Objective

- Focus on the baseline observations

Aim I: **Framinghan score** vs. **MoCA score**

By constructing a summary of modifiable vascular risk factors using the Framingham score, find out whether individuals with high Framingham score have greater cognitive impairment reflected by MoCA score in PD and control group.

Aim II: **Vascular risk factors** vs. **MoCA score**

Identify the relationship between vascular risk factors (hypertension, obesity and smoking) and cognitive impairment.

Data Overview

Variable: 16 variables (29 in total), include

ID, age, PD/control, gender, race, education, ever smoke, depression score (D score), motor score, height, weight, average systolic blood pressure (SBP), average diastolic blood pressure (DBP), hypertension medication, diabetes, MoCA score.

Observation: 1177 observations (2961 in total), exclude

- 168 atypical parkinsonism syndromes patients;
- 96 observations from University of Florida (Gainesville) without height and weight information;
- 1362 visits other than baseline;
- 158 uncompleted cases.

Check missing

- Variables with at least 100 missings

D score	Height	Weight	SBP	DBP	Medication	Diabetes
259	250	235	166	166	158	158

- MoCA score

	Mean	Median	Number
Missing D score	24.44	26	259
Not missing D score	25.69	26	2638
Missing height	24.29	26	250
Not missing height	25.70	26	2647
Missing SBP	26.28	27	166
Not missing SBP	25.53	26	2731
Missing diabetes	21.69	23	158
Not missing diabetes	25.80	26	2739

Descriptive analysis

	MoCA < 20	MoCA 20 - 25	MoCA > 25
Number	61	420	690

Categorical

- Binary:

	MoCA$<$20	MoCA20-25	MoCA$>$25
PD (=1 proportion)	0.902	0.700	0.543
Female	0.213	0.371	0.525
Ever smoke	0.443	0.419	0.380
Medication	0.459	0.324	0.216
Diabetes	0.115	0.060	0.051

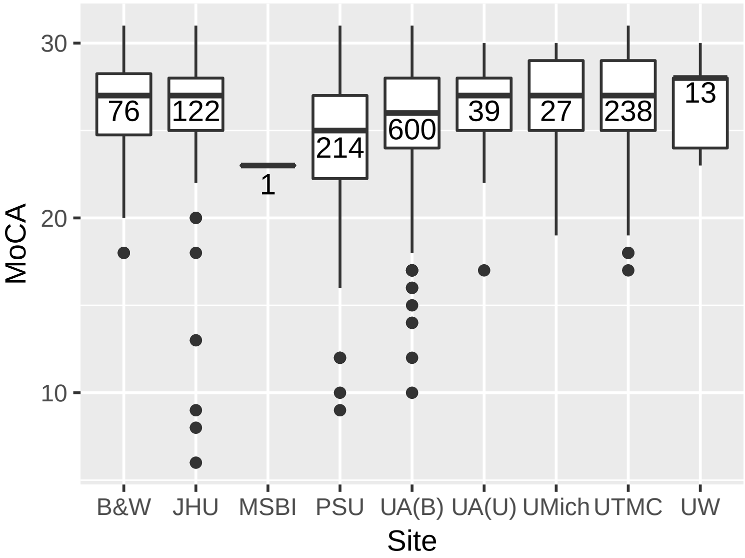
- Others: race ($>$90 Caucasian in each), edu

Descriptive analysis (Continued)

Continuous variables

	MoCA<20	MoCA20-25	MoCA>25
Age (median, SD)	(71,7.27)	(67.92,9.56)	(63.08,9.89)
Height	(178,10.23)	(173,10.13)	(170,10.09)
Weight	(83.9,19.56)	(81.6,18.55)	(79.4,19.33)
D score	(4,5.69)	(3,3.57)	(3,3.65)
Motor score	(31,20.06)	(19,15.7)	(9,13.91)
SBP	(135,24.62)	(132,18.83)	(130,18.12)
DBP	(78,10.85)	(79,10.31)	(79,10.41)
MoCA	(18,2.98)	(24,1.49)	(28,1.32)

Site influence



Regression Analysis (Aim 1)

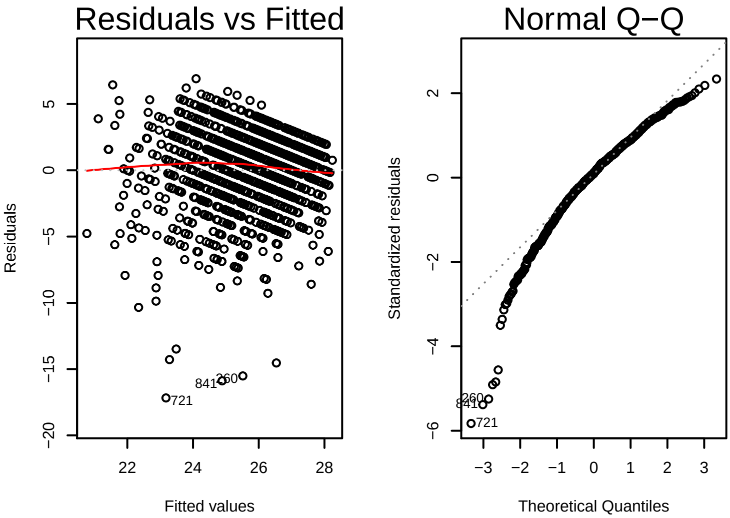
Aim I: **Framinghan score** vs. **MoCA score**

	Estimate	95%CI	P-value
(Intercept)	26.63	[26.09, 27.17]	<0.01
Framingham score	-0.45	[-0.54, -0.37]	<0.01
PD	-0.79	[-1.15, -0.42]	<0.01
Associate degree	0.48	[-0.07, 1.02]	0.09
Bachelors	1.59	[1.06, 2.11]	<0.01
Professional degree	1.68	[1.15, 2.21]	<0.01
Depression Score	-0.11	[-0.16, -0.06]	<0.01

Interaction term - education level with PD/Control

	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	27.03	0.37	72.24	<0.01
Framingham score	-0.45	0.04	-10.21	<0.01
Associate degree	0.48	0.45	1.06	0.29
Bachelors	0.90	0.43	2.11	0.04
Professional degree	0.97	0.44	2.21	0.03
PD	-1.45	0.44	-3.27	<0.01
Depression Score	-0.11	0.02	-4.57	<0.01
Associate degree :PD	0.00	0.57	-0.01	0.99
Bachelors : PD	1.11	0.55	2.04	0.04
Professional degree: PD	1.13	0.55	2.05	0.04

Model Diagnosis (Aim 1)



Multinomial Logistic Regression (Aim 1)

Table 3: Multinomial Logistic Regression Results for Aim 1

	D	95%CI	pval1	MCI	95%CI	pval2
Intercept	0.01	[0, 0.03]	$<$0.01	0.32	[0.22, 0.49]	$<$0.01
Framingham score	1.55	[1.37, 1.77]	$<$0.01	1.27	[1.19, 1.37]	$<$0.01
PD	5.21	[2.15, 12.69]	$<$0.01	1.75	[1.33, 2.31]	$<$0.01
Associate degree	0.68	[0.33, 1.39]	0.29	1.01	[0.68, 1.5]	0.98
Bachelors	0.18	[0.08, 0.42]	$<$0.01	0.51	[0.34, 0.75]	$<$0.01
Professional degree	0.19	[0.08, 0.42]	$<$0.01	0.46	[0.31, 0.68]	$<$0.01
Depression Score	1.11	[1.04, 1.17]	$<$0.01	1.01	[0.98, 1.05]	0.45

Model Selection

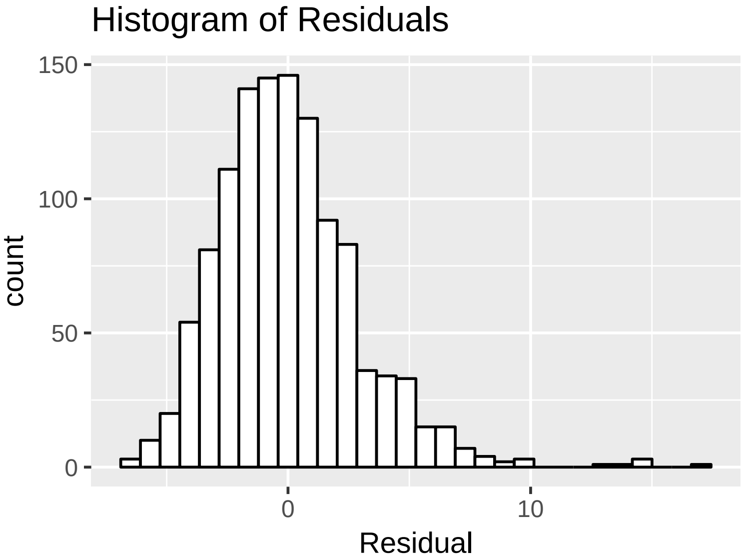
Method: Likelihood Ratio Test

- Start from the model including all covariates
- Delete one variable at each time and compare the current model with the model from last step by using likelihood ratio test
- If p-value < 0.05, there is evidence against the current model in favor of the model containing one more covariate

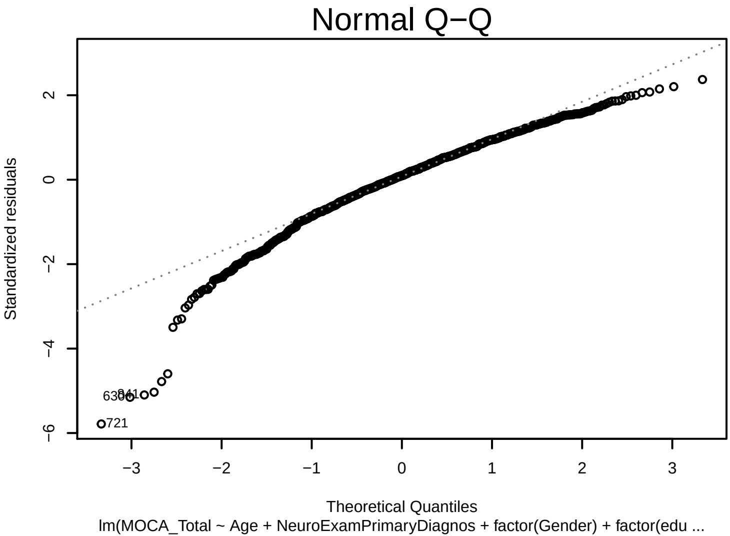
Regression Analysis (Aim 2)

	Estimate	95%CI	P-value
(Intercept)	30.17	[28.96, 31.38]	<0.01
Age	-0.09	[-0.1, -0.07]	<0.01
PD	-0.63	[-1, -0.27]	<0.01
Female	1.27	[0.92, 1.61]	<0.01
Edu: Associate degree	0.46	[-0.07, 0.99]	0.09
Edu: Bachelors	1.74	[1.23, 2.26]	<0.01
Edu: Professional degree	1.95	[1.43, 2.46]	<0.01
Depression Score	-0.11	[-0.16, -0.07]	<0.01

Model Diagnosis (Aim 2)



Model Diagnosis (Continued)



Results

- A person with Parkinson disease has MoCA score 0.69 units higher than a person without Parkinson disease (which means the person with Parkinson has better cognition).
- For each unit increase in BMI, the MoCA score increases by 0.03 (which means the person has better cognition as BMI increases).
- For each year increase in age, the MoCA score decreases by 0.007 (which means the person's cognitive impairment gets worse as age increases).
- Female's MoCA score is 1.14 units higher than male's MoCA score when other variables are controlled.
- A person with higher education tends to have higher MoCA socre. For example, a person with professional degree has MoCA score 2.68 units higher than a person with less than 12th grade degree.

Multinomial Logistic Regression (Aim 2)

Table 4: Multinomial Logistic Regression Results for Aim 2

	D	95%CI	pval1	MCI	95%CI	pval2
Intercept	0	[0, 0]	<0.01	0.02	[0.01, 0.06]	<0.01
PD	4.95	[2.02, 12.21]	<0.01	1.68	[1.26, 2.22]	<0.01
Age	1.14	[1.09, 1.18]	<0.01	1.06	[1.04, 1.08]	<0.01
Female	0.21	[0.1, 0.42]	<0.01	0.52	[0.39, 0.68]	<0.01
Associate degree	0.76	[0.36, 1.6]	0.46	1.03	[0.69, 1.56]	0.87
Bachelors	0.15	[0.06, 0.36]	<0.01	0.45	[0.3, 0.67]	<0.01
Professional degree	0.13	[0.06, 0.31]	<0.01	0.38	[0.25, 0.57]	<0.01
Depression Score	1.12	[1.05, 1.19]	<0.01	1.02	[0.99, 1.06]	0.25

Future Work

- For investigating factors that influence the change of MoCA scores over time, we could use the data of the visits at 12 months, 24 months, etc., to further implement a longitudinal data analysis, such as the linear mixed-effects model, to address the random effect of each individual.