Age-Related Blood Pressure Patterns Across Diverse Ethnicities

Introduction

Age-related changes in blood pressure have long been a subject of scientific interest and clinical significance, as they play a critical role in understanding cardiovascular health and the risk of various chronic diseases. However, it is increasingly recognized that blood pressure patterns may not be uniform across different ethnic groups. This diversity in blood pressure trends can have significant implications for public health, medical practice, and the development of tailored healthcare interventions.

In this study, we investigate the intricate relationship between age and blood pressure, focusing on a diverse range of ethnicities, taking multiple covariates into account, like laboratory health indicators and demographics. By exploring these variations, we aim to give some insights on the nuanced dynamics of blood pressure throughout the aging process and contribute to a more comprehensive understanding of cardiovascular health in multi-ethnic populations.

Data

Our data comes from the National Health and Nutrition Examination Survey by the United States Centers for Disease Control (CDC), which captures many aspects of health during 2017-2018. Each wave surveys an independent sample of people, so this is a cross-sectional rather than a longitudinal study. For our analysis, we took demographic data like gender, ethnicity, and age and health indicators like Weights, Heights, BMI, upper leg length, upper arm length, blood pressure etc., resulting in 12 variables(including response variable) with 3375 observations.

Since our topics focus on ethnicity of Non-Hispanic Whites (NHW) and Non-Hispanic Blacks (NHB), we only filter the parts of ethnicity NHW and NHB. Many biological processes behave differently during development compared to in adulthood. For this analysis, we will focus on people of age 18 or greater. Finally, we remove rows or observations with missing values from our dataset.

Methodology: Dimension reduction regression

For our dataset with 11 predictors, it's possible to exist the curse of dimensionality. As the number of predictor variables (dimensions) increases, the dataset becomes sparser, and traditional regression methods may become less effective or computationally intensive. Dimension reduction can help mitigate these issues by reducing the number of variables while retaining meaningful information. In addition, the usage of dimension reduction regression would be helpful for Interpretability. Dimension reduction can help create a more concise model, making it easier to understand and communicate the relationships between variables and the outcome. Thus, dimension reduction regression would be a suitable method for our goals.

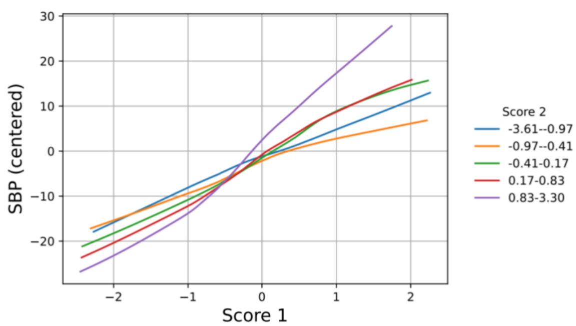
As the dimension reduction regression, the Sliced Inverse Regression (SIR) methodology has evolved adapting to increasingly complex data sets in contexts combining linear dimension reduction with non linear regression.

Consider a univariate response variable Y and a square-integrable multidimensional covariate $X \in R^p$ with and . Let $\beta = [\beta_1, ..., \beta_K]$ be a $p \times K$ matrix (with $K \leq p$) where the β_k's are unknown -dimensional vectors assumed to be linearly independent. The semi-parametric regression model: $Y \perp X \mid \beta^T X$, which means that Y is independent of X given $\beta^T X$. Therefore, one can replace $X \in R^p$ by the index $\beta^T X \in R^K$ without loss of information on the regression of Y on X. Note that β always exists since one may consider $\beta = I_p$ where I_p is the $p \times p$ identity matrix, but there is no dimension reduction in this case. In contrast, when $K < p$, there is an effective dimension reduction.

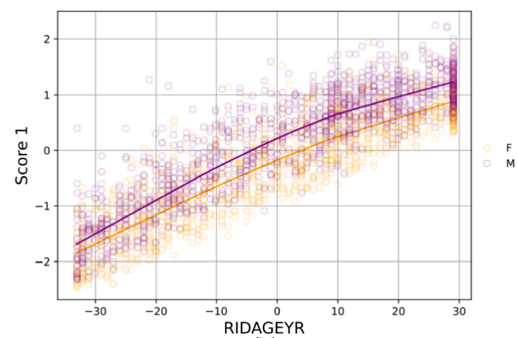
Result and Conclusion

In our analysis, we choose K=2 to reduce 11 dimension variables into 2 scores. This selection allows us to probe and uncover potential interactions among the variables more effectively.

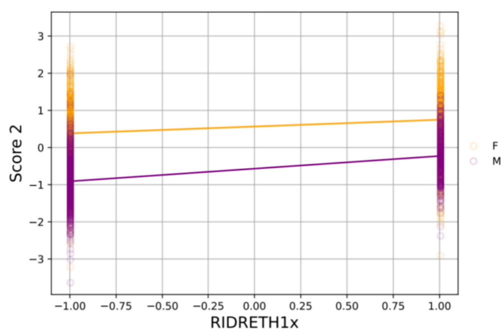
Graph 1 Dimension reduction regression(K=2) Result



(a)



(b)



(c)

	coef	std err	t	P>|t|	[0.025	0.975]
Intercept	86.0622	1.762	48.840	0.000	82.607	89.517
RIAGENDR[T.M]	16.1271	1.859	8.677	0.000	12.483	19.772
RIDAGEYR	0.6383	0.024	26.687	0.000	0.591	0.685
RIDAGEYR:RIAGENDR[T.M]	-0.2713	0.034	-7.908	0.000	-0.339	-0.204
RIDRETH1x	1.0796	1.279	0.844	0.399	-1.429	3.588
RIAGENDR[T.M]:RIDRETH1x	-1.0269	1.859	-0.553	0.581	-4.671	2.617
RIDAGEYR:RIDRETH1x	0.0423	0.024	1.770	0.077	-0.005	0.089
RIDAGEYR:RIAGENDR[T.M]:RIDRETH1x	0.0187	0.034	0.546	0.585	-0.049	0.086
BMXBMI	0.2602	0.040	6.502	0.000	0.182	0.339

(d)

Graph1 (a) illustrates the interaction between score 1($\beta_1^T X$) and score 2($\beta_2^T X$) with centered-SBP(systolic blood pressure) as response. Graph1 (b) demonstrates how score 1($\beta_1^T X$) relates to RIDAGEYR(age). Graph1 (c) demonstrates how score 2($\beta_1^T X$) relates to RIDRETH1x(ethnicity), where -1 represents NHW and 1 represents NHB. Graph1 (d) is the partial output of regression taking 11 co-variants and the interaction structure between them. We only display part of the results who are relevant to our topic.

In conclusion, there is a positive association between an individual's age (RIDAGEYR) and the score 1($\beta_1^T X$). Specifically, as age increases, the score 1($\beta_1^T X$) tends to rise. Additionally, it is observed that Non-Hispanic Whites (NHW) tend to exhibit lower levels of score2($\beta_2^T X$), whereas Non-Hispanic Blacks (NHB) tend to display higher levels of score2($\beta_2^T X$).

Considering the insights from Graph 1 (a), it becomes evident that for the NHW group, the rate of increase in blood pressure tends to be gradual as individuals age. In contrast, for the NHB group, the rate of increase in blood pressure appears to be notably steeper with advancing age.

Based on the regression table in Graph 1 (d), the interaction effect between RIDRETH1 (ethnicity) and RIDAGEYR (age) is statistically significant at a 90% confidence level. This implies that we have grounds to construct a model capturing the interplay between ethnicity and age (RIDRETH1 x RIDAGEYR). Consequently, our assertion that distinct ethnic groups exhibit varying blood pressure changes as individuals age remains well-supported and valid.