

MRI-based prediction of dementia with regression and survival analysis

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Dementia is not a specific disease but is rather a general term for the impaired ability to remember, think, or make decisions that interferes with doing everyday activities.

-- Centers for Disease Control and Prevention (CDC)

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Why Dementia?

- Dementia is a **major source of disease burden** in the United States
- Of those at least 65 years of age, there are an estimated 5 million adults with dementia in 2014 and projected to be **nearly 14 million by 2060**
- Up to 40% of dementia cases **may be delayed or prevented**



What Causes Dementia?

- Dementia is caused by damage or loss of nerve cells and their connections in the brain
- Other risk factors include:
 - Age
 - Sex
 - Education level
 - Family history
 - Smoking and alcohol use
 - ...



Are MRI-based measures predictive of the diagnosis and worsening of dementia, and how does personal risk factors contribute?



Potential Predictors

MRI-based

- Normalized whole-brain volume (nWBV)

Personal

- Sex
- Age



Based on longitudinal data, which were collected from the Open Access Series of Imaging Studies (OASIS), of 150 subjects aged 60 to 96, each of which was scanned for MRI on two or more visits



Statistical Analysis Methods

1

Linear regression



informs

Logistic regression

investigated the association between **nWBV** and **age**

predicted **dementia** (0 = not demented, 1 = demented) with **nWBV**

took into consideration **quadratic age** / **sex** as potential confounders / effect modifiers



Statistical Analysis Methods

2

Survival Analysis

performed survival analysis to find how a low / high level of **nWBV** is related to the **worsening of dementia** (0 = not worsened, 1 = worsened) over the observation period



Results

Logistic Model:

$$\log\left(\frac{\hat{p}}{1 - \hat{p}}\right) = 19.08 - 23.10nWBV + 0.5469Male - 0.00041Age^2$$

The group with a **1% increase** in normalized whole-brain volume (**nWBV**) has **an odds of having dementia** estimated **0.79 times** the odds for population at the baseline, on average, after adjusting for **quadratic age** and **sex**.



Results

Cox Proportional Hazard Model:

$$\frac{h(t|nWBV \geq 0.7125)}{h(t|nWBV < 0.7125)} = e^{-0.9643}$$

The hazards of **worsened dementia** for the group with **nWBV greater or equal to 0.7125** is **0.38 times** the hazards for the group with **nWBV lower than 0.7125**, on average.



Discussion

Our research question:

Are MRI-based measures predictive of the diagnosis and worsening of dementia, and how do personal risk factors contribute?

- **Yes, nWBV is predictive of both the diagnosis and worsening of dementia.**
- **Quadratic age and sex confound the association between dementia with nWBV.**



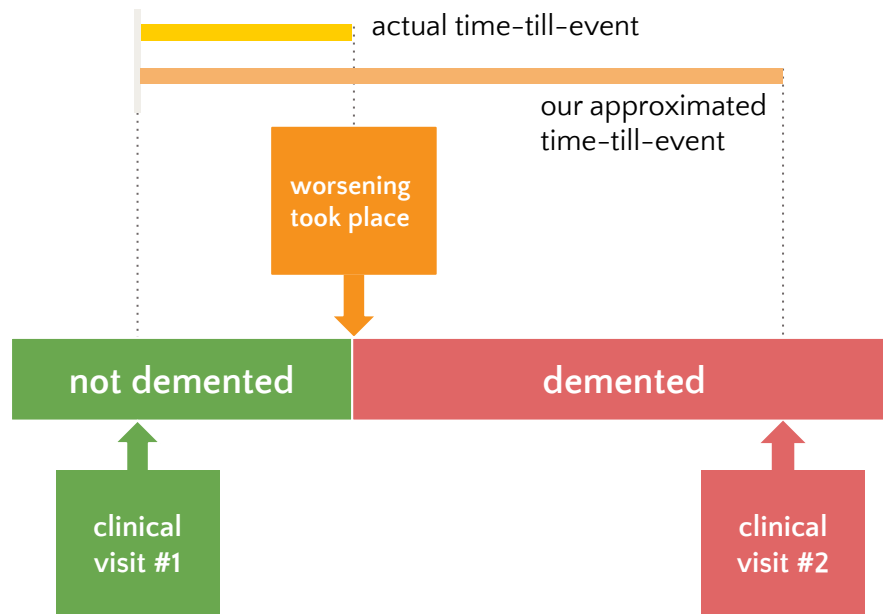
Limitations

- **High rate of right censor**
 - Many individuals were not observed until they had worsened dementia
 - The dataset had a censor rate of 80%
 - This could impact the accuracy and effectiveness of the survival analysis



Limitations

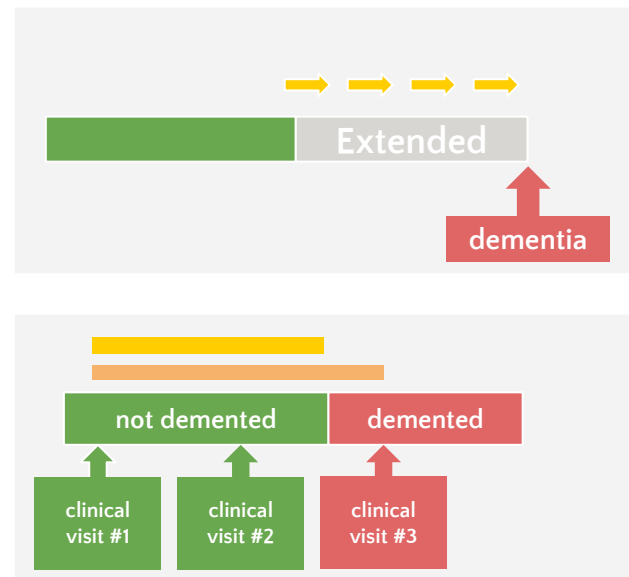
- **Time data lacks precision**
 - No direct measure of time points available
 - We approximated the time when the dementia deterioration occurred with the time of the next visit





Future Scope

- To extend the observation period and collect more data from each individual to provide a complete picture of dementia progression
- To encourage patients to visit more frequently and to collect the exact date of each visit





Conclusion

MRI-based measures are predictive of dementia.

We suggest seniors with suspected symptoms seek early medical attention and undergo an MRI to screen for the risk of dementia.

We suggest that the demented undergo MRI on a regular basis to track the progression of the disease.





Thanks!

Any questions ?

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