STA304H5F : GROUP 10

WRITTEN REPORT

University of Toronto at Mississauga
Fall 2019
SURVEYS, SAMPLING AND OBSERVATIONAL DATA
STA304H5F

COURSE PROJECT

Final Written Report Due – 25 Nov 2020

All undersigned students have made a significant contribution to this project:

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The impact of COVID-19 on the student's mental health
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CONTENTS

1. INTRODUCTION

Efforts to control the COVID-19 pandemic have included policy changes, which have affected the way students live, their residences and their education. Cautiousness is necessary to stop the spread, but excessive worry may be detrimental to other aspects of a person's health, such as increased feelings of stress, anxiety and depression.

The purpose of this study is to analyze how the pandemic has impacted the mental health of STA304 students at University of Toronto Mississauga during the Fall 2020 semester. The classes that these students attend have been moved online, and on-campus living spaces have been emptied in lieu of social-distancing advisories, leading to isolation. Depending on one's personality type, these changes may affect their mental health positively or negatively. This study aims to determine the relationship between the characteristics (stress, anxiety, and depression), overall mental state and the factors that may cause these feelings to be exhibited.

To identify these factors, a 15-question survey was designed where each question aims to measure a particular aspect of the student's mental health. The survey was posted by STA304 course staff on Piazza-- the forum used by students for communicating-- for the students to answer.

2. DESCRIPTION OF VARIABLES IN THE DATA

Mental health is defined as, "the condition of being sound mentally and emotionally that is characterized by the absence of mental illness and by adequate adjustment especially as reflected in feeling comfortable about oneself, positive feelings about others, and the ability to meet the demands of daily life" (Merriam-Webster dictionary). As part of our study, we try to define more variables that can contribute to students' mental health. This condition of mental health can be assessed more concretely by measuring three (negative) emotional states-- stress, anxiety, and depression-- since these are recognizable reactions to difficult scenarios that may require treatment. **Stress** is "a state of mental tension and worry caused by problems in your life, work"(Merriam-Webster). **Anxiety** is "a strong desire sometimes mixed with doubt, fear, or

uneasiness"(Merriam-Webster). **Depression** is "a mood disorder marked especially by sadness, inactivity, difficulty in thinking and concentration" (Merriam-Webster).

3. INTERPRETATION OF RESULTS

A total of 47 students from the STA304H5 Fall 2020 semester responded to the survey. The group of respondents included 21 females and 26 males; six students reported that a family member contracted COVID-19, and another two report that they themselves tested positive.

The questions that asked most directly about mental health were phrased in terms of the feeling (stress/anxiety/depression/overall mental health) and the time period (before COVID/ during COVID). Students were asked to self-report on a 1-to-9 scale how much they agree with a statement, where 1 was indicated to signify no fear and 9 was indicated to signify immense fear. The frequency table below shows the frequencies of how often an option was selected for the following questions:

	Frequencies of Selected Options								
Questions	1	2	3	4	5	6	7	8	9
Before Covid-19, my mental health was poor.	10	4	8	5	8	2	6	1	3
Currently, my mental health is poor.	7	4	6	5	2	8	7	2	6
Before Covid-19, I felt stressed overall.	3	5	2	7	12	10	3	1	4
Currently, I feel stressed nowadays.	1	5	0	4	3	7	12	5	10
Before Covid-19, I felt anxious overall.	5	4	3	7	11	6	3	1	7

Currently, I feel anxious nowadays.	4	3	0	5	3	13	7	3	9
Before Covid-19, I felt depressed.	9	6	5	10	5	6	0	3	3
Currently, I feel depressed nowadays.	4	10	2	5	1	9	6	6	4
I am scared of contracting COVID-19.	3	0	2	8	8	6	10	4	6
I am scared of my family members and/or loved ones contracting COVID-19.	0	0	3	1	7	1	1	12	22

Chart 1. Records frequencies of selected options. There are a total of 47 students who answered the survey, and all of these questions are mandatory.

To determine the reliability and consistency of the variables in the survey, the Cronbach's Alpha test was run on the entire sample of 47 students to determine if the questions asked are relevant to what the study aims to show. A high value of 0.9 was achieved, indicating that the questions in the survey reflect the topic of analysis.

Before analyzing the significance of individual variables, the Principal Component Analysis technique was applied to check which variables preserve most of the information given by their variances. This technique also helps us to check any clustering in the data by different groups. Figure 1 in the Technical Report in the Appendix section shows the result of the principal component analysis. It was noticeable that most of the variation in the data was captured by PC1 and PC2 together. These two referred to the students' mental health before and during COVID-19.

We used a One-Sided Two-Sample Paired T-Test to check for difference in means of the variables of interest. This test is used when two samples are taken from the same observation, and to check for the differences between the samples. There was strong evidence to conclude that the mean difference in the levels of stress/anxiety/depression before and during Covid-19 was above 0. This means that there has been an increase in the levels of all of these three variables. Similar results hold about mental health overall. Results can be found in table 1 of the technical report in appendix. For further analysis, we used principal component analysis (PCA) to check which variables are responsible for major variability in data.

Through analysis, it was discovered that self-reported scores for overall mental health, stress, anxiety and depression increased significantly (became worse) with the pandemic.

Students also feared contracting COVID-19 and their loved ones contracting COVID-19, however this fear was uncorrelated with mental health scores, meaning students do not necessarily have poor mental health levels due to the fear of contracting the virus. The data illustrated that students were more afraid of their family members contracting COVID-19 than contracting COVID-19 themselves.

It was found that the category most predictive of "Mental Health before COVID-19" is "Anxiety during COVID-19", and the category most predictive of "Mental Health during COVID-19" is "Depression during COVID-19". It is possible that COVID-19 may have led to more depression than anxiety.

Students were asked to give reasons as to why students might report lower or higher mental health levels, however this question was optional. Only 41 out of the 47 students answered why they may feel that their mental health decreased. The most common response was that students believed that online school is more difficult than it is in person; this problem was addressed by 30 students. Two other common issues, both tied with 27 votes, were the fact that students were unable to go outside and to see their loved ones/family.

Only 32 out of the 47 samples reported reasons as to why their mental health levels have improved. The most popular response is that students liked staying at home, which received 21

votes, and the second common response is that it is easier to attend office hours and lectures, which received 17 votes.

4. LIMITATIONS AND CONCLUSION

This was a questionnaire based study that invited University of Toronto Mississauga STA304H5 students enrolled in the fall 2020 semester to report their levels of mental health, stress, anxiety, and depression before and during the pandemic. In conclusion, it is evident that STA304 students at University of Toronto Mississauga attending the Fall 2020 semester have experienced poorer mental health and increased levels of stress, anxiety, and depression.

It is important to determine whether individuals' mental health has decreased since the pandemic for detecting another potential public health crisis. Since very few of those surveyed contracted COVID-19, it cannot be said definitively what aspects of mental health changed, and by how much-- this is a topic for further study. Nevertheless, given the apparent decrease in mental well-being it may be advisable to encourage those affected to seek treatment.

Since this was a survey based study, causal relationships can not be established. In addition, only a small number of students (47) were able to be reached out of the 270 students enrolled in STA304 during the time and place of the study.   This low response rate may be attributable to the delivery; the team was unable to specifically control or ask students in person to fill in the survey, as per the guidelines laid out by the professor. For further research regarding student's mental health, we recommend that future researchers should gather larger sample sizes. Due to the limitations of the small sample size, there may be a number of people whose mental health has improved since the beginning of the pandemic, perhaps finding the online environment more comfortable for communication, but did not submit a survey response.

5. REFERENCES

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Stress. (n.d.). https://www.merriam-webster.com/dictionary/stress

6. APPENDIX

QUESTIONNAIRE (WITH CONSENT)

The Impact of COVID-19 on the Mental Health of
STA304 Students Enrolled in Fall 2020 at
University of Toronto Mississauga Questionnaire

This questionnaire explores the potential mental challenges that people may have faced since the beginning of
the pandemic. Although the questions don't ask for in-depth answers, there is a possibility of feeling
discomfort with answering these questions. If you are feeling discomfort, please consult the UTM Health &
Counselling Centre (905-828-5255), Good2Talk (1-866-925-5454), or other mental-help lines.
* Required

1. Hello. Thank you for clicking on the link to our survey. We hope you are doing well during this
    pandemic and with online schooling. We will be analyzing the results from this survey, but we will
    not reveal anyone's identity. At the end of this survey, we will ask for your email if you want a
    chance to win a $10 Amazon gift card. However, it is not mandatory to provide your email and we
    will not share email addresses. Clicking on "yes" below confirms your consent to participate in
    this study. *

    Mark only one oval.

    ◯ Yes
    ◯ No

    Skip to question 2

    The Impact of COVID-19 on the Mental Health of STA304 Students Enrolled in Fall 2020 at
    University of Toronto Mississauga Questionnaire

2. What is your gender? *

    Mark only one oval.

    ◯ Male
    ◯ Female
    ◯ Other
    ◯ Prefer not to answer

3. For the following statements, indicate how much you agree or disagree: Before Covid-19, my
    mental heath was poor. *

    Mark only one oval.

	1	2	3	4	5	6	7	8	9	
Disagree	◯	◯	◯	◯	◯	◯	◯	◯	◯	Agree

4. Currently, my mental health is poor. *

    Mark only one oval.

	1	2	3	4	5	6	7	8	9	
Disagree	◯	◯	◯	◯	◯	◯	◯	◯	◯	Agree

5. Before Covid-19, I felt stressed overall. *

    Mark only one oval.

	1	2	3	4	5	6	7	8	9	
Disagree	◯	◯	◯	◯	◯	◯	◯	◯	◯	Agree

6. Currently, I feel stressed nowadays. *

    Mark only one oval.

	1	2	3	4	5	6	7	8	9	
Disagree	◯	◯	◯	◯	◯	◯	◯	◯	◯	Agree

7. Before Covid-19, I felt anxious overall. *

    Mark only one oval.

	1	2	3	4	5	6	7	8	9	
Disagree	◯	◯	◯	◯	◯	◯	◯	◯	◯	Agree

8. Currently, I feel anxious nowadays. *

    Mark only one oval.

	1	2	3	4	5	6	7	8	9	
Disagree	◯	◯	◯	◯	◯	◯	◯	◯	◯	Agree

9. Before Covid-19, I felt depressed. *

    Mark only one oval.

	1	2	3	4	5	6	7	8	9	
Disagree	◯	◯	◯	◯	◯	◯	◯	◯	◯	Agree

10. Currently, I feel depressed nowadays. *

    Mark only one oval.

	1	2	3	4	5	6	7	8	9	
Disagree	◯	◯	◯	◯	◯	◯	◯	◯	◯	Agree

11. I am scared of contracting COVID-19. *

    Mark only one oval.

	1	2	3	4	5	6	7	8	9	
Disagree	◯	◯	◯	◯	◯	◯	◯	◯	◯	Agree

12. I am scared of my family members and/or loved ones contracting COVID-19. *

    Mark only one oval.

	1	2	3	4	5	6	7	8	9	
Disagree	◯	◯	◯	◯	◯	◯	◯	◯	◯	Agree

13. Have you contracted COVID-19? *

    Mark only one oval.

    ◯ Yes

    ◯ No

    ◯ Unsure/waiting for results

14. Have any of your family members contracted COVID-19? *

    Mark only one oval.

    ◯ Yes

    ◯ No

    ◯ Unsure/waiting for results

15. If you suspect that you are feeling *more* stressed/anxious/depressed since the beginning of the pandemic, please select the following reasons that you relate to.

    Check all that apply.

    ☐ Not getting enough exercise

    ☐ Being unable to go outside

    ☐ Being unable to see friends/family/loved ones

    ☐ Online school is more difficult

    ☐ Unstable internet connection

    ☐ I contracted by Covid-19

    ☐ Someone important to me contracted Covid-19

    ☐ Experiencing financial issues

    ☐ Lost a job/internship

    ☐ More exposed to social media

    ☐ Rising Covid-19 cases

    ☐ Keep getting distracted

16. If you suspect that you are feeling *less* stressed/anxious/depressed since the beginning of the pandemic, please select the following reasons that you relate to.

    Check all that apply.

    ☐ Not commuting
    ☐ Not having to move
    ☐ Easier to attend office hours/lectures
    ☐ Recorded lectures
    ☐ Open book tests
    ☐ Staying at home
    ☐ Not being in massive crowds/lecture halls

17. If you want a chance to win a $10 amazon gift card, please write your email below.

    _____

TECHNICAL REPORT

1. INTRODUCTION

Pandemics such as the COVID-19 raise questions about the state of a population's mental health. The pandemic dominates the headlines, leading to stress and anxiety among the public. Conscientiousness is necessary to stop the spread, but excessive worry may wreck other aspects of a person's health. It is normal to feel stressed and anxious during the COVID-19 outbreak. In particular, we want to monitor the pandemic's effect on mental health, which constitutes the mentioned characteristics of worry above.

Mental health is defined as, "the condition of being sound mentally and emotionally that is characterized by the absence of mental illness and by adequate adjustment especially as reflected in feeling comfortable about oneself, positive feelings about others, and the ability to meet the demands of daily life" (Merriam-Webster dictionary). As part of our study, we try to define more variables that can contribute to students' mental health.This seemingly abstract condition of mental health can be assessed more concretely by measuring three (negative) emotional states-- stress, anxiety, and depression-- since these are recognizable reactions to difficult scenarios that may require treatment. **Stress** is "a state of mental tension and worry caused by problems in your life, work"(Merriam-Webster). **Anxiety** is "a strong desire sometimes mixed with doubt, fear, or uneasiness"(Merriam-Webster). **Depression** is "a mood disorder marked especially by sadness, inactivity, difficulty in thinking and concentration" (Merriam-Webster).

2. OBJECTIVE

The purpose of this study is to analyze how the pandemic has affected the mental health of STA304 students at University of Toronto Mississauga attending the Fall 2020 semester. The classes that these students attend have been moved online, and social-distancing advisories have furthered the isolation; depending on one's personality, these may affect their mental health positively or negatively. This study also aims to determine the correlation between the

three characteristics, namely stress, anxiety, and depression, and overall mental state, as well as the particular factors that may cause these feelings to be exhibited.

3. DATA GATHERING TOOL

We designed an anonymous survey with 15 questions where each question refers to a variable (a survey-item) that attributes to students' mental health. The questions were made to be short and concise as possible to avoid any ambiguity. Next, the survey was posted on the course discussion board called Piazza by instructor and TA's for students to fill out the questionnaire.

The questionnaire consisted of the following items (variables to be include in the analysis): (1) students' gender ; (2) state of their mental health before Covid-19; (3) state of their mental health during Covid-19; (4) the extent to which they felt stressed before Covid-19; (5) the extent to which they felt stressed during Covid-19; (6) the extent to which they felt anxious before Covid-19; (7) the extent to which they felt anxious during Covid-19; (8) the extent to which they felt depressed before Covid-19; (9) the extent to which they felt depressed during Covid-19; (10) the extent to which they were scared of contracting Covid-19; (11) the extent to which they were scared of their family or loved ones contracting Covid-19; (12) did they contract Covid-19; (13) did any of their family member contract Covid-19; There were two optional questions which asked for the reasons behind their betterment/worsening of mental health due to Covid-19. We used a Likert Scale from 1-9 as our options for questions regarding variables mentioned above from (2) to (11), where 1 stands for "strongly disagree" and 9 stands for "strongly agree" The completion of the survey was optional for students. A copy of the questionnaire can be found at https://forms.gle/xnBruX2pUvFF4hF87.

4. DATA SUMMARY

A total of 47 students completed the survey in the fall semester of the academic year 2020-2021. Students who completed the survey were all enrolled in the STA304 course.

Before analyzing the survey results, we had to ensure that the questions in the survey measure the research topic consistently and reliably, and are inter-related to each other. To

determine the reliability and consistency of the test items in the survey, Cronbach's alpha was run on the entire sample size of 47 students. Internal consistency reliability was assessed using Cronbach's alpha to measure the internal consistency of the scale, with preferred values between 0.7 and 1. Initial obtained Cronbach's alpha value of the study-questionnaire is 0.88, which indicates that the survey-items are internally consistent and hence the questionnaire is reliable. However Cronbach's alpha analysis suggested removing an existing variable, namely "the extent to which they were scared of contracting Covid-19", and removing that variable gave Cronbach's alpha value of 0.90, hence that variable was ignored for further analysis.

5. SAMPLING AND RESEARCH METHODOLOGY

We used simple random sampling as our sample technique. This was survey based study and filled out by students at their convenience. Simple random sampling technique was easier to use in this case. Before carrying out the analysis for difference in means of each variable, we ensured that our sample size was close to the actual sample size needed to perform simple random sampling. To estimate the sample size, following R code was used.

```
> N = 270
> sigma = 2
> B = 0.55
> D = (B ** 2) / 4
> n = (N * (sigma ** 2)) / ((N - 1) * D  + (sigma ** 2))
> print(n)
[1] 44.36571
```

Value of sigma was estimated using the formula $\frac{Max - Min}{4}$, where min and max values were 1 and 9. Actual sample size with the bound on error of estimation of 0.55 was found to be 45, which is closer to our sample size 47.

Before analysing the significance of individual variables, principal component analysis was applied to check which variables preserve most of the information given by their variances. This also helps us to check any clustering in the data by different groups. Figure 1 in below shows the result of the principal component analysis.
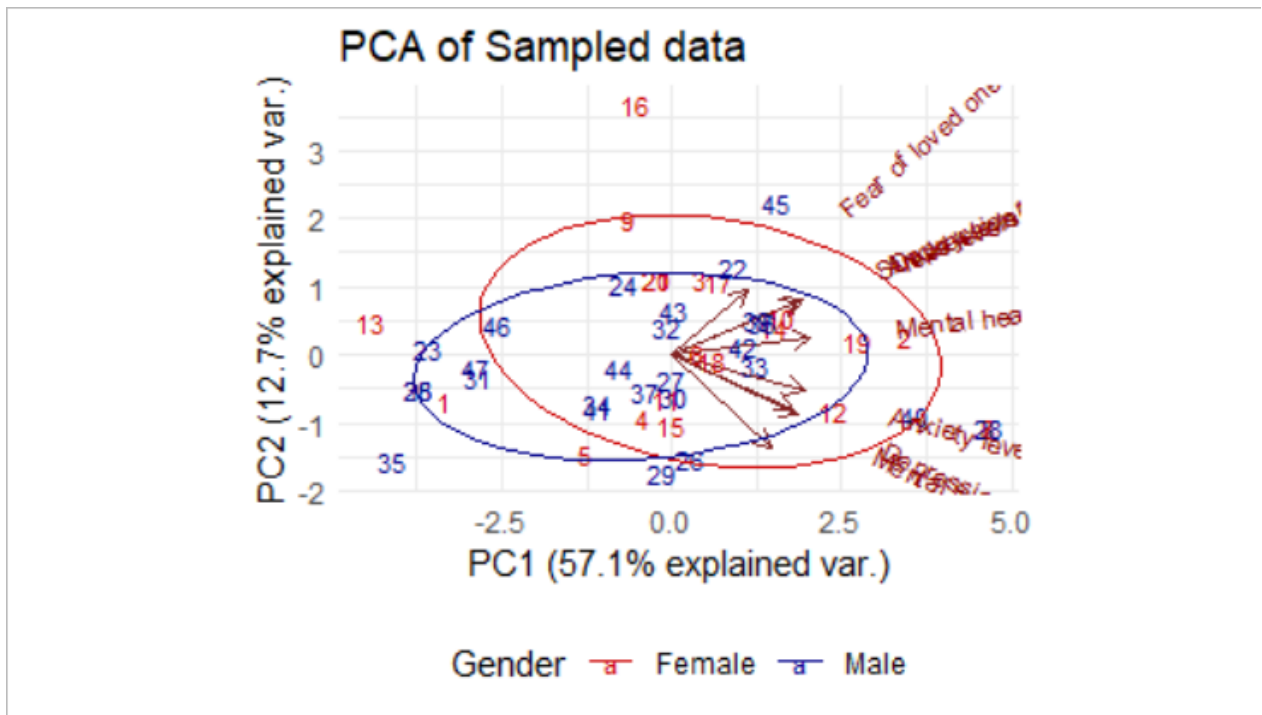
Image 1. PCA Analysis Diagram.

It is noticeable in the above plot that most of the variation in the data was captured by PC1 and PC2 together. These two referred to student's mental health before and during Covid-19.

Boxplots were used for visualizing each variable. Generally, the median was higher for levels of all three variables during the Covid. The figures representing the levels of stress/anxiety/ depression can be found in the appendix section, figure 2-4.

Furthermore, our sample size of 47 was greater than 30. Using the central limit theorem, this ensures that the sampling distribution of differences between variables during and before Covid-19 follows approximately normal distribution.

To test the significance of difference of each variable, we employed one sided two sample paired t-test for difference in means with the significance level of 5%. The hypothesis test below was conducted for each item. We let d denote the difference of two samples, before and during the covid for each variable of interest. We consider the following hypothesis:

$$H_0 : p = 0.5 \text{ vs } H_1 : p > 0.5$$

As expected, the stress, anxiety, and depression level of student's have risen during Covid-19. This is evident from the significant test of item 2,3,4 in Table 1 in which the p-value is notably less than 0.05 (significance level).

Table 1 summarizes the significance of each item's test along with their corresponding p-values reported.

Item	P-value	Test
Difference in the mental health during and before Covid-19.	0.002585	Significant
Difference in the level of stress during and before Covid-19	8.687e-05	Significant
Difference in the level of anxiety during and before Covid-19	0.001238	Significant
Difference in the level of depression during and before Covid-19	1.16e-06	Significant

Table 1. p-values of one-sided two sample paired t tests.

6. RESULTS AND CONCLUSION

Two sample paired T-tests were conducted to investigate the mean difference of variables, which characterizes mental health, before and during Covid-19. Based on the results, there is strong evidence to conclude that the mean difference in the levels of stress/anxiety/depression before and during Covid-19 was above 0. This means that there has been an increase in the levels of all of these three variables. Similar results hold about mental health overall.

Table 2 shows the mean, median, and standard deviation scores of overall mental health levels.

Overall	Before	During
Mean	4.064	4.894
Median	4.000	5.000
Standard Deviation	2.444197	2.664044

Table 2. Overall mental health scores.
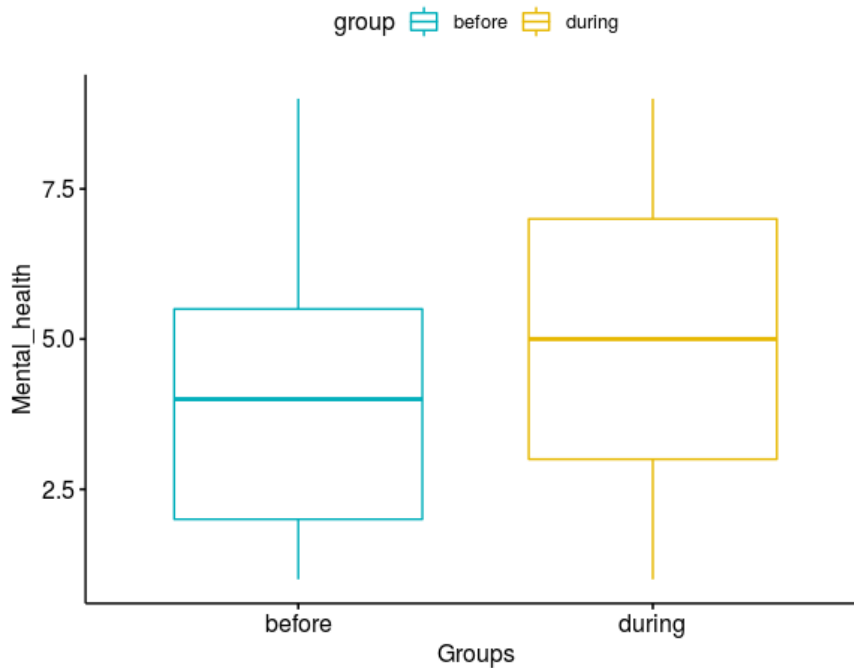
Figure 1. This plot illustrates the data from **Table 1**.

Before the pandemic, we estimated that the level of overall mental health mean is 4.064. This result is from the scale of 1 to 10 as mentioned earlier. Using the Simple Random Sampling formula for the estimated variance of mean, we found the estimated variance and bound to be 0.1049822 and 0.6480191. This bound is a bit on the higher side than our predicted bound of 0.55. The 95% confidence interval for the mean of the level of mental health before Covid-19 is (3.4160, 4.7120).

During the pandemic, we estimated that the overall mental health mean is 4.894. This result is again from the scale of 1 to 10. The estimated variance and bound was found to be 0.1247171 and the bound of error is 0.7063061, which is on the higher side of our predicted bound of 0.55. This might be due to the increase in the variance of data during Covid-19. The 95% confidence interval for the mean of the level of mental health during Covid-19 is (4.187694, 5.600306).

From our two sample paired t-test analysis on the mental health variable, the test statistic was found to be 0.8297872 and 95% confident was (0.2609841, 1.3985904).

Table 3 shows the correlation matrix between each category. It can be noted that Anxiety levels before Covid-19 were most correlated with Mental health before Covid-19. And, Depression levels during Covid-19 was most correlated with Mental health during Covid-19. Since this was a survey based study, causal relationships can not be established.

Table 3 shows the correlation matrix between each category.

	Mental health before Covid-19	Mental health during Covid-19	Stress levels before Covid-19	Stress levels during Covid-19	Anxiety levels before Covid-19	Anxiety levels during Covid-19	Depression levels before Covid-19	Depression levels during Covid-19
Mental health before Covid-19	1.0000000	0.7155262	0.5811242	0.4433055	0.7622344	0.4156523	0.5888319	0.4566728
Mental health during Covid-19	0.7155262	1.0000000	0.3485269	0.6234079	0.6580649	0.6477096	0.6086239	0.7324502
Stress levels before Covid-19	0.5811242	0.3485269	1.0000000	0.4256744	0.5552607	0.3530237	0.5943289	0.2008230
Stress levels during Covid-19	0.4433055	0.6234079	0.4256744	1.0000000	0.5909046	0.8299686	0.3744309	0.6146527
Anxiety levels before Covid-19	0.7622344	0.6580649	0.5552607	0.5909046	1.0000000	0.6605307	0.5636616	0.4811350
Anxiety levels during Covid-19	0.4156523	0.6477096	0.3530237	0.8299686	0.6605307	1.0000000	0.4996236	0.6819592
Depression levels before Covid-19	0.5888319	0.6086239	0.5943289	0.3744309	0.5636616	0.4996236	1.0000000	0.6617122
Depression levels during Covid-19	0.4566728	0.7324502	0.2008230	0.6146527	0.4811350	0.6819592	0.6617122	1.0000000

Table 3.

7. CONCLUSION

Based on the sampled data, it appears that the median and mean of the Likert Scale scores are higher for poor mental health levels; students agree more to the statement of "Currently, my mental health is poor" than the statement of "Before COVID-19, my mental health was poor." Thus, it is reasonable to conclude that the mental health of Fall 2020 STA304 students has decreased since the beginning of this pandemic.

8. REFERENCES

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Stress. (n.d.). https://www.merriam-webster.com/dictionary/stress

9. APPENDIX

EXTRA FIGURES
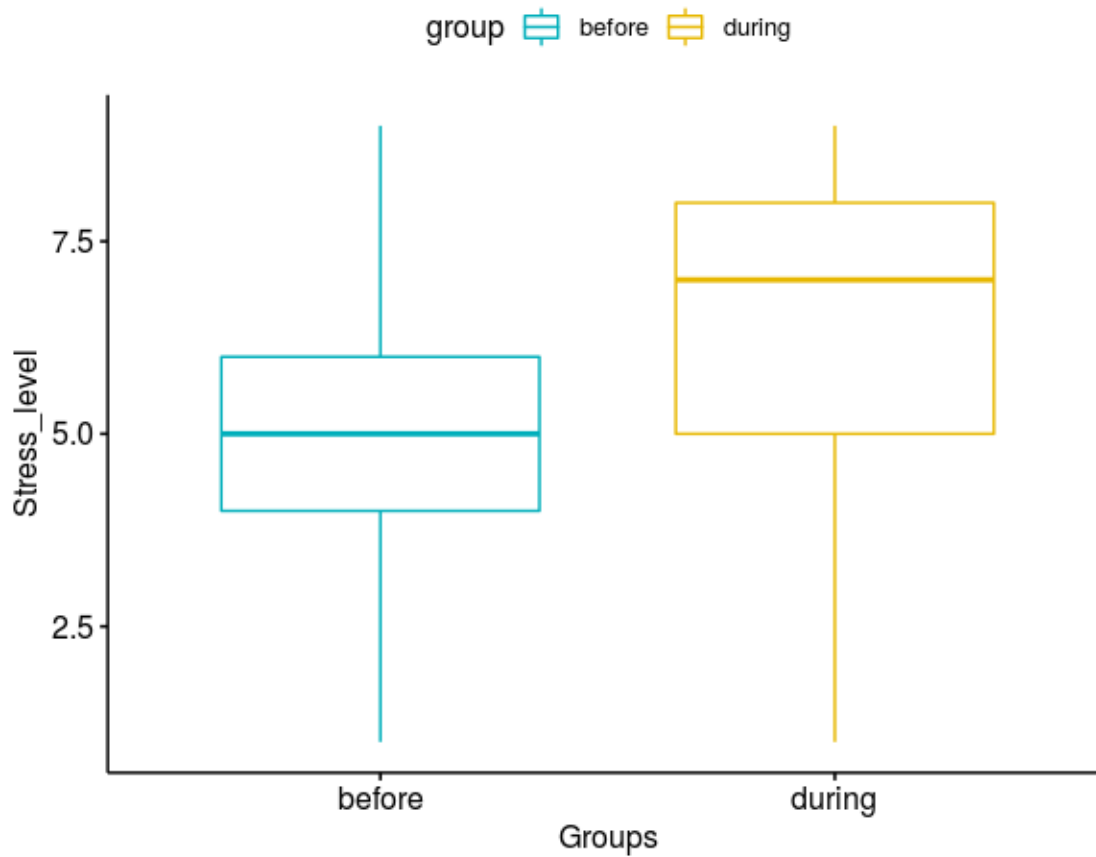
Figure 2. Represents the stress levels before and during the pandemic.
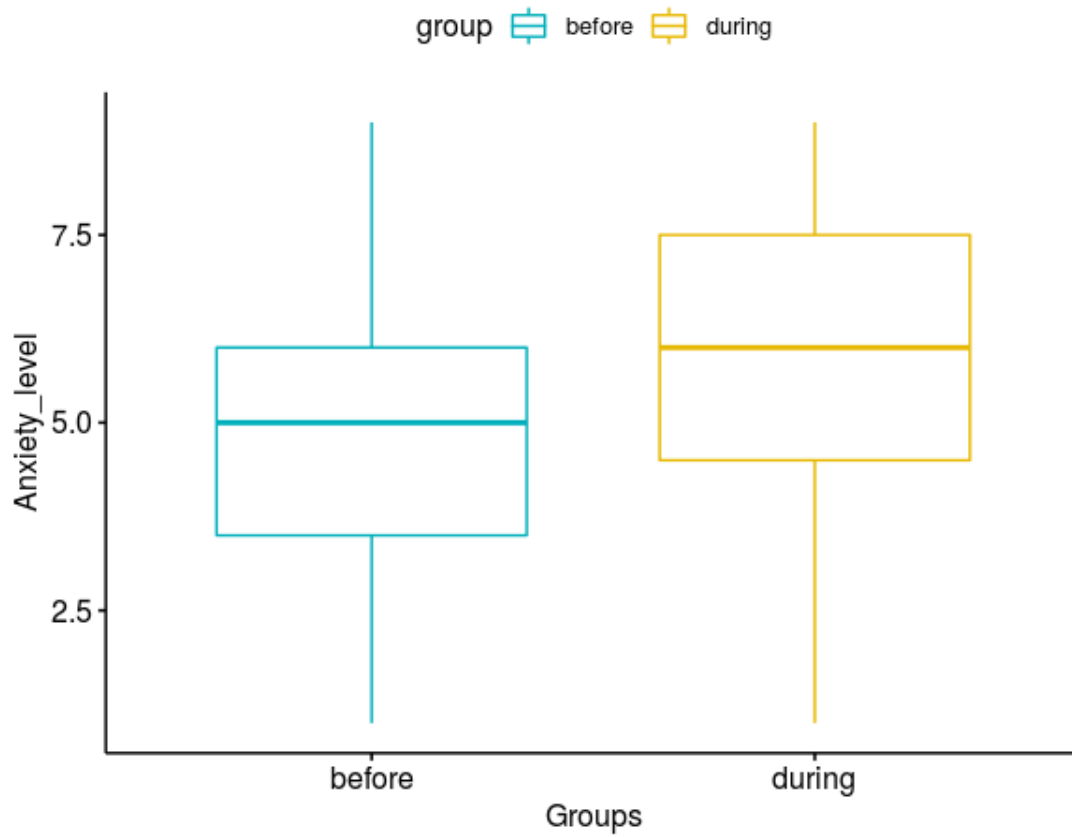
Figure 3. represents the anxiety levels before and during the pandemic.
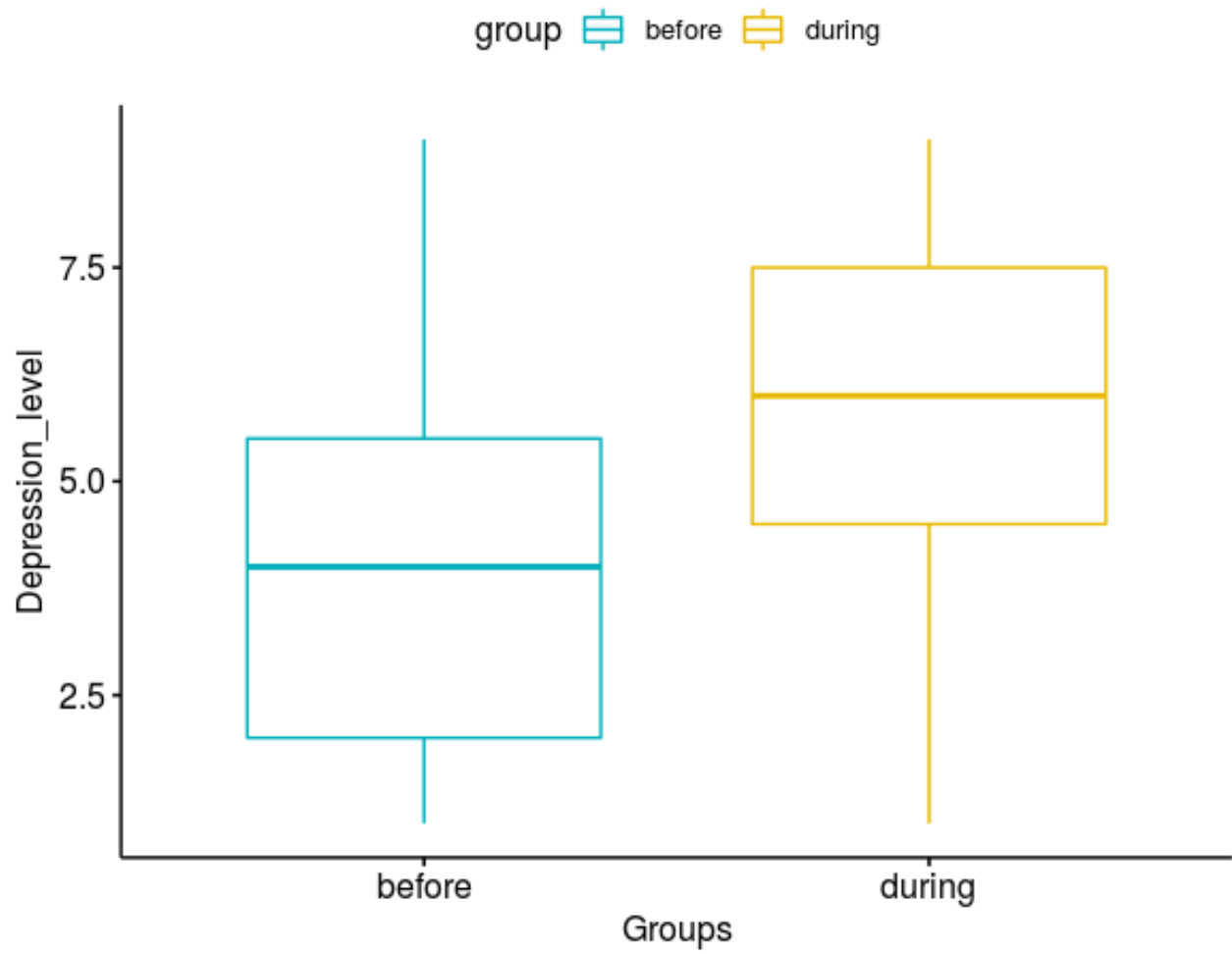
Figure 4. represents the depression levels before and during the pandemic.

If you suspect that you are feeling *more* stressed/anxious/depressed since the beginning of the pandemic, please select the following reasons that you relate to.

41 responses
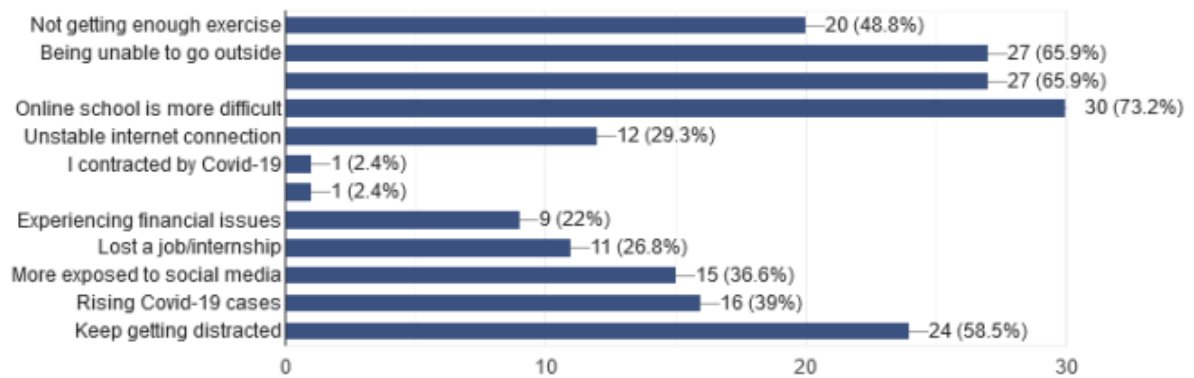
Not getting enough exercise — 20 (48.8%)
Being unable to go outside — 27 (65.9%)
— 27 (65.9%)
Online school is more difficult — 30 (73.2%)
Unstable internet connection — 12 (29.3%)
I contracted by Covid-19 — 1 (2.4%)
— 1 (2.4%)
Experiencing financial issues — 9 (22%)
Lost a job/internship — 11 (26.8%)
More exposed to social media — 15 (36.6%)
Rising Covid-19 cases — 16 (39%)
Keep getting distracted — 24 (58.5%)

If you suspect that you are feeling *less* stressed/anxious/depressed since the beginning of the pandemic, please select the following reasons that you relate to.

32 responses

Not commuting — 15 (46.9%)
Not having to move — 9 (28.1%)
Easier to attend office hours/lectures — 17 (53.1%)
Recorded lectures — 14 (43.8%)
Open book tests — 10 (31.3%)
Staying at home — 21 (65.6%)
Not being in massive crowds/lecture hal… — 7 (21.9%)
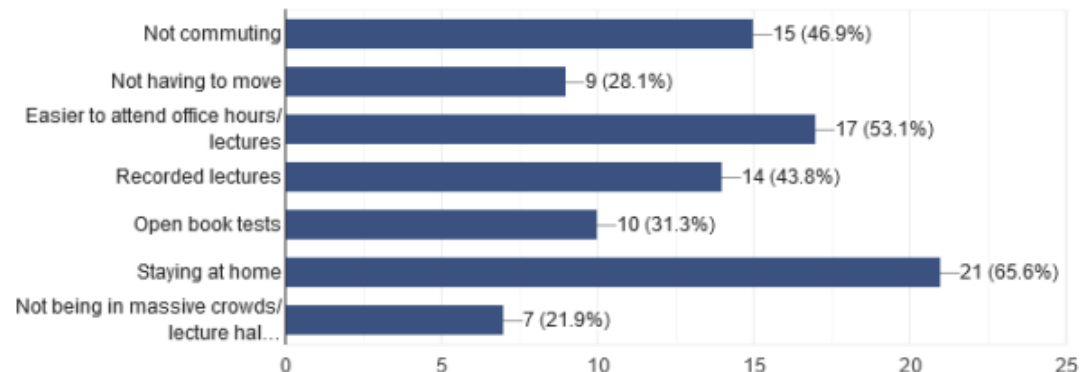
Figure 5. Showing the responses for two optional questions

R-CODE USED
Mean, Median, Standard Deviation

```
> summary(STA304)
   Timestamp              Consent               Gender
Mental.health.before.Covid.19
 Length:47              Length:47             Length:47
Min.    :1.000
 Class :character    Class :character    Class :character
1st Qu.:2.000
 Mode  :character    Mode  :character    Mode  :character
Median :4.000

Mean    :4.064

3rd Qu.:5.500

Max.    :9.000
 Mental.health.during.Covid.19
Stress.levels.before.Covid.19
Stress.levels.during.Covid.19
 Min.    :1.000               Min.    :1.000
  Min.    :1.00
1st Qu.:3.000                 1st Qu.:4.000
  1st Qu.:5.00
Median :5.000                 Median :5.000
  Median :7.00
Mean    :4.894                Mean    :4.936
  Mean    :6.34
3rd Qu.:7.000                 3rd Qu.:6.000
  3rd Qu.:8.00
Max.    :9.000                Max.    :9.000
  Max.    :9.00
```

```
 Anxiety.levels.before.Covid.19
Anxiety.levels.during.Covid.19
Depression.levels.before.Covid.19
 Min.   :1.000                     Min.   :1.000
    Min.   :1.0
 1st Qu.:3.500                     1st Qu.:4.500
    1st Qu.:2.0
 Median :5.000                     Median :6.000
    Median :4.0
 Mean   :4.957                     Mean   :5.894
    Mean   :4.0
 3rd Qu.:6.000                     3rd Qu.:7.500
    3rd Qu.:5.5
 Max.   :9.000                     Max.   :9.000
    Max.   :9.0
 Depression.levels.during.Covid.19
 Min.   :1
 1st Qu.:2
 Median :6
 Mean   :5
 3rd Qu.:7
 Max.   :9
```

```
> sd(STA304$Mental.health.before.Covid.19)
[1] 2.444197
> sd(STA304$Mental.health.during.Covid.19)
[1] 2.664044
> sd(STA304$Stress.levels.before.Covid.19)
[1] 2.099733
> sd(STA304$Stress.levels.during.Covid.19)
[1] 2.286792
> sd(STA304$Anxiety.levels.before.Covid.19)
[1] 2.44022
> sd(STA304$Anxiety.levels.during.Covid.19)
```

```
[1] 2.424818
> sd(STA304$Depression.levels.before.Covid.19)
[1] 2.386557
> sd(STA304$Depression.levels.during.Covid.19)
[1] 2.629267
```

Calculating Variance and Bound

Mental Health, Before Pandemic
```
> n = 47
> mean = 4.064
> s = 2.444197
> est_var = (1 - (n / N)) * ((s ** 2) / n)
> bound = 2 * (est_var ** (1/2))
> min = mean - bound
> max = mean + bound
```

Mental Health, During Pandemic
```
> mean = 4.894
> s = 2.664044
> est_var = (1 - (n / N)) * ((s ** 2) / n)
> bound = 2 * (est_var ** (1/2))
> min = mean - bound
> max = mean + bound
```

Stress Levels, Before Pandemic
```
> mean = 4.936
> s = 2.099733
> est_var = (1 - (n / N)) * ((s ** 2) / n)
> bound = 2 * (est_var ** (1/2))
> min = mean - bound
> max = mean + bound
```

Stress Levels During pandemic
```
> mean = 6.340
> s = 2.286792
```

```
> est_var = (1 - (n / N)) * ((s ** 2) / n)
> bound = 2 * (est_var ** (1/2))
> min = mean - bound
> max = mean + bound
```

Anxiety Levels Before Pandemic

```
> mean = 4.957
> s = 2.44022
> est_var = (1 - (n / N)) * ((s ** 2) / n)
> bound = 2 * (est_var ** (1/2))
> min = mean - bound
> max = mean + bound
```

Anxiety Levels During Pandemic

```
> mean = 5.894
> s = 2.424818
> est_var = (1 - (n / N)) * ((s ** 2) / n)
> bound = 2 * (est_var ** (1/2))
> min = mean - bound
> max = mean + bound
```

Depression Levels Before Pandemic

```
> mean = 4.000
> s = 2.386557
> est_var = (1 - (n / N)) * ((s ** 2) / n)
> bound = 2 * (est_var ** (1/2))
> min = mean - bound
> max = mean + bound
```

Depression Levels During Pandemic

```
> mean = 5.000
> s = 2.629267
> est_var = (1 - (n / N)) * ((s ** 2) / n)
> bound = 2 * (est_var ** (1/2))
> min = mean - bound
```

```
> max = mean + bound
```

Everything Else (Barplots, Correlation Matrix, Cronbach's Alpha)

```r
library(readxl)
install.packages("ggpubr")
library("ggpubr")
install.packages("corrplot")
source("http://www.sthda.com/upload/rquery_cormat.r")
require(dplyr)
install.packages("umx")
install.packages("psych")
library(psych)
library(devtools)
install_github("vqv/ggbiplot")
library(ggbiplot)

data = read_excel("STA304_Group_10_Responses.xlsx")

# Processing the data. Removing first two columns.
df <- data[-c(1,2)]

# Ordering the data by Gender
df = df[order(df$Gender),]
View(df)

# Performing Cronbach's alpha to check internal consistency.
alpha(df[c(2:11)]) #raw_alpha = 0.88. This also tells us to
remove the colum "Fear of contracting covid-19"

#Removing the column gives us raw_alpha = 0.90
df = df[c(-10)]
alpha(df[c(2:10)]) # Raw alpha of 0.9
View(df)
```

```r
# Using PCA(Prinipal Component Analysis) to factor out the
variables which explains the most variance.
df.pca = prcomp(df[,c(2:10)], center = TRUE,scale. = TRUE)
summary(df.pca)
df.group <- c(rep("Female", 21), rep("Male",26))

ggbiplot(df.pca,ellipse=TRUE,obs.scale = 1, var.scale = 1,
labels=rownames(df), groups=df.group) +
  scale_colour_manual(name="Gender", values= c("red3", "dark
blue"))+
  ggtitle("PCA of Sampled data")+
  theme_minimal()+
  theme(legend.position = "bottom")

# Using Boxplots to visualize the difference between two time
periods of all the variables.
# Plot each variable by group and color by group

var_plot <- function(before,during,var_name){
  my_data <- data.frame(
     group = rep(c("before", "during"), each = 47),
     var_vec = c(before,  during)
  )

  ggboxplot(my_data, x = "group", y = "var_vec",
          color = "group", palette = c("#00AFBB", "#E7B800"),
          order = c("before", "during"),
          ylab = var_name, xlab = "Groups")

}

result <- function(during,before){
```

```r
  res <- t.test(during, before, paired = TRUE,alternative =
"greater")
  CI = t.test(during, before, paired = TRUE,conf.level = 0.95)
  return (list(res,CI))
}
# n > 30 so using CLT, we can assume that sampling distribution
of differences of the variables before and during COVID follow
Normal distribution
# Since we can assume normality for differences, we can use two
sample paired t-test to analyze the data.
# d = var_during_covid - var_before_covid.
# Ho = d_bar = 0. Ha: d_bar > 0.

# Mental health
before = df$`Mental health before Covid-19`
during = df$`Mental health during Covid-19`
var_plot(before,during,"Mental_health")

# check for significance and CI
res = result(during,before)

# Stress Level
before = df$`Stress levels before Covid-19`
during = df$`Stress levels during Covid-19`
var_plot(before,during,"Stress_level")

# check for significance and CI
res = result(during,before)

# Anxiety Level
before = df$`Anxiety levels before Covid-19`
during = df$`Anxiety levels during Covid-19`
var_plot(before,during,"Anxiety_level")
```

```r
# check for significance and CI
res = result(during,before)

# Depression Level
before = df$`Depression levels before Covid-19`
after = df$`Depression levels during Covid-19`
var_plot(before,during,"Depression_level")

# check for significance and CI
res = result(during,before)
res

# Contracting Covid-19
personal_fear = df$`Fear of contracting COVID-19.`
family_fear = df$`Fear of loved ones contracting COVID-19.`
my_data <- data.frame(
  group = rep(c("personal_fear", "family_fear"), each = 47),
  var_vec = c(personal_fear,  family_fear)
)
ggboxplot(my_data, x = "group", y = "var_vec",
          color = "group", palette = c("#00AFBB", "#E7B800"),
          order = c("personal_fear", "family_fear"),
          ylab = "Fear_level", xlab = "Groups")

#correlation matrix
reduced_data = df[c(2:9)]
mymatrix = cor(reduced_data)
View(mymatrix)

#Partition the data by gender
gender_data = df[c(1:9)]
View(gender_data)
#gender_data = df[c(1:11)]
f_data = gender_data[gender_data$Gender=="Female",]
```

```r
m_data = gender_data[gender_data$Gender=="Male",]
f_updated_data = f_data[c(2:9)]
m_updated_data = m_data[c(2:9)]
m_matrix = cor(m_updated_data)
f_matrix = cor(f_updated_data)
View(m_matrix)
View(f_matrix)

# Partition data by people whose family members contracted Covid.

family_covid = df[df$`Family members contracted COVID-19` ==
"Yes",]
family_covid_data = family_covid[c(2:9)]
cor_mat = cor(family_covid_data)
View(cor_mat)

family_no_covid=df[df$`Family members contracted COVID-19` ==
"No",]
family_no_covid_data = family_no_covid[c(2:9)]
cor_matrix = cor(family_no_covid_data)
View(cor_matrix)
```

DATA SET

LEGEND:

COLUMN HEADERS:

B.   Consent Given?

C.   Gender?

D.   Mental Health - Before COVID

E.   Mental Health - During COVID

F.   Stress -Before COVID

G.   Stress - During COVID

H.   Anxiety - Before COVID

I.   Anxiety - During COVID

J.   Depression - Before COVID

K.   Depression - During COVID

L.   Fear of getting COVID

M.   Fear of family getting COVID

N.   Contracted COVID?

O.   Family contracted COVID?

DATA ENTRIES:

U means "Unsure." This may appear in the "Contracted Covid?" column if a student has been tested and is awaiting results.

A. Timestamp	B	C	D	E	F	G	H	I	J	K	L	M	N	O
10/3/2020 17:44:32	Yes	Female	1	1	6	2	1	1	2	2	7	9	No	No
10/3/2020 18:07:37	Yes	Male	3	7	4	9	5	6	4	8	7	8	No	No
10/3/2020 18:11:50	Yes	Female	7	9	6	9	9	9	6	8	9	9	U	U
10/3/2020 20:45:02	Yes	Male	1	1	4	4	1	1	1	1	7	9	No	No
10/3/2020 23:42:55	Yes	Female	4	7	4	6	3	7	4	7	7	9	No	Yes
10/5/2020 0:42:08	Yes	Male	1	3	4	6	4	6	4	6	9	9	No	No
10/7/2020 14:19:18	Yes	Male	2	2	2	2	2	2	2	2	5	5	No	No
10/8/2020 16:26:14	Yes	Female	7	2	6	7	5	4	3	2	7	9	No	No
10/9/2020 8:49:06	Yes	Female	5	3	5	4	6	5	3	2	5	5	No	No
10/12/2020 15:09:14	Yes	Male	7	7	6	7	4	4	5	5	4	4	No	No
10/12/2020 15:34:44	Yes	Female	5	6	6	7	7	8	1	1	9	9	No	No
10/13/2020 15:08:02	Yes	Male	3	3	7	8	6	8	3	2	3	7	No	No
10/13/2020 21:16:49	Yes	Female	9	9	9	9	9	9	9	9	6	9	No	No
10/13/2020 23:21:54	Yes	Male	9	9	9	9	9	9	9	9	4	9	No	No
10/14/2020 19:34:42	Yes	Female	9	9	9	9	9	9	9	9	1	9	No	No
10/14/2020 21:19:57	Yes	Female	1	1	4	9	4	9	1	6	8	8	No	No
10/16/2020 18:45:01	Yes	Female	7	7	4	7	9	6	2	8	4	9	No	Yes
10/16/2020 19:37:43	Yes	Male	7	6	5	4	7	4	4	4	6	5	No	No
10/16/2020 22:24:08	Yes	Male	2	3	9	8	6	6	3	2	5	9	No	No
10/17/2020 1:12:51	Yes	Male	1	1	2	2	4	4	4	4	5	5	No	No
10/17/2020 15:36:57	Yes	Male	4	6	5	4	3	6	4	7	7	9	No	No
10/17/2020 15:39:44	Yes	Male	4	7	6	5	4	7	8	7	9	9	No	No
10/17/2020 15:49:24	Yes	Female	6	4	4	5	5	6	6	3	4	8	No	No
10/17/2020 15:56:54	Yes	Male	5	3	6	6	4	4	2	2	7	8	No	No
10/17/2020 19:02:36	Yes	Male	1	1	5	2	2	2	1	1	1	3	No	No
10/18/2020 13:36:06	Yes	Male	5	7	5	8	5	7	5	7	4	8	Yes	Yes
10/18/2020 20:14:38	Yes	Female	8	6	7	7	8	6	6	8	5	9	No	Yes
10/18/2020 20:32:20	Yes	Male	4	3	6	6	5	5	4	4	8	8	No	No
10/19/2020 2:32:56	Yes	Male	2	2	2	2	2	2	2	5	5	No	No
10/19/2020 7:58:27	Yes	Female	1	1	1	1	1	1	1	1	4	9	No	No
10/19/2020 15:15:07	Yes	Female	2	8	5	8	5	8	8	8	6	6	No	No
10/19/2020 17:06:29	Yes	Female	3	4	6	7	6	6	6	4	6	5	No	No
10/19/2020 17:23:25	Yes	Female	1	4	1	9	1	9	1	9	9	9	No	No
10/20/2020 22:13:39	Yes	Female	4	6	5	9	3	6	4	7	7	9	No	No
10/22/2020 17:12:34	Yes	Male	5	7	5	7	4	7	6	7	4	9	No	No
10/22/2020 17:24:41	Yes	Female	5	4	5	7	6	6	5	6	6	8	No	No
10/22/2020 19:06:54	Yes	Male	7	8	8	8	9	9	8	8	8	8	No	Yes
10/23/2020 17:35:59	Yes	Male	1	1	5	6	5	6	6	6	3	3	No	No
10/24/2020 14:46:56	Yes	Male	5	6	5	7	6	7	5	6	4	8	Yes	Yes
10/24/2020 17:15:34	Yes	Male	3	5	5	7	5	7	3	4	5	9	No	No
10/24/2020 21:37:39	Yes	Female	6	9	7	9	7	9	5	6	6	9	No	No
10/25/2020 2:56:46	Yes	Female	3	6	2	6	5	6	4	6	7	8	No	No
10/25/2020 2:56:53	Yes	Female	3	6	2	6	5	6	4	6	7	8	No	No
10/26/2020 16:10:42	Yes	Male	3	4	6	7	5	5	2	2	8	8	No	No
10/27/2020 17:07:48	Yes	Male	5	9	1	9	9	9	1	6	1	9	No	No
10/27/2020 17:30:09	Yes	Male	1	2	3	7	2	7	1	2	9	3	No	No
10/28/2020 3:03:30	Yes	Male	3	5	3	5	1	1	1	3	5	5	No	No

P: Reasons for poor levels of mental health

Rising Covid-19 cases

Not getting enough exercise, Being unable to go outside, Being unable to see friends/family/loved ones, Online school is more difficult, Keep getting distracted

Being unable to go outside, Being unable to see friends/family/loved ones, Online school is more difficult, Experiencing financial issues, Lost a job/internship, More exposed to social media, Rising Covid-19 cases, Keep getting distracted

Being unable to go outside, Being unable to see friends/family/loved ones, Online school is more difficult, Someone important to me contracted Covid-19, Lost a job/internship, More exposed to social media, Rising Covid-19 cases, Keep getting distracted

Not getting enough exercise, Being unable to go outside, Being unable to see friends/family/loved ones, Online school is more difficult, Experiencing financial issues, Rising Covid-19 cases

Not getting enough exercise, Being unable to see friends/family/loved ones, Online school is more difficult, More exposed to social media, Keep getting distracted

Not getting enough exercise, Being unable to go outside, Being unable to see friends/family/loved ones, Online school is more difficult, Unstable internet connection, More exposed to social media, Rising Covid-19 cases, Keep getting distracted

Not getting enough exercise, Being unable to go outside, Being unable to see friends/family/loved ones, Online school is more difficult, Rising Covid-19 cases, Keep getting distracted

Being unable to go outside, Being unable to see friends/family/loved ones, Online school is more difficult, Lost a job/internship, Rising Covid-19 cases, Keep getting distracted

Online school is more difficult, Experiencing financial issues, Rising Covid-19 cases, Keep getting distracted

Online school is more difficult, Unstable internet connection, Experiencing financial issues, Lost a job/internship, Rising Covid-19 cases

Being unable to go outside, Being unable to see friends/family/loved ones, Online school is more difficult, Unstable internet connection, Experiencing financial issues, Keep getting distracted

Not getting enough exercise, Being unable to go outside, Being unable to see friends/family/loved ones, Online school is more difficult, I contracted by Covid-19

Online school is more difficult, Keep getting distracted

Being unable to see friends/family/loved ones

Being unable to see friends/family/loved ones, Keep getting distracted

Not getting enough exercise, Being unable to go outside, Being unable to see friends/family/loved ones, More exposed to social media, Keep getting distracted

Being unable to go outside, More exposed to social media

Not getting enough exercise, Being unable to go outside, More exposed to social media

Not getting enough exercise, Being unable to go outside, Being unable to see friends/family/loved ones, More exposed to social media

Not getting enough exercise, Being unable to go outside, Online school is more difficult, More exposed to social media, Keep getting distracted

Not getting enough exercise, Being unable to see friends/family/loved ones, Online school is more difficult, Unstable internet connection, Keep getting distracted

Not getting enough exercise, Being unable to go outside, Being unable to see friends/family/loved ones, Lost a job/internship, Rising Covid-19 cases

Being unable to go outside, Rising Covid-19 cases

Online school is more difficult, Lost a job/internship

Online school is more difficult, Unstable internet connection

Not getting enough exercise, Being unable to go outside, Being unable to see friends/family/loved ones, Online school is more difficult, Unstable internet connection, Experiencing financial issues, Lost a job/internship, More exposed to social media, Rising Covid-19 cases, Keep getting distracted

Not getting enough exercise, Being unable to go outside, Being unable to see friends/family/loved ones, Online school is more difficult, Unstable internet connection, Lost a job/internship, More exposed to social media, Rising Covid-19 cases, Keep getting distracted

Being unable to go outside, More exposed to social media, Keep getting distracted

Not getting enough exercise, Being unable to go outside, Being unable to see friends/family/loved ones, Online school is more difficult, Experiencing financial issues, Lost a job/internship, Rising Covid-19 cases

Not getting enough exercise, Being unable to go outside, Being unable to see friends/family/loved ones, Online school is more difficult, Unstable internet connection, Experiencing financial issues

Being unable to see friends/family/loved ones, Unstable internet connection, Keep getting distracted

Not getting enough exercise, Being unable to go outside, Being unable to see friends/family/loved ones, Online school is more difficult, Experiencing financial issues, More exposed to social media, Keep getting distracted

Online school is more difficult, More exposed to social media, Rising Covid-19 cases, Keep getting distracted

Not getting enough exercise, Being unable to go outside, Being unable to see friends/family/loved ones, Online school is more difficult, Rising Covid-19 cases, Keep getting distracted

Being unable to go outside, Being unable to see friends/family/loved ones, Online school is more difficult, Unstable internet connection

Being unable to go outside, Being unable to see friends/family/loved ones, Online school is more difficult, Unstable internet connection

Not getting enough exercise, Being unable to go outside, Being unable to see friends/family/loved ones, Online school is more difficult, Unstable internet connection, Lost a job/internship

Being unable to go outside, Being unable to see friends/family/loved ones, Online school is more difficult, Keep getting distracted

Not getting enough exercise, Online school is more difficult, Lost a job/internship, More exposed to social media, Keep getting distracted

Online school is more difficult, Keep getting distracted

Q: Reasons for positive levels for mental health
Easier to attend office hours/lectures, Recorded lectures, Open book tests, Staying at home
Not having to move, Recorded lectures, Not being in massive crowds/lecture halls
Easier to attend office hours/lectures, Recorded lectures, Staying at home
Not commuting, Open book tests, Staying at home
Open book tests
Not commuting, Easier to attend office hours/lectures, Open book tests, Staying at home
Not commuting, Not having to move, Easier to attend office hours/lectures, Recorded lectures, Open book tests, Staying at home, Not being in massive crowds/lecture halls
Not commuting, Recorded lectures
Not commuting, Not having to move, Staying at home
Not commuting, Easier to attend office hours/lectures, Recorded lectures, Staying at home
Not commuting, Recorded lectures, Open book tests
Not commuting, Not having to move, Easier to attend office hours/lectures, Open book tests, Staying at home
Easier to attend office hours/lectures
Not commuting, Not having to move, Easier to attend office hours/lectures
Open book tests
Not commuting, Easier to attend office hours/lectures, Recorded lectures, Staying at home, Not being in massive crowds/lecture halls
Recorded lectures, Open book tests, Staying at home
Not having to move, Easier to attend office hours/lectures, Staying at home, Not being in massive crowds/lecture halls
Easier to attend office hours/lectures, Staying at home
Staying at home
Staying at home
Staying at home
Not having to move
Easier to attend office hours/lectures
Not commuting, Easier to attend office hours/lectures, Recorded lectures, Staying at home
Not commuting, Not having to move, Recorded lectures, Staying at home
Not commuting, Not having to move, Easier to attend office hours/lectures, Recorded lectures, Open book tests, Staying at home, Not being in massive crowds/lecture halls
Staying at home, Not being in massive crowds/lecture halls
Staying at home, Not being in massive crowds/lecture halls
Not commuting, Easier to attend office hours/lectures, Recorded lectures
Not commuting, Easier to attend office hours/lectures, Recorded lectures, Staying at home
Easier to attend office hours/lectures