Diabetes Factors Analysis

SDSC2102 STATISTICAL METHOD AND DATA ANALYSIS

Background and problem formulation

What is diabetes

- Diabetes mellitus (DM)
- Group of metabolic disorders characterized by a high blood sugar level over a prolonged period

Goal

- Assess the relationship between diabetic and it factors
- Finding out the which risk factors are more related to having diabetes
- Significance of that factor causing diabetes

About the Data set

- Source: Centers for Disease Control and Prevention of U.S. Department of Health & Human Services
- Duration: 2017-March 2020 Pre-Pandemic
- Survey Type:
  - Questionnaire Data
  - Examination Data

Data set		# of data
P_ALQ	2017-March 2020 Pre-Pandemic Alcohol Use	8965
P_BMX	2017-March 2020 Pre-Pandemic Body Measures	14300
P_BPQ	2017-March 2020 Pre-Pandemic Blood Pressure & Cholesterol	10195
P_DIQ	2017-March 2020 Pre-Pandemic Diabetes	14986

Data processing method and Justification

LOGISTIC REGRESSION

- It is a non-linear model to predict binary class
- Use to predict the odds of occurrence
- Assumes that class attributes is linear in the coefficients of the predictive attributes

We use classification model instead of regression model because:

- Having diabetes or not is a binary variable
- 1 means the person has diabetes
- 0 means the person does not has diabetes
- If we use regression model instead of a classification model
  - Accuracy will be relatively lower than classification model

Data processing

Environment Setup

OS: Ubuntu 20.04

Conda: 4.12.0

Language: R

Library used:

- dplyr
- ggplot2
- haven
- hrbrthemes
- reshape2
- rpart
- rpart.plot

Data analysis procedure

1. Download data from National Health and Nutrition Examination Survey
2. Merge data into data frame
3. Data transformation
    1. Yes-No answer into binary answers
    2. Data normalization
    3. Data filtering with answers such as “Don’t know”, “Refused to answer”, “Missing” etc.
4. Data pre-processing
    1. Calculate BMI base on weight and height

Data selected

Data Code			
SEQN	Respondent sequence number	BMXBMI	Body Mass Index (kg/m**2)
DIQ010	Doctor told you have diabetes	BPQ020	Doctor told you - high blood pressure
BMXWT	Weight (kg)	BPQ080	Doctor told you - high cholesterol level
BMXHT	Standing Height (cm)	ALQ121	Past 12 mo how often drink alcoholic bev
BMXWAIST	Waist Circumference (cm)	ALQ130	Avg # alcoholic drinks/day - past 12 mos
BMXHIP	Hip Circumference (cm)		

	Number of Instances	Number of Attributes
After merge	5428	12

Data accuracy testing

Calculate BMI base on the equation:

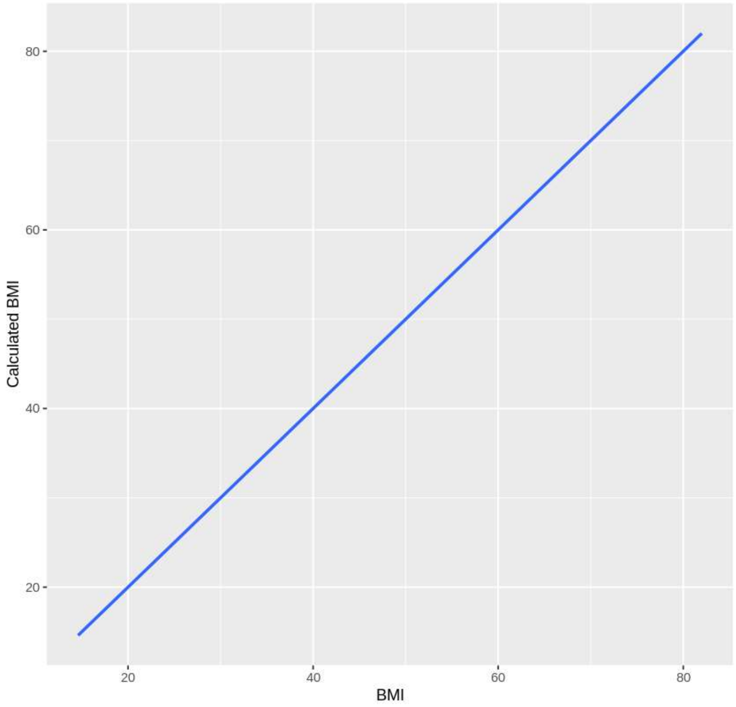
$$BMI = \frac{BMIWT}{{BMXHW/_{100}}^{2}}$$

Compare the BMI in the data set with the calculated BMI

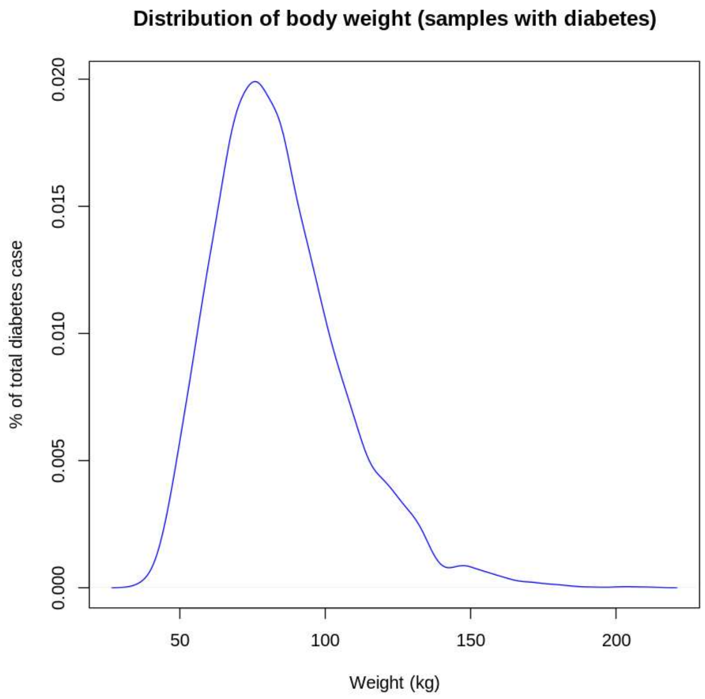
- Test the accuracy of the data

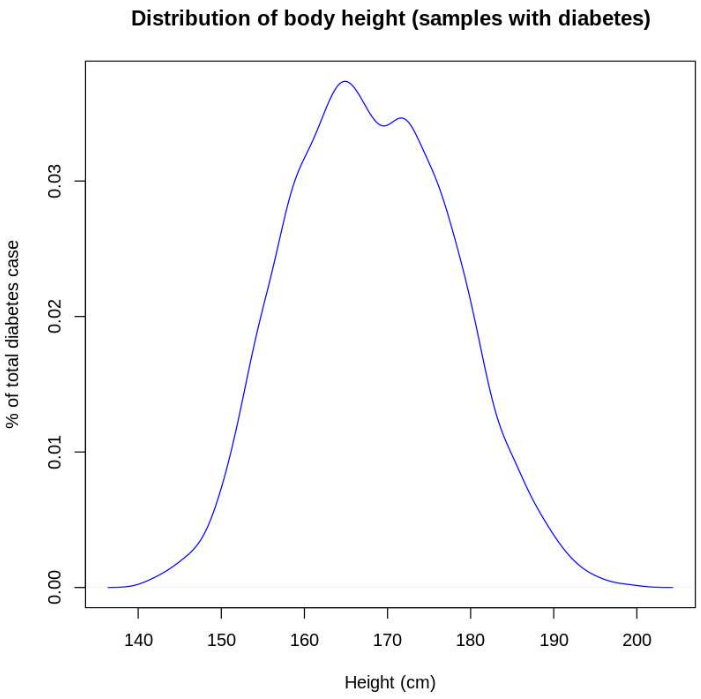
BMI > 25 is overweighted

Linear regression model for BMI ~ Calculated BMI

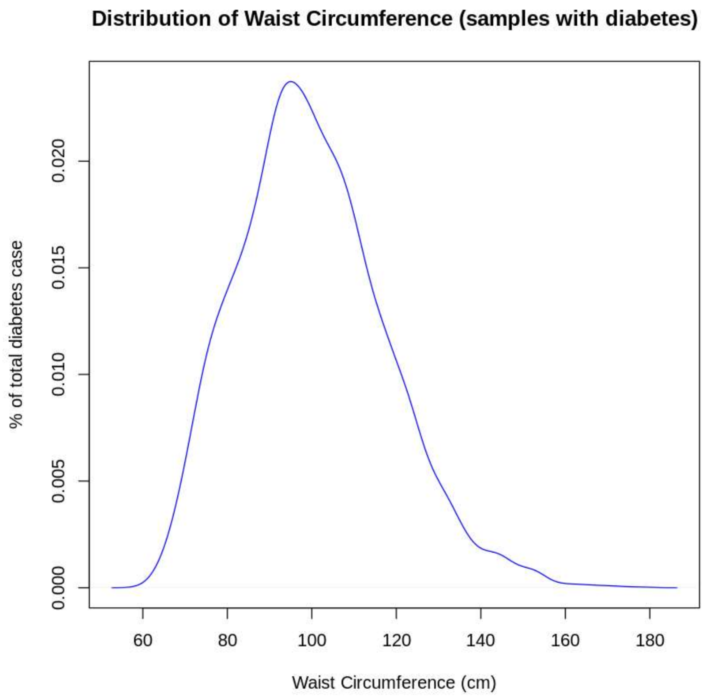


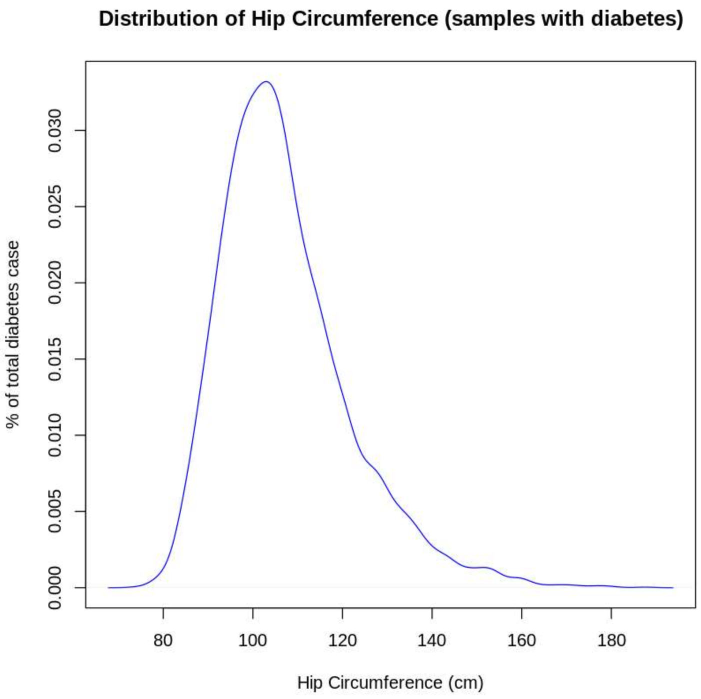
Data overview – weight and height



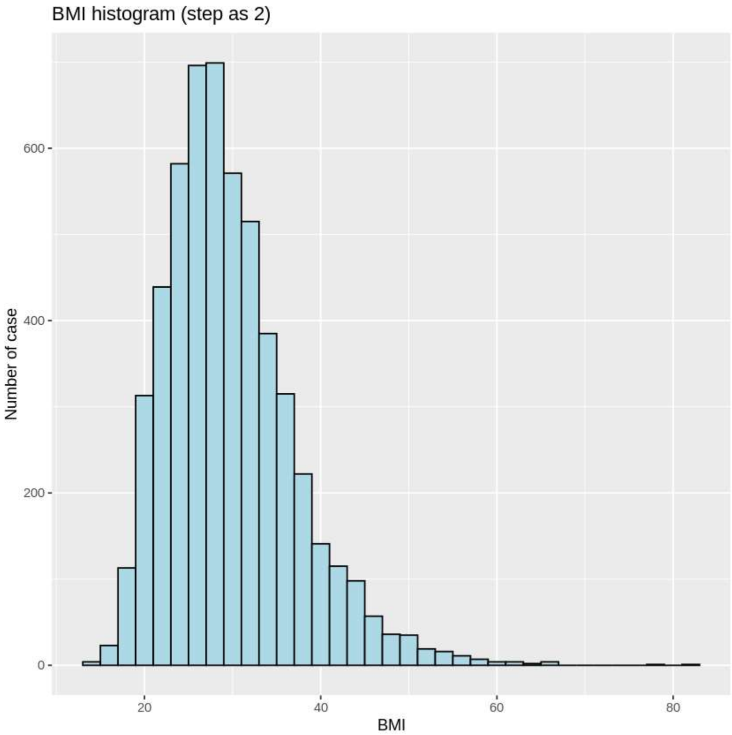


Data overview – Circumferences





Data overview – BMI

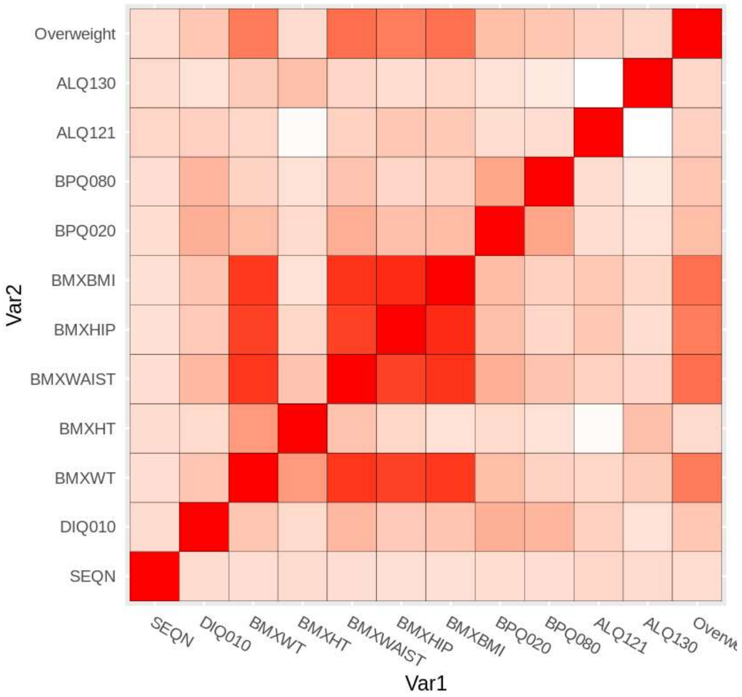


Data analyzing

Data overview

Highly correlated pair:

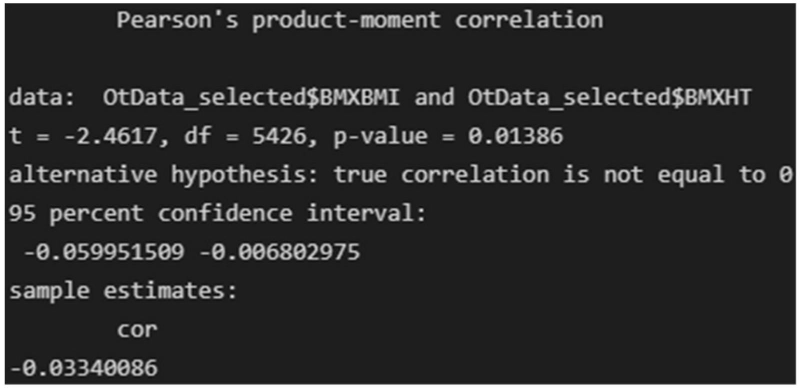
- BMI – Hip Circumference
- BMI – Waist Circumference
- BMI – Weight
- BMI – Height
- Diabetes – Waist Circumference
- Diabetes – BMI
- Diabetes – high blood pressure
- Diabetes – high cholesterol level



Correlation heatmap

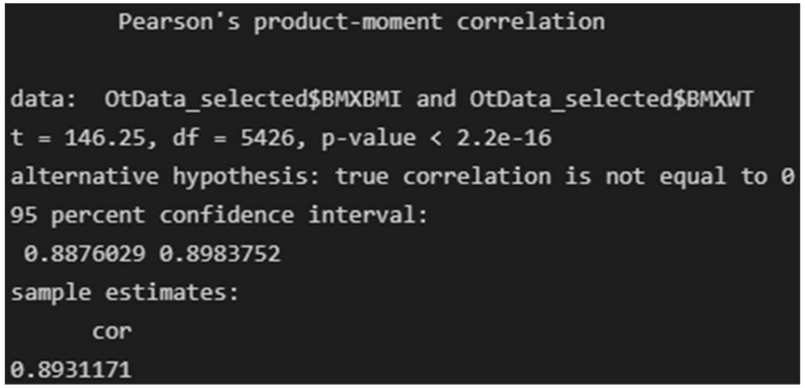
Pearson correlation test

HEIGHT VS BMI



```
        Pearson's product-moment correlation

data:  OtData_selected$BMXBMI and OtData_selected$BMXHT
t = -2.4617, df = 5426, p-value = 0.01386
alternative hypothesis: true correlation is not equal to 0
95 percent confidence interval:
 -0.059951509 -0.006802975
sample estimates:
        cor
-0.03340086
```

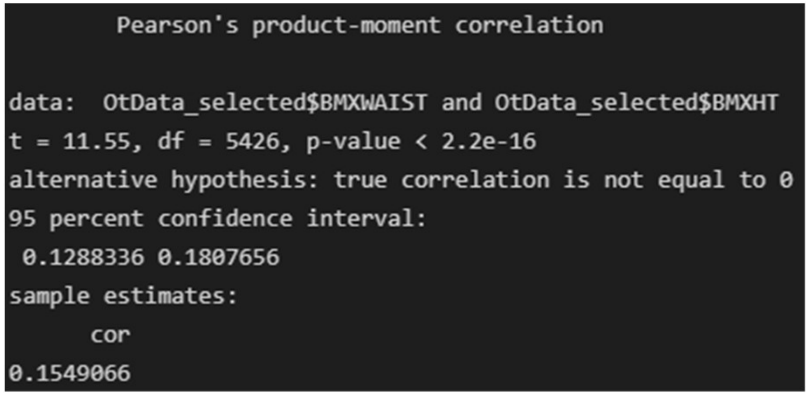
WEIGHT VS BMI



```
        Pearson's product-moment correlation

data:  OtData_selected$BMXBMI and OtData_selected$BMXWT
t = 146.25, df = 5426, p-value < 2.2e-16
alternative hypothesis: true correlation is not equal to 0
95 percent confidence interval:
 0.8876029 0.8983752
sample estimates:
      cor
0.8931171
```

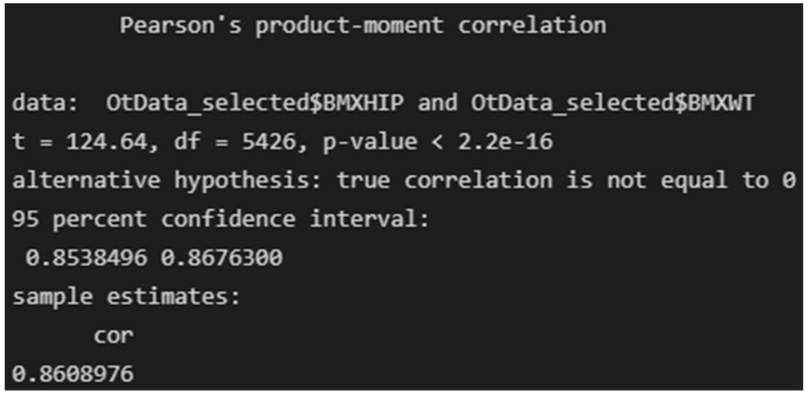
Pearson correlation test

WAIST CIRCUMFERENCE VS BMI



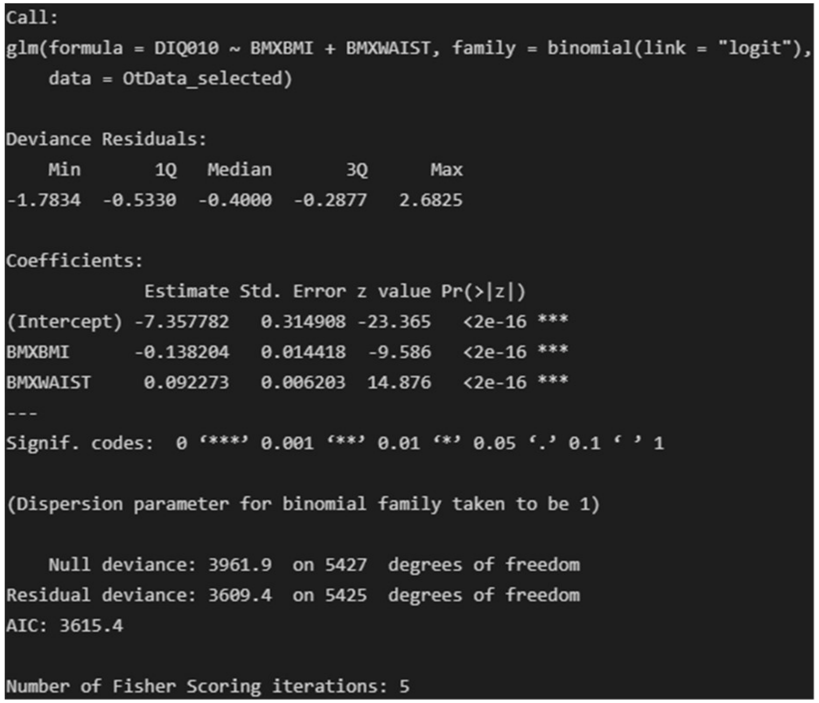
```
        Pearson's product-moment correlation

data:  OtData_selected$BMXWAIST and OtData_selected$BMXHT
t = 11.55, df = 5426, p-value < 2.2e-16
alternative hypothesis: true correlation is not equal to 0
95 percent confidence interval:
 0.1288336 0.1807656
sample estimates:
      cor
0.1549066
```

HIP CIRCUMFERENCE VS BMI



```
        Pearson's product-moment correlation

data:  OtData_selected$BMXHIP and OtData_selected$BMXWT
t = 124.64, df = 5426, p-value < 2.2e-16
alternative hypothesis: true correlation is not equal to 0
95 percent confidence interval:
 0.8538496 0.8676300
sample estimates:
      cor
0.8608976
```

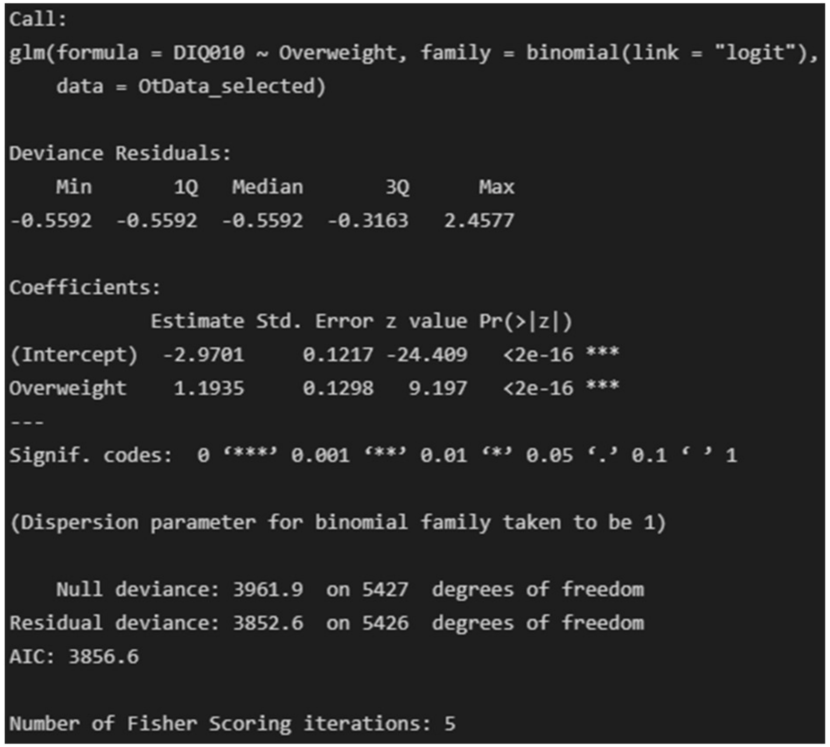
Result – Multiple Logistic regression model



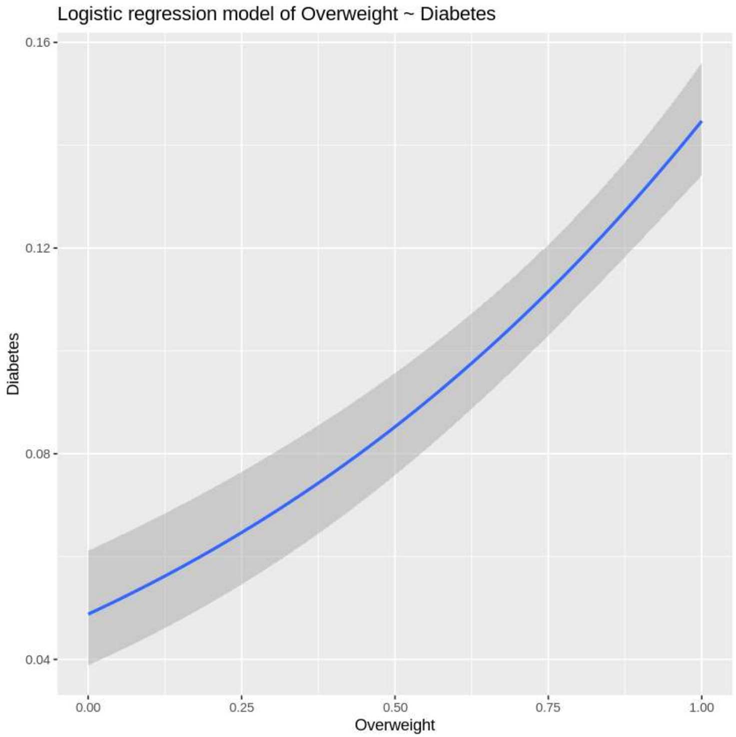
```
Call:
glm(formula = DIQ010 ~ BMXBMI + BMXWAIST, family = binomial(link = "logit"),
    data = OtData_selected)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-1.7834  -0.5330  -0.4000  -0.2877   2.6825

Coefficients:
             Estimate Std. Error z value Pr(>|z|)
(Intercept) -7.357782   0.314908 -23.365   <2e-16 ***
BMXBMI      -0.138204   0.014418  -9.586   <2e-16 ***
BMXWAIST     0.092273   0.006203  14.876   <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 3961.9  on 5427  degrees of freedom
Residual deviance: 3609.4  on 5425  degrees of freedom
AIC: 3615.4

Number of Fisher Scoring iterations: 5
```

Diabetes ~ BMI + Waist Circumference

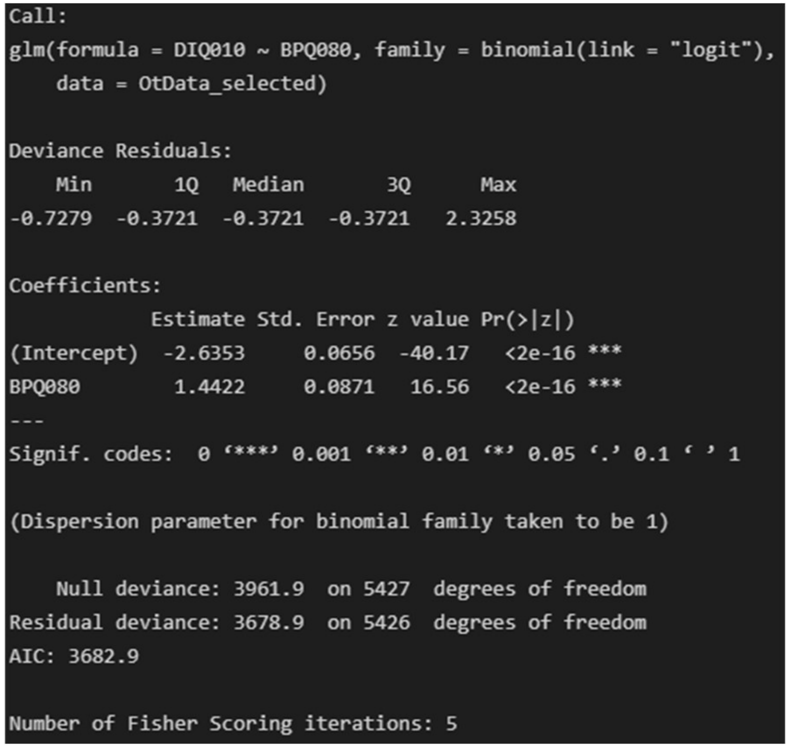
Logistic regression model for Diabetes ~ Overweight



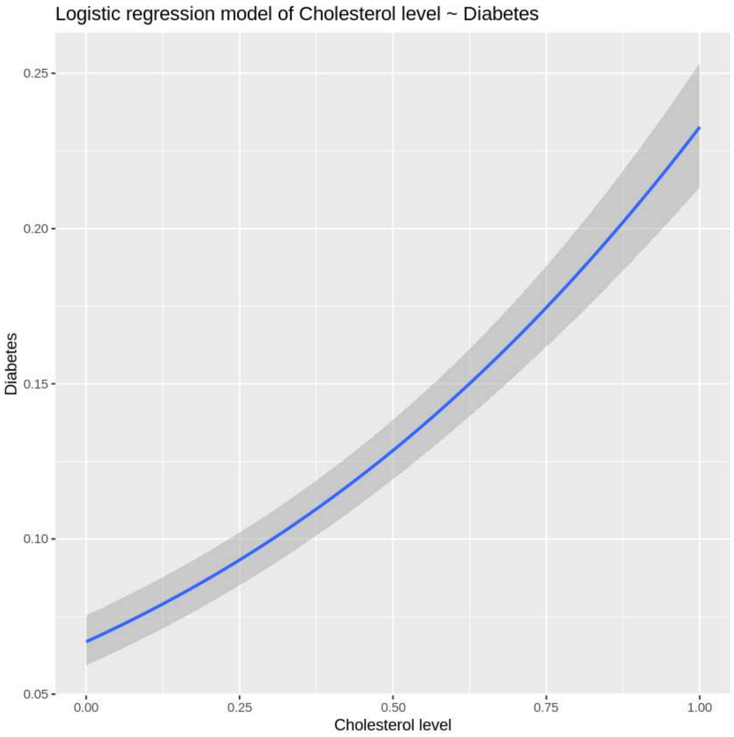
```
Call:
glm(formula = DIQ010 ~ Overweight, family = binomial(link = "logit"),
    data = OtData_selected)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-0.5592  -0.5592  -0.5592  -0.3163   2.4577

Coefficients:
            Estimate Std. Error z value Pr(>|z|)
(Intercept)  -2.9701     0.1217 -24.409   <2e-16 ***
Overweight    1.1935     0.1298   9.197   <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 3961.9  on 5427  degrees of freedom
Residual deviance: 3852.6  on 5426  degrees of freedom
AIC: 3856.6

Number of Fisher Scoring iterations: 5
```



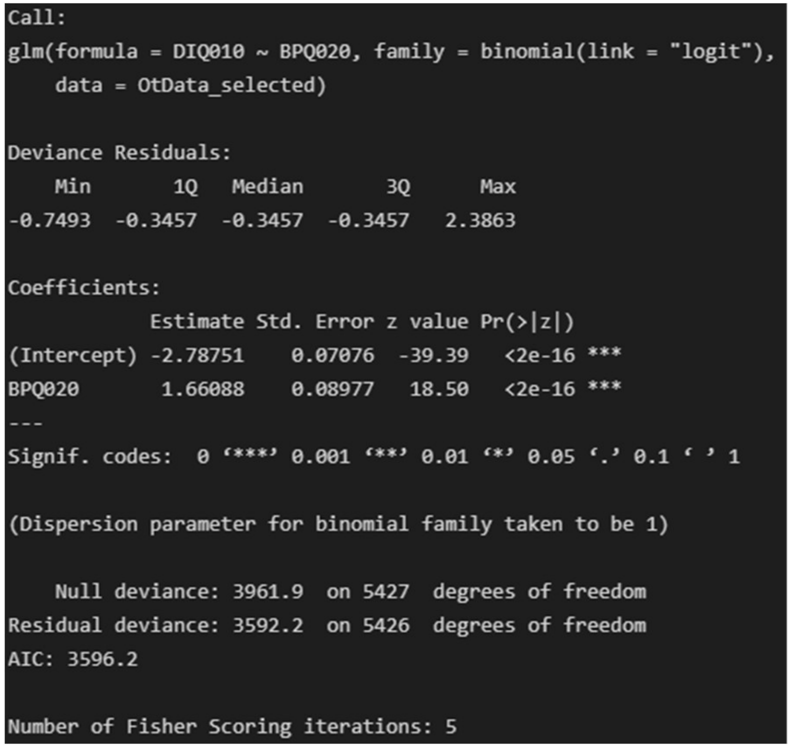
Logistic regression model for Diabetes ~ Cholesterol level



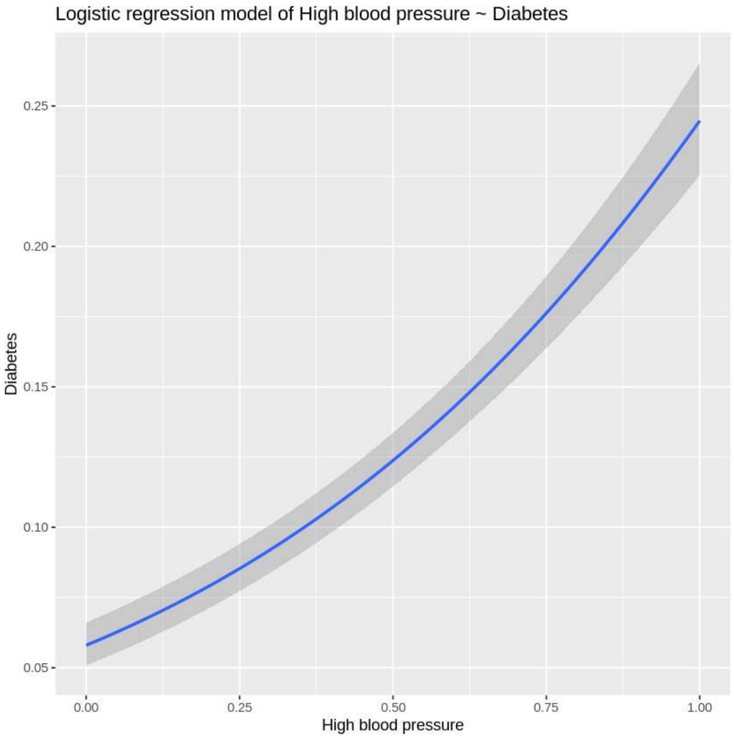
```
Call:
glm(formula = DIQ010 ~ BPQ080, family = binomial(link = "logit"),
    data = OtData_selected)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-0.7279  -0.3721  -0.3721  -0.3721   2.3258

Coefficients:
            Estimate Std. Error z value Pr(>|z|)
(Intercept)  -2.6353     0.0656  -40.17   <2e-16 ***
BPQ080        1.4422     0.0871   16.56   <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 3961.9  on 5427  degrees of freedom
Residual deviance: 3678.9  on 5426  degrees of freedom
AIC: 3682.9

Number of Fisher Scoring iterations: 5
```



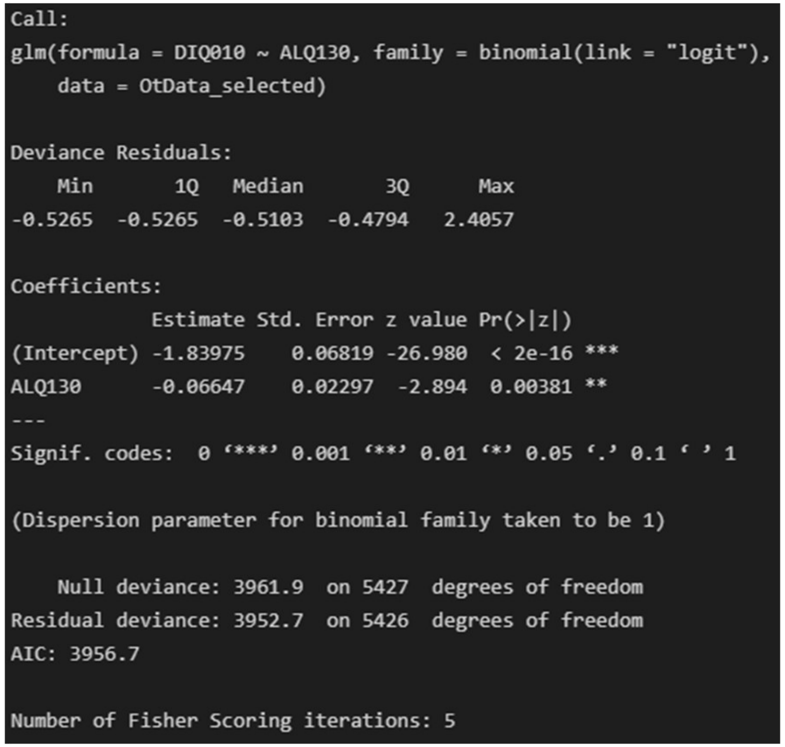
Logistic regression model for Diabetes ~ High blood pressure



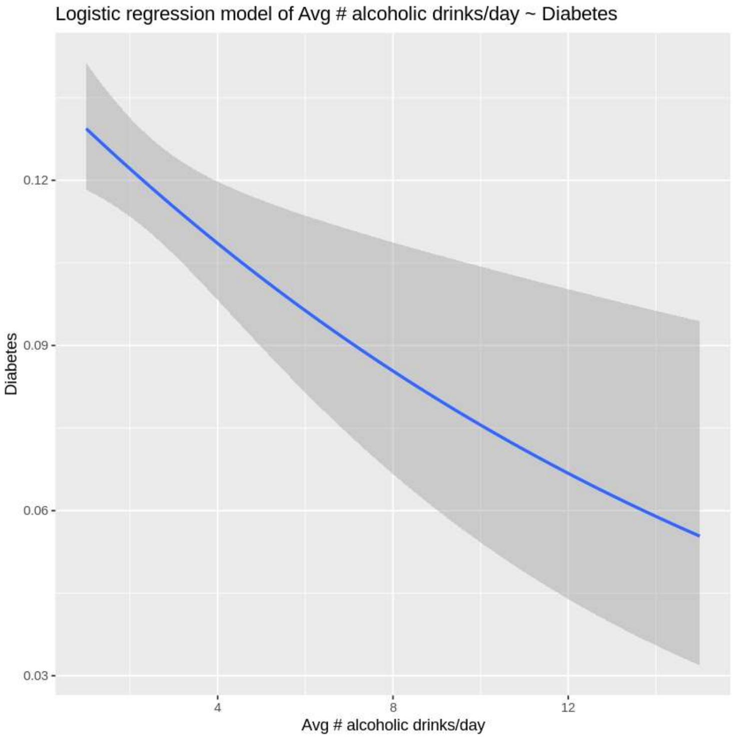
```
Call:
glm(formula = DIQ010 ~ BPQ020, family = binomial(link = "logit"),
    data = OtData_selected)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-0.7493  -0.3457  -0.3457  -0.3457   2.3863

Coefficients:
            Estimate Std. Error z value Pr(>|z|)
(Intercept) -2.78751    0.07076  -39.39   <2e-16 ***
BPQ020       1.66088    0.08977   18.50   <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 3961.9  on 5427  degrees of freedom
Residual deviance: 3592.2  on 5426  degrees of freedom
AIC: 3596.2

Number of Fisher Scoring iterations: 5
```



Logistic regression model of Avg # alcoholic drinks/day ~ Diabetes



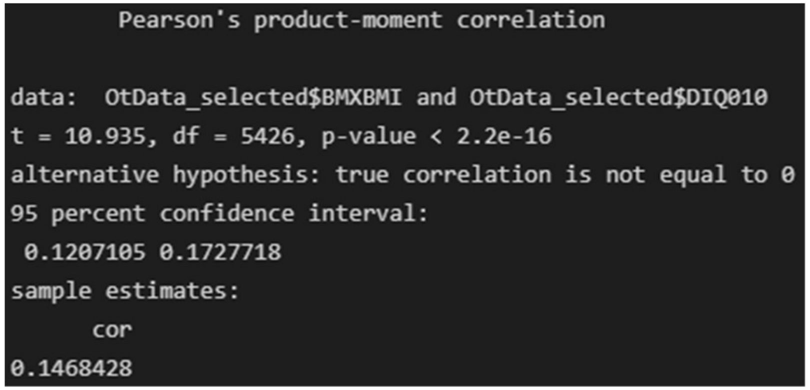
```
Call:
glm(formula = DIQ010 ~ ALQ130, family = binomial(link = "logit"),
    data = OtData_selected)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-0.5265  -0.5265  -0.5103  -0.4794   2.4057

Coefficients:
            Estimate Std. Error z value Pr(>|z|)
(Intercept) -1.83975    0.06819 -26.980  < 2e-16 ***
ALQ130      -0.06647    0.02297  -2.894  0.00381 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 3961.9  on 5427  degrees of freedom
Residual deviance: 3952.7  on 5426  degrees of freedom
AIC: 3956.7

Number of Fisher Scoring iterations: 5
```



Logistic regression model of Avg # alcoholic drinks/day ~ Diabetes

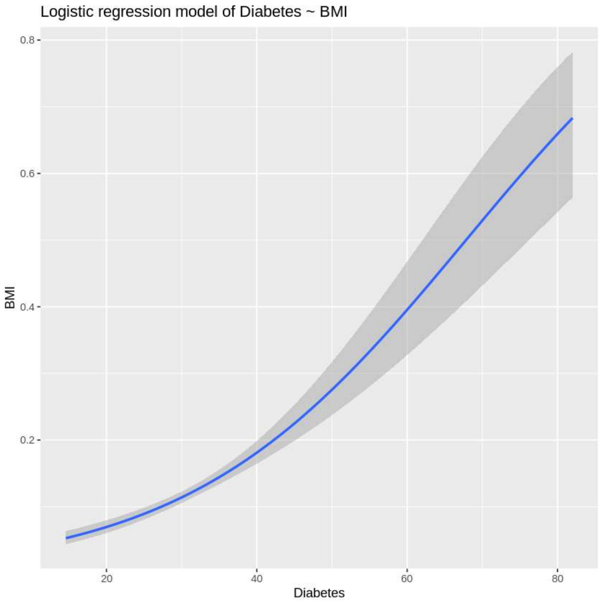
Comparing BMI and Diabetes

PEARSON CORRELATION TEST ON BMI ~ DIABETES

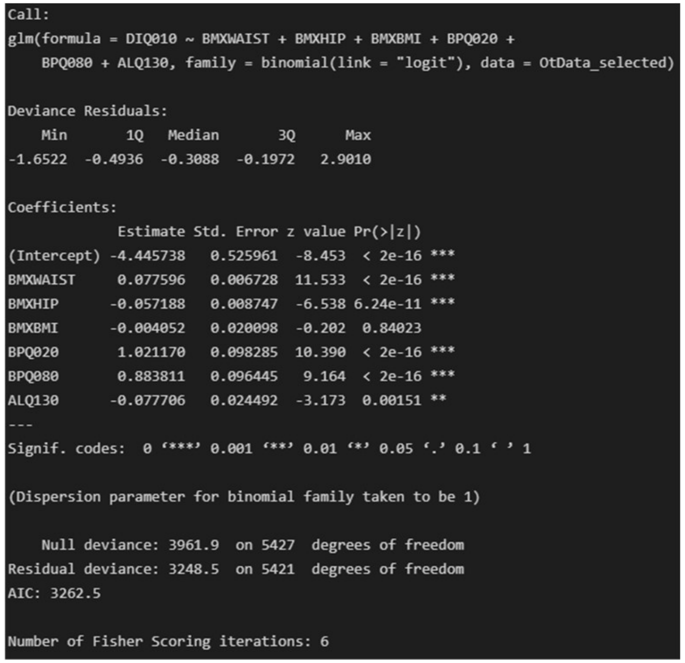


```
        Pearson's product-moment correlation

data:  OtData_selected$BMXBMI and OtData_selected$DIQ010
t = 10.935, df = 5426, p-value < 2.2e-16
alternative hypothesis: true correlation is not equal to 0
95 percent confidence interval:
 0.1207105 0.1727718
sample estimates:
      cor
0.1468428
```

LOGISTIC REGRESSION MODEL OF DIABETES ~ BMI



Result – Multiple Logistic regression model

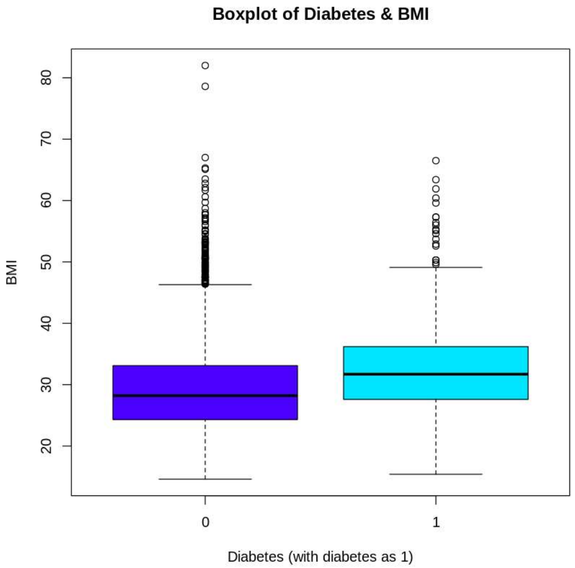


```
Call:
glm(formula = DIQ010 ~ BMXWAIST + BMXHIP + BMXBMI + BPQ020 + 
    BPQ080 + ALQ130, family = binomial(link = "logit"), data = OtData_selected)

Deviance Residuals: 
    Min       1Q   Median       3Q      Max  
-1.6522  -0.4936  -0.3088  -0.1972   2.9010  

Coefficients:
             Estimate Std. Error z value Pr(>|z|)    
(Intercept) -4.445738   0.525961  -8.453  < 2e-16 ***
BMXWAIST     0.077596   0.006728  11.533  < 2e-16 ***
BMXHIP      -0.057188   0.008747  -6.538 6.24e-11 ***
BMXBMI      -0.004052   0.020098  -0.202  0.84023    
BPQ020       1.021170   0.098285  10.390  < 2e-16 ***
BPQ080       0.883811   0.096445   9.164  < 2e-16 ***
ALQ130      -0.077706   0.024492  -3.173  0.00151 ** 
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 3961.9  on 5427  degrees of freedom
Residual deviance: 3248.5  on 5421  degrees of freedom
AIC: 3262.5

Number of Fisher Scoring iterations: 6
```

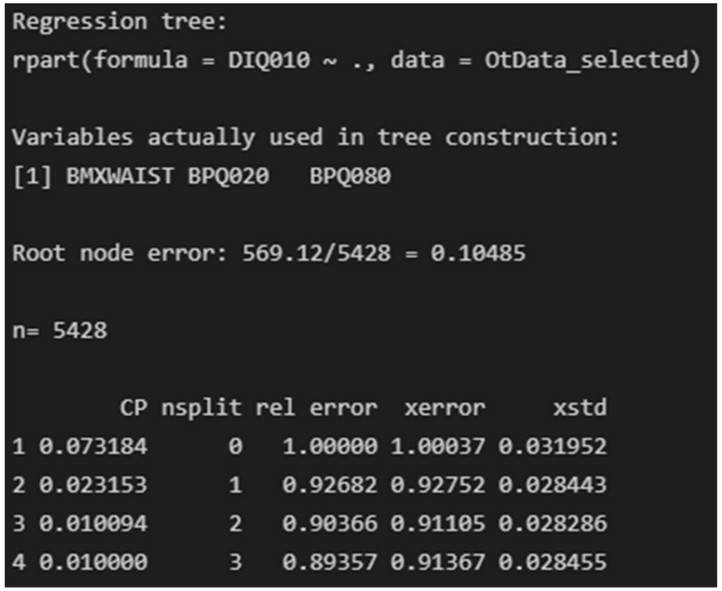
Diabetes ~ WAIST+HIP+BMI+BPQ020+BPQ080+ALQ130

Boxplot analyzing

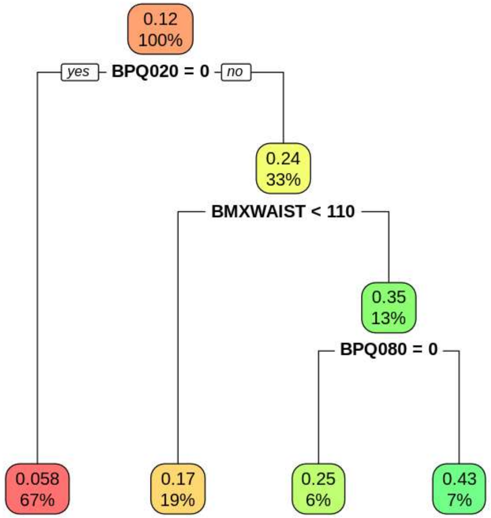
DIABETES & BMI



Decision Tree



```
Regression tree:
rpart(formula = DIQ010 ~ ., data = OtData_selected)

Variables actually used in tree construction:
[1] BMXWAIST BPQ020   BPQ080

Root node error: 569.12/5428 = 0.10485

n= 5428

        CP nsplit rel error  xerror     xstd
1 0.073184      0   1.00000 1.00037 0.031952
2 0.023153      1   0.92682 0.92752 0.028443
3 0.010094      2   0.90366 0.91105 0.028286
4 0.010000      3   0.89357 0.91367 0.028455
```



Conclusion and Discussion

- Significant relation with diabetes
  - Waist Circumference
  - Hip Circumference
  - BMI
  - High blood pressure
  - High cholesterol level
  - Heavy alcohol taking

- Having these factors
  - Tended to have higher chance of having diabetes

- Limitation
  - More variables can be used in this project
  - More datasets can be used in this project