Statistics 135 – Lab Project

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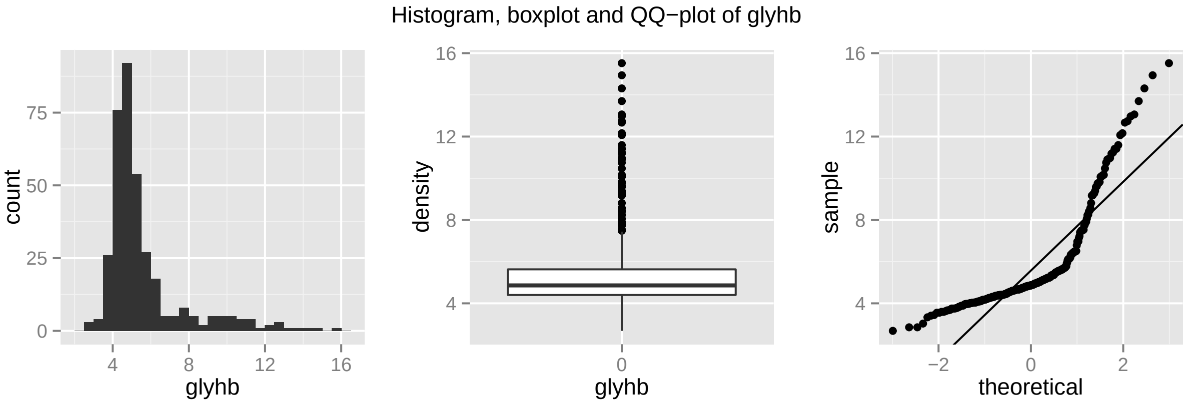
1 Background

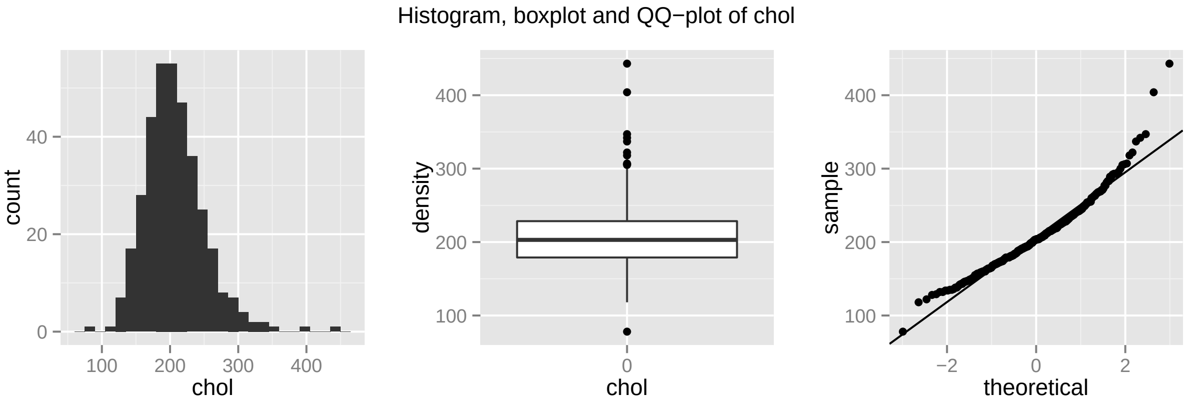
2 Accessing Data, Visualization and Summarization

1.



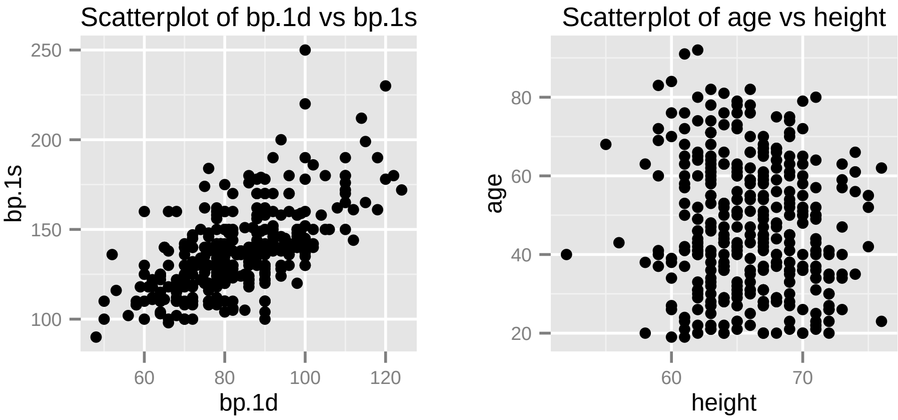
The mean, median and mode of `glyhb` are all approximately 5. The distribution of `glyhb` is left-skewed.

2.



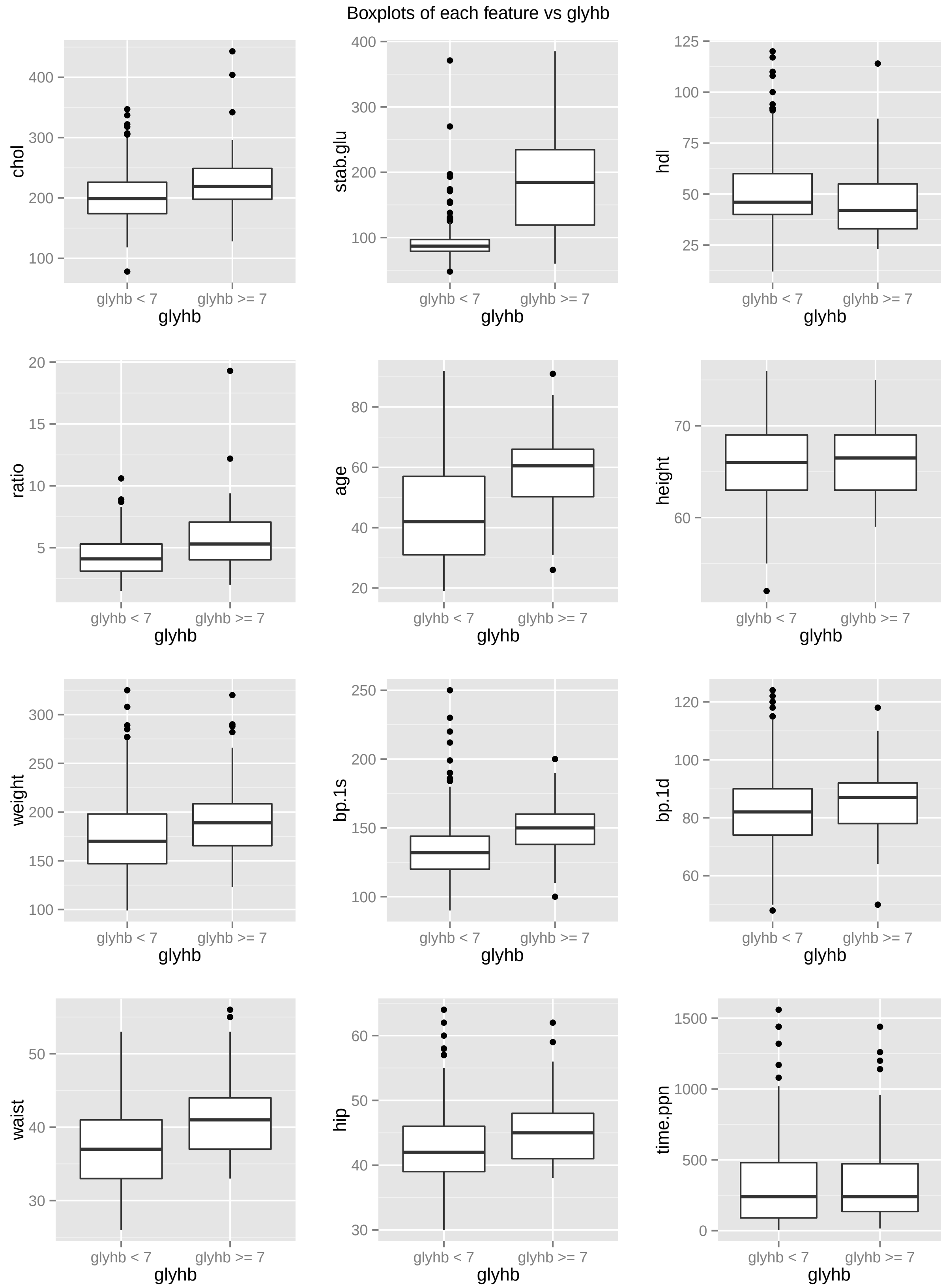
The mean, median and mode of `chol` are all approximately 200. The distribution of `chol` is better approximated with a Gaussian distribution.

3.

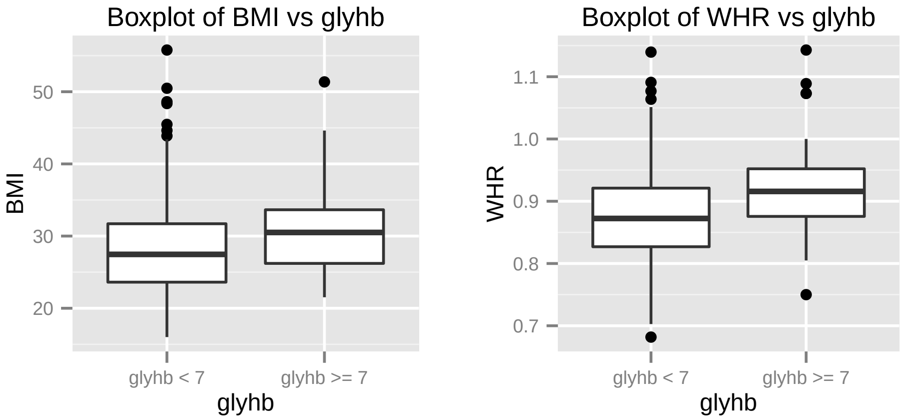


The scatterplot of `bp.1s` and `bp.1d` is near-linear, so they are approximately dependent. The scatterplot of `age` and `weight` is random, so they are approximately independent.

4.
- `chol`: The two distributions have small difference, so it MAY BE a relevant feature.
- `stab.glu`: The two distributions have substantial difference, so it SHOULD BE a relevant feature.
- `hdl`: The two distributions have small difference, so it MAY BE a relevant feature.
- `ratio`: The two distributions have small difference, so it MAY BE a relevant feature.
- `age`: The two distributions have substantial difference, so it SHOULD BE a relevant feature.
- `height`: The two distributions have little difference, so it MAY NOT BE a relevant feature.
- `weight`: The two distributions have small difference, so it MAY BE a relevant feature.
- `bp.1s`: The two distributions have small difference, so it MAY BE a relevant feature.
- `bp.1d`: The two distributions have small difference, so it MAY BE a relevant feature.
- `waist`: The two distributions have small difference, so it MAY BE a relevant feature.
- `hip`: The two distributions have small difference, so it MAY BE a relevant feature.
- `time.ppn`: The two distributions have small difference, so it MAY NOT BE a relevant feature.


Boxplots of each feature vs glyhb
chol
stab.glu
hdl
ratio
age
height
weight
bp.1s
bp.1d
waist
hip
time.ppn
glyhb < 7
glyhb >= 7
glyhb

5.



6. In light of these first experiments, `hdl`, `stab.glu`, `age`, `weight`, `bp.1s`, `bp.1d`, `waist` and `hip` seem related to the presence of type II diabetes; `chol`, `ratio`, `height` and `time.ppn` seem unrelated to the presence of type II diabetes.

3 Parametric Inference

1.

$$X \sim Gamma(\alpha, \beta) = \frac{\beta^\alpha}{\Gamma(\alpha)} x^{\alpha-1} e^{-\beta x}$$

$$E(X) = \frac{\alpha}{\beta}$$

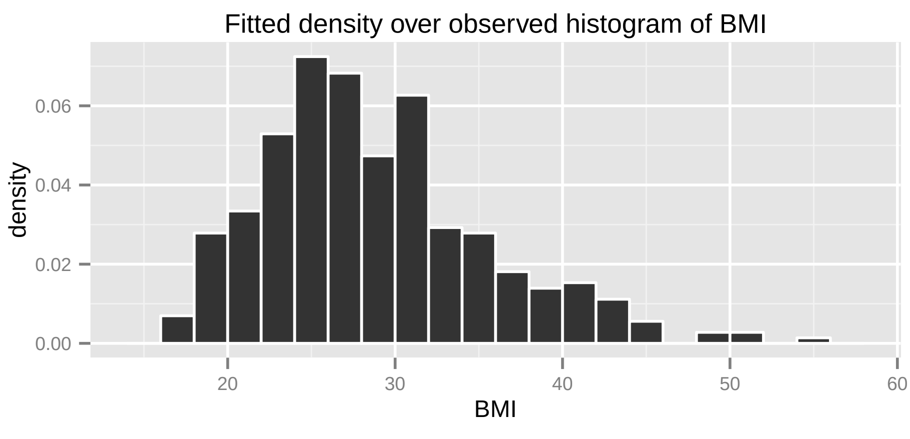
$$\begin{aligned} E(X^2) &= Var(X) + [E(X)]^2 \\ &= \frac{\alpha}{\beta^2} + \left(\frac{\alpha}{\beta}\right)^2 \\ &= \frac{\alpha(\alpha+1)}{\beta^2} \end{aligned}$$

$$\begin{cases} E(X) = \frac{\alpha}{\beta} \\ E(X^2) = \frac{\alpha(\alpha+1)}{\beta^2} \end{cases} \implies \begin{cases} \alpha = \frac{[E(X)]^2}{Var(x)} \\ \beta = \frac{E(X)}{Var(x)} \end{cases} \implies \begin{cases} \hat{\alpha}_{MOM} = \frac{\overline{X}_n}{\frac{1}{n}\sum_{i=1}^n (X_i - \overline{X}_n)^2} \\ \hat{\beta}_{MOM} = \frac{\overline{X}_n^2}{\frac{1}{n}\sum_{i=1}^n (X_i - \overline{X}_n)^2} \end{cases}$$

```
################################################################################
CI.BMI

##           alpha      beta
## 2.5%  15.77434 0.5420062
## 97.5% 21.52204 0.7547185

################################################################################
```



2.

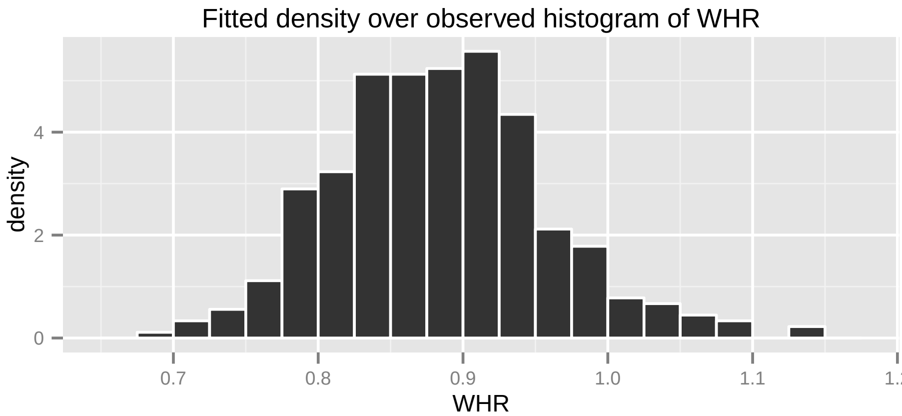
$$\hat{\mu}_{MLE} = \overline{X}_n$$

$$\hat{\sigma}^2_{MLE} = \frac{1}{n}\sum_{i=1}^{n}(X_i - \overline{X}_n)^2$$

```
##############################################################################
CI.WHR

##                mu      sigma
## 2.5%  0.8742748 0.06756228
## 97.5% 0.8903982 0.07952507

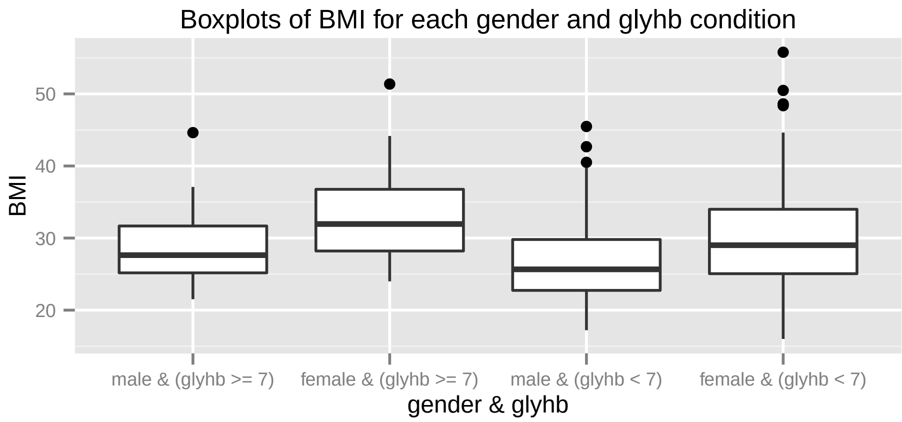
##############################################################################
```



3.
```
################################################################################
CIs.BMI

## $`male & (glyhb >= 7)`
##             mu    sigma
## 2.5%  26.84307 3.427979
## 97.5% 31.01954 7.085508
##
## $`female & (glyhb >= 7)`
##             mu    sigma
## 2.5%  31.05788 4.846527
## 97.5% 35.72685 8.152714
##
## $`male & (glyhb < 7)`
##             mu    sigma
## 2.5%  25.46761 4.762291
## 97.5% 27.43883 6.386971
##
## $`female & (glyhb < 7)`
##             mu    sigma
## 2.5%  28.78206 6.225949
## 97.5% 30.85951 7.839278

################################################################################
```

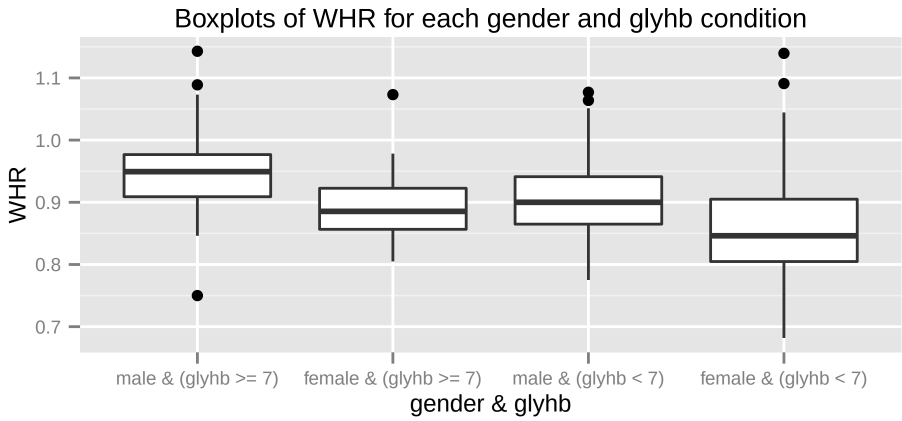


- On average, females have higher BMI than males.
- On average, people with type II diabetes (`glyhb >= 7`) have higher BMI than people without type II diabetes (`glyhb < 7`).
- People with type II diabetes (`glyhb >= 7`) have larger confidence intervals of both mean and standard deviation than people without type II diabetes (`glyhb < 7`), regardless of gender.

```
################################################################################
CIs.WHR

## $`male & (glyhb >= 7)`
##              mu      sigma
## 2.5%  0.9188920 0.04389852
## 97.5% 0.9800054 0.10382869
##
## $`female & (glyhb >= 7)`
##              mu      sigma
## 2.5%  0.8728465 0.04107824
## 97.5% 0.9149814 0.07667731
##
## $`male & (glyhb < 7)`
##              mu      sigma
## 2.5%  0.8948607 0.05534934
## 97.5% 0.9170900 0.07072515
##
## $`female & (glyhb < 7)`
##              mu      sigma
## 2.5%  0.8445763 0.06156524
## 97.5% 0.8650507 0.07899223

################################################################################
```



- On average, males have higher WHR than females.
- On average, people with type II diabetes (`glyhb >= 7`) have higher WHR than people without type II diabetes (`glyhb < 7`).
- People with type II diabetes (`glyhb >= 7`) have larger confidence intervals of both mean and standard deviation than people without type II diabetes (`glyhb < 7`), regardless of gender.

4 Testing

1. ```
   ################################################################################
   gender.glyhb.cond.table

   ##        glyhb >= 7 glyhb < 7
   ## male           24       125
   ## female         30       180

   ################################################################################
   fisher.test(gender.glyhb.cond.table)

   ##
   ##  Fisher's Exact Test for Count Data
   ##
   ## data:  gender.glyhb.cond.table
   ## p-value = 0.6552
   ## alternative hypothesis: true odds ratio is not equal to 1
   ## 95 percent confidence interval:
   ##  0.6126316 2.1465820
   ## sample estimates:
   ## odds ratio
   ##   1.151538

   ################################################################################
   ```

   Since the p-value is 0.6552, which is greater than 0.05, we fail to reject the null hypothesis that males and females are equally exposed to type II diabetes, with 5% significance level.
   ```

2. We choose to the non-parametric Kruskal-Wallis test, because it does not rely on the assumed normal distribution and less affected by outliers.

```
################################################################################
kruskal.test(data.df$hdl, as.factor(data.df$glyhb.cond))

##
##  Kruskal-Wallis rank sum test
##
## data:  data.df$hdl and as.factor(data.df$glyhb.cond)
## Kruskal-Wallis chi-squared = 7.9732, df = 1, p-value = 0.004748

################################################################################
```

Since the p-value is 0.004748, which is smaller than 0.05, we reject the null hypothesis that `hdl` has equal means for those with type II diabetes and those without, with 5% significance interval.

```
################################################################################
kruskal.test(data.df$bp.1s, as.factor(data.df$glyhb.cond))

##
##  Kruskal-Wallis rank sum test
##
## data:  data.df$bp.1s and as.factor(data.df$glyhb.cond)
## Kruskal-Wallis chi-squared = 22.563, df = 1, p-value = 2.034e-06

################################################################################
```

Since the p-value is 2.034e-06, which is smaller than 0.05, we reject the null hypothesis that `bp.1s` has equal means for those with type II diabetes and those without, with 5% significance interval.

```
################################################################################
kruskal.test(data.df$bp.1d, as.factor(data.df$glyhb.cond))

##
##  Kruskal-Wallis rank sum test
##
## data:  data.df$bp.1d and as.factor(data.df$glyhb.cond)
## Kruskal-Wallis chi-squared = 1.9007, df = 1, p-value = 0.168

################################################################################
```

Since the p-value is 0.168, which is greater than 0.05, we fail to reject the null hypothesis that `bp.1d` has equal means for those with type II diabetes and those without, with 5% significance interval.

```
################################################################################
kruskal.test(data.df$BMI, as.factor(data.df$glyhb.cond))

##
##  Kruskal-Wallis rank sum test
##
## data:  data.df$BMI and as.factor(data.df$glyhb.cond)
## Kruskal-Wallis chi-squared = 9.5655, df = 1, p-value = 0.001983
```

```
################################################################################
```

Since the p-value is 0.001983, which is smaller than 0.05, we reject the null hypothesis that `BMI` has equal means for those with type II diabetes and those without, with 5% significance interval.

```
################################################################################
kruskal.test(data.df$WHR, as.factor(data.df$glyhb.cond))

##
##  Kruskal-Wallis rank sum test
##
## data:  data.df$WHR and as.factor(data.df$glyhb.cond)
## Kruskal-Wallis chi-squared = 15.146, df = 1, p-value = 9.95e-05

################################################################################
```

Since the p-value is 9.95e-05, which is smaller than 0.05, we reject the null hypothesis that `WHR` has equal means for those with type II diabetes and those without, with 5% significance interval.

3.
```
################################################################################
pi.male.BMI

## [1] 0.6326667

CI.pi.male.BMI

##      2.5%     97.5%
## 0.5153333 0.7443583

################################################################################
pi.male.WHR

## [1] 0.6853333

CI.pi.male.WHR

##      2.5%     97.5%
## 0.5712917 0.7916833

################################################################################
```

4.

5.

6.

5 Regression

1.

2.

3.

4.

5.

6.

7.