Analysing health parameters on a young adult

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Contents

Objective

The goal of this project is to do a comparison between some health parameters (systolic pressure, diastolic pressure and weight) of one young adult that exercises four times a week versus the average parameters of a healthy young adult to practise how to program in R as well as to practise some statistical concepts.

Material and methods

This project was the result of considering how I could improve my R programming skils as well as practising some basic statistics, the solution was to practise with a dataset, so I created my own dataset by measuring some health parameters that could easily be measured at home, I took a total of 16 observations of my blood pressure , my heart rate (although this variable was not used in the analysis) and my weight.

After having all the measures, the data was processed and later analysed. After the analysis was done , a report was made with Quarto and the results of the project were shared in Github.

The reference values of blood pressure were obtained from the Center for Disease Control and Prevention (1) and the reference weight was calculated using Calculators.org. The analysis was done in R and RStudio.

Results

```r
#Loading our dataset
library(readxl)
library(tidyverse)
#Selecting the Excel file that contains our data-----------------------------------

file.choose()
```

```
[1] "D:\\OneDrive - UAM\\Escritorio\\Data analysis\\R documents\\Proyecto analisis estadisti
```

```r
# We will call raw_data the file location that we got from file.choose(), we add  everything

raw_data <- "D:\\OneDrive - UAM\\Escritorio\\Data analysis\\R documents\\Proyecto analisis e

first_data <- read_excel(raw_data)
first_data
```

```
# A tibble: 16 x 5
   momento_del_dia        ps    pd pulso  peso
   <dttm>              <dbl> <dbl> <dbl> <dbl>
 1 1899-12-31 09:30:00   104    52    52  72.6
 2 1899-12-31 10:30:00   109    52    58  72.6
 3 1899-12-31 11:30:00   100    52    50  72.9
 4 1899-12-31 12:30:00    98    54    47  72.7
 5 1899-12-31 13:30:00   103    57    44  72.2
 6 1899-12-31 14:30:00   102    60    45  72.1
 7 1899-12-31 15:30:00   112    54    44  72.8
 8 1899-12-31 16:30:00   111    53    47  72.9
 9 1899-12-31 17:30:00   120    57    49  73.1
10 1899-12-31 18:30:00   109    55    46  72.6
11 1899-12-31 19:30:00   111    58    46  73.1
12 1899-12-31 20:30:00   116    60    49  72.7
13 1899-12-31 21:30:00   112    63    44  72.4
14 1899-12-31 22:30:00   114    59    49  73.5
15 1899-12-31 23:30:00   111    55    49  73.2
16 1900-01-01 00:30:00   121    66    51  73.2
```

```r
# Removing a date from the variable momento_del_dia--------------------------------

second_data <- separate(first_data, momento_del_dia, into =c("dia", "hora"),sep=" ")

second_data
```

```
# A tibble: 16 x 6
   dia        hora        ps    pd pulso  peso
   <chr>      <chr>    <dbl> <dbl> <dbl> <dbl>
```

```
 1 1899-12-31 09:30:00   104    52    52  72.6
 2 1899-12-31 10:30:00   109    52    58  72.6
 3 1899-12-31 11:30:00   100    52    50  72.9
 4 1899-12-31 12:30:00    98    54    47  72.7
 5 1899-12-31 13:30:00   103    57    44  72.2
 6 1899-12-31 14:30:00   102    60    45  72.1
 7 1899-12-31 15:30:00   112    54    44  72.8
 8 1899-12-31 16:30:00   111    53    47  72.9
 9 1899-12-31 17:30:00   120    57    49  73.1
10 1899-12-31 18:30:00   109    55    46  72.6
11 1899-12-31 19:30:00   111    58    46  73.1
12 1899-12-31 20:30:00   116    60    49  72.7
13 1899-12-31 21:30:00   112    63    44  72.4
14 1899-12-31 22:30:00   114    59    49  73.5
15 1899-12-31 23:30:00   111    55    49  73.2
16 1900-01-01 00:30:00   121    66    51  73.2
```

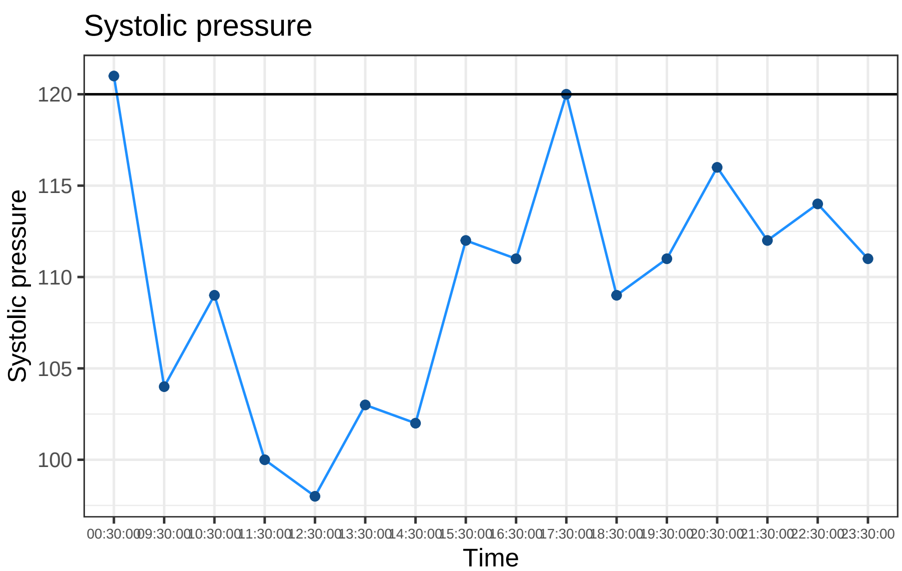
```r
third_data <- second_data %>%
 select(hora, ps, pd, pulso, peso)
third_data
```

```
# A tibble: 16 x 5
   hora        ps    pd pulso  peso
   <chr>    <dbl> <dbl> <dbl> <dbl>
 1 09:30:00   104    52    52  72.6
 2 10:30:00   109    52    58  72.6
 3 11:30:00   100    52    50  72.9
 4 12:30:00    98    54    47  72.7
 5 13:30:00   103    57    44  72.2
 6 14:30:00   102    60    45  72.1
 7 15:30:00   112    54    44  72.8
 8 16:30:00   111    53    47  72.9
 9 17:30:00   120    57    49  73.1
10 18:30:00   109    55    46  72.6
11 19:30:00   111    58    46  73.1
12 20:30:00   116    60    49  72.7
13 21:30:00   112    63    44  72.4
14 22:30:00   114    59    49  73.5
15 23:30:00   111    55    49  73.2
16 00:30:00   121    66    51  73.2
```

```r
# Plotting Systolic pressure-------------------------------------------------------
ps_graph <- third_data %>%
 ggplot(aes(x= hora,
            y=ps))

ps_graph+
```

```r
geom_line(group= "ps",
          color= "dodgerblue")+
geom_point(color="dodgerblue4")+
geom_hline(yintercept = 120)+
labs(title = "Systolic pressure",
     x= "Time",
     y= "Systolic pressure")+
theme_bw()+
theme(axis.text.x= element_text( size= "6"))
```




```r
# Statistical inference of systolic pressure (ps) ---------------------------------


mean_ps <- mean(third_data$ps)
mean_ps
```

```
[1] 109.5625
```

```r
standard_deviation_ps <- sd(third_data$ps)
standard_deviation_ps
```

```
[1] 6.712861
```

```r
# The population value for sistolic pressure for a young adult is 120

population_ps_mean <- 120

# Since we have a small sample size, only 16 observations and we dont know the population st
```

```r
# First hypothesis-------------------------------------------------------------------
#         H0; mean_ps=population_ps_mean
#         H1; mean_ps is different than population_ps_mean

# 1. Calculating 95% Confidence interval (CI) -------------------------------------
#

# n= 16

# mean_ps= 109.5625

# standard_deviation_ps= 6.712861

# degrees of freedom = n-1 = 16-1=15

#since its a 95%CI we do:

alpha <- 0.05
half_alpha <- alpha/2
percentile <- 1-half_alpha

# Now lets look on the t-student distribution table for the value of n-1=16-1=15   degrees o

t_student_ps <- 2.131

# The CI is:

lower_CI <- mean_ps-t_student_ps*(standard_deviation_ps/sqrt(16))
lower_CI
```

```
[1] 105.9862
```

```r
upper_CI <- mean_ps+ t_student_ps*(standard_deviation_ps/sqrt(16))
upper_CI
```

```
[1] 113.1388
```

```r
CI_ps <- c(lower_CI,upper_CI)
CI_ps
```

```
[1] 105.9862 113.1388
```

```r
# Since the CI does not inclue the H0 value, we can reject H0 and accept H1, the systolic pr

# 2. Method of the rejection area -------------------------------------------------
# we have to calculate the pivot value:
```

```r
pivot <-  (mean_ps-population_ps_mean)/(standard_deviation_ps/sqrt(16))
pivot
```

```
[1] -6.219405
```

```r
# Delimiting rejection zone:

#Since we did a bilateral significance test, we will establish two regions , one for values

#This two regions must cover 5% of the values which is the significance we are considering,

# Since its bilateral we will have halph_alpha on each side of the graph, so we will reject

# Our pivot value is : -6.21 which falls within the rejection region, therefore we reject H0

# 3. Calculating the p-value for this test-----------------------------------------

# We are considering both sides of the distribution since H1 is its different than 120, whic

# First we have to calculate the pivot value:

pivot_ps <- (mean_ps-population_ps_mean)/(standard_deviation_ps/sqrt(16))
pivot_ps
```

```
[1] -6.219405
```

```r
# Asumming Ho , the probability of finding lower values of our pivot is:

probability_pivot <- 1-0.9989
probability_pivot
```

```
[1] 0.0011
```

```r
# Since we are considering both sides:

p_value_ps <- probability_pivot*2
p_value_ps
```

```
[1] 0.0022
```

```r
#Second hypothesis-----------------------------------------------------------------

# Now we know that the value is different than the reference value, we want to see if its sm

# H0: ps_mean_david= ps_mean_pop; 109.5625= 120
# H1: ps_mean_david < ps_mean_pop; 109.5625 < 120

# Here we are in a one tail hypothesis test, before we were looking at values above and belo
```

```r
# Now if H1 is true, it means that ps_mean_david is smaller than the population mean.

# 1. Calculating 95% Confidence interval (CI) ------------------------------------
# Looking at the CI calculated before, since it doesnt include H0 , we can already reject H0


# 2. Method of the rejection area ------------------------------------------------
# Now to see the rejection area, since we are in a one tail, the rejection area covers all v

# P5=P95 looking at the normal table, p95= 1.64 therefore p5=-1.64

# Since our pivot = -6.21, it falls within the rejection area , therefore we reject H0 and w

# With the p-value method----------------------------------------------------------

# Here we dont multiply it by 2 because we are only looking at one side of the distribution:

probability_pivot <- 1-0.9989
probability_pivot
```

```
[1] 0.0011
```

```r
# Now we will do the same for the diastolic pressure and the weigh-----------------

#Diastolic pressure comparison-----------------------------------------------------
#This time , to clean the data and remove the date column that was imported from Excel and t

first_data
```

```
# A tibble: 16 x 5
   momento_del_dia        ps    pd pulso  peso
   <dttm>              <dbl> <dbl> <dbl> <dbl>
 1 1899-12-31 09:30:00   104    52    52  72.6
 2 1899-12-31 10:30:00   109    52    58  72.6
 3 1899-12-31 11:30:00   100    52    50  72.9
 4 1899-12-31 12:30:00    98    54    47  72.7
 5 1899-12-31 13:30:00   103    57    44  72.2
 6 1899-12-31 14:30:00   102    60    45  72.1
 7 1899-12-31 15:30:00   112    54    44  72.8
 8 1899-12-31 16:30:00   111    53    47  72.9
 9 1899-12-31 17:30:00   120    57    49  73.1
10 1899-12-31 18:30:00   109    55    46  72.6
11 1899-12-31 19:30:00   111    58    46  73.1
12 1899-12-31 20:30:00   116    60    49  72.7
13 1899-12-31 21:30:00   112    63    44  72.4
14 1899-12-31 22:30:00   114    59    49  73.5
```

```
15 1899-12-31 23:30:00   111    55    49  73.2
16 1900-01-01 00:30:00   121    66    51  73.2
```

```r
pd_analysis <- first_data %>%
 separate_wider_delim(delim = " ",
                      cols = momento_del_dia,
                      names = c("dia", "hora")) %>%
 select(hora,pd)

pd_analysis
```

```
# A tibble: 16 x 2
   hora        pd
   <chr>    <dbl>
 1 09:30:00    52
 2 10:30:00    52
 3 11:30:00    52
 4 12:30:00    54
 5 13:30:00    57
 6 14:30:00    60
 7 15:30:00    54
 8 16:30:00    53
 9 17:30:00    57
10 18:30:00    55
11 19:30:00    58
12 20:30:00    60
13 21:30:00    63
14 22:30:00    59
15 23:30:00    55
16 00:30:00    66
```

```r
pd_mean <- mean(pd_analysis$pd)
pd_mean
```

```
[1] 56.6875
```

```r
pd_reference <- 80
pd_reference
```

```
[1] 80
```

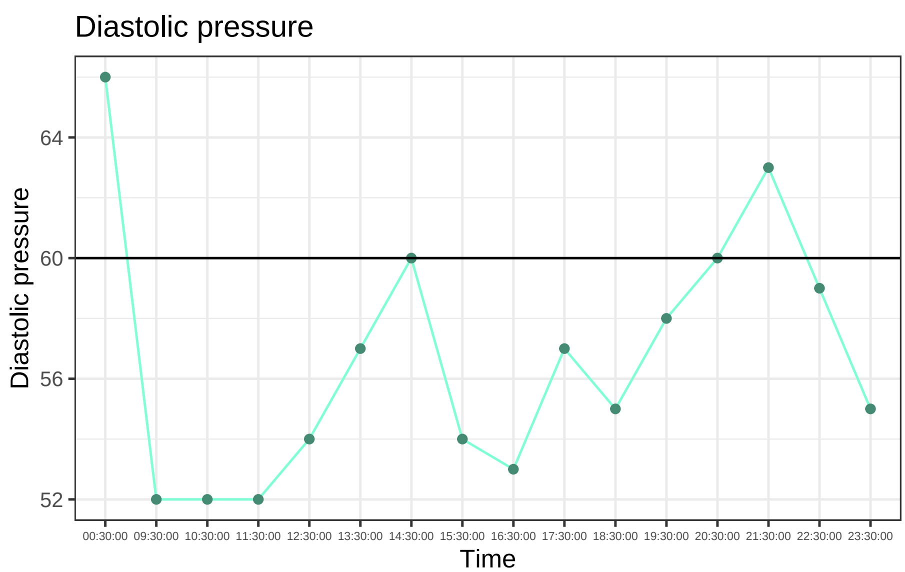
```r
standard_deviation_pd <- sd(pd_analysis$pd)
standard_deviation_pd
```

```
[1] 4.126641
```

```r
# Plotting  the diastolic pressure-------------------------------------------------

pd_graph <-
```

```
third_data %>%
 ggplot(aes(x= hora,
            y= pd))
pd_graph+
 geom_line(group= "pd",
           color= "aquamarine")+
 geom_point(color="aquamarine4")+
 geom_hline(yintercept = 60)+
 labs(title = "Diastolic pressure",
      x= "Time",
      y= "Diastolic pressure")+
 theme_bw()+
 theme(axis.text.x= element_text( size= "5"))
```




```
# Statistical inference of diastolic pressure (pd) --------------------------------

# First hypothesis-----------------------------------------------------------------
#         H0; pd_mean=pd_reference
#         H1; pd_mean is different than pd_reference

# 1. Calculating the 95% CI -------------------------------------------------------

# Formula:

# Lower CI: pd_mean-t(n-1, 1-alpha/2)*(standar_deviation_pd/sqrt(16)
# Upper CI pd_mean+t(n-1,1-alpha/2)*(standar_deviation_pd/sqrt(16)
```

```r
t_15 <- 2.131

t_15
```

```
[1] 2.131
```

```r
CI_pd_15 <- c(pd_mean-t_15*(standard_deviation_pd/sqrt(16)), pd_mean+t_15*(standard_deviatio

CI_pd_15
```

```
[1] 54.48903 58.88597
```

```r
# 2. Rejection area method -------------------------------------------------------

# Calculating the pivot

pd_pivot <- (pd_mean-pd_reference)/(standard_deviation_pd/sqrt(16))

pd_pivot
```

```
[1] -22.59707
```

```r
alpha
```

```
[1] 0.05
```

```r
halph_alpha <- alpha/2

halph_alpha
```

```
[1] 0.025
```

```r
1-halph_alpha
```

```
[1] 0.975
```

```r
# Checking normal distribution table

p97.5 <- 1.96
p2.5 <- -1.96

# Since our pd_pivot -22.59 , it falls in the rejection area, therefore we reject H0 that sa

# 3. Calculating the p-value-------------------------------------------------------

# Now we want to see the probability of getting a pivot of -22.59 if H0 is true:
# The probability of getting a value less than or equal to -22.59 is the same as
# the probability of getting a value equal or higher to 22.59 therefore:
```

```r
# p(Z>22.59)= 1-P(Z<22.59):

1-0.998
```

```
[1] 0.002
```

```r
# Since its a 2 sided we multiply that by 2:

pval_pd <- (1-0.998)*2
pval_pd
```

```
[1] 0.004
```

```r
# Since its smaller than our alhpa (0.05) we reject H0 and accept H1 that its different.

#Second hypothesis------------------------------------------------------------------

# Now, observing the data, it seems like the value is smaller than 60, we want to make the h

# H0: pd_mean= pd_reference
# H1: pd_mean< pd_reference
#
# 1. Calculating the 95% CI ----------------------------------------------------

# With the CI we have already demonstrated that it is below, since it doesnt include H0.

# 2. Rejection are method-----------------------------------------------------------
# Since out pivot is -22.59 it falls within the rejection region we calculated before, when

# 3. Calculating the p-value--------------------------------------------------------

# p(Z<-22.59)=P(z> 22.59)= 1-p(Z<22.59)= pval_pd
# Since its a one tail, the pval is the same as pval_pd :

pval_one_side_pd <- pval_pd
pval_one_side_pd
```

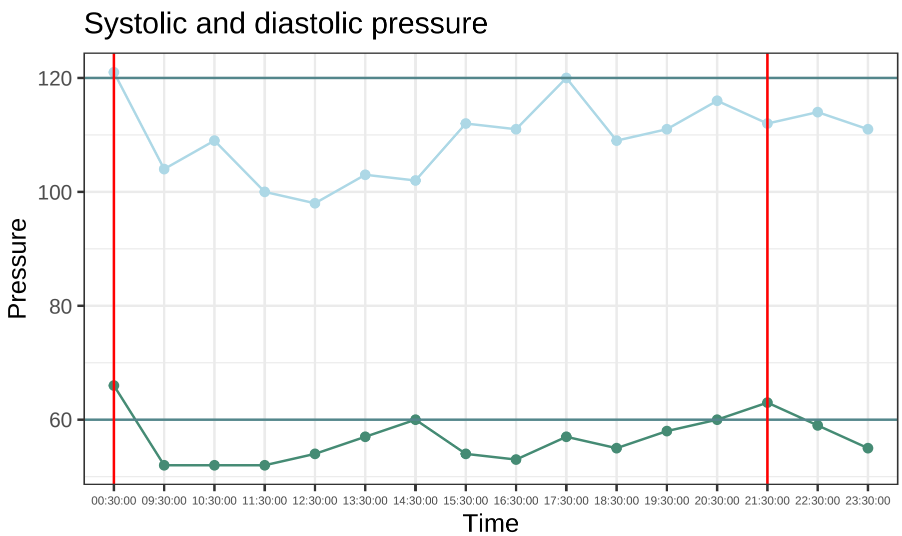
```
[1] 0.004
```

```r
# Since its <  alpha, which is 0.05 , the probability of having a diastolic presure of 56.68

# Plotting systolic and diastolic pressure together--------------------------------

third_data %>%
        ggplot(aes(x= hora))+
        geom_point(aes(y= ps), color= "lightblue")+
        geom_point(aes(y= pd), color= "aquamarine4")+
```

```r
        geom_line(aes(y= ps), group= "ps", color= "lightblue")+
        geom_line(aes(y= pd), group= "pd", color= "aquamarine4")+
        geom_hline(yintercept = 120, color= "cadetblue4")+
        geom_hline(yintercept = 60, color= "cadetblue4")+
        geom_vline(xintercept = c("00:30:00", "21:30:00"),
                   color= "red")+
        labs(title= "Systolic and diastolic pressure",
             x= "Time",
             y= "Pressure",
             caption = "lightblue represents the systolic pressure and the aquamarine4 repre
 theme_bw()+
 theme(axis.text.x= element_text( size= "5"))
```



lightblue represents the systolic pressure and the aquamarine4 represents the dyastolic pressure

```r
# Weight comparison-----------------------------------------------------------------
# To finish the main analysis, we will see if the weight of this person that works out 4 ti

third_data
```

```
# A tibble: 16 x 5
   hora         ps    pd pulso  peso
   <chr>     <dbl> <dbl> <dbl> <dbl>
 1 09:30:00    104    52    52  72.6
 2 10:30:00    109    52    58  72.6
 3 11:30:00    100    52    50  72.9
 4 12:30:00     98    54    47  72.7
 5 13:30:00    103    57    44  72.2
 6 14:30:00    102    60    45  72.1
```

```
 7 15:30:00   112    54    44  72.8
 8 16:30:00   111    53    47  72.9
 9 17:30:00   120    57    49  73.1
10 18:30:00   109    55    46  72.6
11 19:30:00   111    58    46  73.1
12 20:30:00   116    60    49  72.7
13 21:30:00   112    63    44  72.4
14 22:30:00   114    59    49  73.5
15 23:30:00   111    55    49  73.2
16 00:30:00   121    66    51  73.2
```

```
mean_weight <- mean(third_data$peso)
mean_weight
```

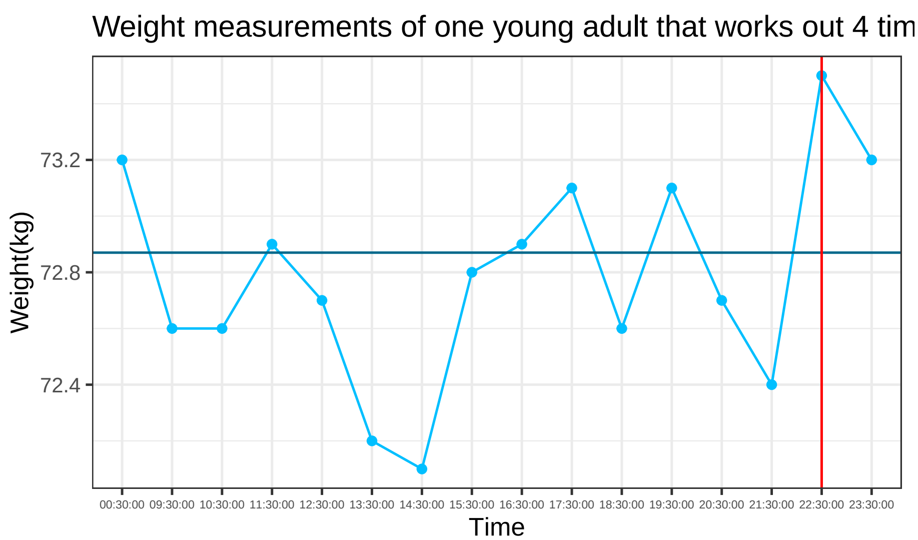
```
[1] 72.7875
```

```
reference_weight <- 72.87
reference_weight
```

```
[1] 72.87
```

```
# Plotting  weight -----------------------------------------------------------------

third_data %>%
ggplot(aes(x= hora))+
 geom_point(aes(y= peso),
            color= "deepskyblue")+
 geom_line(aes(y= peso),group= "peso", color= "deepskyblue1")+
 geom_hline( yintercept= 72.87,
             color= "deepskyblue4")+
 geom_vline(xintercept="22:30:00",
            color= "red")+
 labs( title = "Weight measurements of one young adult that works out 4 times a week",
       caption = "The vertical line shows the highest weight measurement and the horizontal
       x= "Time",
       y= "Weight(kg)")+
 theme_bw()+
 theme(axis.text.x= element_text( size= "5"))
```



ertical line shows the highest weight measurement and the horizontal line the ideal reference value

```
# Statistical inference of weight --------------------------------------------------------

#1. calculating the 95% CI, alpha= 0.05--------------------------------------------

# We dont have the population sd , therefore we are on a t-student

sd_weight <- sd(third_data$peso)
sd_weight
```

```
[1] 0.3792537
```

```
t_value_15_0.975 <- 2.131

error_weight <- 2.131*(sd_weight/sqrt(16))

CI_weight <- c(mean_weight-error_weight, mean_weight+error_weight)

CI_weight
```

```
[1] 72.58545 72.98955
```

```
# Since the confidence interval includes the reference value, with the information we have w

#2. Rejection area method ----------------------------------------------------------

#  H0: mean_weight= Reference_weight
#  H1: mean_weight is different than Reference_weight
#  alpha= 0.05
```

```r
# Calculating the pivot:

pivot_weight <- (mean_weight-reference_weight)/(sd_weight/sqrt(16))
pivot_weight
```

```
[1] -0.87013
```

```r
# The t-student value is (tn-1,1-alpha/2)= t15,1-0.05/2)=t15, 0.975= ± 2.131

# Since our pivot or t = -0.87013, it does not fall within the rejection area, therefore we

#3. calculating the p-value--------------------------------------------------------
# On a normal curve, the probability of getting a value that is equal or less than -0.87 = t

# The probability of getting a value less than 0.87= 0.8078:
one_minus_probability_higher_than_0.87 <- 1-0.8078

one_minus_probability_higher_than_0.87
```

```
[1] 0.1922
```

```r
# 0.1922= p(Z< -0.87)= p(Z>0.87)

# Since we are in a two tail:

p_value_weight <- 2*one_minus_probability_higher_than_0.87
p_value_weight
```

```
[1] 0.3844
```

```r
# Since the p-value is higher than alpha , we fail to reject H0, again there is not enough e
```

Conclusions

After analysing the systolic , diastolic and weight measurements from an individual that works out 4 times a week and comparing the results with the reference values, it was found that both the systolic and diastolic pressure were lower than the average parameters of 120 /80 mmHg of a healthy individual, however, there were no statistically significant differences between the weight and its reference value.

Bibliography

1. *High Blood Pressure Symptoms, Causes, and Problems | cdc.gov.* (2023, August 29). Centers for Disease Control and Prevention. https://www.cdc.gov/bloodpressure/about.htm

2. *How much should I weigh? Ideal body weight calculator for women & men.* (n.d.). https://www.calculators.org/health/ideal-weight.php