THE UNIVERSITY OF CHICAGO

# An analysis: Self-control, self-esteem, and depression during COVID-19

By

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Summer 2022

A paper submitted in partial fulfillment of the requirements for the

Master of Arts degree in the

Master of Arts Program in the Social Sciences

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**Abstract**

The major depressive disorder has drawn wide attention and has been researched for decades in the fields of psychology, and many factors that may have significantly high correlations with depression were discovered and proposed. However, the relationship between these variables and depression during a world-wide epidemic of infectious diseases is unclear. This paper mainly focuses on the relationship between self-control, self-esteem, multiple demographic information, and depression among students of different educational levels during the quarantine of Coronavirus Disease 2019 (COVID-19) pandemic in Xiamen City, China. The significant gender and age differences on the score of self-control, the score of self-esteem, and the severity of depression for participants in either proportional of or the whole data are observed. Moreover, several solid correlations were discovered between the score of self-control, the score of self-esteem, and the severity of depression. The final model suggested the significant influence of the participants' current educational level, parents' marriage status, relationship with parents, electronic devices usage, score of self-control, and score of self-esteem on their severity of depression. The results of this study may draw parents' attention to the mental health, especially depression, of young people during COVID-19 pandemic; moreover, it is imperative for the psychological professionals or educational practitioners to conduct prevention and intervention of mentally abnormal conditions in schools.

**Introduction**

What is the relationship between self-control, self-esteem, and the severity of major depressive disorder? What would happen under a world-wide epidemic of infectious diseases?

Would any demographic factor (E.g., age, gender, relationship with family members, etc.) be significant in predicting depression of students? The purpose of this study is to discover the age and gender differences and the correlations of self-esteem, self-control, and the severity of depressive disorder during Coronavirus Disease 2019 (COVID-19) quarantine.

The sudden outbreak of COVID-19 pandemic in the beginning of 2020 lead to significant influences on people's daily life globally, and the World Health Organization declared the event of COVID-19 as an international public health emergency. Many governments and organizations made great efforts to minimize and prevent the further lost that caused by the epidemic, for instances, performing in-home quarantines, suspension of school, limitation of nonessential production, etc. (Ayittey et al., 2020), and regardless of the effectiveness, such plague harmed both physical and mental health (Talevi et al., 2020). Some researchers expressed their concerns about the possible emergence of children and adolescents' mental health problem under such circumstances, which might include anxiety, depression, the feeling of social isolation, and the turbulences of sleeping and eating (Imran et al., 2020). Other researchers pointed out the concurrent emotional and behavioral disturbances were also found among children, such as worries of their family members' health, inattention, clinginess, etc (Jiao et al., 2020).

Further investigations in questionnaire style of mental health have shown that during COVID-19 pandemic, children, adolescents, and adults were all suffering high mental pressures caused by longstanding school closures, social isolation, financial hardships, and gaps in health care access, leading to the symptoms of depressive disorder and suicidal ideation (Czeisler et al., 2020), and this discovery was in accordance with other researchers' findings on participants

from multiple age groups (Lee, 2020; Liu et al., 2020; Wang et al., 2020). Previous studies and analyses presented that depression, a prolonged existence of physically and mentally abnormal condition which may include sadness, emptiness, irritation, or anhedonia (Kaltenboeck & Harmer, 2018), has the most significant risk factors and the highest correlation with suicidal ideations and even suicidal attempts (Takahashi, 2001), indicating the urgency of future in-depth studies and applicable psychological interventions of depression under COVID-19 pandemic (Xiang et al., 2020). In the following year, 2021, the epidemic showed no clear sign of ending nor getting better. The fear that the rate of viral transmission and mutation exceeded the vaccinates' production and popularization seemed to have come true. Responding to the new rounds of variations of COVID-19 (*Delta* or *Omicron*), the Chinese government has adopted stringent policies to control the spread of the virus.

Numerous archives that are related to this study were selected, investigated, and summarized. In the following sections, multiple past studies on the related research topics will be reviewed, and some inconclusive results act as a promotion for the conduct of further studies.

**Depression & Self-esteem**

Self-esteem is regarded as the individuals' recognitions of their own values (McGregor et al., 2009). Self-esteem could partially reflect individuals' mental health status, for it has indispensable relationship with multiple other psychological features, meaning the variation of self-esteem may also correlate with the variation in other psychological factors, for instances, self-confidence, self-regulation, and psychological endurance (McGregor et al., 2009). Scholars

have discovered high self-esteem is correlated with positive features, such as proactivity, better coping capability, and higher resilience when facing challenges (Baumeister et al., 2003). On the contrary, low self-esteem is correlated with negative mental condition or not socially acceptable behaviors, such as substance abuse, illegal act, and depression (Crocker & Jennifer, 2002). As a result, high self-esteem might make contribution to aid people to overcome setbacks and negative life events.

Numerous studies have shown that low self-esteem is significantly correlated with high depression, and the level of self-esteem could be used as a reference measure to predict individuals' depression levels. The longitudinal study on the relationship between self-esteem and mental health indicated that when the prior symptom severity, gender, and medication is controlled, the initial high self-esteem predicted lower rates of future depression and anxiety compared to the low self-esteem (Henriksen et al., 2017). The straightforward conclusion from the experimental study was also supported by a meta-analysis. Sowislo and Orth (2012) suggested the predictive effect of self-esteem on depression is significantly higher than depression on self-esteem, showing more supportiveness to the vulnerability model which proposes low self-esteem leads to depression, rather than the scar model which states depression weakens self-esteem. Moreover, self-esteem could also play a mediating role between mindfulness, which is a mental state that can help people to stop depressive thinking, and depression, appealing people to attach importance to self-esteem when considering depression (Bajaj et al., 2016).

**Depression & Self-control**

Self-control is a psychological feature which is believed to exclusively possessed by human beings, and it may promote people to positively invest necessary efforts and actions to achieve future goals (Inzlicht et al., 2014). Self-control also helped people control their own behavior by resisting some unreasonable impulses, inappropriate habits, or automatic reflection under certain circumstances (Baumeister et al., 2007). The connection between self-control and depression exists, and some researchers mentioned the mediating effect of social support: the increase of social support would enhance individuals' self-control ability, and the latter would promote the subjective well-being (Klonowicz, 2001); similarly, the social support reduced the severity of individuals' depression, which also leading to a raise in subjective well-being (Yoo et al., 2017).

Moreover, the self-control may interact with depression directly and could be considered as an essential factor that influence the development of depression: when the self-control is impaired, individuals tend to have higher risk of depression (Carver et al., 2008). People may be depressed if they believed the adverse events are out of their control, and thus the subjective well-being would be harmed, indicating the self-control could negatively predict depression (Khan et al., 2008). Researchers have found the relatively low self-control ability is correlated with black mood, low will power, and depression (DeWall et al., 2007). People can also train their self-control ability, which is believed to have a mediating effect between negative life event and depression, and thus by enhancing the self-control ability, individuals may suffer less from depression (Kim & Park, 2015)

**Self-control & Self-esteem**

Self-control and self-esteem are both significant components of individuals' self-cognition, high self-esteem is highly correlated, and could positively predict, self-control. Individuals with low self-esteem tend to have negative self-evaluation and are more likely to perform escape or procrastination when facing difficulties (Uzun et al., 2020).

DeWall et al. (2007) suggested that the low mood would cause the wastage of self-control resource, leading to the decrease in self-control, and then cause the self-criticism and low self-esteem, and result in depression. Consequently, the self-control interacts with self-esteem, and they both influence depression.

**The relationship between age and gender on the variables of this study**

The relationship between age and gender differences on self-esteem, self-control, and depression is studied in various research, yet the results from multiple researchers are inconclusive.

McMullin and Cairney (2004) conducted analysis of the data collected by Statistics Canada and found that for both genders (more than 18000 participants in total), the self-esteem decreased slowly with age after 12 years old, and in each age group, females tend to have lower self-esteem than males. A longitudinal study showed opposite conclusions: among 7100 participants aged 14 to 30 years, which is from adolescence to young adulthood, both genders showed a slowly yet steady increasing self-esteem, and no gender differences were observed (Erol & Orth, 2011). Another research that includes a broader age bracket presented the combination of two former studies: although the self-esteem is relatively stable across time, the score increases from adolescence to middle adulthood and reaches the highest at about age 50

- 60 years, and afterwards the self-esteem decreased rapidly (Orth & Robins, 2014). Bleidorn et al. (2016) was in consistent with former studies, that is, the self-esteem for both genders increased as age, and males' self-esteem were consistently higher than females.

The research that studies the development of self-control suggested that the self-control is developed very early in age, and for a large proportion of people, their self-control remain generally stable; for other people, however, their self-control change dramatically after age 10 (Hay & Forrest, 2006). Duckworth (2014) supported the former study by showing evidence that self-control could be trained and enhanced for school-age children. When comes to gender differences, previous studies might apply testing items with bias, yet the results did not change after researchers modified the measurement: for young adults, males have lower self-control than females (Gibson et al., 2010).

It is believed that depression is a common mental health problem for teenagers, and given there is a relatively high incidence rate, many people already have basic understanding of depression (Cairns et al., 2018). The adolescents' depression rate increases rapidly between age 13 to 15 years old and eventually reached the peak at 17 to 18 years old (Radloff, 1991). Other researchers' study made supplement to the previous ones. Mirowsky and Ross (1992) argued young adults' mental states are getting better as they grow, and the middle-aged adults are the least depressed group of people, however, the depression started to grow after 60 years old. The gender differences in depression are much more concordant among many researchers. Starting at the middle of adolescence to the age of 55, females are about twice likely to have depression or have twice as much depressive symptoms as males (Girgus & Yang, 2015), and the

interpretation of such differences could vary and may be including psychological, neurochemical, anatomic, hormonal, genetic, and personality factors (Grigoriadis & Robinson, 2011).

**Sample Selection**

A typical case of COVID-19 outbreaks and the control was taken place in Xiamen, a southeastern city in China, from August to September 2021. The response solution was the mandatory and strict shut down of the city, and all educational institutions including kindergartens, elementary schools, middle schools, high schools, vocational schools, and colleges had switched to online teaching schedules, thus all students complied with the policy and were quarantined at home for twenty-two days, and all of the participants are students in Xiamen City who have experienced the shut-down.

The participants of this research contained elementary school students who are forth to sixth grade, middle school students who are seventh to ninth grade, high school students who are tenth to twelfth grade, undergraduate students from freshman to senior, and graduate students which includes first to third year master students and Ph.D. students/ candidates. All participants could be briefly categorized as high-grade elementary school students, middle and high school students, and college and graduate students. 2045 high-grade elementary school students, 2100 middle-high school students, and 5345 college-graduate students were initially participated in the online anonymous questionnaire. After eliminating the straight-line answers and unfinished surveys, the number of total valid questionnaires is 9314, all participants' age were within the range from 7 to 56 with the average age of 16.33 (SD = 4.58) years old.

The number of valid questionnaires of high-grade elementary school students were 2029,

indicating a 99.21% retrieving rate. Among all 2029 participants, 1057 (52.09%) were males with average age of 10.21 (SD = 1.14) years old, and 970 (47.80%) participants were females with average age of 10.23 (SD = 1.48) years old.

The same procedures of raw data filtering were also applied on data of middle-high school students and college-graduate students. Among 2100 middle-high school participants, 1988 surveys were valid, and thus the retrieving rate was 94.67%. There were 1057 (53.17%) males, and the average age was 13.17 (SD = 1.46) years old; 931 (46.83%) females, and the average age was 13.16 (SD = 1.15) years old.

College-graduate group had much more participants than the former ones. The number of valid surveys is 5297, yielding a 99.10% retrieving rate. 1942 (36.67%) males with average age of 19.86 (SD = 2.21) years old and 3345 (63.33) females with average age of 19.84 (SD = 2.3) years old contributed the dataset.

Given the fact that the target population of this study are children, adolescents, and young adults, the following analysis will only include participants who are not older than 30 years old. Moreover, the age ranges of high-grade elementary group, middle-high group, and college-graduate group were limited to 7-14 years old, 11-18 years old, and 15-30 years old respectively.

**Method**

All participants were in Xiamen City, China. Convenient sampling was conducted by researchers to all participants by distributing online anonymous questionnaire started on the beginning of October 2021, immediately after the COVID-19 home quarantine lockdown order was lifted. This questionnaire would mainly consist of demographic information, Patient Health

Questionnaire-9 (PHQ-9) Depression Assessment, Self-esteem Scale (SES), and Self-control Scale (SCS). It is expected to observe the age and gender differences in self-esteem, self-control, and the severity of depression; the positive correlation between the self-esteem and the self-control; the negative correlation between self-control and the severity of depression (similar situation between the self-esteem and the severity of depression); the demographic features' influences on the severity of depression in multiple levels and directions. It is also expected to take the combination of demographic features, self-esteem, and self-control to collectively form a valid and sufficient model which could predict the severity of depression.

a. Demographic Information

The research surveys were distributed to local elementary schools, middle schools, high schools, and colleges; thus, the demographic portions would also add items about family relationships and internet usage when taking 22-day online courses besides basic information including gender, age, current educational level. For example, there are three questions for family information: parents' marital status, relationships with parents, and if the participant is single child; while the internet usage section contains four questions: functions of the internet, adaptation level of quarantine and remote education, electronic devices usage per day during COVID-19 quarantine, and whether addicting to electronic games or not. In this study, only the following variables are considered and analyzed: age, gender, current educational level (high-grade elementary school, middle-high school, or college-graduate), if is the participants is single child, relationship with parents (the higher the score, the better the relationship), parents' marriage status (the higher the score, the better the relationship), electronic devices usage

(computer, smartphone), adaptation level of quarantine and remote education.

b. PHQ-9 Depression Assessment

Patient Health Questionnaire (PHQ) Depression Assessment is a self-administered version of the diagnostic measurement for common mental disorders. PHQ-9 is a questionnaire that contains only 9 items and is shorter than other depression scales, which can be used in adolescents 12 years of age (Kroenke et al., 2001). There are only nine DSM-IV criteria to score from 0 (not at all) to 3 (nearly every day). Hence, the score should directly provide the depression severity: 0-4 (none), 5-9 (mild), 10-14 (moderate), 15-19 (moderately severe), and 20-27 (severe). For participants who have scores higher than 10, it is recommended to start reaching out for a series of counselling, pharmacotherapy, or psychotherapy depending on the severity (Kroenke et al., 2002). In this study, the score of PHQ-9 range from 9 to 36, because the designed questionnaires regarded the minimal value as 1 instead of 0. Please refer to the Appendix 1.a for the scale.

c. Self-esteem Scale

Rosenberg's Self-esteem Scale (SES) is a self-esteem measure widely used in social science to assess participants' global self-esteem (Rosenberg, 1965). The ten-item scale has four options for each question, which are strongly agree, agree, disagree, and strongly disagree. Five items are positively worded, while the other five are reverse items, and in general they are presented alternatively. Given the total possible score range is (0-30), scores between 15 and 25 are within the normal range, while scores below 15 suggest low self-esteem. Please refer to the Appendix 1.b for the scale.

d. Self-control Scale

The Self-control Scale (SCS) is a nineteen-item scale of an individual's self-control. It is a modified Chinese version scale from the original SCS proposed by Tangney et al. (2004). Similar to the original English version, the modified version uses a five-point Likert scale ranging from strongly disagree to strongly agree (Tan & Guo, 2008). There are 19 total questions that could be categorized to five dimensions of self-control testing: resistance of temptation, healthy habits, moderation of entertainment, impulse control, and degree of concentration.

The higher scores on all dimensions would represent better self-control capabilities. Then scores on each dimension would show one aspect of self-control abilities, so collecting data from the five dimensions separately would also be crucial. Please refer to the Appendix 1.c for the scale.

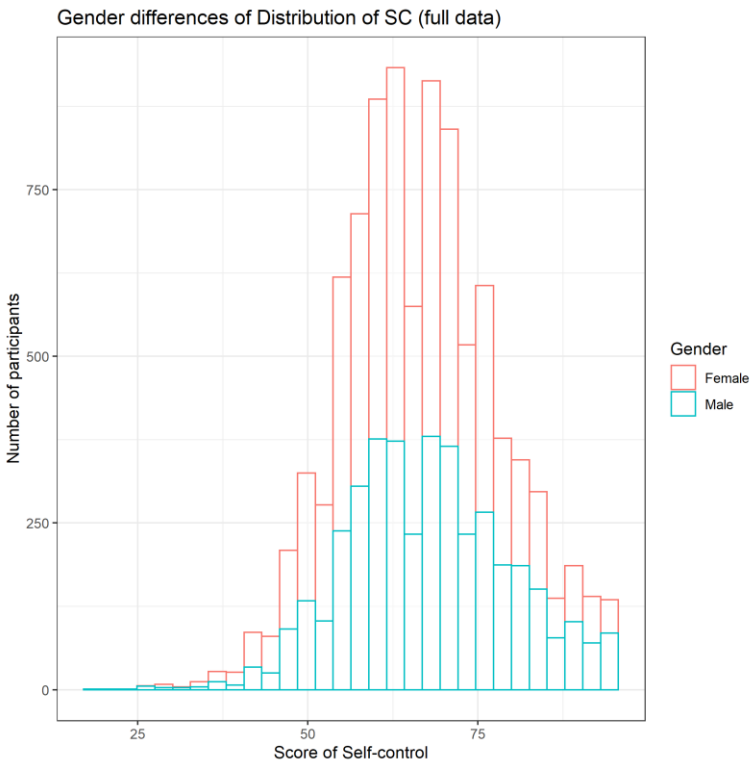
**Results**

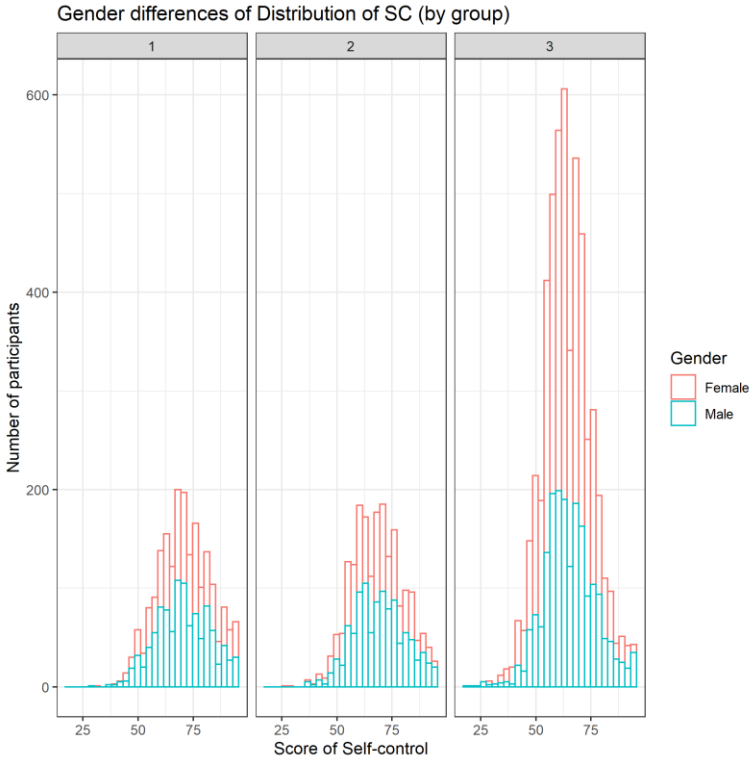
The raw data collected were stored in Excel for Microsoft 365 (version 2205), and the data were first encoded and then pre-processed in the preparation of the following data analysis. For instances, the total score of the PHQ-9 scale, the score of five subfields of the Self-control Scale, and the total score of Self-esteem Scale were calculated based on the instructions of the manual. Additionally, the demographic items are also adapted according to the requirement of the analysis software. All data analysis were conducted by RStudio (version 2022.02.3, Build 492) , based on R (version 4.2.1) and Microsoft Windows 10 Home (version 21H1, 64-bit, OS build 19043.1706).

a. Gender and Self-control

In order to find the significance of gender differences, multiple Welch Two Sample t-test were conducted on the whole data and 3 sub-groups (high-grade elementary, middle-high, and college-graduate) respectively. Among all the participants, 5233 are females, and they have an average score of 65.74 (SD = 11.17) for the Self-control Scale; 4051 are males, and they have an average score of 67.61 (SD = 12.05) for the Self-control Scale. The histograms indicate the distribution of total score of self-control is similar between genders and across groups, and it is slightly left-skewed.

The significant gender differences of self-control are observed in the complete data (t = -7.64, p-value = 2.48e-14), middle-high group (t = -3.20, p-value = 0.001), and college-graduate group (t = -5.08, p-value = 4.068e-07). The difference of self-control in high-grade elementary group is not statistically significant at 0.05 cutoff (t = 1.89, p-value > 0.05). It is also noteworthy that the score of self-control in high-grade elementary group is the highest among all three group (male average = 70.36, SD = 12.10; female average = 71.36, SD = 11.76), and the middle-high group (male average = 69.24, SD = 11.72; female average = 67.57, SD = 11.42) has higher score than college-graduate group (male average = 65.22, SD = 11.73, female average = 63.60, SD = 10.23). Please refer to the Appendix 2.a for boxplots.

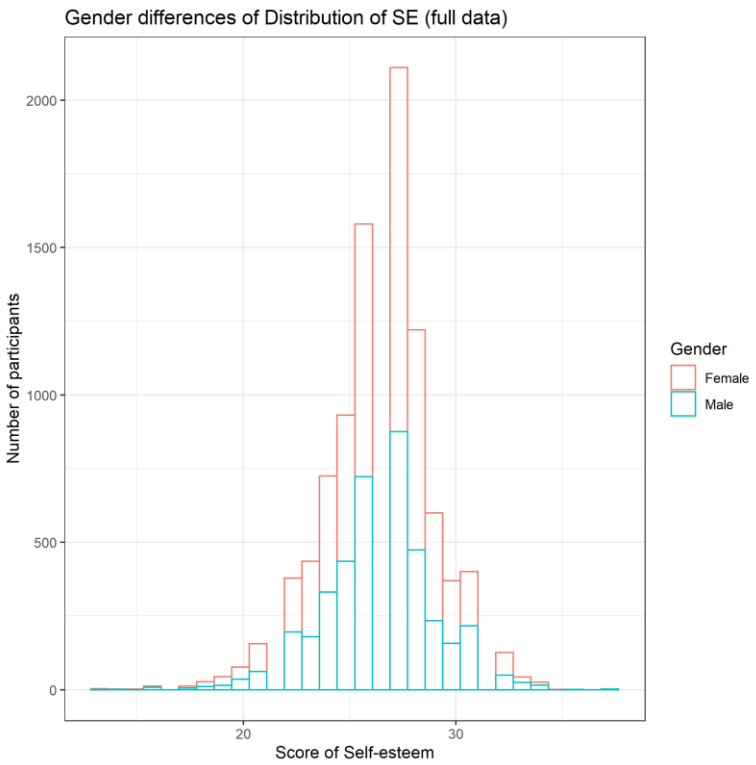


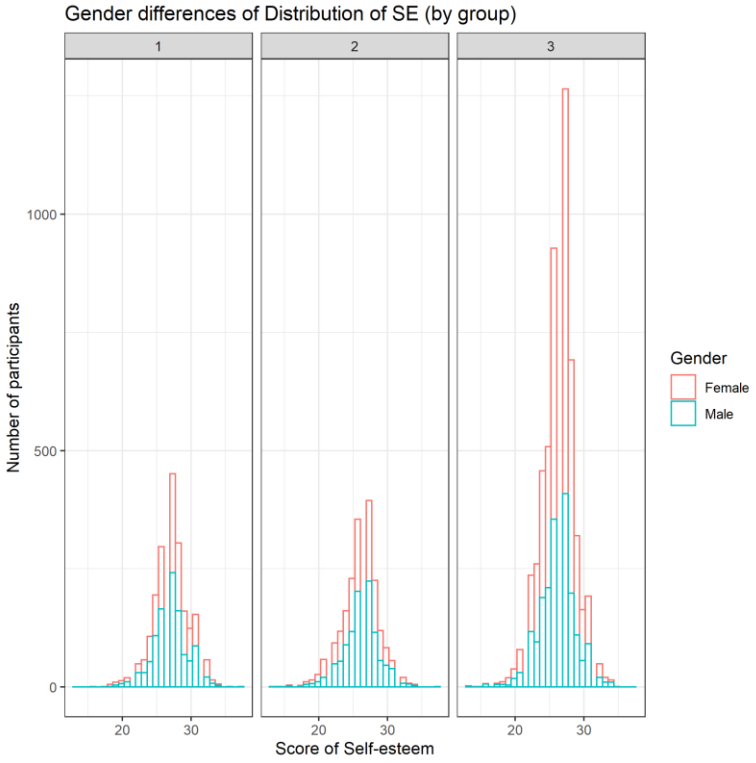




b. Gender and Self-esteem

In order to find the gender differences on the score of Self-esteem Scale, multiple Welch Two Sample t-test were conducted on the whole data and 3 sub-groups (high-grade elementary, middle-high, and college-graduate) respectively. Generally, the female participants have an average score of 26.44 (SD = 2.55) for the Self-esteem Scale, and the male participants have an average score of 26.39 (SD = 2.67) for the Self-esteem Scale. The histograms indicate the distribution of total score of self-esteem is similar between genders and across groups, and it is slightly left-skewed.

The significant gender differences of Self-esteem are observed in the middle-high group (t = -2.71, p-value = 0.007) and college-graduate group (t = -3.22, p-value = 0.001). The difference of Self-control in the complete data (t = 0.93, p-value = 0.35) and High-grade elementary group is not statistically significant at 0.05 cutoff (t = 1.27, p-value = 0.20). The score of Self-esteem in high-grade elementary group is the highest among all three group (male average = 27.04, SD = 2.55; female average = 27.18, SD = 2.66), yet the average scores between middle-high group (male average = 26.17, SD = 2.67; female average = 25.83, SD = 2.83) and college-graduate group (male average = 26.15, SD = 2.68; female average = 26.39, SD = 2.39) are generally very close. Please refer to the Appendix 2.b for boxplots.

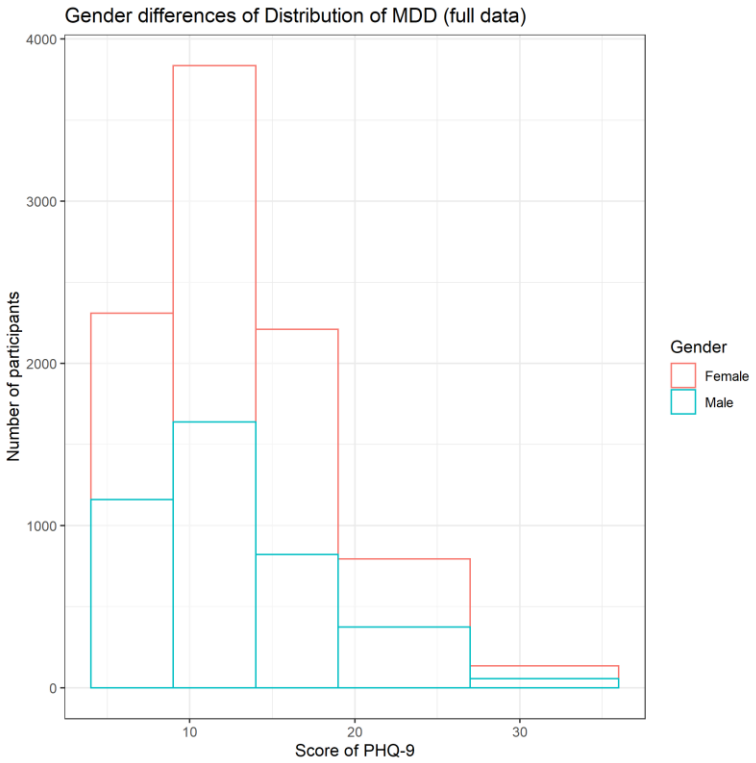


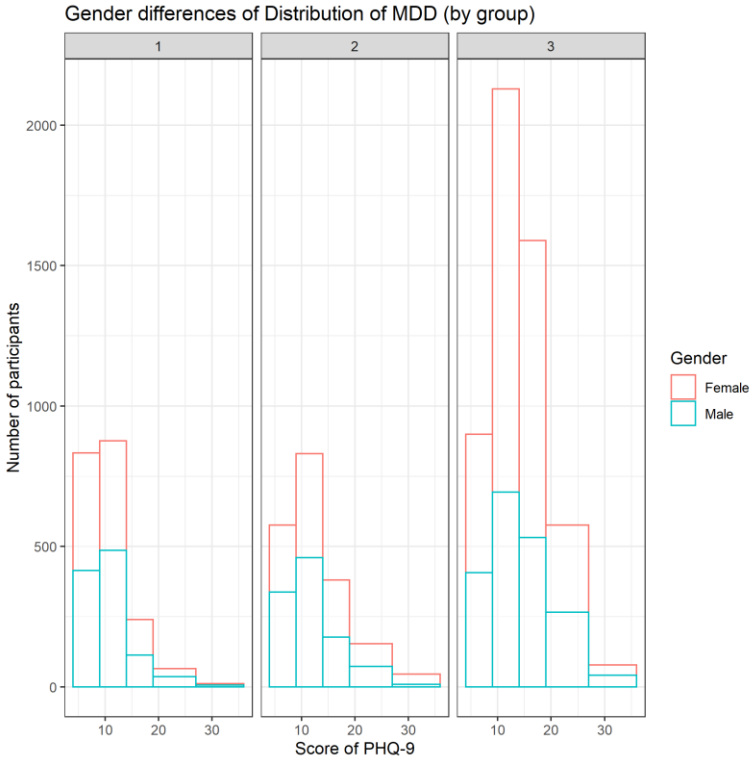




c. Gender and PHQ-9

In order to find the gender differences on the score of PHQ-9 Scale, multiple Welch Two Sample t-test were conducted on the whole data and 3 sub-groups (High-grade elementary, Middle-high, and College-graduate) respectively. In general, the female participants have an average score of 13.67 (SD = 4.60) for the PHQ-9 Scale, and the male participants have an average score of 13.29 (SD = 4.91) for the PHQ-9 Scale. The histograms indicate the distribution of total score of PHQ-9 is similar between genders and across groups, that is, most participants are either normal, mild, or moderate.

The significant gender differences of Self-esteem are observed in the complete data (t = 3.83, p-value = 0.0001), middle-high group (t = 5.52, p-value = 3.79e-08), and college-graduate group (t = -2.57, p-value = 0.01). The gender difference of PHQ-9 score in the high-grade elementary group is not statistically significant at 0.05 cutoff (t = -0.28, p-value = 0.78). The score of PHQ-9 in college-graduate group is the highest among all three group (male average = 14.64, SD = 5.40; female average = 14.27, SD = 4.45), and the average scores of middle-high group (male average = 12.55, SD = 4.41; female average = 13.78, SD = 5.41) is higher than the average score of High-grade elementary group (male average = 11.54, SD = 3.54; female average = 11.50, SD = 3.45). Please refer to the Appendix 2.c for boxplots.

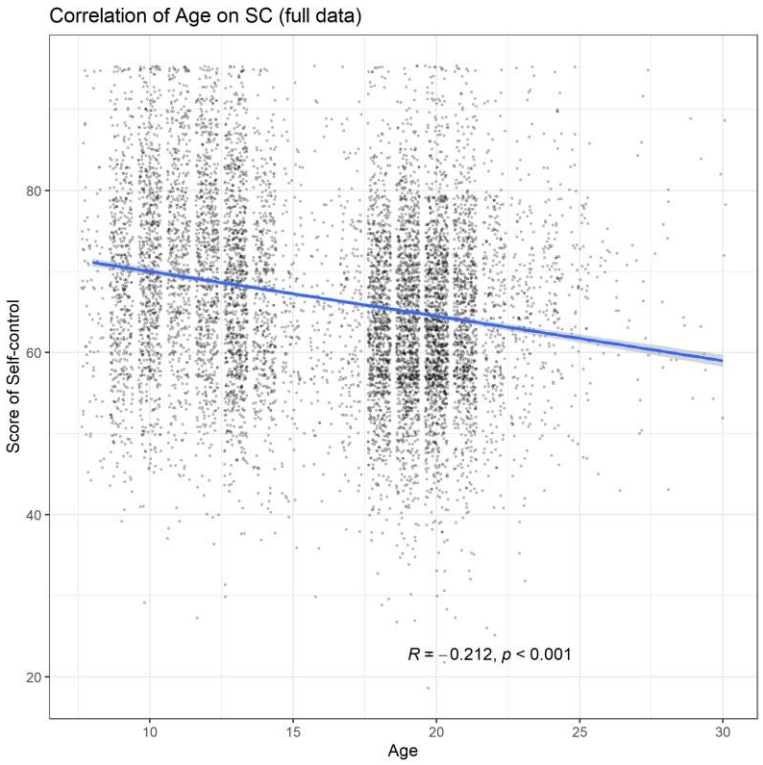


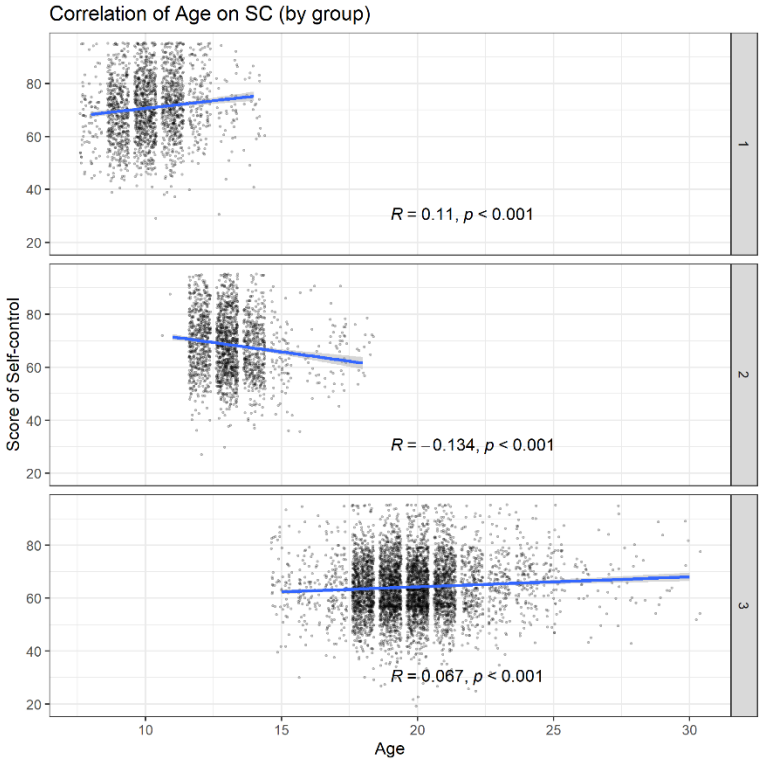




d. Age and Self-control/ Self-esteem/ PHQ-9

In order to find the age differences on the score of the Self-control, the Self-esteem, and the PHQ-9 Scale, multiple Pearson's product-moment correlations and simple linear regression models were conducted on the whole data.

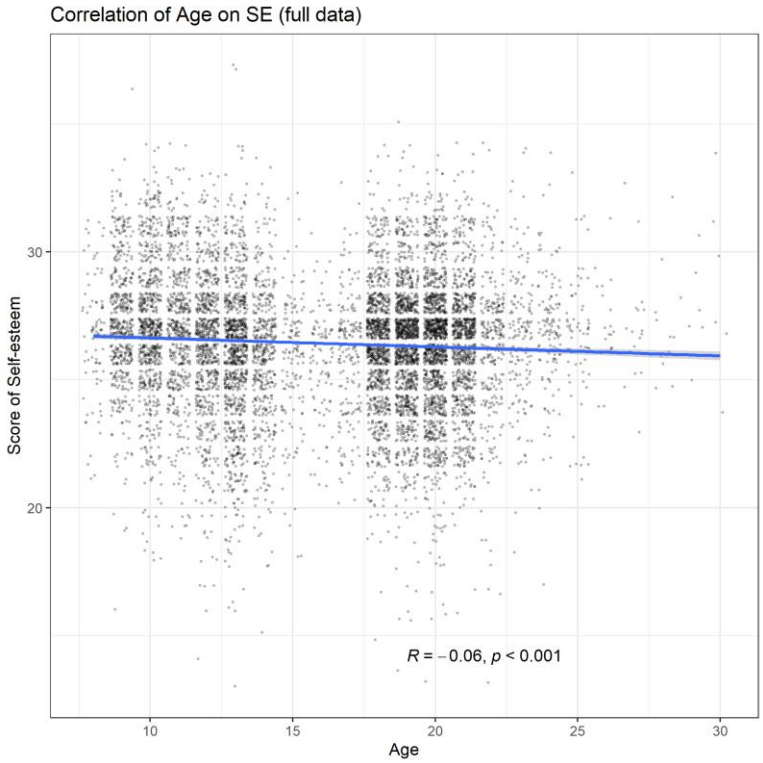
The statistically significant negative correlation = -0.21 between participants' age and the total score of Self-control Scale ($t = -20.87$, p-value < 2.2e-16) is observed. However, when the data is plotted by group of educational levels, only the middle-high group had a negative correlation = -0.134 (p-value < 0.001). The high-grade elementary group ($r = 0.11$) and college-graduate group ($r = 0.067$) had significant positive correlations. The linear regression model which has age as independent variable and the total score of Self-control Scale as the dependent variable suggests the coefficient of age is -0.55 (p-value < 2e-16), and the intercept is 75.53 (p-value < 2e-16). However, the adjusted R-squared is only 0.04, indicating that only 4% variance of the total score of Self-control Scale is explained by age.

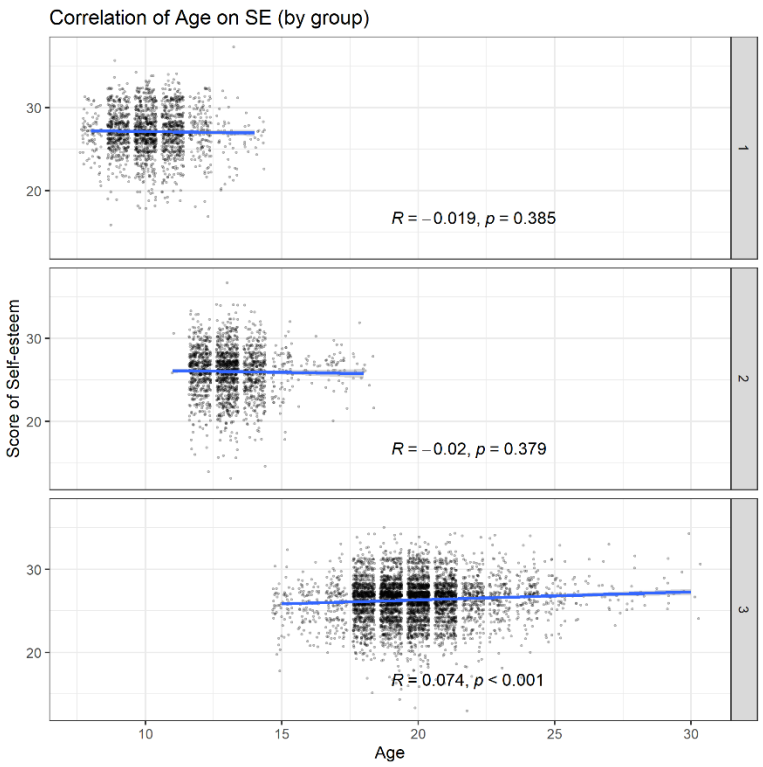


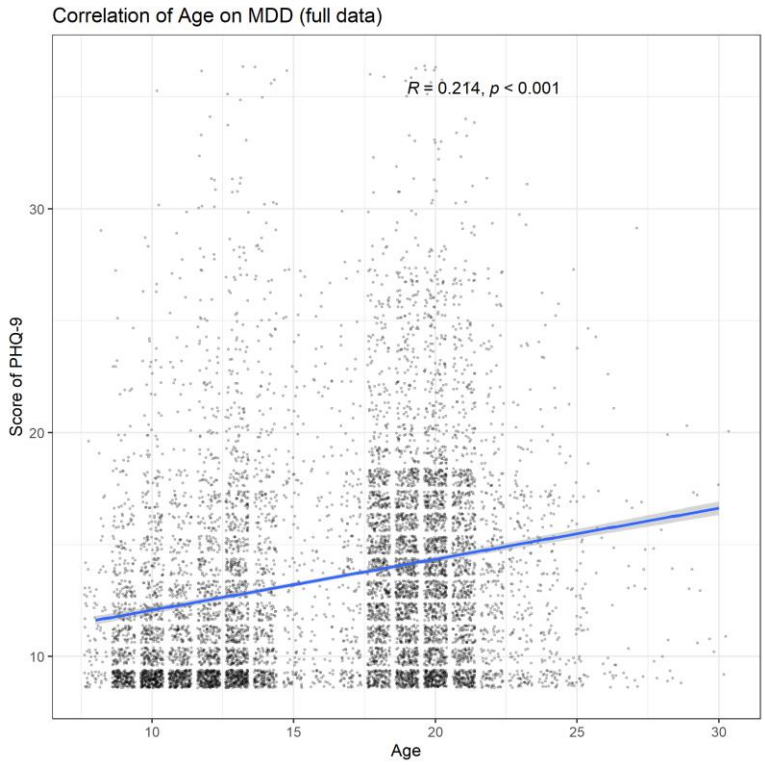

The statistically significant negative correlation = -0.06 between participants' age and the total score of Self-esteem Scale (t = -5.76, p-value = 8.68e-09) is observed. However, when the

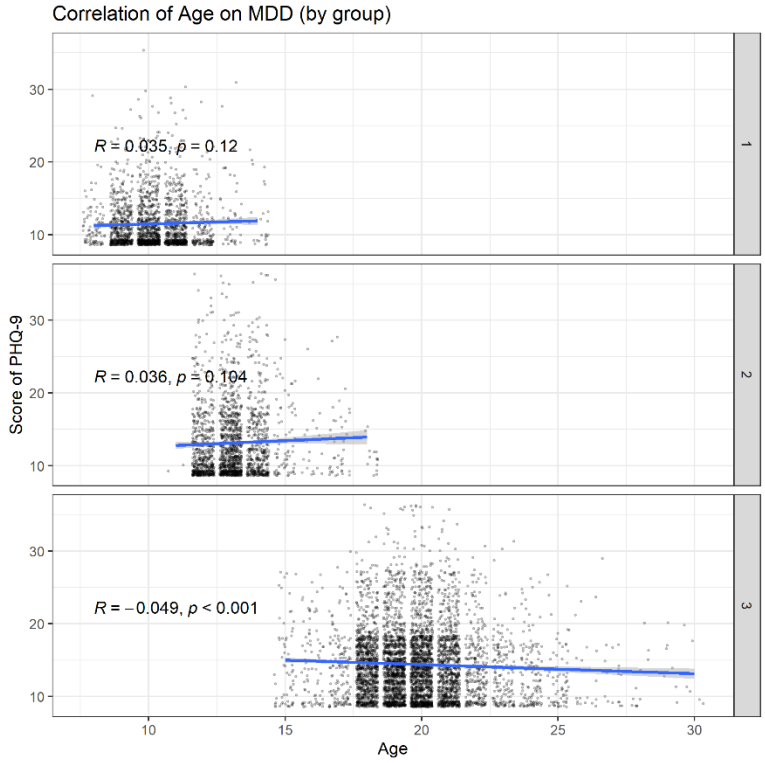
data is plotted by group of educational levels, only the college-graduate group had a significant positive correlation = 0.074 (p-value < 0.001). The high-grade elementary group (r = -0.02) and middle-high group (r = -0.02) were statistically insignificant. The linear regression model which has age as independent variable and the total score of Self-esteem Scale as the dependent variable suggests the coefficient of age is -0.04 (p-value = 8.68e-09), and the intercept is 26.98 (p-value < 2e-16). However, the adjusted R-squared is only 0.004, indicating that only 0.4% variance of the total score of Self-esteem Scale is explained by age.






The statistically significant positive correlation = 0.21 between participants' age and the total score of the PHQ-9 Scale (t = 21.11, p-value < 2.2e-16) is observed. Again, when the data is plotted by group of educational levels, only the college-graduate group had a significant negative correlation = -0.05 (p-value < 0.001). The high-grade elementary group (r = 0.04) and middle-high group (r = 0.04) were statistically insignificant. The linear regression model which has age as independent variable and the total score of PHQ-9 Scale as the dependent variable suggests the coefficient of age is 0.23 (p-value < 2e-16), and the intercept is 9.79 (p-value < 2e-16). However, the adjusted R-squared is only 0.05, indicating that only 5% variance of the total score of PHQ-9 Scale is explained by age.

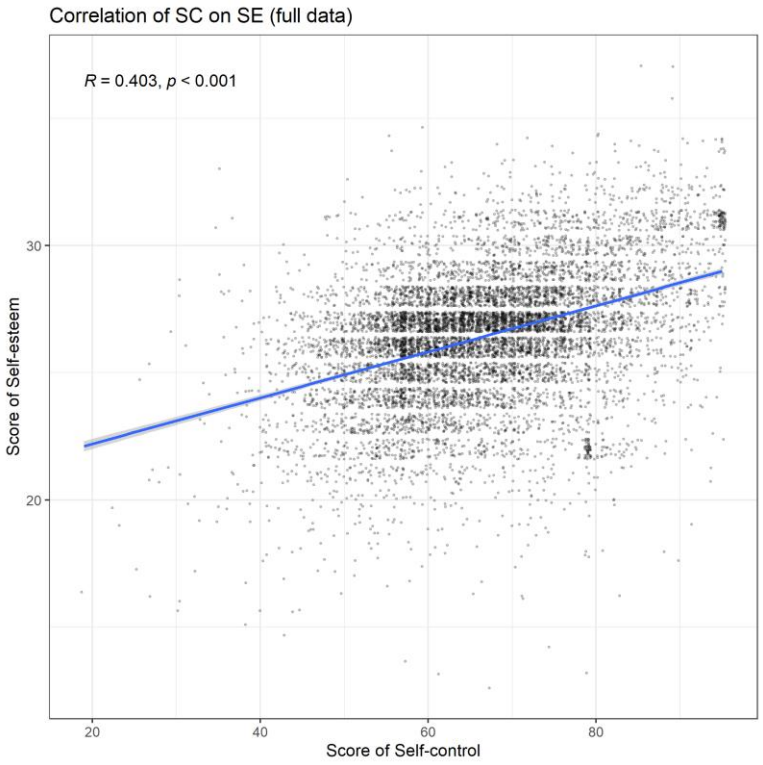


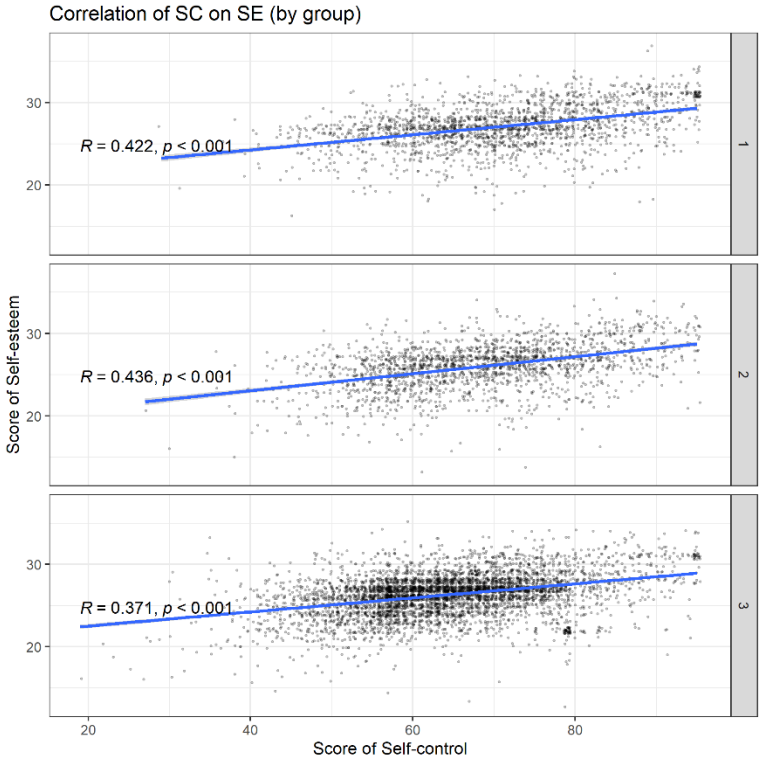




e. Self-control and Self-esteem

In order to find the relationship between the total score and the five subfields of the Self-control Scale and the score of the Self-esteem Scale, multiple Pearson's product-moment correlations and two simple linear regression models were conducted on the whole data by switching the dependent variable with the independent variable.

The statistically significant positive correlation ($r = 0.40$) between participants' total score of the Self-control Scale and the total score of the Self-esteem Scale ($t = 42.55$, p-value $< 2.2e-16$) is observed. When the data is plotted by group of educational levels, all three groups showed steady and significant positive correlations. The first linear regression model which has the total score of the Self-esteem Scale as independent variable and the total score of Self-control Scale as the dependent variable suggests the coefficient of Self-esteem is 1.79 (p-value $< 2e-16$), the intercept is 19.19 (p-value $< 2e-16$). The second linear regression model which has the total score of the Self-control Scale as independent variable and the total score of Self-esteem Scale as the dependent variable suggests the coefficient of Self-control is 0.09 (p-value $< 2e-16$), the intercept is 20.38 (p-value $< 2e-16$). Both models have the adjusted R-squared is 0.16, indicating that 16% variance of the total score of the Self-esteem Scale is explained by the total score of the Self-control Scale.


Correlation of SC on SE (full data)
R = 0.403, p < 0.001
Score of Self-esteem
30
20
20
40
60
80
Score of Self-control

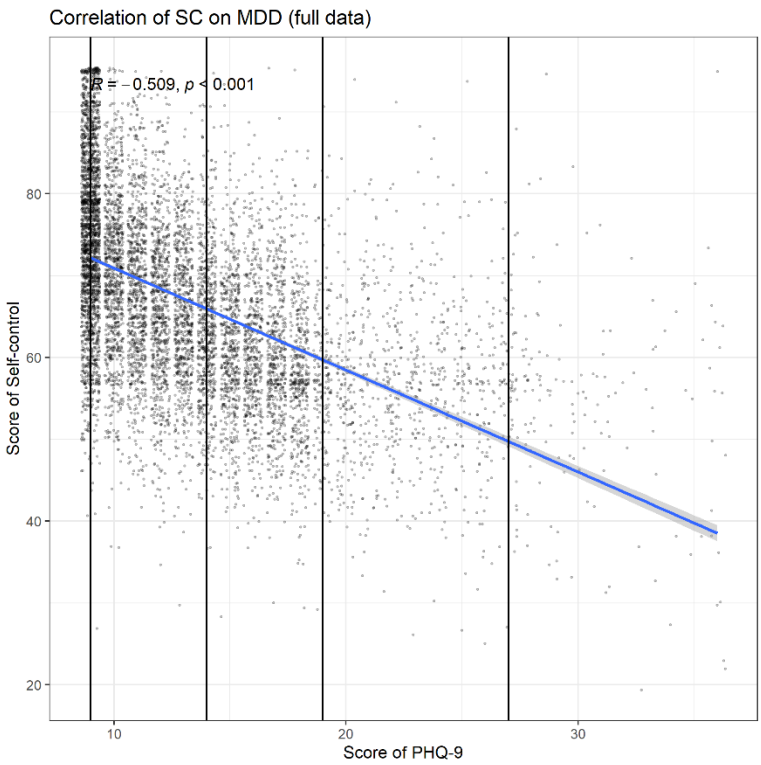

Correlation of SC on SE (by group)
R = 0.422, p < 0.001
R = 0.436, p < 0.001
R = 0.371, p < 0.001
1
2
3
Score of Self-esteem
30
20
20
40
60
80
Score of Self-control

The relationship between five subfields of the Self-control Scale and the total score of Self-esteem Scale were also tested, and the statistically significant positive correlations are observed for all five regression models. Sorted the correlation with Self-esteem from high to low, the resistance of temptation has $r = 0.41$ ($t = 43.84$, p-value < 2.2e-16), degree of concentration has $r = 0.35$ ($t = 36.50$, p-value < 2.2e-16), impulse control has $r = 0.32$ ($t = 32.61$, p-value < 2.2e-16), moderation of entertainment has $r = 0.28$ ($t = 27.90$, p-value < 2.2e-16), and healthy habits has $r = 0.27$ ($t = 26.64$, p-value < 2.2e-16).

f. Self-control and PHQ-9

In order to find the relationship between the total score and the five subfields of the Self-control Scale and the score of the PHQ-9 Scale, multiple Pearson's product-moment correlations and one simple linear regression model were conducted on whole data. Four vertical lines that indicate the cutoffs of normal, mild, moderate, moderately severe, and severe were also plotted as reference.

The statistically significant negative correlation = -0.51 between participants' total score of the Self-control Scale and the total score of the PHQ-9 Scale ($t = -56.96$, p-value < 2.2e-16) is observed. The linear regression model which has the total score of the Self-control Scale as independent variable and the total score of PHQ-9 Scale as the dependent variable suggests the coefficient of Self-control is -0.21 (p-value < 2e-16), the intercept is 27.34 (p-value < 2e-16), and the adjusted R-squared is 0.26, indicating that 26% variance of the total score of the PHQ-9 Scale is explained by the total score of the Self-control Scale.



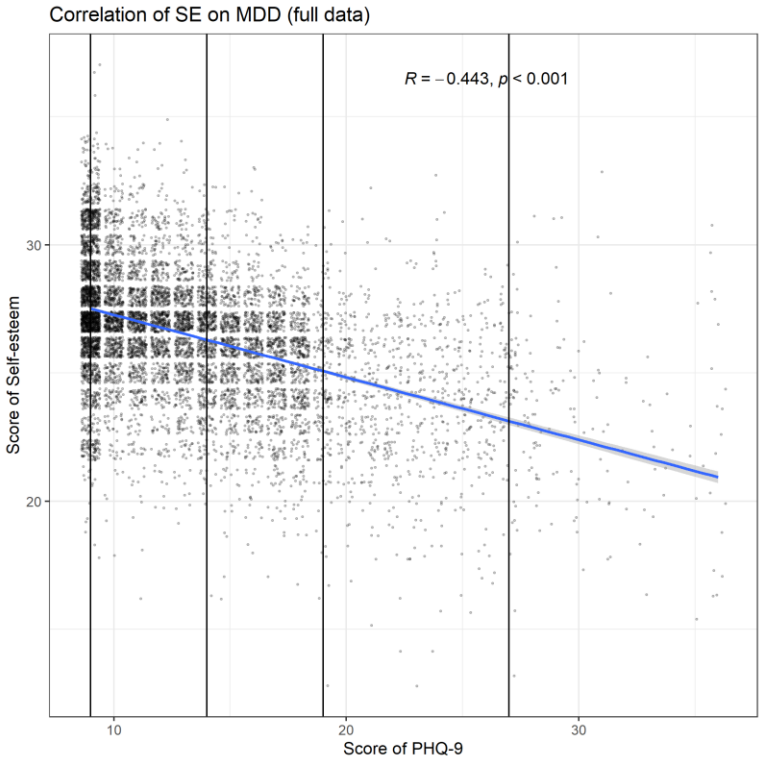

The relationship between five subfields of the Self-control Scale and the total score of PHQ-9 Scale were also tested, and the statistically significant positive correlations are observed for all five trials. Sorted the correlation with PHQ-9 from high to low, moderation of entertainment has r = -0.46 (t = -49.52, p-value < 2.2e-16), impulse control has r = -0.44 (t = -47.84, p-value < 2.2e-16), degree of concentration has r = -0.38 (t = -39.76, p-value < 2.2e-16), healthy habits has r = -0.38 (t = -39.67, p-value < 2.2e-16), and the resistance of temptation has r = -0.36 (t = -36.96, p-value < 2.2e-16).

g. Self-esteem and PHQ-9

In order to find the relationship between the total score of the Self-control Scale and the score of the PHQ-9 Scale, a Pearson's product-moment correlations and one simple linear regression model were conducted on the whole data. Four vertical lines that indicate the

cutoffs of normal, mild, moderate, moderately severe, and severe were also plotted as reference.

The statistically significant negative correlation = -0.44 between participants' total score of the Self-esteem Scale and the total score of the PHQ-9 Scale (t = -47.64, p-value < 2.2e-16) is observed. The linear regression model which has the total score of the Self-esteem Scale as independent variable and the total score of PHQ-9 Scale as the dependent variable suggests the coefficient of Self-control is -0.81 (p-value < 2e-16), the intercept is 34.79 (p-value < 2e-16), and the adjusted R-squared is 0.20, indicating that 20% variance of the total score of the PHQ-9 Scale is explained by the total score of the Self-esteem Scale.




h. Models

Four models were run to analyze the relationship between independent variables and the dependent variable. First, the demographic only model contains all demographic variables (group, age, gender, parents' marriage status, relationship with parents, if is the single child, adaptation to the remote education, and electronic devices usage) to discover the influence of environmental factors on individuals' severity of depressive disorder, which is measured by the total score of the PHQ-9 scale. Except age, gender, and if the participants are single child, all other variables are statistically significant (p-value < 2e-16). It is noticed the top three estimators are relationship with parents (coefficient = -2.30), group of current educational level (coefficient = 1.08), and the usage of electronic devices (coefficient = 0.74). The other three estimators are parents' marriage status (coefficient = 0.634), adaptation of remote education (coefficient = -0.633), and constant (coefficient = 17.60). However, only 15.82% of variances were explained by these variables.

Given both self-esteem and self-control have high correlations with PHQ-9, and they have relatively strong correlation with each other, a model that only consider the total score of the Self-esteem Scale and Self-control Scale as independent variables was established, and both independent variables have statistically significant (p-value < 2e-16) coefficients: the self-control's is -0.16, the Self-esteem's is -0.52, and the constant is 37.88. Together, both Self-esteem and Self-control contributed to the explanation of 32.66% of the variances, indicated by the adjusted R-squared (0.3266).

A more comprehensive model that contains significant variables from the above two models suggest that individuals' adaptations of remote education is no longer significant at

present stage, since the p-value of such variable is 0.30. Moreover, the adjusted R-squared increased to 36.21.

| | Dependent variable: |
|---|---|
| | Score of PHQ-9 |
| Group | 0.634*** |
| | (0.055) |
| Parents' marriage status | 0.355*** |
| | (0.059) |
| Relationship with parents | -1.424*** |
| | (0.116) |
| Adaptation to remote | 0.061 |
| | (0.058) |
| Electronic devices usage | 0.247*** |
| | (0.042) |
| Score of Self-control | -0.135*** |
| | (0.004) |
| Score of Self-esteem | -0.483*** |
| | (0.017) |
| Constant | 36.716*** |
| | (0.556) |
| Observations | 9,284 |
| R2 | 0.363 |
| Adjusted R2 | 0.362 |
| F Statistic | 753.908*** (df = 7; 9276) |
| Note: | *p<0.1; **p<0.05; ***p<0.01 |

The final model removed the insignificant variable, which is the adaptations of remote

education, and it has all remained variables statistically significant. The final model's adjusted R-squared is remain the same, which is 36.21.

| | Dependent variable: |
|---|---|
| | Score of PHQ-9 |
| Group | 0.639*** |
| | (0.055) |
| Parents' marriage status | 0.354*** |
| | (0.059) |
| Relationship with parents | -1.409*** |
| | (0.115) |
| Electronic devices usage | 0.243*** |
| | (0.042) |
| Score of Self-control | -0.135*** |
| | (0.004) |
| Score of Self-esteem | -0.482*** |
| | (0.017) |
| Constant | 36.816*** |
| | (0.548) |
| Observations | 9,284 |
| R2 | 0.363 |
| Adjusted R2 | 0.362 |
| F Statistic | 879.370*** (df = 6; 9277) |
| Note: | *p<0.1; **p<0.05; ***p<0.01 |

## Discussion

Before conducting the analysis, several expectations were proposed. It is expected to observe the impact of age and gender in the score of self-esteem, self-control, and the severity of depression; the positive correlation between the self-esteem and the self-control; the negative correlation between the severity of depression and both self-control and self-esteem; the demographic features' influences on the severity of depression in multiple levels and directions in a model which takes the combination of demographic features, self-esteem, and self-control to predict the severity of depression.

The results showed significant gender differences of self-control, self-esteem, and the severity of depression, if not all, at least in some subgroups of, in participants. The scores of self-control, self-esteem, and depression do not have statistical significance in high-grade elementary group; for self-control, within both middle-high and college-graduate group, male participants tend to have higher scores; for self-esteem, male participants show higher score in middle-high group, yet the opposite situation is discovered in college-graduate group, where female participants have higher score; for depression, male participants show higher score in college-graduate group, yet the opposite situation is discovered in middle-high group, where female participants have higher score. It is noteworthy that some of the observation is inconsistent with former studies, where researchers believed males have lower self-control (Gibson et al., 2010), higher self-esteem (Bleidorn et al., 2016), and lower depression than females (Girgus & Yang, 2015) consistently. There is no observation of statistical significance of gender differences in high-grade elementary group for the result of all three variables. It is possible that the wording, for example, some concepts mentioned, of the survey is relatively complicated for elementary school students to understand, or the length of the survey might be too long for them to concentrate on answering rather than randomly choosing after their patience are exhausted.

The role of age on the score of self-control, self-esteem, and the severity of depression is also significant in this study. Base on the data collected during COVID-19, it is discovered that

older participants tend to show lower self-control, lower self-esteem, and higher severity of depression. Previous studies showed the gradual increase of self-esteem (Erol & Orth, 2011) as they age and a relatively constant self-control (Hay & Forrest, 2006), yet this study shows some different results. A reasonable explanation could be there are more severe negative influences of COVID-19 pandemic on older students, as they have experienced longer life without severe situations as in the COVID-19 pandemic, making them harder to adapt the radical change, and it is already proven the feeling of events are out of control could be a predictor of depression (Khan et al., 2008).

The relationship between self-control, self-esteem, and depression in the analysis of this study is in accordance with former research conclusions (DeWall et al., 2007; Khan et al., 2008; Henriksen et al., 2017). The steady and high positive correlation between self-control and self-esteem is observed, and the depression is negatively correlated with either self-control or self-esteem.

The final model which yields the highest adjusted R-squared score and with all statistically significant variables indicates both the demographic factors, self-control, and self-esteem would contribute to the development of depression. The relationship with parents, self-control, and self-esteem has negative coefficients, yet the group, the parents' marriage status (an ordinal variable, high score means worse status), and the electronic devices usage have positive coefficients. Although age and gender differences were observed in former tests, they were no longer significant in the comprehensive computational model, which may indicate the undifferentiated influence of COVID-19 on the vulnerability of depression.

Granted, the study has some limitations. For instance, as a cross-sectional study, it is impossible to observe more gradual time-series change as in longitudinal studies. Moreover, the

territorial limitation, only sampled in a City of China, may also cause some bias, since the difference of culture, government policies, and epidemic severity may affect participants' answers. The influences of educational level (group) on self-control, self-esteem, and depression are not ignorable. Although the complete data shows negative correlations between age and self-control, it is surprising that in both high-grade elementary and college-graduate group, the two variables had significant positive correlations, and only in middle-high group the score of self-control decreased with increasing age. Such discovery may suggest the difference of the development of self-control in different age brackets or educational level during the COVID-19 epidemic, and the students in middle-high group may need more attention. Similar situation happened when plotted the correlation by educational level (group) between age and self-esteem or between age and depression, and in these two analyses only participants in the college-graduate group showed significant yet contradict correlations with the analyses of the complete data. This may be the sign of inaccurate statistical model choose, which could be a possible modification in the future studies.

Additionally, given the ponderance of depressive disorder among all other mental health problems (Takahashi, 2001), the practical application of this study is to analyze the mental health data collected during quarantine to ensure psychological professionals to conduct proper intervention, counseling, or clinical treatment for mentally abnormal patients, to aid educational practitioners in design a more adaptive teaching strategy for all-age students, and to appeal parents to attach importance to their relationship between each other and with their children.

# Appendix

## Appendix 1 – Questionnaires

### 1.a PHQ-9 Depressive Disorder Scale

**Nine Symptom Checklist**

**Over the last 2 weeks, how often have you been bothered by any of the following problems?**

| | Not at all | Several days | More than half the days | Nearly every day |
|---|---|---|---|---|
| 1. Little interest or pleasure in doing things..... | 0 | 1 | 2 | 3 |
| 2. Feeling down, depressed, or hopeless..... | 0 | 1 | 2 | 3 |
| 3. Trouble falling or staying asleep, or sleeping too much..... | 0 | 1 | 2 | 3 |
| 4. Feeling tired or having little energy..... | 0 | 1 | 2 | 3 |
| 5. Poor appetite or overeating..... | 0 | 1 | 2 | 3 |
| 6. Feeling bad about yourself - or that you are a failure or have let yourself or your family down..... | 0 | 1 | 2 | 3 |
| 7. Trouble concentrating on things, such as reading the newspaper or watching television..... | 0 | 1 | 2 | 3 |
| 8. Moving or speaking so slowly that other people could have noticed? Or the opposite - being so fidgety or restless that you have been moving around a lot more than usual..... | 0 | 1 | 2 | 3 |
| 9. Thoughts that you would be better off dead or of hurting yourself in some way..... | 0 | 1 | 2 | 3 |

(For office coding: Total Score _____ = ___ + ___ + ___)

**If you checked off any problems, how difficult have these problems made it for you to do your work, take care of things at home, or get along with other people?**

| Not difficult at all | Somewhat difficult | Very difficult | Extremely difficult |
|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ |

*From the Primary Care Evaluation of Mental Disorders Patient Health Questionnaire (PRIME-MD PHQ). The PHQ was developed by Drs. Robert L. Spitzer, Janet B.W. Williams, Kurt Kroenke and colleagues. For research information, contact Dr. Spitzer at rls8@columbia.edu. PRIME-MD® is a trademark of Pfizer Inc. Copyright© 1999 Pfizer Inc. All rights reserved. Reproduced with permission.*

### 1.b Self-esteem Scale

Please choose one answer for each items below:

**a. Strongly agree b. Agree c. Disagree d. Strongly Disagree**

1) On the whole, I am satisfied with myself.
2) At times I think I am no good at all.
3) I fell that I have a number of good qualities.
4) I am able to do things as well as most other people.
5) I feel I do not have much to be proud of.
6) I certainly feel useless at times.
7) I feel that I am a person of worth, at least on an equal plane with others.
8) I wish I could have more respect for myself.
9) All in all, I am inclined to feel that I am a failure.
10) I take a positive attitude toward myself.

1.c Self-control Scale

## *brief self-control scale*

*your name:* _____ *today's date:* _____

*using the 1 to 5 scale below, please indicate how much each of the following statements reflects how you typically are:*

*not at all* ... *very much*

***1 2 3 4 5***

| | ***type of activity*** | ***frequency*** |
|---|---|---|
| *1.* | I am good at resisting temptation | |
| *2.* | *I have a hard time breaking bad habits* | |
| *3.* | *I am lazy* | |
| *4.* | *I say inappropriate things* | |
| *5.* | *I do certain things that are bad for me, if they are fun* | |
| *6.* | I refuse things that are bad for me | |
| *7.* | *I wish I had more self-discipline* | |
| *8.* | people would say that I have iron self-discipline | |
| *9.* | *pleasure and fun sometimes keep me from getting work done* | |
| *10.* | *I have trouble concentrating* | |
| *11.* | I am able to work effectively toward long-term goals | |
| *12.* | *sometimes I can't stop myself from doing something, even if I know it is wrong* | |
| *13.* | *I often act without thinking through all the alternatives* | |

*italicised questions (2, 3, 4, 5, 7, 9, 10, 12, 13) should be reverse scored (subtract score from 6).*

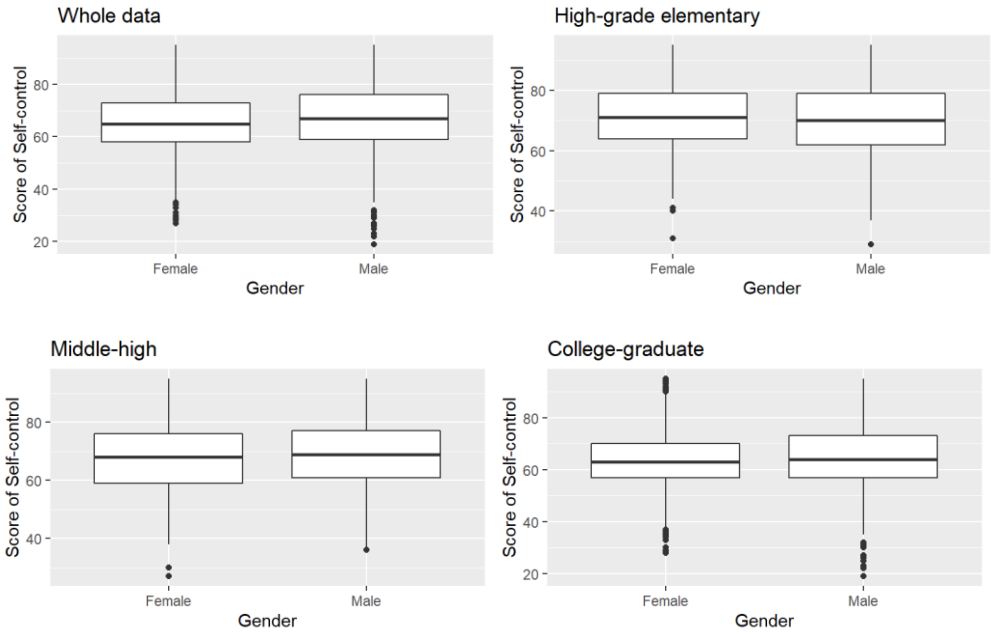
***total score (13-65) =***

*average (mean) score for 606 students was 39.5, with approximately 70% falling in the range 31 to 48, and approximately 95% in the range 22.5 to 56.*

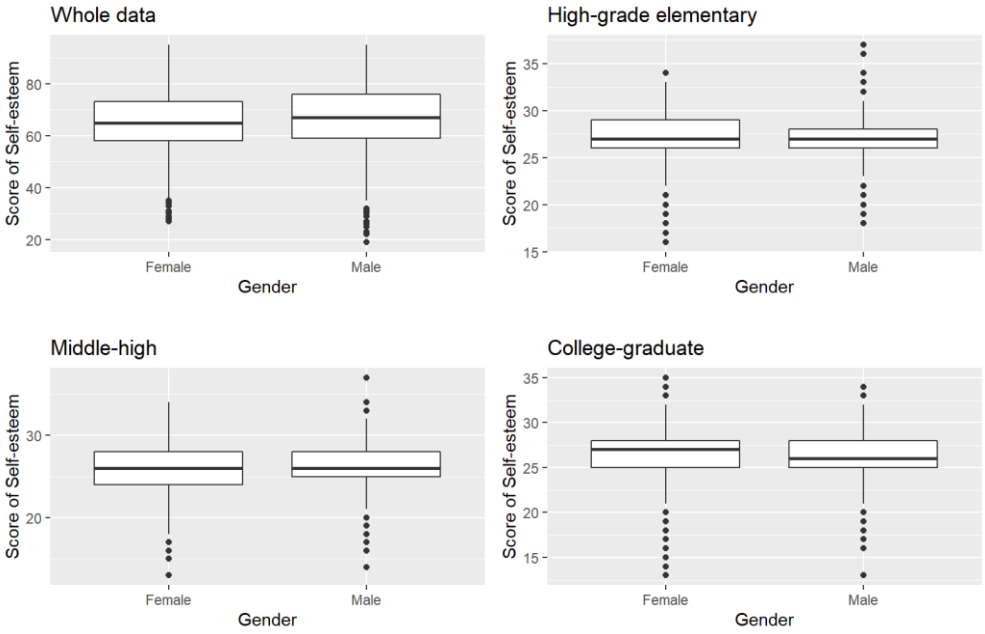
Tangney, J. P., R. F. Baumeister, et al. (2004). "High self-control predicts good adjustment, less pathology, better grades, and interpersonal success." J Pers 72(2): 271-324. What good is self-control? We incorporated a new measure of individual differences in self-control into two large investigations of a broad spectrum of behaviors. The new scale showed good internal consistency and retest reliability. Higher scores on self-control correlated with a higher grade point average, better adjustment (fewer reports of psychopathology, higher self-esteem), less binge eating and alcohol abuse, better relationships and interpersonal skills, secure attachment, and more optimal emotional responses. Tests for curvilinearity failed to indicate any drawbacks of so-called overcontrol, and the positive effects remained after controlling for social desirability. Low self-control is thus a significant risk factor for a broad range of personal and interpersonal problems.

## Appendix 2 – Boxplots

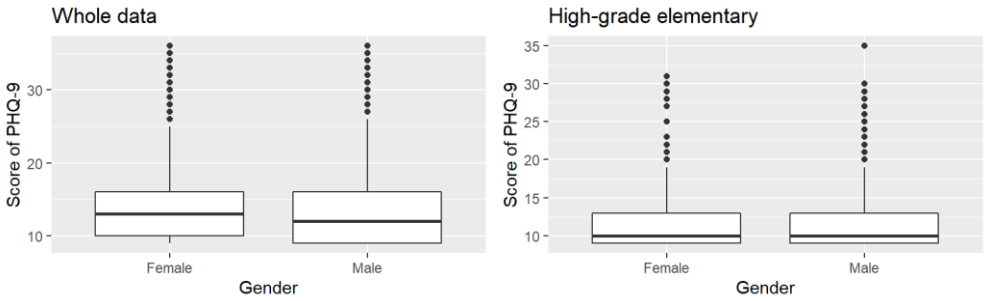
2.a Gender and Self-control



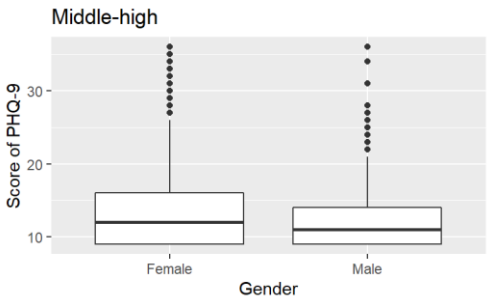

2.b Gender and Self-esteem

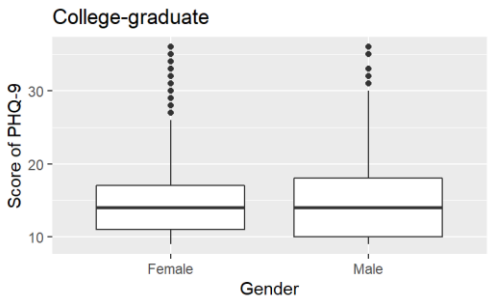



2.c Gender and Depression


Whole data
Score of PHQ-9
30
20
10
Female
Male
Gender


High-grade elementary
Score of PHQ-9
35
30
25
20
15
10
Female
Male
Gender


Middle-high
Score of PHQ-9
30
20
10
Female
Male
Gender


College-graduate
Score of PHQ-9
30
20
10
Female
Male
Gender

**Reference**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