Analyzing the Impact of Sleep and Distress on Preventable Hospitalizations Across Racial and Ethnic Groups

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Introduction

Preventable Hospital Stays (PHS)—the frequency of hospitalizations due to ambulatory-care-sensitive conditions such as congestive heart failure, diabetes, and hypertension, per 100,000 Medicare enrollees—imposes a substantial financial burden on healthcare systems and individuals. By identifying avoidable hospitalization factors, healthcare providers can reduce unnecessary admissions, save costs, and improve efficiency. Reduced hospitalization can also alleviate psychological and physical stress for patients and their families minimizing disruption to their daily lives.

Our research aims to analyze how sleep insufficiency and distress levels impact preventable hospital stays, particularly among various racial and ethnic groups. We seek to address healthcare disparities and inform insights for reducing preventable hospitalizations in diverse populations.

Contributing Factors to Preventable Hospital Stays

Using *2023 County Health Rankings & Roadmaps* compiled by the University of Wisconsin Population Health Institute, we focus on the following (age-adjusted) county-level variables:

- **Sleep Deprivation Ratio**: Ratio of adults who report fewer than 7 hours of sleep on average.
- **Physical/Mental Distress Ratio** : Ratio of adults reporting 14 or more days of poor physical/mental health per month.
- **Racial-Ethnic Groups**: AIAN (American Indian/Alaska Native), Asian, Black, Hispanic, White.

Sleep deprivation, physical distress, and mental distress are positively correlated pairwise across all racial and ethnic groups. The relationships between these factors are similar across all groups except Asians. Asians typically exhibit lower physical and mental distress compared to the other groups, but they are not necessarily less sleep-deprived on average.
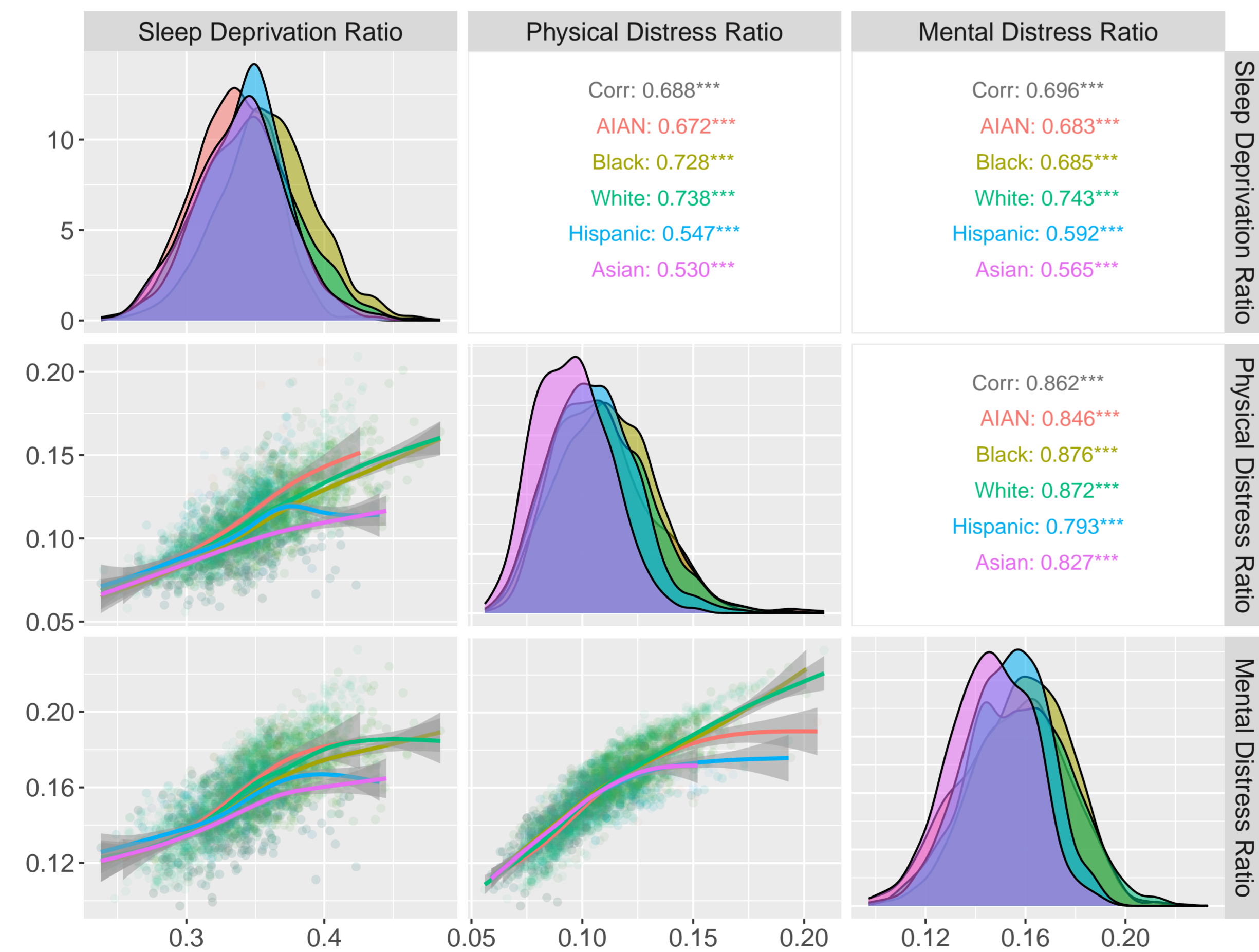

## Findings from Exploratory Data Analysis

1. Insufficient sleep correlates with Preventable Hospital Stays with heterogeneous racial impacts.

Sleep deprivation is positively correlated with preventable hospital stays. We found three clusters of racial and ethnic groups sharing similar relationships—Asian, White & Hispanic, and AIAN & Black—with increasing order of baseline preventable hospital stays.

Sleep deprivation is linked to increased mental distress and chronic health conditions like heart disease, high blood pressure, and diabetes (Lee et al, 2018). Mental distress can hinder health management, potentially causing delayed medical attention and unavoidable hospital stays.
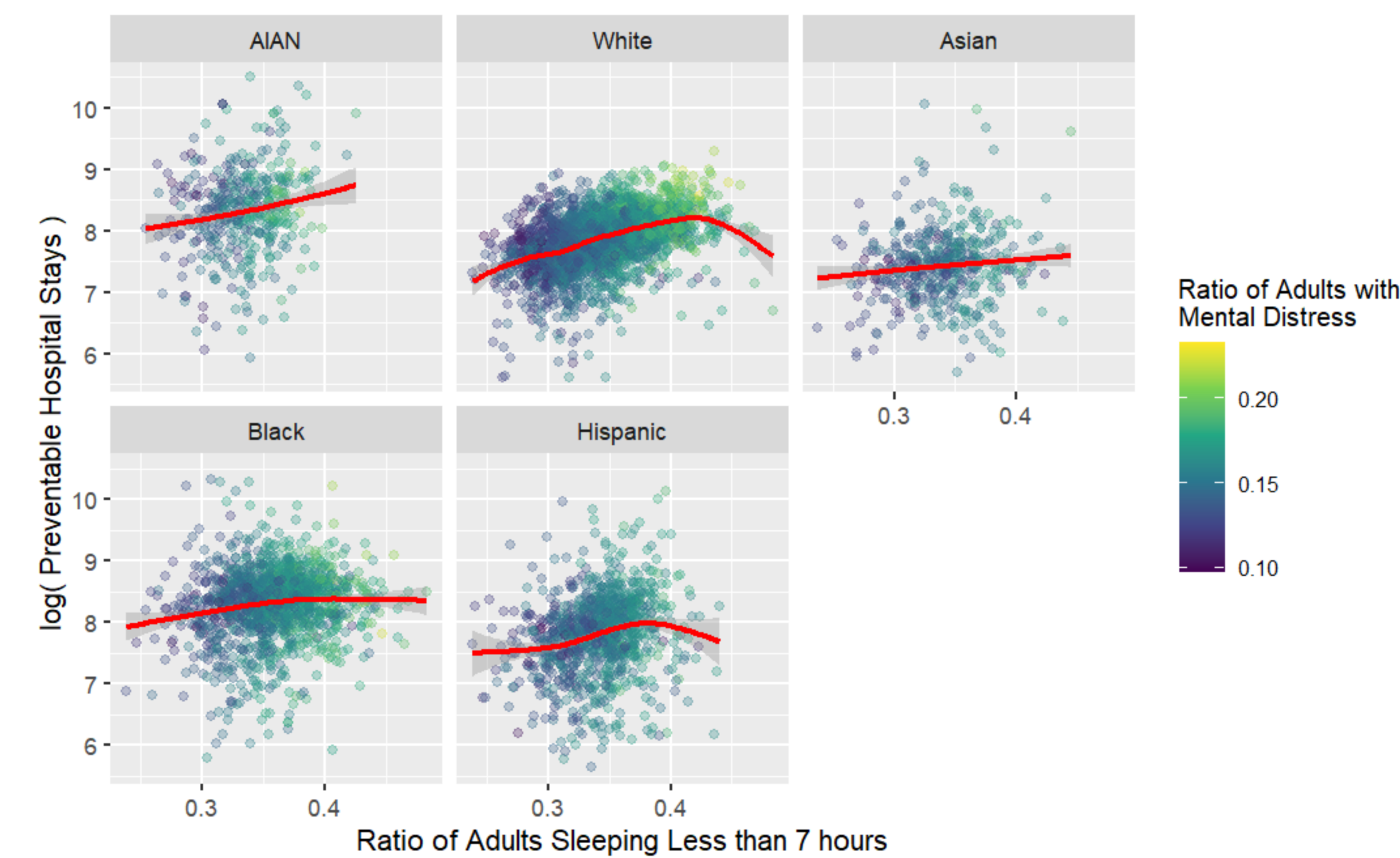

2. Counties in the Southern and Appalachian regions experience more sleep deprivation and have a higher rate of preventable hospital stays.
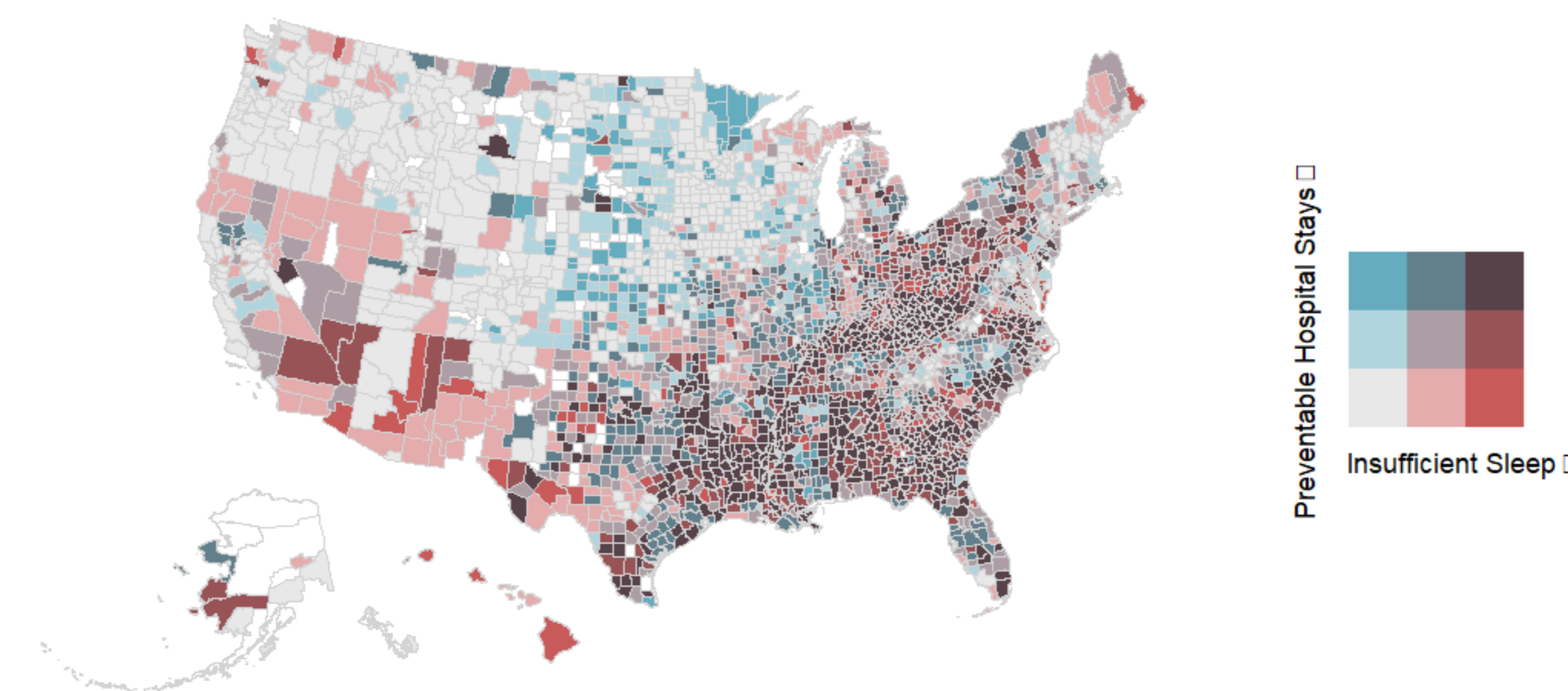

Model-explained Impact of Insufficient Sleep and Racial Groups

- We used Gradient Boosted Decision Tree to predict preventable hospital stays from all the other 81 factors in the 2023 dataset.
- Racial and ethnic group is the most important variable in predicting preventable hospital stays based on mean absolute SHAP value. The sleep deprivation ratio ranked 5th.

1. Partial SHAP values contributed by the races match with Finding 1 from EDA.

Ascending order of predicted preventable hospital stays: Asian, White & Hispanic, AIAN & Black.
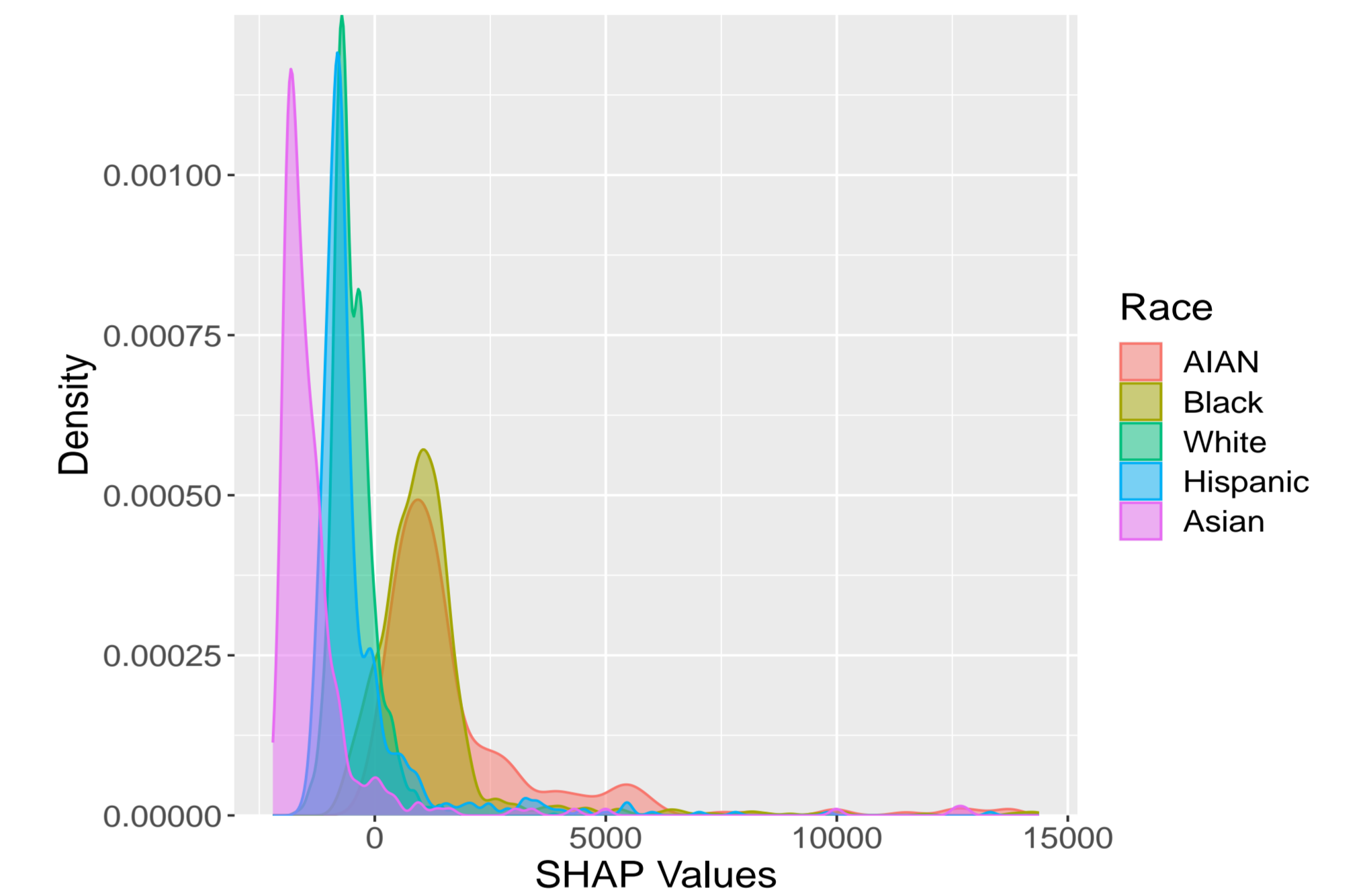
2. A sharp transition occurs in the effect of the sleep deprivation ratio: above 33%, the model predicts higher preventable hospital stays, positively correlated with the mental distress ratio.
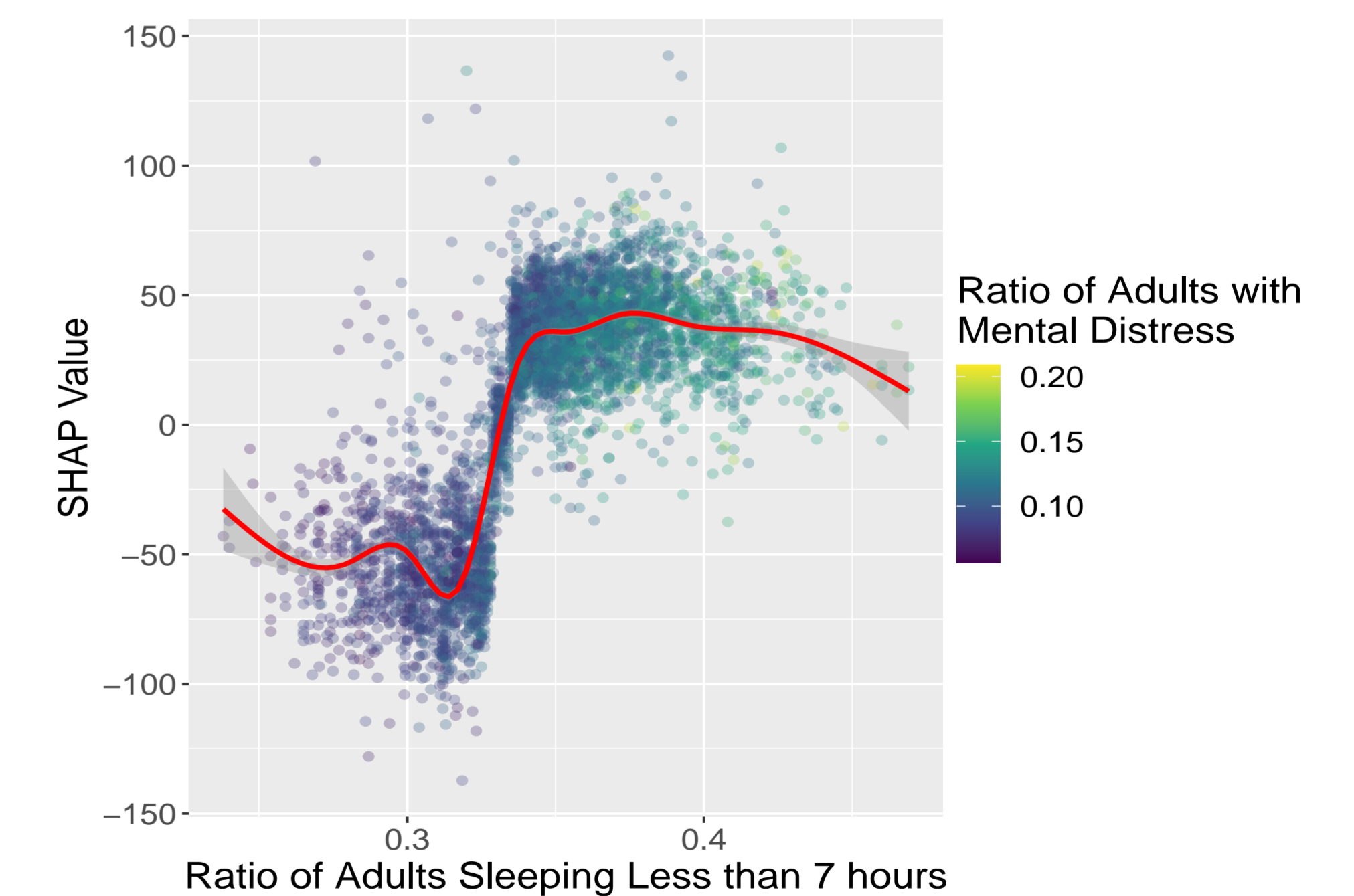
References

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