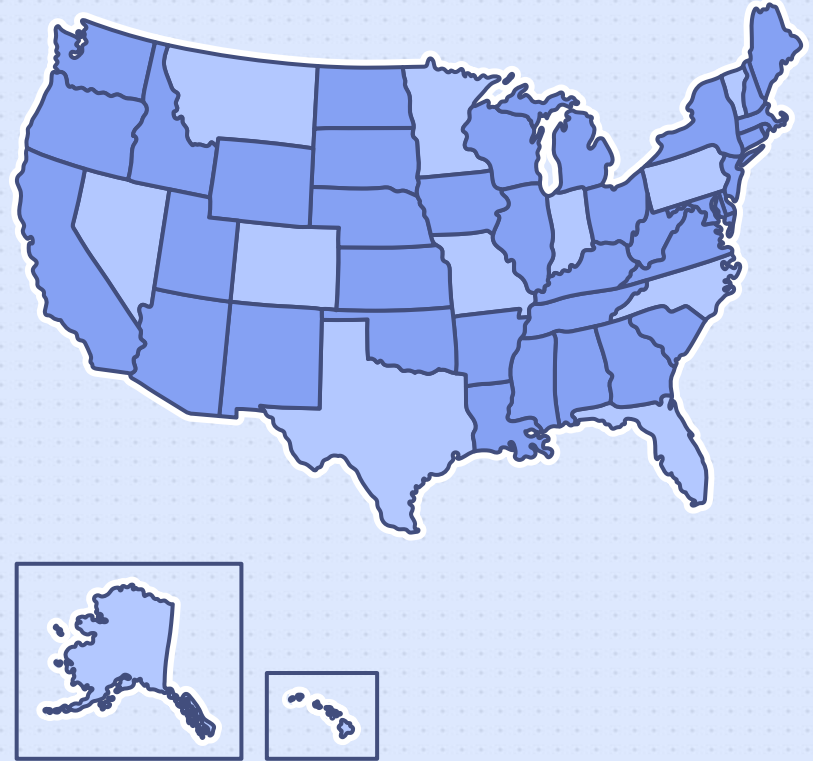


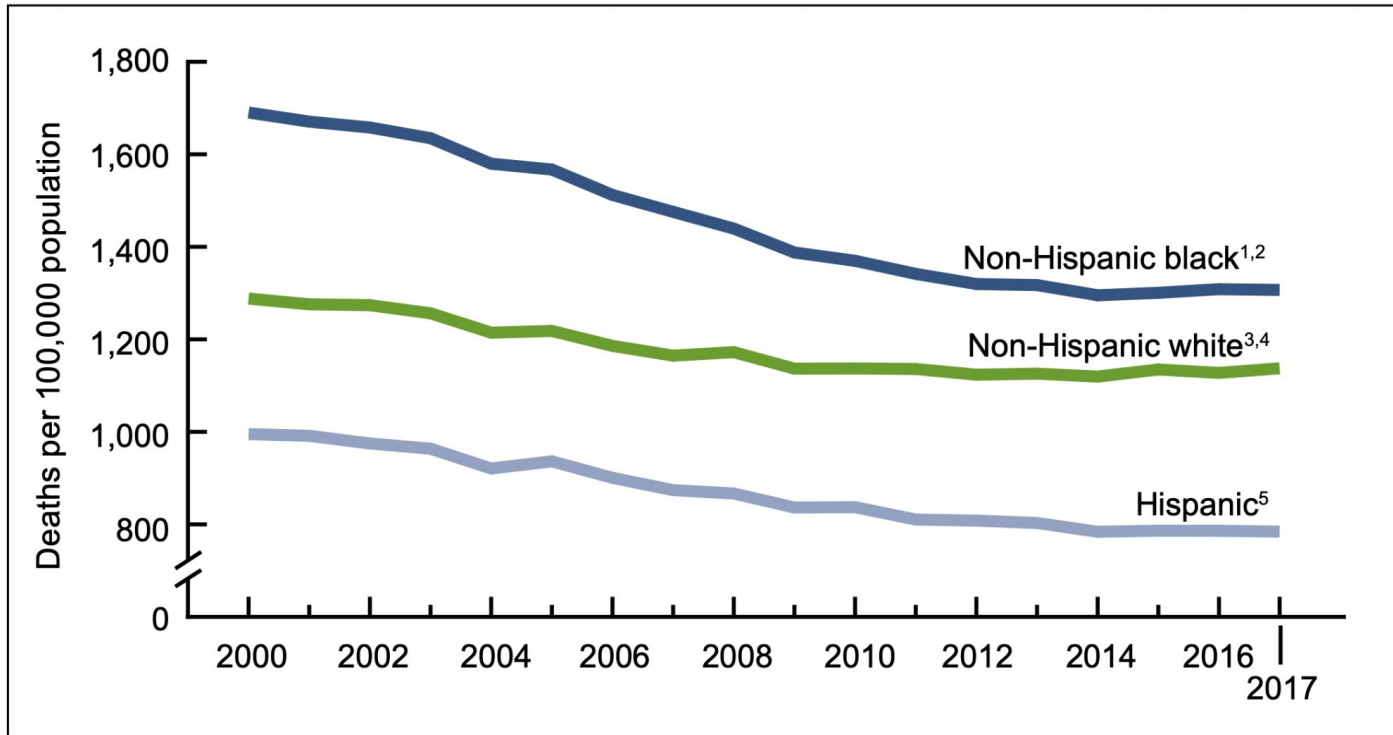
Human Demographics and Death Rate in 2004 by State

Jordyn Lucier, Madelaine Brown,
& Harley Clifton



INTRODUCTION

Figure 1. Age-adjusted death rates for persons aged 25 and over, by Hispanic origin and race: United States, 2000–2017



Analyze which
Human Demographics
Contribute to the Death Rate
by County and State
in the U.S. in 2004.

Data Overview

Death Rate: Response

Race: Fixed effect

Sex: Fixed effect

Income: Fixed effect

Physician Rate: Fixed effect

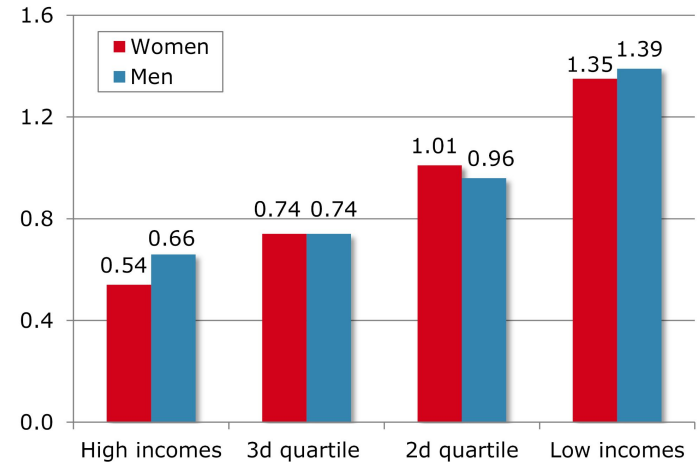
Age: Fixed effect

Population Density: Fixed Effect

County: Random effect nested w/ state

State: Random effect nested w/ county

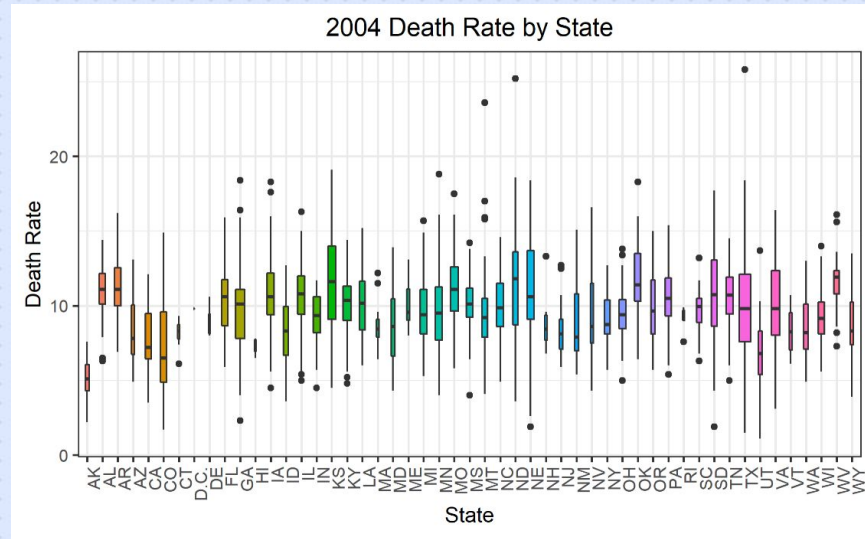
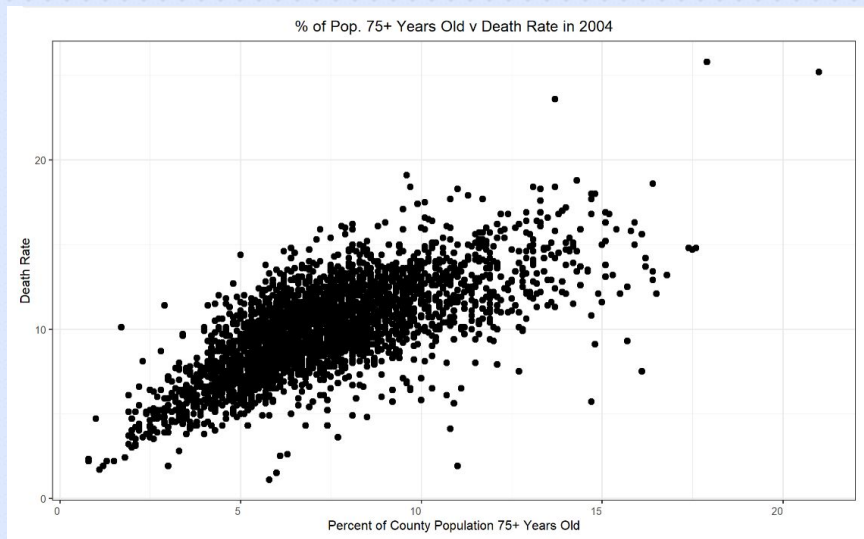
Death Rates Rise as Incomes Fall*



Source: Brookings Institution.

* Annual death rates shown between 1992 and 2010 for individuals ages 50-74. The rates equal the mortality rate of each income group divided by the mortality rate for the entire age 50-74 population. If the rate exceeds 1, people in that income group are more likely to die than the overall population.

Exploratory Data Analysis



Methods

1. Data Wrangling
2. EDA
3. Initial Linear Model
4. Mixed effect model: “Beyond-Optimal Model”
5. Selection for random effects
6. Selection for fixed effects
7. Log transformation
8. Non-Constant Variance (varPower)
9. Redo fixed effect variable selection
10. Model Diagnostics

Final Model

Fixed Effects:

Physician Rate

Income

Age (5-14, 15-24, 25-34, 35-44, 45-54, 55-64, 65-74, 75+ years)

Race (African American, Asian, Hispanic or Latino)

Physician RateAfrican American***

Physician RateHispanic or Latino***

Physician RateIncome***

Random Effects:

State: including a nested effect with county was overfitting the data

Final Estimated Non-Constant Variance Model

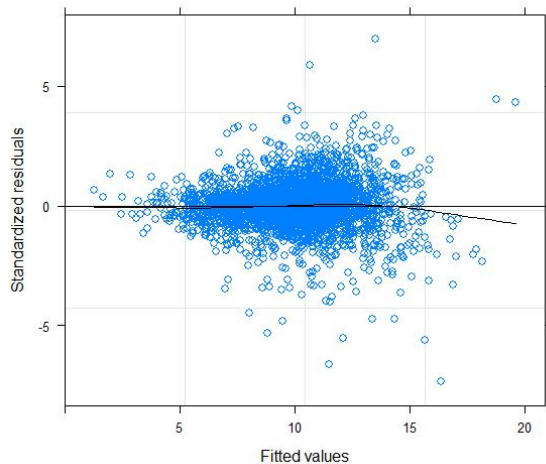
$$\begin{aligned} \text{DeathRate}_i = & 39.71716 - 0.00210\text{PhysicianRate}_i - 0.00011\text{Income}_i \\ & - 0.44548\text{PercentAge5to14}_i - 0.39574\text{PercentAge15to24}_i - 0.38688\text{PercentAge25to34}_i \\ & - 0.33072\text{PercentAge35to44}_i - 0.35441\text{PercentAge45to54}_i - 0.15201\text{PercentAge55to64}_i \\ & - 0.26820\text{PercentAge65to74}_i + 0.39235\text{PercentAge75plus}_i + 0.01682\text{PercentAfricanAmerican}_i \\ & - 0.05235\text{PercentAsian}_i - 0.04246\text{PercentHispanicOrLatino}_i \\ & + 0.000013\text{PhysicianRate}_i : \text{PercentAfricanAmerican}_i \\ & + 0.000038\text{PhysicianRate}_i : \text{PercentHispanicOrLatino}_i + 0.000000061\text{PhysicianRate}_i : \text{Income} \end{aligned}$$

$$\epsilon_i \sim N(0, \sigma^2 x | \text{PercentAge25to34}|^{2(-1.217987)})$$

Model Diagnostics: Residual vs. Fitted

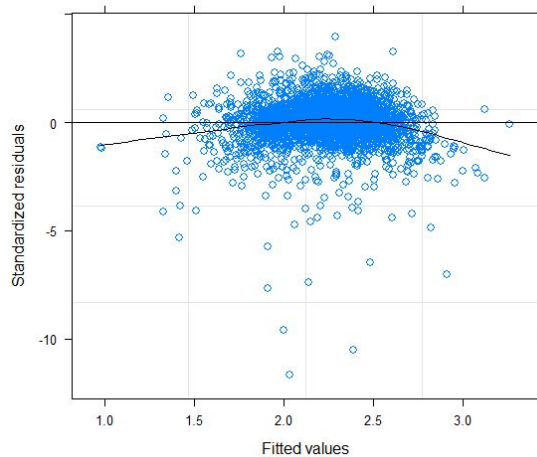
Original Model:

Normalized Residual vs. Fitted plot for Original Model



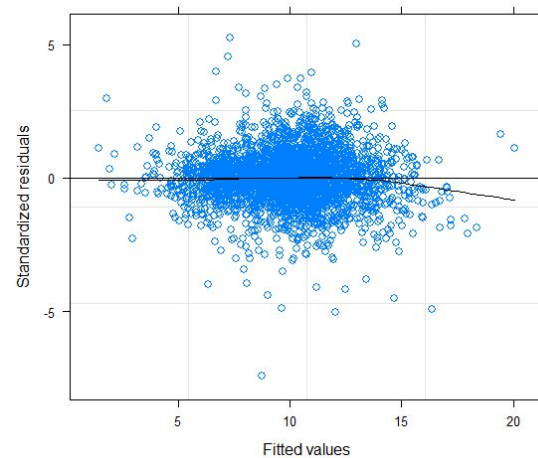
Log-Response Model:

Normalized Residual vs. Fitted plot for Log-Response Model



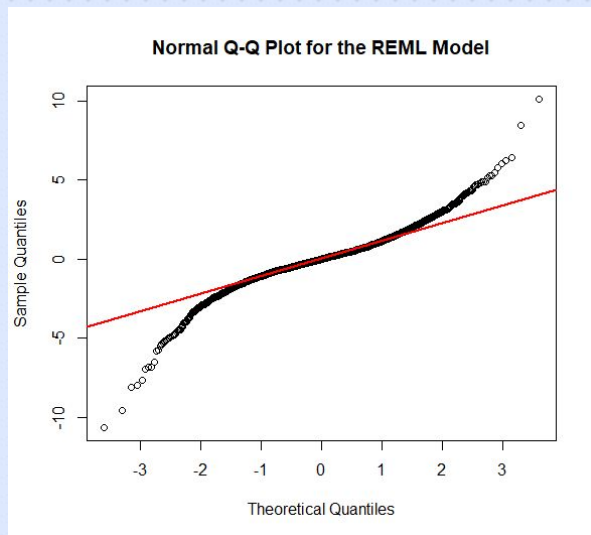
varPower Model:

Normalized Residual vs. Fitted plot for varPower Model

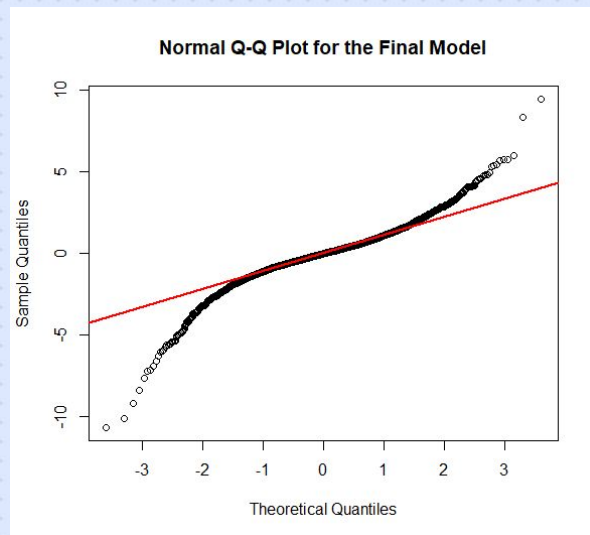


Model Diagnostics: Normal Q-Q Plots

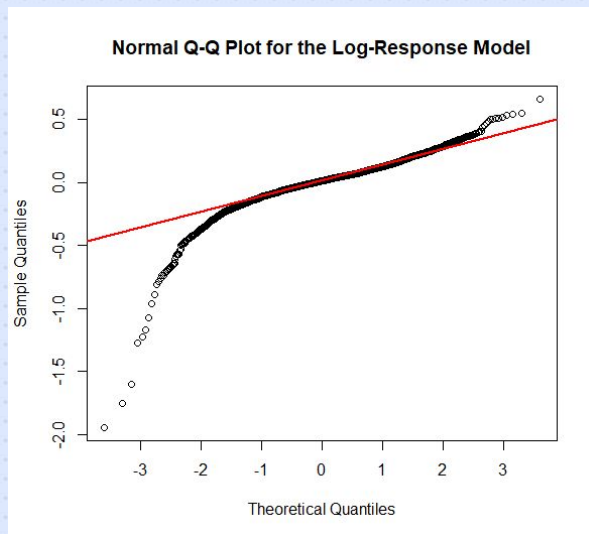
Original Model:



varPower Model:

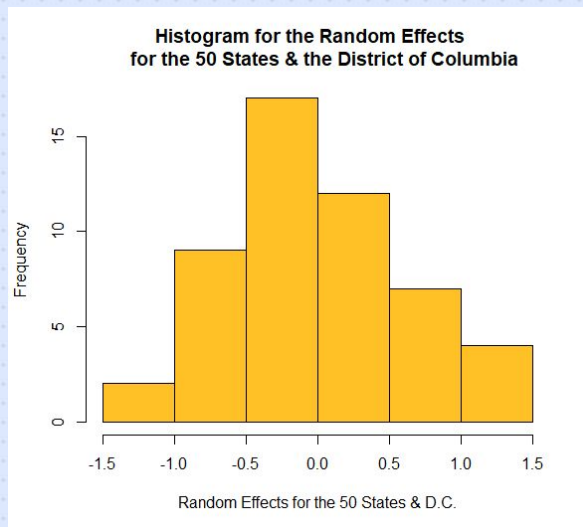


Log-Response Model:

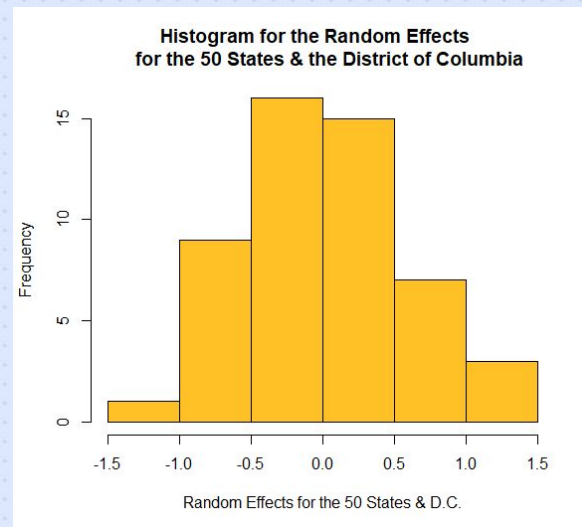


Model Diagnostics: Normal Random Effects

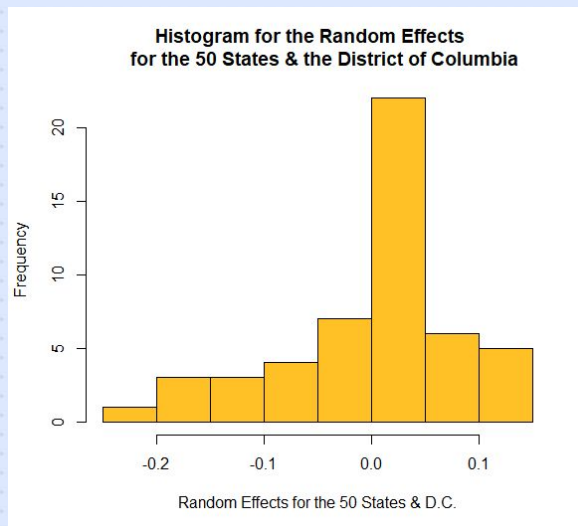
Original Model:



varPower Model:



Log-Response Model:



Sources

Xu JQ, Murphy SL, Kochanek KD, Arias E. Mortality in the United States, 2018. NCHS Data Brief, no 355. Hyattsville, MD: National Center for Health Statistics. 2020.

Curtin SC, Arias E. Mortality trends by race and ethnicity among adults aged 25 and over, 2000–2017. NCHS Data Brief, no 342. Hyattsville, MD: National Center for Health Statistics. 2019.

Heron M. (2007). Deaths: Leading Causes for 2004. Natl Vital Stat Rep. 2007 Nov 20;56(5):1-95. PMID: 18092547.

US Census Bureau. (2021). "States & Local Areas." Census.gov, 16 Dec. 2021, <https://www.census.gov/library/publications/2010/compendia/databooks.html>.

"Preventing Chronic Disease." (2012). Centers for Disease Control and Prevention, Centers for Disease Control and Prevention, https://www.cdc.gov/pcd/issues/2012/11_0120.htm.

Shi, J. et al. (2021). "The Impact of Income Definitions on Mortality Inequalities." SSM - Population Health, Elsevier, 7 Sept. 2021, <https://reader.elsevier.com/reader/sd/pii/S2352827321001907?token=18223EDC1508B5C76DF567A36B1ECA6CA61EE180DD708FCA14E199C596A03E4D3F14E182A965102488BD3804EEA8A3E9&originRegion=us-east-1&originCreation=20221205224919>.

Wickham, H. (2016). The ggplot2 Package: Elegant Graphics for Data Analysis. Springer-Verlag New York. <https://ggplot2.tidyverse.org>.

Pinheiro, J., Bates, D., R Core Team. (2022). The nlmePackage: Linear and Nonlinear Mixed Effects Models. R package version 3.1-159, <https://CRAN.R-project.org/package=nlme>.

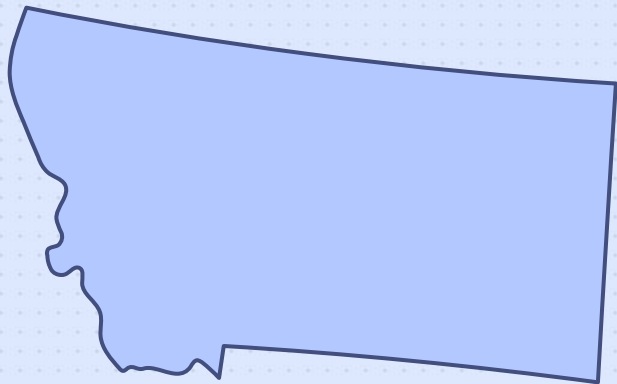
R Core Team (2022). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL <https://www.R-project.org/>.

Bates D, Mächler M, Bolker B, Walker S (2015). "Fitting Linear Mixed-Effects Models Using lme4." *Journal of Statistical Software*, 67(1), 1–48. doi:10.18637/jss.v067.i01

Revelle, W. (2022). The psych Package: Procedures for Personality and Psychological Research, Northwestern University, Evanston, Illinois, USA, <https://CRAN.R-project.org/package=psych> Version = 2.2.5.

<https://www.theonion.com/missing-teens-friends-go-on-tv-to-plead-for-her-release-1819595016>

<https://www.youtube.com/watch?v=m93L5cdOLJU>



Montana

Thank You