Can Body Mass Index (Underweight/Overweight) be used to predict the risk of getting health issues like Diabetes/Hypertension?

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Introduction

Exposure: Body mass index (BMI) is a person's weight in kilograms divided by the square of height in meters. As the World Health Organization (WHO) defines, BMI is an inexpensive and easy screening method for weight categories—underweight (BMI<18.5), normal weight (18.5-24.9), overweight (25-29.9), obesityI (30-34.9), obesityII (35-39.9), and obesityIII (BMI>=40)—that may lead to health problems.

Importance: A high amount of body fat (higher BMI: overweight/obesity) increases risk of weight related diseases and other health issues as several studies have reported on the association of higher BMI with Shorter Longevity[1], significantly increased risk of Strokes[2], Ischemic Heart Diseases (IHD)[3], severe COVID-19–associated illness[4,5], Infectious diseases[6,7], higher mortality in Esophageal Cancer[8].

Objective: To estimate the risk of Diabetes & Hypertension by different weight categories.

Keywords: BMI; Underweight; Overweight; Obesity; Blood Pressure; Hypertension; Diabetes.

Methodology

Dataset Information: The National Longitudinal Study of Adolescent to Adult Health (Add Health)[9] collected and pooled individual-level data under a longitudinal population-based cohort study conducted in the United States starting with a nationally representative sample of adolescents in grades 7-12 during the 1994-95 school years. Add Health followed the cohort members into young adulthood with five in home interviews. In Wave V, the researchers collected anthropometric (including BMI), smoking status, cardiovascular, metabolic, and inflammatory measures, and biomarkers of chronic kidney diseases by surveying 19,828 cohort members (aged 33 to 44). There were 1,712 participants with complete covariate information.

Analyses: All of the following statistical analyses were performed with R (version 4.1.2) using the RStudio (version 2021.09.2), at the $\alpha = 0.01$ significance level:
➜ Analysis of Variance (ANOVA) with post-hoc test to determine effect of BMI on Systolic BP.
➜ Logistic regression to predict the risk factors (including BMI) of Hypertension.
➜ Chi-square test of independence to find association between Diabetes and Weight Categories.

Results

❖ ANOVA revealed that there is a significant difference in mean Systolic Blood Pressure between normal weight and overweight people (p<0.001), and on average overweight people have 6.73 MMHg higher blood pressure than people who have normal weight.

❖ Multiple logistic regression adjusting for age, gender, BMI, smoking status, and diabetes class showed that being overweight in comparison with normal weight was associated with a significantly higher risk of being diagnosed with hypertension (odds ratio [OR]= 3.429, p<0.001). Also, Smoking was associated with a significantly higher risk of hypertension (OR=1.483, p<0.01).

❖ When examining the association between the Systolic Blood Pressure (MMHg) and Diastolic Blood Pressure (MMHg), the least squares linear regression line revealed that there is a positive and significantly strong relationship between them (t=10.366, p<0.001), as every 1 MMHg increase in the Systolic BP results in a 0.61 MMHg increase in the Diastolic BP (Diastolic BP = 4.74+0.61*Systolic BP).

❖ When examining the association between the Diabetes status (whether or not has diagnosed with diabetes) and Body Mass Index (BMI) class (underweight, normal weight, and overweight), a chi-square test of independence revealed that there is a significant evidence of a strong relationship between them ($\chi 2(2)$=215.09, p<0.001).
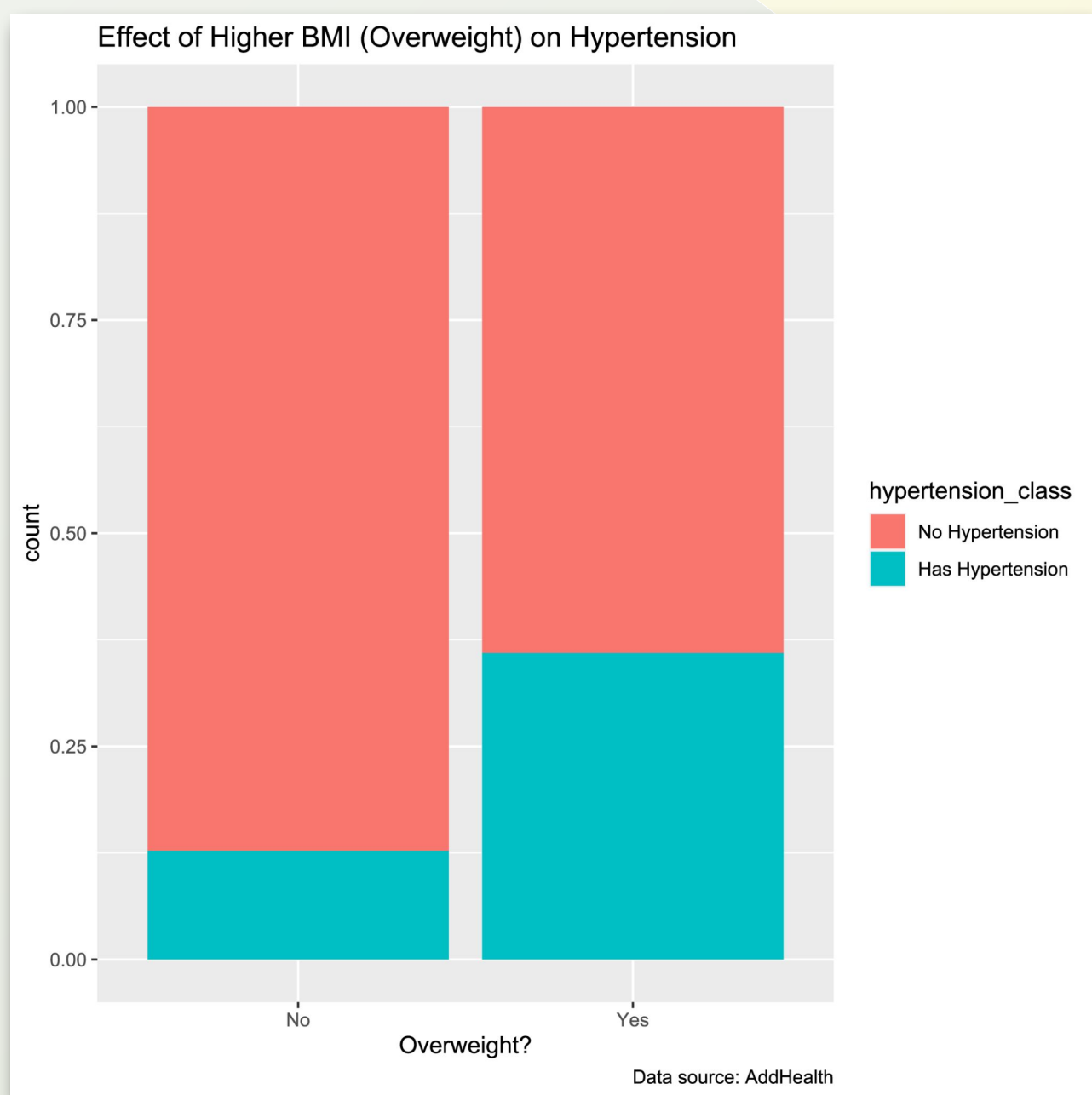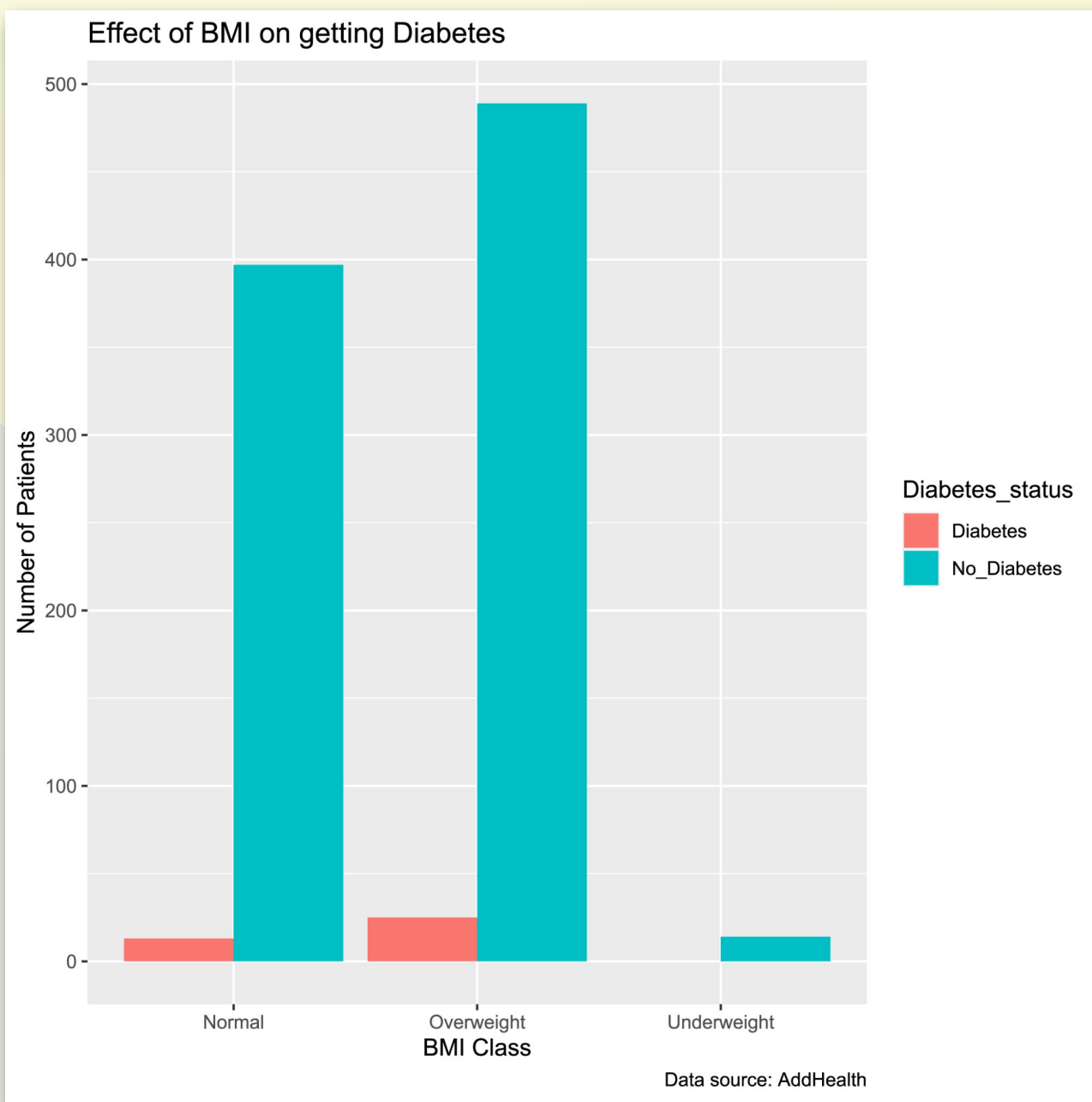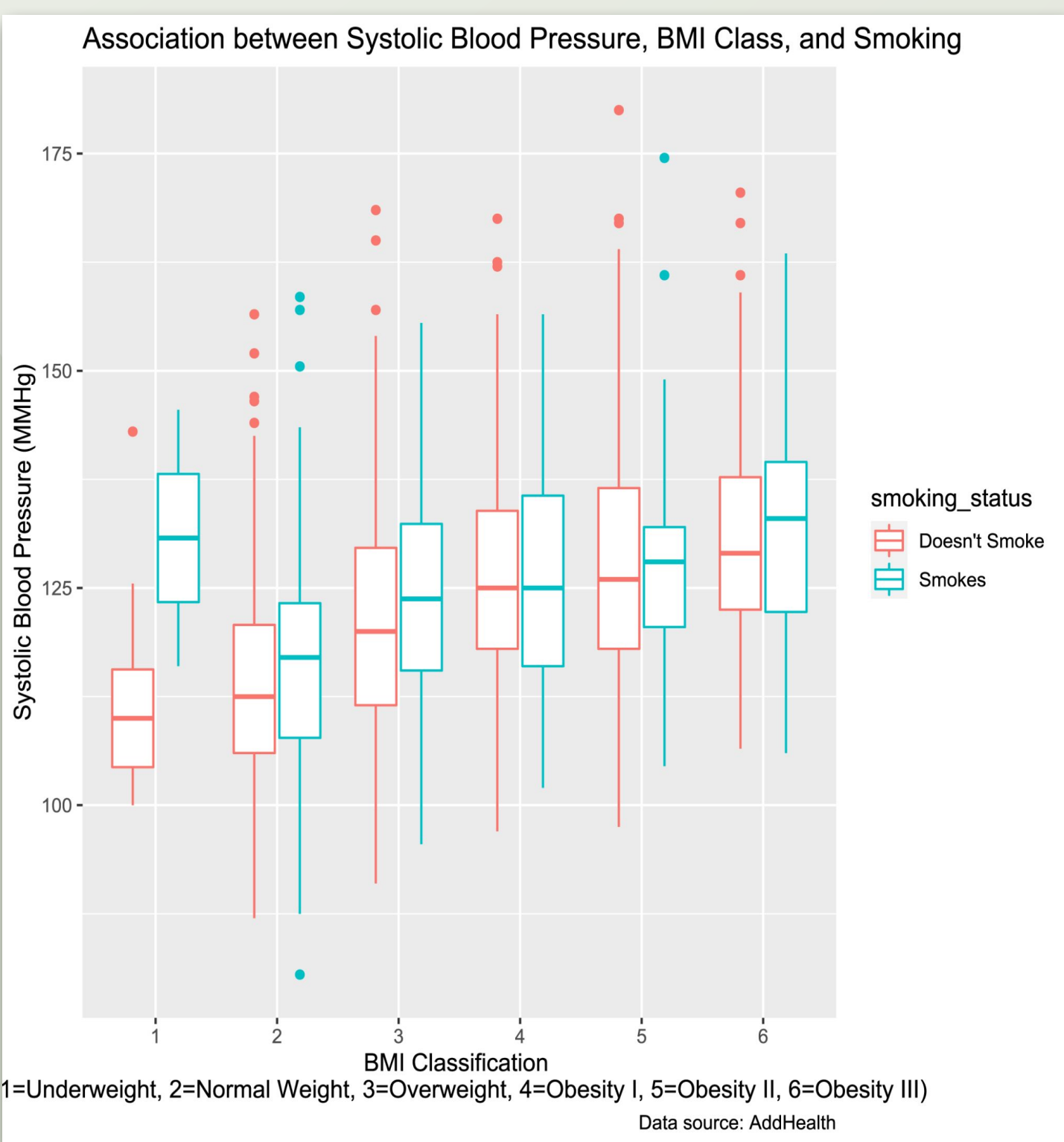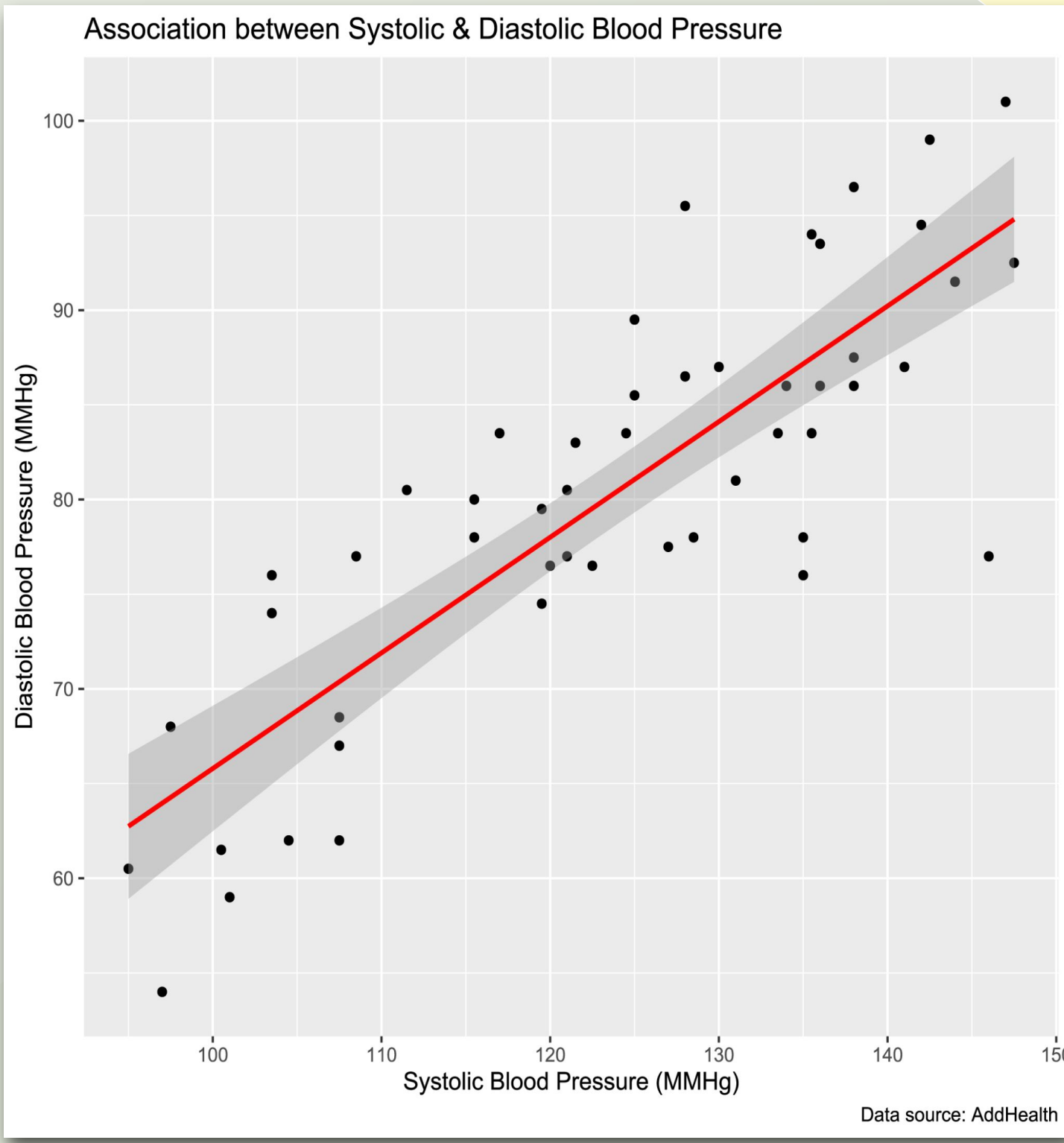

Figure 1

Figure 2

Figure 1

Figure 4

Weight	Normal W	Overweight	Underweight
No Diabetes	397	1158	14
Has Diabetes	13	130	0
No Hypertension	358	825	12
Has Hypertension	52	463	2

Table 1

Conclusions

In this large study of US young adults, lifetime risk of being diagnosed with Hypertension, Diabetes, and High Blood Pressure was signficantly high for all participants who were overweight and obese (BMI>=25). Although smoking, age and gender also have some effects on these diseases, their significance is lower compared to the effect of higher BMI on different health issues. However,the number of participants with underweight being only about 0.8% of the total population might cause not finding any significance relation with lower BMI.

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