Quantifying the Effects of Social Determinants of Health on Adverse Birth Outcomes in Louisiana using Bayesian Linear Mixed-Effects Models

José Irizarry-Ayala[1], Jian Li[2], W. Susan Cheng[3], David R. Crosslin[1]

[1] Division of Biomedical Informatics and Genomics, Tulane University School of Medicine, New Orleans, LA

[2] Department of Biostatistics and Data Science, Tulane University Celia Scott Weatherhead School of Public Health and Tropical Medicine, New Orleans, LA

[3]Department of Social, Behavioral, and Populational Sciences, Tulane University Celia Scott Weatherhead School of Public Health and Tropical Medicine, New Orleans, LA

INTRODUCTION

- Louisiana is ranked last for maternal health outcomes among all fifty states and Puerto Rico. [1]
- Currently, it is theorized that Social Determinants of Health (SDoH) are a major factor influencing the incidence of adverse birth outcomes (ABOs).
- Previous works have identified SDoH associated with the incidence of ABOs in Louisiana.[2,3]
- Important factors include parish-level racial and ethnic composition, and economic attainment. [2]
- These works, however, have been criticized for limiting the amount of SDoH included in their modelling process.
- In addition, spatial data analysis techniques exist which identify patterns of spatial correlation have been developed, but not yet applied to ABOs in Louisiana. [4]

AIM

- Corroborate previous associations of the effects of SDoH on the incidence of ABOs in Louisiana.
- Identify changes in the incidence of ABOs across time and space within Louisiana.
- Identify spatial clusters of high or low ABO outcome correlation in Louisiana.

METHODS

- We amassed ABO data from the Louisiana Department of Health for Preterm Birth (PTB) and Low Birth Weight (LBW) at the parish-level from 2009 to 2020.
- We also acquired a data set from the Agency of Healthcare Research and Quality. for the same time frame with 1330 variables.
- We subset the larger dataset to only include numeric variables with less than 30% missing observations.
- We imputed missing values base don county median.
- We calculated principal components for our SDoH dataset.
- We fit two Bayesian linear mixed-effect models for PTB and LBW, with year and parish as random effects and principal components 1-9 as fixed effects.
- We calculated Local Moran's I for all parishes.

RESULTS

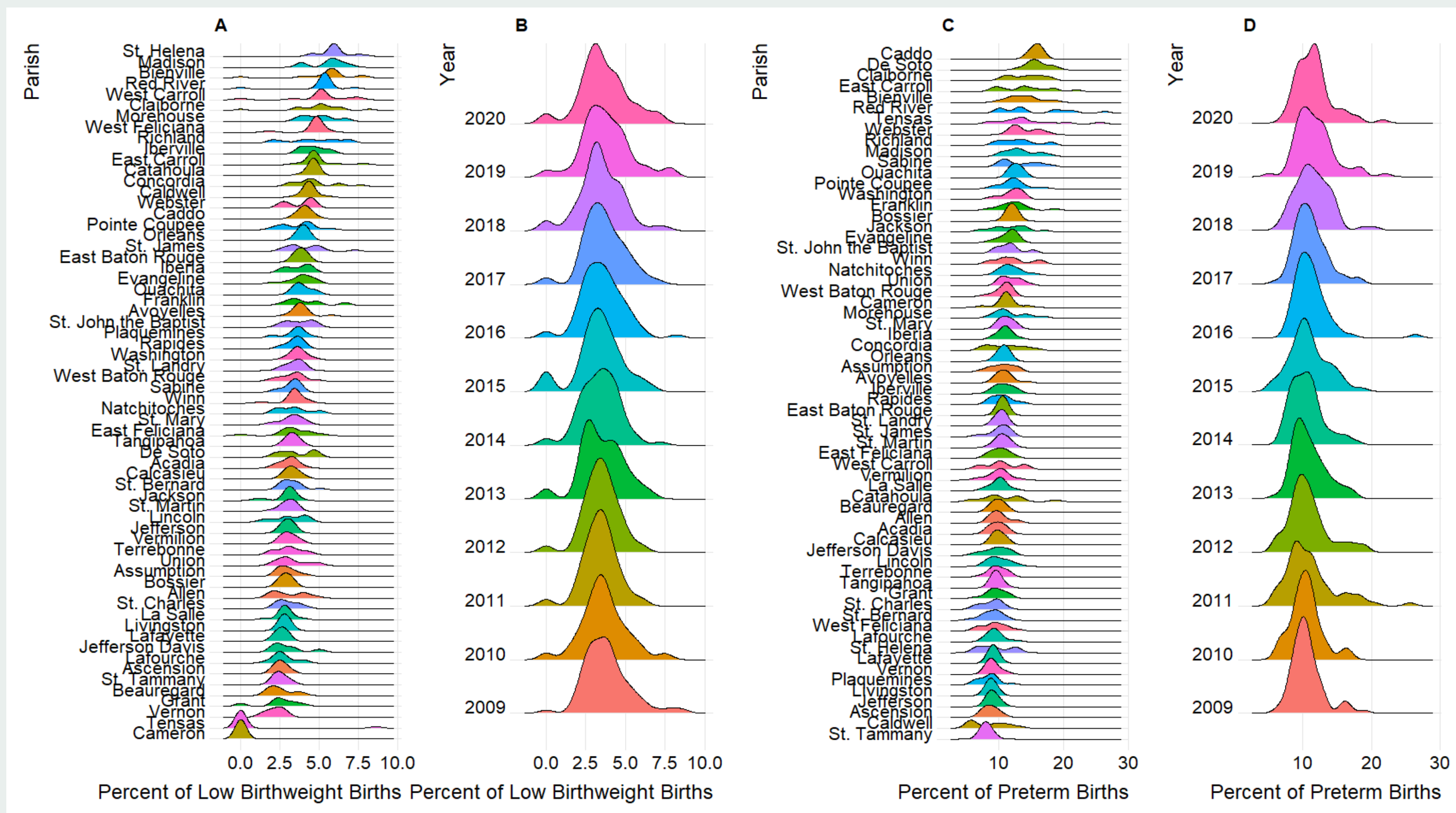

Figure 1. Ridgeline plot of parish-level and year-level distributions for LBW and PTB.

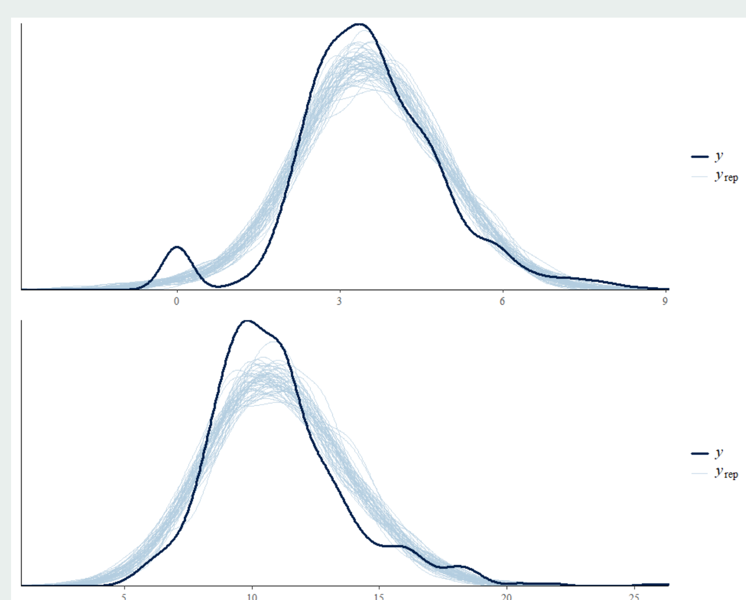

Figure 1. Posterior predicted distributions of LBW and PTB vs. true distributions.

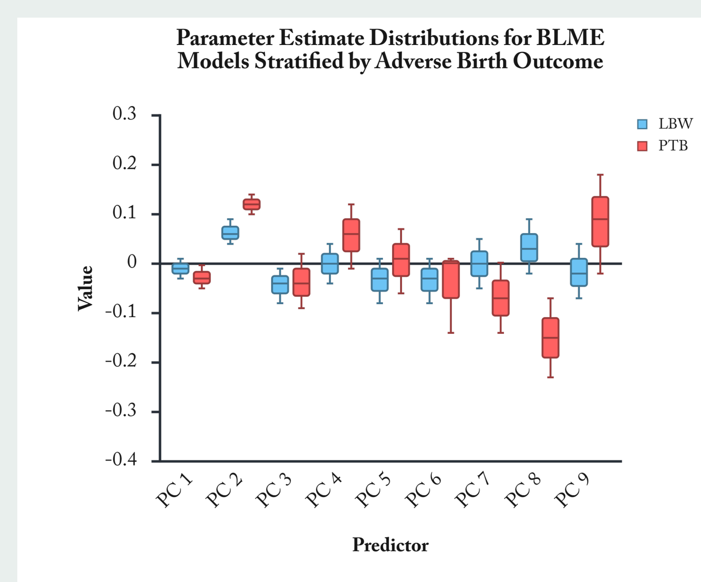

Figure 2. Box Plot of parameter estimates for the first 9 principal components.

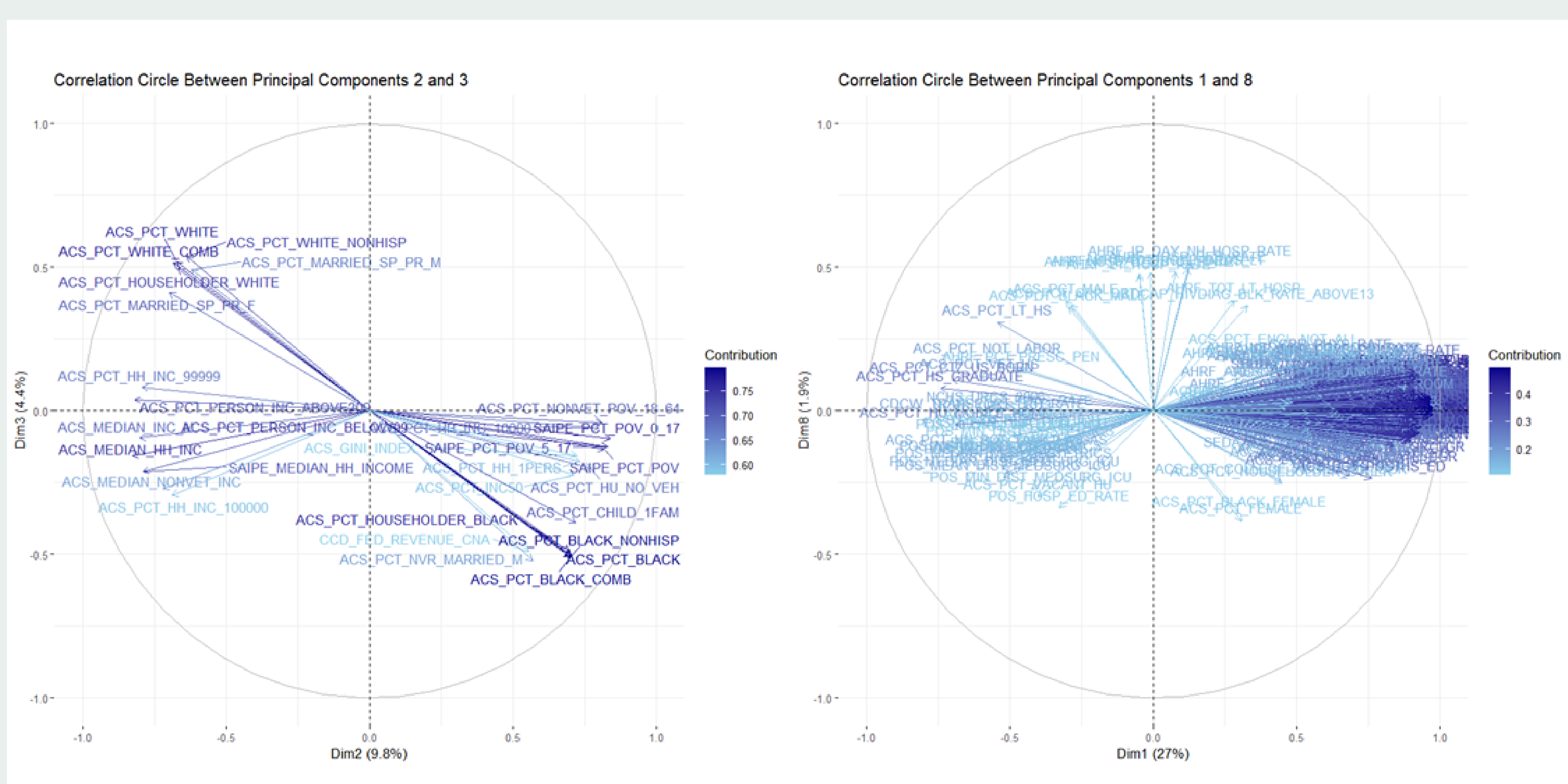

Figure 4. Correlation circles which illustrate the variables which best separate principal components. From left to right, PC 2 vs PC 3, PC 1 vs. PC 8. Direction corresponds to correlation patterns between variables while X,Y coordinates correspond to correlation to PCs.

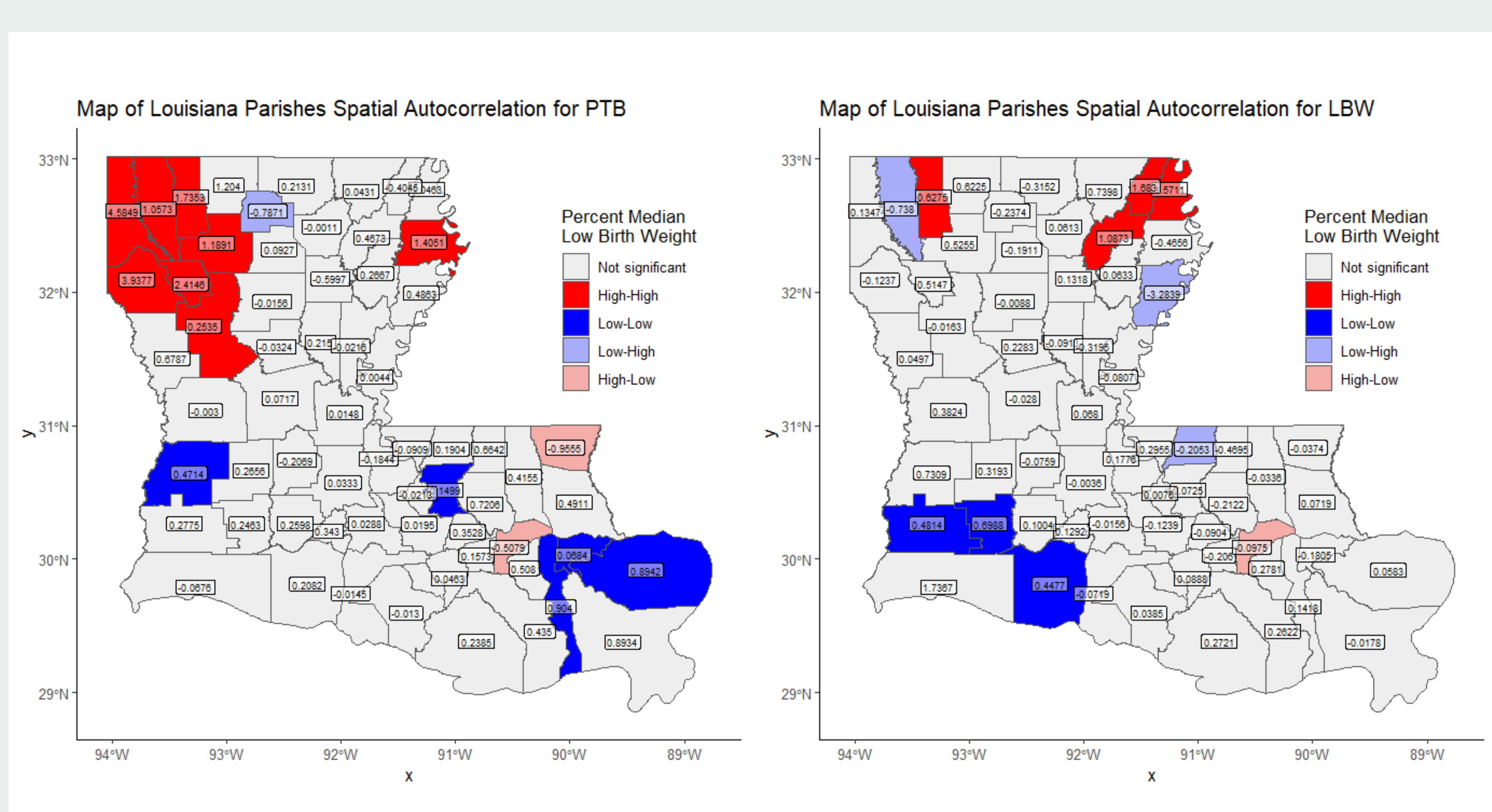

Figure 5. Map of Louisiana colored by clusters as calculated by Local Moran's I.

RESULTS CONT.

- First, we visualized our outcomes by parish and year. (Fig. 1)
- We assessed goodness of fit by comparing our model's predicted distribution with the true distribution. (Fig. 2)
- The predictive models had Bayesian R2 of 52.5% and 46.1% for LBW and PTB, respectively.
- We identified several significant effects related to parish and SDoH-derived principal components (Fig. 3)
- No significant effects were identified across years.
- We assessed the relationship between SDoH and adverse birth outcomes by inspecting correlation circles (Fig. 4) and using these to assign qualitative labels to the PCs.
- We identified several clusters of spatially correlated parishes in terms of ABO incidence. (Fig. 5).

DISCUSSION

- Our models had reasonable goodness of fit as corroborated by comparison of the posterior predicted distribution and the Bayesian R^2 metrics.
- The statistically significant parameters we estimated suggest correlative associations between space, racial and ethnic composition, economic attainment, and the incidence of both LBW and PTB.
- For PTB specifically, our models also suggest population density and healthcare usage as important predictive factors.
- We identify no associations between year and te incidence of ABOs in Louisiana.
- We identify several clusters of parishes in Louisiana which are correlated in terms of ABOs.

CONCLUSION

- Our study's analysis validates previous studies" associations of SDoH with ABOs.
- We also identify spatial associations and clusters of high and low ABO incidence in Louisiana.
- We find no change of ABO incidence across time, suggesting ABO incidence in Louisiana has not significantly worsened or improved.

ACKNOWLEDGEMENTS

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LITERATURE

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Code and Supplemental Figures

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