10 Year Risk of Heart Disease

A logistic regression approach to the Framingham Heart Study Data

Contents

01

INTRODUCTION

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Framingham Heart Study
1948-present

- Heart disease No. 1 cause of death in U.S.
- Identify risk factors for cardiovascular disease

- ~5000 participants from Framingham, Mass
- Exam/ lab tests/ lifestyle questions
- Track major heart events: chest pain, heart attacks, strokes, death…

- Data subset 1956 - 1968

“Can we predict if a person will develop heart disease within 10 years?”

OUR QUESTION

Can we predict if a person will develop heart disease within 10 years?

- Binary response (Yes/No)
- Logistic Regression

$$\ln \frac{p}{1-p} = X'\beta$$

02

EXPLORING DATA ANALYSIS

Identify risk factors

↓

Data cleaning

↓

Predictors/Responses relationships

Potetial Risk Factors

➢Demographics

- Sex (1707 Men, 2282 Women)
- **Age** (Range: **30-70**)

➢Lifestyle

- Smoking Status (Yes or No)
- Cigarettes per day

➢Medical Exam

- Period (1-3)
- Time (days)
- Systolic BP (mm HG)
- Diastolic BP (mmHG)
- Total Cholesterol (mg/dL)
- Body Mass Index (BMI)
- Glucose (mg/dL)
- Heart rate (per min)

➢Medical History

- Diabetes
- Blood pressure medication
- Prev. Angina pectoris
- Prev. Myocardial infarction
- Prev. Stroke
- Prev. Hypertension

Total: 11,627 observations

Dealing with Missing Values and Multicollinearity

➢Design matrix

- PERIOD=1
  - the most observations available
  - sufficient time to measure 10 year risk

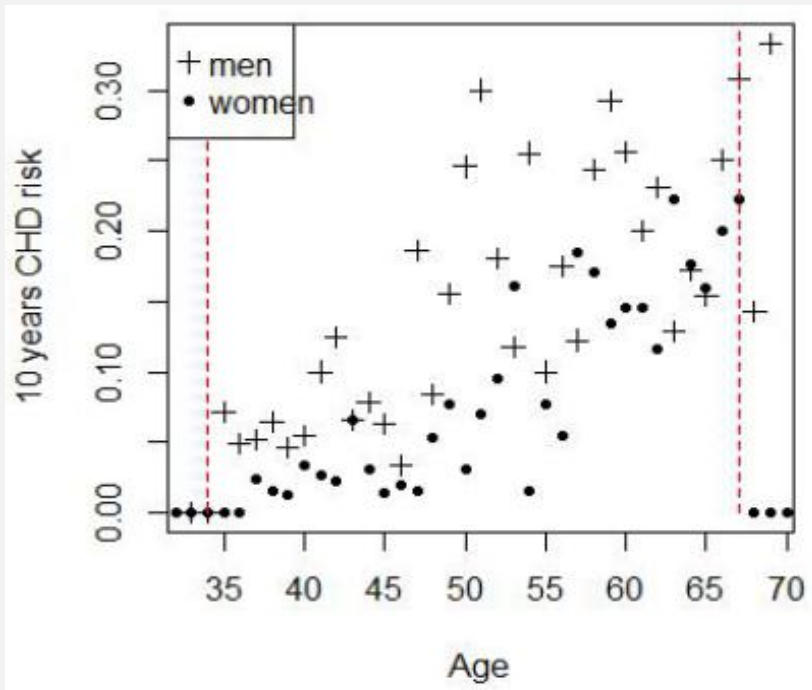
➢Missing Values

- Remove observation
- Replace value with 0
- Replace value with mean of the column

➢Correlation

- Systolic BP and diastolic BP (.78)
- Smoking and cigarettes per day (.77)
- Glucose and diabetes (.61)
- Prev hypertension and both systolic and diastolic BP
- (.69 and.62 respectively)

After cleaning: 3,531 observations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10 years CHD risk
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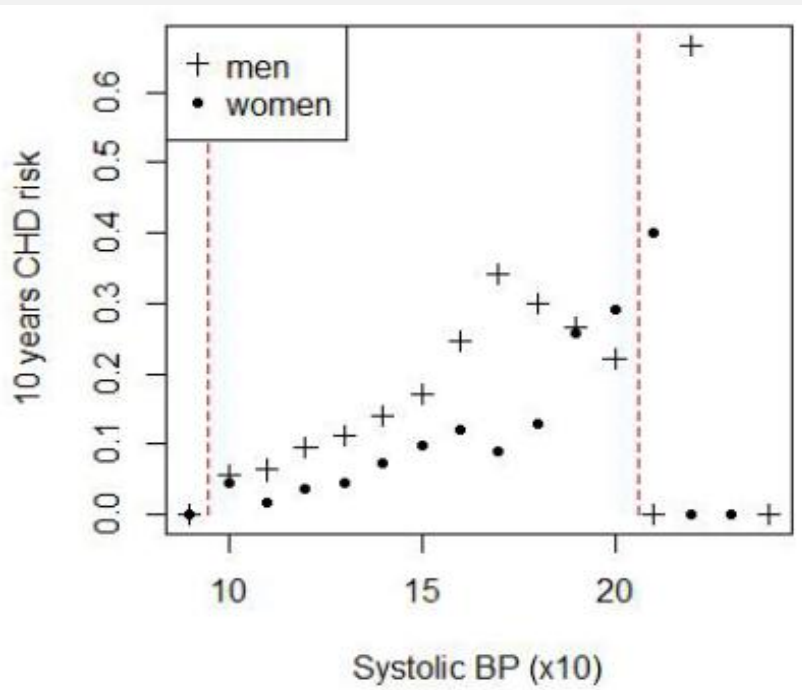
Age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10 years CHD risk
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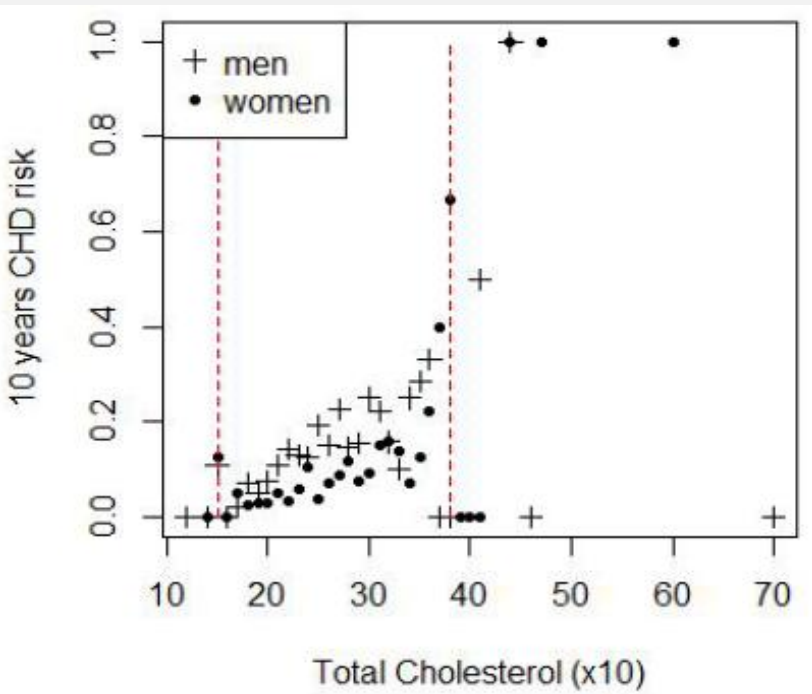
Systolic BP (x10)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10 years CHD risk
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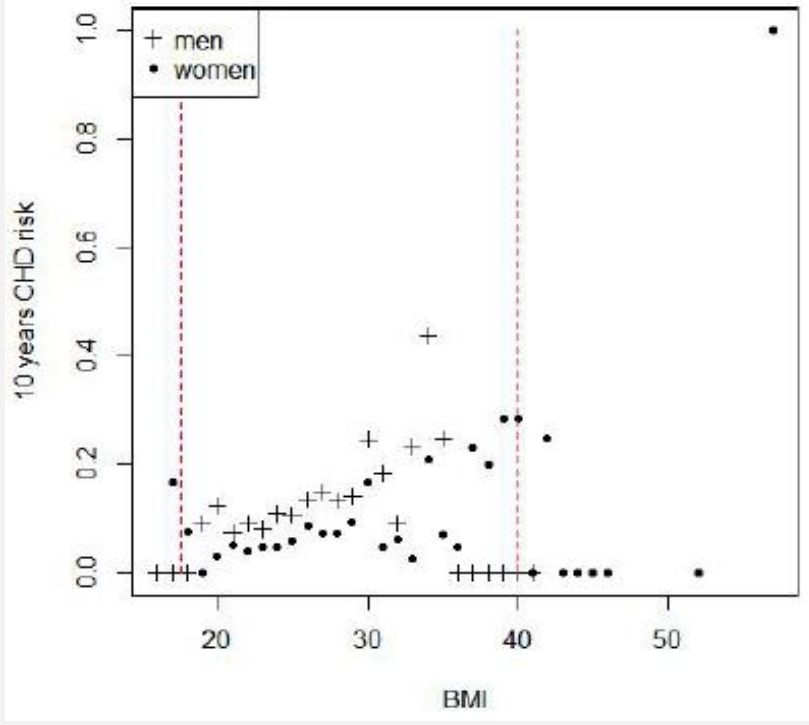
Total Cholesterol (x10)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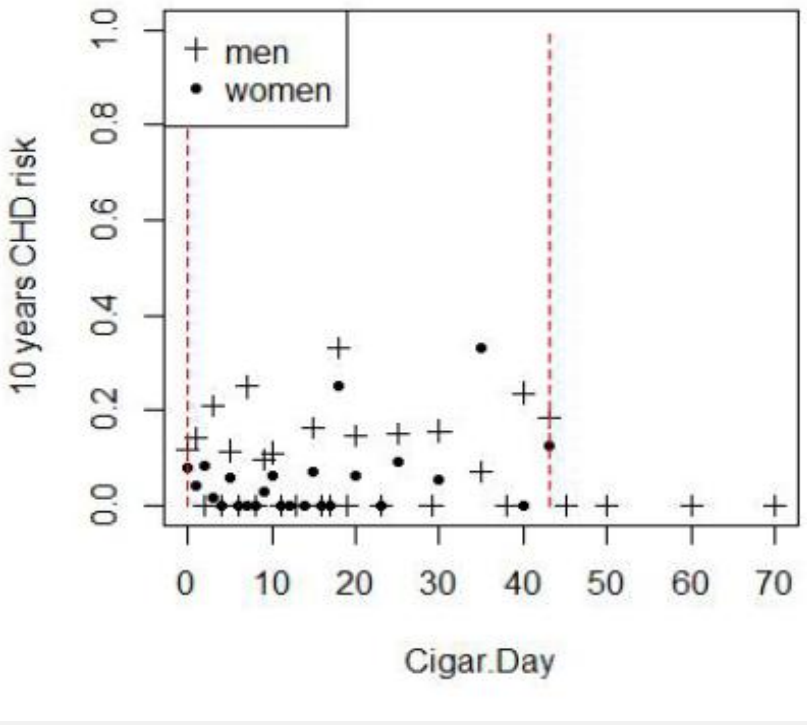
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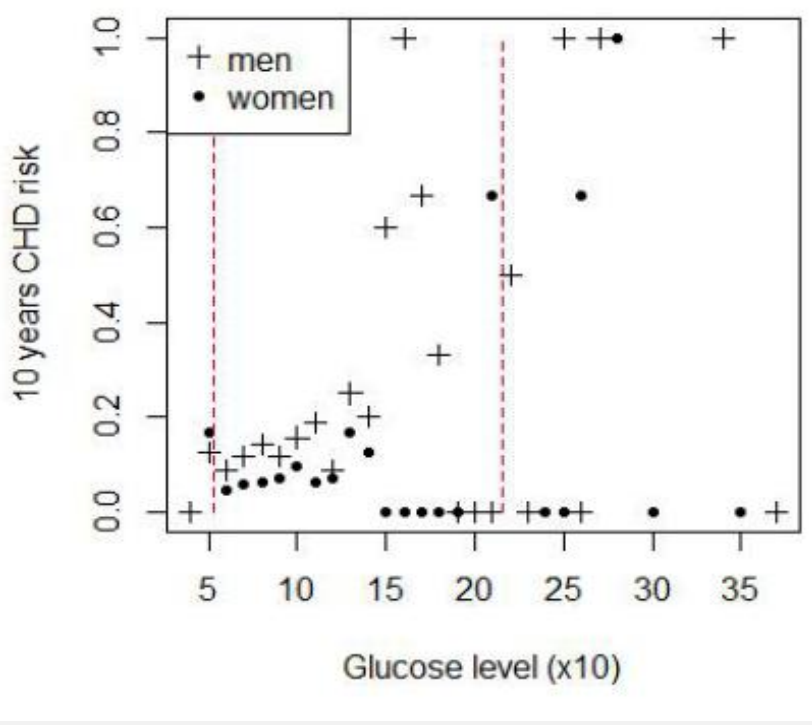
Cigar.Day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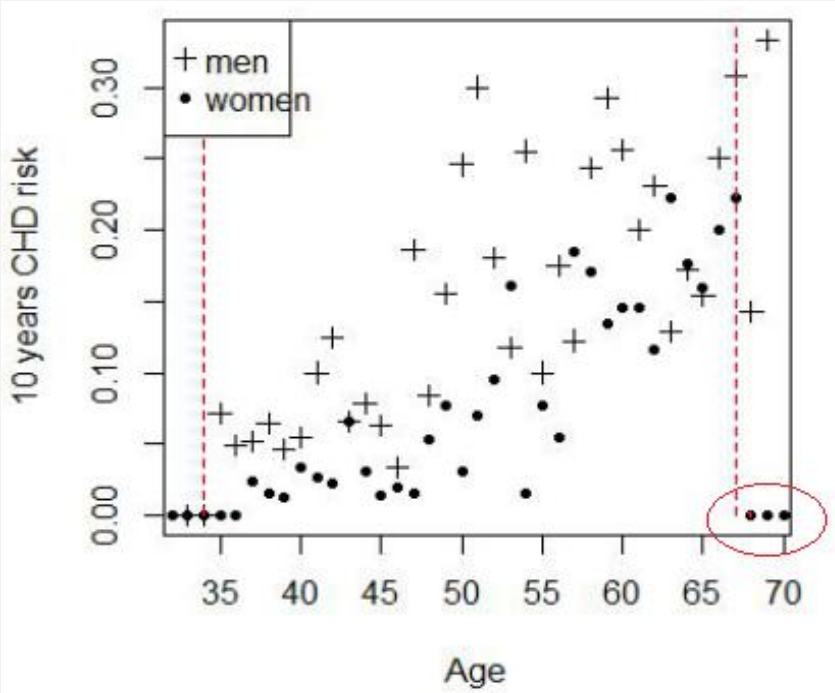
Glucose level (x10)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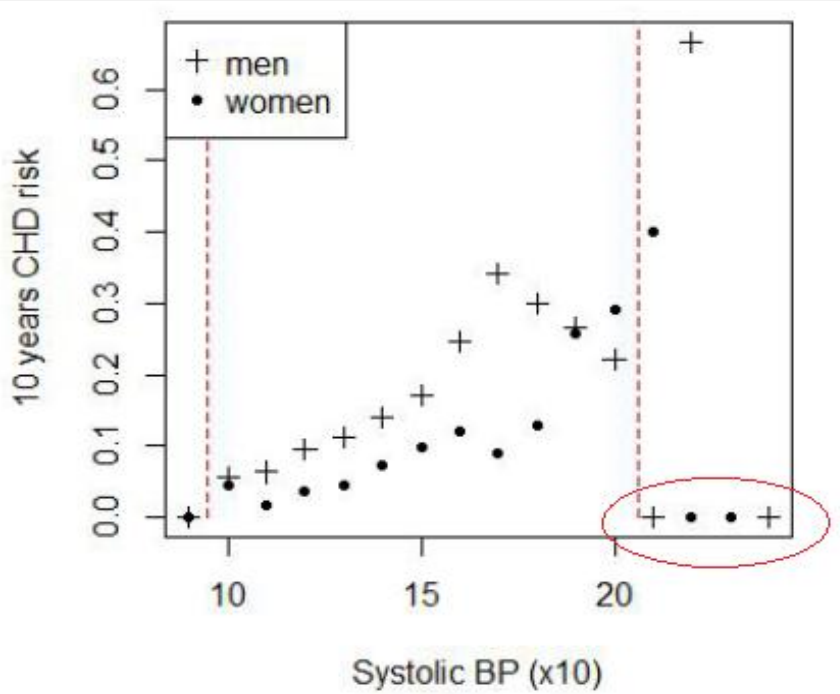
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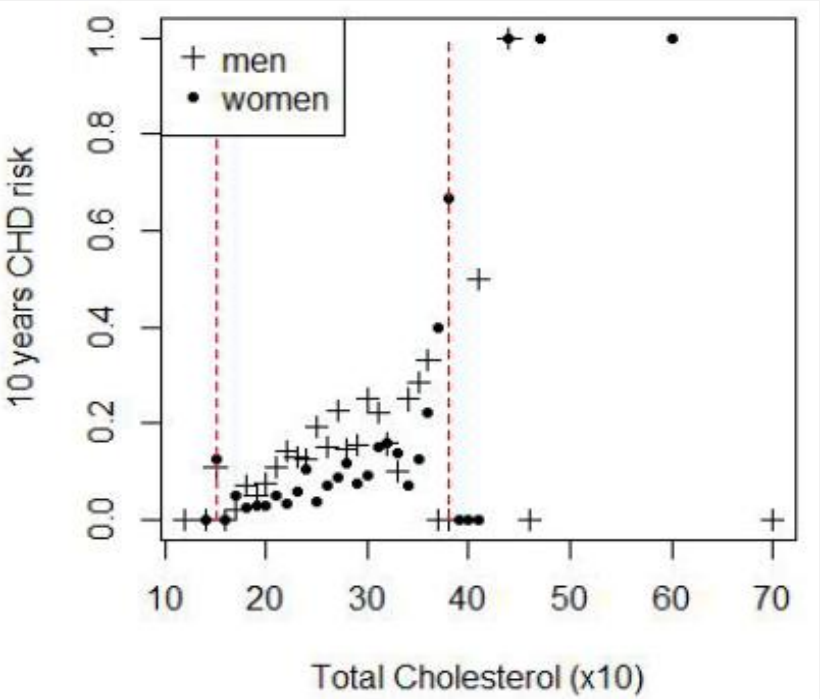
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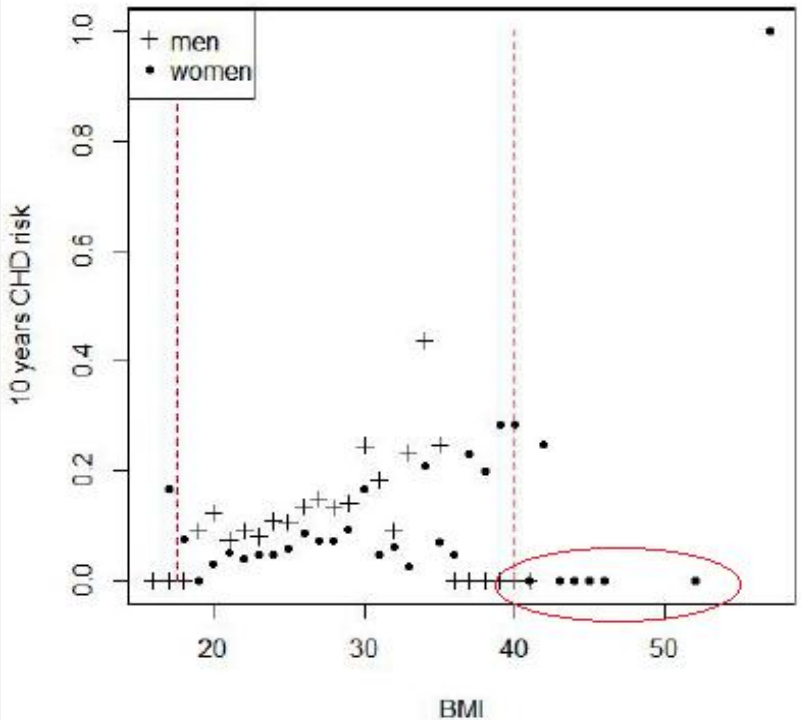
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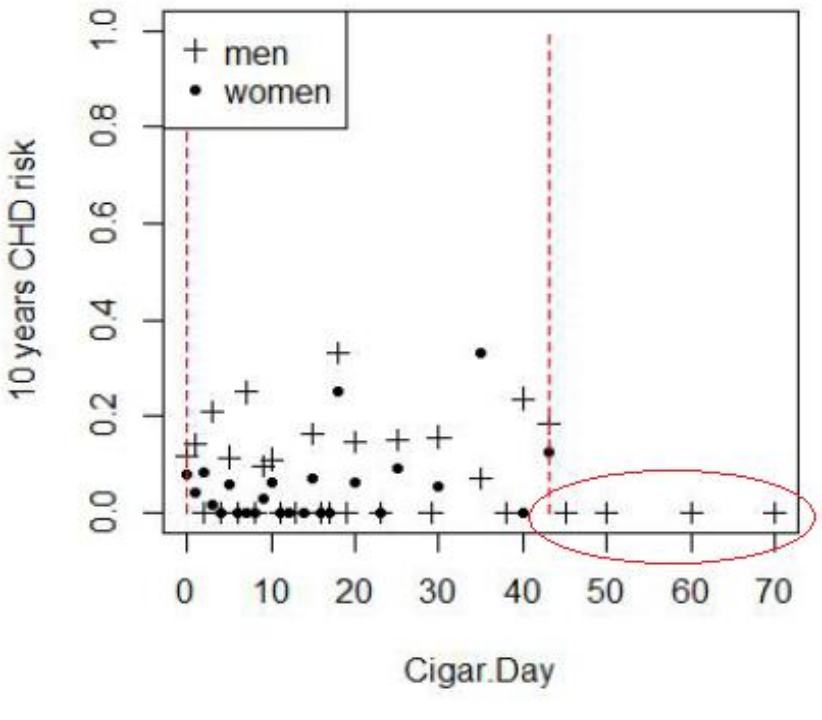
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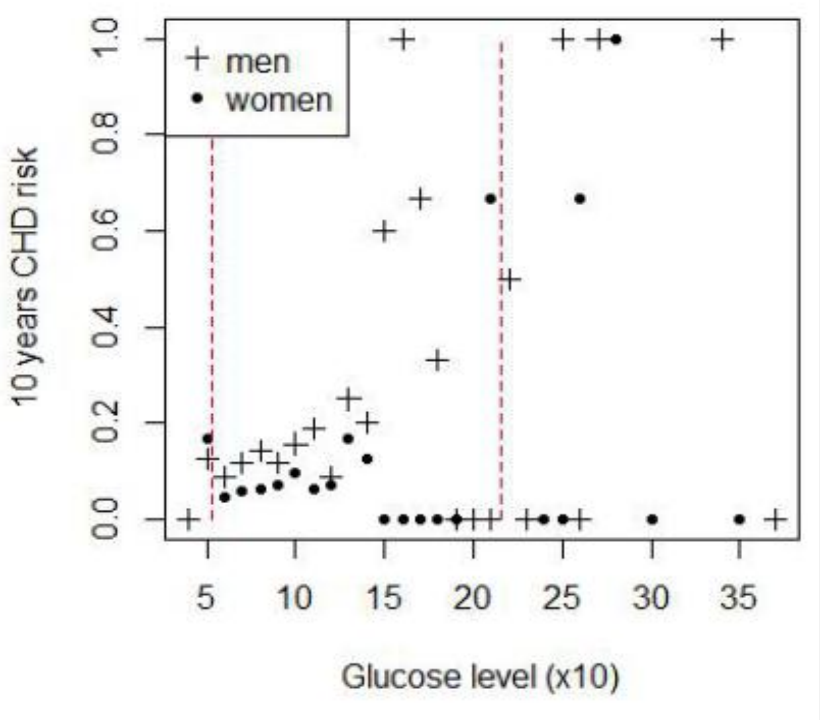
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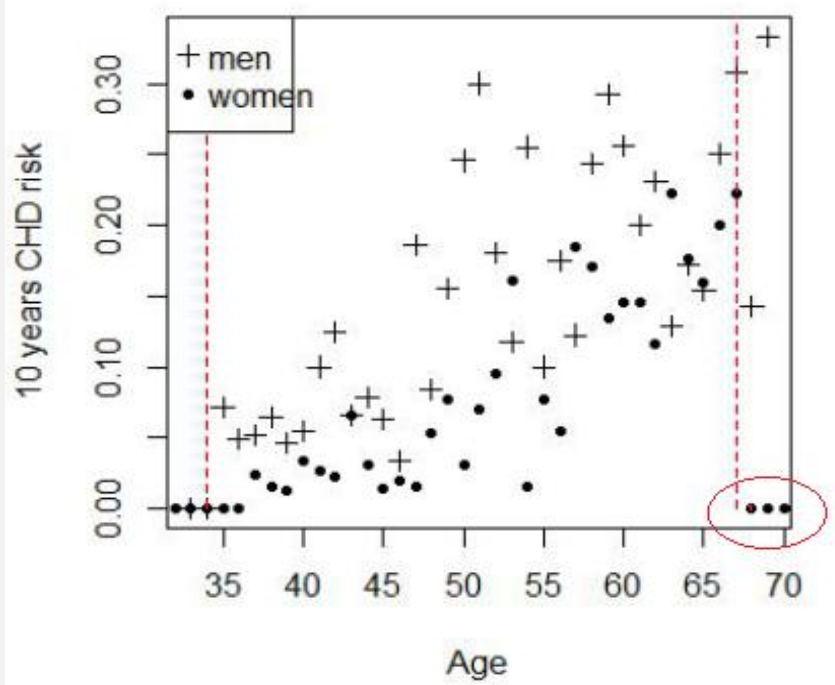
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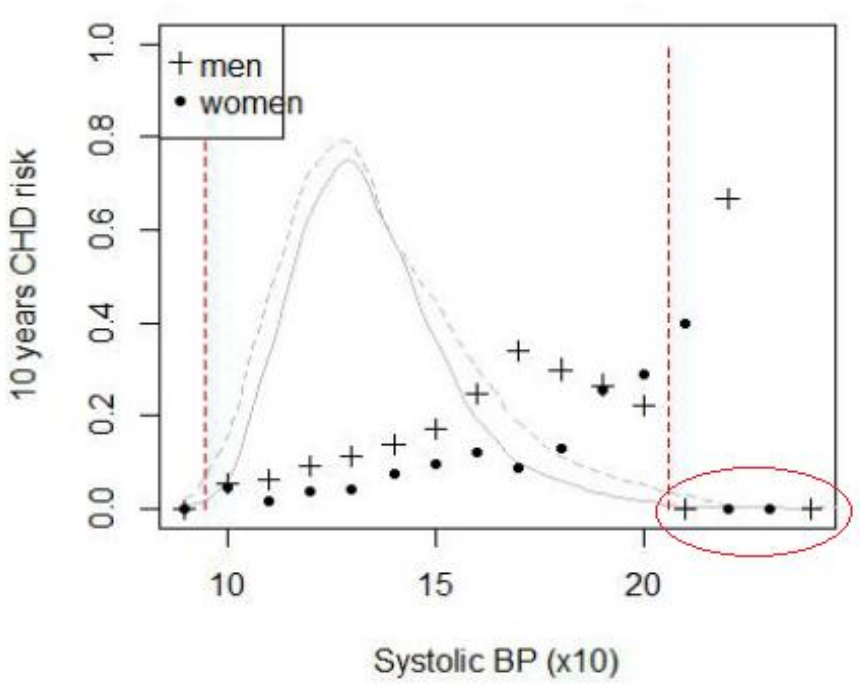
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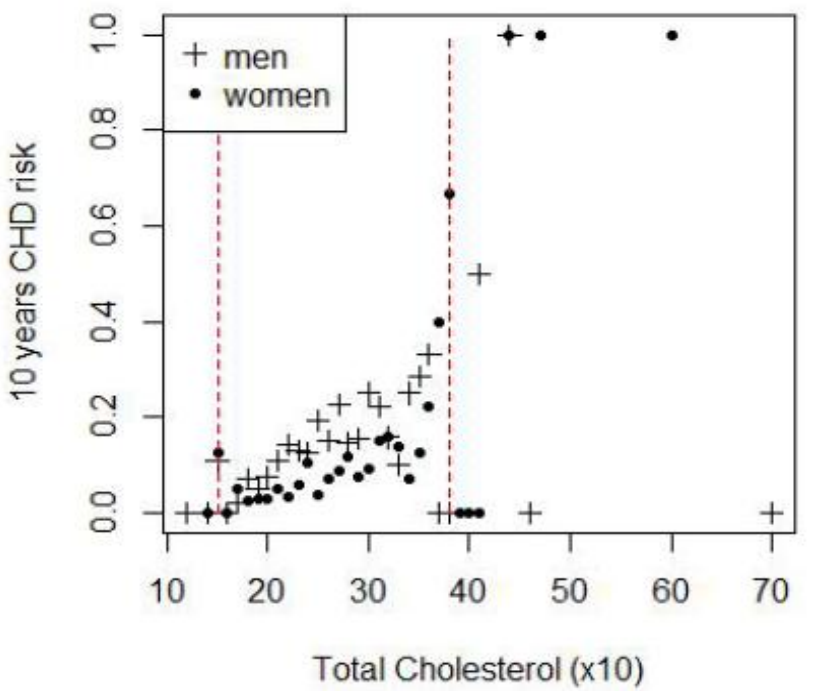
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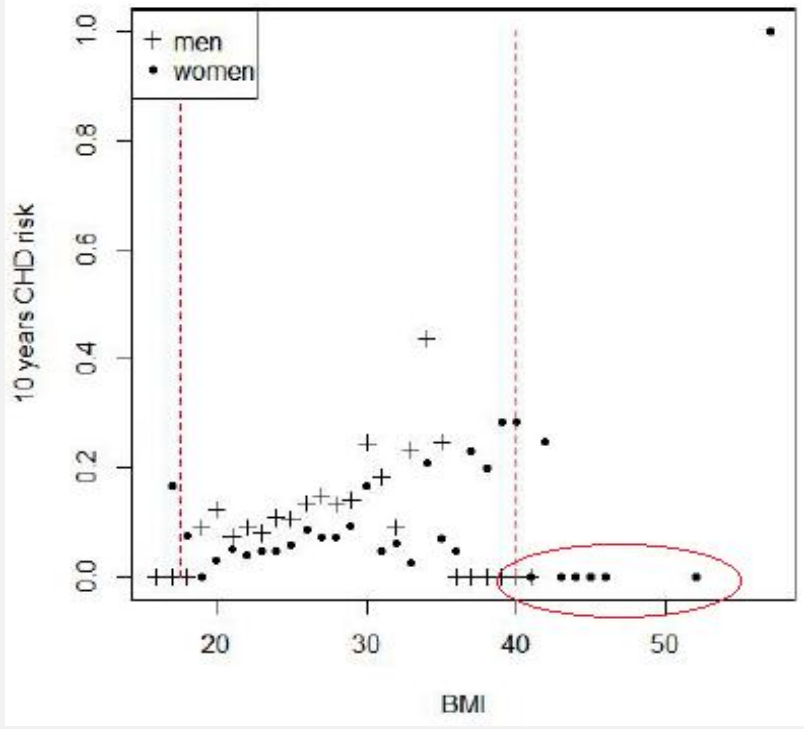
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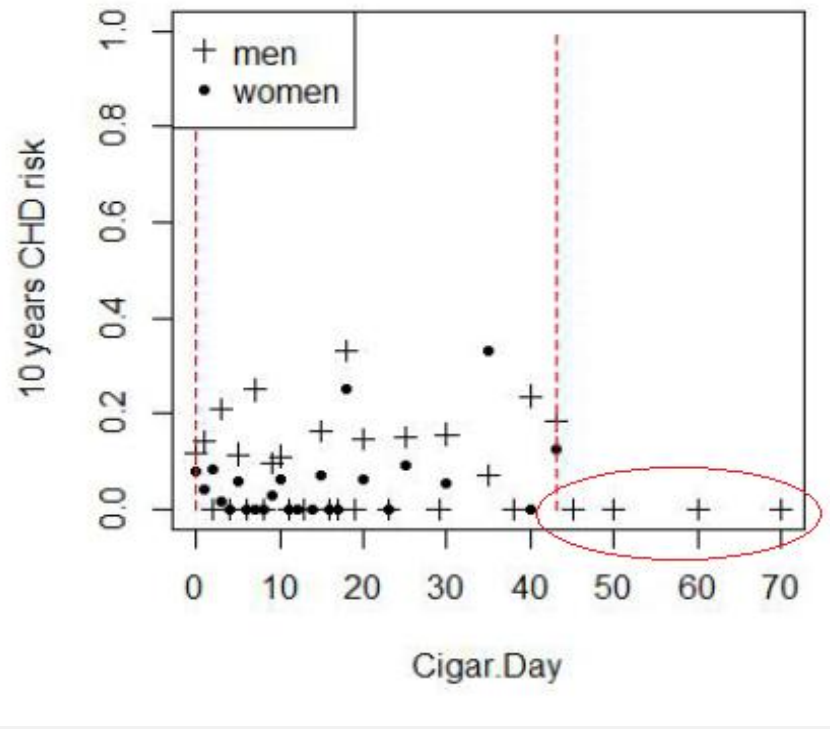
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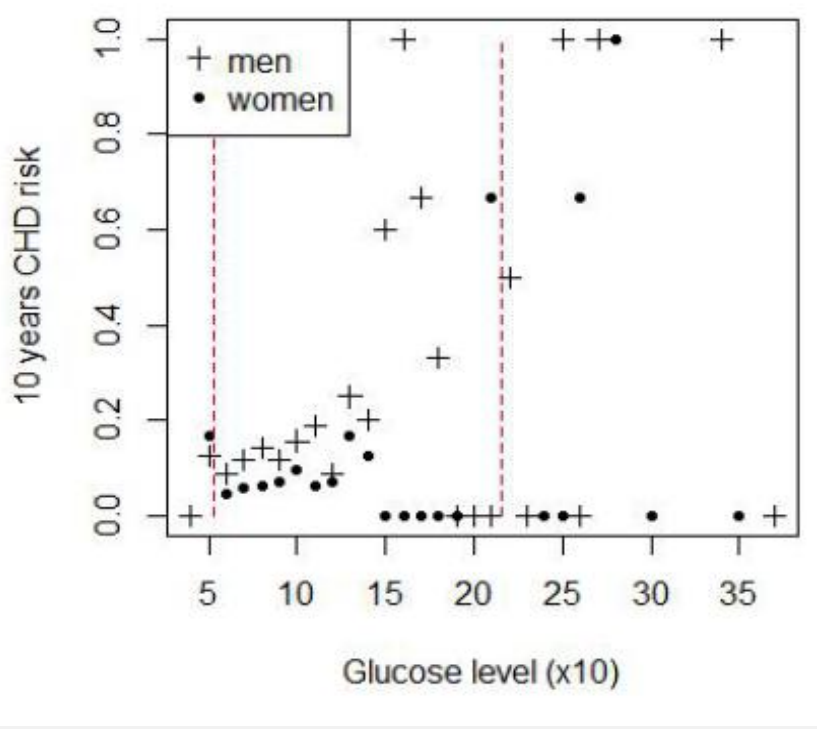
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Glucose level (x10)

03

VARIABLE SELECTION

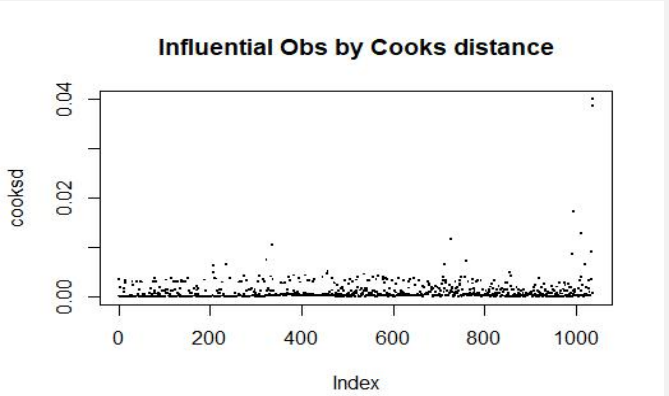
Variable Selection

- Variable transformations, interactions (sex with cig smoked per day,bp and heart rate)
- combining predictors sys Bp and Dia BP.0-normal, (1-elevated, 2-high stage1, 3-high stage2, 4-hypertensive crisis)
- Binning of age groups(30-40,41-50, 51-60 and 6 -70)
- But we found it not significant in getting higher predictive power.
- AIC , Deviance, LRT, and p-value of Pearson Chi Squared test.

Variable selection

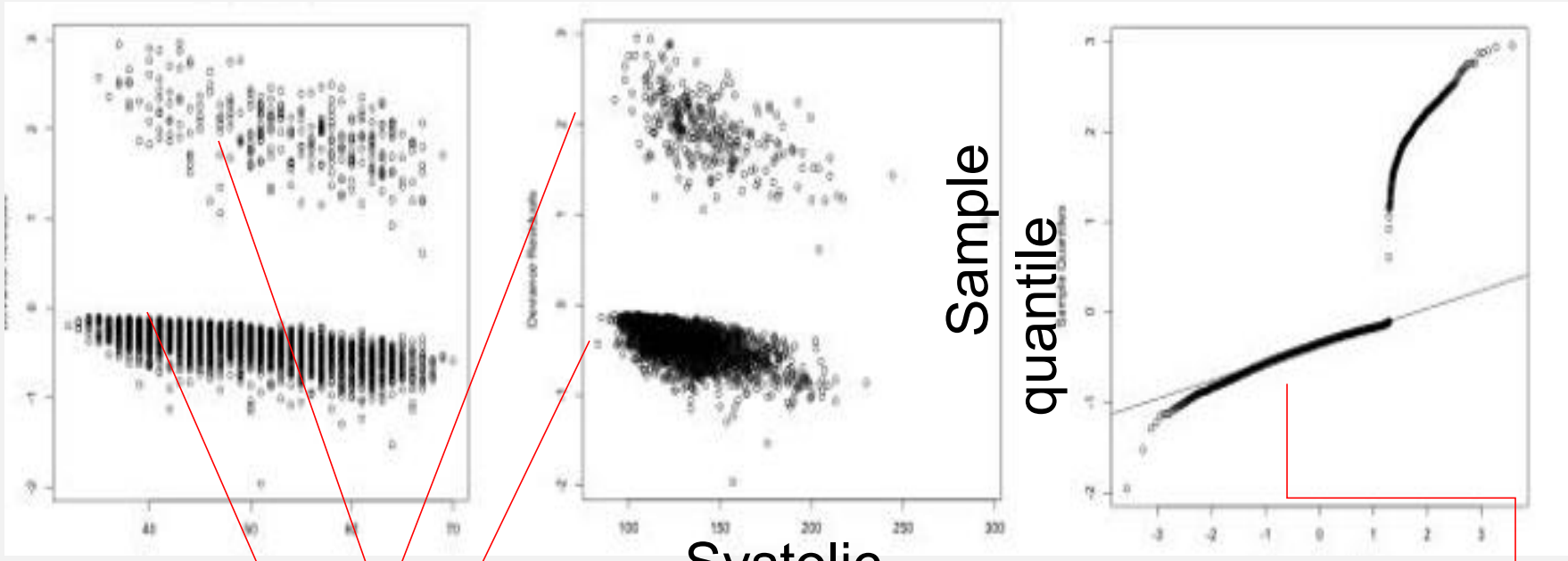
No	k	p	Intercept	HeartRate	BMI	Gluc	Cigar.Day	Tol.Chol	SysBP	Sex	Age	AIC	Deviance	LRT	Pear.Chi
1	8	9	1	1	1	1	1	1	1	1	1	2037.84	2019.84	1.00	0.78
2	7	8	1	0	1	1	1	1	1	1	1	2038.70	2022.70	1.00	0.78
3	6	7	1	0	1	1	1	0	1	1	1	2066.11	2052.11	1.00	0.93
4	7	8	1	1	1	1	1	0	1	1	1	2066.35	2050.35	1.00	0.93

Full Model	Reduce Model	P-value
1	2	0.09104



Event~BMI+Gluc+Cigar.Day+Tol.Chol+SysBP+Sex+Age

Residual plots and qq-plot



Two chunks of data because of binary responses 0 and 1

Normall distributed

04

MODEL VALIDATION

Model Validation

- Generated 80%:20% training to validation split with 2824 and 707 records respectively
- Misclassification error rate: 9.4% on the validation sample
- Model Concordance: 75.62%

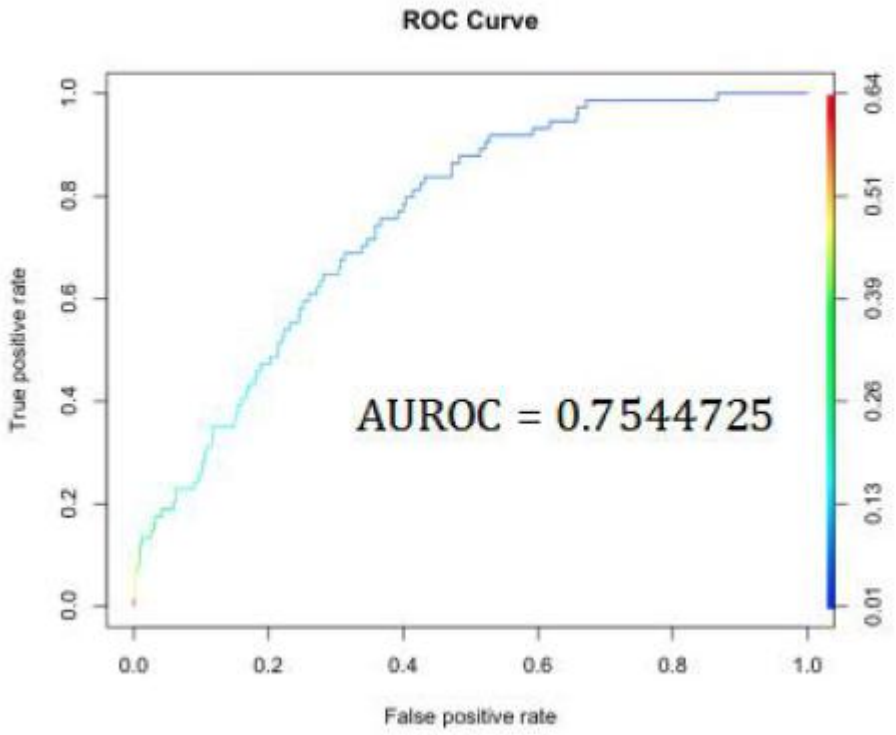
  - a measure of predictive accuracy of the logistic model

		Actual	
		0	1
Predicted	0	627	58
	1	9	13

Confusion Matrix

Since the dataset is imbalanced with proportion of events=10%, the model is able to better predict for the non occurrence of disease than its occurrence

Receiver Operating Characteristics



Mean Area for 1000 iterations: 0.746

>If the model has no predictive power, you have a 50-50 chance of correctly classifying the possibility of disease.

>More area beneath the ROC curve indicates greater predictive power Area= 0.5 for no predictive power and 1.0 for perfect predictive power

>Here, the model has a 75% chance of correct classification (quite an improvement over 50%).

04

CONCLUSION

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Q&A

Thank you very much for watching

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