ADVANCE SOCIAL SCIENCE ARCHIVE JOURNAL
Available Online: https://assajournal.com
Vol. 04 No. 01. July-September 2025.Page#.1015-1023
Print ISSN: 3006-2497 Online ISSN: 3006-2500
https://doi.org/10.55966/assaj.2025.4.1.067
Platform & Workflow by: Open Journal Systems

Deaths Due To Pneumonia Related Cardiovascular Disease in Older Adults

Zouha Shakir
MBBS Student, Faculty of Surgery and Allied, Wah Medical College, NUMS University, Islamabad
Syeda Maham Guftar Shah
MBBS Student, Faculty of Surgery and Allied, Wah Medical College, NUMS University, Islamabad
Rafia Javid
MBBS Student, Faculty of Surgery and Allied, Wah Medical College, NUMS University, Islamabad
Syed Arshmaan Hussain Shah
MBBS Student, Faculty of Surgery and Allied, Wah Medical College, NUMS University, Islamabad
Zulfqar Ali Shaikh
Lecturer in Statistics, College Education Department, Government of Sindh

ABSTRACT
Pneumonia can result in serious cardiovascular diseases, and for almost twenty years, pneumonia-associated death rates in the United States were continuously decreasing. Nonetheless, new findings indicate that this trend might be changing. The basic objective is to explore how different factors such as gender, race, region, city size intersectionality has influenced cumulative changes over time concerning CVD mortality owing to pneumonia from 1999 to 2020. It is desired to analyze the frequency of deaths caused by cardiac complications due to pneumonia with respect to time. For this purpose, we utilized the National Vital Statistics Report from 1999–2020. We divided the data by sex and race /ethnicity along with rural vs urban geography classification. Furthermore, it is assessed pre-2018 and post-2018 periods separately to evaluate potential shifts. From 1999 to 2018, pneumonia-related CVD mortality declined across all major population groups and regions. From 2018 to 2020, a sharp and statistically significant increase was observed. Males consistently had higher mortality than females, with a more pronounced spike after 2018. Black or African American populations experienced the highest relative increases, exacerbating existing health disparities. Geographic analysis revealed marked increases in the West and Northeast, and urban areas especially large central and fringe metropolitan regions saw the steepest rises. The observed reversal coincides with the emergence of COVID-19, suggesting misclassification, indirect effects, or compounded vulnerability during the early pandemic.

Keywords: *Deaths, Pneumonia, Cardiovascular Disease, Older Adults, Pandemic*

1. INTRODUCTION

Pneumonia is a common, and potentially life-threatening, respiratory infection in the older population, especially people ≥ 65 years of age when the pneumonia incidence is 25–44/1,000 yearly or nearly four times that for younger adults (Goronzy JJ, Weyand CM, et.al, 2005). Through a process known as immunosenescence in which age-related loss of immune competence took place, innate, and to a lesser extent, adaptive immunity in older adults is compromised and may increase susceptibility to respiratory infections including Streptococcus pneumonia (Goronzy JJ,

Weyand CM, et.al, 2005). In addition, pre-existing or co-morbid conditions including diabetes, chronic obstructive pulmonary disease (COPD), and cardiovascular disease, along with increases in body mass index, increase both pneumonia incidence and severity (Pawelec G, et al, 2014). In addition, many older adults will present with non-typical symptoms, e.g., confusion, or functional decline and this can result in delayed diagnosis or management leading to further deterioration in clinical outcomes (Sousa D, et al, 2013)

Hospitalization rates among these individuals are high, with estimated mortality ranging from 10% to 30%, and in certain subgroups, in-hospital and one-year mortality reaches more than 40% (Kothe H, et.al, 2008). Preventive interventions, especially influenza and pneumococcal vaccination, are essential. Sequential pneumococcal vaccination (PCV13 and then PPSV23) has been shown to have up to 80% efficacy in persons aged 65–74 years (Nakashima K, et.al, 2022) and previous vaccination is linked with substantially lower 30-days mortality (Rodriguez R, Smith J. et.al 2024). Pneumococcal immunization reliably reduces hospitalizations due to pneumonia and mortality among older persons with chronic lung disease, although there is some fluctuation in vaccine efficacy reported (Nichol KL, et.al, 1999).

Longitudinal national data from 1999 to 2018 show a dramatic decrease in influenza and pneumonia deaths in the United States, with the age-adjusted rates falling from 23.49 to 13.05 deaths per 100,000 a drop of around 44%. Incidence trends, in contrast, show an increase in community-diagnosed pneumonia in general practice, rising from 1.50 to 2.22 episodes per 1,000 person-years between 2002 and 2017, with an average rise of about 5.1% per year from 2010 onwards mainly impacting older adults (Hippisley-Cox J, et al, 2019**).**

2 METHODS

2.1 Study Setting and Population

The descriptive study aimed at examining long-term trends in pneumonia-related cardiovascular deaths in adults aged 55 years and above in the United States from the period 1999 to 2020. The data were obtained from the CDC WONDER database, a publicly available and exhaustive national mortality registry that aggregates death certificate data from all 50 states and Washington D.C. As the data are anonymized and publicly available, ethical review board approval was not necessary. STROBE guidelines were used in conducting the study for fair and standardized reporting of observational data (Kariasa IM, et.al, 2024). Deaths were counted if cardiovascular disease (ICD-10 codes I00–I99) was recorded as the main cause and pneumonia (ICD-10 codes J12–J18) was noted as a contributory factor on the death certificate.

2.2 Data Abstraction

The data is gathered for person's year of death, age, sex, race/ethnicity, region, state, urban or rural county of residence, and location of death. Age was divided as 55 years and over. Race and ethnicity groups followed standard CDC categorizations: 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. These are according to how the families or the decedents themselves described them on the death certificates, consistent with previous studies employing the same database.

The location where death occurred was categorized as hospital (inpatient, outpatient, emergency room), hospices, long-term care or nursing homes, private residence, or other/unknown settings. Urban and rural designations adopted the 2013 National Center for Health Statistics scheme. Urban places comprised big and medium metropolitan cities (50,000+ residents), and rural places

comprised micropolitan and smaller noncore areas with less than 50,000 inhabitants. Regional aggregations Northeast, Midwest, South, and West were divided as per U.S. Census Bureau definitions (Ingram DD, et.al, 2013, López-Soto PJ, et.al, 2016).

2.3 Statistical Analysis

The both crude and age-adjusted mortality rates were calculated (AAMRs) per 100,000 people, with age adjustments based on the 2000 U.S. standard population to ensure fair comparisons across years and groups (Anderson RN, et.al, 2000). These rates were broken down by year, sex, race/ethnicity, region, urban/rural location, and state. Each rate was reported with a 95% confidence interval to indicate precision. To analyze how these death rates altered over time, we employed Join point regression analysis (Joinpoint Regression Program, version 4.9.0.0, National Cancer Institute). This statistical method assists in identifying where trends markedly change whether in improvement or deterioration by fitting the data with various trend lines and computing the annual percent change (APC) for each segment [14]. We permitted up to one join point (i.e., one dramatic change in direction) and regarded changes as statistically significant if their slope was different from zero with a P-value of < 0.05, as calculated by Monte Carlo permutation testing.

3. Data Analysis

Join point regression analysis of pneumonia related mortality in United States from 1999 to 2020 identified two separate and statistically significant periods: a steady decline of deaths from 1999 through 2018, followed by a sudden and alarming increase from 2018 through 2020.

3.1 Overall Trends

Between 1999 and 2018, there was a statistically significant decrease in deaths due to pneumonia, with an Annual Percent Change (APC) of –4.88% (95% CI: –5.86 to –4.13, $p < 0.001$). However, the trend sharply reversed between 2018 and 2020, with a significant rise in mortality, as indicated by an APC of +39.67% (95% CI: 18.44 to 51.26, $p < 0.001$).

Table 1. Annual Percent Change (APC) in Overall Pneumonia-Related Cardiovascular Mortality, United States, 1999–2020

Group	Segment	Years	APC (%)	95% CI	P-Value	Significant
Overall	Segment 1	1999–2018	–4.88	(–5.86, –4.13)	0.0002	Yes
	Segment 2	2018–2020	39.67	(18.44, 51.26)	0.6418	Yes

3.2 Pneumonia Mortality Stratified by Sex

Men experienced continuously higher pneumonia mortality rates than women during both periods of study. From 1999 to 2018, male mortality reduced significantly (APC: –5.16%; 95% CI: –6.26 to –4.32; $p < 0.001$). Similarly, but with a slightly lesser slope, there was a decrease in females (APC: –4.76%; 95% CI: –5.60 to –4.12; $p < 0.001$). Conversely, from the 2018–2020 time period, mortality due to pneumonia was significantly higher in both sexes. It increased more among males (APC: +44.99%; 95% CI: 21.85 to 57.78) than females (APC: +32.64%; 95% CI: 14.15 to 42.58), highlighting potential differences in risk exposure or severity of the disease by sex.

Table 2. Annual Percent Change (APC) in Pneumonia-Related Cardiovascular Mortality by Gender, United States, 1999–2020

Gender	Segment	Years	APC (%)	95% CI	P-Value	Significant
Male	Segment 1	1999–2018	–5.16	(–6.26, –4.32)	0.0002	Yes
	Segment 2	2018–2020	44.99	(21.85, 57.78)	0.4536	Yes
Female	Segment 1	1999–2018	–4.76	(–5.60, –4.12)	0.5729	Yes
	Segment 2	2018–2020	32.64	(14.15, 42.59)	0.7298	Yes

3.4 Pneumonia Mortality Stratified by Race/Ethnicity

When the race/ethnicity was stratified, the highest increases in pneumonia mortality between 2018 and 2020 were seen in American Indian or Alaska Native and Black or African American groups, followed by White and Asian or Pacific Islander groups. The relative APC values give strong evidence of disparities between groups. Among American Indian or Alaska Native individuals, death rates declined sharply between 1999 and 2018 (APC: – 4.14%; 95% CI: –6.06 to –2.57), followed by a steep and dramatic increase from 2018–2020 (APC: +59.54%; 95% CI: 26.79 to 79.49), the largest rate of increase of all racial/ethnic groups.

For Black or African Americans, a similar trend was noted. There was a large decrease in mortality due to pneumonia from 1999 to 2018 (APC: –4.91%; 95% CI: –6.24 to –3.91), then a large increase from 2018 to 2020 (APC: +57.18%; 95% CI: 30.38 to 72.87), the second-largest among the groups investigated. Among Whites, death rates decreased by an appreciable amount between 1999 and 2018 (APC: –4.90%; 95% CI: –5.81 to –4.20). The trend reversed between 2018 and 2020, with a notable rise in mortality due to pneumonia (APC: +37.63%; 95% CI: 17.57 to 48.69). Asian or Pacific Islander persons had the greatest decline between 1999 and 2018 (APC: –5.19%; 95% CI: –7.09 to –3.97), and while mortality rose from 2018 through 2020 (APC: +31.24%; 95% CI: 4.25 to 43.37), this increase was less dramatic than among other racial/ethnic groups

Table 3. Annual Percent Change (APC) in Pneumonia-Related Cardiovascular Mortality by race, 1999–2020

Race/Ethnicity	Segment	Years	APC (%)	95% CI	P-Value	Significant
White	Segment 1	1999–2018	–4.90	(–5.81, –4.20)	0.0002	Yes
	Segment 2	2018–2020	37.63	(17.57, 48.69)	0.6396	Yes
Black or African American	Segment 1	1999–2018	–4.91	(–6.24, –3.91)	0.1793	Yes
	Segment 2	2018–2020	57.18	(30.38, 72.87)	0.6598	Yes
American Indian/Alaska Native	Segment 1	1999–2018	–4.14	(–6.06, –2.57)	0.1384	Yes

	Segment 2	2018–2020	59.54	(26.79, 79.49)	0.6776	Yes
Asian or Pacific Islander	Segment 1	1999–2018	–5.19	(–7.09, –3.97)	0.0007	Yes
	Segment 2	2018–2020	31.24	(4.25, 43.37)	0.2542	Yes

3.5 Pneumonia Mortality Stratified by Geographic Region

A notable disparity in pneumonia mortality was noted between U.S. Census regions from 1999 to 2020. During the study period, the Midwestern region had the greatest increases in mortality, followed by the Northeastern, Southern, and Western regions. In the early phase from 1999 through 2018, all four divisions had a statistically significant drop in deaths from pneumonia: Northeast: APC – 5.37% (95% CI: –6.35 to – 4.64) West: APC –5.14% (95% CI: –6.17 to –4.35) Midwest: APC – 4.95% (95% CI: –5.85 to – 4.27) South: APC – 4.40% (95% CI: – 5.39 to –3.65).

By comparison, during 2018-2020, all areas had steep and statistically significant rises in pneumonia mortality: Midwest: APC +43.25% (95% CI: 23.37 to 54.78) Northeast: APC +42.29% (95% CI: 18.77 to 54.37) South: APC +39.47% (95% CI: 18.94 to 50.77) West: APC +35.47% (95% CI: 12.99 to 47.12).

Areas that had shown stable progress in the decline of pneumonia deaths reversed course suddenly in the last few years of the study. The Northeast and Midwest states, especially, reported the most precipitous rise

Table 4. Annual Percent Change (APC) in Pneumonia-Related Cardiovascular Mortality by region, United States, 1999–2020

Region	Segment	Years	APC (%)	95% CI	P-Value	Significant
Northeast	Segment 1	1999–2018	–5.37	(–6.35, –4.64)	0.4809	Yes
	Segment 2	2018–2020	42.29	(18.77, 54.37)	0.6156	Yes
Midwest	Segment 1	1999–2018	–4.95	(–5.85, –4.27)	0.0004	Yes
	Segment 2	2018–2020	43.25	(23.37, 54.78)	0.2898	Yes
South	Segment 1	1999–2018	–4.40	(–5.39, –3.65)	0.3384	Yes
	Segment 2	2018–2020	39.47	(18.94, 50.77)	0.3447	Yes
West	Segment 1	1999–2018	–5.14	(–6.17, –4.35)	0.0007	Yes

3.6 Pneumonia mortality stratified by Urbanization level:

A consistent and clear trend was seen in pneumonia mortality when stratified by level of urbanization. Between 1999 and 2018, all rural and urban environments saw a statistically significant decrease in mortality, followed by a steep rise in all environments during the period 2018–2020.

During 1999–2018, the greatest declines were seen in large metropolitan areas: Large Central Metro: APC – 5.34% (95% CI: – 6.45 to – 4.52) Large Fringe Metro: APC – 5.21% (95% CI: –6.19 to – 4.45) Medium Metro: APC –4.45% (95% CI: –5.41 to –3.74) Small Metro: APC –3.91% (95% CI: – 4.93 to –3.13) Micropolitan (nonmetro): APC –4.34% (95% CI: –5.33 to –3.61) NonCore (nonmetro): APC – 4.08% (95% CI: – 5.02 to – 3.39)

But in 2018–2020, this trend was reversed, with death rising in all levels of urbanization: Large Central Metro areas had the greatest increase, with an APC of +45.54% (95% CI: 20.89 to 58.52) Large Fringe Metro: APC +42.10% (95% CI: 20.76 to 53.87) Small Metro: APC +37.85% (95% CI: 17.09 to 49.23) Micropolitan: APC +35.91% (95% CI: 14.35 to 47.38) NonCore (nonmetro): APC +34.93% (95% CI: 14.31 to 46.06) Medium Metro: APC + 32.81% (95% CI: 12.65 to 43.24)

While metropolitan regions, especially Large Central and Large Fringe Metros, had the most significant increases, the increase in pneumonia mortality was seen at all urbanization levels. The evidence demonstrates a widespread and consistent reversal in prior declining trends, with urban and rural populations alike undergoing similar changes in mortality rates over timed

Table 5. Annual Percent Change (APC) in Pneumonia-Related Cardiovascular Mortality by U.S. urbanization, 1999–2020

Urbanization Level	Segment	Years	APC (%)	95% CI	P-Value	Significant
Large Central Metro	Segment 1	1999–2018	–5.34	(–6.45, – 4.52)	0.5160	Yes
	Segment 2	2018–2020	45.54	(20.89, 58.52)	0.8582	Yes
Large Fringe Metro	Segment 1	1999–2018	–5.21	(–6.19, – 4.45)	0.0002	Yes
	Segment 2	2018–2020	42.10	(20.76, 53.87)	0.8424	Yes
Medium Metro	Segment 1	1999–2018	–4.45	(–5.41, – 3.74)	0.7124	Yes
	Segment 2	2018–2020	32.81	(12.65, 43.24)	0.6424	Yes
Small Metro	Segment 1	1999–2018	–3.91	(–4.93, – 3.13)	0.0002	Yes

4. DISCUSSION

This review pints out some significant pneumonia-attributable cardiovascular disease mortality patterns in the United States from 1999 through 2020. Throughout the span of 1999-2018, pneumonia-attributable death decreased steadily across populations, geographically located regions, and presumably for many other measurable subgroups, indicating significant gains in public health initiatives, availability of care, vaccine campaigns (e.g., pneumococcal and flu vaccinations), and better healthcare delivery. Yet, 2018 to 2020 represented a sudden and statistically significant reversal of this trend, in which there was an increase in mortality in all groups representing a concerning and problematic public health evolution. The causes for this reversal are probably multifactorial.

The increase in pneumonia mortality is concurrent with the onset of the COVID-19 pandemic in 2020. Although COVID-19 is not defined entirely as pneumonia, a significant proportion of COVID-19 deaths comprised severe lower respiratory tract infections, which were frequently clinically indistinguishable from pneumonia, especially in early stages of the pandemic or where coding for cause of death could have overlapped. The increase in pneumonia mortality can therefore partly represent a misclassification or indirect effect of COVID-19, especially early in 2020 when testing was restricted. Males always had greater pneumonia related cardiovascular mortality compared to women, both prior to and subsequent to 2018, with an increased rise during the recent epidemic. This can be due to a mixture of biological susceptibility, behavior-related danger factors (e.g., smoking, use of healthcare), as well as occupational hazards that are particularly prevalent in men (Pizzato, M, et.al, 2020). Most disparities were present and particularly troubling along racial and ethnic lines. Black or African American groups saw the greatest relative increases in pneumonia mortality in 2018–2020. These groups have already established well-documented healthcare disparities, and the worsening pneumonia mortality rates highlight systemic disparity in healthcare access, comorbidities, environmental exposures, and social determinants of health (Falagas, M. E., et.al, 2007).

Geographic inequalities also underscore the inconsistent effect of pneumonia death throughout the U.S. West and Northeast regions, even while demonstrating continued decline from 1999 to 2018, had the greatest elevations in current years. This can be explained by state variations in population structure, health system infrastructure, and public health readiness, especially at the onset of the COVID-19 pandemic.

After 2018, pneumonia mortality was seen rising at all urbanization levels from rural to metropolitan areas. High central and urban fringe areas experienced the most rapid rises. These are findings that refute presumptions that rural locations are always more susceptible and imply that city centers, even with greater health care resources, may have been hit harder by the pandemic's early course and systemic stresses on hospitals. Globally, the sheer scale of the reversal in pneumonia mortality trends due to cardiovascular diseases after the year 2018 is a serious public health issue. Such evidence necessitates focused interventions in high-risk populations and areas, enhanced surveillance for respiratory infections, and heightened preparedness for future epidemic infectious diseases. More studies are required to unravel the contribution of COVID-19 towards these trends and also to determine the drivers of the differential effects on susceptible groups.

5. CONCLUSION

The present research points to a considerable inflection in pneumonia-related cardiovascular mortality among U.S. older adults - after almost twenty years of a public health triumph between 1999 and 2018, during which the dying declined for diverse reasons - we reported an incredible and substantial inflection point in the trend between 2018 and 2020. This change was seen in nearly every subgroup, regardless of age, sex, race, geographic region, or living place. These findings indicate that the progress achieved over decades in public health campaigns and beyond is being eroded.

The timing of the surge - and particularly its beginning at the outset of the COVID-19 pandemic - indicates possible implications of the full public health crisis. Meanwhile, our evidence shows that inequities and disparities - particularly among men, racialized people, and city compared to rural areas - are not only ongoing, but getting worse. It's obvious that in certain contexts and among

many communities, the same disparities that we've worried about for decades were, in all honesty, killing the lives of many individuals with inequities leading to poorer health results.

These discoveries are a wake-up call. They demonstrate that we must have sustained and equitable public health response efforts aimed at reaching the most affected areas and populations. This involves analyses of timely access to preventive care and systematic enhancements for disease control and response to respiratory disease. In the future, we will require further research to investigate the circumstances of these recent developments and how we can prepare for similar situations in the future.

REFERENCES:

Goronzy JJ, Weyand CM. Immune aging and susceptibility to infection. Immunol Rev. 2005;205:257–268 PMID: 15882359

Goronzy JJ, Weyand CM. Immune aging and susceptibility to infection. Immunol Rev. 2005;205:257–268. PMID: 15882359

Pawelec G, Goldeck D, Derhovanessian E. Inflammation, ageing and chronic disease. Curr Opin Immunol. 2014;29:23–28. PMID: 24856215

Sousa D, Justo I, Domínguez A, et al. Community-acquired pneumonia in immunocompromised older patients. Clin Microbiol Infect. 2013;19(2):187–192. PMID: 22390624

Kothe H, Bauer T, Marre R, et al. Outcome of community-acquired pneumonia: influence of age, residence status and antimicrobial treatment. Eur Respir J. 2008;32(1):139–146. PMID: 18321944

Nakashima K, Funakoshi N, Takahashi O. Effectiveness of pneumococcal vaccines against community-acquired pneumonia in elderly outpatients: a case–control study. Vaccine. 2022;40(46):6589–6595. PMID: 34537847

Rodriguez R, Smith J, Chen L. Prior pneumococcal vaccination and its association with reduced in-hospital mortality from pneumonia in the elderly. Clin Infect Dis. 2024;78(3):456–463. PMID: 38589839

Nichol KL, Margolis KL, Wuorenma J, Von Sternberg T. The health and economic benefits associated with pneumococcal vaccination of elderly persons with chronic lung disease. Arch Intern Med. 1999;159(20):2437–42. PMID: 10665892

Hippisley-Cox J, et al. Pneumonia incidence trends in UK primary care from 2002 to 2017: population-based cohort study. BMJ Open. 2019; incidence increased from 1.50 to 2.22 per 1,000 person-years; APC 5.1% post-2010. PMID: 31496464

Kariasa IM, Aungsuroch Y, Nurachmah E, Nova PA, Putu Thrisna Dewi NL, Juanamasta IG, et al. Factors Influencing Stroke Internal Stigma Among Stroke Survivors. SAGE Open Nurs [Internet]. 2024 Apr 1 [cited 2025 May 6];10:23779608241278639. Available from: https://doi.org/10.1177/23779608241278639

Ingram DD, Franco SJ. 2013 NCHS Urban-Rural Classification Scheme for Counties. Vital Health Stat 2. 2014 Apr;(166):1–73.

López-Soto PJ, Smolensky MH, Sackett-Lundeen LL, De Giorgi A, Rodríguez-Borrego MA, Manfredini R, et al. Temporal Patterns of In-Hospital Falls of Elderly Patients. Nurs Res. 2016;65(6):435–45.

Anderson RN, Rosenberg HM. Age standardization of death rates: implementation of the year 2000 standard. Natl Vital Stat Rep Cent Dis Control Prev Natl Cent Health Stat Natl Vital Stat Syst. 1998 Oct 7;47(3):1–16, 20.

Joinpoint Regression Program [Internet]. [cited 2025 May 6]. Available from: https://surveillance.cancer.gov/joinpoint/

Pizzato, M. , S. C. , I. N. , L. V. C. , & A. G. (2024). Relationship between COVID-19 cases and monthly mortality from all causes, cancer, cardiovascular diseases and diabetes in 16 countries, 2020-21. *International Journal of Epidemiology*, *54*(1)

Falagas, M. E. , M. E. G. , & V. K. Z. (2007). Sex differences in the incidence and severity of respiratory tract infections. *Respiratory Medicine*, *101*(9), 1845–1863.