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A Nationwide Analysis of Diabetes Mellitus and Interstitial Lung Disease Mortality in the United States, 1999–2024: Temporal Trends, Demographic and Geographic Disparities, and Projections to 2040

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Abstract:

Background: Diabetes mellitus and interstitial lung disease (ILD) frequently coexist and may contribute to adverse clinical outcomes. However, national mortality trends and disparities among individuals with both conditions remain insufficiently characterized. This study aimed to evaluate temporal trends, demographic and geographic disparities, and future mortality projections involving diabetes mellitus and ILD in the United States.

Methods: This retrospective epidemiological study used the Centers for Disease Control and Prevention Wide-Ranging Online Data for Epidemiologic Research (CDC WONDER) Multiple Cause-of-Death database to identify deaths involving both diabetes mellitus (ICD-10 codes E10–E14) and ILD (J84) among U.S. residents aged ≥45 years from 1999 through 2024. Age-adjusted mortality rates (AAMRs) were calculated per 100,000 population and stratified by demographic and geographic characteristics. Temporal trends were assessed using joinpoint regression, with annual percent changes (APCs) and average annual percent changes (AAPCs). Time-series forecasting using Prophet was performed to project mortality trends through 2040.

Results: A total of 61,157 deaths involving both diabetes mellitus and ILD were identified between 1999 and 2024. Overall mortality increased during the study period, with a marked rise between 2018 and 2021 followed by a partial decline. Mortality was highest among adults aged ≥85 years, men, and Hispanic or Latino individuals. Geographically, the highest mortality burden was observed in the West, while nonmetropolitan areas experienced higher mortality rates than metropolitan areas. Most deaths occurred in hospital inpatient facilities, followed by private residences. Forecasting models projected a continued increase in mortality through 2040, with the greatest projected burden among adults aged ≥85 years and men. Persistent disparities were also projected among Hispanic or Latino individuals and residents of nonmetropolitan areas.

Conclusion: Mortality involving diabetes mellitus and ILD among U.S. adults aged ≥45 years increased substantially between 1999 and 2024, with considerable demographic and geographic disparities. Although mortality declined following the 2018–2021 surge, projections suggest a continued increase through 2040. These findings highlight the need for improved surveillance, targeted preventive strategies, and equitable access to specialized care for populations disproportionately affected by both conditions.

Introduction:

Diabetes represents a major global health burden, affecting hundreds of millions of adults worldwide, while interstitial lung disease (ILD) encompasses a heterogeneous group of pulmonary disorders associated with substantial morbidity and mortality (1,2).

Diabetes has been recognized as a relevant comorbidity in patients with interstitial lung disease, particularly idiopathic pulmonary fibrosis, and recent cohort data indicate that diabetes is associated with poorer respiratory-related outcomes and higher all-cause mortality in fibrotic ILD (3,4). However, much of the available evidence derives from clinical cohorts or selected patient populations and therefore does not fully characterize the population-level mortality burden associated with deaths involving both conditions.

Furthermore, diabetes and ILD exhibit distinct demographic patterns. U.S. data demonstrate substantial racial and ethnic variation in diabetes prevalence (5), while national mortality analyses have identified differences in ILD mortality according to sex and race and ethnicity (2). Understanding how these overlapping but distinct population patterns intersect may therefore provide additional insight into the distribution of mortality involving both diseases.

Large-scale epidemiological studies have evaluated long-term mortality associated with ILD and with selected comorbid conditions. Recent CDC WONDER analyses have demonstrated the utility of multiple-cause-of-death data for examining long-term mortality trends and demographic and geographic disparities among individuals with ILD and specific coexisting conditions, including chronic ischemic heart disease (6).

However, to our knowledge, national mortality trends and demographic and geographic patterns of deaths involving both diabetes mellitus (DM) and interstitial lung disease (ILD) have not been comprehensively characterized across the United States over an extended period. Therefore, this study aimed to examine these trends among US adults aged ≥45 years from 1999 to 2024 using data from the CDC WONDER Multiple Cause of Death database. We additionally projected mortality through 2040 using time-series forecasting models to estimate the potential future burden.

METHODS

Research Design and Data Source

This descriptive, retrospective epidemiological study utilized mortality records from the Centers for Disease Control and Prevention Wide-Ranging Online Data for Epidemiologic Research (CDC WONDER) Multiple Cause-of-Death database to examine deaths involving both diabetes mellitus (DM) and interstitial lung disease (ILD) in the United States (7). The CDC WONDER database provides nationwide mortality and population information collected from death certificates of U.S. residents, with causes of death classified according to the International Classification of Diseases, Tenth Revision (ICD-10). Records were retrieved for deaths in which both diabetes mellitus and ILD were listed on the death certificate, irrespective of their designation as underlying or contributing causes. Diabetes mellitus was identified by ICD-10 codes E10–E14, while ILD was identified by code J84.

Accordingly, the analysis focused on mortality involving the coexistence of these two conditions, rather than deaths attributed solely to either disease. The use of these ICD-10 code groupings is consistent with previously published CDC WONDER mortality studies examining diabetes and ILD (6,8).

Ethical considerations

This research utilized publicly available government data that has been de-identified, which qualifies for exemption from institutional review board oversight, and the reporting followed the STROBE guidelines (Strengthening the Reporting of Observational Studies in Epidemiology) (9).

Data Extraction and Population Stratification

Mortality records spanning 1999–2024 were retrieved from the CDC WONDER Multiple Cause-of-Death database, covering individuals aged ≥45 years residing in all 50 U.S. states and the District of Columbia. Eligible deaths were those in which both diabetes mellitus (ICD-10 codes E10–E14) and interstitial lung disease (ICD-10 code J84) appeared on the death certificate, either as underlying or contributing causes. The extracted data were further categorized by demographic characteristics, geographic location, and place of death, based on the variables provided by CDC WONDER. Demographic stratification included age, sex, and race/ethnicity, with sex classified as male or female according to information recorded on the death certificates.

Age was categorized as 45–54, 55–64, 65–74, and 75–84 years, with a final category of ≥85 years. Race/ethnicity was categorized as non-Hispanic White, non-Hispanic Black or African American, Hispanic or Latino, non-Hispanic Asian or Pacific Islander, and non-Hispanic American Indian or Alaska Native. Regions were classified as Northeast, Midwest, South, and West according to U.S. Census Bureau definitions (10). Urban–rural status was assigned at the county level using the National Center for Health Statistics Urban–Rural Classification Scheme for Counties, where available. Counties were grouped as urban (large metropolitan areas with population ≥1,000,000; medium/small metropolitan areas with population 50,000–999,999) or rural (nonmetropolitan areas with population <50,000) U.S. (11) Place of death was classified using the categories provided by CDC WONDER, including inpatient medical facilities, outpatient or emergency departments, private residences, hospice facilities, and nursing homes or other long-term care facilities. As county-level urbanization data in the dataset used for this study were limited to 1999–2020, analyses comparing urban and rural mortality patterns were confined to this period.

Statistical Analysis

According to CDC recommendations, age-adjusted mortality rates (AAMRs) and crude mortality rates (CMRs), expressed per 1,00,000 people based on the US population in 2000, were calculated. AAMRs were directly standardized to the 2000 U.S. standard population, consistent with CDC/National Center for Health Statistics methodology, to facilitate comparisons across calendar years and demographic subgroups with differing age

distributions. Temporal trends in mortality involving diabetes mellitus and ILD from 1999 through 2024 were evaluated using joinpoint regression analysis with the Joinpoint Regression Program (version 5.4.0; National Cancer Institute). Joinpoint regression analysis was employed to detect statistically significant shifts in AAMR trends over the study period (12). The models permitted a maximum of four joinpoints, with the optimal model selected using the program's statistical testing procedure. For each temporal segment, the Annual Percent Change (APC) and corresponding 95% confidence interval (CI) were estimated. The Average Annual Percent Change (AAPC) and corresponding 95% CI were calculated to summarize the overall temporal trend across the study period. Statistical significance was assessed using a two-sided α level of 0.05.

Time-series Forecasting and Projection Analysis

Time-series forecasting was performed using R software to project future mortality trends through 2040. Three forecasting approaches were initially considered: Autoregressive Integrated Moving Average (ARIMA), Exponential Smoothing State Space Models (ETS), and Prophet. These models were considered to provide distinct yet complementary methods for forecasting mortality trends in epidemiological research. ARIMA accounts for relationships between successive observations through autoregressive and moving-average components, with differencing applied to attain stationarity. In contrast, ETS uses exponential smoothing to model the underlying level and trend of a time series, whereas Prophet employs an additive framework that incorporates nonlinear trends and identifies structural shifts through automatic changepoint detection.

Historical mortality data were used for model development. Model performance was evaluated using Mean Error (ME), Root Mean Square Error (RMSE), Mean Absolute Error (MAE), Mean Percentage Error (MPE), Mean Absolute Percentage Error (MAPE), Mean Absolute Scaled Error (MASE), and the lag-1 autocorrelation of residuals (ACF1). Lower RMSE, MAE, MAPE, and MASE values were considered indicative of better predictive performance, while ME was used to assess systematic forecasting bias and ACF1 to evaluate residual autocorrelation. However, the final model selection prioritized the ability to capture the underlying temporal trajectory and accommodate complex changes in mortality patterns.

Prophet was selected as the final forecasting model for all analytical strata, including overall mortality and all available sex-, race-, age-, and geographic-stratified analyses. Prophet was chosen because of its flexibility in modeling non-linear temporal trends and structural changes through automated changepoint detection. This approach allows the underlying mortality trajectory to adapt to changes in trend over time and was considered appropriate for the heterogeneous mortality patterns observed across the different analytical strata, even when alternative models demonstrated lower values for some individual accuracy measures.

The final Prophet models were fitted separately to each stratum using the complete historical dataset and were used to generate mortality projections through 2040. Prophet models were

specified using a linear growth framework with automated changepoint detection and the standard changepoint prior scale of 0.05. No holiday effects were included. Because the data consisted of annually aggregated mortality rates, weekly and daily seasonalities were disabled, and no monthly seasonal component was included to avoid fitting artificial short-term seasonal patterns that could not be reliably estimated from annual observations.

Forecast uncertainty was quantified using 95% prediction intervals, with point estimates and corresponding lower and upper prediction limits generated for each projected year and analytical stratum.

Results

3.1 Overall mortality trends and projections

Out of the total deaths, 61,157 were males (57.29%) and females (42.71%). AAMRs rose substantially from 1.36 (95% CI: 1.29–1.44) in 1999 to 2.45 (95% CI: 2.37–2.53) in 2024 with Average Annual Percent Change (AAPC) of 2.19 (95% CI: 1.31 to 3.09, $p < 0.001$). The joinpoints were well defined in the trend analysis, with a substantial increase in AAMR from 1999 to 2004 (APC: 5.33; 95% CI: 3.25 to 7.45, $p < 0.001$) and a significant decrease from 2004 to 2018 (APC: -0.47; 95% CI: -0.87 to -0.07, $p = 0.024$). AAMR grew significantly from 2018 to 2021 (APC: 18.19; 95% CI: 10.86 to 26.00, $p < 0.001$) and decreased significantly from 2021 to 2024 (APC: -4.94; 95% CI: -7.42 to -2.38, $p = 0.001$). **(Table1; Figure1; Supplementary Table1).**

Time-series forecasting projected the AAMR to rise from 2.40 (95% CI: 2.11–2.71) in 2025 to 2.94 (95% CI: 2.64–3.26) per 100,000 by 2040, representing a further 22.9% increase relative to the projected 2025 value (equivalent to a 20.2% increase above the 2024 observed rate of 2.45/100,000). The 95% prediction interval widens markedly by 2040 (2.64–3.26), indicating considerable forecast uncertainty. **(Supplementary Table2; Figure1).**

Annual observed age-adjusted mortality rates (AAMRs) per 100,000 population are represented by individual points, while a vertical dashed line marks the transition from historical observations to forecasted estimates. The shaded regions surrounding the projected trends represent the 95% prediction intervals generated by the Prophet model. AAMR, age-adjusted mortality rate; Prophet, time-series forecasting model. (Figure 1).

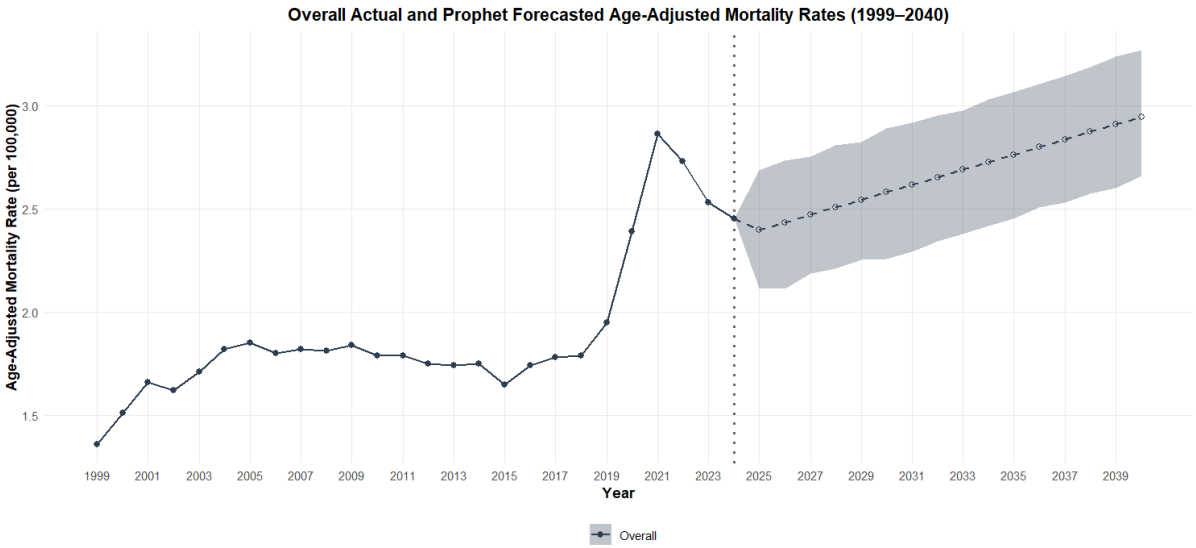


Figure 1: Overall Actual and Prophet Forecasted Age-Adjusted Mortality Rates (per 100,000) for Diabetes Mellitus and Interstitial Lung Disease (ILD) among U.S. adults, 1999 to 2024 and time-series forecasts (2025–2040)

3.2. Gender-Stratified AAMR Trends and Projections

The average AAMR was higher in males (2.58) than in females (1.42) over the study period.

For males, AAMRs increased from 1.71 (95% CI: 1.58–1.85) in 1999 to 3.44 (95% CI: 3.30–3.59) in 2024, with a significant increase in the overall (AAPC: 2.76; 95% CI: 1.66 to 3.88, $p < 0.001$). The AAMR increased significantly from 1999 to 2003 (APC, 6.92; 95% CI, 3.01 to 10.99; P =.002) and continued to increase significantly from 2003 to 2018 (APC, 0.56; 95% CI, 0.11 to 1.02; P =.018). Mortality increased steeply and significantly (APC: 17.01; 95% CI: 8.60-26.06, $p < 0.001$) between 2018 and 2021. Mortality decreased significantly from 2021 to 2024 (APC: −4.62; 95% CI: −7.69 to −1.44, $p = 0.008$).

AAMRs increased from 1999 to 2024 (1.13, 95% CI: 1.04–1.21 to 1.65, 95% CI: 1.57–1.74) with a significant overall increase (AAPC: 1.39; 95% CI: 0.29 to 2.49, $p = 0.013$). AAMR rose markedly from 1999 to 2004 (APC: 5.06; 95% CI: 2.77 to 7.40, $p < 0.001$) and decreased significantly from 2004 to 2018 (APC: −1.62; 95% CI: −2.08 to −1.15, $p < 0.001$). Mortality rates then increased significantly between 2018 and 2021 (APC: 17.97; 95% CI: 8.72 to 28.01, $p < 0.001$). Mortality rates considerably decreased from 2021 to 2024 (APC: -5.51; 95% CI: -8.71 to -2.20, $p = 0.003$). **(Table1; Figure2; Supplementary Table3).**

Model-based projections through 2040 suggest that sex differences will widen in absolute terms if recent trends continue. Among male decedents, the projected AAMR increases from 3.45 (95% CI: 3.08–3.85) in 2025 to 4.43 (95% CI: 4.03–4.84) in 2040, a projected increase of approximately 28%. Female decedents had a smaller projected increase from 1.61 (95% CI: 1.39–1.82) in 2025 to 1.81 (95% CI: 1.58–2.03) by 2040, an increase of 13%. The

relative gap in the projection model is increasing as the male to female ratio of AAMR is estimated to increase from 2.15 in 2025 to 2.45 in 2040. **(Figure2; Supplementary Table4).**

Mortality trends are presented individually for male and female decedents, with a vertical dashed line marking the transition between observed data and future projections. The shaded regions illustrate the corresponding 95% prediction intervals. AAMR, age-adjusted mortality rate; Prophet, time-series forecasting model (Figure 2).

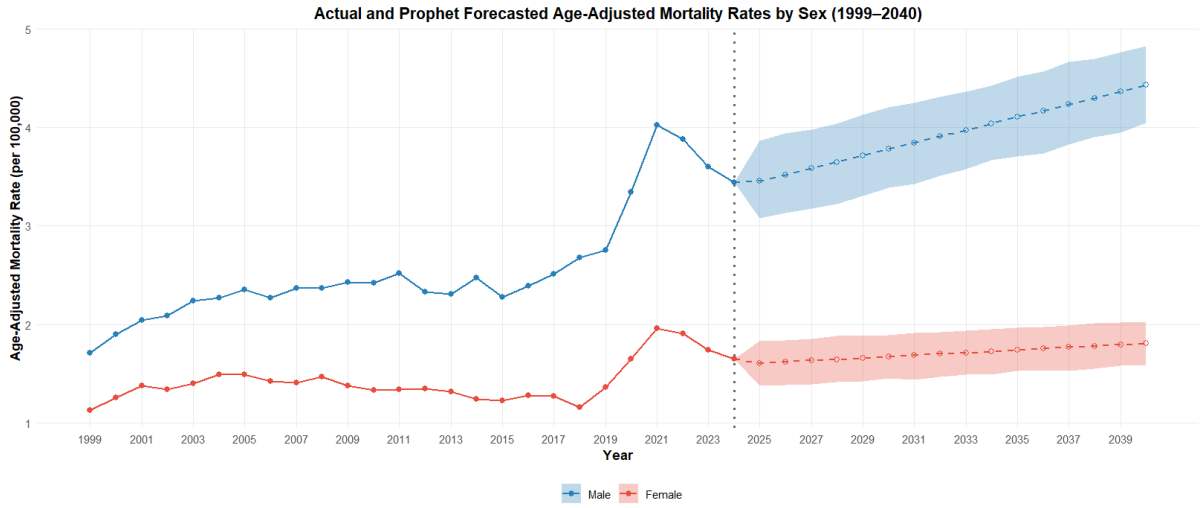


Figure 2: Actual and Prophet Forecasted Age-Adjusted Mortality Rates by Sex (per 100,000) for Diabetes Mellitus and Interstitial Lung Disease (ILD) among U.S. adults, 1999 to 2024 and time-series forecasts (2025–2040).

3.3. Age-stratified trends and projections

The highest average crude mortality rate in the research period was found in the group of ≥85 years (9.59), followed by 75–84 years (6.32), 65–74 years (2.49), 55–64 years (0.66), 45–54 years (0.15).

In the 45–54 year age group, CMRs showed a non-significant overall increase from 0.13 (95% CI: 0.10–0.17) in 1999 to 0.16 (95% CI: 0.12–0.20) in 2024 (AAPC: 0.89; 95% CI: -0.07 to 1.86, p = 0.068). Trend analysis showed no joinpoints, a constant, not significant

trend for the whole study period.

For people aged 55–64 years, there was an overall non-significant shift in CMRs from 0.49 (95% CI: 0.40–0.58) in 1999 to 0.70 (95% CI: 0.62–0.78) in 2024 (AAPC: −0.30; 95% CI: −3.21 to 2.70, p = 0.844). The mortality rate considerably decreased from 1999 to 2018 (APC: -1.64; 95% CI: -2.45 to -0.82, p < 0.001). This was followed by a non-significant increase between 2018 and 2021 (APC: 19.45; 95% CI: -5.86 to 51.56, p = 0.134) and a non-significant decrease between 2021 and 2024 (APC: -9.33; 95% CI: -18.16 to 0.46, p = 0.060).

Among those aged 65–74 years, CMRs increased generally from 1.97 (95% CI: 1.77–2.17) in 1999 to 2.61 (95%CI: 2.45–2.78) in 2024 although this was not statistically significant (AAPC: 0.78; 95% CI: -0.29 to 1.86, p = 0.153). Mortality rates increased considerably from 1999 to 2003 (APC: 6.56; 95% CI: 2.33 to 10.97, p = 0.004), fell dramatically from 2003 to 2017 (APC: −1.87; 95% CI: −2.45 to −1.28, p < 0.001) and then climbed significantly from 2017 to 2021 (APC: 11.31; 95% CI: 6.25 to 16.62, p < 0.001). There was a significant reduction in death rates between 2021 and 2024 (APC: −7.23; 95% CI: −11.07 to −3.23, p = 0.002).

CMRs increased from 4.36 (95% CI: 3.99–4.73) in 1999 to 7.91 (95% CI: 7.51–8.31) in 2024 among adults aged 75–84 years (AAPC: 2.45; 95% CI: 1.30 to 3.61, p < 0.001). Mortality rates increased significantly between 1999 and 2005 (APC: 5.28; 95% CI: 3.23 to 7.38, p < 0.001), remained stable between 2005 and 2018 (APC: -0.23; 95% CI: -0.83 to 0.37, p = 0.421) and increased significantly between 2018 and 2021 (APC: 17.38; 95% CI: 8.02 to 27.54, p < 0.001). Mortality rates dropped significantly between 2021 and 2024 (APC: -5.04; 95% CI: -8.40 to -1.56, p = 0.008).

In the age group ≥85 years, CMRs rose from 5.68 (95% CI: 4.96-6.41) in 1999 to 15.36 (95% CI: 14.40-16.32) in 2024 (AAPC: 4.01; 95% CI: 2.55 to 5.49, p < 0.001). Mortality rates considerably increased from 1999 to 2011 (APC: 3.48; 95% CI: 2.53 to 4.45, p < 0.001) and followed a rather stable course with a non-significant shift from 2011 to 2018 (APC: 0.25; 95% CI: -1.77 to 2.31, p = 0.799). Then, rates showed a strong, substantial rise during 2018-2021 (APC: 19.90; 95% CI: 8.06 to 33.03, p = 0.002). Between 2021 and 2024, death rates were very stable (APC: 0.36; 95% CI: -4.04 to 4.95, p = 0.868). **(Figure3; Supplementary Table5).**

During the study period, the mortality was concentrated among the older populations. Projections to 2040 show a clear difference between age groups with a greater burden in the future that will disproportionally affect the older cohorts. The crude mortality rate among those aged 45–54 years is projected to increase gradually from 0.17 (95% CI: 0.13–0.21) per 100,000 in 2025 to 0.19 (95% CI: 0.15–0.23) per 100,000 in 2040, an 11.1% increase. Small projected increases were also observed in the 55–64 and 65–74 age groups with crude rates projected to reach 0.73 (95% CI: 0.60–0.85) and 2.79 (95% CI: 2.44–3.15) in 2040.

The oldest populations, however, are expected to show the steepest upward trends. For the 75–84 years age group, the crude mortality rate is expected to increase from 8.00 (95% CI: 7.06–8.98) in 2025 to 10.03 (95% CI: 9.10–10.98) in 2040, an increase of 25.4%. For people aged 85+ years, the rate is expected to increase steeply from 14.13 (95% CI: 12.38–15.89) in 2025 to 19.52 (95% CI: 17.72–21.39) in 2040, representing a projected increase of 38.2% and the highest absolute risk in the cohort. **(Figure3; Supplementary Table6).**

Trend lines are displayed separately for the 45–54, 55–64, 65–74, 75–84, and 85+ year age groups. The dashed vertical line separates the observed and projected values. The shaded bands indicate the 95% prediction intervals for the Prophet forecast. Prophet, time-series forecasting model (Figure 3).

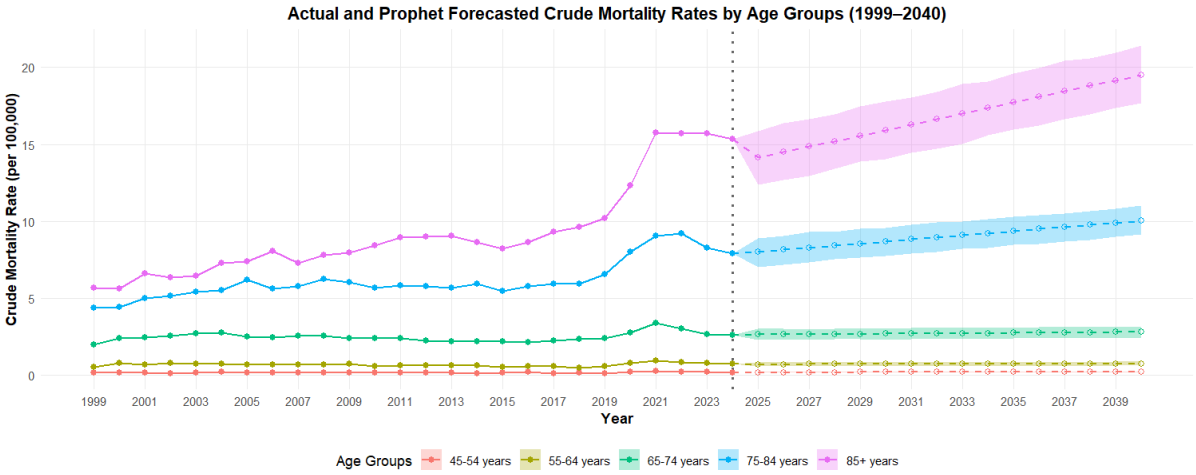


Figure 3: Actual and Prophet Forecasted Crude Rate Mortality by Age (per 100,000) for Diabetes Mellitus and Interstitial Lung Disease (ILD) among U.S. adults, 1999 to 2024 and time-series forecasts (2025–2040).

3.4 Racial and ethnic disparities in trends and projections

The Hispanic or Latino population had the highest average AAMR throughout the study period (3.02), followed by the White population (1.81), the Black or African American population (1.69), and the Asian or Pacific Islander population (1.64).

The overall AAMRs among the Hispanic or Latino population increased non-significantly from 2.42 (95% CI: 1.95–2.89) in 1999 to 3.43 (95% CI: 3.13–3.75) in 2024 (AAPC: 1.33; 95% CI: -0.40 to 3.09, p = 0.133). Mortality rates were non-significantly increased from 1999 to 2004 (APC: 3.90; 95% CI: -0.92 to 8.96, p = 0.106), but non-significantly decreased from 2004 to 2018 (APC: -0.77; 95% CI: -1.60 to 0.06, p = 0.066). There was a significant increase in the rates from 2018 to 2021 (APC: 19.70; 95% CI: 6.43 to 34.64, p = 0.005). The mortality rates declined significantly from 2021 to 2024 (APC: −9.30; 95% CI −13.90 to −4.46, p < 0.001).

AAMRs in Whites increased from 1.27 (95% CI: 1.19–1.35) in 1999 to 2.35 (95% CI: 2.26–2.44) in 2024 and an overall increase was statistically significant (AAPC: 2.55; 95% CI: 1.43 to 3.68, $p < 0.001$). AAMR considerably rose from 1999 to 2001 (APC: 11.94; 95% CI: 2.24 to 22.55, $p = 0.019$) and continued to significantly grow from 2001 to 2008 (APC: 1.34; 95% CI: 0.09 to 2.60, $p = 0.037$). Rates non-significantly decreased from 2008 to 2018 (APC: − 0.58; 95% CI: − 1.22 to 0.07, $p = 0.075$) and then sharply and significantly increased from 2018 to 2021 (APC: 17.30; 95% CI: 9.68 to 25.45, $p < 0.001$). However, death rates decreased significantly between 2021 and 2024 (APC: -3.61; 95% CI: -6.50 to -0.63, $p = 0.022$).

The overall increase in AAMRs for the Black or African American population was non-significant from 1.41 (95% CI: 1.15-1.66) in 1999 to 1.96 (95% CI: 1.74-2.20) in 2024 (AAPC: 1.14; 95% CI: -0.69 to 3.00, $p = 0.223$). AAMR increased non-significantly from 1999 to 2005 (APC: 2.95; 95% CI: -0.12 to 6.11, $p = 0.058$) and then decreased significantly from 2005 to 2018 (APC: -1.97; 95% CI: -2.91 to -1.03, $p < 0.001$). Thereafter, mortality rates significantly increased from 2018 to 2021 (APC: 18.31; 95% CI: 3.49 to 35.25, $p = 0.017$). Rates decreased from 2021 to 2024 but not significantly (APC: −4.43; 95% CI: −10.25 to 1.76, $p = 0.144$).

The AAMRs increased non-significantly from 1.42 (95% CI: 0.95-2.04) in 1999 to 2.11 (95% CI: 1.81-2.45) in 2024 among the Asian or Pacific Islander population (AAPC: 1.38; 95% CI: -1.32 to 4.16, $p = 0.319$). Trend analysis showed a non-significant extended change for the period 1999-2018 (APC: 0.23; 95% CI: -0.74 to 1.22, $p = 0.624$). That was followed by a non-significant increase between 2018 and 2021 (APC: 16.24; 95% CI: -6.21 to 44.07, $p = 0.158$) and a non-significant fall between 2021 and 2024 (APC: -4.95; 95% CI: -13.18 to 4.06, $p = 0.254$). **(Table1, Figure4; Supplementary Table7).**

Model-based projections through 2040 suggest that while absolute mortality rates will rise across all groups, the relative racial differences may slightly narrow. Among Hispanic or Latino decedents, the projected AAMR increases from 3.60 (95% CI: 3.07–4.15) in 2025 to 4.26 (95% CI: 3.75–4.77) in 2040, a projected increase of 18%. Among White decedents, the projected AAMR increases from 2.29 (95% CI: 2.01–2.55) in 2025 to 2.82 (95% CI: 2.54–3.08) in 2040, representing a projected increase of 23%. Asian or Pacific Islander decedents show a projected increase from 2.05 (95% CI: 1.75–2.34) in 2025 to 2.51 (95% CI: 2.20–2.81) by 2040, a 22% increase. Black or African American decedents show the smallest projected growth, rising from 1.86 (95% CI: 1.58–2.14) to 2.06 (95% CI: 1.76–2.34) over the same period, a 10% increase. The projected Hispanic or Latino to White AAMR ratio decreases slightly from 1.57 in 2025 to 1.51 in 2040, indicating a slight decrease in relative disparity in the projection model. **(Figure4; Supplementary Table8).**

Trend lines are displayed separately for Hispanic or Latino, Asian or Pacific Islander, Black or African American, and White decedents. The dashed vertical line separates the observed

and projected values. The shaded bands indicate the 95% prediction intervals. AAMR, age-adjusted mortality rate; Prophet, time-series forecasting model (Figure 4).

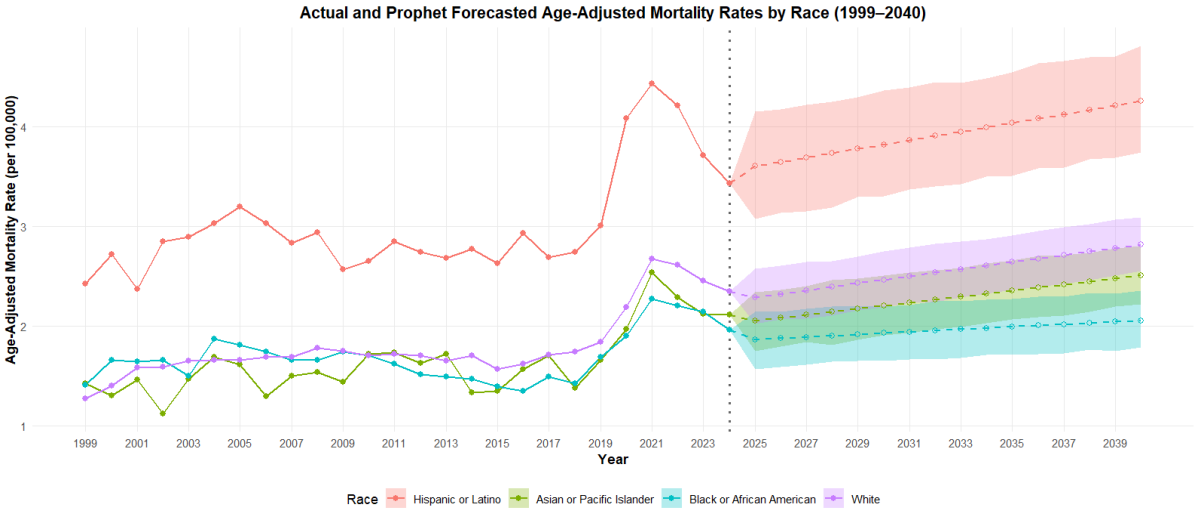


Figure 4: Actual and Prophet Forecasted Age-Adjusted Mortality Rates by Race (per 100,000) for Diabetes Mellitus and Interstitial Lung Disease (ILD) among U.S. adults, 1999 to 2024 and time-series forecasts (2025–2040).

3.5 Urbanization trends and projections

The average AAMR was greater for non-metropolitan areas (1.96), followed by metropolitan areas (1.73) (Figure 5).

The AAMRs in non-metropolitan areas were 1.57 (95% CI: 1.38–1.75) in 1999 and 2.81 (95% CI: 2.60–3.03) in 2020, indicating a substantial overall increase (AAPC: 3.00; 95% CI: 1.40 to 4.64, $p < 0.001$). The trend increased significantly from 1999 to 2004 (APC: 5.55; 95% CI: 1.28 to 10.01, $p = 0.014$) and then changed non-significantly from 2004 to 2018 (APC: 0.27; 95% CI: -0.58 to 1.13, $p = 0.504$). Thereafter, rates increased sharply and significantly between 2018 and 2020 (APC: 16.96; 95% CI: 2.11 to 33.97, $p = 0.027$).

In urban regions, AAMRs grew from 1.31 (95% CI: 1.23–1.39) in 1999 to 2.28 (95% CI: 2.19–2.37) in 2020, with an overall significant increase (AAPC: 2.26; 95% CI: 1.44 to 3.09, $p < 0.001$). AAMR grew considerably between 1999 and 2004 (APC: 4.98; 95% CI: 2.67 to 7.35, $p < 0.001$), and subsequently decreased non-significantly between 2004 and 2018 (APC: −0.45; 95% CI: −0.90 to 0.00, $p = 0.050$). This was followed by a sharp, substantial increase between 2018 and 2020 (APC: 15.60; 95% CI: 8.07 to 23.65, $p < 0.001$). **(Table1, Figure5; Supplementary Table9).**

Projected rates through 2040 show that non-metropolitan rates will always be higher than metropolitan rates and that the two will diverge over time. Metropolitan AAMRs are projected to rise from 1.91 (95% CI: 1.75–2.08) in 2021 to 2.20 (95% CI: 2.04–2.39) by 2040, representing an increase of 15.5%. Non-metropolitan rates are projected to rise from 2.33 (95% CI: 2.09–2.57) in 2021 to 2.93 (95% CI: 2.70–3.15) in 2040, a 25.9% increase from the 2021 baseline. This indicates that the rural-urban mortality gap is projected to persist and widen by 2040. **(Figure5; Supplementary Table10).**

Separate trend lines illustrate mortality patterns in metropolitan and non-metropolitan areas. As urbanization-specific data from CDC WONDER were limited to the period ending in 2020, forecasted estimates begin in 2021. A vertical dashed line distinguishes the historical data from the projections, with shaded areas representing the corresponding 95% prediction intervals. AAMR, age-adjusted mortality rate; Prophet, time-series forecasting model (Figure 5).

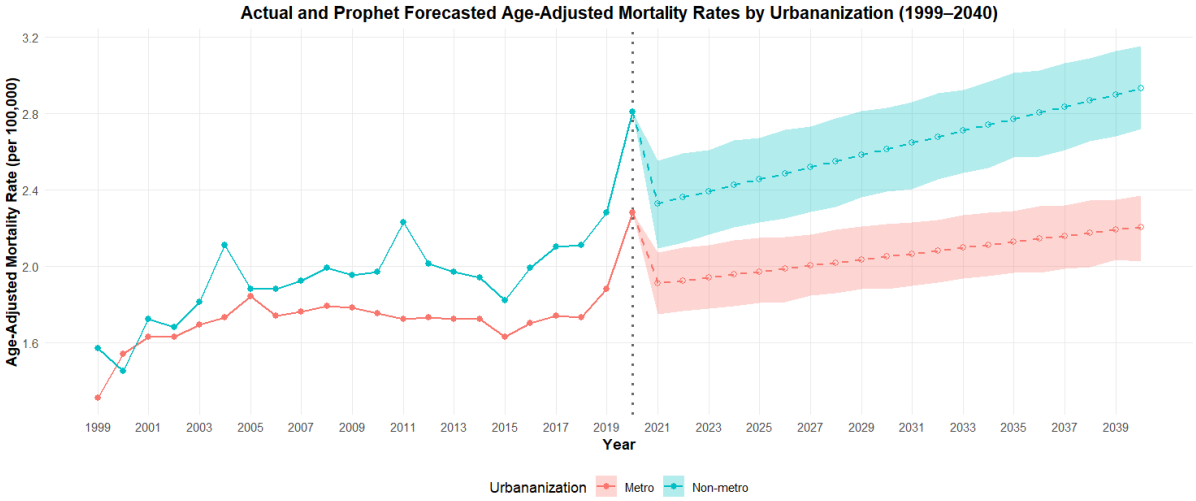


Figure 5: Actual and Prophet Forecasted Age-Adjusted Mortality Rates by Urbanization (per 100,000) for Diabetes Mellitus and Interstitial Lung Disease (ILD) among U.S. adults, 1999 to 2020 and time-series forecasts (2021–2040).

3.6. Census Region Trends and Projections

The West region had the highest average AAMR throughout the study period (2.24), followed by the Midwest region (2.01), the South region (1.86) and the Northeast region (1.48).

In the West area, AAMRs grew from 1.66 (95% CI: 1.47–1.84) in 1999 to 2.80 (95% CI: 2.62–2.99) in 2024, with a significant overall change (AAPC: 2.16; 95% CI: 0.93 to 3.40, $p < 0.001$). 1999-2005, APC: 3.84, 95% CI: 1.60 to 6.13, $p = 0.002$) and was generally stable

between 2005 and 2018 with a non-significant shift (APC: 0.19, 95% CI: -0.47 to 0.84, p = 0.556). Then, rates rose markedly and significantly between 2018 and 2021 (APC: 16.62; 95% CI: 6.78 to 27.36, p = 0.002). Mortality rates decreased significantly between 2021 and 2024 (APC: −5.74; 95% CI: −9.31 to −2.03, p = 0.005).

In the Midwest area, the AAMRs increased from 1.46 (95% CI: 1.31–1.62) in 1999 to 2.35 (95% CI: 2.19–2.53) in 2024 (AAPC: 1.98; 95% CI: 0.07 to 3.93, p = 0.042). AAMR increased significantly between 1999 and 2004 (APC: 7.89, 95% CI: 3.64 to 12.32, p = 0.001) and then decreased significantly from 2004 to 2018 (APC: -1.10, 95% CI: -1.90 to -0.29, p = 0.011). In 2018-2021, AAMR showed a sharp but non-significant increase (APC: 14.90, 95% CI: -0.05 to 32.08, p=0.051) and in 2021-2024, the death rates decreased non-significantly (APC: -4.91, 95% CI: -10.76 to 1.32, p=0.112).

In the South area, AAMRs increased from 1.29 (95% CI: 1.17–1.41) in 1999 to 2.62 (95% CI: 2.49–2.76) in 2024 (AAPC: 2.85; 95% CI: 1.34 to 4.38, p < 0.001). AAMR increased non-significantly from 1999 to 2001 (APC: 13.93; 95% CI: -0.50 to 30.46, p = 0.058) and then remained non-significantly unchanged for a lengthy period from 2001 to 2018 (APC: -0.07; 95% CI: -0.50 to 0.37, p = 0.747). Rates then increased substantially throughout the period 2018 to 2021 (APC: 20.30; 95% CI: 10.18 to 31.35, p < 0.001). Mortality rates declined non-significantly from 2021 to 2024 (APC: -3.35; 95% CI: -6.88 to 0.32, p = 0.070).

In the Northeast, AAMRs increased non-significantly from 1.10 (95% CI, 0.95-1.25) in 1999 to 1.72 (95% CI, 1.57-1.89) in 2024 (AAPC, 1.38; 95% CI, -0.23-3.01, p=0.094). Mortality rates increased significantly between 1999 and 2005 (APC: 3.85; 95% CI: 1.28–6.49, p = 0.006), then decreased significantly between 2005 and 2018 (APC: −1.17; 95% CI: −1.98 to −0.35, p = 0.008). There was a large and steep increase between 2018 and 2021 (APC: 16.84; 95% CI: 3.76–31.57, p=0.014). Significant reduction in death rates from 2021 to 2024 (APC: -6.44; 95% CI: -11.49 to -1.11, p=0.022). **(Table 1, Figure 6; Supplementary Table 11).**

The AAMRs are projected to continue to rise in all four regions through 2040 with the West remaining highest. In the West, the incidence is projected to increase from 2.89 (95% CI: 2.57–3.21) in 2025 to 3.62 (95% CI: 3.26–3.94) in 2040. The South increases from 2.44 (95% CI: 2.07–2.80) to 3.07 (95% CI: 2.71–3.42). The Midwest rises from 2.37 (95% CI: 2.10–2.65) to 2.78 (95% CI: 2.48–3.07). The Northeast had the lowest rate, which increased from 1.72 (95% CI: 1.50–1.93) to 1.98 (95% CI: 1.77–2.21). **(Figure 6; Supplementary Table 12).**

Trend lines are displayed separately for the Northeast, Midwest, South, and West regions. The dashed vertical line separates the observed and projected values. The shaded bands indicate the 95% prediction intervals. AAMR, age-adjusted mortality rate; Prophet, time-series forecasting model (Figure 6).

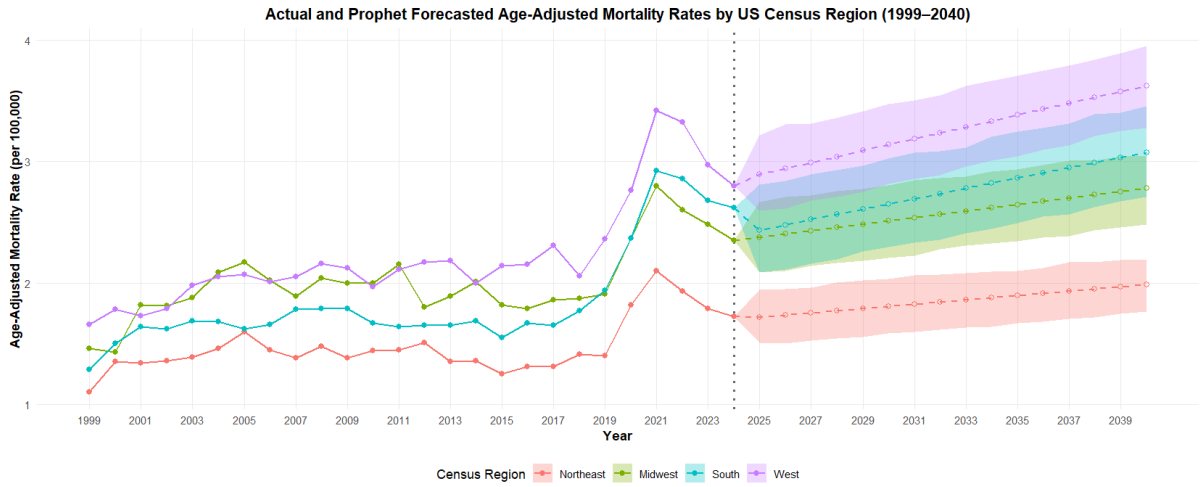


Figure 6: Actual and Prophet Forecasted Age-Adjusted Mortality Rates by Census Regions (per 100,000) for Diabetes Mellitus and Interstitial Lung Disease (ILD) among U.S. adults, 1999 to 2024 and time-series forecasts (2025–2040).

3.7. State-Stratified AAMR Trends

Vermont had the greatest average AAMR from 1999 to 2020, with an AAMR of 3.42, and Nevada had the lowest average AAMR, with an AAMR of 0.81. The states in the top 90th percentile were Vermont, Oregon, Wyoming, Washington, South Dakota, and Minnesota, while the states in the lowest 10th percentile were Nevada, New York, Arkansas, Florida, Georgia and Louisiana (Figure 7).

Wyoming had the highest average AAMR at 5.70 and Connecticut had the lowest at 1.13 from 2021-2024. States that continually rank high in AAMRs, in the top percentile, include Wyoming, Oklahoma, South Dakota, Minnesota, Oregon and South Carolina. Conversely, the lowest average AAMR was in Connecticut, followed by Massachusetts, North Dakota, Illinois, New York, and Alabama. **(Supplementary Table 13).**

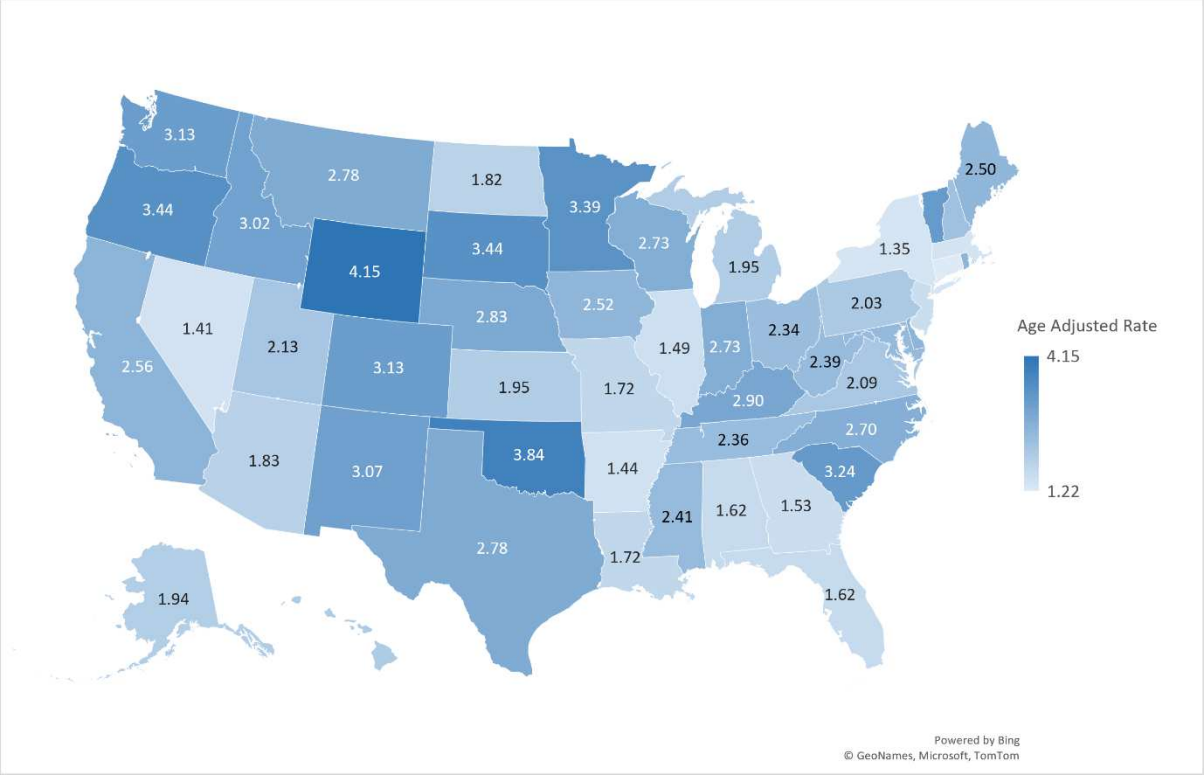


Figure 7: State-Stratified Age-adjusted mortality rates (per 100,000) for Diabetes Mellitus and Interstitial Lung Disease (ILD) among U.S. adults, 1999 to 2024.

3.8. Place of Death-Stratified Trends

Place-of-death research found that the biggest proportion of deaths occurred in hospital inpatient settings (40.7%), followed by the decedent's home (33.1%) and nursing homes or long-term care facilities (12.4%). Deaths occurred in medical outpatient or emergency room facilities (5.8%), at hospice institutions (4.1%) and in other settings in lower amounts. **(Figure 8; Supplementary Table 14).**

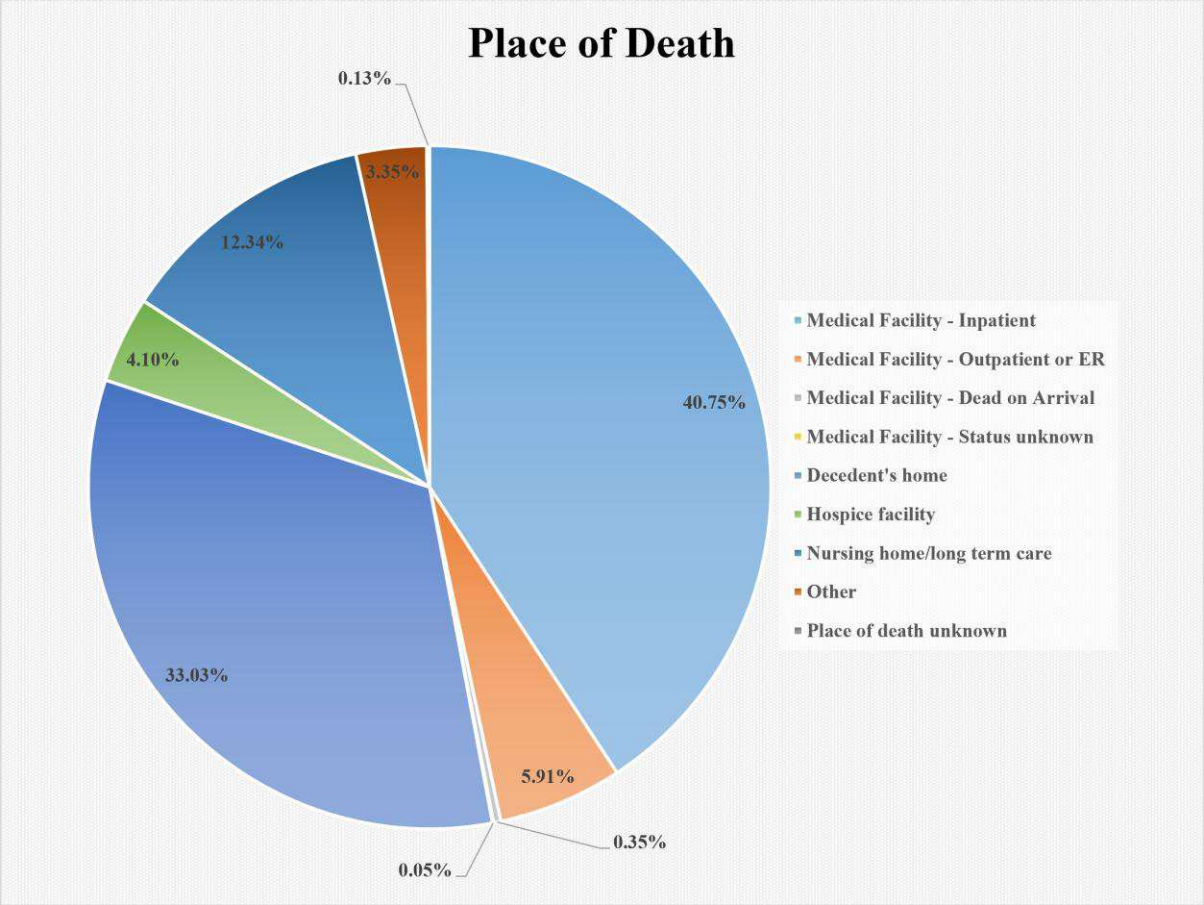
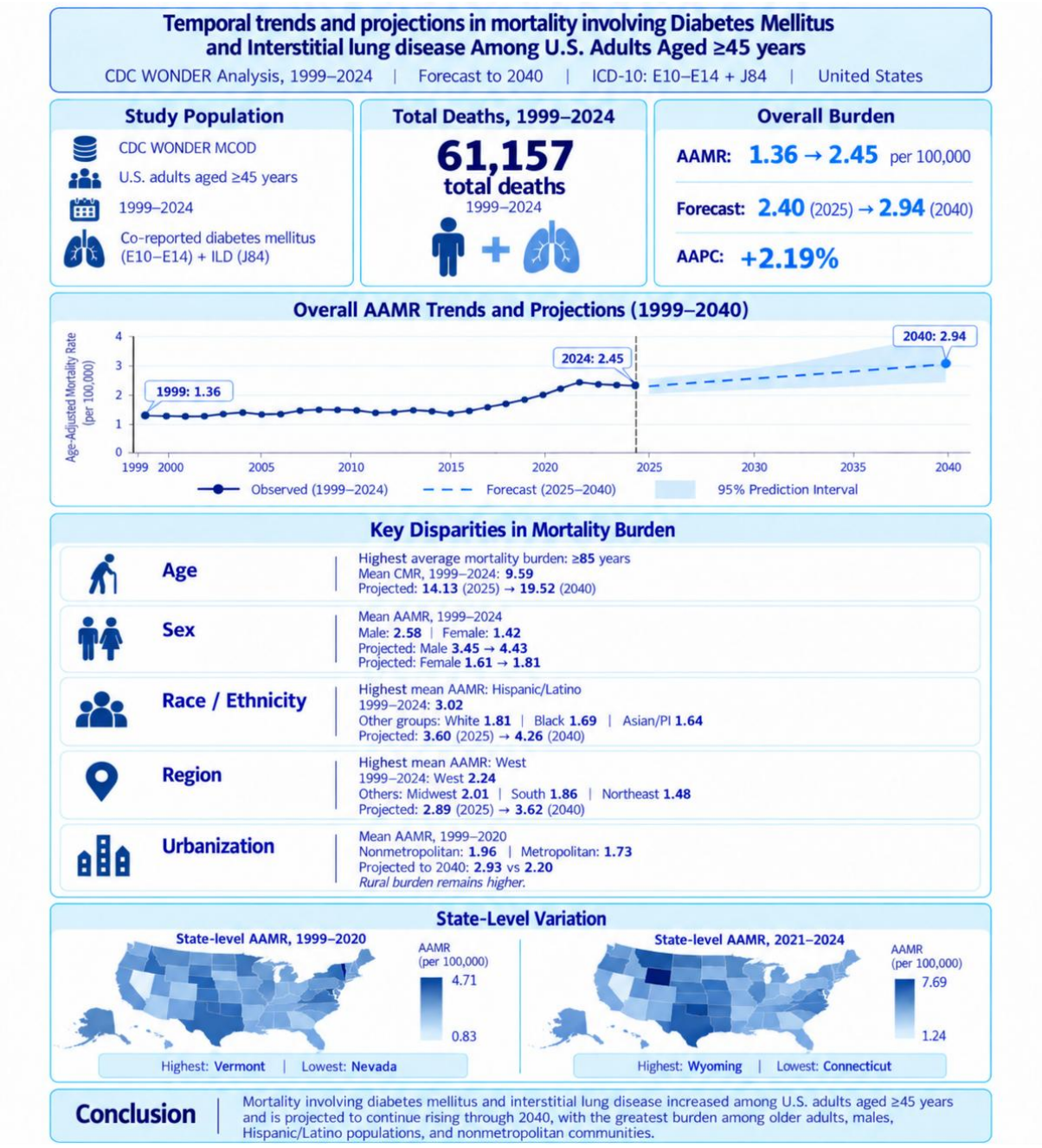


Figure 8: Place of Death-stratified trends

Discussion:

In this 26-year nationwide analysis of 61,157 deaths in which both diabetes mellitus and ILD were recorded on the death certificate, mortality among U.S. adults aged ≥45 years increased over the study period. The increase was marked by a sharp rise between 2018 and 2021, followed by a partial decline. Substantial disparities were observed. Mortality was highest among the oldest adults, men, Hispanic or Latino adults, residents of the West and residents of nonmetropolitan areas. Most deaths occurred in hospital inpatient settings, followed by the decedent's home. Projections suggest that mortality will continue to rise through 2040, particularly among adults aged ≥85 years and men, with a persistent excess in nonmetropolitan areas. To our knowledge, this is the first study to describe national long-term trends and projections for mortality involving both conditions.



The co-occurrence of these conditions on death certificates is biologically plausible. In a meta-analysis of nine case–control studies, diabetes was more common in patients with idiopathic pulmonary fibrosis (IPF) than in controls (pooled OR 1.65). However, heterogeneity was substantial and causality was not established (13). Diabetes has also been linked to pulmonary microangiopathy and excess extracellular connective tissue in the lung (14).

The early rise in mortality coincided with rapid growth in diagnosed diabetes. Among U.S. adults aged 20–79 years, the prevalence and incidence of diagnosed diabetes increased by about 4.5% and 4.7% per year, respectively, between 1990 and 2008 (15). ILD mortality also increased during this period (15). The subsequent period of gradual decline overlapped with three developments: diabetes prevalence and incidence stopped rising between 2008 and

2012 (15); diabetes-related complications fell substantially between 1990 and 2010 (16); and phase 3 trials published in 2014 showed that antifibrotic therapies slow lung function decline in IPF (14,17). Because IPF is only one of the conditions coded as J84 and the design is ecological, these temporal associations cannot be attributed to specific causes.

The sharp rise between 2018 and 2021 is temporally consistent with the COVID-19 pandemic. However, the rise began before the pandemic, and we did not examine COVID-19 on death certificates. Both conditions have been associated with poor COVID-19 outcomes. In an international multicenter study, patients with ILD hospitalized with COVID-19 had a mortality of 49% and poorer survival than matched controls (18). In a whole-population study in England, type 1 and type 2 diabetes were associated with adjusted odds ratios of 3.51 and 2.03, respectively, for in-hospital COVID-19 death (19). Diabetes has also been associated with post-COVID-19 pulmonary fibrosis, although with considerable heterogeneity between studies (20). Mortality with ILD as the underlying cause showed no comparable surge: it fell in 2020 and rose only modestly in 2021 (15). One possible explanation is that part of the excess observed here reflects deaths in which COVID-19 or another condition was the underlying cause and diabetes and ILD were contributing conditions. Analysis by underlying cause could test this. The subsequent decline coincided with widespread COVID-19 vaccination, which modelling estimates suggest prevented 14.4 million deaths worldwide in its first year (21). However, the decline was smaller than the preceding increase.

Mortality was concentrated among the oldest adults, consistent with the age distribution of both conditions. Diabetes affects 29.2% of U.S. adults aged ≥65 years (22), and among U.S. veterans the risk of IPF rose with each decade of age up to 80 years (23). Notably, mortality among adults aged ≥85 years did not decline after 2021, unlike in the 65–74 and 75–84 year groups, and this group is projected to have the largest increase through 2040. The U.S. population aged ≥85 years is expected to more than double, from 6.5 million in 2018 to 14.4 million in 2040 (**ACL 2020:** Administration for Community Living. 2019 Profile of Older Americans. Washington, DC: U.S. Department of Health and Human Services; 2020) (24). The number of deaths in this group could therefore grow proportionally more than the rates.

Men had higher mortality than women and a steeper increase over the study period. A male excess has also been reported for ILD as the underlying cause of death (15). In a Swedish case–control study, the adverse effect of smoking on severe pulmonary fibrosis was amplified by male sex and occupational exposure (25). Sex differences in these exposures may therefore contribute, although our data contain no information on smoking or occupation. The sex gap is projected to widen through 2040.

Hispanic or Latino adults had the highest mortality of any racial or ethnic group. A national analysis of ILD as the underlying cause of death did not report rates for Hispanic adults (15), so the contribution of ILD to this excess cannot be assessed. However, Hispanic adults have

the highest age- and sex-adjusted diabetes prevalence of the major U.S. racial and ethnic groups (22.1% vs 12.1% in non-Hispanic White adults) (17), which may contribute. Hispanic adults also had among the highest COVID-19 death rates in 2020 (26). In our data, Hispanic rates rose sharply during 2018–2021 and then declined more steeply than in any other group. Over the full study period, however, the Hispanic–White difference narrowed, because only White adults had a significant overall increase. Black adults had a high diabetes prevalence (20.4%) (17) but relatively low mortality involving both conditions, consistent with their lower ILD mortality compared with White adults (15). This suggests that the population distribution of ILD may matter as much as that of diabetes. Projections indicate continued increases in all groups through 2040, with Hispanic adults remaining the most affected.

Mortality was highest in the West and lowest in the Northeast. The highest-burden states in 1999–2020 (Vermont, Oregon, Wyoming, Washington, South Dakota and Minnesota) lie outside the southern "diabetes belt" identified at county level (27). In contrast, several of the lowest-burden states (Arkansas, Florida, Georgia and Louisiana) contain belt counties. The geography of mortality involving both conditions therefore does not simply follow the distribution of diabetes and may reflect regional variation in ILD. Possible contributors include occupational exposures, which account for an estimated 26% of IPF (28), and differences in diagnostic practice and death certification, although our data cannot assess these. The South nevertheless showed the steepest increase, and the West is projected to remain the highest-burden region through 2040.

Nonmetropolitan areas had higher mortality than metropolitan areas, and their rates rose faster. This is consistent with a broader rural disadvantage in diabetes outcomes: between 1999–2000 and 2017–2018, diabetes mortality did not change in rural counties but declined in more urbanized counties (29). Differences in access to specialist care may contribute but could not be examined here. The rural excess is projected to widen by 2040. However, these projections begin in 2021 because urbanization data were available only through 2020, so they do not incorporate observed rates from the pandemic period.

Most deaths occurred in hospital inpatient settings, followed by the decedent's home, and few occurred in hospice facilities. CDC WONDER records the place of death, not hospice or palliative care enrollment. Home and nursing-home deaths may therefore include patients receiving hospice care, and these data cannot measure palliative care use. Nonetheless, the large share of inpatient deaths is consistent with evidence that palliative care referral may be infrequent in fibrotic ILD. In a single-center cohort of 106 patients with IPF admitted to intensive care, only 3.8% had been referred to palliative care beforehand (30).

Our projections suggest that mortality will continue to rise through 2040. These estimates describe the trajectory expected if historical patterns persist; they are not predictions. The Prophet model projects forward a linear trend estimated from the 1999–2024 series, whereas joinpoint analysis showed a significant decline after 2021. The projection therefore implicitly assumes that this decline will not continue. Because AAMRs are standardized to the 2000 U.S. population, population ageing (24) would increase the number of deaths rather than the

age-adjusted rates. Continued growth in diabetes prevalence (13) could, however, contribute to rising rates. These findings suggest that diabetes warrants attention as a comorbidity in the care of patients with ILD. They also support continued prioritization of adults with both conditions for prevention of respiratory infections, including vaccination. Further work is warranted to evaluate access to palliative care, to reach nonmetropolitan and Hispanic communities, and to extend surveillance stratified by underlying cause of death.

Limitations

This study has several limitations. First, death certificates are prone to misclassification, and diabetes is often omitted. In a U.S. managed-care cohort, diabetes was recorded anywhere on the death certificate for only 41% of decedents with known diabetes (31). Our estimates therefore probably understate the true burden, and changes in recording practices over time could affect the trends. Second, co-occurrence on a death certificate does not establish causation, and we did not stratify by underlying cause, including COVID-19. Third, the J84 code group is heterogeneous. It does not capture sarcoidosis, hypersensitivity pneumonitis or ILD associated with connective tissue disease that is coded elsewhere (15), and diabetes types (E10–E14) were analyzed together. Fourth, CDC WONDER lacks individual-level clinical and socioeconomic data, race and ethnicity on death certificates may be misclassified, and urbanization data were available only through 2020. Finally, the forecasts extrapolate 16 years ahead from 26 annual observations (22 for urbanization) that include the pandemic period. Prophet was selected for its flexibility, although alternative models had lower values on some accuracy measures. Its uncertainty intervals assume that future trend changes will resemble those in the historical series (32), so they cannot anticipate new shocks, therapies or coding changes. The projections should therefore be interpreted as model-based scenarios rather than precise forecasts. Despite these limitations, the use of 26 years of nationally representative multiple-cause-of-death data, analysed with joinpoint regression and forecasting across demographic and geographic strata, provides a comprehensive overview of this growing burden.

Conclusions

Mortality involving both diabetes mellitus and ILD among U.S. adults aged ≥45 years increased between 1999 and 2024, with a sharp rise during 2018–2021 that has only partly reversed. The burden falls disproportionately on adults aged ≥85 years, men, Hispanic or Latino adults, and residents of the West and of nonmetropolitan areas. If historical trends continue, mortality is projected to rise further by 2040, with widening sex and rural–urban gaps. Attention to diabetes as a comorbidity in ILD, protection of this population against respiratory infections, equitable access to specialist and palliative care, and continued surveillance may help address this burden.

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Conflicts of interest:

The authors report no relationships that could be construed as a conflict of interest

Ethics approval and consent to participate:

This study was conducted in accordance with the ethical principles of the Declaration of Helsinki, as applicable to research involving publicly available, de-identified aggregate data. The analysis utilized mortality records obtained from the Centers for Disease Control and Prevention Wide-Ranging Online Data for Epidemiologic Research (CDC WONDER) database. As the data were publicly accessible and contained no personally identifiable information, formal institutional ethics committee approval and individual informed consent were not required. No direct interaction with human participants occurred.

Trial registration

Not applicable. This study was a retrospective analysis of publicly available, de-identified mortality data from the CDC WONDER database and did not involve a clinical trial.

Study Participants:

The research is based on de-identified human death certificate data from the CDC WONDER database. https://wonder.cdc.gov/mcd.html.

Declaration of Generative AI in Scientific Writing:

The authors report no AI usage to facilitate this manuscript.

Consent for publication:

Not applicable

Consent and Ethics Approval:

The research is based on de-identified data and does not require the consent of the participants or ethics approval.

Availability of data and materials:

The datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request.

AUTHOR CONTRIBUTIONS: SM: conceptualization, supervision, formal analysis, validation, visualization, writing–original draft, writing–review and editing; **TH, AE**: software and formal analysis, visualization, writing–original draft, writing–review and editing; **MB**: methodology, investigation, validation, writing–original draft, writing–review and editing; **MW, MK**: data curation, software analysis, methodology, visualization; **RA, NH**: data curation, resources, writing–original draft; **AN, SQ**: data curation, resources, writing–original draft; **J.H.J.A.**,**SM**: writing–review, supervision and editing, critical revision; **MMS, HA**: supervision, validation, manuscript review and final approval.

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Table 1: Annual percent change (APC) of Mortality Trends and Disparities in Middle-Aged and Older Adults with Diabetes Mellitus and Other specified interstitial pulmonary diseases, shown as age-adjusted mortality rates per 100,000 population in the United States, 1999–2024

Year Interval	APC (95% CI)	P value
Overall		
1999-2004	5.3302* (3.2490 - 7.4533)	0.000056
2004-2018	-0.4740* (-0.8735 - -0.0729)	0.023665
2018-2021	18.1883* (10.8580 - 26.0032)	0.000054
2021-2024	-4.9353* (-7.4194 - -2.3846)	0.000997
Male		
1999-2003	6.9239* (3.0060 - 10.9909)	0.001665
2003-2018	0.5608* (0.1085 - 1.0151)	0.018410
2018-2021	17.0056* (8.6046 - 26.0564)	0.000429
2021-2024	-4.6158* (-7.6872 - -1.4422)	0.007661
Female		

1999-2004	5.0587* (2.7655 - 7.4031)	0.000250
2004-2018	-1.62 (-2.08 - -1.15)	<0.001
2018-2021	17.9712* (8.7184 - 28.0114)	0.000616
2021-2024	-5.5119* (-8.7140 - -2.1975)	0.003189
NH White		
1999-2001	11.9353* (2.2390 - 22.5512)	0.018910
2001-2008	1.3398* (0.0946 - 2.6006)	0.037019
2008-2018	-0.5793 (-1.2221 - 0.0676)	0.074704
2018-2021	17.3011* (9.6806 - 25.4511)	0.000231
2021-2024	-3.6142* (-6.5046 - -0.6345)	0.021802
NH Black or African American		
1999-2005	2.9474 (-0.1179 - 6.1068)	0.058456
2005-2018	-1.9741* (-2.9140 - -1.0251)	0.000505
2018-2021	18.3058* (3.4862 - 35.2476)	0.017228
2021-2024	-4.4324 (-10.2465 - 1.7583)	0.144498
NH Asian or Pacific Islander		
1999-2018	0.2329 (-0.7448 - 1.2201)	0.624143
2018-2021	16.2423 (-6.2119 - 44.0723)	0.157975
2021-2024	-4.9505 (-13.1819 - 4.0613)	0.254294
Hispanic or Latino		
1999-2004	3.9034 (-0.9179 - 8.9594)	0.106407
2004-2018	-0.7732 (-1.5963 - 0.0568)	0.065601
2018-2021	19.7036* (6.4260 - 34.6377)	0.005268
2021-2024	-9.3011* (-13.9004 - -4.4561)	0.001163
Metropolitan Areas		
1999- 2004	4.9839* (2.6684 - 7.3516)	0.000356
2004-2018	-0.4513 (-0.9015 - 0.0010)	0.050438
2018-2020	15.6008* (8.0729 - 23.6531)	0.000399

Non-Metropolitan Areas		
1999-2004	5.5510* (1.2772 - 10.0052)	0.014087
2004-2018	0.2735 (-0.5788 - 1.1332)	0.503749
2018-2020	16.9576* (2.1053 - 33.9704)	0.026787
Northeast		
1999-2005	3.8523* (1.2794 - 6.4906)	0.005824
2005-2018	-1.1654* (-1.9755 - -0.3486)	0.008342
2018-2021	16.8424* (3.7629 - 31.5706)	0.013606
2021-2024	-6.4403* (-11.4852 - -1.1079)	0.021768
Midwest		
1999-2004	7.8939* (3.6414 - 12.3209)	0.001097
2004-2018	-1.0994* (-1.9038 - -0.2884)	0.011330
2018-2021	14.8992 (-0.0462 - 32.0794)	0.050672
2021-2024	-4.9138 (-10.7649 - 1.3210)	0.111503
South		
1999-2001	13.9319 (-0.4987 - 30.4555)	0.057968
2001-2018	-0.0676 (-0.5046 - 0.3714)	0.746863
2018-2021	20.2989* (10.1755 - 31.3524)	0.000440
2021-2024	-3.3466 (-6.8753 - 0.3159)	0.070035
West		
1999-2005	3.8397* (1.6010 - 6.1277)	0.002207
2005-2018	0.1850 (-0.4674 - 0.8416)	0.555581
2018-2021	16.6195* (6.7839 - 27.3611)	0.002056
2021-2024	-5.7407* (-9.3141 - -2.0265)	0.005268

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