Community Sociodemographics and Rural Hospital Survival Analysis

JANUARY 2023 POLICY BRIEF

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KEY FINDINGS

- Among rural hospitals at risk of financial distress, closures disproportionately take place in communities with specific sociodemographic characteristics:

  - lower incomes
  - lower percentage of college graduates
  - larger populations
  - lower percentages of White population
  - higher percentages of Black population
  - higher child poverty
  - higher unemployment rates
  - higher uninsurance for those under 65
  - higher percentage of adults reporting fair or poor health
  - higher obesity levels
  - higher rates of smoking.

- However, a statistical approach known as survival analysis shows that most of the sociodemographic characteristics listed above are NOT associated with increased risk of closure between 2010 and 2019.

- Survival analysis results show that rural hospitals at risk of financial distress are more likely to experience closure if their communities have:

  - higher unemployment
  - higher uninsurance for those under 65.

INTRODUCTION

Rural hospital closures are a source of concern to rural health policymakers and providers, especially since areas with the highest number of rural hospital closures tend to be some of the country's most vulnerable ones.[1] Hospitals in financial distress are at a particularly high risk of closure, and the sociodemographic characteristics of the communities served by high-risk rural hospitals are notably different.[2-3] However, only a small fraction (7%) of all rural hospitals predicted to be at risk of financial distress between 2010 and 2019 have closed. This suggests that beyond rurality and financial distress, there may

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be other factors associated with hospital closure. We hypothesize that within the pool of rural hospitals at risk of financial distress, community sociodemographic characteristics could be associated with hospital survival or closure. Our study builds on Thomas, Holmes, and Pink (2016), who study to what extent community characteristics explain differences in closure among financially distressed rural hospitals.[4] We extend this body of research by 1) including more sociodemographic variables, 2) expanding the sample to include more recent data, and 3) using survival analysis. Survival analysis is a multivariate regression approach that follows subjects over time (i.e. hospitals) and measures how long they stay in the sample (survival) and their risk of experiencing an event of interest (i.e. hospital closure).

METHODS

We use a national sample of 985 rural hospitals at risk of financial distress to analyze the relationship between community sociodemographic characteristics and hospital survival or closure. A hospital community is defined as the county where a hospital is located, and is considered rural if the county has a Rural-Urban Continuum Code (RUCC) greater than or equal to four. A hospital is considered closed if it stopped providing general, short-term, acute inpatient care. A hospital is not considered closed if it merged with another hospital but continued to provide inpatient care; converted to critical access status; or both closed and reopened during the same year.[5] We control for risk of financial distress using the Financial Distress Index (FDI) developed by the Sheps Center for Health Services Research, and consider a hospital at risk of financial distress if it is assigned a high or mid-high risk level based on its FDI at any point between 2010 and 2019. Annual community characteristics are retrieved from the Census (American Community Survey) and the Robert Wood Johnson Foundation (County Health Rankings). First, we use Wilcoxon rank-sum tests to measure whether sociodemographic variables' yearly medians differ between rural communities with hospitals at risk of financial distress that closed between 2010 and 2019, and those that remained open. Then, our survival analysis uncovers which sociodemographic characteristics are significantly associated with hospital survival or closure. . For a more detailed review of the methods, please refer to the underlying journal article (http://doi.org/10.1111/jrh.12728).

FINDINGS

1. Community sociodemographic composition differs significantly between rural hospitals at risk of financial distress that closed between 2010 and 2019, and those that remained open. Communities with hospitals that closed had larger populations, higher percentages of Black population, lower percentages of White population, lower incomes, higher child poverty, higher unemployment rates, higher uninsurance rates for those under
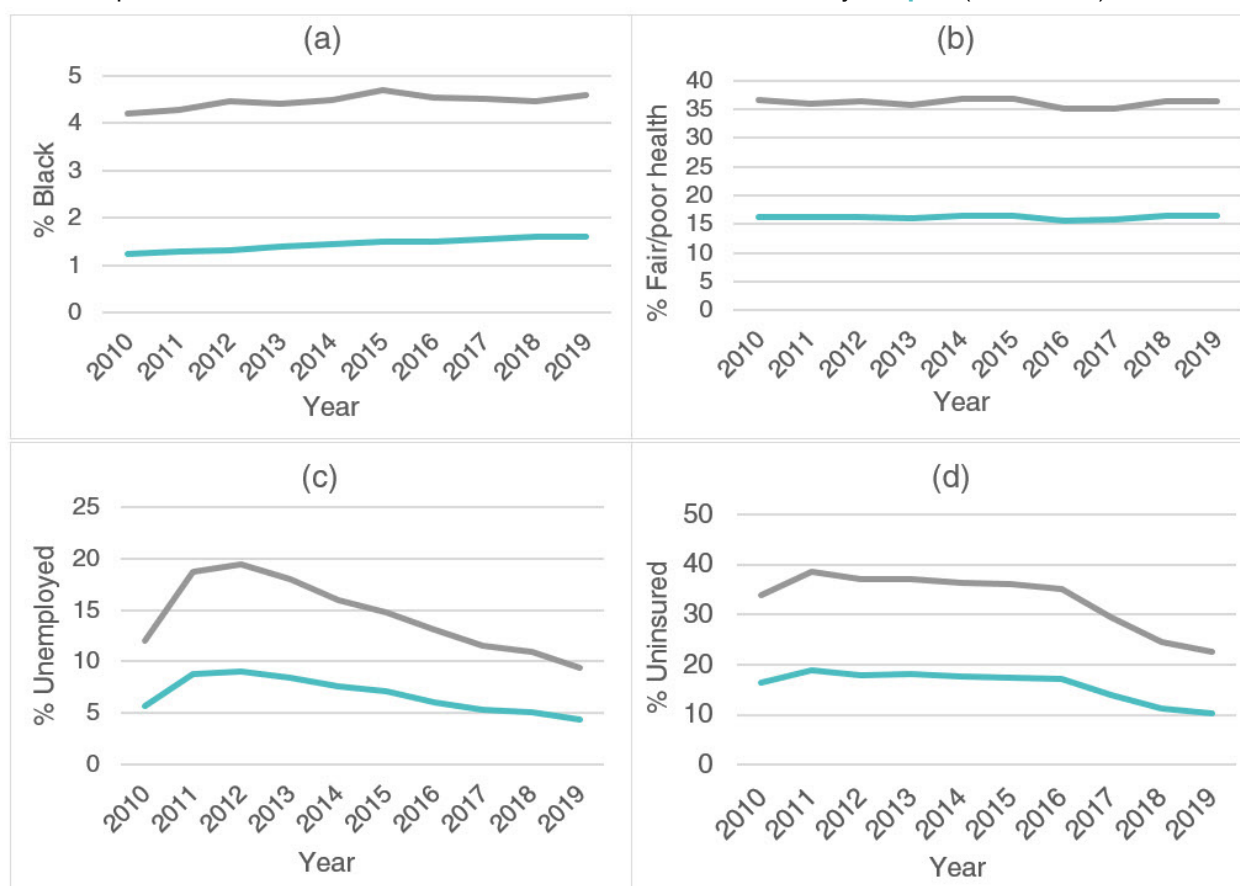
Socioeconomic variables included in the study:

- Population
- Median age
- Percent of the population 65 years and older
- Median family income
- Percent of children in poverty
- Percent unemployed
- Percent of population under 65 without health insurance
- Percent of population less than a High School graduate
- Percent of the population with a Bachelor's degree or higher
- Percent of the population White alone
- Percent of the population Black or African American alone
- Percent of the population Hispanic or Latino
- Percent of adults reporting fair or poor health
- Percent of adults reporting obesity
- Percent of adults reporting smoking

65, less college graduates, and a higher percentage of adults reporting fair or poor health, higher obesity levels, and higher rates of smoking. Yearly medians of selected community sociodemographic characteristics are shown on Figure 1 to illustrate the differences between communities with hospitals that closed and communities with hospitals that remained open.

2. We move beyond these simple associations between community characteristics and hospital closure by using survival analysis. This modeling technique accounts for the fact that many of these characteristics are inherently linked together. Under this more statistically advanced approach, most of the sociodemographic characteristics listed above – race, poverty, obesity, income – are not associated with increases in the likelihood of hospital survival or closure. However, the survival analysis shows that higher rates of community unemployment and uninsurance are associated with increases in the likelihood of closure: with a one-percentage point increase in unemployment raising the hazard rate (i.e. probability of rural hospital closure) by 36.12%, and a one-percentage point increase in uninsurance raising the hazard rate by 13.46%.

Figure 1. Yearly median differences in sociodemographic characteristics for communities served by rural hospitals at risk of financial distress that **closed** vs. those that stayed **open** (2010-2019)

3. An important benefit of survival analysis is the ability to estimate and visualize survival functions (i.e. functions that report the probability of a hospital surviving beyond a given time). As we can see in Figures 2 and 3, hospitals with higher rates of community unemployment and uninsurance that persist over time experience sharper decreases in their survival functions.
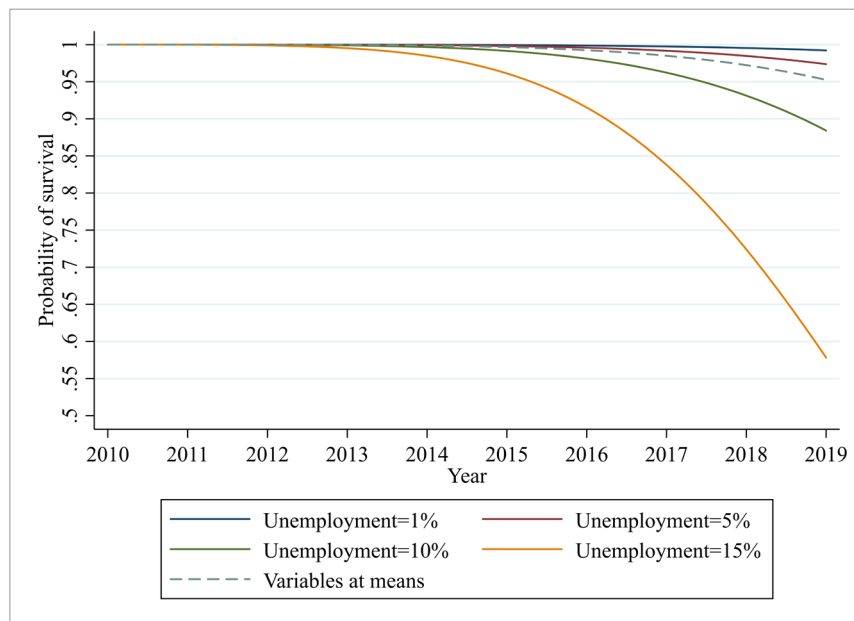
DISCUSSION

We restrict our dataset to rural hospitals at risk of financial distress to focus on hospitals with a higher risk of closure. Figure 1 demonstrates differences in yearly medians for select sociodemographic characteristics between communities served by hospitals that stayed open versus those that closed. For example, Figure 1(a), (b), (c), and (d) show that rural communities with hospitals that closed had higher percentages of Black residents, higher rates of individuals reporting fair or poor health, higher unemployment, and higher uninsurance rates for those under 65 throughout the 2010-2019 period. These results are consistent with earlier findings[1,4] and suggest that even when limited to rural facilities at risk of financial distress, hospital closures disproportionately take place in communities with specific sociodemographic characteristics.

Simple yearly median differences such as those displayed in Figure 1 allow us to see how community sociodemographic composition differs between rural hospitals at risk of financial distress that close, and those that remain open. However, they provide little information on whether certain sociodemographic characteristics are statistically linked to likelihoods of hospital survival or closure. Alternatively, survival analysis allows us to assess which of the associations are the most important predictors of closure. Although it does not allow for a strictly causal argument given the observational nature of the data, survival analysis moves us towards being able to make a (limited) case for causality. Our survival analysis shows that most of the sociodemographic characteristics that showed differences between communities with open and closed hospitals (race/poor health/income/child poverty) are not statistically linked to risk of closure. Only unemployment rates and the percentage of the population under 65 without health insurance are associated with increased risk of closure over time (at the α=0.05 level).
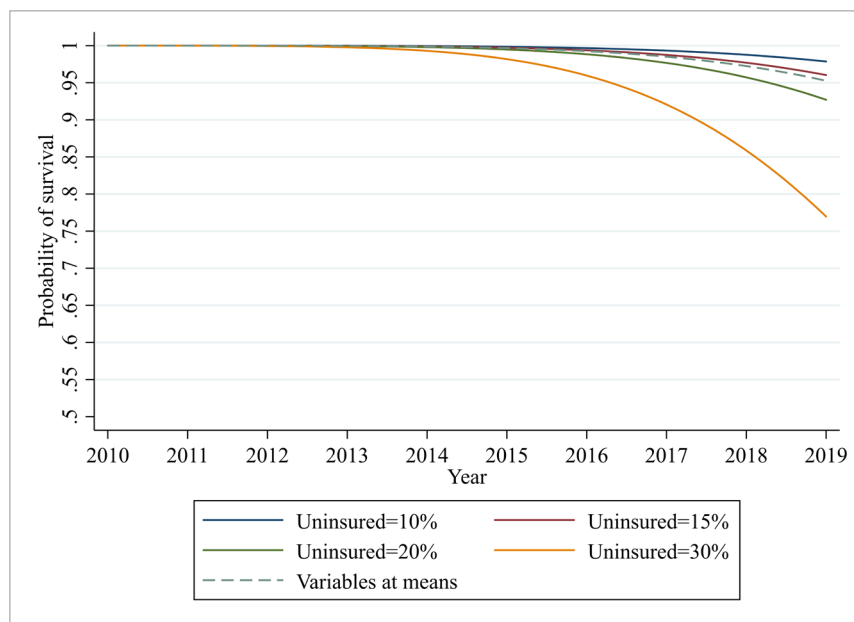
Survival analysis post-estimation tools allow us to visualize survival functions (i.e. functions that report the probability of a hospital with certain sociodemographic characteristics surviving beyond a given time). Figures 2 and 3 show survival functions for rural hospitals at risk of financial distress with different unemployment and uninsurance rates. As shown in Figure 2, the probability of a rural hospital at risk of financial distress staying open greatly decreases over time in areas with unemployment rates at or above 15%, when compared to areas with 10% unemployment or less. Figure 3 shows a similar (although

Figure 2. Survival functions for rural hospitals at risk of financial distress (2010-2019) with different **community unemployment levels**

not as dramatic) pattern for communities with uninsurance rates of 30% for those under 65. Such rates are not uncommon – our data show over 100 rural counties with unemployment rates greater than 15% at some point during our period of analysis, and 75 counties with uninsurance rates that exceeded 30% during the 2010 – 2013 time frame. The sharp drops in the survival functions in Figures 2 and 3 stress the cumulative nature of the relationships, where sustained high levels of unemployment and uninsurance dramatically reduce the likelihood of survival over time. Broader-scale policies focusing on

Figure 3. Survival functions for rural hospitals at risk of financial distress (2010-2019) with different **percentages of their population under 65 without health insurance**

unemployment and uninsurance rates in rural areas should be aware of these implications for local health infrastructure and viability.

IMPLICATIONS

While rural hospital closures slowed during 2020-2021 due to pandemic-related financial support, there are concerns that rural hospitals will quickly revert to historical trends for financial distress and closure rates. As such, this study has relevant policy and research implications. In terms of health equity, our results agree with previous research findings that closures of rural hospitals at risk of financial distress disproportionately take place in communities with vulnerable sectors of the population and racial minorities.[1,4,6,7] Further, our survival analysis results point local leaders and policymakers to two specific community characteristics that are statistically linked with increases in the likelihood of hospital closure over time: unemployment and uninsurance rates. These characteristics can be tracked at the county level, though with varying delays (unemployment data are available through the Bureau of Labor Statistics with only a 2-3 month delay; uninsurance rates are reported by the Census' Small Area Health Insurance Estimates but with a roughly 18-month lag). Informed communities and hospitals can make their local and federal representatives aware of these potentially causal relationships, and make the case for broader policies that focus on lowering unemployment or uninsurance. Recent studies have also found that increases in community unemployment[8] and uninsurance[9] are associated with hospitals' financial distress and closure, but have stopped short of documenting the time-relevant associations of these variables. We hypothesize that increases in hospitals' community unemployment and uninsurance levels lead to increased spending on uncompensated care, which in turn weakens hospitals' financial positions.

The results are also directly relevant to Medicaid expansion. Several studies have found that states that expand their Medicaid programs experience large reductions in uninsurance rates.[10-12] Policies like Medicaid expansion, which promote improved health insurance coverage for previously uninsured people, help reduce uncompensated care expenditures and strengthen hospitals' financial positions.[13,14] Previous studies have also found that Medicaid expansion is associated with improved hospital financial performance and lower likelihoods of closure,[9,15] and our analysis reinforces the importance of local uninsurance rates for hospital closures.

This Policy Brief is based on research presented at the 2022 Southern Regional Science Association Annual Conference. The article underlying this policy brief has been published in the Journal of Rural Health (http://doi.org/10.1111/jrh.12728).

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ENDNOTES

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