EVALUATING THE IMPACT OF A WELLNESS PROGRAM

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ST 3010

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Evaluating the Impact of a Workplace Wellness Program on Employee Health

Abstract

This report evaluates the effectiveness of a nine-month workplace wellness program implemented by a large corporation. The program included regular exercise classes, mental health support, and nutrition counseling, with the goals of reducing stress, promoting physical fitness, and enhancing mental health. This study analyzes synthetic data of 200 employees, focusing on changes in stress levels, physical fitness, and other health outcomes before and after the program. Additionally, it explores variations in outcomes across different job roles and departments and investigates the relationships between lifestyle factors and health improvements.

Introduction

The corporate wellness team at a large corporation implemented a workplace wellness program aimed at improving employee health and productivity. The program lasted for nine months and included a variety of activities such as exercise classes, mental health support sessions, and nutrition counseling. The primary goals of the program were to reduce employee stress, enhance physical fitness, and improve mental health. This report evaluates the impact of the program on employee health using synthetic data generated to simulate pre- and post-program conditions.

Data description

• **Employee**: Unique identifier for each employee.

• **Age**: Age of the employee (years)

• **Gender**: Gender of the employee (Male/Female).

• **Department**: Department in which the employee works (“Sales”/ “Engineering”/ “HR”/ “Finance”).

• **Job Role**: Specific job role of the employee

If Department = “Sales”	then Job role = “Manager” or “Sales Executives”
Department = “Engineering”	then Job role = "Engineer" or "Senior Engineer", or “Technician"
Department = “HR”	then Job role = ("HR Manager" or “Recruiter")
Department = “Finance”	then Job role = ("("Financial Analyst" or "Accountant"")

• **Pre-Stress Level**: Self-reported stress level before the program (integer between 4 - 10).

• **Pre-Exercise Frequency**: Frequency of exercise before the program (times per week) (integers between 0 - 5).

• **Pre-Smoking Status**: Smoking status before the program (Smoker/Non-Smoker).

• **Pre-BMI**: Body Mass Index before the program. (floats between 18.5 - 35.0)

• **Pre-Mental_Health_Score**: Mental health score before the program (integer between 4 - 10).

• **Post-Stress Level**: Self-reported stress level after the program (decreased by 0 to 3 points from the pre-stress level, but not below 1).

• **Post-Exercise Frequency**: Frequency of exercise after the program (times per week). (Increased by 0 to 3 times from Pre-exercise frequency, but not more than 7)

• **Post-Smoking Status:** Smoking status after the program (Smoker/Non-Smoker). (There is small chance of quitting smoking)

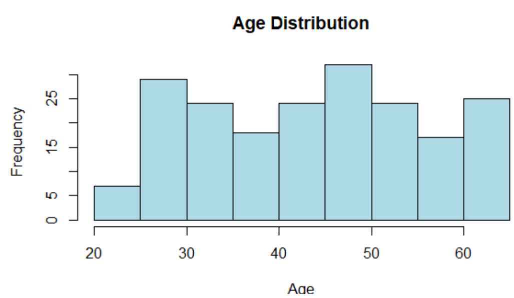
• **Post-BMI**: Body Mass Index after the program. (Decreased by 0.0 to 2.5 units from Pre-BMI randomly, but not below 18.5)

• **Post-Mental_Health_Score:** Mental health score after the program (Increased by 0 to 3 points from Pre-Mental_Health_Score, but not more than 10).

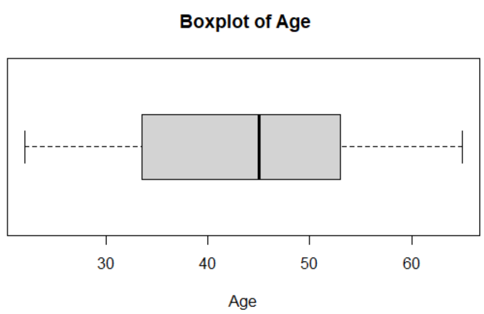
Descriptive analysis

1.0 Continuous variables

1.1 Age summary



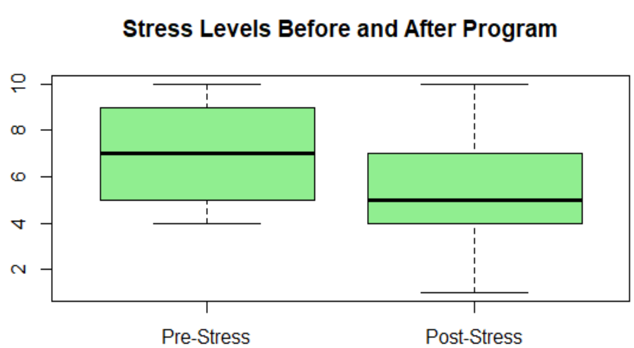

```
> summary(Age)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max. 
  22.00   33.75   45.00   44.19   53.00   65.00 
> 
```



These are the summary data of the variable **Age.**

- There are no outliers in the Age variable.
- We can see that Age variable slightly skewed to right distribution.
- Most of the observations are coming from age group 45-50.
- Least of the observations are coming from the age group 20-25

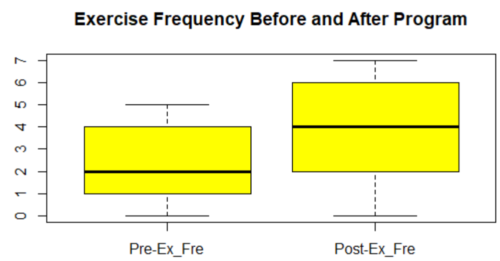
1.2 Stress level




```
> summary(Pre_Stress_Level)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max. 
   4.00    5.00    7.00    6.91    9.00   10.00 
> summary(Post_Stress_Level)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max. 
  1.000   4.000   5.000   5.445   7.000  10.000 
> 
```

- There are no outliers in the data set.
- We can see Pre-stress level has slightly skewed to left, while post-Stress level has clearly skewed to left.
- The comparison of these summary statistics suggests that, on average, participants had lower stress level after the wellness program.

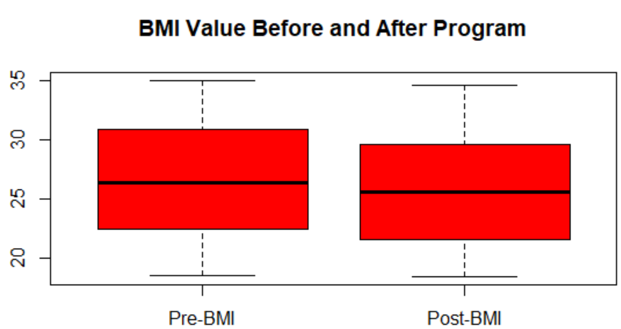
1.3 Exercise Frequency




```
> summary(Pre_Exercise_Frequency)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max. 
   0.00    1.00    2.00    2.52    4.00    5.00 
> summary(Post_Exercise_Frequency)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max. 
   0.00    2.00    4.00    3.97    6.00    7.00 
> 
```

- There are no outliers in both Pre-Exercise and Post-Exercise variables.
- We can see Pre-Exercise frequency has clearly skewed to left, while post-Exercise frequency has slightly skewed to left.
- This summary statistic suggests that, on average, participants increase their exercise frequency after the wellness program. The increment in the minimum,1 st quartile ,median,3rd quartile and maximum values after the program indicate a positive impact on exercise frequency among program participants.

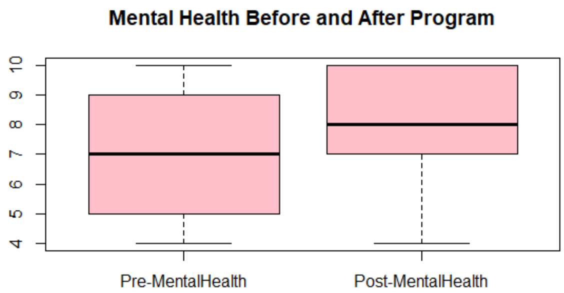
1.4 BMI Value




```
> summary(Pre_BMI)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max. 
  18.60   22.50   26.35   26.79   30.73   35.00 
> summary(Post_BMI)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max. 
  18.50   21.61   25.61   25.66   29.66   34.63 
> 
```

- The box plot shows that people's BMI (body mass index) didn't change much after the program.
- This means the program might not have been very effective in helping people lose weight or gain weight.
- And also it shows both box plots are distributed as Normal.

1.5 Mental Health

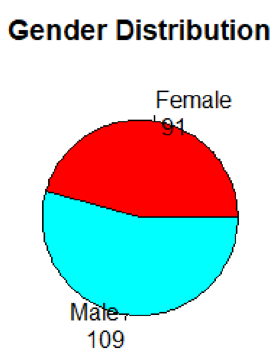


The box plot shows that mental health scores were slightly higher after the program compared to before. This suggests that the program might have been effective in improving mental health.

- The median mental health score increased after the program, indicating a general improvement in mental health.
- The spread of scores (represented by the boxes and whiskers) is similar before and after the program.
- There are no extreme outliers observed in either group.

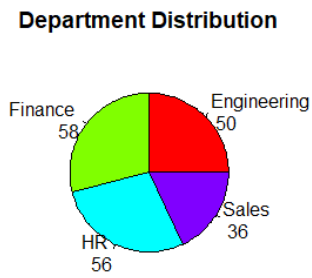
2.0 Categorical variables

2.1 Gender



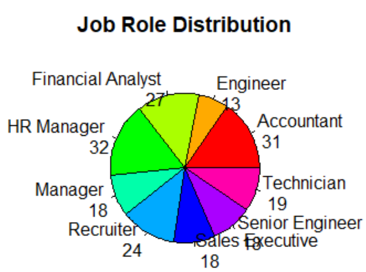
- The pie chart shows the gender distribution of a group of people.
- Males are the majority, making up approximately **54.5%** of the total.
- Females constitute the minority, representing around **45.5%** of the population.

2.2 Department



- The pie chart shows the distribution of employees in different departments.
- Finance has the highest number of employees (58), followed by Engineering (50), HR (56), and Sales (36).

2.3 Job Role



- The pie chart shows the distribution of job roles in a company.
- The largest numbers of employees are Financial Analysts, followed by HR Managers and Accountants.
- The smallest numbers of employees are Engineers and Senior Engineers.

2.4 Smoking status

```
> table(Pre_Smoking_Status)
Pre_Smoking_Status
Non-Smoker      Smoker
        96         104
> table(Post_Smoking_Status)
Post_Smoking_Status
Non-Smoker      Smoker
       114          86
>
```

The program may have contributed to reduction smoking habit among participants, as evidence by the decrease in “smoker” category for post_smoking_status compared to the “non-smoking” category. However further statistical analysis would be needed to determine whether this change is statistically significant.

Statistical Analysis

Objectives:

1. Evaluate the impact of the wellness program on stress levels and physical fitness among employees.

2. Analyze whether different job roles or departments experienced varying levels of health improvements.

3. Investigate any potential relationships between lifestyle factors (e.g., smoking, exercise frequency) and changes in health outcomes.

1.0 Evaluate the impact of the wellness program on stress level and physical fitness among employees.

1.1 Stress level

Normality assumption

In the Descriptive Statistical section, we observed that Pre-stress level has slightly skewed to left, while post-Stress level has clearly skewed to left. It implies maybe we can't use parametric test for these variables.

So, we should check for Normality assumption for these variables before using the parametric test.

```
        Shapiro-Wilk normality test

data:  workplace_wellness_dataset$Pre_Stress_Level
W = 0.91667, p-value = 3.342e-09
```

```
> shapiro.test(workplace_wellness_dataset$Post_Stress_Level)

        Shapiro-Wilk normality test

data:  workplace_wellness_dataset$Post_Stress_Level
W = 0.96785, p-value = 0.0001545
```

A statistical test for the hypothesis that the data distribution differs from a similar normal distribution is the Shapiro-Wilk test. If the test yields a non-significant result ($p>0.05$), it indicates that there is no significant difference in the sample distribution.

Based on a normal distribution, **it is evident that the p value is less than 0.05, which suggests that these variables are markedly distinct from the normal distribution**.
Therefore, non-parametric tests should be used instead of parametric testing.

To evaluate the impact of the wellness program on stress level, we can apply **Wilcoxon signed-rank test for match pairs.**

Hypothesis :

H0 : $M_{pre\_stress\ -\ post\_stress} = 0$

H1 : $M_{pre\_stress\ -\ post\_stress} > 0$

- Since the observations are greater the 30, we want to use the z test and some calculations, apart from that we can use p-value for give a conclusion.

```
Stress_Level
V = 9591, p-value < 2.2e-16
alternative hypothesis: true location shift is greater than 0
95 percent confidence interval:
 2.000058      Inf
sample estimates:
(pseudo)median
      2.000037
```

Interpretation:

The p-value is compared significance level (0.05). The p-value is less than 0.05, would reject the null hypothesis and conclude that the post-stress levels are significantly lower (better) than the pre-stress levels. In stress level, with a p-value of 2.2e-16, would reject the null hypothesis, suggesting that the post-stress level is significantly better than the pre-stress level.

1.2 Exercise Frequency

In the Descriptive Statistical section, we observed that Pre-Exercise frequency has clearly skewed to left, while post-Exercise frequency has slightly skewed to left.

So, we should check for Normality assumption for these variables before using the parametric test.

```
> shapiro.test(workplace_wellness_dataset$Pre_Exercise_Frequency)

        Shapiro-Wilk normality test

data:  workplace_wellness_dataset$Pre_Exercise_Frequency
W = 0.87917, p-value = 1.43e-11

> shapiro.test(workplace_wellness_dataset$Post_Exercise_Frequency)

        Shapiro-Wilk normality test

data:  workplace_wellness_dataset$Post_Exercise_Frequency
W = 0.93651, p-value = 1.153e-07
```

A statistical test for the hypothesis that the data distribution differs from a similar normal distribution is the Shapiro-Wilk test. If the test yields a non-significant result ($p>0.05$), it indicates that there is no significant difference in the sample distribution.

Based on a normal distribution. **It is evident that the p value is less than 0.05, which suggests that these variables are markedly distinct from the normal distribution**.
Therefore, non-parametric tests should be used instead of parametric testing.

Hypothesis :

H0 : $M_{post\_exercise\_freq\ -\ pre\_exercise\_freq} = 0$

H1 : $M_{post\_exercise\_freq\ -\ pre\_exercise\_freq} > 0$

- Since the observations are greater the 30, we want to use the z test and some calculations, apart from that we can use p-value for give a conclusion.

```
	Wilcoxon signed rank test with continuity correction

data:  Post_Exercise_Frequency and Pre_Exercise_Frequency
V = 10731, p-value < 2.2e-16
alternative hypothesis: true location shift is greater than 0

> |
```

Interpretation:

A significance level of 0.05 is used to compare the p-value. Since the p-value is less than 0.05, the null hypothesis would be rejected, and it would be determined that the post-Exercise frequencies are substantially greater (better) than the pre-Exercise frequencies. A p-value of 2.2e-16 for Exercise frequency would indicate that the post-Exercise Frequency is much better than the pre-Exercise Frequency, rejecting the null hypothesis.

2.0 Analyze whether different job roles or departments experienced varying levels of health improvements.

In this section we determine if there are any significant differences between various job roles or departments in terms of health outcomes.

- Demographic variables: - Departments (Sales, Engineering, HR, Finance)

  Job roles (Manager, Sales Executives, Engineer, Senior - Engineer, Technician, HR Manager, Recruiter, Financial Analyst, Accountant)

- Health outcomes: - Body Mass Index/BMI (After health program)

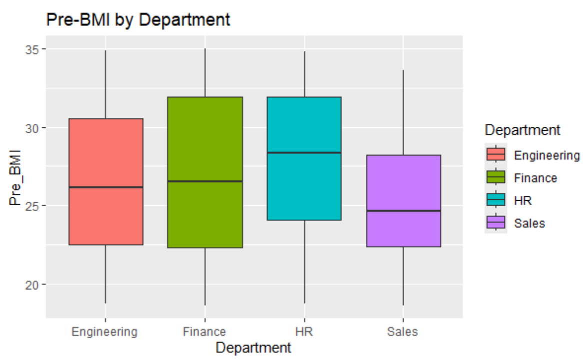
  Stress level (After health program)

  Exercise Frequency (After health program)

  Mental health (After health program)

2.1 Pre/Post BMI ~ Department

```
  `workplace_wellness_dataset$Department` mean_pre_bmi sd_pre_bmi median_pre_bmi
  <chr>                                          <dbl>      <dbl>          <dbl>
1 Engineering                                     26.7       4.90           26.2
2 Finance                                         26.9       5.18           26.6
3 HR                                              27.6       4.86           28.4
4 Sales                                           25.4       4.13           24.6
> print(summary_stats1)
# A tibble: 4 × 4
  `workplace_wellness_dataset$Department` mean_post_bmi sd_post_bmi median_post_bmi
  <chr>                                           <dbl>       <dbl>           <dbl>
1 Engineering                                      25.5        4.75            25.0
2 Finance                                          25.8        5.05            25.7
3 HR                                               26.6        4.89            27.5
4 Sales                                            24.2        4.03            23.1
> |
```



1. It shows that for each Department, the mean BMI and the median BMI has decreased after the wellness program, depicts a potential positive impact of the program on reducing BMI
2. There are no outliers in both plots in each category.

Hypothesis:

H0: There is no difference in location between the population from which ‘K’ samples have been drawn.

H1: There is a difference in locations in at least one or more populations.

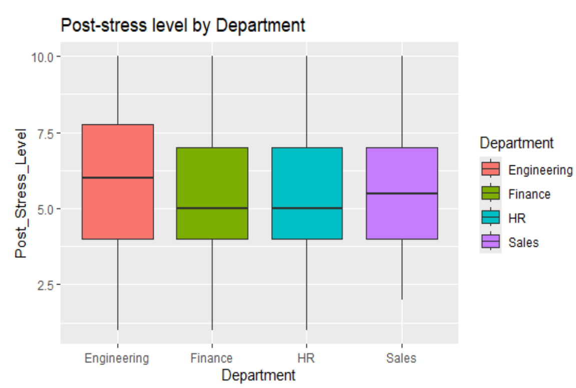
```
> kruskal.test(Post_BMI~Department)

        Kruskal-Wallis rank sum test

data:  Post_BMI by Department
Kruskal-Wallis chi-squared = 5.5921, df = 3, p-value = 0.1332
```

We accept the null hypothesis because the p-value (0.1332) is greater than 0.05, which is the standard level of significance.

We have enough statistical evidence to conclude that there are not statistically significant differences in post-BMI among the four Department groups.

2.2 Pre/Post stress-level ~ Department

```
  workplace_wellness_dataset$Depart…` mean_pre_stress sd_pre_stress median_pre_stress
  <chr>                                         <dbl>         <dbl>             <dbl>
1 Engineering                                    7.02          2.06               7
2 Finance                                        6.76          2.03               6.5
3 HR                                             6.88          2.05               7
4 Sales                                          7.06          1.87               7
# ℹ abbreviated name: ¹`workplace_wellness_dataset$Department`
> print(summary_stats1)
# A tibble: 4 × 4
  workplace_wellness_dataset$Dep…¹ mean_post_stress sd_post_stress median_post_stress
  <chr>                                       <dbl>          <dbl>              <dbl>
1 Engineering                                  5.64           2.27                6
2 Finance                                      5.45           2.45                5
3 HR                                           5.14           2.36                5
4 Sales                                        5.64           2.09                5.5
# ℹ abbreviated name: ¹`workplace_wellness_dataset$Department`
```



1. It shows that the mean and median stress levels have gone down in each department after the wellness program. This suggests that the program may have helped lower workers' stress levels.
2. There are no outliers in boxplots.
3. The median stress levels of Finance and HR departments are not varied.

Hypothesis:

H0: There is no difference in location between the Department from which the ‘K’ samples have been drawn.

H1: There is a difference in locations in at least one or more populations.

```
        Kruskal-Wallis rank sum test

data:  Post_Stress_Level by Department
Kruskal-Wallis chi-squared = 1.2177, df = 3, p-value = 0.7488

>
```

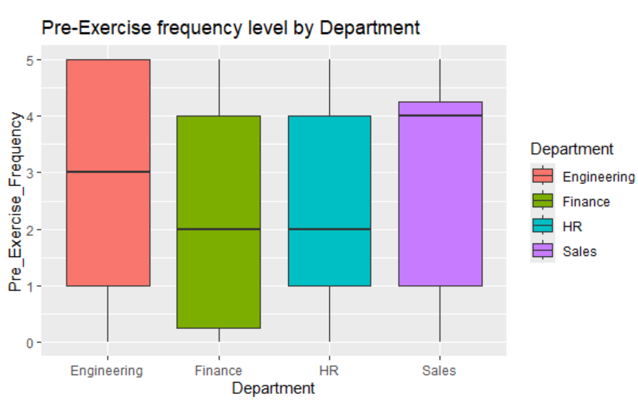
The p-value is reported as "0.7488"

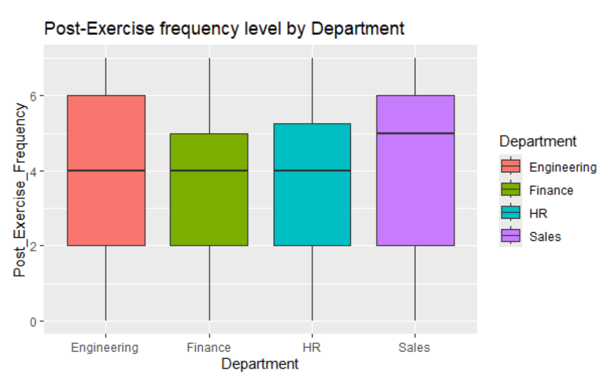
So, we do not reject the Null hypothesis.

We have enough statistical evidence to conclude that there are not statistically significant differences in post-stress level among the four Department groups.

2.3 Pre/Post Exercise Frequency ~ Department

```
  <chr>                                          <dbl>      <dbl>          <dbl>
1 Engineering                                     2.78       1.94              3
2 Finance                                         2.16       1.68              2
3 HR                                              2.45       1.84              2
4 Sales                                           2.86       1.93              4
> print(summary_stats1)
# A tibble: 4 × 4
  workplace_wellness_dataset$Departmen…¹ mean_post_Exer sd_post_Exer median_post_Exer
  <chr>                                          <dbl>        <dbl>            <dbl>
1 Engineering                                     4.18         2.19                4
2 Finance                                         3.55         1.96                4
3 HR                                              4.02         1.92                4
4 Sales                                           4.28         2.36                5
```





1. It shows that the mean and median Exercise frequency have gone up in each department after the wellness program. This suggests that the program may have helped grown up workers' Exercise frequency.
2. There are no outliers in boxplots.
3. The median Exercise frequency of Engineering, Finance and HR departments are not varied.

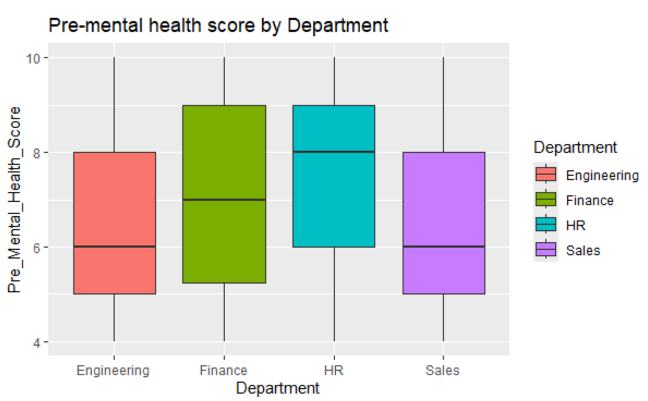
```
> kruskal.test(Post_Exercise_Frequency~Department)

        Kruskal-Wallis rank sum test

data:  Post_Exercise_Frequency by Department
Kruskal-Wallis chi-squared = 3.6441, df = 3, p-value = 0.3025

>
```

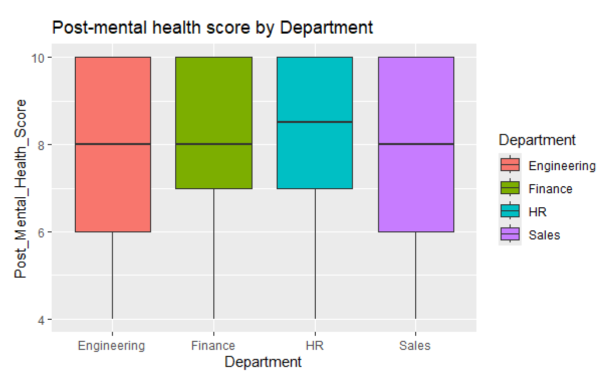
The p-value is 0.3025. Since this p-value is greater than 0.05 (the common significance level),

We do not reject the Null hypothesis. We have enough statistical evidence to conclude that there are not statistically significant differences in post-Exercise frequency among the four Department groups.

2.4 Pre/Post Mental Health ~ Departments

```
  workplace_wellness_dataset$Depart…¹ mean_pre_mental sd_pre_mental median_pre_mental
  <chr>                                          <dbl>         <dbl>             <dbl>
1 Engineering                                     6.54          1.91                 6
2 Finance                                         7.05          2.10                 7
3 HR                                              7.39          1.95                 8
4 Sales                                           6.5           1.80                 6
# ℹ abbreviated name: ¹`workplace_wellness_dataset$Department`
> print(summary_stats1)
# A tibble: 4 × 4
  workplace_wellness_dataset$Depa…¹ mean_post_mental sd_post_metal median_post_mental
  <chr>                                        <dbl>         <dbl>              <dbl>
1 Engineering                                   7.92          1.88                8
2 Finance                                       8.09          1.78                8
3 HR                                            8.38          1.75                8.5
4 Sales                                         7.78          1.93                8
# ℹ abbreviated name: ¹`workplace_wellness_dataset$Department`
```





1. There are no outliers in boxplots.
2. Overall, the average and median mental health score has gone up in all departments since the wellness program started. This suggests that the program may have improved the mental health of adult workers.
3. The median Exercise frequency of Engineering, Finance and Sales departments are not varied.

```
> kruskal.test(Post_Mental_Health_Score~Department)

        Kruskal-Wallis rank sum test

data:  Post_Mental_Health_Score by Department
Kruskal-Wallis chi-squared = 3.0318, df = 3, p-value = 0.3867
```

Since the p-value (0.3867) is greater than the commonly used significance level of 0.05, we **fail to reject the null hypothesis**. The null hypothesis states that there is no difference in the median post-mental health scores across the departments.

The data does not support the claim that there is a significant variation in post-mental health scores among the different departments.

- In all these cases the health improvements after the wellness program, we can't see any variations between Departments.

- According to job roles also we can proceed this test and it will also give the same outputs as above, so we can say that the health outcomes after the wellness program not varying between job roles

3.0 Investigate any potential relationships between lifestyle factors (e.g., smoking, exercise frequency) and changes in health outcomes.

<u>Life style factors</u>

- Smoking status
- Exercise frequency

<u>Changes in health outcomes</u>

- Stress level
- BMI
- Mental health

3.1 Correlation tests for Exercise Frequency:

1) Relationship between Change In stress level

```
> print(pre_exercise_stress_corr)

        Pearson's product-moment correlation

data:  workplace_wellness_dataset$Pre_Exercise_Frequency and stress_change
t = 0.14038, df = 198, p-value = 0.8885
alternative hypothesis: true correlation is not equal to 0
95 percent confidence interval:
 -0.1289434  0.1485116
sample estimates:
        cor 
0.009976115 

> print(post_exercise_stress_corr)

        Pearson's product-moment correlation

data:  workplace_wellness_dataset$Post_Stress_Level and stress_change
t = 8.0828, df = 198, p-value = 6.159e-14
alternative hypothesis: true correlation is not equal to 0
95 percent confidence interval:
 0.3860268 0.5956681
sample estimates:
      cor 
0.4980912 
```

Pre-exercise frequency and stress change:

- **Null hypothesis (H0):** There is no correlation between pre-exercise frequency and stress change.
- **Alternative hypothesis (H1):** There is a correlation between pre-exercise frequency and stress change.

  The correlation coefficient is very small (0.009976115).
  The p-value is 0.8885, which is much higher than a typical significance level (e.g., 0.05).

  Conclusion: There is no significant correlation between pre-exercise frequency and stress change.

Post-exercise stress level and stress change:

- **Null hypothesis (H0):** There is no correlation between post-exercise stress level and stress change.
- **Alternative hypothesis (H1):** There is a correlation between post-exercise stress level and stress change.

The correlation coefficient is moderate (0.4980912).
The p-value is extremely small (6.159e-14), indicating strong statistical significance.

Conclusion: There is a significant positive correlation between post-exercise stress level and stress change. This suggests that post-exercise stress levels are associated with greater reductions in overall stress.

2) Relationship between change in BMI

```
> print(pre_exercise_BMI_corr)

        Pearson's product-moment correlation

data:  workplace_wellness_dataset$Pre_Exercise_Frequency and BMI_change
t = 0.71385, df = 198, p-value = 0.4762
alternative hypothesis: true correlation is not equal to 0
95 percent confidence interval:
 -0.08869887  0.18808454
sample estimates:
       cor
0.05066565

> post_exercise_BMI_corr <- cor.test(workplace_wellness_dataset$Post_Exercise_Frequency,
BMI_change )
> print(post_exercise_BMI_corr)

        Pearson's product-moment correlation

data:  workplace_wellness_dataset$Post_Exercise_Frequency and BMI_change
t = 1.2129, df = 198, p-value = 0.2266
alternative hypothesis: true correlation is not equal to 0
95 percent confidence interval:
 -0.05350276  0.22197205
sample estimates:
       cor
0.08587572
```

Pre-exercise frequency and BMI change:

- **Null hypothesis (H0):** There is no correlation between pre-exercise frequency and BMI change.
- **Alternative hypothesis (H1):** There is a correlation between pre-exercise frequency and BMI change.

The correlation coefficient is moderately positive (0.18808454).
The p-value is 0.4762, which is higher than a typical significance level (e.g., 0.05).
Conclusion: While there is a positive relationship between pre-exercise frequency and BMI change, it is not statistically significant at the 0.05 level.

Post-exercise frequency and BMI change:

- **Null hypothesis (H0):** There is no correlation between post-exercise frequency and BMI change.
- **Alternative hypothesis (H1):** There is a correlation between post-exercise frequency and BMI change.

  The correlation coefficient is smaller than the pre-exercise correlation (0.08587572).
  The p-value is 0.2266, which is also higher than the typical significance level.
  Conclusion: There is no significant correlation between post-exercise frequency and BMI change.

3) Relationship between change in Mental Health

```
> print(pre_exercise_mental_corr)

	Pearson's product-moment correlation

data:  workplace_wellness_dataset$Pre_Exercise_Frequency and mental_change
t = 1.4143, df = 198, p-value = 0.1589
alternative hypothesis: true correlation is not equal to 0
95 percent confidence interval:
 -0.0392832  0.2354767
sample estimates:
      cor
0.1000028

> post_exercise_mental_corr <- cor.test(workplace_wellness_dataset$Post_Exercise_Freque
cy,mental_change )
> print(post_exercise_mental_corr)

	Pearson's product-moment correlation

data:  workplace_wellness_dataset$Post_Exercise_Frequency and mental_change
t = 1.036, df = 198, p-value = 0.3015
alternative hypothesis: true correlation is not equal to 0
95 percent confidence interval:
 -0.06598786  0.21002683
sample estimates:
       cor
0.07342538
```

Pre-exercise frequency and mental change:

- **Null hypothesis (H0):** There is no correlation between pre-exercise frequency and mental health change.
- **Alternative hypothesis (H1):** There is a correlation between pre-exercise frequency and mental health change.

The correlation coefficient slightly larger (0.1000028).
The p-value is 0.1589, which is higher than a typical significance level (e.g., 0.05).

Conclusion: There is no significant correlation between pre-exercise frequency and mental change.

Post-exercise frequency and mental change:

- **Null hypothesis (H0):** There is no correlation between post-exercise frequency and mental health change.
- **Alternative hypothesis (H1):** There is a correlation between post-exercise frequency and mental health change.

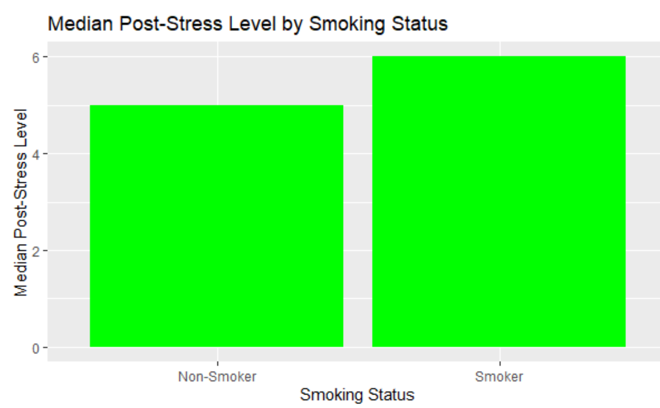
The correlation coefficient is slightly larger (0.07342538).
The p-value is 0.3015, which is still higher than the typical significance level.

Conclusion: There is no significant correlation between post-exercise frequency and mental change.

3.2 Relation between smoking status:

1) Relationship between change in stress level

To determine if smokers and non-smokers experience different changes in stress levels, one can utilize **Wilcoxson's rank sum test**.



```
> wilcox.test(Post_Stress_Level~Post_Smoking_Status)

        Wilcoxon rank sum test with continuity correction

data:  Post_Stress_Level by Post_Smoking_Status
W = 4728.5, p-value = 0.667
alternative hypothesis: true location shift is not equal to 0

> wilcox.test(Pre_Stress_Level~Pre_Smoking_Status)

        Wilcoxon rank sum test with continuity correction

data:  Pre_Stress_Level by Pre_Smoking_Status
W = 4601, p-value = 0.3344
alternative hypothesis: true location shift is not equal to 0
```

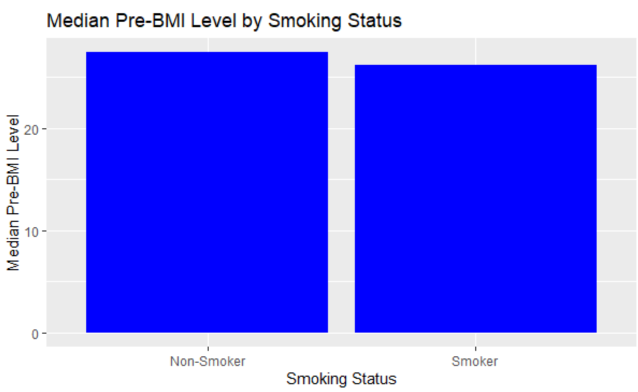
From the bar charts, we can see that the median stress level of non-smokers is less than that of smokers both before and after the program. However, the gap between the median stress level of non-smokers and smokers is greater after the program. Furthermore, analysis can do using Wilcoxson's ran sum test.

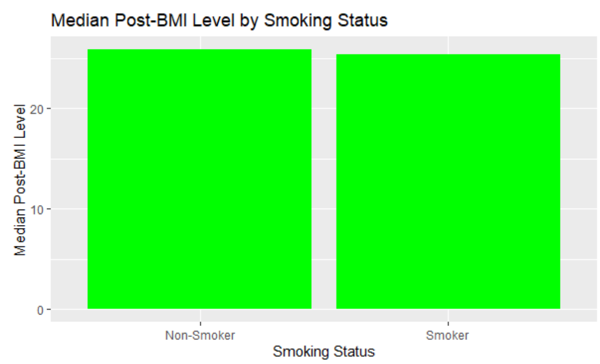
H0: There is no difference in location between stress levels between non-smokers and smokers.

H1: There is a difference in location between stress levels between non-smokers and smokers.

In both tests, the p-value is more than 0.05, hence the null hypothesis is not rejected. Thus, we can draw the conclusion that there is no discernible difference between smokers and non-smokers in the median of their pre- and post-stress levels.

2) Relationship between change in stress BMI





```
        Wilcoxon rank sum test with continuity correction

data:  Post_BMI by Post_Smoking_Status
W = 5152, p-value = 0.538
alternative hypothesis: true location shift is not equal to 0

> wilcox.test(Pre_BMI~Pre_Smoking_Status)

        Wilcoxon rank sum test with continuity correction

data:  Pre_BMI by Pre_Smoking_Status
W = 5301.5, p-value = 0.4499
alternative hypothesis: true location shift is not equal to 0

> 
```

The bar chart shows the median pre-BMI level for non-smokers and smokers. The median pre-BMI level for both groups is around 20. This indicates that there is no significant difference in the pre-BMI levels between non-smokers and smokers. there is no significant difference in either pre- or post-BMI levels between non-smokers and smokers. This suggests that smoking status does not appear to have a substantial impact on body mass index, at least in the context of the data presented.

Null Hypothesis (H0): There is no difference in the median pre- and post-BMI levels between non-smokers and smokers.

Alternative Hypothesis (H1): There is a difference in the median pre- and post-BMI levels between non-smokers and smokers.

The p-value for the pre-BMI comparison is 0.4499. This suggests that there is no significant difference in the pre-BMI levels between non-smokers and smokers. The p-value for the post-BMI comparison is 0.538. This also indicates that there is no significant difference in the post-BMI levels between the two groups. Based on the Wilcoxon rank sum tests, there is no statistically significant difference in either pre- or post-BMI levels between non-smokers and smokers.

3) Relationship between change in Mental Health score

The bar chart shows the median pre-mental health score level for non-smokers and smokers. The median pre-mental health score level for both groups is around 6. This indicates that there is no significant difference in the pre-mental health scores between non-smokers and smokers.

The median post-mental health score level for smokers and non-smokers is displayed in the bar chart. For both groups, the median post-mental health score is approximately 8. This suggests that there is little difference between smokers and non-smokers' post-mental health scores.

```
        Wilcoxon rank sum test with continuity correction

data:  Post_Mental_Health_Score by Post_Smoking_Status
W = 5444, p-value = 0.1698
alternative hypothesis: true location shift is not equal to 0

> wilcox.test(Pre_Mental_Health_Score~Pre_Smoking_Status)

        Wilcoxon rank sum test with continuity correction

data:  Pre_Mental_Health_Score by Pre_Smoking_Status
W = 5179.5, p-value = 0.6439
alternative hypothesis: true location shift is not equal to 0

> 
```

Null Hypothesis (H0): There is no difference in the median pre- and post-mental health scores between non-smokers and smokers.

Alternative Hypothesis (H1): There is a difference in the median pre- and post-mental health scores between non-smokers and smokers.

The p-value for the pre-mental health score comparison is 0.6439. This suggests that there is no significant difference in the pre-mental health scores between non-smokers and smokers. The p-value for the post-mental health score comparison is 0.1698. While this p-value is lower than the previous one, it is still not statistically significant at a typical alpha level of 0.05. Therefore, there is no significant difference in the post-mental health scores between non-smokers and smokers either.

Based on the Wilcoxon rank sum tests, there is no statistically significant difference in either pre- or post-mental health scores between non-smokers and smokers.

Conclusion

Based on the study, we can conclude that the wellness program has significantly improved the participants' overall well-being. By examining at the pre and the post values for important areas such as stress level, exercise frequency, smoking level, BMI, and mental health scores, we can identify that the wellness program has resulted in a positive impact of participants' health. The participants had reduced stress levels and increased physical activity, indicating that the program has promoted healthy habits and behaviors. The decrease in smoking level among participants also shows that the wellness program was successful and effective in encouraging better health choices. Moreover, the reduction in BMI values and improvement in mental health scores, highlight the positive benefits of the wellness program in both physical and mental health of the participants.

Appendix: R codes

```
attach(workplace_wellness_dataset)

## continuous variables
summary(Age)
hist(workplace_wellness_dataset$Age, main="Age Distribution", xlab="Age", col="lightblue",
border="black",freq = FALSE)
lines(density(workplace_wellness_dataset$Age), col="red", lwd=2)

boxplot(workplace_wellness_dataset$Age, horizontal = TRUE, main = " Boxplot of Age", xlab = "Age")

summary(Pre_Stress_Level)
summary(Post_Stress_Level)
boxplot(workplace_wellness_dataset$Pre_Stress_Level, workplace_wellness_dataset$Post_Stress_Level,
names=c("Pre-Stress", "Post-Stress"), main="Stress Levels Before and After Program",col="lightgreen")

summary(Pre_Exercise_Frequency)
summary(Post_Exercise_Frequency)
boxplot(workplace_wellness_dataset$Pre_Exercise_Frequency,
workplace_wellness_dataset$Post_Exercise_Frequency, names=c("Pre-Ex_Fre", "Post-Ex_Fre"),
main="Exercise Frequency Before and After Program",col="yellow")

summary(Pre_BMI)
summary(Post_BMI)
boxplot(workplace_wellness_dataset$Pre_BMI, workplace_wellness_dataset$Post_BMI, names=c("Pre-
BMI", "Post-BMI"), main="BMI Value Before and After Program",col="red")

summary(Pre_Mental_Health_Score)
summary(Post_Mental_Health_Score)
boxplot(workplace_wellness_dataset$Pre_Mental_Health_Score,
workplace_wellness_dataset$Post_Mental_Health_Score, names=c("Pre-MentalHealth", "Post-
MentalHealth"), main="Mental Health Before and After Program",col="pink")

## categorical variables
# Calculate the frequency distribution for Gender
gender_dist <- table(data$Gender)

# Create the pie chart
pie(gender_dist, main="Gender Distribution", col=rainbow(length(gender_dist)),
labels=paste(names(gender_dist), "\n", gender_dist))

# Calculate the frequency distribution for Department
department_dist <- table(data$Department)
```

```
# Create the pie chart
pie(department_dist, main="Department Distribution", col=rainbow(length(department_dist)),
labels=paste(names(department_dist), "\n", department_dist))

# Calculate the frequency distribution for Job Role
jobrole_dist <- table(data$Job_Role)

# Create the pie chart
pie(jobrole_dist, main="Job Role Distribution", col=rainbow(length(jobrole_dist)),
labels=paste(names(jobrole_dist), "\n", jobrole_dist))

summary(Pre_Smoking_Status)
summary(Post_Smoking_Status)
table(Pre_Smoking_Status)
table(Post_Smoking_Status)

## Statistical Analysis
shapiro.test(workplace_wellness_dataset$Pre_Stress_Level)
shapiro.test(workplace_wellness_dataset$Post_Stress_Level)
shapiro.test(workplace_wellness_dataset$Pre_Exercise_Frequency)
shapiro.test(workplace_wellness_dataset$Post_Exercise_Frequency)

##stress level wilcox test
wilcox.test(workplace_wellness_dataset$Pre_Stress_Level,workplace_wellness_dataset$Post_Stress_Lev
el,alternative = "greater",paired = T, conf.level = 0.95)

##Exercise freqeuncy wilcox test
wilcox.test(Post_Exercise_Frequency,Pre_Exercise_Frequency,mu=0,alternative = "greater",paired =
T,conf.level = 0.95)

## objective 2
##(1)
library(dplyr)
library(ggplot2)

summary_stats <- workplace_wellness_dataset %>%
group_by(workplace_wellness_dataset$Department) %>%summarize(mean_pre_bmi =
mean(Pre_BMI),sd_pre_bmi = sd(Pre_BMI),median_pre_bmi = median(Pre_BMI), )

summary_stats1 <- workplace_wellness_dataset
%>%group_by(workplace_wellness_dataset$Department) %>%summarize( mean_post_bmi =
mean(Post_BMI),sd_post_bmi = sd(Post_BMI),median_post_bmi = median(Post_BMI),  )

print(summary_stats)
print(summary_stats1)
```

```
ggplot(workplace_wellness_dataset, aes(x = Department, y = Pre_BMI, fill = Department))
+geom_boxplot() +labs(title = "Pre-BMI by Department")

ggplot(workplace_wellness_dataset, aes(x = Department, y = Post_BMI, fill = Department))
+geom_boxplot() +labs(title = "Post-BMI level by Department")

kruskal.test(Post_BMI~Department)

#(2)

summary_stats <- workplace_wellness_dataset %>%
group_by(workplace_wellness_dataset$Department) %>%summarize(mean_pre_stress =
mean(Pre_Stress_Level),sd_pre_stress = sd(Pre_Stress_Level),median_pre_stress =
median(Pre_Stress_Level), )

summary_stats1 <- workplace_wellness_dataset
%>%group_by(workplace_wellness_dataset$Department) %>%summarize( mean_post_stress =
mean(Post_Stress_Level),sd_post_stress = sd(Post_Stress_Level),median_post_stress =
median(Post_Stress_Level),  )
print(summary_stats)
print(summary_stats1)

ggplot(workplace_wellness_dataset, aes(x = Department, y = Pre_Stress_Level, fill = Department))
+geom_boxplot() +labs(title = "Pre-stress level by Department")

ggplot(workplace_wellness_dataset, aes(x = Department, y = Post_Stress_Level, fill = Department))
+geom_boxplot() +labs(title = "Post-stress level by Department")

kruskal.test(Post_Stress_Level~Department)

# (3)
summary_stats <- workplace_wellness_dataset %>%
group_by(workplace_wellness_dataset$Department) %>%summarize(mean_pre_Exer =
mean(Pre_Exercise_Frequency),sd_pre_Exer = sd(Pre_Exercise_Frequency),median_pre_Exer =
median(Pre_Exercise_Frequency), )

summary_stats1 <- workplace_wellness_dataset
%>%group_by(workplace_wellness_dataset$Department) %>%summarize( mean_post_Exer =
mean(Post_Exercise_Frequency),sd_post_Exer = sd(Post_Exercise_Frequency),median_post_Exer =
median(Post_Exercise_Frequency),  )

print(summary_stats)
print(summary_stats1)

ggplot(workplace_wellness_dataset, aes(x = Department, y = Pre_Exercise_Frequency, fill =
Department)) +geom_boxplot() +labs(title = "Pre-Exercise frequency level by Department")

ggplot(workplace_wellness_dataset, aes(x = Department, y = Post_Exercise_Frequency, fill =
Department)) +geom_boxplot() +labs(title = "Post-Exercise frequency level by Department")

kruskal.test(Post_Exercise_Frequency~Department)
```

```
#(4)

summary_stats <- workplace_wellness_dataset %>%
group_by(workplace_wellness_dataset$Department) %>%summarize(mean_pre_mental =
mean(Pre_Mental_Health_Score),sd_pre_mental = sd(Pre_Mental_Health_Score),median_pre_mental =
median(Pre_Mental_Health_Score), )

summary_stats1 <- workplace_wellness_dataset
%>%group_by(workplace_wellness_dataset$Department) %>%summarize( mean_post_mental =
mean(Post_Mental_Health_Score),sd_post_metal = sd(Post_Mental_Health_Score),median_post_mental
= median(Post_Mental_Health_Score),  )

print(summary_stats)
print(summary_stats1)

ggplot(workplace_wellness_dataset, aes(x = Department, y = Pre_Mental_Health_Score, fill =
Department)) +geom_boxplot() +labs(title = "Pre-mental health score by Department")

ggplot(workplace_wellness_dataset, aes(x = Department, y = Post_Mental_Health_Score, fill =
Department)) +geom_boxplot() +labs(title = "Post-mental health score by Department")

kruskal.test(Post_Mental_Health_Score~Department)

## objective 3

## (1)

stress_change <- workplace_wellness_dataset$Post_Stress_Level -
workplace_wellness_dataset$Pre_Stress_Level
pre_exercise_stress_corr <- cor.test(workplace_wellness_dataset$Pre_Exercise_Frequency,stress_change
)
print(pre_exercise_stress_corr)

post_exercise_stress_corr <-
cor.test(workplace_wellness_dataset$Post_Exercise_Frequency,stress_change )
print(post_exercise_stress_corr)

## (2)
BMI_change <- workplace_wellness_dataset$Post_BMI - workplace_wellness_dataset$Pre_BMI
pre_exercise_BMI_corr <- cor.test(workplace_wellness_dataset$Pre_Exercise_Frequency,BMI_change )
print(pre_exercise_BMI_corr)

post_exercise_BMI_corr <- cor.test(workplace_wellness_dataset$Post_Exercise_Frequency,BMI_change
)
print(post_exercise_BMI_corr)
## (3)
mental_change <- workplace_wellness_dataset$Post_Mental_Health_Score -
workplace_wellness_dataset$Pre_Mental_Health_Score
pre_exercise_mental_corr <-
cor.test(workplace_wellness_dataset$Pre_Exercise_Frequency,mental_change )
```

```
print(pre_exercise_mental_corr)

post_exercise_mental_corr <-
cor.test(workplace_wellness_dataset$Post_Exercise_Frequency,mental_change )
print(post_exercise_mental_corr)

## smoking status vs health outcomes
## smoking statsu vs change in health outcomes
# Load ggplot2 library
library(ggplot2)

ggplot(workplace_wellness_dataset, aes(x = Pre_Smoking_Status, y = Pre_Stress_Level))
+geom_bar(stat = "summary", fun = "median", fill = "blue") + ggtitle("Median Pre-Stress Level by
Smoking Status") +xlab("Smoking Status") +  ylab("Median Pre-Stress Level")

ggplot(workplace_wellness_dataset, aes(x = Post_Smoking_Status, y = Post_Stress_Level))
+geom_bar(stat = "summary", fun = "median", fill = "green") +ggtitle("Median Post-Stress Level by
Smoking Status") +xlab("Smoking Status") + ylab("Median Post-Stress Level")

wilcox.test(Post_Stress_Level~Post_Smoking_Status)
wilcox.test(Pre_Stress_Level~Pre_Smoking_Status)


##SMOKING STATUS VS BMI
ggplot(workplace_wellness_dataset, aes(x = Pre_Smoking_Status, y = Pre_BMI)) +geom_bar(stat =
"summary", fun = "median", fill = "blue") +ggtitle("Median Pre-BMI Level by Smoking Status") +
xlab("Smoking Status") + ylab("Median Pre-BMI Level")

ggplot(workplace_wellness_dataset, aes(x = Post_Smoking_Status, y = Post_BMI)) +geom_bar(stat =
"summary", fun = "median", fill = "green") +ggtitle("Median Post-BMI Level by Smoking Status")
+xlab("Smoking Status") + ylab("Median Post-BMI Level")

wilcox.test(Post_BMI~Post_Smoking_Status)
wilcox.test(Pre_BMI~Pre_Smoking_Status)


##SMOKING STATUS VS Mental health score

ggplot(workplace_wellness_dataset, aes(x = Pre_Smoking_Status, y = Pre_Mental_Health_Score))
+geom_bar(stat = "summary", fun = "median", fill = "blue") +ggtitle("Median Pre-mental health score
Level by Smoking Status") +xlab("Smoking Status") +  ylab("Median Pre-mental health score Level")

ggplot(workplace_wellness_dataset, aes(x = Post_Smoking_Status, y = Post_Mental_Health_Score))
+geom_bar(stat = "summary", fun = "median", fill = "green") +ggtitle("Median Post-mental health score
Level by Smoking Status") +xlab("Smoking Status") + ylab("Median Post-mental health score Level")

wilcox.test(Post_Mental_Health_Score~Post_Smoking_Status)
wilcox.test(Pre_Mental_Health_Score~Pre_Smoking_Status)
```