All-cause Mortality Rates and Primary Care Physician Supply in US Counties 2021

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# 1. Summary/Abstract

In this project, I will conduct a cross-sectional study on the county level and examine the potential association between age-adjusted all-cause mortality rate and primary care physician supply for US counties. A multilevel linear model will be used, and multiple potential confounders will be accounted for in the model.

# 2. Introduction

## 2.1 General Background Information

The all-cause mortality rate is an important indicator of general population health. Although the age-adjusted all-cause mortality rate consistently declined in the US from 1935 to 2014, a notable increasing trend after 2015 has been observed (Woolf, Wolf, & Rivara, 2023). Personal level access to primary care is highly associated with mortality, morbidity, and healthcare costs (Peart, Lewis, Brown, & Russell, 2018). There is a need to study how primary care physician supply on the geographic levels is associated with all-cause mortality rates in the US.

My hypothesis is that primary care physician supply is negatively associated with age-adjusted all-cause mortality rate among US counties.Since counties can be considered nested within states or regions, a multilevel linear model will be used. The dependent variable will be mortality rate, main predictor will be primary care physician supply, and the socioeconomic measures will be the covariates in the model.

# 3. Methods

Three data sources were used for this study. (1) Multiple Cause of Death File of 2021 from CDC WONDER (https://wonder.cdc.gov/mcd.html). I will obtain county-level age-adjusted all-cause mortality rates (deaths/100k people) from this source. (2) Area Health Resource File of 2021 from U.S. Department of Health & Human Services (https://data.hrsa.gov/data/download). I will obtain county-level primary care physician supply (physicians/100k people) and rural/urban categorization of the county from this file. (3) estimates of 2021 from 2017-2021 5-year American Community Survey (https://www.nhgis.org/). I will obtain states, regions, and some county-level socioeconomic measures as potential confounders for modeling. These measures may include %Living under poverty line, %Without a high school diploma, %Hispanic, %NH-Black, %Unemployed, %Without health insurance, and so on. Data from the three sources will be merged by using the FIPS code which serves as the ID for counties.

# 4. Results

## 4.1 Descriptive Statistics

We included 3079 US counties in this study, 1162 of which were defined as metropolitan counties (Table 1). The mean age-adjusted all-cause mortality rates were 1380/100k for all counties, 1190/100k for metropolitan counties, and 1490/100k for the non-metro counties. Metro and non-metro counties had similar mean percentages of Hispanic population and unemployment rate. On average, metro counties had higher PCP supply(60.1/100k vs 46.2/100k) and percentages of NH-Black population (10.8% vs 7.8%). Average percentages of population without high school diploma (10.5% vs 13.0%), living under federal poverty line (12.6% vs 15.6%), and without health insurance (8.5% vs 10.3%) were lower among metro counties compared to non-metro counties.

According to the scatter plot between mortality rate and log-transformed PCP supply, there was a linear association between the two, and the association did not considerably differ by metro status of the county (Figure 1).

Without adjustment of other factors, log-transformed PCP supply was negatively associated with mortality rate (beta=-37.3, 95% CI=-43.0- -31.5, p-value<.001), non-metro counties had significantly higher mortality rates (beta=310.5, 95% CI=287.2-333.8, p-value<.001) (Table 2); %Hispanic was negatively association with mortality rates (beta=-9.8, 95% CI=-11.0 - -8.7, p-value<.001), %NH-Black was not significantly associated with mortality rate (beta=0.3, 95% CI=-0.9-1.5, p-value=0.657) (Table 3); both %No high school diploma (beta=16.7, 95% CI=14.2 -19.1, p-value<.001) and %Poverty (beta=23.5, 95% CI=21.4–25.6, p-value<.001) were positively associated with mortality rates (Table 4).

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| Table 1: Descriptive statistics of US counties in 2021.   |  | Metro | Non-metro | Overall | | --- | --- | --- | --- | |  | (N=1162) | (N=1917) | (N=3079) | | Mortality rate (n/100k) |  |  |  | | Mean (SD) | 1190 (332) | 1490 (343) | 1380 (368) | | Median [Min, Max] | 1170 [411, 3590] | 1490 [288, 2910] | 1380 [288, 3590] | | PCP supply (n/100k) |  |  |  | | Mean (SD) | 60.1 (40.2) | 46.2 (34.3) | 51.5 (37.2) | | Median [Min, Max] | 54.3 [0, 581] | 41.2 [0, 508] | 45.5 [0, 581] | | % Hispanic |  |  |  | | Mean (SD) | 10.5 (13.0) | 9.30 (14.5) | 9.76 (13.9) | | Median [Min, Max] | 5.80 [0, 95.5] | 3.82 [0, 96.3] | 4.51 [0, 96.3] | | % NH-Black |  |  |  | | Mean (SD) | 10.8 (13.4) | 7.80 (14.8) | 8.95 (14.4) | | Median [Min, Max] | 5.50 [0, 79.7] | 1.26 [0, 87.0] | 2.21 [0, 87.0] | | % No high school diploma |  |  |  | | Mean (SD) | 10.5 (4.84) | 13.0 (6.14) | 12.1 (5.81) | | Median [Min, Max] | 9.67 [2.12, 50.3] | 11.9 [1.38, 47.9] | 10.8 [1.38, 50.3] | | % Poverty |  |  |  | | Mean (SD) | 12.6 (4.97) | 15.6 (6.39) | 14.5 (6.08) | | Median [Min, Max] | 12.0 [1.80, 38.5] | 14.5 [3.54, 59.0] | 13.5 [1.80, 59.0] | | % Unemployed |  |  |  | | Mean (SD) | 5.15 (1.93) | 5.35 (2.92) | 5.27 (2.59) | | Median [Min, Max] | 4.90 [0.699, 26.2] | 4.93 [0, 32.4] | 4.92 [0, 32.4] | | % No health insurance |  |  |  | | Mean (SD) | 8.48 (4.15) | 10.3 (5.37) | 9.62 (5.02) | | Median [Min, Max] | 7.81 [1.06, 33.2] | 9.13 [1.17, 44.9] | 8.51 [1.06, 44.9] |   **Note:** aSD, standard deviation; PCP, primary care physician. |

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| Figure 1: Association between age-adjusted all-cause mortality rate and Log (PCP supply) by metropolitan status among US counties, 2011 |

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| Table 2: Results of unadjusted multilevel linear regression.   | Predictors | Estimates | CI | p | Estimates | CI | p | | --- | --- | --- | --- | --- | --- | --- | | (Intercept) | 1444.6 | 1389.1 – 1500.0 | <0.001 | 1129.1 | 1076.0 – 1182.3 | <0.001 | | log(pcp\_100k + 0.01) | -37.3 | -43.0 – -31.5 | <0.001 |  |  |  | | Metropolitan status:Non-metro |  |  |  | 310.5 | 287.2 – 333.8 | <0.001 | | N | 51 state | 51 state | 51 state | 51 state | 51 state | 51 state | | Observations | 3079 |  |  | 3079 |  |  | | Marginal R2 / Conditional R2 | 0.042 / 0.260 |  |  | 0.156 / 0.371 |  |  | | AIC | 44497.021 |  |  | 44036.552 |  |  |   **Note:** ap, p-values; CI, 95% confidence interval. |

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| Table 3: Results of unadjusted multilevel linear regression.   | Predictors | Estimates | CI | p | Estimates | CI | p | | --- | --- | --- | --- | --- | --- | --- | | (Intercept) | 1407.0 | 1350.3 – 1463.6 | <0.001 | 1311.5 | 1257.4 – 1365.7 | <0.001 | | % Hispanic | -9.8 | -11.0 – -8.7 | <0.001 |  |  |  | | % NH-Black |  |  |  | 0.3 | -0.9 – 1.5 | 0.657 | | N | 51 state | 51 state | 51 state | 51 state | 51 state | 51 state | | Observations | 3079 |  |  | 3079 |  |  | | Marginal R2 / Conditional R2 | 0.119 / 0.352 |  |  | 0.000 / 0.230 |  |  | | AIC | 44402.708 |  |  | 44658.061 |  |  |   **Note:** ap, p-values; CI, 95% confidence interval. |

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| Table 4: Results of unadjusted multilevel linear regression.   | Predictors | Estimates | CI | p | Estimates | CI | p | | --- | --- | --- | --- | --- | --- | --- | | (Intercept) | 1133.5 | 1080.8 – 1186.1 | <0.001 | 993.7 | 943.8 – 1043.5 | <0.001 | | % No high school diploma | 16.7 | 14.2 – 19.1 | <0.001 |  |  |  | | % Poverty |  |  |  | 23.5 | 21.4 – 25.6 | <0.001 | | N | 51 state | 51 state | 51 state | 51 state | 51 state | 51 state | | Observations | 3079 |  |  | 3079 |  |  | | Marginal R2 / Conditional R2 | 0.067 / 0.236 |  |  | 0.150 / 0.285 |  |  | | AIC | 44483.556 |  |  | 44215.238 |  |  |   **Note:** ap, p-values; CI, 95% confidence interval. |

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| Table 5: Results of unadjusted multilevel linear regression.   | Predictors | Estimates | CI | p | Estimates | CI | p | | --- | --- | --- | --- | --- | --- | --- | | (Intercept) | 1137.5 | 1078.6 – 1196.4 | <0.001 | 1200.6 | 1141.8 – 1259.3 | <0.001 | | % Unemployed | 32.7 | 27.7 – 37.7 | <0.001 |  |  |  | | % No health insurance |  |  |  | 13.0 | 9.7 – 16.4 | <0.001 | | N | 51 state | 51 state | 51 state | 51 state | 51 state | 51 state | | Observations | 3079 |  |  | 3079 |  |  | | Marginal R2 / Conditional R2 | 0.049 / 0.271 |  |  | 0.030 / 0.240 |  |  | | AIC | 44494.841 |  |  | 44598.291 |  |  |   **Note:** ap, p-values; CI, 95% confidence interval. |

## 4.2 Basic statistical analysis

## 4.3 Full analysis

# 5. Discussion

## 5.1 Summary and Interpretation

## 5.2 Strengths and Limitations

## 5.3 Conclusions

# 6. References

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