Final Project - Alzheimer's Disease

Michael Paris

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Introduction

Dementia is defined as a decline in mental ability severe enough to interfere with daily life. Alzheimer's is a degenerative brain disease that is caused by complex brain changes following cell damage. It leads to dementia symptoms that gradually worsen over time. ("Dementia Vs. Alzheimer's Disease: What Is the Difference?" n.d.) Two of my grandparents died with several of the signs of dementia but never had a diagnosis of Alzheimer's disease.

In this analysis, we'll discuss several research questions and attempt to glean some incites from the data.

- What are the main risk factors for developing this disease?
- Are there any secondary risk factors?
- Is Alzheimer's disease becoming more common?
- Is it possible to predict who might develop this disease?

To answer these questions, we'll perform an analysis of the data to determine the significant correlation between risk factors to determine which factors may be considered major versus minor. If the data is available, a similar approach will be taken to determine if there is a correlation within families. To determine if different ethnicities are more or less at risk, analyzing positive cases as a percent of the total ethnic population will be reviewed.

To determine if the disease is becoming more common, I plan to plot the positive diagnosis numbers against the general population over time to see if variables are increasing at similar rates or if they are not connected. With the information above, we may be able to show which groups are more at risk of developing the disease.

Datasets

The datasets we will analyze are listed below:

- Weekly counts of death by jurisdiction and cause of death ** Center for Disease Control ** https://healthdata.gov/dataset/weekly-counts-death-jurisdiction-and-cause-death ** Updated February 17, 2021 ** 334K records, 15 columns
- Population, Population Change, and Estimated Components of Population Change: April 1, 2010 to July 1, 2019 (NST-EST2019-alldata) ** United States Census Bureau

** https://www2.census.gov/programs-surveys/popest/datasets/2010-2019/national/totals/nst-est2019-alldata.csv

- ACS Demographic and Housing Estimates ** United States Census Bureau ** https://data.census.gov/cedsci/table?q=demographics&tid=ACSDP1Y2019.DP05&hidePreview=false
- Alzheimer's Disease and Healthy Aging Data ** Center for Disease Control ** https://healthdata.gov/dataset/alzheimers-disease-and-healthy-aging-data ** Updated January 20, 2021 ** 144k records, 39 columns
- Oasis MRI Demographics Data ** Oasis ** https://www.oasis-brains.org/

Data Cleanup

For the weekly count of death by jurisdiction and cause of death, we have performed several operations on the dataset. In the first step in the cleanup, we removed rows that contained estimated deaths for a specific period while keeping the rows of actual death data. In step two, we combined weekly data into a single row representing each year.

	Year	Cause.Group	Cause.Subgroup	Number.of.Deaths
1	2015	Alzheimer disease and dementia	Alzheimer disease and dementia	489139
14	2016	Alzheimer disease and dementia	Alzheimer disease and dementia	497457
27	2017	Alzheimer disease and dementia	Alzheimer disease and dementia	523662
40	2018	Alzheimer disease and dementia	Alzheimer disease and dementia	533988
53	2019	Alzheimer disease and dementia	Alzheimer disease and dementia	543350
66	2020	Alzheimer disease and dementia	Alzheimer disease and dementia	613544

For the population dataset, we reduced the number of columns to match the same years for the death data. Years 2015 through 2019. We removed data for the year 2020 as it was only a partial year's worth of data.

Year	Population
2015	320635163
2016	322941311
2017	324985539
2018	326687501

2019 328239523

2020 331002651

For the Oasis data, several of the columns needed to be changed from character over to factors including columns such as Male/Female and Group. Columns that were not pertinent to the analysis were also removed. These columns included hand, subject.id, and MRI.Id. The column hand was removed as all of the patients in the dataset were right-handed.

Subject.ID	MRI.ID	Group	Visit	M.F	Hand	Age	EDUC	SES	MMSE	CDR	eTIV	nWBV	ASF
OAS2_0001	OAS2_0001_MR1	Nondemented	1	M	R	87	14	2	27	0	1987	0.696	0.883
OAS2_0001	OAS2_0001_MR2	Nondemented	2	M	R	88	14	2	30	0	2004	0.681	0.876
OAS2_0002	OAS2_0002_MR1	Demented	1	M	R	75	12	2	23	0.5	1678	0.736	1.046
OAS2_0002	OAS2_0002_MR2	Demented	2	M	R	76	12	2	28	0.5	1738	0.713	1.010
OAS2_0002	OAS2_0002_MR3	Demented	3	M	R	80	12	2	22	0.5	1698	0.701	1.034
OAS2_0004	OAS2_0004_MR1	Nondemented	1	F	R	88	18	3	28	0	1215	0.710	1.444

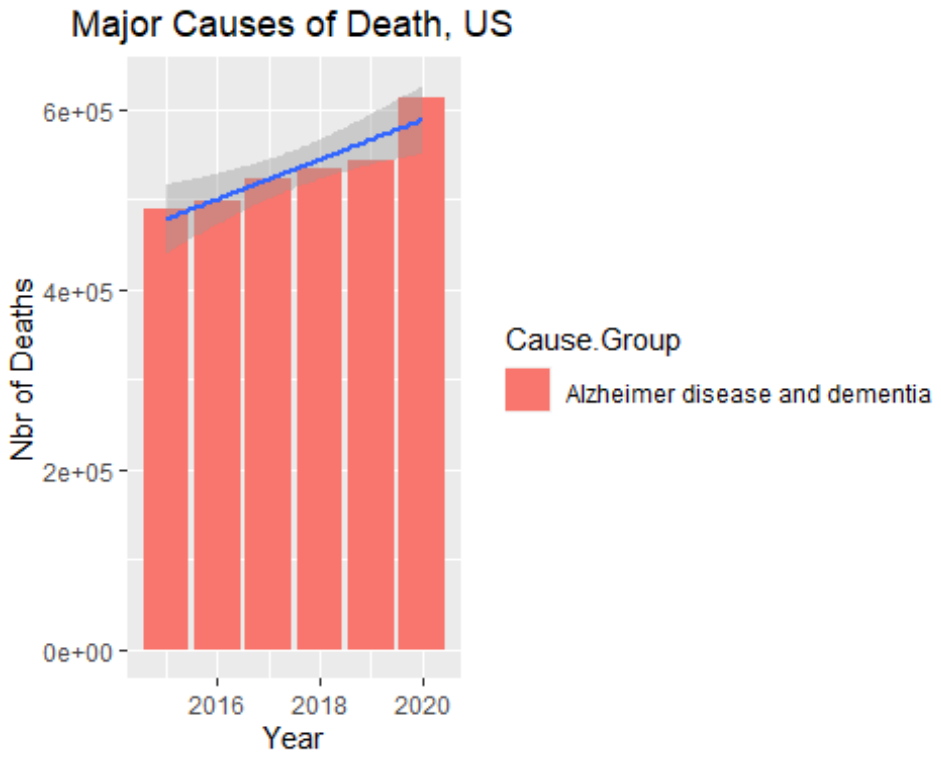
Group Non-Demented, Demented
EDUC Years of education SES Socioeconomic Status MMSE Mini Mental State Examination CDR Clinical Dementia Rating eTIV Estimated Total Intracranial Volume nWBV Normalize Whole Brain Volume ASF Atlas Scaling Factor

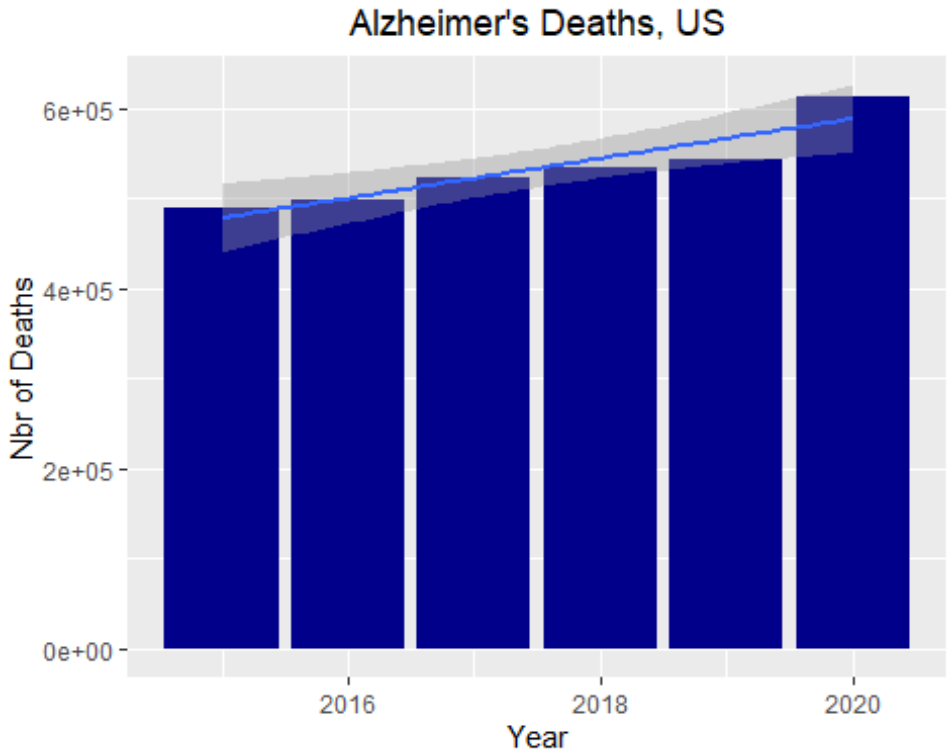
Technical Libraries

These are the libraries used in the analysis.

- library(bibtex) Package used to create bibliographies
- library(ggplot2) Package used to create graphics
- library(dplyr) Package used for data manipulation
- library(caTools) Package containing utility functions

Graphs

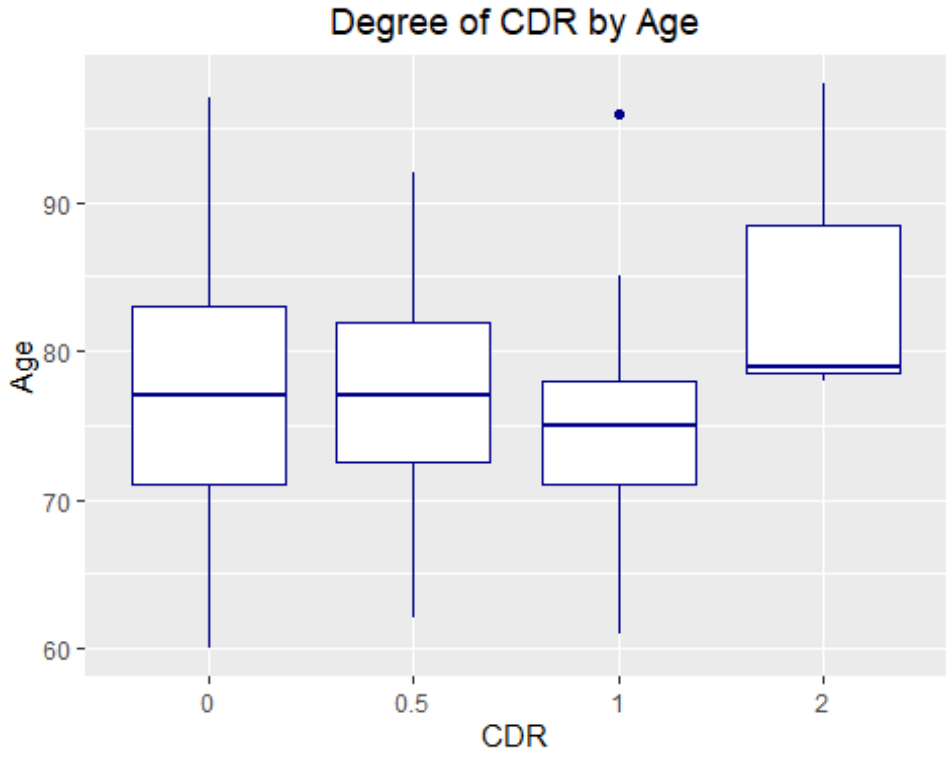

Major Causes of Death, US
6e+05
4e+05
2e+05
0e+00
Nbr of Deaths
2016
2018
2020
Year
Cause.Group
Alzheimer disease and dementia


Alzheimer's Deaths, US
6e+05
4e+05
2e+05
0e+00
Nbr of Deaths
2016
2018
2020
Year

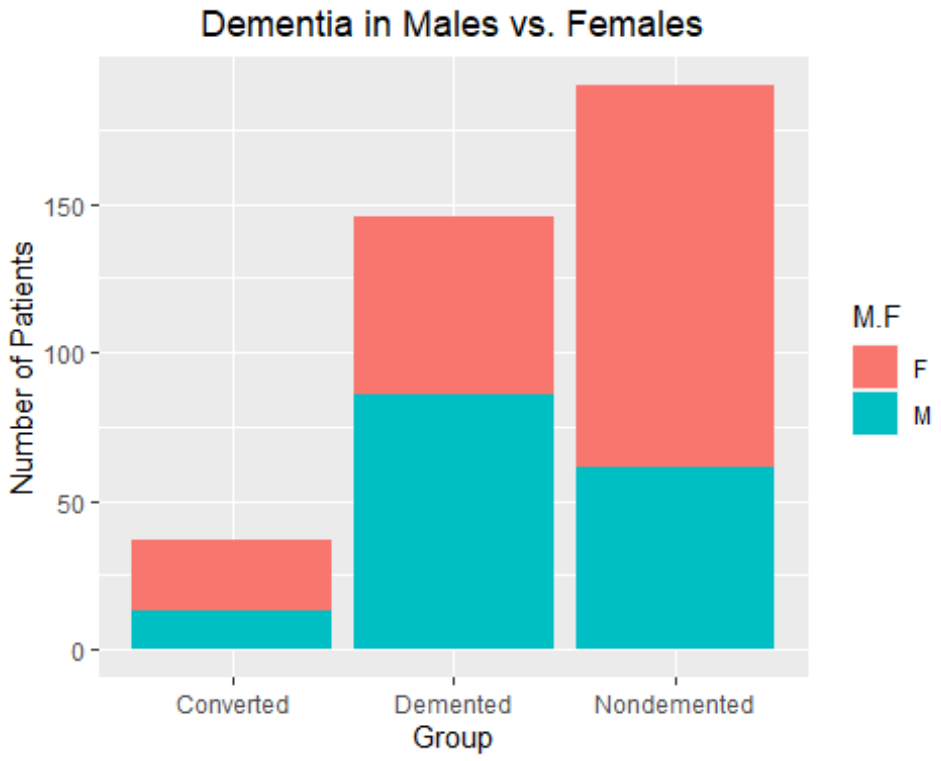
From 2015 through 2019, there has been an increase in deaths from Alzheimer's disease of just over 25%. Over the same period, the population of the United States grew at a rate of just over 3%. Does this by itself suggest that instances of Alzheimer's are increasing or could it indicate that doctors can diagnose the disease with more accuracy?

I believe the Oasis MRI dataset is the most interesting of the group, so we'll spend some time analyzing it.

We can see the average age for each degree of the CDR Scoring table is relatively close, but there is a definite difference in the median age relative to the interquartile range.



From the Oasis MRI dataset, we can see that more men than women were afflicted with the disease.



Modeling the Oasis Data

```
Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred


Call:
glm(formula = diagnosis ~ m_f + age + educ + ses + mmse + CDR +
    eTIV + nWBV + ASF, family = "binomial")

Deviance Residuals:
     Min        1Q    Median        3Q       Max
-2.98272   0.05529   0.24088   0.43144   1.29609

Coefficients:
             Estimate Std. Error z value Pr(>|z|)
(Intercept)  -49.69218   36.68907  -1.354 0.175604
m_fM           0.02569    0.59303   0.043 0.965444
age           -0.08002    0.03531  -2.266 0.023454 *
educ           0.14144    0.10230   1.383 0.166792
ses2           2.28273    0.61998   3.682 0.000231 ***
ses3           2.37507    0.66684   3.562 0.000368 ***
ses4           3.66705    1.06637   3.439 0.000584 ***
ses5          19.43175 3768.61537   0.005 0.995886
mmse          -0.30330    0.13766  -2.203 0.027573 *
CDR0.5        -1.59969    0.51661  -3.096 0.001958 **
CDR1          15.37247 1378.60065   0.011 0.991103
```

```
CDR2          16.16303 5501.45980   0.003 0.997656
eTIV           0.02445    0.01244   1.966 0.049300 *
nWBV          -6.48180    7.96640  -0.814 0.415850
ASF           26.81757   15.06294   1.780 0.075016 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 241.19  on 372  degrees of freedom
Residual deviance: 177.89  on 358  degrees of freedom
AIC: 207.89

Number of Fisher Scoring iterations: 18
```

From the summary of the model's fit, we can see that there are two statistically significant variables: Socioeconomic status (ses) and Mini-Mental State Examination (mmse). Socioeconomic status (ses) was really surprising to me that it had such a high level of significance. What would drive this variable to be significant? This finding would suggest that additional study around this variable would be warranted. Could it be a lack of regular medical care, diet, or other factors such as smoking?

"Dementia Vs. Alzheimer's Disease: What Is the Difference?" n.d. *Alzheimer's Disease and Dementia*. Alzheimer's Association. https://www.alz.org/alzheimers-dementia/difference-between-dementia-and-alzheimer-s.