



# PREDICTING MORTLITY & ALGORITHMIC FAIRNESS OF ICU PATIENTS

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## 1. Introduction

The rapid advancement of technology and the abundance of patient clinical data have enabled the development of machine learning models to predict ICU patient mortality (Johnson et al., 2023).

Pang et al. (2022) develops and compares machine learning models using the MIMIC-IV database to predict ICU mortality risk, but it is not addressing algorithmic biases to ensure equitable healthcare outcomes across demographic groups.

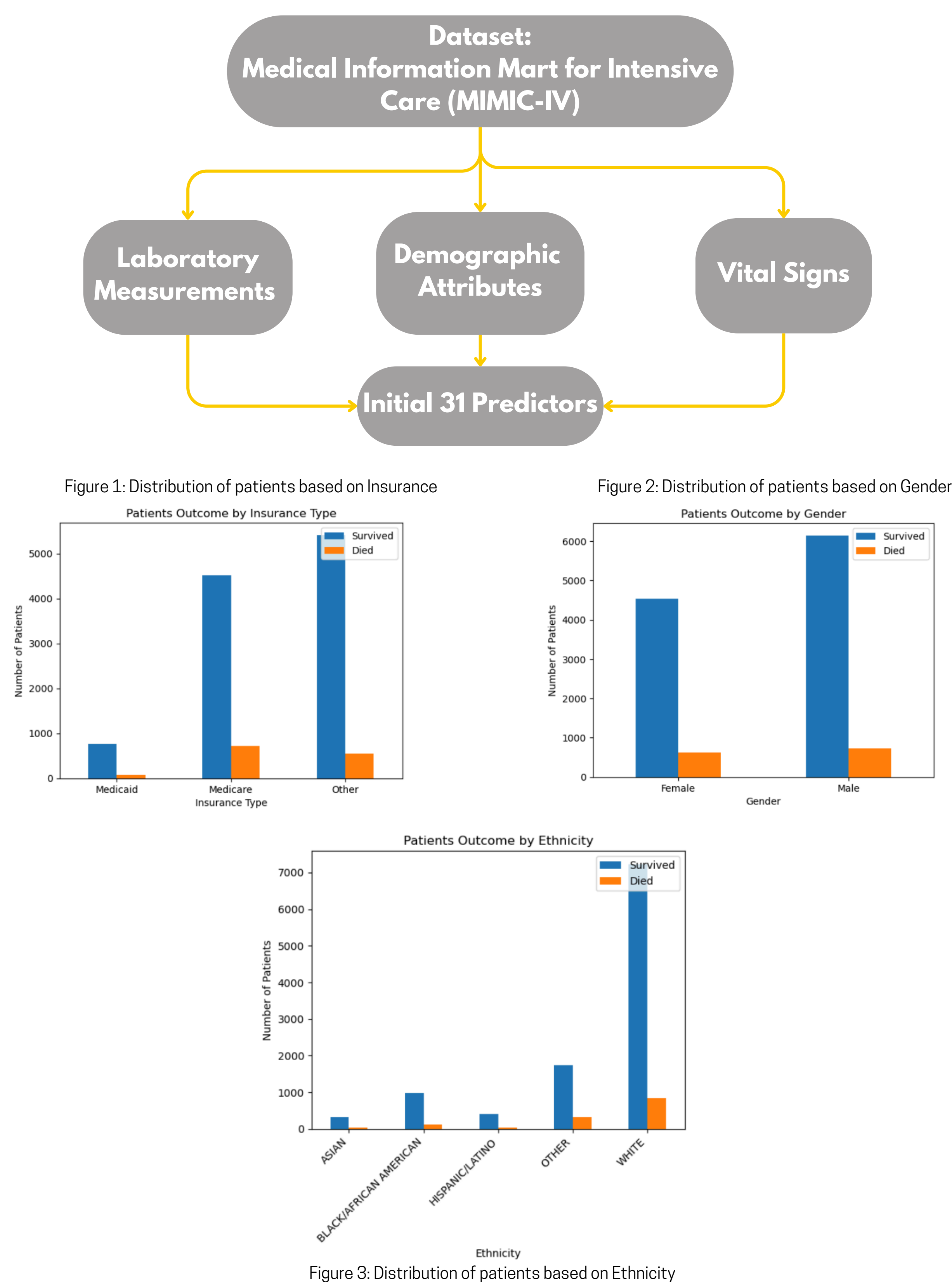
## 2. Aims & Objectives

**Research Question:** How effectively machine learning models predict mortality in ICU patients, while mitigating potential biases according to some patients' attributes?

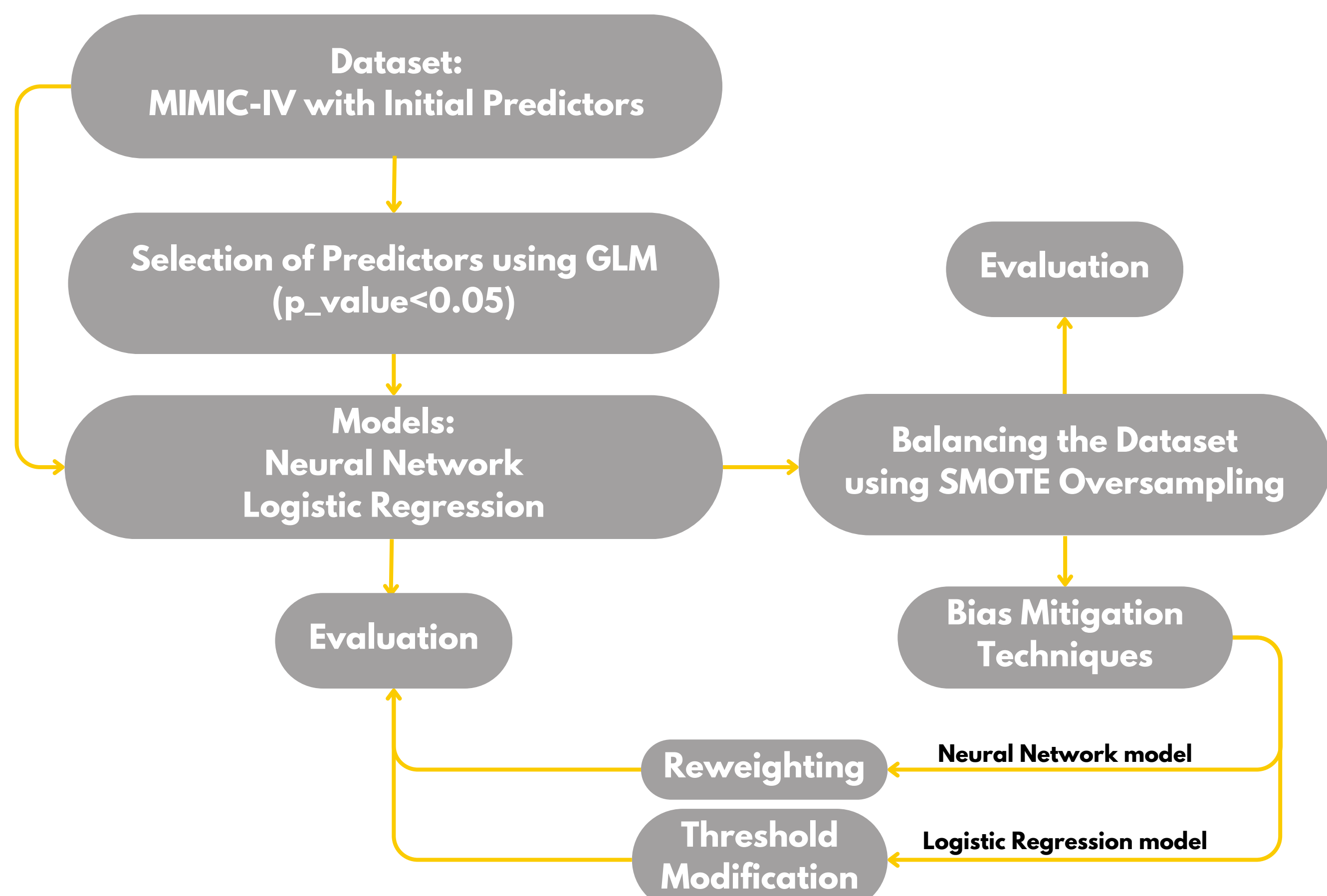
**Sub-questions:**

- Does the selection of predictors insert potential biases across sensitive attributes?
- How bias mitigation techniques affect the performance of the models?
- Are there groups of patients that are more prone to algorithmic bias?

## 3. Data



## 4. Methodology



## 5. Results

### Performance of Neural Network vs Logistic Regression

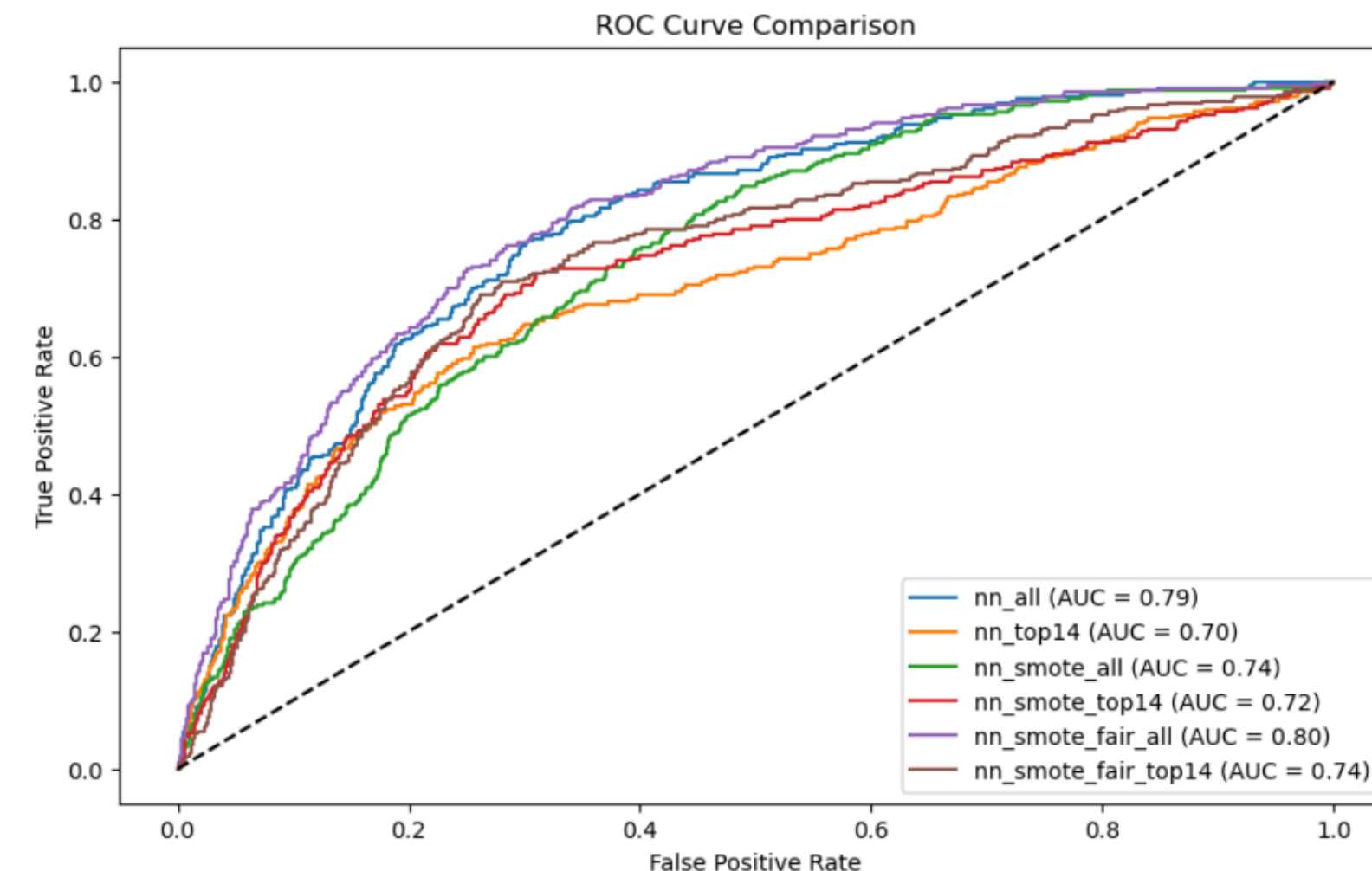


Figure 4: Performance of Neural Network models

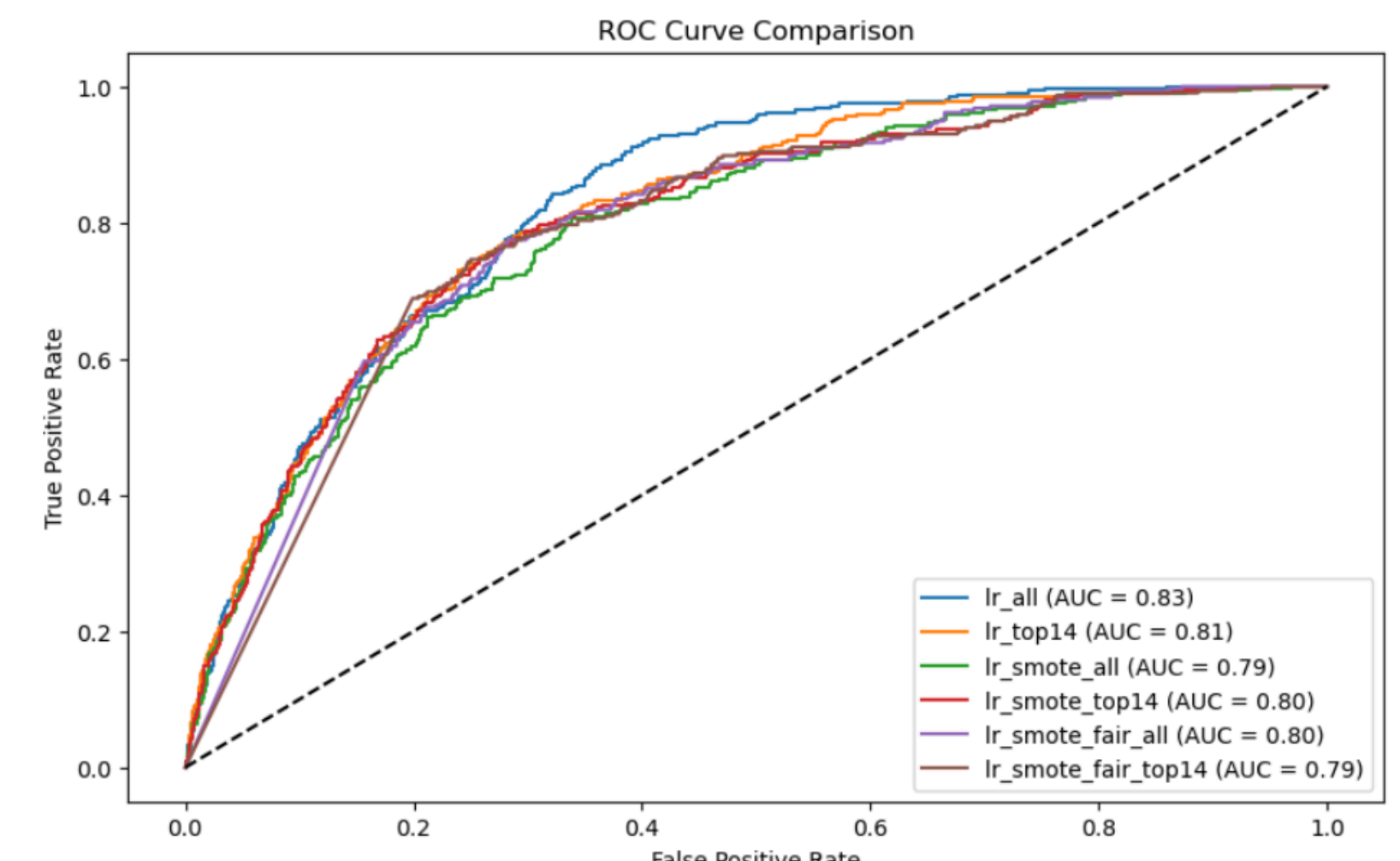


Figure 5: Performance of Logistic Regression models

### Fairness Evaluation

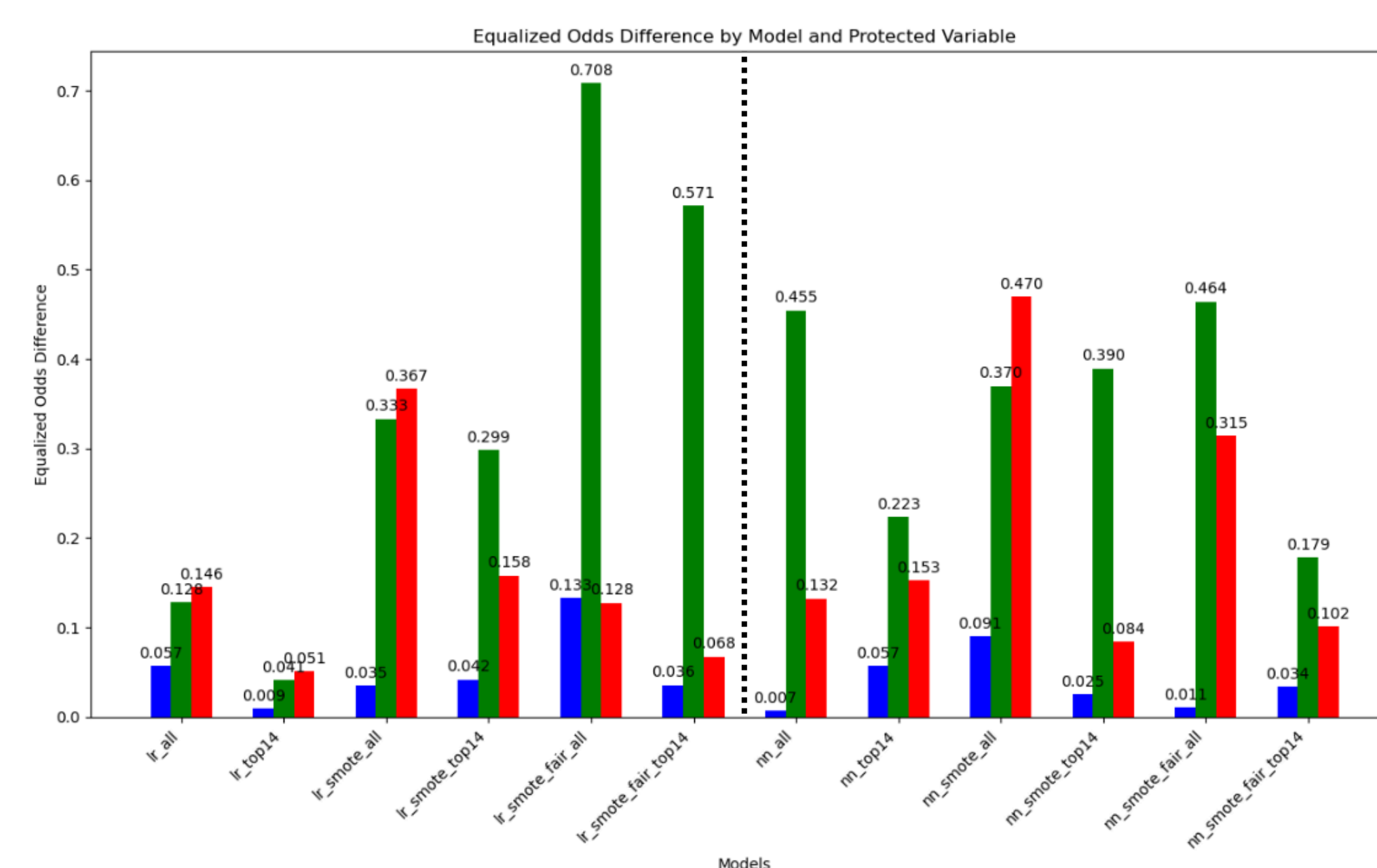
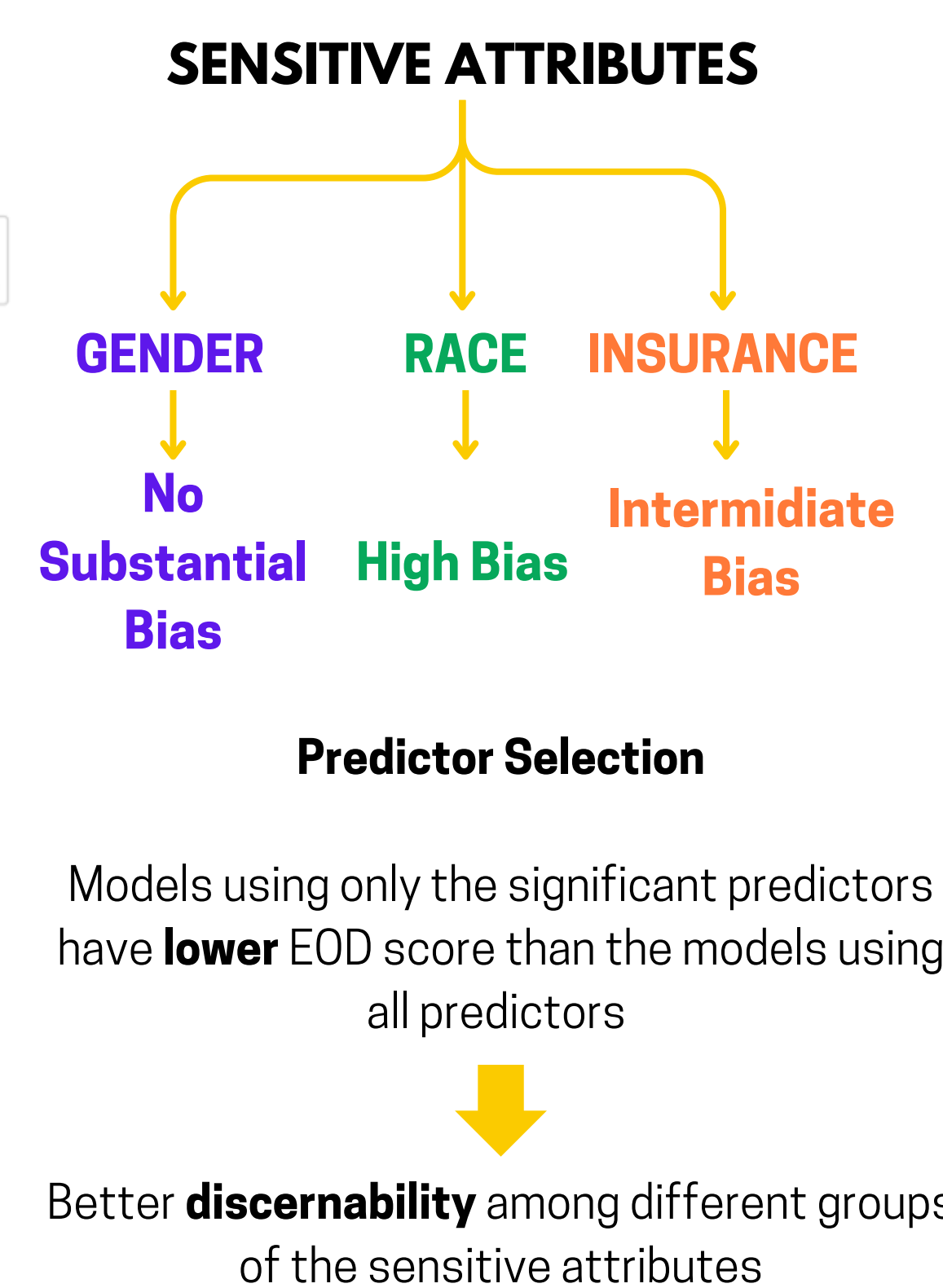


Figure 6: Equalized Odds Difference (EOD) of ALL models



### Exploratory Analysis After Bias Mitigation

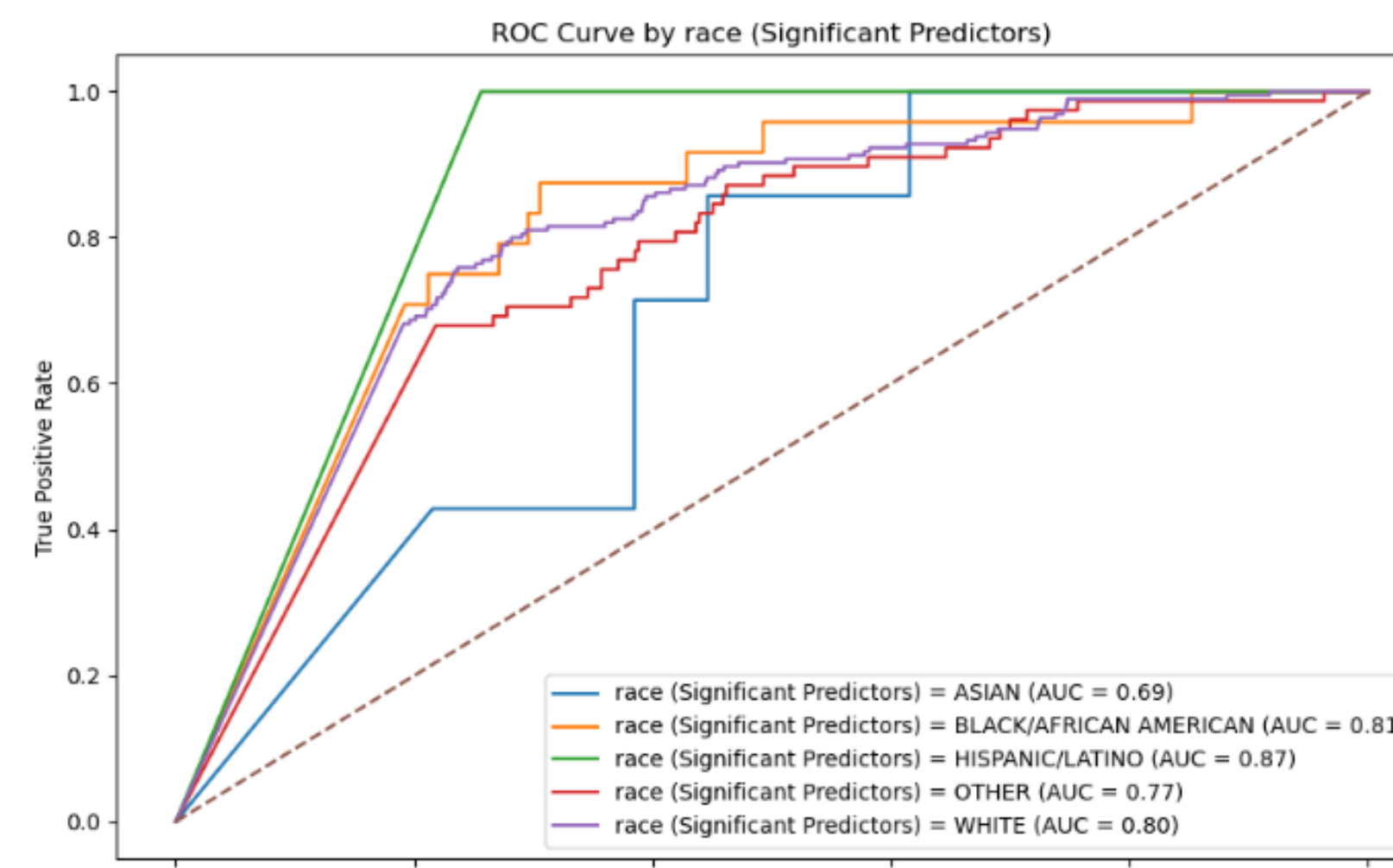


Figure 7: ROC curve for Ethnicity using LR models after bias mitigation

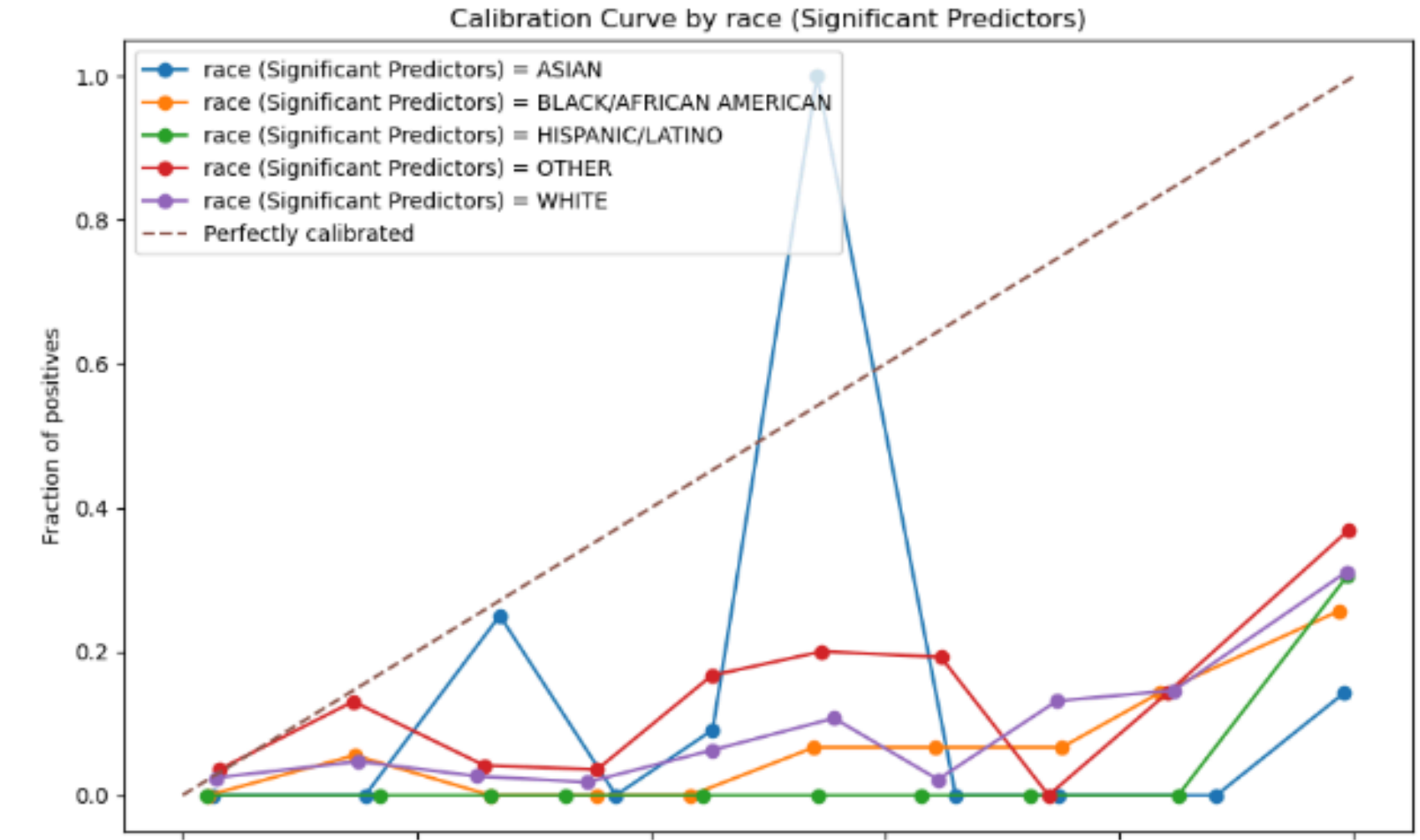


Figure 8: Calibration plot for Ethnicity using LR models after bias mitigation

Asian patients have an AUC score of **0.69**, while all other groups have **higher** AUC scores.

Low True Positive Rate → Model makes less accurate predictions for Asian patients

The calibration plot shows that Asian patients are **not well calibrated** compared to the other groups of patients based on Ethnicity.

Prone to Bias

## 6. Discussion & Conclusion

- **Performance of Initial Predictors:** Models using the initial comprehensive set of predictors outperform those using only the most significant predictors in both Neural Network and Logistic Regression models.
- **Susceptibility to Algorithmic Bias:** Models utilizing all predictors are more susceptible to algorithmic bias compared to those using only the most significant predictors.
- **Trade-off Between Performance and Bias:** Increasing model performance often leads to an increase in bias, highlighting a trade-off between accuracy and fairness.
- **Demographic Vulnerability to Bias:** Asian patients are particularly more prone to algorithmic bias, indicating the need for different bias mitigation strategies for this demographic group.
- **Model Selection:** According to this analysis, the neural network model trained on the balanced dataset and after reweighting technique to address algorithmic bias is the one that provides a decent trade-off between performance and fairness.

## References

- [1] Johnson, A. E. W., Bulgarelli, L., Shen, L., Gayles, A., Shammout, A., Horng, S., Pollard, T. J., Hao, S., Moody, B., Gow, B., Lehman, L. H., Celi, L. A., & Mark, R. G. (2023). MIMIC-IV, a freely accessible electronic health record dataset. Scientific Data, 10(1).
- [2] Pang, K., Li, L., Ouyang, W., Liu, X., & Tang, Y. (2022). Establishment of ICU Mortality Risk Prediction Models with Machine Learning Algorithm Using MIMIC-IV Database. Diagnostics, 12(5), 1068.