

# Analysis on key factors affecting life satisfaction

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### Abstract

*Here is where you give a brief (one paragraph overview of your entire paper). This should include some background/introduction, some methodology, results and conclusions.*

We use the 2017 General Social Survey(GSS) data to study the response of people in Canada's life satisfactions to \_\_\_\_\_. The target population includes all non-institutionalized persons 15 years of age and older, living in the 10 provinces of Canada. The frame population is everyone who is registered combining both landline and cellular with Statistics Canada's address registers, and the sampled population is whoever is reached via telephone. The target population was divided into 27 strata by geographic areas – mostly CMA – and simple random sampling without replacement of records was performed in each stratum (which means, from each stratum/group, everyone has an equal probability of being chosen).

Through the analysis, We find: 1. a strong linear relationship between mental health rate and life satisfaction rate. People who rate themselves as “mentally healthy” are relatively more satisfied with their lives. The analysis also shows a linear relationship between health rate and life satisfaction. 2. no overall effects of hours worked on life satisfaction level. Together, these results suggest that no matter how much the income or working hours are, the most important factor that decides people's life satisfaction level is their mental and physical health.

### Introduction

There are many factors that determines one's well being and satisfaction of life. It could be health condition, economic status, relationships, religion, or any other element one would value or prioritize.

Particularly, in these uncertain and unprecedented times caused by the COVID-19 pandemic, many people across the world are feeling more stressed due to the changes that the pandemic has brought into their lives and those concerns negatively influence their own well being. Therefore, as this ongoing COVID-19 crisis reminds us of the importance of well being, our group decided to investigate and determine some factors that influence one's well being and satisfaction of life.

Throughout this report, we are going to determine and analyze some potential factors that affect one's life satisfaction, as well as to identify the most significant factor among them.

To be more specific, in the following sections, we will use statistical methods to build a regression model of life satisfaction score by potential factors, and interpret the regression output to find relationships between the life satisfaction score and potential factors.

This process includes cleaning the given data into a simpler, but efficient version, linear regression modelling, graphical visualizations and interpretations of the outputs.

## Data

The data set we chose for this assignment contains responses of the General Social Survey conducted in 2017. The contents of the survey include some characteristics of diverse families in Canada, their socio-economic status, as well as other subjective information such as the respondent's life satisfaction and health conditions.

Since we want to identify some key factors affecting one's life satisfaction as mentioned previously, the focus of our analysis will be "Health and subjective well-being".

The reason for choosing the 2017 GSS is because it is the most recent<sup>1</sup> survey that includes the "Health and subjective well being" topic.

One of the characteristics of our data set is that the majority of the variables are categorical. However, some disadvantages of using such data is that there is a limit to the kinds of statistical analysis that we can use with our data, as well as numerical operations or quantitative analysis cannot be performed on such data. Not only this, but there are number of columns in our data set with too many NAs in them, and this indicates that the data set contains some unnecessary/pointless variables. If we want to use such variables in our analysis, we would first need to exclude those 'NA' observations from our data; however, any results drawn from the data could possibly be biased or misleading due to the small number of observations available.

Since the original data set contains too many variables that are not necessary, we are going to clean the data set prior to analysis by removing them.

Here is our newly created data:

```
## # A tibble: 6 x 8
##   ID   age sex  satisfaction_sc~ self_rated_heal~ self_rated_ment~
##   <dbl> <dbl> <chr>          <dbl>          <dbl>          <dbl>
## 1     1  52.7 Fema~             8             5             5
## 2     2  51.1 Male             10            3             3
## 3     5   28  Male             8             3             3
## 4     9  63.8 Fema~             8             4             4
## 5    11  15.7 Male             10            5             5
## 6    12  40.3 Fema~             6             4             3
## # ... with 2 more variables: family_income <chr>, work_hours <chr>
```

Our data contains 8 variables: ID, age, sex, satisfaction\_score, self\_rated\_health, self\_rated\_mental\_health, family\_income, and work\_hours.

Detailed descriptions on variables are provided in the footnote<sup>2</sup>

Since we want to observe how the life satisfaction score is related to potential factors such as health or financial conditions, the response variable of our analysis will be satisfaction\_score and the predictors will be the potential factors: self\_rated\_health, self\_rated\_mental\_health, family\_income, and work\_hours.

## Model

Introduce the selected model here. It is expected that you will use some mathematical notation here. If you do please ensure that all notation is explained. You may also want to discuss any special (hypothetical) cases of your model here, as well as any caveats.

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<sup>1</sup>As it is stated in the documentation of the GSS, one of the primary objectives of the General Social Survey is to monitor the well being of Canadians over time. As a result, every survey conducted so far contain the responses related to the questions asking for the respondents' well being, and the 2017 GSS is the most recent survey with such responses.

<sup>2</sup>\* satisfaction\_score indicates the life satisfaction score on a scale of 0(very dissatisfied) to 10(very satisfied).

\* self\_rated\_health and self\_rated\_mental health are the physical and mental health ratings, respectively, on a scale of 1(poor) to 5(Excellent) given by the respondent.

\* work\_hours indicates the average number of hours worked per week.

Now, we are going to fit a multiple linear regression model in order to find linear associations between `satisfaction_score` and other predictor variables: `self Rated health`, `self Rated mental health`, `family income`, and `work hours`.

Note, the equation for our regression line looks like this:

$$\text{satisfaction\_score} = \hat{B}_0 + \hat{B}_1 * x_{health2} + \hat{B}_2 * x_{health3} + \hat{B}_3 * x_{health4} + \hat{B}_4 * x_{health5} + \hat{B}_5 * x_{mental2} + \hat{B}_6 * x_{mental3} + \hat{B}_7 * x_{mental4} + \hat{B}_8 * x_{mental5} + \hat{B}_9 * x_{income2} + \hat{B}_{10} * x_{income3} + \hat{B}_{11} * x_{income4} + \hat{B}_{12} * x_{income5} + \hat{B}_{13} * x_{income6} + \hat{B}_{14} * x_{work2} + \hat{B}_{15} * x_{work3} + \hat{B}_{16} * x_{work4} + \hat{B}_{17} * x_{work5}$$

(The detailed descriptions on the x-variables are found in the footnote<sup>3</sup>.)

As it is shown above, we are going to have a very long equation for our regression line; however, this is inevitable since each of our predictor variables has several levels in them.

One thing we should notice in our data is that both the `income` and `work hours` variables are categorical. To be more specific, we are given a range of values instead of an exact amount as income or average work hours in each variable. However, since our response variable is numerical, and we want to determine if each predictor has a linear relationship with it, we are going to treat our observations in both `income` and `work hours` as numbers by replacing each category in `income` and `work hours` with the midpoint. This process will allow us to investigate the linear relationships between the life satisfaction and the two predictors numerically; however, there is a chance where the true values for `income` or `work hours` could be very different from the midpoint. Therefore, we need to take into account when interpreting the regression model, that the two predictor variables could be biased and so does the result.

After finding some relationships between our response and predictor variables using the regression model, we are going to identify which predictor is the most significant factor in explaining the variability in the response variable. In other words, we are going to find out which of the potential factors (among physical health condition, mental health condition, income and average work hours) can explain the variability in life satisfaction the most.

## Results

Here you will include all results. This includes descriptive statistics, graphs, figures, tables, and model results. Please ensure that everything is well formatted and in a report style. You must also provide an explanation of the results in this section. You can overflow to an Appendix if needed.

Please ensure that everything is well labelled. So if you have multiple histograms and plots, calling them Figure 1, 2, 3, etc. and referencing them as Figure 1, Figure 2, etc. in your report will be expected. The reader should not get lost in a sea of information. Make sure to have the results be clean, well formatted and digestible.

Here is the summary of the multiple linear regression model:

```
##
## Call:
## lm(formula = satisfaction_score ~ as.factor(self Rated health) +
##      as.factor(self Rated mental health) + as.factor(family income) +
##      as.factor(work hours), data = model_data)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
```

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<sup>3</sup>\*  $x_{health_i}$  is a physical health rating indicator for  $i$  from 2 to 5  
(i.e.  $x_{health_5} = 1$  if the respondent's `self Rated health` = 5, and  $x_{health_5} = 0$  otherwise).

\*  $x_{mental_i}$  is a mental health rating indicator for  $i$  from 2 to 5.

\*  $x_{income_i}$  is an average income range indicator for  $i$  from 2 to 6  
(i.e.  $x_{income_2} = 1$  if the family income is in the second category “\$25,000 to \$49,999”, and  $x_{income_2} = 0$  otherwise).

\*  $x_{work_i}$  is a working hours range indicator for  $i$  from 2 to 5  
(i.e.  $x_{work_2} = 1$  if the average hours of work is in the second category “0.1 to 29.9 hours”, and  $x_{work_2} = 0$  otherwise).

```
## -9.1029 -0.7224 0.0663 0.8971 6.1204
##
## Coefficients:
##
## Estimate Std. Error t value Pr(>|t|)
## (Intercept) 3.44552 0.29424 11.710 < 2e-16 ***
## as.factor(self_rated_health)2 0.51471 0.10379 4.959 7.17e-07 ***
## as.factor(self_rated_health)3 0.83475 0.09740 8.571 < 2e-16 ***
## as.factor(self_rated_health)4 0.98584 0.09793 10.067 < 2e-16 ***
## as.factor(self_rated_health)5 1.17522 0.09973 11.784 < 2e-16 ***
## as.factor(self_rated_mental_health)2 1.63274 0.11629 14.040 < 2e-16 ***
## as.factor(self_rated_mental_health)3 2.69951 0.10889 24.790 < 2e-16 ***
## as.factor(self_rated_mental_health)4 3.24499 0.10932 29.684 < 2e-16 ***
## as.factor(self_rated_mental_health)5 3.72145 0.11004 33.818 < 2e-16 ***
## as.factor(family_income)37499.5 0.11351 0.04979 2.280 0.0226 *
## as.factor(family_income)62499.5 0.33408 0.04959 6.736 1.69e-11 ***
## as.factor(family_income)87499.5 0.35903 0.05021 7.151 9.10e-13 ***
## as.factor(family_income)112499.5 0.47951 0.05232 9.166 < 2e-16 ***
## as.factor(family_income)125000 0.52816 0.04640 11.384 < 2e-16 ***
## as.factor(work_hours)15 0.29608 0.27262 1.086 0.2775
## as.factor(work_hours)35 0.23252 0.27176 0.856 0.3922
## as.factor(work_hours)45.05 0.32056 0.27335 1.173 0.2409
## as.factor(work_hours)50.1 0.39476 0.27448 1.438 0.1504
## ---
## Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.298 on 12927 degrees of freedom
## (62 observations deleted due to missingness)
## Multiple R-squared: 0.2733, Adjusted R-squared: 0.2724
## F-statistic: 286 on 17 and 12927 DF, p-value: < 2.2e-16
```

With the estimates from the regression output, we know that our regression line has a following equation:

$$\begin{aligned} \text{Satisfaction Score} = & 3.44552 + 0.51471 * x_{\text{health}2} + 0.83475 * x_{\text{health}3} + 0.98584 * x_{\text{health}4} + 1.17522 * x_{\text{health}5} + \\ & 1.63274 * x_{\text{mental}2} + 2.69951 * x_{\text{mental}3} + 3.24499 * x_{\text{mental}4} + 3.72145 * x_{\text{mental}5} + 0.11351 * x_{\text{income}2} + \\ & 0.33408 * x_{\text{income}3} + 0.35903 * x_{\text{income}4} + 0.47951 * x_{\text{income}5} + 0.52816 * x_{\text{income}6} + 0.29608 * x_{\text{work}1} + \\ & 0.23252 * x_{\text{work}2} + 0.32056 * x_{\text{work}3} + 0.39476 * x_{\text{work}4} \end{aligned}$$

(\*Note, you can find the descriptions for x-variables from the footnotes in the previous page.)

As we can observe from the output, estimated `satisfaction_score` increases as each of `self_rated_health`, `self_rated_mental_health` and `family_income` increases; however, the slope estimates for `work_hours` are found to be quite inconsistent, because there is a decrease in slope estimates from 0.29608 to 0.23252 in the first two categories of `work_hours`, but they increase again in the third and fourth categories.

Furthermore, p-values of `work_hours` that are much greater than the significance level of 0.05 provide us with more evidence that there is no linear relationship between the average working hours and the life satisfaction score.

Hence, the regression model suggests that only the physical health, mental health and financial conditions have positive linear relationships with the life satisfaction score.

Now that we've found that the life satisfaction score has linear relationships with physical health, mental health, and financial conditions, we want to ask ourselves: are those factors equally important in terms of explaining the variability in `satisfaction_score`?

The answer is 'No'.

Although they all have positive linear relationships with the response variable, not all variables may contribute significantly in explaining the variability of the response variable.

Hence, we would now like to identify the most important predictor variable in this regression model.

There are two ways to do this<sup>4</sup>. In this analysis, specifically, we are going to use the method where we compute and compare the changes in adjusted  $R^2$  for the last variable added to the model<sup>5</sup>. This is a valid method for identifying which predictor explains the most variability in the response variable, because by the definition,  $R^2$  gives the percentage of variation in the response variable explained by the regression line, and also, if the newly added predictor variable is the only difference between the two models, the associated change in ‘adjusted  $R^2$ ’ will represent the ‘goodness-of-fit’.

(\*Note, we are not using  $R^2$  here, because  $R^2$  will always be inflated by adding more predictors to the model even if the newly added predictor is not significant.)

We are going to begin with fitting a linear model with only one predictor, and then add another predictor to the model at a time to see how much  $R^2_{adjusted}$  changes when each variable is added.

Key point in this method is to identify the predictor variable with the largest increase in  $R^2_{adjusted}$  when it is the last variable added to the model.

This is the table with  $R^2_{adjusted}$  values in each model, and the change in  $R^2_{adjusted}$  as more variables are added:

```
## # A tibble: 3 x 3
##   Predictors                                R_squared_adjust~ Change
##   <chr>                                     <dbl> <dbl>
## 1 selfRatedHealth                         0.117 0.117
## 2 selfRatedHealth + selfRatedMentalHealth 0.240 0.122
## 3 selfRatedHealth + selfRatedMentalHealth + famil~ 0.253 0.0137
```

As it is shown in the table, there is a greatest increase in  $R^2_{adjusted}$  when the second predictor, selfRatedMentalHealth is added to the model. This increase is quite close the  $R^2_{adjusted}$  of our initial simple linear regression model with a predictor, selfRatedHealth.

On the other hand, the change in  $R^2_{adjusted}$  is relatively small when familyIncome is added to the regression model compared to the previous changes, and therefore, we know that the family income does not contribute significantly in explaining the variation in the satisfaction score.

Hence, the result suggests that both physical and mental health are significant predictors, however, mental health is a more important factor than physical health in terms of explaining the variability of the life satisfaction score.

## Discussion

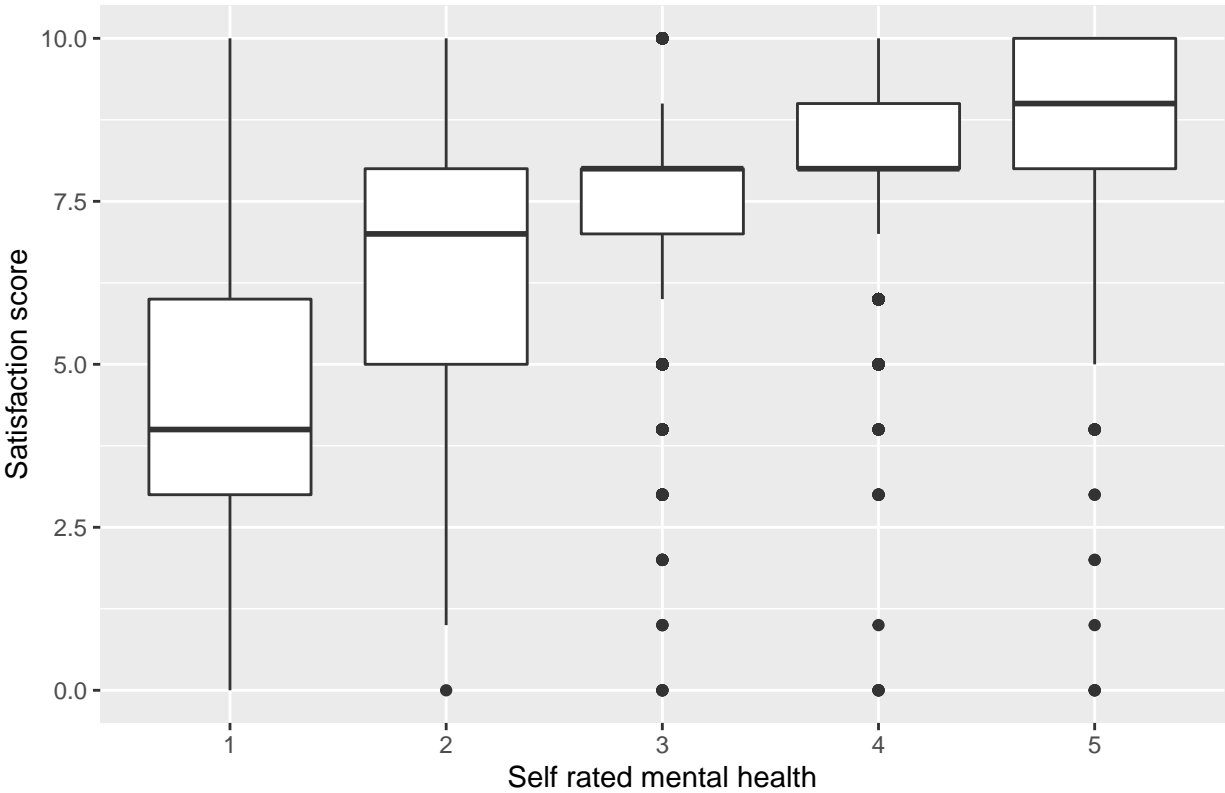
\*Woolim Kim The goal of this process is to find what are some factors that affects and has big influence on person’s satisfaction of their lives.

Graphical visualization of positive correlation of the mental health and life satisfaction score:

<sup>4</sup>One way is to compare the standardized regression coefficients, and the other way is to compare the increases in adjusted  $R^2$  when each predictor is added to the regression model. For this analysis, specifically, we cannot use the first method, because our model contains categorical predictor variable which cannot be standardized.

<sup>5</sup> $R^2_{adjusted} = 1 - (1 - R^2) * (\frac{n-1}{n-p-1})$  where n is the total sample size and p is the number of additional predictor variables. Hence, unlike  $R^2$ , if the newly added predictor does not explain variation in the response variable well,  $R^2_{adjusted}$  will go down.

How Mental Health Affects People's Satisfaction



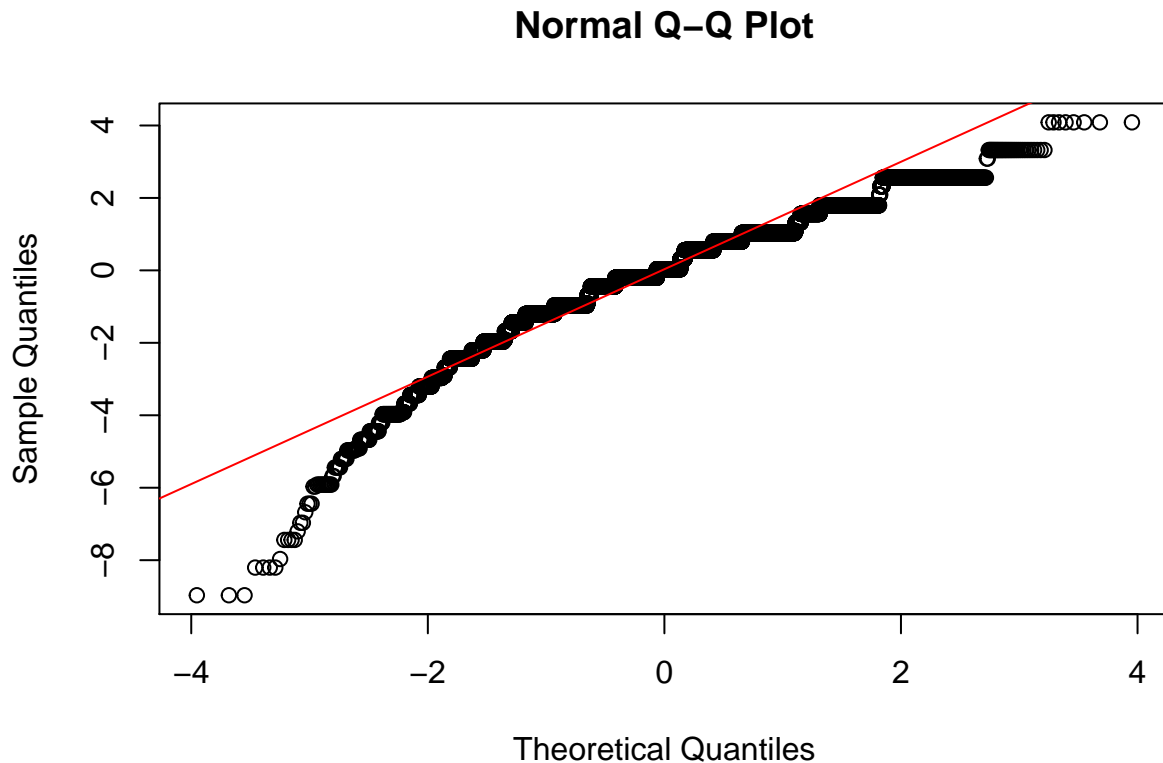


Figure 1. The boxplot has positive linear relationship between the two variables.

It signifies that average of life satisfaction score increases as the self rated mental health increases.

The normal QQ plot shown above graphically analyze and compare two probability distributions by plotting their quantiles against each other. The bottom end of the Q-Q plot is below the straight line, this shows that the distribution has a longer tail to its left which means it is left-skewed.

Here you will discuss conclusions drawn from the results and comment on how it relates to the original goal of the study (which was specified in the Introduction).

## Weaknesses

Here we discuss weaknesses of the study, data, analysis, etc. You can also discuss areas for improvement.

\*Woolim Every statistic data study and analysis includes some bias and weaknesses. One of our weakness is that the predictor variables are categorical variable, which made it challenging to visualize the linear regressions model we found and show the significance between the life satisfaction score and other factors.

## Next Steps

Here you discuss subsequent work to be done after this report. This can include next steps in terms of statistical analysis (perhaps there is a more efficient algorithm available, or perhaps there is a caveat in the data that would allow for some new technique). Future steps should also be specified in terms of the study setting (eg. including a follow-up survey on something, or a subsequent study that would complement the conclusions of your report).

## References

1. GSS Data: <https://sda-artsci-utoronto-ca.myaccess.library.utoronto.ca/cgi-bin/sda/hsda?harcsta4+gss31>
2. Data Cleaning Code:
3. Identifying the most significant predictor: <https://statisticsbyjim.com/regression/identifying-important-independent-variables/>