APPENDIX TEXT

Confirmatory Factor Modeling

Previous studies have presented analyses on racism using a variety of geographic units, including nations,[1] states,[2] and counties.[3] This paper focuses on counties for several reasons. Some candidate indicators (comparison of segregation across schools, for example) necessitate a unit of analysis larger than census tract or neighborhood. However, there is little doubt that policies implemented by governmental units below the state level are important drivers of racial inequity. For example, school systems are often operated by county governments, which set educational policies that can encourage, or prohibit, school segregation. The close relationship[4] between school segregation and residential segregation reflects the appropriateness of a county level analysis. Finally, creating a measure based on a sub-county unit of analysis would exclude areas of the U.S. in which the county represents the smallest unit of government. A measure based on metropolitan statistical area would have excluded large portions of the U.S. population and restricted the analysis to urban areas, both of which would have represented significant limitations.

BMI was ascertained using Behavioral Risk Factor Surveillance System data from 2011 and 2012. It was expected that county structural racism would exhibit a lagged effect on BMI. There is little guidance in the literature on how much time might elapse between exposure to structural racism and BMI changes. Results reported by Franco et al[5] suggest BMI changes in response to large-scale social dynamics are rapid. In Cuba, the advent of the 1991 economic crisis coincided with a downward shift in mean population BMI that occurred over 3 years. Because BMI measurements are reported in 3-year intervals, it is uncertain whether this shift occurred more

quickly. However, modeled estimates of diabetes prevalence suggest a rapid shift over a single year or less. It is likely that CSR does not affect BMI with the same rapidity as a wholesale economic downturn of the type seen in Cuba, because the effects of CSR are not as proximal to the ability to purchase food as an immediate change in one's income. In light of this, the 2007–2011 American Community Survey 5-year data file was used, which provided a lag of 2.5 years. A similar vintage for other files was selected. Some files, such as the U.S. Department of Justice Census of Jails, were not available for 2009. In those instances, the available vintage closest to 2009 was used.

When the data permitted calculations using counts of non-Hispanic whites and non-Hispanic blacks, those categories were used. In some instances, the count of non-Hispanic blacks was unavailable. In those cases, the count of all blacks was used. Counties with black population of less than 500 were excluded.

Regarding development of indicators for the health care domain, the issue of reverse causation constrained the available choices. Evaluating indicators that are either in the causal pathway between structural racism and BMI, caused by BMI, or are otherwise associated directly with BMI, this could give rise to spurious association between structural racism and BMI. Thus, indicators more closely tied to access to care instead of indicators of health outcomes or health status were sought.

CSR was estimated with confirmatory factor analysis (CFA). This approach leverages common, rather than total, variability across available indicators in a summary factor and thus minimizes

the effect of random measurement error. CFA empirically determines the degree to which each indicator is weighted in the composite estimate. Unidimensional factor models, all of which specified CSR as the sole latent variable of interest and contained at least one indicator from each domain, were evaluated. Rather than scaling models to an anchor item, we specified models such that the latent variable would have mean 0 and a standard deviation of 1, with larger values indicating higher structural racism. Models were fit using robust maximum likelihood estimation, which produces unbiased estimates when fit to data with missing and skewed indicators. Model fit was evaluated with the Tucker–Lewis index, the confirmatory fit index, the root mean square error of approximation, and the standardized root mean square residual.

Table 1 describes candidate variables, along with those included in the final model. The approach to processing and modeling indicators was as follows:

1. Orient candidate indicators such that larger values indicate higher CSR.
2. Transform indicators when appropriate to reduce skew by taking the square root or natural log, or winsorizing at the 1st and 99th percentiles.
3. Remove candidate indicators that are unlikely to function well in CFA modeling (e.g., high proportion of missing data, minimal correlation with all other indicators, indicators that are functions of another indicator).
4. Develop a list of candidate CFA models including all possible indicator combinations that would yield a CFA with at least one indicator per domain.
5. Fit candidate CFA models to a derivation sample of data and extract fit statistics.
6. Identify feasible models: Acceptable fit statistics[6], ≥1 indicator per domain, absence of diagnostics indicating Heywood case (standardized loading >1,

nonconvergence).

7. Select final model that provides optimal combination of a higher number of indicators and larger indicator loadings.

8. Fit final model to validation sample of data, evaluate results, and fit model to full dataset.

Most items removed after the initial assessment (Step 3 above) were poorly correlated with other candidate indicators. A further explanation of the model selection process is provided in Dougherty and Dean (2017)[7]. The final model exhibited acceptable fit statistics, with a confirmatory fit index of 0.97, a Tucker–Lewis fit index of 0.95, root mean square error of approximation of 0.04 and standardized root mean square residual of 0.05. The final model included the H (entropy) index; white/black high school graduation ratio, school dissimilarity index, the black/white poverty ratio; the black/white incarceration ratio; a ratio of white to black access to primary care, and a ratio of black to white inpatient hospital admission for ambulatory care sensitive conditions. All loadings were statistically significant.

APPENDIX REFERENCES

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Appendix Table 1. Candidate Indicator Data Sources and Dispositions

Domain	Indicator	Transformation	Data custodian	Database	Description	Status
Criminal justice	Jail staff ratio	Square root	U.S. Department of Justice	Census of Jail Facilities, 2006	Ratio of non-Hispanic white to non-Hispanic black proportions of county residents employed as sworn jail staff	Dropped, initial assessment
Criminal justice	Jail incarceration ratio	—	U.S. Department of Justice	Census of Jail Inmates, 2005	Ratio of non-Hispanic black to non-Hispanic white county jail incarceration	Included in final model
Criminal justice	Jail incarceration ratio	—	U.S. Census Bureau	Decennial Census, 2000	Ratio of black to white county jail incarceration	Dropped, initial assessment
Criminal justice	Police staff ratio	—	U.S. Department of Justice	Law Enforcement Management and Administrative Statistics, 2007	Ratio of non-Hispanic white to non-Hispanic black proportions of county residents employed as police officers	Dropped, initial assessment
Education	High school graduation ratio	—	U.S. Department of Education	Adjusted four-year cohort graduation rates public use file, 2010–2011	Ratio of non-Hispanic white to non-Hispanic black high school graduation rates	Included in final model
Education	College graduation ratio	1/square root	U.S. Census Bureau	American Community Survey SF-1 (2007–2011)	Ratio of non-Hispanic white to black college degree prevalence	Dropped, initial assessment
Education	School dissimilarity index	—	U.S. Department of Education	Common Core of Data (2007–2008)	Calculated as described in Reardon and Townsend[8]	Included in final model
Education	School	—	U.S.	Common Core of	Calculated as described in	Dropped, initial

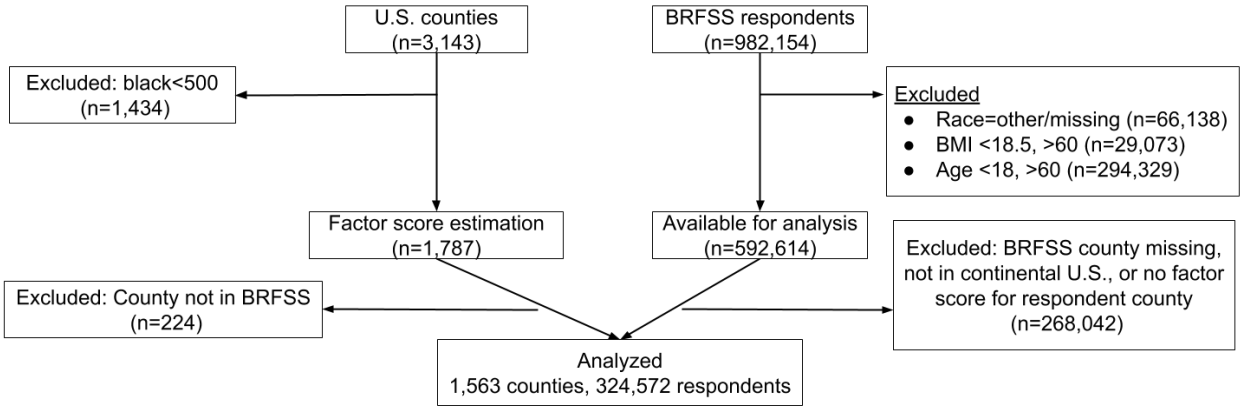
	diversity index		Department of Education	Data (2007–2008)	Reardon and Townsend[8]	assessment
Education	Thiel's H index	Natural logarithm	U.S. Department of Education	Common Core of Data (2007–2008)	Calculated as described in Reardon and Townsend[8]	Dropped in CFA assessment
Education	School Simpson Index	—	U.S. Department of Education	Common Core of Data (2007–2008)	Calculated as described in Reardon and Townsend[8]	Dropped in CFA assessment
Education	School isolation index	—	U.S. Department of Education	Common Core of Data (2007–2008)	Calculated as described in Reardon and Townsend[8]	Dropped, initial assessment
Employment	Per capita income ratio	Natural logarithm	U.S. Census Bureau	American Community Survey, 2007–2011	Ratio of non-Hispanic white to non-Hispanic black per capita income	Dropped, initial assessment
Employment	Median income ratio	Natural logarithm	U.S. Census Bureau	American Community Survey, 2007–2011	Ratio of non-Hispanic white to non-Hispanic black median income	Dropped, CFA assessment
Employment	Poverty ratio	Square root	U.S. Census Bureau	American Community Survey, 2007–2011	Ratio of non-Hispanic black to non-Hispanic white poverty proportions	Included in final model
Employment	Employment ratio	1/value cubed	U.S. Census Bureau	American Community Survey, 2007–2011	Ratio of non-Hispanic white to non-Hispanic black employment proportions	Dropped, CFA assessment
Health care	Mortality ratio	—	Centers for Disease Control and Prevention	Compressed Mortality File, 2007–2011	Age-adjusted non-Hispanic black to non-Hispanic white mortality rate	Dropped, CFA assessment

Health care	A1c follow-up ratio		Dartmouth Atlas of Health Care	2012 Atlas	Ratio of annual proportion of white non-Hispanic to black non-Hispanic diabetic Medicare enrollees ages 65–75 years having hemoglobin A1c test	Dropped, initial assessment
Health care	Mammogram ratio		Dartmouth Atlas of Health Care	2012 Atlas	Ratio of proportion of white non-Hispanic to black non-Hispanic female Medicare enrollees aged 67–69 years having ≥1 mammogram over a 2-year period	Dropped, initial assessment
Health care	Insurance ratio	Natural logarithm	U.S. Census Bureau	American Community Survey, 2008–2012	Ratio of proportion of white non-Hispanic to black county residents with health insurance	Dropped in CFA assessment
Health care	Ambulatory care sensitive conditions ratio		Dartmouth Atlas of Health Care	2012 Atlas	Ratio of proportion of black non-Hispanic to white non-Hispanic Medicare beneficiaries discharged from a hospital for an ambulatory care sensitive condition	Included in final model
Health care	Primary care ratio		Dartmouth Atlas of Health Care	2012 Atlas	Ratio of average annual proportion of white non-Hispanic to black non-Hispanic Medicare enrollees having at least one ambulatory visit to a primary care clinician	Included in final model
Housing	Dissimilarity index, spatial		U.S. Census Bureau	American Community Survey, 2007–2011	Calculated as described in Reardon and O'Sullivan[9]	Dropped, initial assessment

Housing	Dissimilarity index, aspatial	U.S. Census Bureau	American Community Survey, 2007–2011	Calculated as described in Reardon and Townsend[8]	Dropped, CFA assessment
Housing	Diversity index	U.S. Census Bureau	American Community Survey, 2007–2011	Calculated as described in Reardon and Townsend[8]	Dropped, initial assessment
Housing	H (entropy) index	U.S. Census Bureau	American Community Survey, 2007–2011	Calculated as described in Reardon and Townsend[8]	Included in final model
Housing	Index of Spatial Proximity	U.S. Census Bureau	American Community Survey Public Use Microdata 2007	Mean intragroup proximity for majority and minority groups, weighted by the each group's percentage of the total population.	Dropped, initial assessment
Housing	Mortgage approval ratio	Federal Financial Institutions Examination Council	Home Loan Disclosure Act, 2007	Percentage of white single-family home mortgage applications approved divided by black percentage approved	Dropped, initial assessment
Housing	Diversity index	U.S. Census Bureau	American Community Survey, 2007–2011	Calculated as described in Reardon and Townsend[8]	Dropped, initial assessment
Housing	Isolation index	U.S. Census Bureau	American Community Survey, 2007–2011	Calculated as described in Reardon and Townsend[8]	Dropped, initial assessment

CFA, confirmatory factor analysis.

Appendix Figure 1. Data processing summary.



BRFSS, Behavioral Risk Factor Surveillance System.