Stat251 Final Project

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Introduction

Alzheimer's is a brain disease where cells degenerate and cause memory loss. 40 million people worldwide suffer from this disease and a cure does not exist. Although there is no definitive cause of Alzheimer's, scientists speculate that genetics, aging, and environmental influences may affect the probability of developing the disease. Some specialists have found that the larger the brain, the more the brain may combat against the effects of cognitive atrophy. The total intracranial volume (TIV) is a way to quantify the size of the brain. TIV includes the volume of the cranium, brain, and spinal fluid. To discover how brain size relates to Alzheimer's, we will investigate the average TIV for patients 60 years and older of those with and without the disease. The parameter of interest is the average TIV for demented and non-demented patients.

Methods

Figure 1 is a plot of the TIV values for demented and non-demented groups. We see that these values have a uniform and bell-shaped distribution therefore, we use a normal distribution with parameters μ and σ^2 as the likelihood to model our data. The likelihood of our model is also listed below.

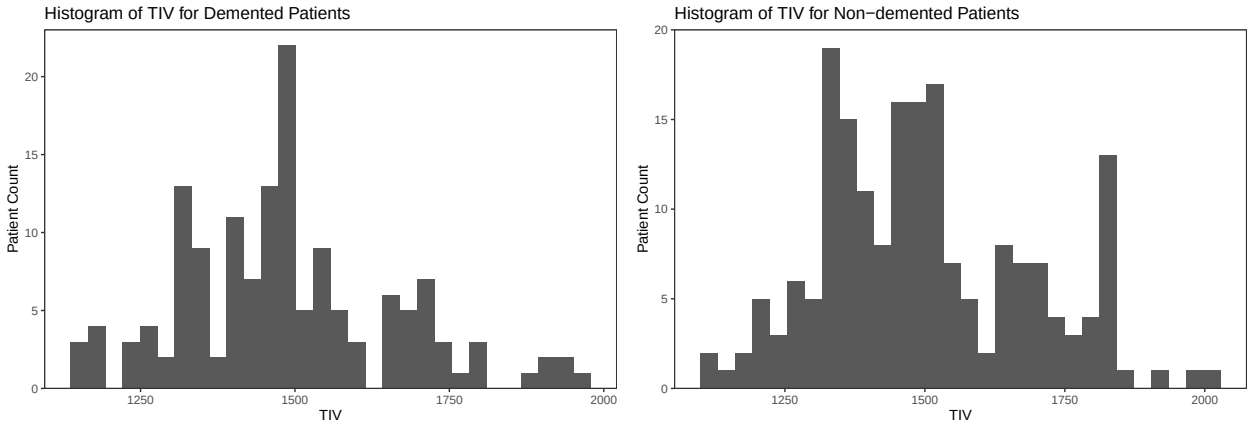

Figure 1: Histograms of TIV for Alzheimers patients.

$x_i|\mu, \sigma^2 \sim N(\mu, \sigma^2),\ i = 1, ...n$

We assume that the prior parameter μ which represents that average TIV for both populations, is normally distributed. We also assume that the variance denoted by σ^2 follows an inverse gamma distribution because the variance of TIV for both populations is positive and right-skewed. The distributions of the prior distributions for our parameters are listed below. We assume the prior distributions for both the demented (D) and non-demented (N) populations to be the same.

Prior distribution for demented population

$$\mu_D \sim N(\lambda, \tau^2)$$

$$\sigma_D \sim IG(\gamma, \phi)$$

Prior distribution for non-demented population

$$\mu_N \sim N(\lambda, \tau^2)$$

$$\sigma_N \sim IG(\gamma, \phi)$$

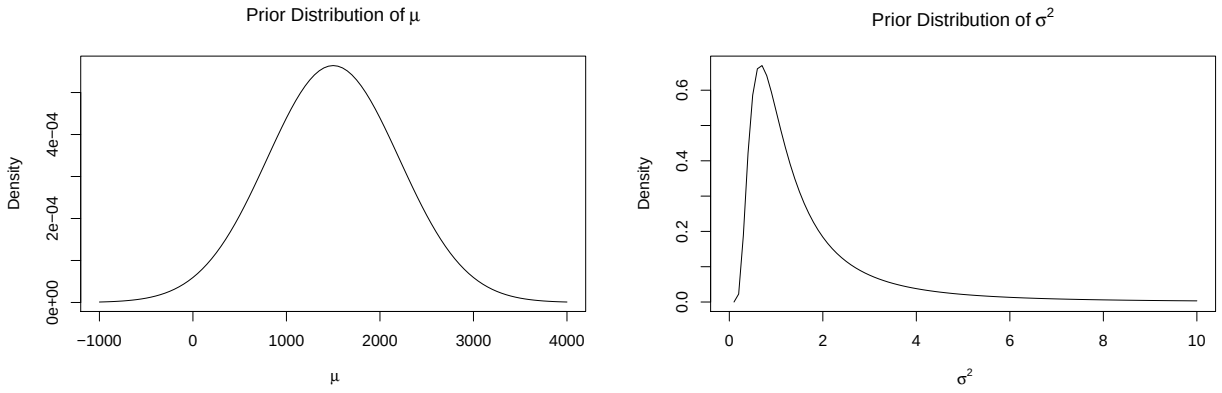

Figure 2: Prior distribution for the TIV measurement for a randomly selected patient.

In order to investigate this question, we analyzed a dataset taken from Kaggle that includes data from a sampled set of patients 60 years and older. Metrics collected on these individuals include whether they have Alzheimer's (our response variable), gender, age, education level, TIV measurements (our explanatory variable), and other physiological characteristics. The outcome variable of interest is whether the patient is demented or non-demented.

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Table 1: Patient TIV Summary Statistics

	Demented	Non-Demented
Min	1143	1106
Q1	1357	1358
Median	1476	1474
Mean	1485	1495
Q3	1566	1634
Max	1957	2004

Results

Because of our likelihood and prior distributions, we can approximate a posterior distribution for both populations μ and σ^2 with Gibbs sampling.

The mean and variance of our posterior distribution for demented patients are 1485.7665 and 2.9704186×10^4 respectively.

The mean and variance of our posterior distribution for demented patients are 1495.2329 and 3.3760544×10^4 respectively.

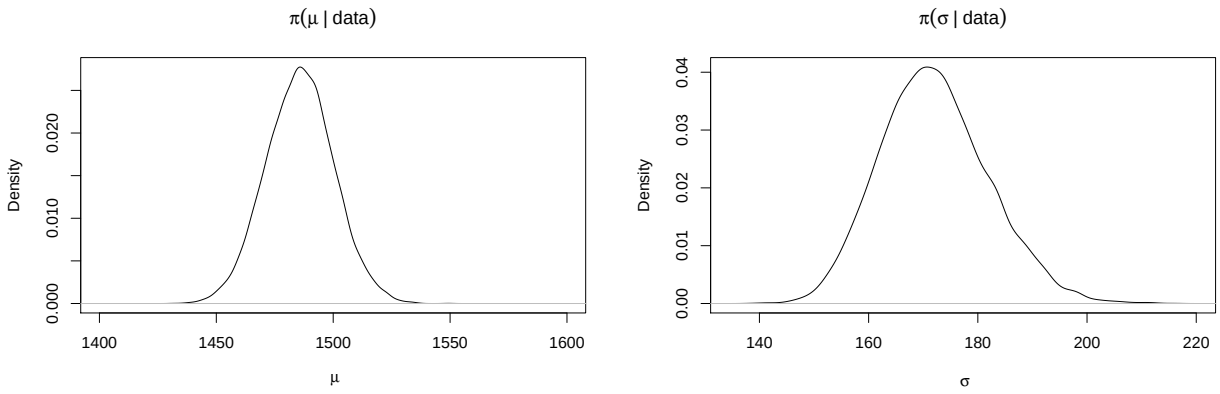

Figure 3: Posterior distribution for average the TIV measurement of a patient with Alzheimers.

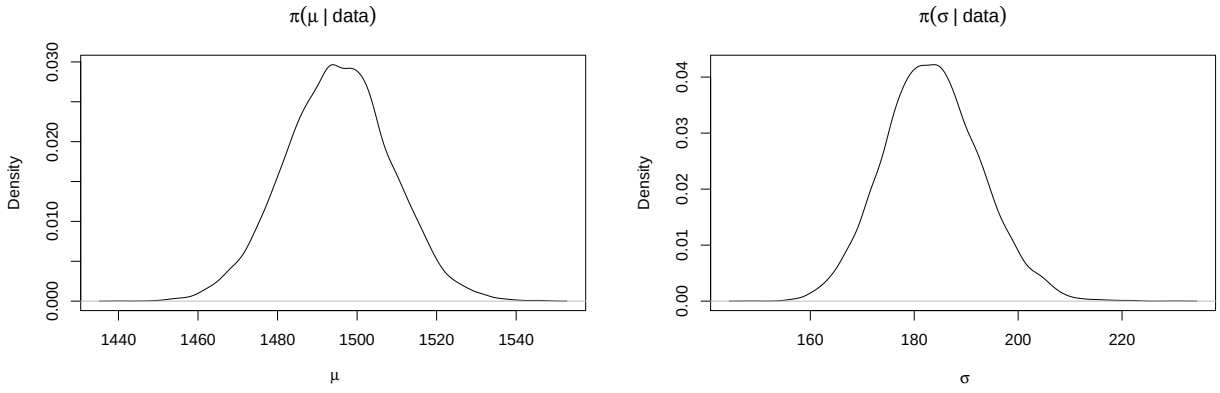

Figure 4: Posterior distribution for average the TIV measurement of a patient without Alzheimers.

We conducted this analysis because we wanted to understand if there was a difference between average TIV measurements of patients with and without Alzheimer's. In the plot below (posterior distribution of the difference in means), we see that the average TIV difference (Demented - Nondemented) is -9.466. This means that on average, the non-demented patients have 9.466 cmˆ3 more total intracranial volume than demented patients. This confirms our hunch that Alzheimer's erodes away brain matter. The 95% credible interval of this distribution is between -47.7 and 28.8. Because this credible interval contains zero, we conclude that these results are not significant.

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## [1] -9.466401
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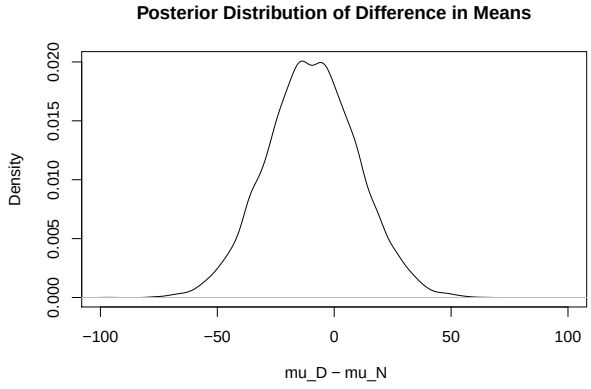

Figure 5: Posterior distribution for the difference in average TIV measurements between patients with and without Alzheimers.