3.8 (95% CI: 3.7 to 3.9) in 2020. The trend increased significantly from 1999 to 2012 [APC: 1.59 (95% CI: 0.93 to 2.24), followed by a steep decline until 2015 [APC: -7.99 (95% CI: -19.60 to 5.30), followed by a moderate increase until 2020 [APC: 1.87 (95% CI: -1.11 to 4.95).

For respiratory and intrathoracic organs, the AAMR increased from 2.1 (95% CI: 2 to 2.2) in 1999 to 2.2 (95% CI: 2.2 to 2.1) in 2020. From 1999 to 2012 the trend increased significantly [APC: 2.49 (95% CI: 1.57 to 3.42), followed by a steep decline until 2015 [APC: -11.44 (95% CI: -26.72 to 7.04), followed by period of stabile increase until 2020 [APC: 0.12 (95% CI: -4.30 to 4.75).

For Genitourinary System Cancers, the AAMR fell from 5.6 (95% CI: 5.5 to 5.8) in 1999 to 4.2 (95% CI: 4.1 to 4.3) in 2020. The trend showed non-significant decline until 2012 [APC: -0.68 (95% CI: -1.33 to -0.03), followed by a steep decline until 2015 [APC: -8.63 (95% CI: -22.38 to 7.55), followed by non-significant increase until 2020 [APC: 0.62 (95% CI: -3.04 to 4.42).

The AAMR for Lymphoid tissue cancer fell from 4.2 (95% CI: 4.1 to 4.3) in 1999 to 3.2 (95% CI: 3.1 to 3.3) in 2002. From 1999 to 2003, the trend increased significantly [APC: 3.02 (95% CI: 1.75 to 4.31), followed by a significant decline until 2009 [APC: -3.03 (95% CI: -3.89 to -2.16), followed by significant increase until 2012 [APC: 4.50 (95% CI: 0.26 to 8.93). Thereafter, the AAMR decreased steeply from 2012 to 2015 [APC: -7.73 (95% CI: -11.79 to -3.49), followed by a slight decrease until 2020 [APC: -1.17 (95% CI: -2.29 to -0.04) (Fig. 6, Supplemental Table 9, 10)

4. Discussions

In this study, we present key trends in malignant neoplasm and renal failure-related mortality in the U.S. over the past two decades. After an initial rise, mortality rates declined significantly across most strata. The highest burden persisted among males, Black individuals, adults aged ≥ 85 years, residents of non-metropolitan areas,

and those in the Midwest and West. Mortality was greatest in renal failure patients with malignancies of the urinary organs. These patterns highlight both the impact of recent healthcare improvements and the persistent gaps in equitable policy implementation across regions.

The overall stability or potential decline in certain AAMRs for patients with renal failure and cancer co-mortality suggests a positive shift in outcomes, which may be attributed to advancements in healthcare like the “Affordable Care Act (ACA)”, which is identified by many as a reason to decrease mortality among other factors (11). The segmented trends may reflect changes in detection, treatment paradigms, and comorbidity management over time. However, an initial increasing mortality trend could perhaps be blamed on the lag in cancer detection in the absence of robust technology or the cumulative impact of shared comorbidities in either cancer or renal disease patients. The early-2010s inflection in renal failure & cancer co-mortality likely reflects concurrent system-level and clinical shifts: adoption of KDIGO AKI/CKD (12) about guidance for standardizing prevention and early management, pressure on development of oncology related nephroprotection protocols (13)(14) notably cisplatin hydration and electrolytes, advocated for cancer treatments related nephrotoxicity leading to the adoption of safer usage guidelines.

As echoed in prior studies (16) men with cancer and renal failure experienced higher AAMRs throughout the study period while women experienced a decline, suggesting men are at higher risk for death due to RF & cancer-related co-mortality than women. Although, women have increased onset but slowed progression and decreased fatality of renal complications, often owing to protective effects of increases levels of estrogen hormone (17)(18)(19). Hence, the persistent male disadvantage highlights the need for sex-specific interventions, such as targeted screening and risk factor modification, to reduce disparities in mortality outcomes.

Significant racial and ethnic disparities in mortality from malignant neoplasms and renal failure were observed. Black or African Americans shared the highest burden of mortality, followed by White, Hispanics, American Indian or Alaska Native, and Asian or Pacific Islanders. Even though Black individuals have higher incidences of survival reaching end-stage renal failure than their white counterparts (20), their limited access to surgical procedures and healthcare (21) makes them more at risk of death due to cancer and renal pathologies. Multiple other determinants, like social and structural inequities, and earlier onsets of risk factors such as diabetes (22), hypertension (23), and obesity (24), explain higher AAMRs in Black individuals.

Encouraging declines after 2007 and 2011 were observed across several racial groups, consistent with gains in early detection, integrated onco-nephrology care, treatment access, and prevention. Yet persistently elevated mortality among Black individuals and the volatility of trends in Asian/Pacific Islander populations are indicative of the fact that these improvements are not equitably shared. Sustained public health surveillance with routine disaggregation by race, ethnicity, and social determinants is essential to monitor gaps and guide equitable improvements in cancer-related renal outcomes.

The observed age-group mortality patterns reveal a clear gradient, with the highest mortality rates observed for individuals aged ≥ 85, followed by 65–84 and 45–64. Consistent with national surveillance, age-specific mortality for both kidney disease and cancer is highest in the oldest adults (26). The risk for renal failure and cancer rises exponentially with age due to increased oxidative stress, exposure to carcinogens, and age-related immune and renal decline (27).

Simultaneously, we observed a stable mortality trend for individuals aged 45–64, which highlights the competing influence of renal failure and cancer mortality against advancements in renal-oncological integrated care and early detection strategies. There are modest temporal fluctuations seen in 65-84-year-old individuals; the biological plausibility of this interaction is supported by how CKD-associated metabolic, immune, and vascular alterations accelerate carcinogenesis and worsen survival effects that are most prominent in older adults. (28)

Our analysis also revealed distinct urban-rural disparities in co-mortality between renal failure and malignant cancers from 1999 to 2020. Both metropolitan and non-metropolitan regions demonstrated rising mortality through the early 2000s, peaking near 2012, followed by a decline between 2012 and 2015. However, while metropolitan mortality stabilized thereafter, non-metropolitan counties exhibited a concerning rebound from 2015 onward, suggesting an emerging divergence in health outcomes despite national advances in oncologic and nephrologic care. The initial upward trajectories echo the established pathophysiological link between cancers and kidney failures, as well as the prior nationally observed trends (29). The transient decline can plausibly be owed to the diffusion of national cancer-control gains alongside the rise of onco-nephrology practices that emphasized earlier kidney risk assessment and systematic monitoring for treatment-related nephrotoxicity. In this period, consensus guidance and conference reports catalyzed coordinated oncology–nephrology care, and clinical protocols for platinum-agent monitoring became more widely disseminated (30). Yet the rebound in non-metropolitan mortality is consistent with structural fragility in rural delivery systems: multiple analyses document sustained rural hospital closures across the 2010s (31), reducing local access to dialysis and infusion services and disrupting continuity for dual-burden patients. Regional patterning of trends showed that co-mortality rose modestly in the Midwest and South while remaining flat in the Northeast and modestly higher in the West. These geographical patterns mirror long-described risk “belts” concentrated in the South and parts of the Midwest, most notably the obesity belt and the diabetes belt (32), which map higher cardio-metabolic burden into the same census regions showing higher baselines and post-2015 increases in our series. Consistently higher mortality data in the South and Midwest may be reinforced by obesity surveillance showing the highest adult obesity in these regions compared to the West and Northeast (33), providing a larger pool at risk for CKD and obesity-related cancers. Mid 2010s, capacity and coverage gradients diverged: states in the Northeast and Midwest adopted policies like Medicaid expansion (34) which have arguably earlier shown early diagnostic and lower short-term cancer mortality patterns compared with non-expansion states mostly concentrated in the South and Midwest, plausibly stabilizing their curves.

In our cohort, over half of deaths occurred as inpatient hospital deaths, with a substantial minority outside acute hospitals, in the following order: home, nursing home or long-term care, and hospice facilities. Only a small fraction occurred in the outpatient setting or were dead on arrival/status unknown; other/unknown sites comprised a little more. Roughly 40% of decedents died outside inpatient wards (home + hospice + nursing/LTC), underscoring the sizeable end-of-life burden managed in community and long-term settings for patients with concurrent renal failure and malignancy, where coordination of dialysis, symptom control, and oncologic care is logistically harder and may influence utilization patterns and outcomes.

There were notable variations in the death rates from malignant tumours and renal failure among the states in the United States. Compared to low-burden states like Arizona, Florida, Montana, and New Mexico, rates in the District of Columbia were over twice as high. These variations at the state level are indicative of long-standing regional trends in the outcomes of chronic renal disease and cancer (36, 37). They most likely result from a

combination of disparities in healthcare system capacity, population health profiles, and structural inequities (36, 38). West Virginia, California, North Dakota, and the District of Columbia have the highest death rates. Metabolic disease, tobacco use, hypertension, and severe chronic renal disease are more common in these states (37, 38). Additionally, they have trouble getting timely access to coordinated nephrology and oncology care (36, 40).

Preventable risk factors are common in Appalachia, particularly in West Virginia, and a lack of dialysis services and cancer specialists causes fragmented care and delayed diagnoses (38, 40). However, several states in the Southwest have lower death rates; this could be because fewer people smoke, more people get cancer screenings, and chronic illness management programs are better integrated (37, 39). Despite having an older population, Florida's comparatively low average yearly mortality rate may possibly be related to improved outpatient dialysis capacity, more hospice services, and more reliable insurance coverage for senior citizens (40).

When combined, these trends indicate that states must clearly modify their responses. The disparities in outcomes for patients with both cancer and renal failure may be reduced by improving communication between oncology and nephrology teams, increasing dialysis and infusion services in areas without them, and addressing the metabolic and social factors that put individuals at higher risk.

Across cancer regions, genitourinary cancers showed the highest mortality in individuals with renal failure, which aligns with evidence that kidney and urothelial cancers carry a disproportionately high burden in CKD and ESKD populations (41, 42). These malignancies share several biological and clinical connections with kidney dysfunction, including overlapping risk factors, late-stage presentation, and reduced tolerance for full-dose therapy. The long-term decline in genitourinary cancer mortality in our analysis may plausibly reflect improvements in detection and management (42).

Lymphoid and hematopoietic cancers demonstrated the greatest year-to-year variation, consistent with research showing a strong interaction between kidney injury and these malignancies. Nephrotoxic chemotherapies, immunotherapies, and transplant-related complications frequently used in the treatment of lymphoma, leukemia, and myeloma can produce unstable mortality patterns over time (43, 45). The relatively stable mortality seen in digestive organ cancers also aligns with evidence that, although these cancers are common in ESKD, their CKD-specific risk is more moderate and less influenced by rapid shifts in therapeutic practice (44, 41). Respiratory cancers showed the lowest mortality and minimal long-term variation, which may reflect competing risks in advanced kidney disease, where cardiovascular and infectious deaths often occur before lung cancer becomes clinically dominant (42).

5. Limitations

To our knowledge, this is one of the few countrywide studies spanning more than two decades that has looked at the co-mortality patterns of malignant neoplasms and renal failure in varied demographic and regional populations. The inclusion of a large, nationally representative dataset increases the reliability and generalizability of our findings. However, several constraints must be noted. First, our research is based on CDC WONDER death certificate data, which is dependent on documentation and coding accuracy; thus, potential misclassification or underreporting of reasons of deaths typically due to clinical uncertainty like lack of medical

history or complex comorbidities and procedural errors, such as a lack of physician training, compounded by social stigma surrounding certain causes of death and systemic pressures like declining autopsy rates and heavy workloads may have influenced certain trends. Secondly, because this study is retrospective and population-based, the findings represent associations and temporal trends rather than direct causative correlations between renal failure and cancer mortality.

Third, differences in diagnostic practices and reporting accuracy across states and regions may have contributed to regional variations in observed mortality. Additionally, essential factors such as treatment exposure, socioeconomic background, comorbidities, genetic risks, and healthcare access were not uniformly recorded and could not be accounted for in the analysis. Lastly, the study period extends through 2020, during which the COVID-19 pandemic may have affected healthcare utilization and mortality reporting, potentially influencing recent estimates.

6. Conclusion

From 1999 to 2020, deaths in which malignant neoplasms and renal failure appeared together continued to differ widely across demographic and geographic groups in the United States. The overall national mortality rates showed significant shifts during this period, noticeable gaps remained between states and across age, sex, and racial and ethnic categories. These patterns likely reflect differences in when patients enter the health system, how easily they can access coordinated kidney and cancer care, and the uneven distribution of chronic kidney disease in the population. The cancer-specific trends we observed, especially the high mortality seen in genitourinary cancers and the irregular patterns in hematologic malignancies show how kidney dysfunction can influence both cancer progression and the ability to receive full treatment. Taken together, these findings point to the need for earlier recognition of patients at increased risk and better coordination between oncology and nephrology to help reduce the disparities that have persisted over time.

Declarations

Ethics Approval and Consent to participate:

Not applicable. This study utilized publicly available, de-identified data from the CDC WONDER database and did not involve human participants.

Consent for publication:

Not applicable.

Conflicts of Interests:

The authors declare no conflicts of interest.

Funding:

The authors received no funds, grants, or financial support for this study.

Author Contribution

Topic was selected by AS. Data extraction and analysis was done by DB. All authors contributed to manuscript writing equally. Submission was handled by HA.

Acknowledgments:

Not applicable

Data Availability

The data that support the findings of this study are available in CDC WONDER at https://wonder.cdc.gov/mcd.html. These data were derived from the following resources available in the public domain:- Multiple Cause of Death, 1999-2020, https://wonder.cdc.gov/mcd-icd10.html

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Figures

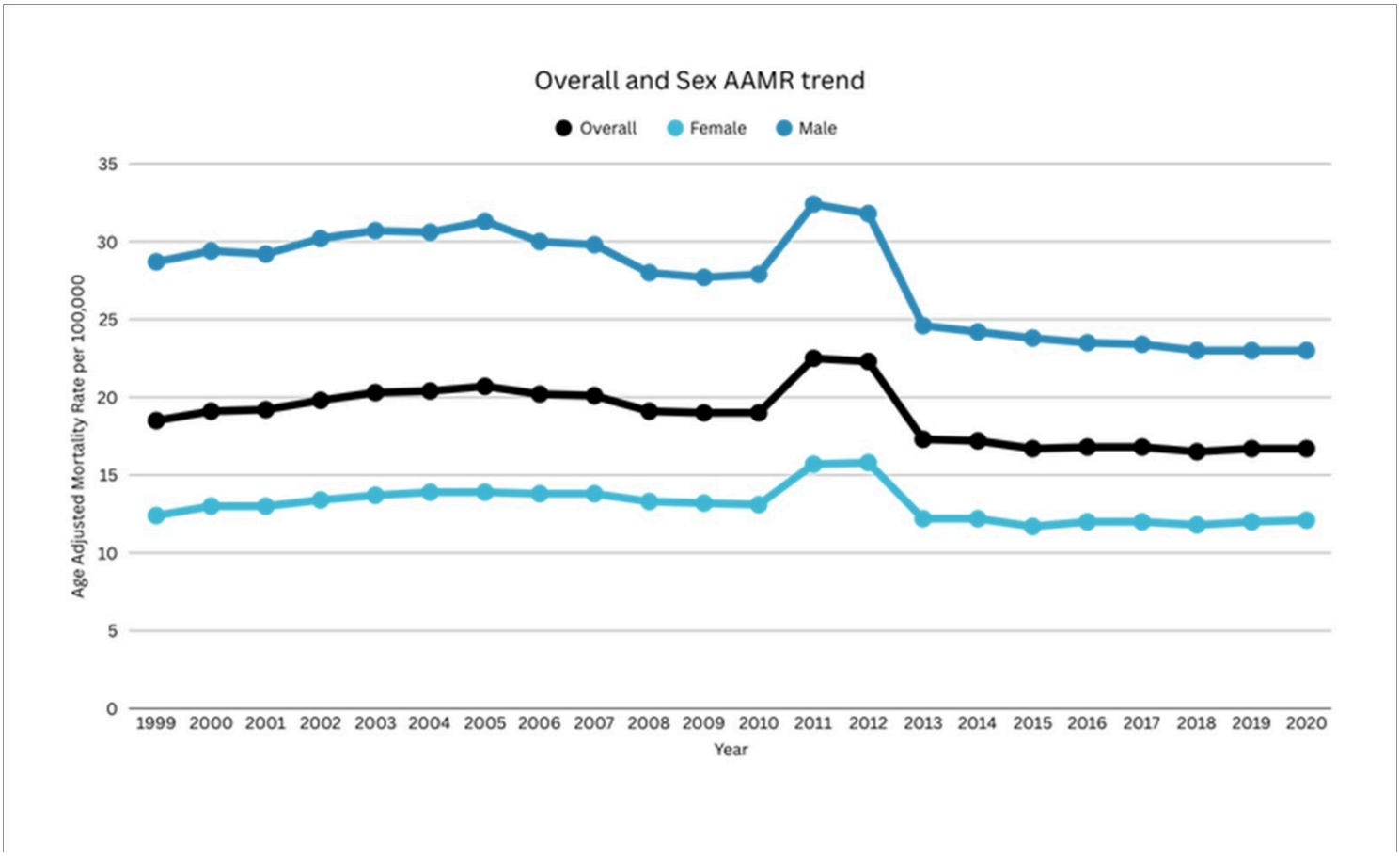


Figure 1

Renal Failure and Malignant Neoplasms-related mortality in the US older adult population, 1999-2020, Overall and Sex AAMR trends

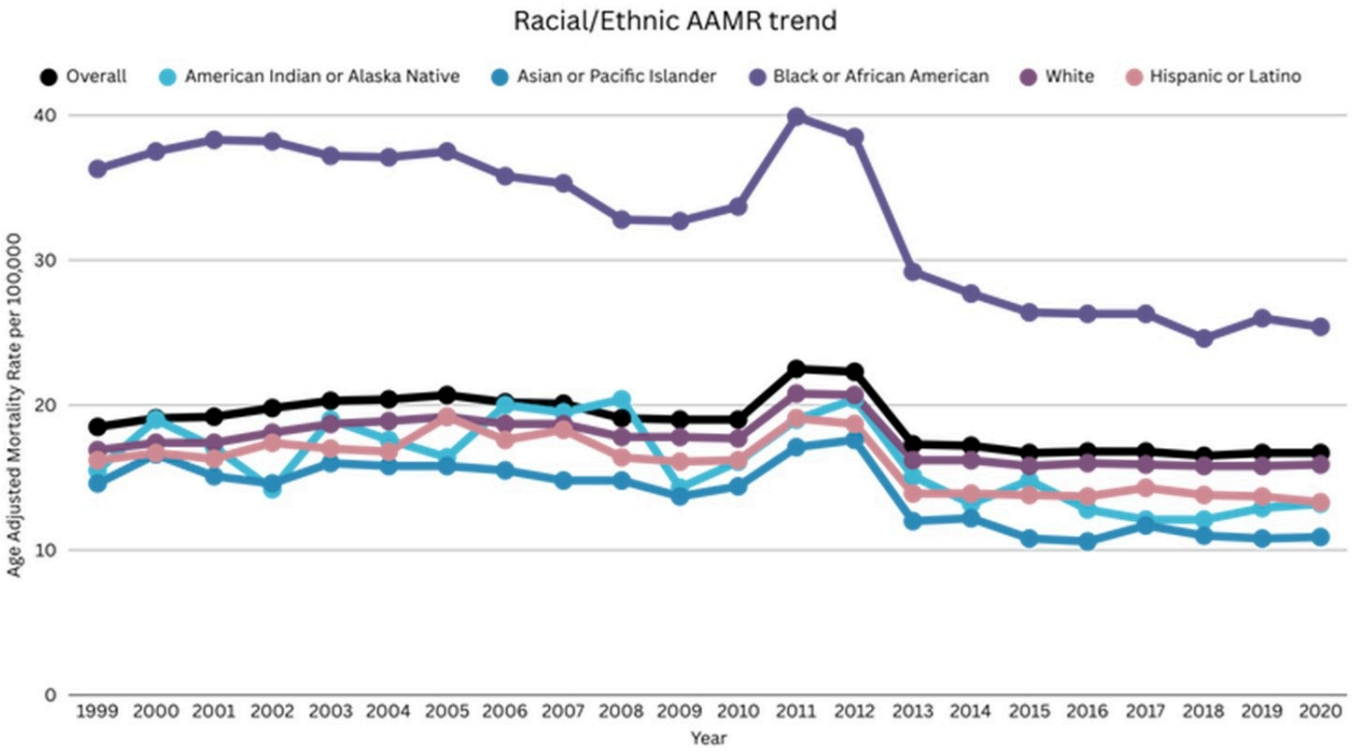


Figure 2

Renal Failure and Malignant Neoplasms-related mortality in the US older adult population, 1999-2020, Race/Ethnicity AAMR Trends

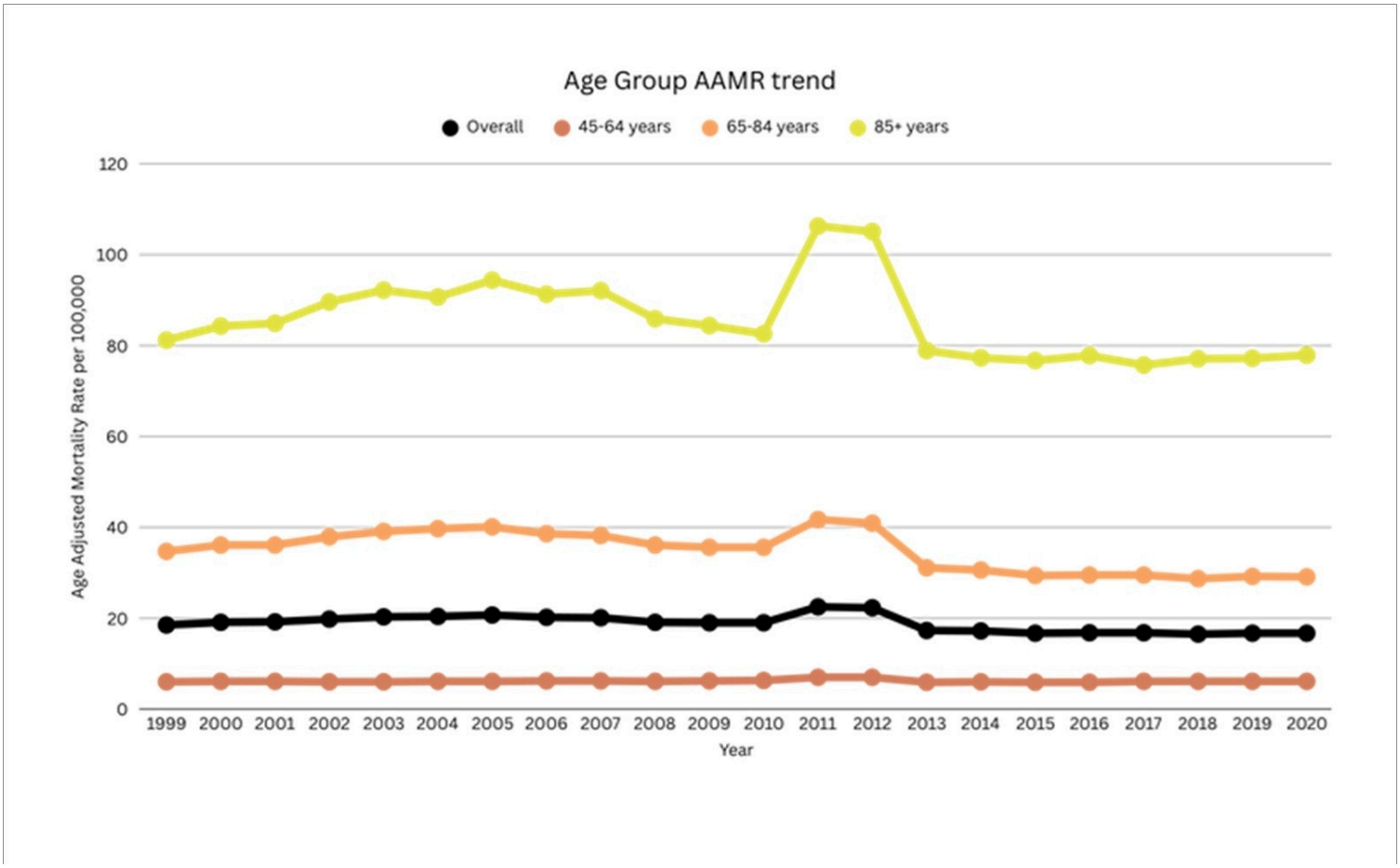


Figure 3

Renal Failure and Malignant Neoplasms-related mortality in the US older adult population, 1999-2020, Age-group Trends

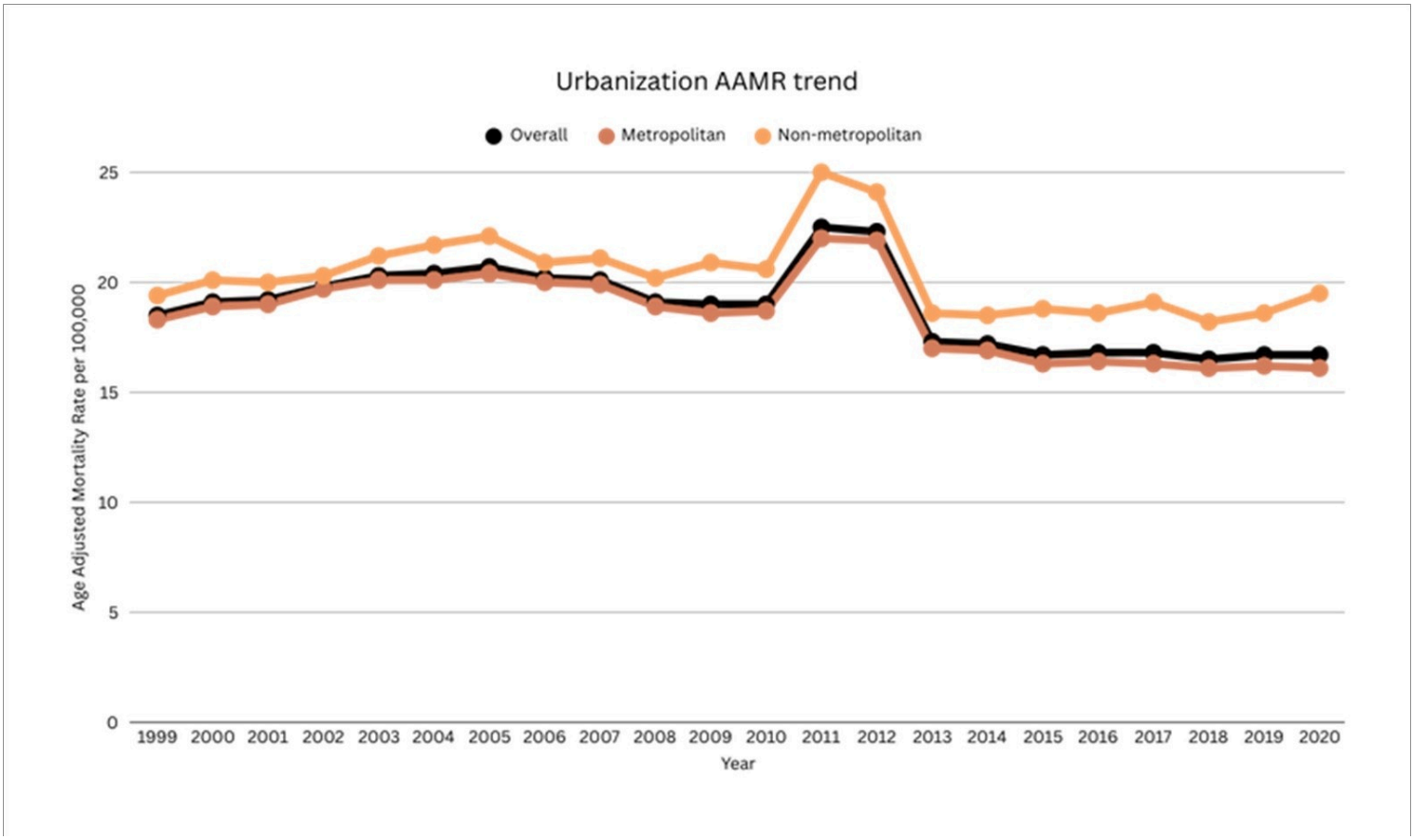


Figure 4

Renal Failure and Malignant Neoplasms-related mortality in the US older adult population, 1999-2020, Urbanization Trends

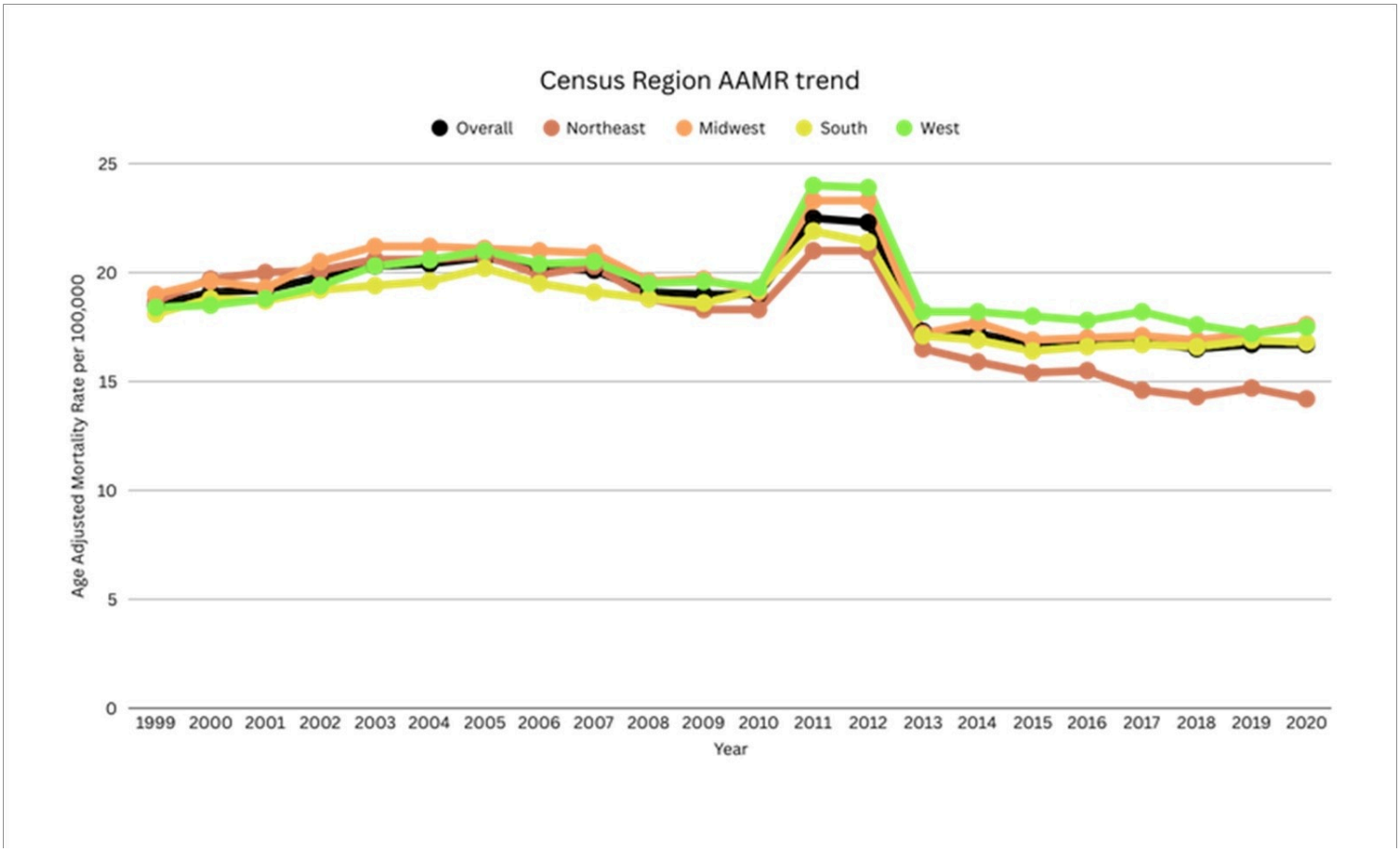


Figure 5

Renal Failure and Malignant Neoplasms-related mortality in the US older adult population, 1999-2020, Census Region Trends

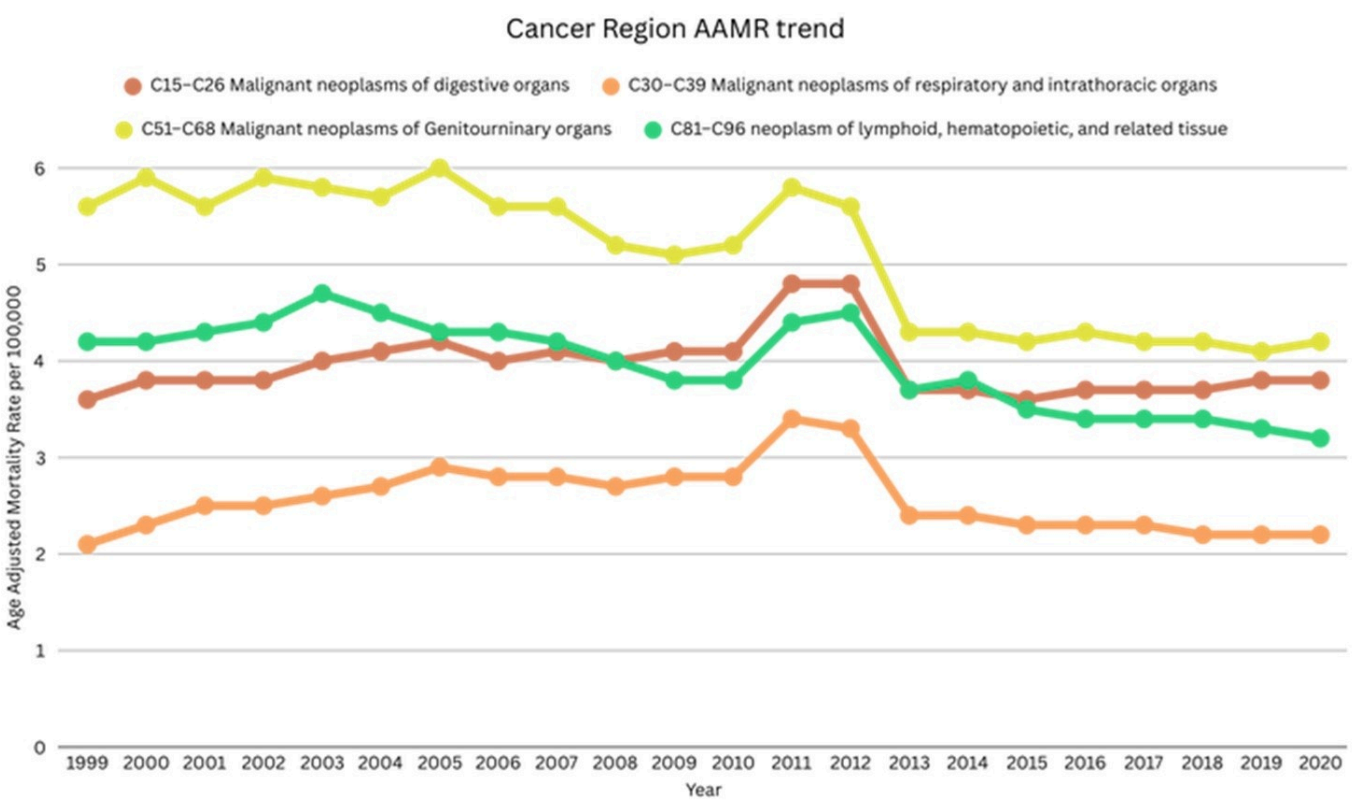


Figure 6

Renal Failure and Malignant Neoplasms-related mortality in the US older adult population, 1999-2020, Cancer region trend

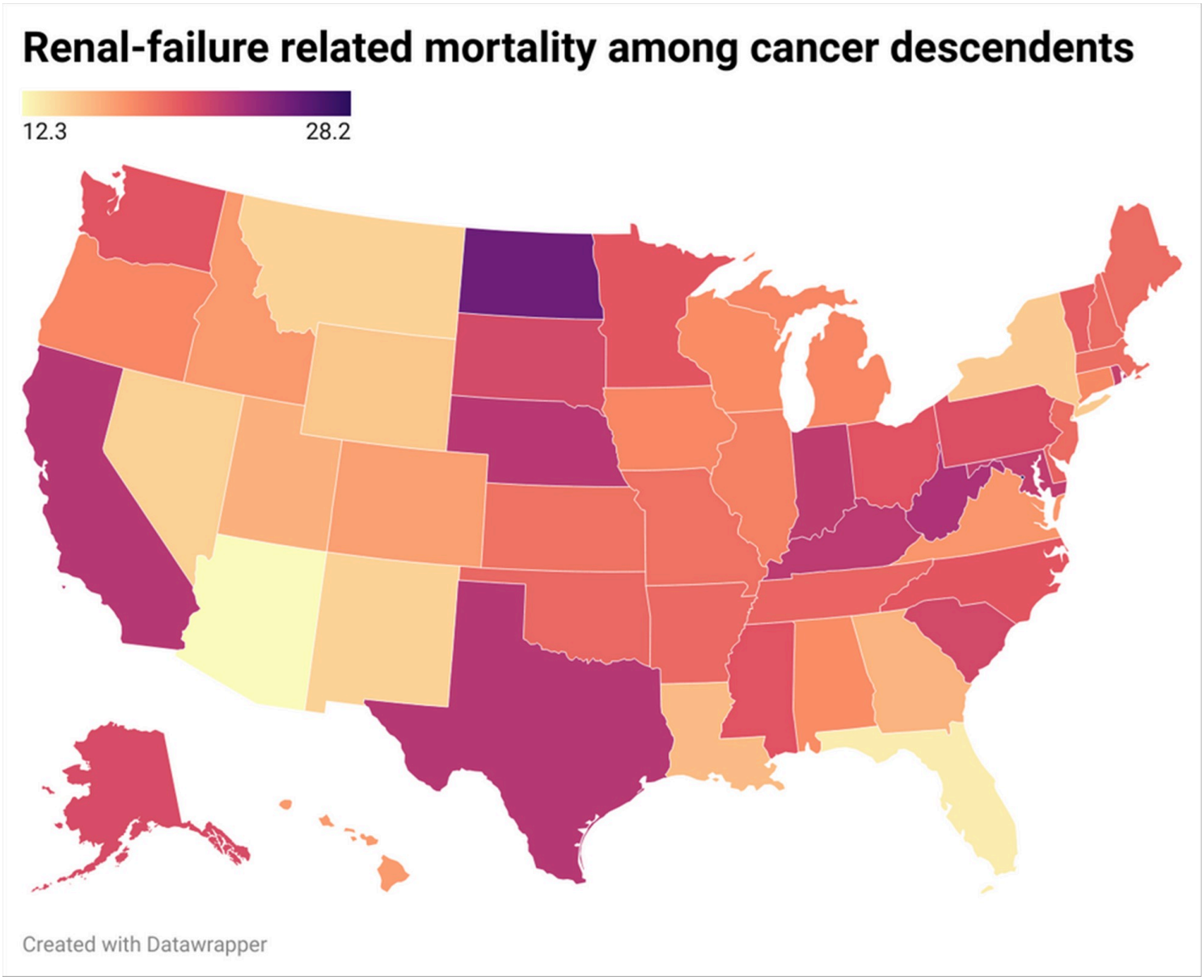


Figure 7

Renal Failure and Malignant Neoplasms-related mortality in the US older adult population, 1999-2020, State Trends

Supplementary Files

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