IMPACTS OF THE COVID-19 PANDEMIC ON THE MENTAL HEALTH OF CANADIANS

Malavika Prabhuram (20893169)
Jugal Kedia (20891429)

1. INTRODUCTION

The COVID-19 pandemic affected millions globally and caused vast government shutdowns and breakdown of systems. The economic recession and extended lockdowns due to COVID-19 is expected to have had a severe impact on the mental health of adults and is expected to continue having a long-lasting impact on the general population. In fact, according to a US Census report 4 in 10 adults reported symptoms of anxiety during the pandemic. Given that the pandemic is ongoing and the situation is developing daily, the entirety of the psychological effects on the populace has not been understood.

This study aims to understand the mental state of individuals by analysing the changes in their behaviours and routines during the COVID-19 pandemic. For the purposes of our research, we have chosen to explore factors such as the ability to exercise regularly during the pandemic, individual concerns about their own health and well-being, the ability of the population to maintain social ties with their friends and family, and the stress caused by extended confinement periods due to global shutdowns. We believe that exercise can lead to a positive effect on mental health whereas concerns and stressors from the pandemic have had a detrimental effect on the psychological well-being of individuals.

While there have been similar studies carried out for each individual factor that we have proposed across different countries, very few have chosen these four factors collectively or studied them in the Canadian population. There are numerous studies conducted during the pandemic that support our assumptions. Gloster (2020) examined established predictors of declining mental health internationally and found that 10% of the populations suffered from extreme mental health issues. Son and Hegde (2020) reported that 71% of college students in the United States reported an increase in anxiety and stress due to the COVID-19 pandemic. Guintella (2020) proved that the lifestyle changes associated with the pandemic are inextricably linked with psychology and that physical activity and sleep cycle changes resulting from the pandemic have negative effects on mental health. These studies suggest a strong need for further research on our proposed hypotheses.

Our model uses the Impacts of COVID-19 survey carried out by Statistics Canada to conduct an analysis of the 10 provinces of Canada specifically. This survey gathered responses from approximately 5000 participants in order to assess the social, economic and behavioural impacts of the pandemic on residents. We attempt to substantiate our assumptions by implementing ordinal logistic regressionto find factors that can influence the psychological and sociological well-being of people during a global pandemic.

2. LITERATURE REVIEW

	Paper	Objective	Data and Methodology	Results
1.	Examining the relationship between physical activity and mental health during the COVID-19 pandemic across five U.S. States. Grocke-Dewey, M et al. (2021)	The authors attempted to study how the COVID-19 pandemic affected physical activity, mental health and the relationship between the two outcomes the two across 5 US states.	Online survey across Louisiana, Montana, North Carolina, Oregon and West Virginia with 2904 responses Logistic Regression	The model showed a bidirectional and cyclic relationship between physical activity and mental health. It also showed a relationship between exercise levels before the pandemic and mental health during pandemic.
2.	Effects of Covid-19 confinement on the mental health of children and adolescents in Spain. Pizarro-Ruiz, J.P. & Nuria Ordóñez, C. (2021)	The study attempts to analyse the effect of strict lockdown measures and confinement on the mental health of minors in Spain by studying factors like anxiety, depression, self-esteem etc.	An anonymous survey with parental consent of 790 students aged 8-18. One-sample t-test, MANOVA or ANOVA was chosen based on hypothesis	The study showed a significant behavioural changes and psychological stress as a result of as little as 8-10 days of confinement. It also found more anxiety and depression in older aged students due to academic stress and changes in normal schooling due to COVID.
3.	Health anxiety, coping mechanisms and COVID 19: An Indian community sample at week 1 of lockdown. Millar, E.B. et al. (2021)	This paper focused on the health anxiety and coping mechanisms developed by people during the first week of lockdown in India, by studying effects of the uncertainty during the beginning of the pandemic on mental health of participants.	Anonymous online survey of 234 participants across India. Structural equation modelling	The results showed that younger people were more likely to experience health related anxiety and attempt to cope via social media. Older people were found to find internal coping mechanisms rather than seeking external help.

4.	Social Connection and Well-Being during COVID-19. Okabe-Miyamoto, K., & Lyubormirsky, S. (2021).	Study analyzed the risk factors associated with physical distancing and mental health and did an extensive study on the increased dependence on social media as a form of remaining connected with your family and friends.	Data collected from participants across the US. Panel data estimation	The study showed increased symptoms of depression, generalized anxiety disorder, stress and intrusive thoughts among adults who followed physical distancing measures. It also found that the presence of an extensive social network did not affect these results.
5.	Gender differences in mental health during the COVID-19 pandemic. Moyser, M. (2020)	Compared the self-rated mental health, changes in mental health since the pandemic began, generalized anxiety disorder and stress in male, female and gender diverse people.	Statistics Canada crowdsourced questionnaire. Panel data estimation	The research found that female participants were more likely to report worse mental health during physical distancing, generalized anxiety disorder and stress due to the pandemic.
6.	COVID-19 restrictions and age-specific mental health—U.S. probability-based panel evidence. Sojli, E. et al. (2021)	Research attempts to identify factors resulting from social distancing measures and the pandemic that contribute to adverse mental health and behavioural changes in different age groups.	Multivariate logistic regression	The research found that the pandemic restrictions predominantly affected young adults aged 18-34 while the effect on older people (>55) was significantly lesser. The study also found that the adverse mental health characteristics varied by age group.

Table 1. An analysis of existing literature

Citations for the above-mentioned papers can be found in the References section.

3. METHODS

In this social science study, we employ ordinal regression modelling to check and estimate the effects of Exercise (Exercise), Concerns about own Health (Concern_Health), Concerns of Maintaining Social ties with Family & Friends (Concern_Social) and Concerns of Family stress due to confinement (Concern_Confine) on mental health (Mental_Health) of Canadians from different age groups (Age_Group) and sex (Gender).

Given that our data is ordinal, we have chosen the proportional odds model for regression analysis. Proportional odds model is a special case of ordinal logistic regression, where the odds are based on the cumulative probabilities of the classes. Hence, this model allows for separated intercepts of the classes and calculates cumulative odds.

For the purposes of our research, we have proposed four hypothesis relating mental health with various stressors. Our hypotheses arise from an expectation that exercising to maintain a healthy body and mind has a positive effect on mental health. Contrarily, the various concerns arising from the pandemic such as health, social and confinement concerns are largely expected to have a detrimental effect on the psychological welfare of citizens. The model assumes that these factors also vary among different age groups and gender identities and hence for each of the given models, these have been used as control variables.

The mathematical representations of our hypotheses are as follows:

H1: Exercise impacts mental health of individuals.

$$\text{Logit}\,[\text{Prob}(\text{Mental\_Health} \leq j)] = \alpha - (\beta_{\text{Exercise}}\text{Exercise} + \beta_{\text{Age\_Group}}\text{Age\_Group} + \beta_{\text{Gender}}\text{Gender})$$

H2: Concerns about health and wellbeing due to pandemic have impacted mental health of individuals.

$$\text{Logit}\,[\text{Prob}(\text{Mental\_Health} \leq j)] = \alpha - (\beta_{\text{Concern\_Health}}\text{Concern\_Health} + \beta_{\text{Age\_Group}}\text{Age\_Group} + \beta_{\text{Gender}}\text{Gender})$$

H3: Concerns about maintaining ties with friends and family during the pandemic have impacted the mental health of individuals.

$$\text{Logit}\,[\text{Prob}(\text{Mental\_Health} \leq j)] = \alpha - (\beta_{\text{Concern\_Social}}\text{Concern\_Social} + \beta_{\text{Age\_Group}}\text{Age\_Group} + \beta_{\text{Gender}}\text{Gender})$$

H4: Concerns about family stress due to confinement have impacted mental health of individuals.

$$\text{Logit}\,[\text{Prob}(\text{Mental\_Health} \leq j)] = \alpha - (\beta_{\text{Concern\_Confin}}\text{Concern\_Confin} + \beta_{\text{Age\_Group}}\text{Age\_Group} + \beta_{\text{Gender}}\text{Gender})$$

where j = 1, 2, …, 4
j = 1 refers to lying in “Poor” Mental Health group,
j = 2 refers to lying in “Fair” or lower Mental Health group,
j = 3 refers to lying in “Good” or lower Mental Health group,
j = 4 refers to lying in “Very Good” or lower Mental Health group,

4. DATA

4.1. Dependent variable

Mental Health (Mental_Health) - The perceived mental health of respondents. Participants in the survey were asked how they felt their general mental health was on a scale of 1 to 5; 1 being Excellent and 5 being Poor. The perceived mental health of individuals is affected by various factors resulting from the COVID-19 pandemic. For consistency, we have reordered this data such that 1 represents Poor mental health and 5 represents Excellent mental health.

4.2. Independent variables

Exercise Outdoors (Exercise) – The variable indicates whether participants exercised during the pandemic for their physical or mental health. Exercising is a well-known treatment for anxiety and depressive tendencies and hence has a positive effect on mental health. However, the pandemic and accompanying lockdown measures have resulted in disruption in the ability of people to exercise outdoors and have resulted in several difficulties in maintaining a healthy body and mind. We expect that those who continued to exercise for their health will generally show better tendencies of mental health.

The question posited to the participants required them to declare whether they exercised for the physical health, mental health, both or neither. For the purpose of our analysis we have combined these response to form a binary variable that reports and outcome of No (1) or Yes (2) when asked if participants exercised outdoors during the pandemic.

Concern due to COVID-19: Health (Concern_Health) – The variable indicated the level of concern people had for their own health due to the pandemic. With a global pandemic and widespread disruption of medical services, there is a possibility of fear among people of getting infected with COVID-19 and being unable to access adequate treatment. The concern of falling fatally sick may directly cause anxiety and stress, thus adversely affecting mental health.

Concern due to COVID-19: Maintaining Social Ties (Concern_Social) – The response analyses the concern of maintaining ties with friends and family during the pandemic. As a result of physical distancing measures, people are dependent on social media and the internet to maintain connections with their peers. While this is helpful, it cannot act as a substitute for human connection and can often cause feelings of loneliness and depression.

Concern due to COVID-19: Family stress from confinement (Concern_Confine) – The response checks whether participants were concerned about stress resulting from extended periods of confinement due to the pandemic. The pandemic has led to many countries imposing strict lockdown or stay-at-home measures, including Canada. These measures mean that many families have been forced to stay in for extended periods, without any physical meetings outside of their immediate family.

4.3. Control variables

Age (Age_Group) - The survey was conducted for respondents aged 15 and above. The age was divided into 7 ranges of 10 with the highest being individuals aged 75 or higher. The participants were asked to name which age group they fall under. Majority of participants declared their age as 55-64.

Sex (Gender) - Gender is a binary control variable with the responses being male or female. Among the responses in the survey, 53% were from female participants while 47% were male.

Variable	Mean	Standard Deviation	Minimum	Maximum	Count of Observations
Mental_Health	2.385984	1.049304	1	5	4552
Exercise	3.160802	0.692689	1	4	4490
Concern_Health	2.347231	0.829225	1	4	4605
Concern_Social	2.14888	0.881149	1	4	4554
Concern_Confine	2.096689	0.931933	1	4	4561

Table 2. Descriptive Statistics

For additional details about the chosen variables, please refer to the Appendix.

5. RESULTS

5.1. Normality test for the Dependent Variable

H0: The data distribution is normal
Ha: The data is not normally distributed

The dependent variable i.e. Mental health is tested for normality. We have employed two tests here – Shapiro-Wilk test and Kolmogorov-Smirnov test. If we find the p-value of the test is less than 0.05, we can reject the null hypothesis that the data distribution is normal. This means that we can state with 95% confidence that the data is not normally distributed. The outcome for our tests are given as follows:

Shapiro-Wilk Test

From the test we found that,

Shapiro-Wilk test W	0.89386
Shapiro-Wilk test p- value	2.2e-16

Table 3. Shapiro-Wilk Test

Given that $p < 0.05$ we reject the null hypothesis i.e. the data is not normal.

Kolmogorov-Smirnov Test

Similar to the previous normality test, we found that

Kolmogorov-Smirnov test D	0.20907
Kolmogorov-Smirnov test p- value	2.2e-16

Table 4. Kolmogorov-Smirnov Test

Given that $p < 0.05$ we reject the null hypothesis i.e. the data is not normal.

5.2. Model Estimates

Model 1: Exercise vs Mental Health							
Variable	Regression Coefficient	Std Error	t-value	p-value	Odds Ratio	Confidence Interval	
						Lower Limit	Upper Limit
Exercise	**0.4479**	0.0604	7.4073	1.2880e-13	1.5650	1.3902	1.7621
Age_Group	0.2443	0.0172	14.1996	9.2085e-46	1.2767	1.2344	1.3206
Gender	-0.3092	0.0555	-5.5653	2.6158e-08	0.7340	0.6582	0.8184
Intercepts							
Poor | Fair	-2.3840	0.1723	-13.8306	1.6655e-43			
Fair | Good	-0.4770	0.1536	-3.1045	1.9054e-03			
Good | VG	1.0563	0.1540	6.8571	7.0261e-12			
VG|Excellent	2.6216	0.1578	16.6102	5.8746e-62			
Model_2: Concern_Health vs Mental Health							
Concern_Health	**-0.3774**	0.0350	-10.7542	5.6609e-27	0.6856	0.6400	0.7344
Age_Group	0.2825	0.0175	16.1286	1.6051e-58	1.3265	1.2820	1.3731
Gender	-0.2711	0.0556	-4.8724	1.1021e-06	0.7625	0.6837	0.8504
Intercepts							
Poor | Fair	-3.8302	0.1626	-23.5471	1.341e-122			
Fair | Good	-1.9222	0.1401	-13.7169	8.0413e-43			
Good | VG	-0.3774	0.1370	-2.7538	5.8891e-03			
VG|Excellent	1.2082	0.1379	8.7581	1.9854e-18			
Model_3: Concern_Social vs Mental Health							
Concern_Social	**-0.2092**	0.0319	-6.5509	5.7175e-11	0.8111	0.7619	0.8635
Age_Group	0.2509	0.0171	14.5906	3.2229e-48	1.2851	1.2428	1.3295
Gender	-0.2933	0.0555	-5.2846	1.2594e-07	0.7457	0.6689	0.8315
Intercepts							
Poor | Fair	-3.5331	0.1619	-21.8105	1.840e-105			
Fair | Good	-1.6336	0.1398	-11.6823	1.5697e-31			
Good | VG	-0.1039	0.1374	-0.7563	4.4942e-03			
VG|Excellent	1.4612	0.1390	10.5075	7.9713e-26			
Model_4: Concern_Confine vs Mental Health							
Concern_Confine	**-0.4670**	0.0311	-15.0124	6.0816e-51	0.6268	0.5896	0.6661
Age_Group	0.2275	0.0173	13.1315	2.1714e-39	1.2554	1.2136	1.2989
Gender	-0.2921	0.0557	-5.2451	1.5619e-07	0.7466	0.6693	0.8326
Intercepts							
Poor | Fair	-4.2382	0.1667	-25.4239	1.369e-124			
Fair | Good	-2.3063	0.1439	-16.0250	8.5365e-58			
Good | VG	-0.7313	0.1397	-5.2324	1.6728e-07			
VG|Excellent	0.8772	0.1399	6.2670	3.6794e-10			

Table 5. Summary of model

From the summary table of the model, we can see that for all the variables the p-value is less than 0.05 ($p<0.05$) so we can say that all the coefficients are statistically significant and different from Zero, at 95% level of confidence. Hence, we interpret that the results of the model are significant and consistent with our assumptions and the correlations produced are meaningful.

Given that the control variables Age Group and Gender are held constant for each model, we obtain the following results:

1. The coefficient of Exercise is 0.4479 i.e. for unit increase in Exercise, we expect about 0.4479 increase in the expected value of Mental Health on the log odds scale.
2. Similarly, the coefficient of Concern_Health -0.3774 which implies that, for unit increase in the Concern_Health, we expect about 0.3774 decrease in the expected value of "Mental Health" on the log odds scale.
3. For Concern_Social coefficient -0.2092, there is 0.2092 log odds decrease in Mental_Health for unit increase in Concern_Social.
4. Finally, the coefficient of Concern_Confine is -0.4670. Therefore, for unit increase in the Concern_Confine, we expect about 0.4670 decrease in the expected value of Mental Health on the log odds scale.

From the above results, we can compute a probabilistic representation of the dependent vs independent variables for constant Age Group and Gender.

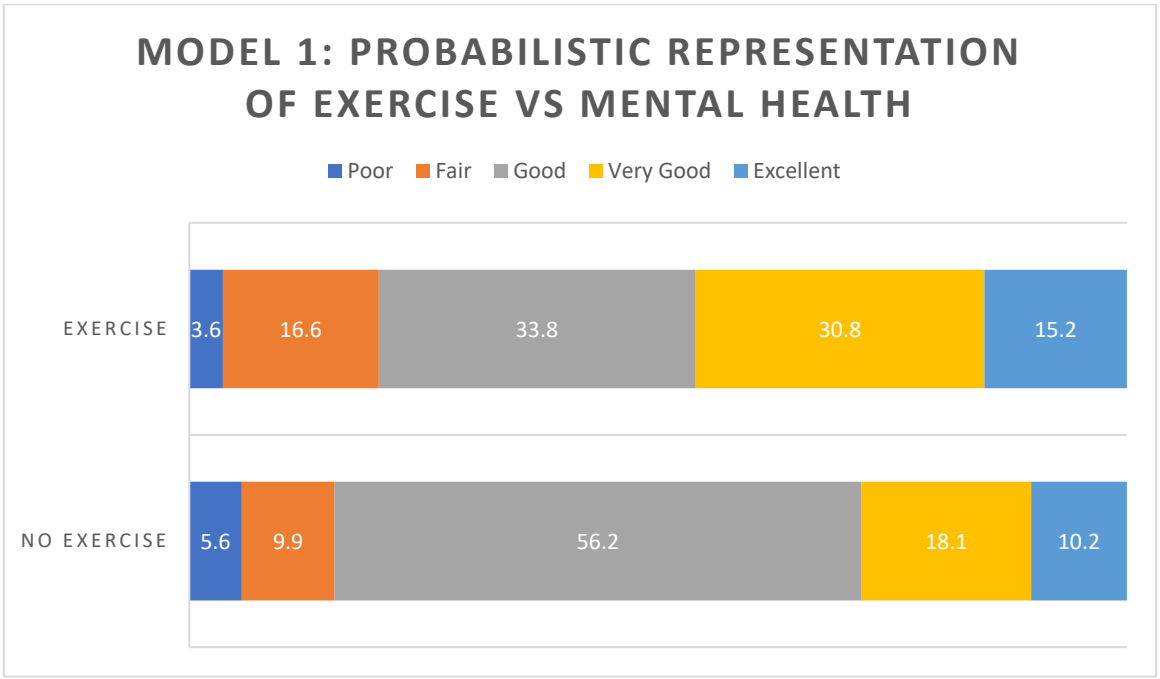

Fig 1. Exercise vs Mental Health

Hence, from the representation we see that there is a higher probability of lying in regions of better mental health for people who exercise as compared to people who do not exercise.

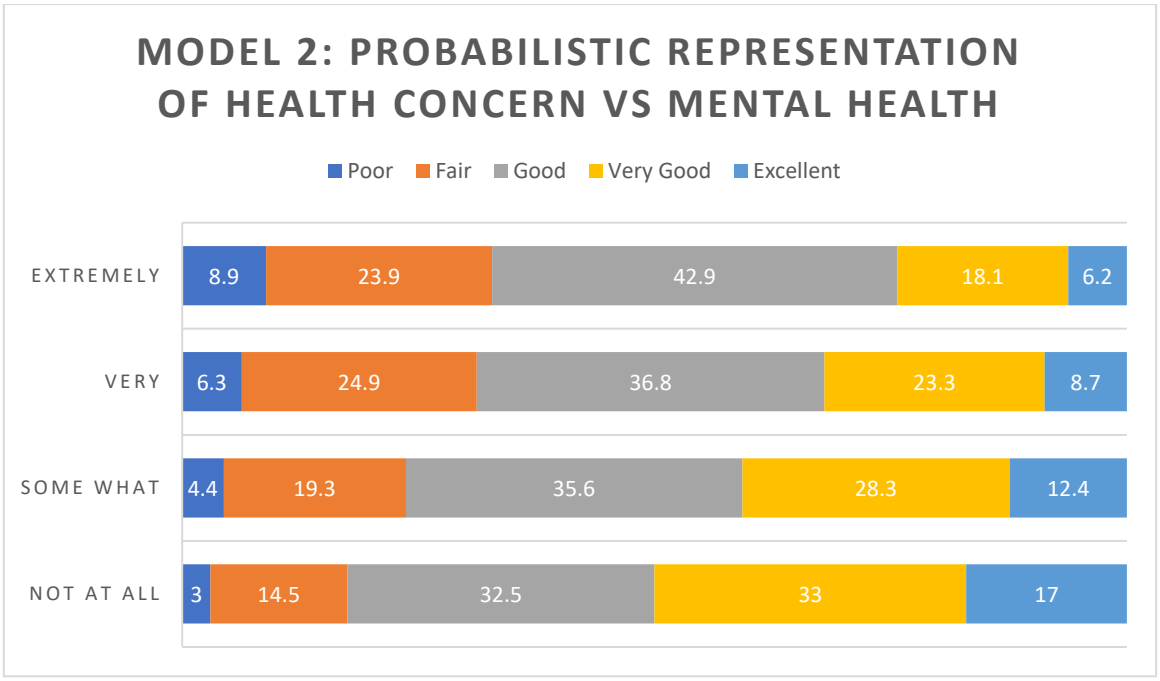

Fig 2. Concern_Health vs Mental Health

We see that as we progress from lower level of concerns about one's own health to higher levels of concern, the probability of lying in regions of higher mental health decreases. This shows that as concern about health increases, there is a detrimental effect on mental health.

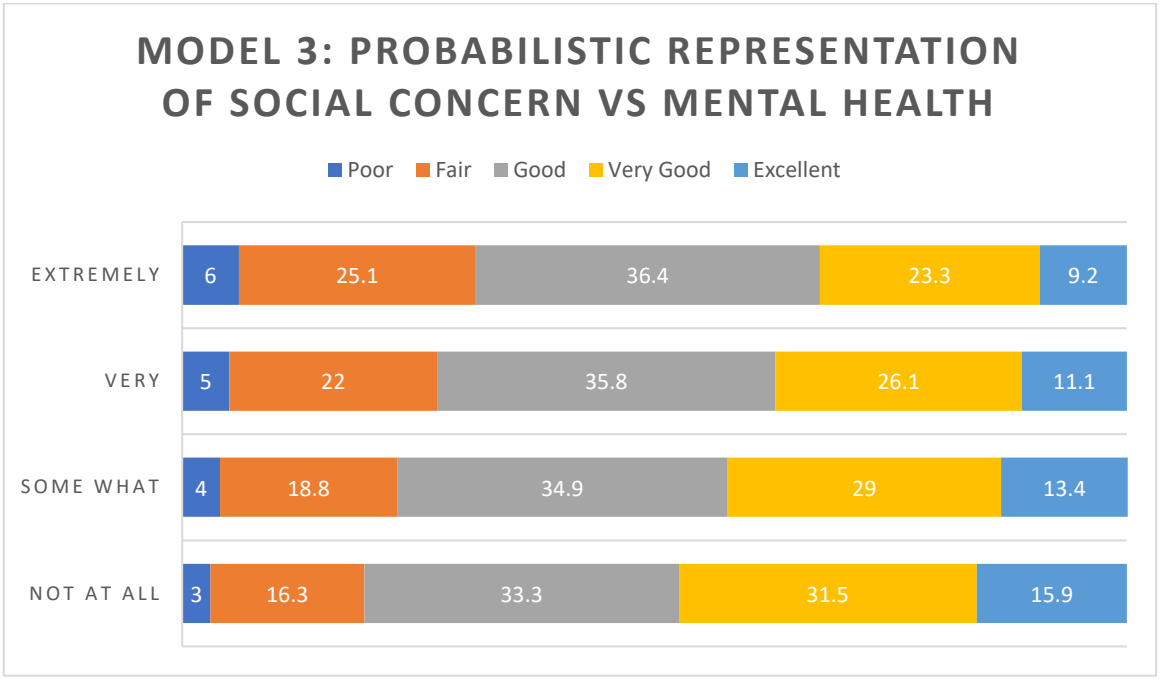

Fig 3. Concern_Social vs Mental Health

Similarly, for concerns about maintaining social ties, we find that there is a negative effect of increasing concern on the mental health.

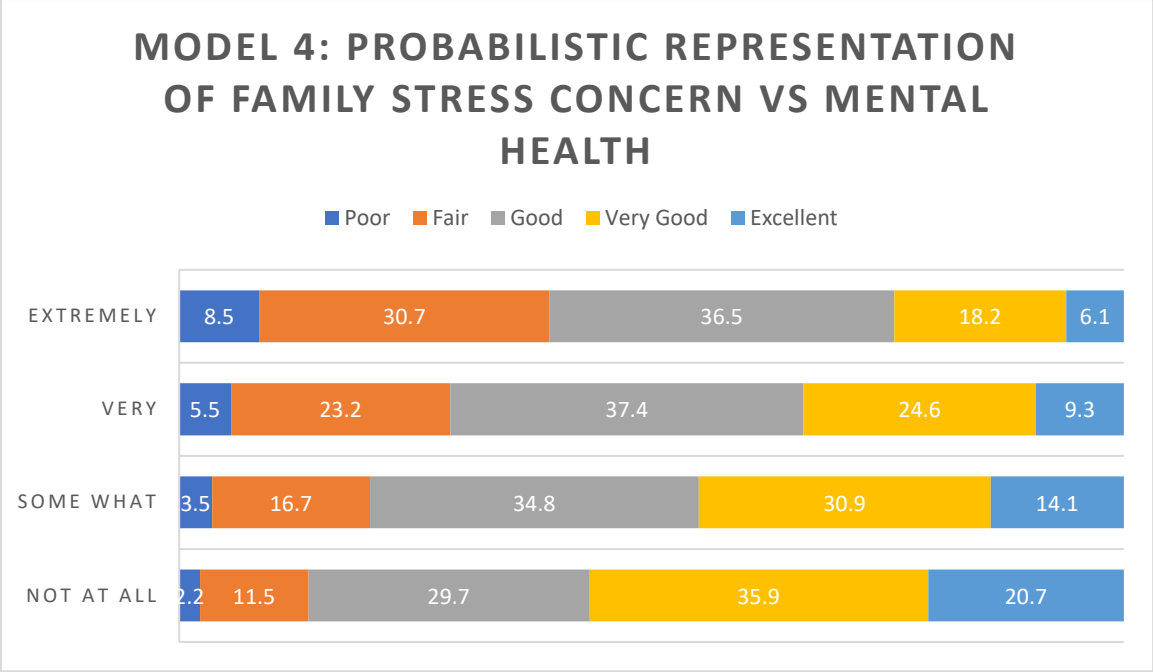

Fig 4. Concern_Confine vs Mental Health

Finally, as concerns about stress due to confinement increases, there is visible decline in mental health of individuals.

6. IMPLICATIONS AND CONCLUSIONS

The aim of this research is to understand the effect of COVID-19 pandemic and its resulting outcomes on the psychological well-being of Canadian citizens. Across 4339 participants from the 10 Canadian provinces, we studied the effects of social, economic and behavioural factors on mental health. For the purpose of our study, we focused on exercise, concerns about health, social ties and confinement on the mental health of individuals.

Our research found that there was a significant effect of all four factors on the mental welfare of individuals as a result of the pandemic. We found that exercise had a highly positive effect on the mental health of individuals. According to the odds ratio, the mental health of an individual increases from Poor, Fair, Good and Very Good to Excellent by 56% for people who exercise, given constant age and gender.

On the other hand, we found that concerns about health, social ties and confinement stress had negative effects on mental health, with confinement stress having the most impact and social ties having the least impact. A closer look at the odds ratio shows that the probability of having Excellent mental health decreases by 31%, 19% and 37% respectively for concern about health, social ties and confinement stress.

Interestingly, every model showed odds ratio for Age_Group to be greater than 1. This means the probability of having better mental health increases as we go from lower to higher ages. Hence, in the Canadian population older people showed signs of better mental health and coping strategies as compared to younger people.

Conversely, every model showed odds ratio for Gender to be lesser than 1. Given increase in gender (change from Male to Female), we find that female population in general has lower levels of mental health as compared to the male population. We see that females reported worse mental health due to the pandemic as compared to men.

Our research however is limited in its inability to compare the effect of each of the independent variables on each other. For example, it is theoretically possible that those concerned about family stress due to confinement have in general had trouble maintaining ties with their social circle. Hence, in order to improve our model in the future, we must find a way to account for the correlations between the independent variables.

7. REFERENCES

[1] Grocke-Dewey, M., Hardison-Moody, A., Haynes-Maslow, L., Maras, S., Webber, E., Andress, L., Houghtaling, B., Patton-Lopez, M., Shanks, J., & Byker-Shanks, C. (2021). Examining the relationship between physical activity and mental health during the COVID-19 pandemic across five U.S. States. *Preventive medicine reports*, *24*, 101537. https://doi.org/10.1016/j.pmedr.2021.101537

[2] Pizarro-Ruiz, J.P., Ordóñez-Camblor, N. Effects of Covid-19 confinement on the mental health of children and adolescents in Spain. *Sci Rep* 11**,** 11713 (2021). https://doi.org/10.1038/s41598-021-91299-9

[3] Millar, E. B. (2021, April 21). *Health anxiety, coping mechanisms and COVID 19: An Indian community sample at week 1 of lockdown*. Plos One. Retrieved 2021, from https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0250336

[4] Okabe-Miyamoto, K., & Lyubormirsky, S. (2021). *Social Connection and Well-Being during COVID-19*. The World Happiness Report. https://worldhappiness.report/ed/2021/social-connection-and-well-being-during-covid-19/

[5] Gender differences in mental health during the COVID-19 pandemic. (2020, July 9). Statistics Canada. https://www150.statcan.gc.ca/n1/pub/45-28-0001/2020001/article/00047-eng.htm

[6] Sojli, E. (2021, August 4). COVID-19 restrictions and age-specific mental health, U.S. probability-based panel evidence. Translational Psychiatry. https://www.nature.com/articles/s41398-021-01537-x

[7] Gloster, A. T. (2020, December 31). Impact of COVID-19 pandemic on mental health: An international study. JMIIR Publications. https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0244809

[8] Effects of COVID-19 on College Students' Mental Health in the United States: Interview Survey Study. (2020, September 3). Journal of Medical Internet Research. https://www.jmir.org/2020/9/e21279/

[9] Giuntella, O. (2021, March 2). *Lifestyle and mental health disruptions during COVID-19*. PNAS. https://www.pnas.org/content/118/9/e2016632118

[10] Nwakuya, M. T. (2019). Ordered Logistic Regression on the Mental Health of Undergraduate Students. Scientific & Academic Publishing. http://article.sapub.org/10.5923.j.ijps.20190801.02.html

APPENDIX

Appendix A

Variable	Description	Type	Scale	Construction	Associated Question
Mental_Health	The perceived mental health of individuals	Ordinal	Excellent to Poor (1-5)	Order reversed to represent ascending mental health	In general, how is your mental health?
Exercise	Whether the individual exercised outdoors during the pandemic	Ordinal	1 to 4 where 1-3 represent yes	Converted to binary variable where 1 is No and 2 is Yes	Are you doing any of the following activities for your health? – Exercise outdoors
Concern_Health	Whether the individual is concerned about their own health due to the pandemic	Ordinal	Not to Very concerned (1-4)	The values were retained as obtained	How concerned are you about each of the following impacts of COVID-19? - My own health
Concern_Social	Whether the individual is concerned about maintaining social ties during the pandemic	Ordinal	Not to Very concerned (1-4)	The values were retained as obtained	How concerned are you about each of the following impacts of COVID-19? - Maintaining social ties
Concern_Confine	Whether the individual is concerned about confinement stress during the pandemic	Ordinal	Not to Very concerned (1-4)	The values were retained as obtained	How concerned are you about each of the following impacts of COVID-19? - Family stress from confinement

Table 6. Detailed description of variables

Appendix B

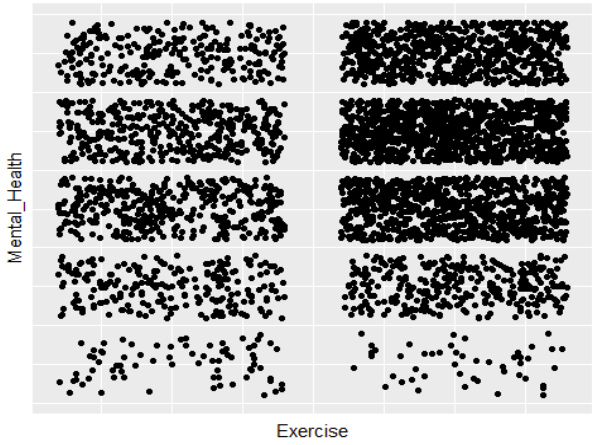

Fig 5. Scatterplot of Exercise with Mental Health

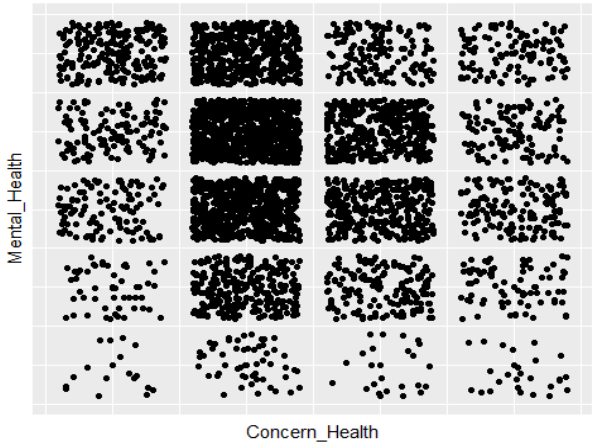

Fig 6. Scatterplot of Concern_Health with Mental Health

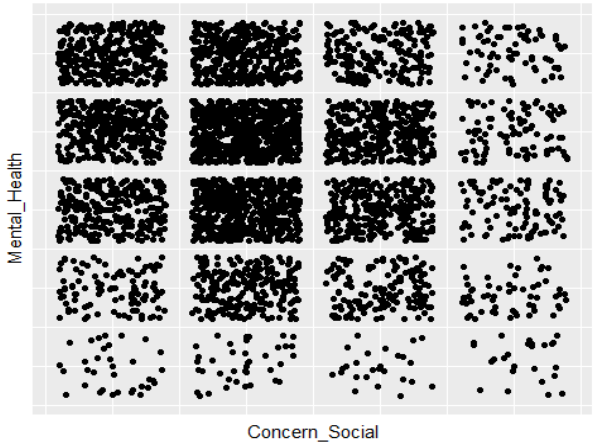

Fig 7. Scatterplot of Concern_Social with Mental Health

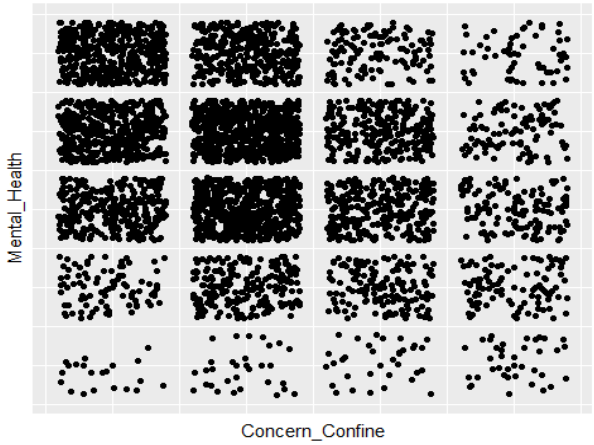

Fig 8. Scatterplot of Concern_Confine with Mental Health