Original Article

Geographic and Demographic Disparities in Bacterial Pneumonia Mortality: A Comparative Analysis of U.S.-Mexico Border and Non-Border Regions

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Abstract

Background: Bacterial pneumonia remains a significant public health concern in the U.S., particularly in regions with limited access to healthcare. Previous studies have highlighted disparities in infectious disease outcomes, but few have examined mortality trends specific to U.S.-Mexico border regions. The objective of this study is to compare bacterial pneumonia mortality rates between U.S.-Mexico border and non-border counties from 2000 to 2020 and assess demographic disparities.
Methods: This study utilized data from the CDC WONDER Multiple Cause of Death database. Bacterial pneumonia deaths were identified using ICD-10 codes J13–J15. Crude mortality rates and age-adjusted standardized mortality rates (ASMR) were calculated and stratified by gender, race, and ethnicity. Risk ratios were computed to compare mortality differences between groups.
Results: The ASMR for bacterial pneumonia in the U.S.-Mexico border counties was 2.2 per 100,000—double that of non-border counties (1.1). Males had higher mortality than females across all regions. Non-Hispanics and American Indian/Alaskan Native populations showed disproportionately higher mortality rates, particularly in border regions. The overall mortality risk in border regions was twice that of non-border areas (RR: 2.0).
Conclusion: Bacterial pneumonia mortality is significantly higher in the U.S.-Mexico border regions, with notable disparities across gender, race, and ethnicity. These findings suggest systemic healthcare access barriers and underinvestment in public health infrastructure in border communities. Targeted public health interventions addressing geographic and social determinants of health are critical to reducing pneumonia-related mortality in these vulnerable populations.

Keywords: bacterial pneumonia, mortality, health disparities

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Introduction

Bacterial pneumonia is characterized by inflammation of the lung parenchyma and alveolar spaces in response to a bacterial infection. Among the infectious causes of pneumonia, bacteria have a significant impact on the overall morbidity and mortality rates of pneumonia. Globally, community-acquired pneumonia (CAP) incidence is up to 450 million cases annually. In the U.S., the burden of CAP is substantial as there is an estimate of 2.2 to 8 million hospitalizations and 100,000 cases of CAP-related deaths annually, with 2.6-18.5% global mortality rates at the time of hospitalization and up to 31-44.5% within a year of hospitalization.[1]

Health disparities related to pneumonia have also been observed. One study found that pneumonia and influenza accounted for the largest number of infectious disease deaths throughout the 20th century, with the oldest age groups being heavily impacted.[2] CAP incidence rates among low-income and African-American populations were especially high in previous studies, demonstrating the importance of socioeconomic factors, such as poor housing conditions, poor air quality, increased rates of smoking, lack of medical insurance, and limited access to medical care, as well as the role of race as risk factors for CAP.[3,4]

Antimicrobial resistance is also a growing issue globally due to increased healthcare utilization, costs, morbidity and mortality. One study found increased antimicrobial resistance across 8 hospitals along the U.S.-Mexico border over the course of 6 years, with improper antimicrobial use, ineffective infection control precautions, travel, and cross-border migration as potentially contributing factors.[5] The significant burden of pneumonia on the U.S. healthcare system in addition to the unique challenges and disparities associated with the border region prompt further investigation. This study aims to examine differences in bacterial pneumonia mortality between U.S.-Mexico border regions and non-border regions, utilizing data from the CDC Wonder Multiple Cause of Death Database.

Methods:

We queried the CDC WONDER Multiple Cause of Death database for bacterial pneumonia deaths from 2000-2020 based on ICD-10 codes J13, J14, and J15. The crude rate and ASMR per 100,000 people

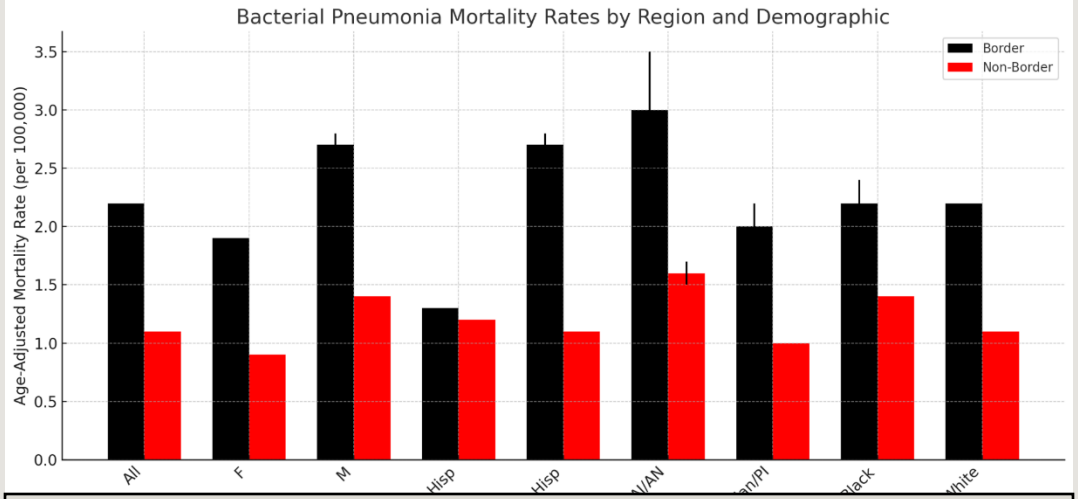

Figure 1. Bacterial Pneumonia Age-Adjusted Mortality Rates by Region and Demographic. Across nearly all groups, border regions experienced significantly higher mortality rates compared to non-border regions.

from bacterial pneumonia were compared between border and non-border regions. The crude mortality rate and ASMR, stratified by gender, ethnicity (Hispanic or Latino vs. non-Hispanic or Latino), and race, were also compared between border and non-border regions. 95% confidence intervals (CI) without overlap were considered significantly different.

Results:
Figure 1 shows the age-adjusted mortality rate for bacterial pneumonia in U.S.-Mexico border counties was 2.2 per 100,000, which was double the rate observed in U.S. non-border counties (1.1 per 100,000). This pattern of higher mortality in border regions was consistent across all demographic groups.

In Table 1, among genders, males exhibited higher mortality rates than females in both border and non-border regions. In border counties, males had a mortality rate of 2.7 (95% CI: 2.6–2.8), compared to 1.4 (95% CI: 1.4–1.4) in non-border males. Female rates were 1.9 (95% CI: 1.8–1.9) in border regions versus 0.9 (95% CI: 0.9–0.9) in non-border regions. Similarly, ethnic disparities revealed that non-Hispanic individuals had significantly higher mortality rates than Hispanics, particularly in border counties (2.7 vs. 1.3 per 100,000). Among racial groups, American Indians/Alaskan Natives showed the highest mortality rates, with 3.0 in border regions and 1.6 in non-border regions.

Risk ratios in Table 2 revealed that the overall mortality risk in border regions was double that of non-border regions (RR: 2.0). Subgroup-specific comparisons demonstrated that non-Hispanics in border counties had a 2.5-fold higher risk compared to Hispanics. Gender-based comparisons showed males had a higher risk than females across all regions, with border-region males at 1.9 times the risk of their female counterparts. Racial group comparisons within border regions indicated that American Indians/Alaskan Natives had the highest relative risks compared to Whites.

Conclusion
The findings of this study align with established literature documenting health disparities in U.S.-Mexico border regions due to significant healthcare access barriers. Residents in border counties often face challenges such as geographic isolation, inadequate healthcare infrastructure, and low rates of insurance, which contribute to delays in the diagnosis and treatment of bacterial pneumonia.[6] Historically, underinvestment in public health infrastructure in border areas has compounded these challenges, leading to higher morbidity and mortality rates.[7]

Consistent with Ruiz et al. (2016), Hispanic populations exhibited lower mortality rates despite socioeconomic disadvantages. This phenomenon, known as the Hispanic health paradox, may be attributed to strong familial and community support networks, cultural resilience, and protective health behaviors.[8] However, these protective factors require further investigation in the context of bacterial pneumonia. American Indians/Alaskan Natives demonstrated the highest mortality rates, underscoring systemic inequities in healthcare access and quality.[6] These disparities are consistent with historical patterns of underinvestment in healthcare services for these populations.[7] The higher mortality rates among males reflect patterns observed in other infectious diseases. Potential explanations include biological differences, occupational

exposures, variations in substance-use rates, and lower healthcare-seeking behaviors among males.

Addressing these disparities requires targeted public health interventions. The Global Health Security Agenda emphasizes

Table 1. Age-adjusted mortality rates per 100,000 with 95% confidence intervals – Death due to bacterial pneumonia

	Demographic	Age-adjusted rate	Standard error	95% Confidence Interval
US-Mexico Border Region	All	2.2	0.0	2.1 - 2.3
	Female	1.9	0.0	1.8 - 1.9
	Male	2.7	0.1	2.6 - 2.8
	Hispanic	1.3	0.0	1.2 – 1.4
	Non-Hispanic	2.7	0.1	2.6 – 2.8
	American Indian or Alaskan Native	3.0	0.5	2.2 – 4.1
	Asian or Pacific Islander	2.0	0.2	1.7 – 2.3
	Black or African American	2.2	0.2	1.7 - 2.7
	White	2.2	0.0	2.1 – 2.3
US Non-Border Region	All	1.1	0.0	1.1 – 1.1
	Female	0.9	0.0	0.9 - 0.9
	Male	1.4	0.0	1.4 – 1.4
	Hispanic	1.2	0.0	1.2 – 1.3
	Non-Hispanic	1.1	0.0	1.1 – 1.1
	American Indian or Alaskan Native	1.6	0.1	1.5 – 1.7
	Asian or Pacific Islander	1.0	0.0	1.0 – 1.0
	Black or African American	1.4	0.0	1.4 - 1.4

the importance of improving healthcare access and implementing comprehensive surveillance systems to reduce health disparities.[9] Interventions aimed at social determinants of health, such as expanding healthcare coverage and reducing poverty, have been shown to reduce mortality in high-risk populations.[6,9]

Lessons from global studies demonstrate that geographical accessibility to healthcare significantly impacts infectious disease outcomes.[10] These insights suggest that addressing healthcare access barriers in U.S.-Mexico border regions could mitigate the disparities observed in bacterial pneumonia mortality rates.

This study has several limitations, largely related to the use of the CDC WONDER Multiple Cause of Death database. The database contains only mortality data and does not capture incidence, access to care, or treatment outcomes, which restricts our ability to assess the complete burden of

Table 2. Age-adjusted risk ratios comparing key demographic categories by and within US-Mexico border classifications – death due to bacterial pneumonia

Group 1	Group 2	Age-Adjusted Risk Ratio
US-Mexico border region	***US non-border region***	
All	All	2.0
Female	Female	2.1
Male	Male	1.9
Hispanic	Hispanic	1.1
Non-Hispanic	Non-Hispanic	2.5
American Indian or Alaskan Native	American Indian or Alaskan Native	1.9
Asian or Pacific Islander	Asian or Pacific Islander	2.0
Black or African American	Black or African American	1.6
White	White	2.0
US-Mexico border region only		
Female	Male	0.7
Hispanic	Non-Hispanic	0.5
American Indian or Alaskan Native	White	1.4
Asian or Pacific Islander	White	0.9
Black or African American	White	1.0
US non-border region only		
Female	Male	0.6
Hispanic	Non-Hispanic	1.1
American Indian or Alaskan Native	White	1.5
Asian or Pacific Islander	White	0.9
Black or African American	White	1.3

disease. Furthermore, the accuracy of cause-of-death reporting depends on death certificate documentation, which may underreport or misclassify HCV or HCC and result in potential misestimation of mortality rates. Individual-level variables — such as socioeconomic status, insurance coverage, comorbid conditions, and access to screening or treatment — are also unavailable, despite their potential influence on mortality patterns and disparities. As a result, while our analysis identifies notable differences in mortality across geographic and demographic groups, the precise drivers of these disparities remain unclear.

Further research is necessary to explore the protective factors associated with the Hispanic health paradox and their applicability to other at-risk populations. Additionally, comparative studies of bacterial pneumonia mortality trends across other international border regions could provide valuable insights for global health policies and interventions.

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