Southwest Rural HEALTH RESEARCH CENTER

Cancer Mortality in Rural America 1999-2016

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Purpose

In this study, our primary aim was to understand the scope of cancer mortality in urban and rural areas of the U.S. We analyzed mortality associated with some of the most common cancer types in the U.S.—breast, cervical, lung, prostate, and colon—over an eighteen-year period from 1999-2016 and explored the roles played by rurality and region in this process.

Background

For scholars and policymakers alike, understanding the burden of cancer on society is a critical topic for investigation. It is estimated that in 2016 alone, almost 1.7 million Americans were diagnosed with cancer and the disease consistently ranks as the second leading cause of death in the United States — accounting for one in every four deaths.[1-4] Cancers of the prostate, breast, lung, and colorectal areas are particularly problematic. Prostate, lung, and colorectal cancer account for roughly 50% of cancer cases in men and cancers of the breast, lung, and colorectal areas account for 50% of cancer cases in women.[2,5]

Critically, prior research suggests anecdotal evidence of variation in cancer rates and mortality across rural and urban America. For example, research has found higher rates of colorectal cancer in rural Georgia than urban Georgia,[5-6] higher mortality rates of all cancers combined in rural Appalachian regions as compared to non-Appalachian regions,[5,7] and higher cervical cancer rates among rural as compared to urban residents.[5,8] Our research intends to build on this work to present a comprehensive picture of mortality from common cancers across levels of rurality. In addition, we assess whether the influence of rurality on cancer mortality varies across regions of the U.S.

Methods

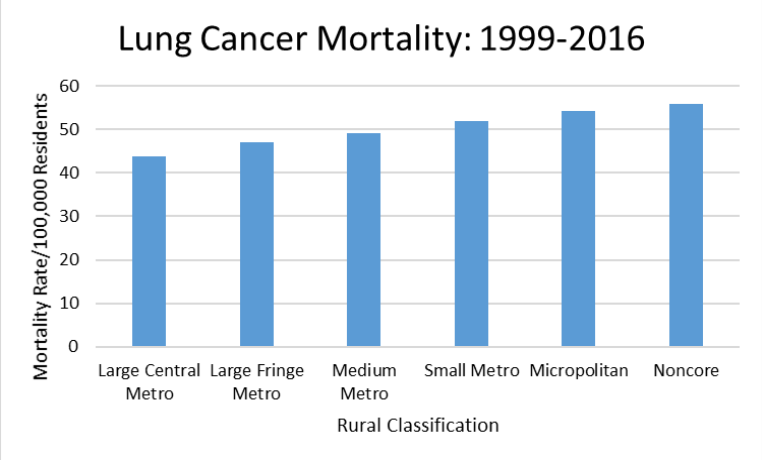
In order to analyze cancer mortality in the U.S., we rely on data from the National Center for Health Statistics (NCHS) at the Centers for Disease Control and Prevention (CDC). The data are publicly available using the CDC's Wonder platform and include information on the underlying cause of death collected from state registries. Importantly, this platform provides information on mortality by cause of death while accounting for a variety of geographic and demographic factors including rurality.

Key Findings

- Common cancers such as breast, cervical, lung, prostate, and colon have been responsible for more than 976,000 deaths in America's rural areas from 1999-2016.
- Age-adjusted crude mortality rates are higher for lung, prostate, and colon cancer in rural than urban areas.
- Age-adjusted crude mortality rates are higher for breast and cervical cancer in large central metro areas than in America's rural areas.
- Lung cancer mortality is higher in rural than urban areas for all regions except the Midwest, with particularly large discrepancies in the South and Northeast.
- Cancer mortality rates are consistently lower in the West region of the U.S. for all analyzed cancer types except prostate cancer — where rates in the rural West are higher than in any other region.
- Colon cancer mortality rates are similar across large central metros and rural areas for all regions except the South where mortality rates are higher in rural areas.

Our brief focuses on mortality attributable to breast cancer, cervical cancer, lung cancer, prostate cancer, and colon cancer from 1999-2016 as determined by ICD-10 codes. Mortality rates for each cancer type are age-adjusted and calculated per 100,000 residents that live within the rurality classification at hand. Rurality in our study is determined using the 2013 NCHS Urban-Rural Classification Scheme that relies on six levels of rurality as seen in Table 1, ranging from most urban to most rural: large central metros, large fringe metros, medium metros, small metros, micropolitan areas, and non-core areas. We consider both micropolitan and non-core areas to be rural while all other classifications should be considered urban.

Figure 1. Lung Cancer Mortality for Entire Population, 1999-2016



Results

Tables 1-5 of our analysis present age-adjusted mortality estimates across levels of rurality for each of the cancers included in our study. The results in Table 1 present our findings from lung cancer and show the importance of accounting for rurality when investigating cancer mortality. Age-adjusted crude rates for lung cancer mortality from 1999-2016 are higher in rural areas than urban areas and display a steady increase in mortality as rurality increases.[i] Compared to large central metropolitan areas, which have more than one million residents, America's rural non-core areas with fewer than 10,000 residents have a 12-point higher crude mortality rate.[9] [ii]

Table 2 builds on the findings in Table 1 in conveying the importance of accounting for rurality in the study of cancer mortality, but complicates the story by showing that rural America has lower cancer rates than urban areas for some cancers. Specifically, Table 2 shows that breast cancer mortality rates are slightly lower in rural areas than in urban areas. The age-adjusted crude rate for breast cancer mortality is one crude point higher in large central metros than in the rural noncore areas. Furthermore, the mortality rate declines consistently for breast cancer as rurality increases. Thus, it appears cancer mortality varies by rural status, but can vary in impact from potentially protective to problematic.

Table 1. Lung Cancer Mortality for Entire Population, 1999-2016

Rural Classification		Age-Adjusted Crude Rate Per 100,000 Residents
Metropolitan Areas	Large Central Metro	43.9
	Large Fringe Metro	47.2
	Medium Metro	49.2
	Small Metro	51.9
Non-Metropolitan Areas	Micropolitan	54.4
	Noncore	55.9

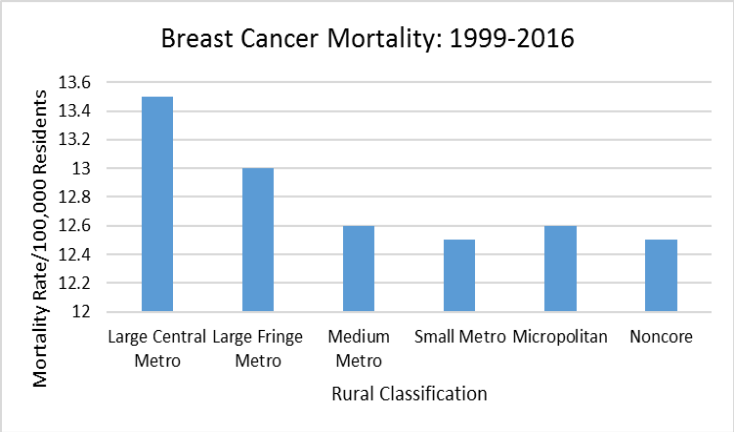
i. Age adjusted mortality rates are created based on weighted averages of age-specific death rates for each type of cancer being analyzed. Age adjustment is used to eliminate the impact of age on mortality rates because different populations have different age structures and thus changes of death independent of the effect of the cancer being analyzed. [10] In other words, age adjustment allows for the study of how cancer mortality varies across levels of rurality and region even if the age of the population differs based on level of rurality or region.

ii. Crude rates indicate deaths per 100,000 individuals, adjusted for the age of a given population. Thus, a 12 point higher crude mortality rate indicates 12 more deaths per 100,000 residents.

Table 2. Breast Cancer Mortality for Entire Population, 1999-2016

Rural Classification		Age-Adjusted Crude Rate
Metropolitan Areas	Large Central Metro	13.5
	Large Fringe Metro	13.0
	Medium Metro	12.6
	Small Metro	12.5
Non-Metropolitan Areas	Micropolitan	12.6
	Noncore	12.5

Figure 2. Breast Cancer Mortality for Entire Population, 1999-2016



The results in Table 3, which focuses on cervical cancer, further complicate the relationship between rurality and cancer mortality. While the findings for cervical cancer mirror those of breast cancer with higher mortality rates in large central metropolitan areas than rural areas, the steady decline in mortality rates across levels of rurality is not maintained from Table 2. Instead, differences across levels of rurality appear quite small. Rates are highest in large central metro areas, lowest in large fringe metro areas, and then steadily increase across levels of rurality. With that said however, these differences should be interpreted with caution given the small size of the differences across levels of rurality.

When analyzing the differences in prostate cancer mortality across levels of rurality in Table 4, the findings most closely match those seen for cervical cancer with the two highest rates seen in large central metropolitan areas and rural noncore areas. Critically however, when analyzing prostate cancer mortality, noncore areas as opposed to large central metro areas see the highest mortality rates. In other words, prostate cancer mortality rates are highest in America's rural noncore areas. As com-

Figure 3. Cervical Cancer Mortality for Entire Population, 1999-2016

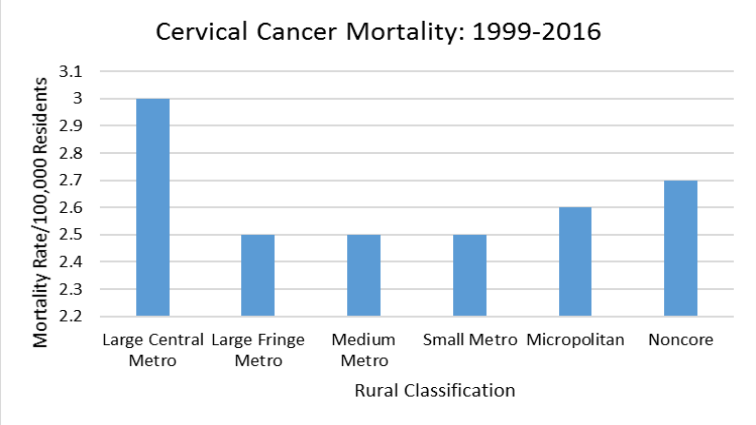


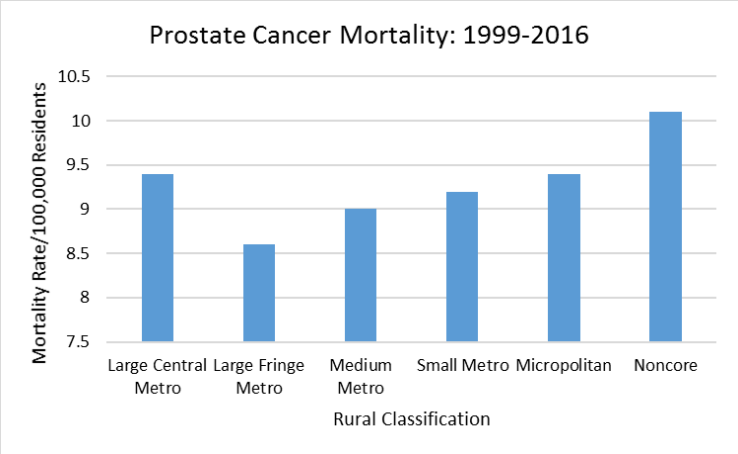
Table 3. Cervical Cancer Mortality for Entire Population, 1999-2016

Rural Classification		Age-Adjusted Crude Rate
Metropolitan Areas	Large Central Metro	3.0
	Large Fringe Metro	2.5
	Medium Metro	2.5
	Small Metro	2.5
Non-Metropolitan Areas	Micropolitan	2.6
	Noncore	2.7

Table 4 . Prostate Cancer Mortality for Entire Population, 1999-2016

Rural Classification		Age-Adjusted Crude Rate
Metropolitan Areas	Large Central Metro	9.4
	Large Fringe Metro	8.6
	Medium Metro	9.0
	Small Metro	9.2
Non-Metropolitan Areas	Micropolitan	9.4
	Noncore	10.1

Figure 4. Prostate Cancer Mortality for Entire Population, 1999-2016



pared to the lowest prostate cancer mortality rates, which are seen in large fringe metro areas, mortality rates are 0.8 and 1.5 points higher in large central metropolitan areas and rural noncore areas respectively. That said, it is important to note that these differences are still quite small compared to the stark differences across levels of rurality seen for lung cancer.

Next, when analyzing deaths attributable to colon cancer in Table 5, we see higher mortality rates in rural areas than urban areas. The crude rates of 15.6 and 14.8 for the noncore and micropolitan areas are higher than rates seen in large central metropolitan areas or large fringe metropolitan areas, suggesting that colon cancer mortality rates are higher in rural areas. Interestingly, colon cancer is the only cancer analyzed where rates are lowest in medium metropolitan areas.

Finally, it is important to acknowledge that while mortality rates appear to vary across rurality for all of the cancers in our analysis, the rates of cancer mortality fluctuate dramatically across cancer types. Over our period of

Figure 5. Colon Cancer Mortality for Entire Population, 1999-2016

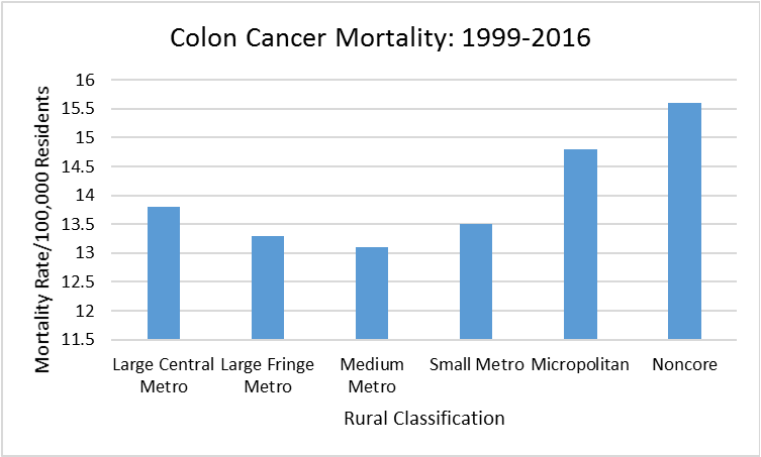


Table 5 . Colon Cancer Mortality for Entire Population, 1999-2016

Rural Classification		Age-Adjusted Crude Rate
Metropolitan Areas	Large Central Metro	13.8
	Large Fringe Metro	13.3
	Medium Metro	13.1
	Small Metro	13.5
Non-Metropolitan Areas	Micropolitan	14.8
	Noncore	15.6

analysis from 1999-2016, lung cancer was responsible for over 2.8 million deaths while no other analyzed cancer was responsible for more than 800,000 deaths. During the same period, breast cancer has killed over 747,000 Americans, colon cancer has killed more than 793,000, prostate cancer has been responsible for over 524,000, and cervical cancer has been responsible for just over 151,000. Of these deaths, over 976,000 have occurred in rural areas (micropolitan and noncore).

Regional Variation in Cancer Mortality

While general patterns of death across cancer types and levels of rurality are informative, important additional information is gained when assessing cancer mortality across levels of rurality in each U.S. census region. Prior research has shown the importance of regional differences in the impact of rurality on health across a variety of settings – for example for diabetes and other chronic diseases. [11-12] However, little is known about its impact on cancer mortality. Prior research suggests variation in seeking cancer care across rural regions, but our analysis allows for a more definitive look at the roles of rurality and region on cancer mortality.[5]

The importance of accounting for region becomes apparent in Table 6, which explores differences in lung cancer mortality across levels of rurality and region. When comparing lung cancer mortality in large central metro areas and noncore areas, dramatic differences emerge across regions. Lung cancer mortality is 16.2 points higher per 100,000 residents in the rural South as compared to the urban South and only 3.7 points higher in the rural West as compared to the urban West. Notably, lung cancer mortality is actually lower in the rural Midwest than the urban Midwest.

For other cancers, regional differences in mortality are less pronounced. Table 7 for example, which examines age-adjusted breast cancer mortality estimates across regions and rurality shows similar results across regions. In all four regions, breast cancer mortality declines as rurality increases and breast cancer mortality rates are identical in rural noncore areas of the Northeast and Midwest. Notably, the highest rural breast cancer mortality is seen in the South and the lowest is seen in the West—which has the lowest mortality rates across levels of rurality.

Table 8, which focuses on cervical cancer mortality closely follows the pattern of results seen for breast cancer. Mortality rates are highest in the South and lowest in the West and all regions except for the South have lower mortality rates in rural areas.

While the results thus far have pointed to the West as the region least impacted by cancer mortality, with lower rates in urban and rural areas, prostate cancer serves as an interesting outlier in Table 9. Prostate cancer mortality is lowest across the United States in the West's large central metro areas, but in small metropolitan areas,

Table 6 . Lung Cancer Mortality by Region, 1999-2016

Rural Classification		Northeast	Midwest	South	West
Metropolitan Areas	Large Central Metro	43.3	52.8	46.8	37.6
	Large Fringe Metro	45.7	50.7	48.7	40.5
	Medium Metro	48.0	52.2	53.3	39.3
	Small Metro	50.3	51.5	57.1	43.5
Non-Metropolitan Areas	Micropolitan	50.4	53.2	61.3	43.8
	Noncore	51.6	51.7	63.0	41.3

Table 7 . Breast Cancer Mortality by Region, 1999-2016

Rural Classification		Northeast	Midwest	South	West
Metropolitan Areas	Large Central Metro	14.2	14.9	13.6	12.1
	Large Fringe Metro	13.4	13.2	12.8	12.1
	Medium Metro	12.9	13.2	12.7	11.7
	Small Metro	12.6	12.7	12.8	11.5
Non-Metropolitan Areas	Micropolitan	12.3	12.5	13.1	11.6
	Noncore	12.0	12.0	13.1	11.1

Table 8 . Cervical Cancer Mortality by Region, 1999-2016

Rural Classification		Northeast	Midwest	South	West
Metropolitan Areas	Large Central Metro	3.4	3.2	3.0	2.6
	Large Fringe Metro	2.5	2.3	2.5	2.3
	Medium Metro	2.5	2.6	2.6	2.2
	Small Metro	2.5	2.3	2.7	2.1
Non-Metropolitan Areas	Micropolitan	2.4	2.5	2.9	2.2
	Noncore	2.4	2.4	3.1	2.1

Table 9. Prostate Cancer Mortality by Region, 1999-2016

Rural Classification		Northeast	Midwest	South	West
Metropolitan Areas	Large Central Metro	9.3	10.1	9.6	9.0
	Large Fringe Metro	8.3	8.5	8.7	9.4
	Medium Metro	8.5	9.1	9.2	9.2
	Small Metro	8.8	8.9	9.2	10.0
Non-Metropolitan Areas	Micropolitan	8.8	8.9	9.9	10.3
	Noncore	9.7	9.6	10.4	10.9

Table 10. Colon Cancer Mortality by Region, 1999-2016

Rural Classification		Northeast	Midwest	South	West
Metropolitan Areas	Large Central Metro	14.8	15.2	14.1	12.3
	Large Fringe Metro	13.8	13.5	13.3	11.9
	Medium Metro	13.6	14.0	13.2	11.7
	Small Metro	13.7	13.6	14.1	11.8
Non-Metropolitan Areas	Micropolitan	14.1	15.0	15.6	12.8
	Noncore	15.0	15.5	16.3	12.9

micropolitan areas, and noncore areas, prostate cancer mortality is higher in the West than any other region. Table 9 also suggests differences in the impact of rurality across regions. In the Northeast, South, and West, prostate cancer mortality increases across levels of rurality, but that pattern is not observed in the Midwest.

Finally, in Table 10, it appears that the role of rurality in colon cancer mortality is different across regions. While differences between metropolitan centers and rural areas are relatively small for the Northeast, Midwest, and West, they are much larger in the South. Specifically, colon cancer mortality rates are only 0.2, 0.3, and 0.6 points higher in rural noncore areas of the Northeast, Midwest, and West respectively as compared to large central metropolitan areas, but 2.2 points higher in the South.

Discussion

This brief highlights the varied nuances of rurality and region on mortality attributable to a variety of cancers from 1999-2016 in the United States. It demonstrates that mortality patterns across levels of rurality and region are different for lung, breast, cervical, prostate, and colon cancer.

In particular, it suggests that the influence of rurality varies across cancer type. While lung cancer, prostate cancer, and colon cancer rates are higher in rural areas than urban areas, the reverse is true in breast cancer and cervical cancer. In addition, this brief's emphasis on region illustrates the importance of accounting for location in discussions of cancer mortality and rurality. For

most of the cancers studied here, rates are highest in the South and lowest in the West—with the highest rates typically seen in the rural South. Higher cancer mortality rates in the South and in rural America comport well with existing research on cancer across the United States.[5,13] Even when cancer mortality is better in rural areas than urban areas, as is the case with breast cancer, this study shows that rates are higher in the rural noncore South than rural noncore areas in any other region. Prostate cancer however is a notable exception. Prostate cancer mortality is higher in the rural West than anywhere else in the country, the only time the West holds that distinction here.

Implications

This research highlights that even as cancer is the second leading cause of death in the United States, geographic factors play a critical role in the distribution of cancer mortality across the United States. For some common cancers—lung, prostate, and colon in particular—rural areas have been struck particularly hard, with higher mortality rates in rural areas. For other common cancers – particularly those impacting women (breast and cervical cancers)—rural areas appear to be performing better. Rates for breast and cervical cancer are higher in urban areas than rural areas, pointing to both the importance of rural status and variation in its impact across cancer type. Furthermore, this research emphasizes that studying rurality alone is insufficient for scholars and policymakers interested in cancer mortality across the United States. Region also plays a crucial role. The South and the rural South in particular appears to be an area of concern – seeing higher mortality rates for many common cancers. The West on the other hand consistently sees lower cancer rates across levels of rurality except in the case of prostate cancer where it performs uncharacteristically poorly. Finally, while mortality rates in the Midwest are consistently moderate between the extremes of the South and West, it is not consistent with the rural pattern seen in the other three United States regions with almost no rural differences for these common cancers.

Recommendations

While this brief provides a helpful snapshot of the variation in cancer mortality across levels of rurality and region, it is critical to acknowledge the need for further research in this area. Even as variation has been demonstrated across these dimensions, additional work is needed to understand the causes of this variation. Specifically, future research should analyze why mortality rates are higher in rural areas than urban areas for some cancers but the reverse is true for other cancers. Research that provides insight into the lower rates of breast and cervical cancer in rural America should be undertaken to identify treatment and training changes that could potentially improve mortality rates in rural areas for lung, prostate, and colon cancers. Potentially fruitful areas for analysis include studying the impact of limited oncologists in rural areas on mortality rates, how limited transportation in rural areas impacts access to regular chemotherapy, and how differences in cancer screening in rural and urban America might contribute to discrepancies in mortality.[14-16] In addition, given the large discrepancies in mortality across levels of rurality for lung cancer, future work should look at the relationship between smoking rates (both traditional and e-cigarettes) across geographic units and their impact on cancer mortality rates.

Furthermore, the differences identified here across regions help to identify areas where cancer interventions and funding should be targeted. Findings here suggest that additional resources are needed in the rural South to reduce mortality from lung, colon, and cervical cancers and in the rural West to combat prostate cancer. In addition, resources should be invested to study why the Midwest appears largely immune from the large differences in cancer mortality across rurality seen in other regions.

Finally, while this brief does present critical information that can be used to inform policy, the findings should be understood in the context of the limitations of the data. Critical factors to mortality differences such as screening rates, sex, smoking status, race, ethnicity, etc., were not included in the analyses and should be explored in future research for a more complete picture of cancer mortality. In addition, given the descriptive nature of data available from the CDC Wonder platform, results necessarily need to be interpreted with caution. Tests for statistical significance are not possible, and as such, all differences across geographic units, particularly small differences need to be interpreted carefully.

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