DSC 230
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DOES HIGHER MEAN BMI LEAD TO A HIGHER RISK OF STROKE?

I. CONTEXT:

Individuals who are overweight have a high chance of having a stroke. This is because excess body weight leads to higher blood pressure which is the leading cause of stroke (Obesity and Stroke Fact Sheet, 1). If a person is obese, that risk increases by 64% (*STROKE RISK FACTORS: WEIGHT*, 2). Over long periods of time, obesity damages blood vessels to the heart and brain and raises the likelihood that a blood clot may develop and move to the brain, causing a stroke.

Knowing the risk of high BMI could negatively affect our health, our group decided to work on the topic for this project. When looking for a dataset to use, we decided to utilize Kaggle as it is a relatively well-known data library used by data scientists. As such, we used the Stroke Disease Prediction dataset from Kaggle to test if the mean BMI of a stroke patient is likely greater than 25 kg/m2 which is defined as overweight. The dataset has 5 qualitative variables (gender, ever_married, work_type, Residence type, smoking_status) and 6 quantitative variables (age, hypertension, heart_disease, avg_glucose_level, bmi, stroke). It includes 4981 data collections. To be more specific, we are going to test if the mean BMI of a stroke patient is greater than the mean BMI of a normal person - in other words, we are using normal patients as our control group. Based on this result, it will be clearer and more logical to draw a conclusion to our big question: “Does a greater mean BMI lead to a higher risk of stroke?” For additional support, we will construct a confidence interval to indicate our expected range of mean BMI of stroke patients.

Thanks to this project, we can learn that maintaining an unhealthy BMI could potentially lead to an increased risk of a stroke which is the second leading cause of death and the third leading cause of disability.

The range of BMI to consider:

Category	BMI range - kg/m^2
Severe Thinness	< 16
Moderate Thinness	16 - 17
Mild Thinness	17 - 18.5
Normal	18.5 - 25
Overweight	25 - 30
Obese Class I	30 - 35
Obese Class II	35 - 40
Obese Class III	> 40

Figure 1. Table displaying different BMI ranges and their associated classes of body fitness.

II. SUMMARY STATISTICS:

The dataset includes different variables:

gender	“Male” or “Female”
age	the age of a patient
hypertension	0 if the patient does not have hypertension, 1 if the patient has hypertension
heart_disease	0 if the patient does not have any heart diseases, 1 if the patient has heart disease
ever_married	"No" or "Yes"
work_type	“Private” or “Self-employed” or “Govt_job” or “children”

Residence_type	"Urban" or "Rural"
avg_glucose_level (mg/dL)	average glucose level in blood
bmi (kg/m^2)	body mass index
smoking_status	"never smoked" or "Unknown" or "formerly smoked" or "smokes"
stroke	1 if the patient has a stroke or 0 if not

III. TESTING:

+*Hypothesis test to find if the true mean BMI of stroke patients is > 25*:

- H_0: $\mu = 25$
- H_A: $\mu > 25$

⇒ p-value < `2.2e-16` which is much smaller than the significance level (α) of 0.05

⇒ We reject H_0. We can conclude that the true mean BMI of a stroke patient is greater than 25 which is considered overweight or obese.

+*Hypothesis test to find if mean BMI of the stroke patient > mean BMI of a normal patient*:

- H_0: $\mu_{stroke} = \mu_{normal}$
- H_A: $\mu_{stroke} > \mu_{normal}$

⇒ p-value = `1.491e-06` which is much smaller than the significance level (α) of 0.05

⇒ We reject H_0. We can conclude that the mean of the stroke patient is higher than the mean BMI of a person who does not have a stroke.

+*95 % Confidence Interval*: (`29.48,30.89`)

- We test the confidence interval to verify if the population mean is equal to a specific value by checking if that value falls within the interval
- We are 95% confident that the mean BMI of an individual who gets a stroke is between 29.48 kg/m^2 and 30.89 kg/m^2.

IV. ANALYSIS:

A. HYPOTHESIS TESTING

Our analysis question and hypotheses were meant to determine whether or not the average BMI of stroke patients indicates patients are overweight on average and if this is higher than the average BMI of normal patients (those who have not had a stroke).

For our first hypothesis test, we rejected the null hypothesis that the mean BMI of a stroke patient is 25. We can infer with 95% confidence from these results that the average stroke patient's BMI in our dataset is greater than 25 kg/m^2. This means we are 95% confident stroke patients, on average, are overweight or obese as defined by the CDC (*Defining Adult Overweight & Obesity*).

In our second hypothesis test, we also rejected our null hypothesis stating that the mean BMI of stroke patients was equal to that of normal patients. With these results, we are inferring with 95% confidence that the average stroke patient has a greater BMI than the average normal patient - meaning stroke patients, on average, are more likely to have a higher BMI than normal patients.

This matches up with the 95% confidence interval we constructed for the mean BMI of an individual patient who has had a stroke. We are 95% confident that the mean BMI of a patient will occur between 29.48 kg/m^2 and 30.89 kg/m^2, placing them at either highly overweight or lowly obese.

From these results, we can conclude that there is statistically significant evidence for the connection between average stroke patients and their likelihood of having an elevated BMI.

B. LINEAR REGRESSION PLOT

We also chose to weigh the effects of high average blood glucose on BMI in all patients. We chose the glucose level variable to create the linear regression for BMI because high blood glucose is one of the three main risk factors for stroke. When blood glucose increases, BMI may increase, causing damage to the blood vessels of the brain and the heart. Looking at our line of

best fit in Figure 2 below, we can observe that a higher average glucose level indicates a higher mean BMI for patients.

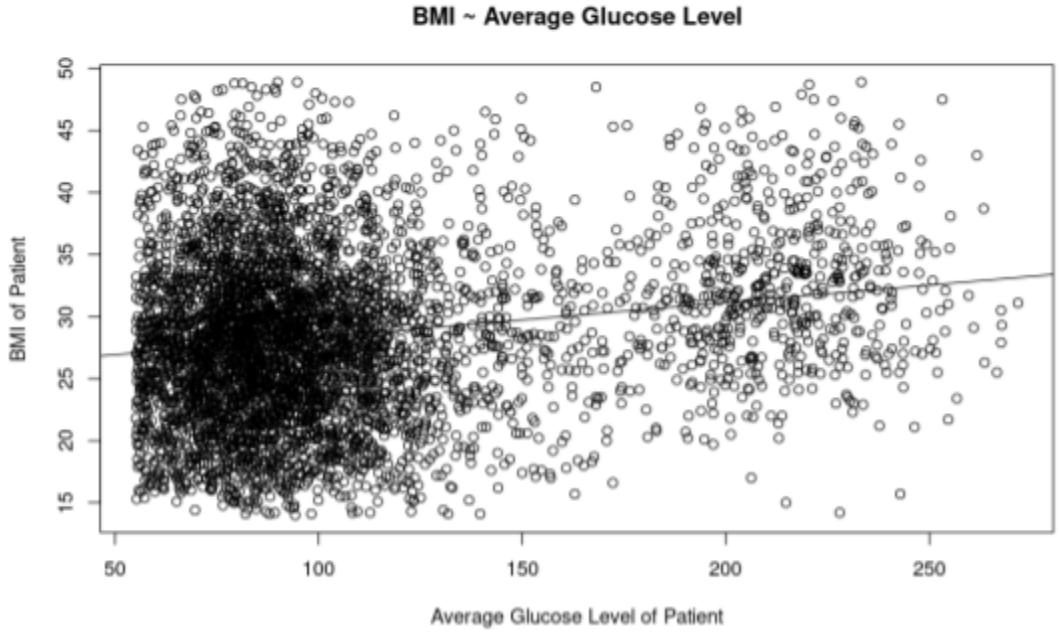

Figure 2. BMI as a function of average glucose level in our data population. Each circle represents a patient included within our dataset and compares their BMI versus their average blood glucose level. n = 4981

V. CONCLUSION:

We can conclude from our testing that a higher mean BMI can lead to a higher risk of stroke. There is a major association between BMI and stroke. A high BMI may be caused by high average glucose levels in individuals. When BMI is greater than 25 (overweight or obese), inflammation is likely to occur, which causes poor blood flow. Therefore, the heart exerts heightened levels of force to pump blood throughout the body. Our testing of the different patient groups - stroke and normal patients - shows that the increase in mean BMI is indicative of the risk of stroke. One thing we learned from this project is that maintaining a healthy BMI is a good way to minimize the possibility of a stroke. That said, our study did have limitations - our dataset was not very well described on the site it was retrieved from, so we cannot determine if the data is from a region like the United States or elsewhere.

Works Cited

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