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Research Article

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Epidemiologic Trends in Urinary Tract Infection-Related Mortality Among Older Adults in the United States: a CDC Wonder Metanalysis Study

Short title: Mortality due to Urinary Tract Infections

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Abstract

Introduction: Urinary tract infections (UTIs) are a major cause of morbidity and mortality among older adults, particularly in vulnerable populations. This study evaluated long-term trends and disparities in UTI-related mortality in the United States.

Methods: Data for adults aged ≥65 years from 1999 to 2020 were obtained from the CDC WONDER database. UTI-related deaths-including nephritis, cystitis, urethritis, and non-specific UTIs—were analyzed using Joinpoint regression to calculate annual percent change (APC). Age-adjusted mortality rates (AAMRs) were stratified by sex, race, region, and urbanicity.

Results: A total of 820,913 UTI-related deaths were identified (supplementary table 1.1). The AAMR declined from 99.2 in 1999 to 79.8 in 2018 (APC: −1.04), followed by an increase to 89.0 in 2020 (APC: 3.1). Females had higher mortality than males (92.6 vs. 82.5). The highest AAMRs were observed among non-Hispanic Black individuals (107.8), followed by non-Hispanic American Indian/Alaska Native, White, Hispanic, and Asian/Pacific Islander populations. Regionally, the Southern United States had the highest mortality (AAMR: 97.3), with Mississippi, Kentucky, North Carolina, Arkansas, and Indiana ranking highest. Nonmetropolitan areas consistently exhibited higher mortality than metropolitan areas. Most deaths (94.6%) were attributed to non-specific UTIs. Both nephritis- and UTI-related mortality demonstrated significant geographic disparities, with higher rates in rural areas and notable regional variation.

Conclusion: UTI-related mortality among older adults has increased since 2018, with persistent disparities across demographic and geographic groups. Targeted prevention, early diagnosis, and timely management are essential to reduce this burden.

Keywords: Cystitis; Mortality; Nephritis; Aged; Trends; Urinary tract infection

Introduction

A urinary tract infection (UTI) is an infection of any part of the urinary system which consists of the lower urinary tract (bladder and urethra) and upper urinary tract (kidneys and ureters) [1]. UTI is the second most common infection in adults aged ≥ 65 in both hospitalized patients and community-dwelling adults [2,3]. The incidence of UTI for men aged 65-74 years is estimated to increase by 0.05 per person-year [4]. It mostly occurs due to Escherichia coli (E. coli) bacteria

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and is more prevalent in women than men [5,6]. In 2019, more than 404.6 million individuals had UTIs globally, and nearly 236,786 people died of UTIs [7]. Many reasons can lead to a UTI, such as hospitalization, catheters, or even antibiotic exposure when a person’s immune system is weakened and compromised. Urosepsis is a sepsis that occurs as a result of a UTI. Urosepsis is one of the most common causes of sepsis, and the urogenital tract accounts for around 25% of sepsis cases [8]. Sepsis is our body's life-threatening response to an infection, with a mortality rate of 15% to 59% [9]. If not treated in time, urosepsis can result in death. Urosepsis severity depends on the virulence of the pathogen and the state of the individual's immune system [10]. It is of utmost importance that urinary tract-related disorders are treated timely and efficiently to avoid deaths due to urosepsis [11]. Urosepsis cases in the ageing population are also increasing owing to the high life expectancy all around the world. Hence, there is a need for research to investigate, prevent and decrease the mortality due to UTI as it leads to urosepsis. The aim of this research is to find out mortality trends due to UTIs in US elderly population by examining demographic characteristics and geographical areas of patients who died from UTIs. Our research will help identify high-risk elderly individuals that need medical attention.

Methods

Study Setting and Population

For this descriptive retrospective cohort study, we utilized data from death certificates obtained from the CDC WONDER (Centers for Disease Control and Prevention Wide-Ranging On-Line Data for Epidemiological Research) database. The data for UTI-related mortality rates among older adults across United States spanning from 1999 to 2020 were retrieved using codes from the International Statistical Classification of Diseases and Related Health Problems-10th Revision (ICD-10). The codes used were N10, N11, N12, N13.6, N15.1, N15.8 & N15.9; N30.0, N30.1, N30.2, N30.3, N30.8 & N30.9; N34; N39.0 for Nephritis, Cystitis, Urethritis & non-specific UTIs respectively. Similar codes have been used in a previous study. ICD-10 codes were grouped into four categories: nephritis (N10, N11, N12, N13.6, N15.1, N15.8, N15.9), cystitis (N30.0, N30.1, N30.2, N30.3, N30.8, N30.9), urethritis (N34), and non-specific UTI (N39.0). Table 1 shows the details of these codes [12]. Overall UTI analysis was done by using all codes. Then subcategories nephritis, cystitis, urethritis and non-specific UTI were analysed separately. The Multiple Cause-of-Death Public Use records and death certificates were analysed to discern UTI-related deaths which were selected as those with Urinary Tract Infections (UTIs) reported anywhere on the death certification either as contributing or underlying cause of death. Older Adults were defined as those who were 65 years or older at the time of death [13,14]. This study follows the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines for reporting [15].

Data Abstraction

The study analyzed population size, year, demographics, states, region, and urban-rural classification. Demographic data included sex and race/ethnicity, with male and female participants aged ≥65. Race/ethnicity was classified into non-Hispanic White, Black, African American, Hispanic, American Indian, Alaska Native, and Asian/Pacific Islander [16]. Geographical data was stratified into six counties as per the National Center for Health Statistics (NCHS), with metropolitan counties being large central metro counties, nonmetropolitan counties micropolitan and noncore counties, and census regions into Northeast, Midwest, South & West [17].

Statistical Analysis

The crude and age-adjusted mortality rates (AAMRs) per 100,000 people with 95% CIs were used to examine the nationwide trend in UTI-related mortality among the adult population of the United States from 1999-2020. Crude mortality rates were calculated by dividing the number of UTI-related deaths by the corresponding US population of that year. AAMRs were calculated by standardizing the deaths to 2000 standard US population. The Annual percentage change (APC) in AAMRs with 95% CI is analyzed using the Joinpoint Regression Program (Joinpoint v 5.2.0, National Cancer Institute) to ascertain the significant changes in annual mortality patterns [18,19]. This method finds out significant changes in AAMRs over time by fitting long linear regression models and identifying where temporal variations take place. The annual percentage change was said to be either increasing or decreasing if the slope showed a change in mortality differing significantly from zero. A p-value of <0.05 was taken as statistically significant. Due to the relatively small number of urethritis-related deaths, age-adjusted mortality rates were not calculated for stratified analyses, as they may yield unstable estimates. Instead, proportions of total deaths were reported to describe subgroup distributions.

Results

Annual Trends for Overall UTI-related AAMR

From the year 1999 to 2020, a total of 8,20,913 UTI-related deaths occurred among older adults (≥65 years) in the USA (Supplemental Table 1.1). The AAMR was 99.2 in 1999 and 89 in 2020. The overall AAMR declined from 99.2 to 79.8 in the years 1999 to 2018 (APC: -1.0; 95% CI: -2.7 to 2.8) followed by an increase in AAMR to 89 in the years 2018 to 2020(APC: 3.1; 95% CI: -1.1 to 5.6) (Supplementary Figure 1.1, Supplemental Tables 1.3 and 1.4). The highest number of deaths related to UTIs were in medical facilities, followed by nursing homes or long-term care facilities, homes and hospices (Supplemental Table 1.2).

Overall UTI-related AAMR Stratified by Sex

Throughout the study, older females had consistently higher AAMRs than older males (Overall UTI AAMR females: 92.6; 95% CI: 92.4 to 92.9; males: 82.5; 95% CI: 82.2 to 82.8). In 1999, the AAMR for older females was 101 (95% CI: 99.6 to 102.3) which decreased steadilyto 91.8 (95%CI: 90.8 to 92.9) until the year 2020 (APC: -0.8; 95% CI: -1.1 to -0.5). Similarly, the AAMR for older males in 1999 was 95.1(95% CI: 93.3 to 96.9) which decreased steadily to 75.2(95% CI: 74 to 76.4) until 2018 (APC: -1.1; 95% CI: -1.5 to -0.9), followed by a rapid rise to 85(95% CI: 83.8 to 86.2) in 2020 (APC: 5.2; 95% CI: 0.1 to 7.7) (Supplementary Figure 1.1, Supplemental Tables 1.1).

Overall UTI-related AAMR stratified by Race/ Ethnicity

When stratified by race/ethnicity, AAMRs were highest among NH Black or African American followed by NH American Indian or Alaskan Native, NH White, Hispanic or Latino and NH Asian or Pacific Islander populations (overall AAMR NH Black or African American:107.8; 95% CI: 107-108.5; NH American Indian or Alaskan Native: 96.3; 95% CI: 93.2-99.5; NH White: 89.6; 95% CI: 89.4-89.8; Hispanic or Latino: 68.2; 95% CI: 67.5-68.9; NH Asian or Pacific Islander: 48.3; 95% CI: 47.5-49). The AAMR of NH Black or African American population declined drastically from 145.4 to 84.8 in the years 1999 to 2018 (APC: -2.9; 95% CI: -3.5 to -2.6) followed by an increase to 99.5 in 2020(APC: 6.6; 95% CI: -1.4 to 10.0). In the same way, the AAMR of the Hispanic or Latino population declined steadily from 81.1 to 59.4 in the years 1999 to 2018(APC: -1.6; 95% CI: -3.4 to 0.3) followed by an increase to 70.8 in 2020 (APC: 5.5; 95% CI: -1.4 to 9.3). The AAMR of NH White population also declined continuously from 96.6 to 91.9 in the years 1999 to 2020 (APC: -0.6; 95% CI: -0.8 to -0.3). However, the AAMR of NH American Indian or Alaskan Native population first increased from 82 to 102.6 in the years 1999 to 2011(APC: 1.8; 95% CI: -2.6 to 6.5) followed by a decrease to 83.7 in 2018 (APC: -4.4; 95% CI: -10.9 to 6.5) and again an increase to 95.8 in 2020 (APC: 6.5; 95% CI: -3.2 to 13.7). Moreover, the AAMR of NH Asian or Pacific Islander population remained steady from 56.9 to 57.2 in the years 1999 to 2009 (APC: 0.3; 95% CI: -0.6 to 1.8) followed by a decline to 37.1 in 2018 (APC: -4.5; 95% CI: -6.9 to -3.7) and again a rise to 45.4 in 2020 (APC: 8.1; 95% CI: 0.9 to 11.9). In short, the AAMRs of all five races/ethnicities were at their minimum recorded levels in 2018, regardless of the trends in the previous years. However, after 2018 until 2020, the AAMRs were recorded to rise again except for the AAMR of the NH White population (Supplementary Figure 1.2, Supplemental Tables 1.5).

Overall UTI-related AAMR Stratified by Geographic Region

When stratified according to the 2013 urbanization classification, UTI-related age-adjusted mortality rates (AAMRs) were consistently higher in nonmetropolitan areas throughout the study period. The AAMRs were 103.3 (95% CI: 102.6–104.0) in micropolitan areas and 102.1 (95% CI: 101.4–102.8) in noncore areas. In contrast, metropolitan areas demonstrated lower AAMRs, including 82.7 (95% CI: 82.4–83.1) in large central metro areas, 79.9 (95% CI: 79.5–80.3) in large fringe metro areas, 91.6 (95% CI: 91.2–92.1) in medium metro areas, and 94.2 (95% CI: 93.6–94.8) in small metro areas. AAMRs in both nonmetropolitan areas (micropolitan and noncore) and in two metropolitan categories (medium and small metro areas) demonstrated a steady decline from 1999 to 2020 (APC: −0.2; 95% CI: −0.5 to 0.1 for micropolitan areas, −0.3; 95% CI: −0.6 to −0.02 for noncore areas, −0.5; 95% CI: −0.8 to −0.3 for medium metro areas, and −0.5; 95% CI: −0.8 to −0.2 for small metro areas). In contrast, AAMRs in large central and large fringe metro areas initially declined from 1999 to 2018 (APC: −1.7; 95% CI: −3.4 to 0.1 and −1.4; 95% CI: −2.2 to −1.1, respectively), followed by an increase through 2020 (APC: 2.9; 95% CI: −1.7 to 5.7 and -4.7; 95% CI: −0.9 to −7.8, respectively) (Supplementary Figure 1.3; Supplemental Tables 1.3 and 1.8). Regionally, the highest UTI-related mortality during the study period was observed in the Southern United States, with an average AAMR of 97.3 (95% CI: 97.0–97.6), followed by the Western region (AAMR: 89.4; 95% CI: 89.0–89.8), the Midwestern region (AAMR: 84.5; 95% CI: 84.1–84.9), and the Northeastern region (AAMR: 77.6; 95% CI: 77.2–78.0). Temporal trends revealed a steady decline in the Northeastern region from 85.2 in 1999 to 74.9 in 2020 (APC: −1.0; 95% CI: −1.4 to −0.7). Similarly, the Midwestern region showed a consistent decline from 94.1 to 87.9 over the same period (APC: −0.7; 95% CI: −1.0 to −0.3). In the Southern region, AAMRs decreased from 112.9 in 1999 to 87.2 in 2018 (APC: −1.3; 95% CI: −1.8 to −1.0), followed by a sharp increase to 100.2 in 2020 (APC: 5.9; 95% CI: −0.3 to 8.9). In contrast, the Western region remained relatively stable between 1999 and 2007 (97.1 to 95.1; APC: 0.2; 95% CI: −0.6 to 3.5), followed by a steady decline to 82.8 by 2020 (APC: −1.5; 95% CI: −2.4 to −1.1) (Supplementary Figure 1.4; Supplemental Table 1.7). At the state level, UTI-related AAMRs demonstrated substantial variation across the United States, ranging from 49.8 (95% CI: 47.8–51.8) in Hawaii to 128.0 (95% CI: 125.5–130.4) in Mississippi. States in the top 90th percentile-including Mississippi, Kentucky, North Carolina, Arkansas, and Indiana—had nearly double the AAMRs compared to those in the lowest 10th percentile, including Hawaii, Florida, Arizona, and Nevada (Supplementary Figure 1.5; Supplemental Table 1.6).

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Nephritis

Annual Trends for Nephritis-related AAMR

From the year 1999 to 2020, a total of 31448 nephritis-related deaths occurred among older adults (≥65 years) in the USA. The AAMR was 4.4 in 1999 and 4.3 in 2020. The overall AAMR for nephritis-related deaths first decreased from 4.4 to 2.9 in the years 1999 to 2010 (APC: - 3.7; 95% CI: -5.8 to -2.5) followed by an increase to 3.5 in 2018 (APC: 2.5; 95% CI: -4.9 to 4.4) and finally a steeper rise to 4.3 in 2020 (APC: 11.2; 95% CI: 3.6 to 15.5) (Supplemental Figure 2.1, Supplemental Tables 2.2, 2.3 and 2.4).

Overall Nephritis-related AAMR Stratified by Sex

Throughout the study, older females had consistently higher AAMRs than older males (Overall AAMR females: 3.7; 95% CI: 3.6 to 3.7; males: 3.1; 95% CI: 3 to 3.2) (Supplemental Figure 2.1, Supplemental Tables 2.3 and 2.4).

Overall Nephritis-related AAMR stratified by Race/Ethnicity

When stratified by race/ethnicity, AAMRs were highest among NH Black or African American population followed by NH White, Hispanic/Latino and NH Asian or Pacific Islander populations (overall AAMR NH Black or African American: 3.5; 95% CI: 3.3-3.6; NH White: 3.4; 95% CI: 3.4-3.5; Hispanic or Latino: 3.4; 95% CI: 3.3-3.6; NH Asian or Pacific Islander: 2.3; 95% CI: 2.1-2.5) (Supplemental Figure 2.2, Supplemental Tables 2.1, 2.3 and 2.5).

Overall Nephritis-related AAMR Stratified by Geographic Region

When stratified according to the 2013 urbanization classification, nephritis-related age-adjusted mortality rates (AAMRs) were consistently higher in nonmetropolitan areas throughout the study period. The overall AAMRs were 4.1 (95% CI: 4.0–4.2) in micropolitan areas and 4.3 (95% CI: 4.2–4.5) in noncore areas. In contrast, metropolitan areas demonstrated lower AAMRs, with rates of 3.1 (95% CI: 3.1–3.2) in large central metro areas, 2.7 (95% CI: 2.6–2.7) in large fringe metro areas, 3.8 (95% CI: 3.7–3.9) in medium metro areas, and 3.7 (95% CI: 3.6–3.9) in small metro areas. Among these, large fringe metro areas consistently exhibited the lowest AAMRs over time, decreasing from 3.4 in 1999 to 2.0 in 2008 (APC: −5.0; 95% CI: −10.7 to −2.8), followed by a period of relative stability until 2014 (AAMR: 2.1; APC: 0.4; 95% CI: −4.8 to 5.9), and subsequently increasing to 3.6 by 2020 (APC: 7.8; 95% CI: 4.7 to 17.4). Conversely, noncore areas consistently had the highest AAMRs, declining from 5.4 in 1999 to 3.5 in 2011 (APC: −3.2; 95% CI: −5.1 to −1.9), followed by an upward trend reaching 4.9 in 2020 (APC: 3.2; 95% CI: 1.3 to 6.4) (Supplemental Figure 2.3; Supplemental Tables 2.3 and 2.8). Regionally, the Western United States demonstrated the highest nephritis-related mortality during the study period, with an average AAMR of 4.7 (95% CI: 4.6–4.8), followed by the Southern region (AAMR: 3.6; 95% CI: 3.5–3.6), the Midwestern region (AAMR: 3.1; 95% CI: 3.0–3.2), and the Northeastern region (AAMR: 2.1; 95% CI: 2.1–2.2) (Supplemental Figure 2.4; Supplemental Table 2.7). At the state level, substantial variation in nephritis-related AAMRs was observed across the United States, ranging from 1.7 (95% CI: 1.5–1.9) in New Jersey to 10.1 (95% CI: 8.1–12.1) in Alaska. States within the top 90th percentile—including Alaska, Utah, Washington, Tennessee, Idaho, and Wyoming—had approximately three- to five-fold higher AAMRs compared to those in the lowest 10th percentile, including New Jersey, Florida, the District of Columbia, Pennsylvania, and New York (Supplemental Figure 2.5; Supplemental Table 2.6).

Cystitis

Annual Trends for Cystitis AAMR

The AAMR for cystitis-related deaths first decreased from 1.4 to 1.1 in the years 1999-2011 (APC: -0.7; 95% CI: -2.5-13.0), followed by a further decrease to 1.0 in 2014 (APC: -6.5; 95% CI: -9.1-15.9) and then increased to 3.2 in 2020 (APC: 21.8; 95% CI: 18.4-3.4) (Supplementary Figure 3.1, Supplemental Tables 3.3 and 3.4).

Cystitis AAMR Stratified by Sex

The AAMR in older females for 1999 was 1.4 (95% CI: 1.2 to 1.6) which steadily decreased to 0.9 (95% CI: 0.8 to 1.0) until 2014 (APC:-1.8; 95% CI: -6.3-8.2). The trend then showed a steep rise to 2.0 (95% CI: 0.8-1.0) up until 2017 (APC: 26.7; 95% CI: -10.4-33.0) and then rose less steeply to 3.2 (95% CI: 3.0-3.4) up until 2020 (APC: 15.7; 95% CI: 9.7-21.7). Whereas, the AAMR for older males was 1.3 (95% CI: 1.1-1.5) in 1999 which declined to 1.0 (95% CI: 0.9- 1.2) up until 2014 (APC: -1.7; 95% CI: -3.3 to -0.3) and then sharply increased to 3.2 (95% CI: 3.0-3.4) in 2020 (APC: 19.9; 95% CI: 16.4-25.4) (Supplemental Figure 3.1, 3.4)

Cystitis AAMR stratified by Race/Ethnicity

In Blacks or African Americans in the year 1999, the AAMR was 1.8 and decreased to 1.0 in 2013 (APC: -3.6; 95% CI: -7.4 to -0.7). The AAMR increased to 3.5 from 2013 to 2020 (APC: 21.9; 95% CI: 15.6-31.7). A similar trend was seen in the White population. The AAMR in 1999 was 1.3 and decreased to 1.0 (APC: -1.7; 95% CI: -3.0 to -0.5) up until 2013 and increased to 3.4 (APC: 19.2; 95% CI: 16.7-22.7) in 2020 (Supplemental Tables 3.5).

Cystitis AAMR Stratified by Geographic Region

In large central metropolitan areas, cystitis-related AAMR decreased from 1.3 (95% CI: 1.1–1.5) in 1999 to 0.8 in 2014 (APC: −2.66; 95% CI: −4.3 to −1.4), followed by a marked increase through 2020 (APC: 17.8; 95% CI:

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14.1–23.9). Trends for other urban and rural categories are shown in Supplemental Figure 3.2. Regionally, AAMRs declined initially and then rose across all census regions. In the Northeast, rates decreased from 1.0 (95% CI: 0.8–1.3) to 0.6 (95% CI: 0.5–0.8) until 2013 (APC: −2.0; 95% CI: −4.6 to 0.0), then increased to 2.1 in 2020 (APC: 16.4; 95% CI: 12.7–22.7). Similar patterns were observed in the Midwest (1.4 to 1.1 until 2014, APC: −1.8; 95% CI: −3.7 to −0.4; rising to 3.2 in 2020, APC: 18.6; 95% CI: 12.6–26.3), South (1.4 to 1.0 until 2013, APC: −1.9; 95% CI: −3.8 to −0.4; rising to 4.0 in 2020, APC: 21.7; 95% CI: 18.8–26.1), and West (1.7 to 1.0 until 2014, APC: −0.8; 95% CI: −2.6 to 0.8; rising to 2.8 in 2020, APC: 14.2; 95% CI: 9.3–22.5) (Supplemental Figure 3.3; Supplemental Table 3.7). At the state level, AAMR ranged from 0.7 (95% CI: 0.7–0.8) in Florida to 3.5 (95% CI: 3.1–3.8) in Oklahoma (Supplemental Figure 3.4; Supplemental Table 3.6).

Urethritis

Urethritis Stratified by Sex

The percentage of total deaths in females was 27.30% whereas in males it was 10.70% in 1999 rising to 72.70% in 2020.

Urethritis stratified by Race/Ethnicity

The percentage of total deaths in Blacks or African Americans due to urethritis was 12.40%. In the White population, the mortality percent was 11.60% in 1999 and 85.10% in 2020. In the non-Hispanic Blacks or African American population, the percent of total deaths was 13.00%. In non-Hispanic White population it was 12.20% in 1999 and 84.30% in 2020.

Urethritis Stratified by Geographic Region

The percent mortality rate in the Northeast was 10.70%, 24.80% in the Midwest, 34.70% in the South and 29.80% in the West. The percentage of total deaths in large central metro cities was 28.90%, 17.40% in large fringe metro cities, 22.30% in medium metro cities and 10.70% in small metro cities. In non- metro Micropolitan in non-core non-metro cities it was 9.10%.

Non-specific UTI

Annual Trends for non-specific UTI AAMR

The overall age-adjusted mortality rate in 1999 was 93.8 and in 2020 was 81.6 showing a decreasing trend (APC: -1.0; 95% CI: -1.2 to -0.7) (Supplemental Figure 4.1, Supplemental Tables 4.3 and 4.4).

Non-specific UTI AAMR Stratified by Sex

In females, the AAMR in 1999 was 95.4 which decreased to 84.4 in 2020 (APC: -0.9; 95% CI: - 1.2 to -0.6). In males in 1999, the AAMR was 89.9 which decreased to 69.8 in 2018 (APC: - 1.2; 95% CI: 2.0 to -0.9) and became 77.7 in 2020 (APC: 3.5; 95% CI: -0.9-5.8). The percentage of total deaths increased from 1.40% to 2.10% from 1999-2020 (Supplemental Figure 4.1, Supplemental Tables 4.3 and 4.4).

Non-specific UTI AAMR stratified by Race/Ethnicity

In non-Hispanic American Indians or Alaskan natives, the AAMR in 1999 was 72.4 increased to 100.4 in 2010 (APC: 2.0; 95% CI: 0.2-10.0) and decreased to 85.5 from 2010 to 2020 (APC: -3.2; 95% CI: -7.0 to -1.4). In non-Hispanic Asian or Pacific Islanders, the AAMR was 53.9 in 1999 with a slight increase to 54.1 in 2009 (APC: 0.6; 95% CI: -0.5-2.3),and thereby declined to 33.7 up until 2018 (APC: -4.8; 95% CI: -8.0 to -3.9). The AAMR increased to 42 up until 2020 (APC: 7.3; 95% CI: -0.7-11.8). In non-Hispanic Blacks or African Americans, the AAMR in 1999 was 138.6 and then decreased to 78.8 up until 2018 (APC: -3.0; 95% CI: -3.8 to -2.6). The AAMR then increased to 92.4 from 2018 to 2020 (APC: 5.4; 95% CI: -2.4-8.9). The AAMR of non-Hispanic Whites was 91.2 in 1999 and decreased to 84.3 in 2020 (APC: - 0.7; 95% CI: -0.9 to -0.4). In the Hispanic population, the AAMR was 76 in 1999 and 63.5 in 2020 (APC: -1.5; 95% CI: -1.9 to -1.0) (Supplemental Tables 4.3 and 4.5., Supplementary figure 4.2 and 4.3)

Non-specific UTI AAMR Stratified by Geographic Region

In large central metro cities, the AAMR in 1999 was 97.9 which decreased to 74.2 in 2020 (APC: -1.7; 95% CI: -2.0 to -1.4). Details for other metropolitan and non-metropolitan cities can be found in Supplemental Tables 4.3 and 4.8. In the Northeast, the AAMR in 1999 was 81.9 decreased to 79.8 in 2011 (APC: -0.5; 95% CI: -1.0-2.6) and then 69.7 in 2020 (APC: -2.1; 95% CI: -5.4 to -1.3). Details for other census are presented in Supplemental Figure 4.4 and Supplemental Table 4.7. The AAMR of States can be found in Supplemental Table 4.6 and Supplemental Figure 4.5

Discussion

This study evaluated mortality trends due to UTIs in individuals aged ≥65 years in the United States. Overall UTI-related mortality declined from 1999 to 2018, followed by a sharp increase thereafter; a similar pattern was observed for nephritis. Cystitis decreased until 2011, then increased, with a marked rise from 2014 to 2020, while non-specific UTIs showed a gradual decline throughout. Females consistently had higher AAMRs across overall UTI, nephritis, and non-specific UTI. Among racial groups, non-Hispanic Black individuals had the highest mortality. Higher AAMRs were observed in the Southern region, nonmetropolitan areas, and states such as Mississippi, Kentucky, North Carolina,

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Arkansas, and Indiana, identifying key high-risk populations. Recent studies reveal an increasing trend of urinary tract infections (UTIs) among older adults, with multi-drug resistance to antibiotics being a significant issue. Older adults are more likely to have diseases such as prolapsed bladder, urinary incontinence, dementia, Parkinson's disease, and diabetes, which can make hygiene care difficult and lead to urinary retention and loss of bladder control [22-23]. Diagnosing UTIs can be challenging as many patients do not present with urinary symptoms but may present with non-specific symptoms like cognitive decline or anorexia [24-25]. The high prevalence of asymptomatic bacteriuria in older people may be misdiagnosed as UTI, leading to adverse outcomes [26-27]. Unnecessary antibiotic treatment can lead to multi-drug resistance organisms. A higher number of UTI-related deaths are found in medical facilities and long-term facilities due to catheter-associated infections [28-29]. Delay in treatment can lead to severe consequences, such as urosepsis, which has a mortality rate of 25% to 60% [30]. Data for population size, year, demographics, states, region, and urban-rural classification were abstracted, with demographic data including sex and race/ethnicity. Geographical data was further stratified into six counties, with metropolitan counties being large central metro counties, nonmetropolitan counties being micropolitan counties, and census regions being Northeast, Midwest, South & West. We found that females had a higher mortality rate than males. An explanation for this might be that females are found to have a higher prevalence of acute UTIs (23.3% vs 6.8%) and recurrent UTIs (54.2% and 15.7%) [31]. Furthermore, females have a shorter urethra making them susceptible to infections. In older post-menopausal women, factors such as lack of estrogen and loss of lactobacilli in the vaginal flora along with pelvic prolapse lead to higher UTI rates32 Our study found differences in mortality rate among races with NH Blacks taking the lead followed by NH American Indians, NH Whites, Hispanics and lastly NH Asians. A reason for this might be that diabetes is a risk factor for UTI, and Blacks have the highest prevalence of Type 2 diabetes (13.2%) when compared to Hispanics (12.8%), Asians (9%) and NH Whites (7.6%). Native Americans showed varying prevalence from 6 % to 24.1%. [33-34]. However, we found a cross-sectional study in which Hispanics had the highest diabetes prevalence35. Furthermore, access to healthcare is affected depending on the race or ethnic group36 Our findings demonstrated higher UTI-related mortality in nonmetropolitan areas, the Southern region, and states such as Mississippi and Kentucky. These disparities may be attributed to limited healthcare access, workforce shortages, and suboptimal aseptic practices during catheterization. Strengthening infection control measures and improving healthcare worker training are essential to mitigate these risks. Policymakers, clinicians, and public health organizations should further investigate the underlying causes of geographic and demographic disparities to guide targeted interventions. As one of the first CDC WONDER analyses focusing on UTI mortality in older adults, continued surveillance is necessary to monitor evolving trends and support informed healthcare planning and resource allocation. A notable finding of our study was the significant rise in urethritis-related mortality in recent years, which was not previously highlighted. This increase may reflect improved recognition and coding practices, as well as a true rise in disease burden, particularly among older adults with multiple comorbidities. Increased use of urinary catheterization, higher prevalence of antimicrobial resistance, and delayed diagnosis in vulnerable populations may also contribute. Additionally, the relatively low baseline number of urethritis-related deaths may exaggerate percentage-based increases over time. These findings should be interpreted cautiously and warrant further investigation to better understand underlying causes and trends.

Study limitations

Our study has several limitations. We used multiple cause-of-death data instead of the underlying cause of death to identify individuals who died of UTI to cover a broader range of people. This might make our UTI study population a less accurate representation of the disease. Mortality data in some subcategories was unreliable or unavailable due to the small number of cases or so we were unable to do analysis. Data on medical therapy, UTI treatment and socioeconomic determinants of health was also not available, which may impact access to care.

Conclusions

Mortality trends have seen an overall decline from the year 1999 to 2018 and then an increase from 2018 onwards. Higher AAMRs were observed in Black or African Americans as well as American Indian or Alaska Natives, the Southern region of the United States and in nonmetropolitan areas in the specific age strata studied of older adults aged >65 years. Further targeted interventions are needed to prevent and treat UTI among older adults to reduce these levels of UTI-related mortality.

Declaration of interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Ethical statement

The study conforms to the Declaration of Helsinki.

Irb approval

No IRB approval required for this manuscript as no human subjects were involved.

Data availability statement

The authors confirm that the studies included in this research are publicly available on PubMed Central. Data supporting the findings of this study are available within the article and Supplementary material files.

Consent to Participate declaration

Not applicable

Consent to Publish declaration

Not applicable

Supplementary Files Link

https://cdn.fortunejournals.com/supply/epidemiologic-trends-in-urinary-tract-infection-related-mortality-10020-supplementary.docx

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