Investigating the Relationship of Screen Time and Depressive Symptoms and Moderation by Loneliness in Young Adults

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ABSTRACT

Depressive symptoms among young adults are steadily increasing in the past decades. This study aimed to investigate the influence of smartphone and social media screen time on this trend. Additionally, the moderating influence of loneliness on the relationship was investigated. The study was based on data gathered by an online survey, which contained the Center for Epidemiologic Studies Depression Scale, the UCLA Loneliness scale and a questionnaire to assess the screen times of 87 participants. A correlational analysis between depressive symptoms and smartphone and social media screen time measurements, as well as a moderation analysis of loneliness were performed. The analysis resulted in a significant weak correlation ($r(85)=.27$, $p=.013$) between social media screen time and depressive symptoms and no correlation between smartphone screen time and depressive symptoms. The moderation analysis did also not substantiate the hypothesized moderation effect of loneliness on the relationship between screen time and depressive, but instead indicated that the initial correlation diminishes, once loneliness is introduced. Therefore, screen time is proposed to be solely associated with loneliness and not depressive symptoms.

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1. Introduction

The prevalence of depressive symptoms among young adults and adolescents has undergone a steady increase within the past decade (Mojtabai et al., 2016). A national study, based on a sample drawn in the United States, states that the prevalence of depression has increased by 2,5% in the period from 2005 till 2014. In comparison to other age groups, young adults (age: 18-25) and adolescents (age: 10-18) were observed to experience the largest increase in depressive symptoms (Mojtabai et al., 2016). A depressive episode is a common affective disorder which about 10% of the general population experience at least once in their lifetime (Kessler & Bromet, 2013). It commonly presents itself with heightened levels of Anhedonia or depressed mood, which is often accompanied by changes in appetite and sleeping patterns, feelings of worthlessness or guilt, difficulties in decision making and concentration and suicidal ideations. The combination, as well as the intensity of these symptoms may vary per person and form the basis of an assessment of the severity of depression (Kessing, 2007). A Scandinavian survey stated that in 2020 about 22% of adolescents display depressive symptoms, which is double to the prevalence in the adult population (Ghaemi, 2020). In efforts to explain this trend, a variety of research has focused on the influence of the ongoing digitalization on the mental health of young adults and adolescents (Shakya & Christakis, 2017; Berryman et al., 2017; Barry et al., 2017; Orben & Przybylski, 2019; Tang et al., 2021).

1.1 Screen media and depression

A nationally representative study from the United States stated that adolescents who spend more time with on-screen activities like social media, television or video games display significantly more depressive symptoms, as well as overall mental health issues, compared to adolescents that spend more time with non-screen activities, like social interaction, sports or print media (Twenge et al., 2018). Additionally, several other studies figured that a large amount of digital media exposure can have detrimental effects on the mental health of adolescents and young adults. Especially depression, anxiety and ADHD have been found to be connected to excessive digital media behavior (Lepp et al., 2013; Maras et al., 2015; Montagni et al., 2016). This becomes

particularly noteworthy, considering that according to a national study based on a sample of 2600 participants, an adolescent has an average screen time of 9 hours per day (RIDEOUT V, 2015). In this context, screen time refers to the cumulated time a person uses screen media devices, which is frequently used as a measurement of media exposure. Typically, the media included are smartphones, televisions and computers (Twenge et al., 2018). Some studies which used this operationalization, found significant relationships between depression and screen time (Heffer et al., 2019).

However, the relationship between depression and screen time is a relatively recent topic and existing research is far from reaching consensus. For example, a study conducted by Twenge and Campbell (2018) stated that among their sample population, high users (7+ hours per day) were twice as likely to have been previously diagnosed with depression and moderate users (4-7 hours per day) displayed significantly lower psychological well-being. However, it has to be noted that the sample population consisted of an age group between 14-17, wherefore it cannot be generalized to the young adult population, for which no reliable information was available at the time of investigation. Opposing the findings of Twenge and Cambell, a study conducted by Orben and Przybylski (2019) investigated the same issue and concluded that overall screen time can be neglected as a significant negative influence on general well-being, including symptoms of depression. However, researchers that focused on specific types of screen time like social media or smartphone screen time partly came to different conclusions than those that combined all types of screen media.

1.2 Smartphone screen time and depression

Investigations of the relationship between smartphone screen time and depressive symptoms have produced the most significant link to depressive symptoms results, compared to other types of screen time. This was found in a meta-analysis conducted by Tang et al. (2021), which identified three scientifically valid studies investigating this relationship, of which two reported a significant relationship between the two variables. One study claimed that no significant relationship exists. However, none of these studies used precise measurements of screen time and instead relied on individual estimations about the amount of time spent using a smartphone (Bickham, et al., 2015; Khouja et al., 2019, Liu et al., 2018). This could distort the measurement,

as screen time measurements based on estimations oftentimes fail to resemble the true amount of time spent using a screen device (Kaye, 2020).

Besides the existing research using screen time measurements, several other ways of quantifying smartphone behavior have been used and found significant relationships to depressive symptoms (Elhai et al., 2017). Especially non-social activities performed on smartphones have previously been associated to depressive symptoms, whereas social activities like networking or texting seemed to have an opposite effect (Elhai et al., 2017). This becomes particularly interesting, considering the strong correlation between loneliness and smartphone screen time (Darcin et. al, 2016) and the strong association between loneliness and depression (Matthew et. al, 2019).

In this context, loneliness describes an unpleasant feeling which stems from a deficiency in an individual's social network (Perlman & Peplau, 1981). This might indicate that people who suffer from loneliness and therefore lack social relationships, are not able to make use of the beneficial social opportunities of a smartphone and are more likely to engage in malicious passive smartphone behaviors. A possible explanation for this assumption is provided by the displacement effect theory. Following this theory, the unpleasant feeling of loneliness might be displaced towards a more pleasant supplement for the missing interpersonal relations (Stevic et al., 2021). Consequently, the non-social time spend on the smartphone consumes the time which could otherwise be used for meaningful social interactions, which thereby further diminishes and loneliness increases, posing an additional risk factor for depressive symptoms (Stevic et al., 2021).

1.3 Social media and depression

Besides overall smartphone screen time, use of social media specifically has been hypothesized to have a connection to depressive symptoms by various researchers. A longitudinal study conducted by Shakya and Christakis (2017) concluded that Facebook usage has a significant negative influence on an individual’s well-being. This might partly be explained by the tendency to detract from real life social interactions, which social media use can accompany, as well as reduced engagement in meaningful activities and increased sedentary behaviors (Leung & Lee, 2005). These tendencies might pose a heightened risk of developing depressive symptoms, as the lack of purposeful activity and sedentary behaviors are linked to the maintenance of depressive tendencies

(Robak & Griffin, 2000; Teychenne et al., 2010). In line with this proposition, a study conducted by Heffer et al. (2019), concluded that depression increases social media use, based on a significant relation between the two concepts. However, the study did not include the amount of time which the participants spend on social media in their analysis.

In efforts to investigate the impact of the amount of social media consumption, a variety of researchers relied on screen time measurements. The meta-analysis of Tang et al. (2021) stated that the existing evidence for the relation social media screen time and depressive symptoms was split, including some studies stating an influence of depressive symptoms and others not. Another meta-analysis, conducted by Neophytou et al. (2021), did find more significant relationships between smartphone screen time and depression.

A possible explanation for these conflicting findings may lay in how young adults use their screen time (Barry et al., 2017). While some types of social media consumption might be harmful, active use and authentic self-representation can have a beneficial effect on the mental health of young adults (Berryman, et. al, 2017). At the same time, excessive social media usage may enhance feelings of loneliness and make people feel less connected to their peers (Song et al., 2014). This could imply that people who use social media to contact and maintain their social relations might be less prone to depressive tendencies, compared to users which suffer from loneliness and are therefore unable to actively participate in the social media environment.

1.4 Social media, depression and loneliness

Combining these findings of differing effects on mental health by for different types of social media use and the risk of increasing loneliness and depressive symptoms by excessive media behavior, a link between loneliness and the effect screen time has on the mental health of young adults is proposed. This connection may further be substantiated by the strong correlation between depression and loneliness in young adults (Matthews et al., 2019). This relationship has previously been investigated in an experiment conducted by Hunt et al. (2018). In the experiment, the researchers challenged their participants to limit their social media use and investigated the effect it has on multiple facets of their mental health. The results showed that refraining from social media affected their level of perceived loneliness and depression in a positive way. Though the

results of the study were significant, quantitative measures of this of the influence of loneliness on the relationship between screen time and depressive symptoms are scarce.

A possible explanation for the moderating effect of loneliness might be social displacement theory (Boers et al., 2019; Smith, 2021). The social displacement theory claims that the time spent on social media, consumes the time that would otherwise be spent with maintaining meaningful interpersonal relationships, which consequently diminish and leave the individual lonely and more prone to depression. This might be less severe, if the activities performed using social media are proactively social, as these types of interactions might be more likely to benefit the maintenance of meaningful interpersonal relationships, compared to people who lack these kinds of relationships and use social media differently. However, the efforts to validate the social displacement theory in the context of social media failed to reach statistical significance (Boers et al., 2019; Smith, 2021).

1.5 Aims of this study

Overall, this study aims to contribute to the contradictory research about the relationships between smartphone and social media screen time and depressive symptoms. Therefore, the relationships between smartphone screen time and depressive symptoms are investigated. Instead of self-reported screen time, which has been used by previous studies and were criticized for its inaccuracy, this study aimed to incorporate exact measurements of screen time. Additionally, this study aims to investigate the moderating effect of loneliness on the relationship between smartphone screen time and depressive symptoms. This leads to the following research questions:

Research question 1

To what extent is total smartphone associated with depressive symptoms

Hypothesis 1

Smartphone screen time positively correlates with the level of depressive symptoms in young adults.

Research question 2

To what extent is social media screen time associated with depressive symptoms?

Hypothesis 2

There is a positive relationship between SMST and depressive symptoms.

Research question 3

To what extent does loneliness moderate the relationship between smartphone screen time and depressive symptoms in young adults?

Hypothesis 3

Loneliness moderates the relationship between depressive symptoms and social media screen time.

Research question 4

To what extent does loneliness moderate the relationship between social media screen time and depressive symptoms in young adults?

Hypothesis 4

Loneliness moderates the relationship between depressive symptoms and social media screen time.

2. Methods

2.1 Participants

The required sample size to achieve 95% statistical power, with a significance level of .05 was calculated using G*power (version 3.1) and indicated a minimum of 56 participants. All participants were recruited via the survey distribution application Sona Systems and were able to receive credits for their participation. According to the requirements of becoming part of the study, all subjects were fluent in the English language. The initial sample consisted of 109 participants (83 female, 24 male, 1 preferred not to say, 1 other) with an average age of 21 years (SD=2.56). It was composed of 69 German, 21 Dutch and 19 participants of other nationalities. After excluding

participants which did not meet the inclusion criteria, as well as incomplete responses, the final sample consisted of 87 participants (Table 1).

Table 1

Sociodemographic Characteristics of Participants in Final Sample

Baseline Characteristic	Sample	
	n	%
Gender		
Male	52	59.77
Female	34	39.08
Other	1	1.15
Nationality		
German	54	62.07
Dutch	16	18.39
Other	17	19.54

Note. $N = 87$. Participants were on average 20.7 years old ($SD = 2.23$)

2.2 Procedure

Before publishing the study, the ethical approval was obtained from the ethics committee of the University of Twente (Nr. 211231). Once the participants volunteered to participate in the study, they received a link to the survey, which entailed an informed consent form (Appendix A), followed by measurements of depressive symptoms, loneliness and screen time. The measurements of loneliness and depression were presented in randomized order. The participants were able to freely choose the time at which they wanted to perform the survey. Additionally, they were asked to perform the survey on a computer, to prevent interruptions occurring during multitasking on a mobile device.

2.3 Materials

Demographics

After agreeing to the informed consent form, the participants were asked to state their demographics by means of a brief questionnaire. The questionnaire entails information about (1) gender, (2) age, (3) nationality and (4) current occupation.

Screen time measures

To assess the different types of screen time of the participants, a questionnaire was designed by the researcher. The questionnaire asked for total smartphone screen time, social media screen time on a smartphone and estimated screen time on other devices than a smartphone.

The participants were firstly asked whether they are using a mobile phone at all and which type of mobile phone they are using. Depending on their input, the participants were presented with a tutorial in written and video format, explaining how to retrieve their exact screen time from their mobile phone. The input window was presented in the same format as the default type of display of the indicated type of smartphone. Therefore, Android users were asked to indicate their daily screen time within the last 14 complete days and Apple users were asked to indicate their average daily average for the last two weeks. The measures entailed social media screen time, total smartphone screen time and an estimation of the social media screen time on other devices than their smartphone.

Assessment of depressive symptoms

In order to assess the level of depressive symptoms of the participants, the Center for Epidemiologic Studies Depression Scale (CES-D) was chosen. The CES-D is a 20-item questionnaire, which indicates the severity of depressive symptoms based on the cumulated score of all items. Each item consists of four statements which represent depressive markers in four different intensities and asks the participants to indicate the most suitable to their experience (e.g. *I felt that everything I did was an effort.*). The CES-D was chosen because of its sufficient reliability and validity estimates, while being applicable for self-reported use. The internal consistency (α=.85-91) and test-retest reliability ($r \geq .53$) are adequate, and the external validity has been indicated by associations with measurement tools for depression for both clinical and non-

clinical populations (Roberts, 1980; Radloff, 1977). The current sample resembled the high internal consistency (α=.90).

Assesment of Loneliness

For the measurement of the experienced level of loneliness, the 20-item UCLA Loneliness scale (version 3) was chosen. The questionnaire is composed of 20 items, which cover different facets of loneliness (e.g. *How often do you feel that you lack companionship?*). The participants were asked to what extent this resembles their experience by means of a 4-point Likert scale (1=never, 4= often). The reliability estimates of the questionnaire are high, with internal reliability estimates ranging from α=.89 to α=.94 and sufficient test-retest reliability scores (r=.73). The external validity has been shown by significant correlations to measurements of other related constructs (Russell, 1996). The current sample resembled the high internal consistency (α=.91).

Data Analysis The analysis was conducted using Excel (version 16.44) for the data preparation and Rstudio (version 3.0.1) for the analysis. Incomplete responses were excluded, using Excel. Afterwards the data retrieved by the questionnaire was transferred into a format usable in RStudio.

Subsequently, the data of the screen time measurements, the UCLA Loneliness scale and the CES-D are checked for linearity, normality and homoscadecity. The linearity assumption was checked using a scatterplot. The normality check was done by a q.q. Plot, a density plot and a Shapiro Wilk test and the homoscedacity is checked, using the Breusch Pagan Test.

To answer the first two research questions, a correlation analysis was performed between the CES-D score and the screen time measurements. For the second research question, the social media screen time measurements were used.

Subsequently, the moderation analyses were performed, to answer the third and fourth research question. Therefore, firstly the scores of the independent variables were standardized to prevent the distortion caused by multicollinearity. Afterwards, the interaction effect of the screen time measures, and the UCLA loneliness scale (loneliness) were computed, using R. Subsequently a multiple regression model was fitted, setting screen time, loneliness and the interaction effect of

screentime*loneliness as the predictors. The computed correlation coefficient, combined with the computed p-value was observed as an estimate of the significance of the moderation effect.

3. Results

3.1 Data Preparation

Firstly, the data was scanned for errors and incomplete responses were removed. Further investigation of the data revealed, that in some participants the measure of average daily social media screen on their smartphone, exceeded their total smartphone screen time. This type of error occurred only in participants who reported to use Apple Smartphones, which display the total time per week for social media applications in the same format as the average daily scores of all combined applications. Therefore, it was assumed that this group of participants had given their weekly total social media screen time instead of their daily average. In order to scan for this type of error, the value for the daily average of smartphone screen time was divided by the value given for social media screen time on the smartphone. In case this resulted in a value higher than one for both weeks, it was assumed that they had given their total value of the week. In these cases, the responses were divided by seven. The participants who displayed this type of inconsistency only for one week were excluded, because the possibility that they had indicated the screen time for the first week as the input for the second week and vice versa could not be ruled out.

Table 2

Descriptive Statistics of CES-D, UCLA and Screen time measurements

	N	Mean	Min	Max	Std. Deviation	Std. Error
CES-D	87	18.25	2	46	10.13	1.09
UCLA	87	43.01	25	68	9.6	1.03
Smartphone screen time	87	259.58	0	603	112.66	12.08
Social media screen time (smartphone)	87	134.51	0	335	72.07	7.73
Social media screen time (all devices)	87	273.97	0	831	170.24	18.25

Note. Descriptive statistics of measurements after correction and exclusion

3.2 Normality check

After correcting the responses, the data of all variables were checked for normality.

The data retrieved by the CES-D showed no normal distribution, based on the interpretation of the density plot (Appendix B), the q.q. plot (Appendix C) and the Shapiro Wilk Test, $W(85) = 0.94269$, $p<.001$. Based on the moderately positive skewness of 0.7327654, the data was transformed by calculating the square root. The transformed data of the CES-D showed a normal distribution, based on the density plot (Appendix D), the q.q. plot (Appendix E) and the Shapiro Wilk Test, $W(85) = 0.98633$, $p=0.5$.

The results of the UCLA Loneliness Questionnaire indicated an approximately normal distribution, based on the density plot (Appendix F), the q.q Plot (Appendix G). The Shapiro-Wilk Test, $W(85) = 0.98336$, $p = .33$. The critical value of the Shapiro Wilk test was not reached, but the interpretation of the density plot and the q.q. plot indicated that an approximately normal distribution can be assumed.

The average daily social media screen time, including the estimation on other devices than the smartphone was not normally distributed, based on the interpretation of the density plot (Appendix H), the q.q. Plot (Appendix I) and the Shapiro Wilk-Test, $W(85) = 0.91671$, $p= <.001$. Based on the positive skewness of 1.134146, the data was transformed by calculating the square root. The transformed data showed an approximately normal distribution, based on the density plot (Appendix J), the q.q. Plot (Appendix K) and the Shapiro Wilk Test, $W(85) = 0.98569$, $p = 0.46$.

The exact measurements of social media screen time using the smartphone, excluding the estimated values on other devices showed an approximately normal distribution with, based on the density plot (Appendix L), the q.q. Plot (Appendix M) and the Shapiro Wilk test $W(85) = 0.96961$, $p = .04$.

The average smartphone screen time was normally distributed, based on the density plot (Appendix N), the q.q. Plot (Appendix O) and the Shapiro Wilk test, $W(85) =0.9761$, $p = .1072$.

3.3 Correlation between smartphone screen time and depression

After transforming the non-normally distributed variables, the first hypothesis was investigated. Therefore, a model was created, in which the square root of the CES-D was set as the independent variable and the total smartphone screen time was set as the dependent variable. The scatter plot (Appendix P) indicated a linear relationship and the Breusch-Pagan test indicated that homoscedacity can be assumed (p=.4309)

Subsequently, the correlation between the total smartphone screen time and depression was investigated. Therefore, firstly a scree plot was computed. Afterwards, the Pearson correlation coefficients were computed, which showed no siginificant correlation, r(85)=0.21 , p=0.050.

3.4 Correlation between social media screen time and depression

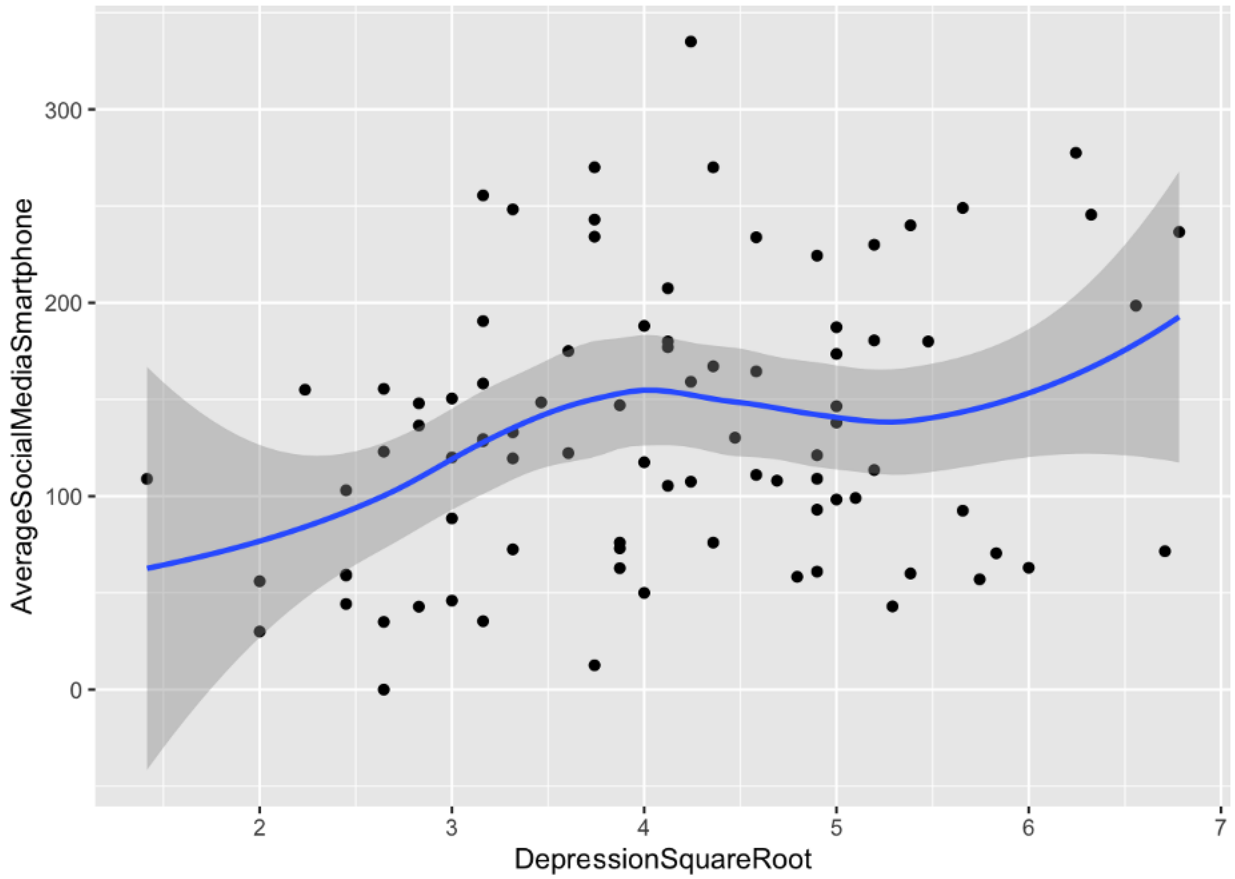
To test the second hypothesis, two models were created. In the first model, the square root of the cumulated score of the CES-D was set as the dependent variable and the square root of the social media screen time on the smartphone, combined with the estimated social media screen time on other devices was set as the dependent variable. The scatter plot of the two variables indicated a linear relationship (Appendix Q) and the Breusch-Pagan test confirmed the homoscedacity (P=.5).

Subsequently, a scree plot was computed. As both datasets were normally distributed, the Pearson correlation coefficient was chosen to investigate the relationship of the two variables. The Pearson correlation coefficient of the square rooted CES-D and the average social media screen time on all devices showed no significant correlation, r(87)=.21 , p=0.053.

The second model consisted of the square rooted CES-D score and the exact social media screen time measurement, retrieved from the smartphone as the dependent variables. The scatter plot indicated a linear relationship (Appendix R) and the Beusch Pagan Test showed that homoscadecity can be assumed (p=.5). Afterwards, the Pearson correlation coefficients were computed, which showed a significant weak correlation, r(85)=.27, p=0.013.

Figure 1

Correlation of social media screen time on smartphone and depression



Note. Scatter plot of average daily social media screen time on smartphone

3.5 Moderation by loneliness on relationship between smartphone screen time and depression

The moderation by loneliness on the relationship between smartphone screen time and depression were investigated by a multiple regression analysis. A model was created in which smartphone screen time, loneliness and the interaction term SmartphoneScreenTime*loneliness were set as the predictors for depression.

The model was significant ($F(3,83)=25.56$, $p<.001$) with an R^2 of .4803.

Loneliness displayed a moderate significant correlation, $r(3,83)= .66$, $t=3.008$, $p<.001$.

Smartphone screen time showed no significant correlation r(3,83)=.00, t=1.014, p=.314.

The interaction term Loneliness*SmartphoneScreenTime showed no correlation, r(3,83)=.00, t=-.685, p=.495.

3.6 Moderation by loneliness on relationship between social media screen time and depression

Lastly, the moderation effect of Loneliness on the previously established relationship between social media screen time and depression was studied. Therefore, a multiple regression analysis was performed. A model was created in which social media screen time, loneliness and the interaction term SocialMediaScreenTime*loneliness as the predictors for depression.

The model was significant ($F(3,83)=26.85$, $p<.001$) with an R^2 of .4925.

Loneliness displayed a strong significant correlation, r(3,83)= .77, t=8.122, p<.001.

The social media screen time showed no significant correlation r(3,83)=.18, t=1.912, p=.060 .

The interaction term Loneliness*SocialMediaScreenTime showed no correlation, r(3,83)=-.06, t=-.643, p=.52.

4. Discussion

The study aimed to investigate the relationship between screen time and depressive symptoms. Overall, the study could not find a link between smartphone screen time and depressive symptoms, using exact screen time measurements. It thereby contradicts the findings of previous investigations, which used estimations to assess the participants screen time (Bickham, et. al, 2015; Khouja et. al, 2019.). Still, the results about the relationship between smartphone screen time and depressive symptoms were close to the cut-off point for a statistically significant relationship. The smaller sample size, as well as the differences in measurements may partly account for the difference to the findings of previous research. However, the proximal link disappeared

completely, once loneliness was considered as an additional predictor. Moreover, the study found an initial link between social media screen time and depressive symptoms, which also disappeared after loneliness was introduced.

Based on the results, the hypothesized moderation effect of loneliness could not be substantiated. Instead, it could be argued that the relationship of screen time and depression can be attributed to loneliness and no direct link between screen time and depression exists. This might explain the split evidence found by the meta-analysis of Tang et. al (2021), about the relationship of social media screen time and depressive symptoms, as screen time could have masked the effect of loneliness in a similar way, as in the current study.

As proposed by the social displacement theory, spending time on screen devices might serve as a substitute for missing interpersonal connections, which is experienced more positively than real life interactions and make the individual more prone for depression (Boers et. al 2019; Smith, 2021). However, the results of this study indicate that depression is caused solely by comorbid loneliness and not the interplay of loneliness and screen time. This is in line with the strong association of depressive symptoms and loneliness observed in previous research (Matthew et. al, 2019) and the strong association between screen time and loneliness (Darcin et. al, 2016).

However, even if no direct link between depression and screen time exists, refraining from social media could still be beneficial for people suffering from depression, as previous research showed (Hunt et. al, 2018). The missing substitute for the deficiency in interpersonal relations, evoked by not using social media, might cause a necessity to productively cope with loneliness. Consequently, the decreased loneliness could counteract the development of depressive symptoms, with loneliness as a perpetuating influence.

4.3 Limitations

The results of the study need to be viewed in the light of some limitations. Firstly, the exact data retrieved from the smartphone tracking application might underestimate the screen time of people which primarily use social media on another device. Though, mobile apps are generally the most widespread device to access social media, some social media sites (e.g. LinkedIn) are more often accessed using a computer (AudienceProject, 2019). Therefore, one should be cautious to generalize the results to all kinds of social media use.

Secondly, due to the timely restrictions of the study, the collected data only represents a snapshot of the investigated variables. As the individual levels of depression and loneliness might fluctuate over time, repeated measures could give a more valid picture about their relationship to screen time, as well as stronger conclusions about the causality. This would also enable the researchers to compare the results in a within-subject design, opposed to between-subject design which had to be chosen for this study, because of the single measurement.

Thirdly, the results must be viewed under consideration of the ongoing COVID-19 pandemic at the time of conducting the study, which caused significant increases in loneliness, especially among young adults (Killgore, 2020). This trend, combined with the necessity to self-isolate, might have altered the overall social media behavior of the participants compared to studies which were taken before the onset of the pandemic, as well as the motivations to use smartphones and social media.

4.4 Implications

If refraining from social media prevents the formation of depressive symptoms, as suggested by the findings of this study and that of Hunt and colleagues (2018), this might imply a clinical importance to monitor social media activity in young adults who are at risk of developing depression. However, the results of this indicate that the underlying issue might be rooted in comorbid loneliness. This could indicate that the therapeutic potential of refraining from social media is caused by a more adaptive style of coping with loneliness, which could therefore be considered in therapeutic settings.

Moreover, the study indicates that effects of loneliness could have been attributed to the influence of screen time in previous studies, which might indicate that these findings might benefit from being revisited under consideration of loneliness. Furthermore, the studies used by Tang et. al (2021) did not discriminate between the different uses of smartphones, which resulted in differing results in this study. Accordingly, it might be advisable for researchers, to gather the data for social media separated from the total scores of screen time.

Overall, the results of the study indicate that screen time measurements are very limited in their capability to predict depressive symptoms, as the introduction of loneliness caused all relationships to disappear. Therefore, one should be cautious to make assumptions about the impact of smartphone or social media on depressive symptoms, based on studies which exclusively rely on screen time measurements.

References

AudienceProject (2019, October). Share of social media users in the United States who access social networks via select digital devices as of 3rd quarter 2019. *Statista.* https://www-statista-com.ezproxy2.utwente.nl/statistics/184318/daily-social-media-activities-of-us-adults-device/

Coyne, S. M., Hurst, J. L., Dyer, W. J., Hunt, Q., Schvanaveldt, E., Brown, S., & Jones, G. (2021). Suicide Risk in Emerging Adulthood: Associations with Screen Time over 10 years. *Journal of Youth and Adolescence.* doi:10.1007/s10964-020-01389-6

Barry, C. T., Sidoti, C. L., Briggs, S. M., Reiter, S. R., & Lindsey, R. A. (2017). Adolescent social media use and mental health from adolescent and parent perspectives. *Journal of Adolescence, 61*, 1–11. doi:10.1016/j.adolescence.2017

Berryman, C., Ferguson, C. J., & Negy, C. (2017). Social Media Use and Mental Health among Young Adults. *Psychiatric Quarterly, 89*(2), 307–314. doi:10.1007/s11126-017-9535-6

Boers, E., Afzali, M.H.. Newton, N., Conrod, P. (2019). Association of Screen Time and Depression in Adolescence. *JAMA Pediatrics..* doi:10.1001/jamapediatrics.2019.1759

Bickham, D. S.; Hswen, Y., Rich, M.(2015). Media use and depression: exposure, household rules, and symptoms among young adolescents in the USA. *International Journal of Public Health, 60*(2), 147–155. doi:10.1007/s00038-014-0647-6

Darcin, A. E., Kose, S., Noyan, C. O., Nurmedov, S., Yılmaz, O., & Dilbaz, N. (2016). Smartphone addiction and its relationship with social anxiety and loneliness. *Behaviour & Information Technology, 35*(7), 520-525. doi:10.1080/0144929X.2016.1158319

Elhai, J. D., Levine, J. C., Dvorak, Robert D., Hall, B. J. (2017). Non-social features of smartphone use are most related to depression, anxiety and problematic smartphone use. *Computers in Human Behavior, 69,* 75–82. doi:10.1016/j.chb.2016.12.023

Ernala, S.K.; Burke, M.; Leavitt, A.; Ellison, N.B. (2020) How well do people report time spent on Facebook? An evaluation of established survey questions with recommendations. Proceeding of ACM CHI Conference on Human Factors in Computing Systems, USA. doi:10.1145/3313831.3376435

Faul, F., Erdfelder, E., Buchner, A., & Lang, A.-G. (2009). Statistical power analyses using G*Power 3.1: Tests for correlation and regression analyses. *Behavior Research Methods*, *41*, 1149-1160.

Frison, E., & Eggermont, S. (2016). Exploring the relationships between different types of Facebook use, perceived online social support, and adolescents' depressed mood. *Social Science Computer Review, 34*(2), 153–171. doi:10.1177/0894439314567449

Ghaemi, S. N. (2020). Digital Depression: A New Disease of the Millennium*?*. *Acta Psychiatrica Scandinavica, 141*(4). doi:10.1111/acps.13151

Heffer, T., Good, M., Daly, O., MacDonell, E., & Willoughby, T. (2019). The longitudinal association between social-media use and depressive symptoms among adolescents and young adults: An empirical reply to Twenge et al. (2018). *Clinical Psychological Science, 7*(3), 462–470. doi:10.1177/2167702618812727

Hunt, M. G.; Marx, R., Lipson, C., Young, J. (2018). No More FOMO: Limiting Social Media Decreases Loneliness and Depression. *Journal of Social and Clinical Psychology, 37*(10), 751–768. doi:10.1521/jscp.2018.37.10.751

Hussain, Z., Griffiths, M.D. (2021). The Associations between Problematic Social Networking Site Use and Sleep Quality, Attention-Deficit Hyperactivity Disorder, Depression, Anxiety and Stress. *Int J Ment Health Addiction, 19*, 686–700. Doi:10.1007/s11469-019-00175-1

Kaye L. K., Orben, A., Ellis, D. A., Hunter S. C., Houghton, S. (2020). The Conceptual and Methodological Mayhem of "Screen Time". *International Journal of Environmental Research and Public Health*, *17*(10), 3661. doi:10.3390/ijerph17103661

Kessing, L.V. (2007). Epidemiology of subtypes of depression. *Acta Psychiatrica Scandinavica*, (433), 85–89. doi:10.1111/j.1600-0447.2007.00966.x

Kessler, R. C.; Bromet, E. J. (2013). The Epidemiology of Depression Across Cultures. *Annual Review of Public Health, 34*(1), 119–138. doi:10.1146/annurev-publhealth-031912-114409

Khouja, J. N.; Munafò, M.R.; Tilling, K., Wiles, N J.; Joinson, C., Etchells, P. J. John, A., Hayes, F.M., Gage, S. H., Cornish, R. P. (2019). Is screen time associated with anxiety or depression in young people? Results from a UK birth cohort. *BMC Public Health, 19*(1), 82. doi:10.1186/s12889-018-6321-9

Killgore, W. D., Cloonan, S. A., Taylor, E. C., & Dailey, N. S. (2020). Loneliness: A signature mental health concern in the era of COVID-19. *Psychiatry Research, 290*, 113117. doi:10.1016/j.psychres.2020.113117

Lepp, A., Barkley, J., & Karpinski, A. C. (2013). The relationship between cell phone use, academic performance, anxiety and satisfaction with life in college students. *SAGE Open, 5(*1), 1–9. https://doi.org/10.1177 /2158244015573169.

Leung, L., Lee, P.S. (2005). Multiple determinants of life quality: the roles of Internet activities, use of new media, social support, and leisure activities. *Telemat Inform*. *22*(3), 161–180. doi:10.1016/j.tele.2004.04.003

Liu, S., Wing, Y. K., Hao, Y., Li, W., Zhang, J., & Zhang, B. (2019). The associations of long-time mobile phone use with sleep disturbances and mental distress in technical college students: a prospective cohort study. *Sleep*, *42*(2), doi:10.1093/sleep/zsy213.

Maras, D., Flament, M., Murray, M., Buchholz, A., Henderson, K., Obeid, N., & Goldfield, G. (2015). Screen time is associated with depression and anxiety in Canadian youth. *Preventive Medicine, 73*, 133- 138. doi:10.1016/j.ypmed.2015.01.029.

Matthews, T., Danese, A., Caspi, A., Fisher, H., Goldman-Mellor, S., Kepa, A., Terrie E. Moffitt, T E., Odgers, C. L., Arseneault, L. (2019). Lonely young adults in modern Britain: Findings from an epidemiological cohort study. *Psychological Medicine, 49*(2), 268-277. doi:10.1017/S0033291718000788

Mojtabai, R., Olfson, M., & Han, B. (2016). National Trends in the Prevalence and Treatment of Depression in Adolescents and Young Adults*.* *PEDIATRICS, 138*(6). doi:10.1542/peds.2016-1878

Montagni, I., Guichard, E., & Kurth, T. (2016). Association of screen time with self-perceived attention problems and hyperactivity levels in French students: a cross-sectional study. *BMJ Open, 6*(2), 1–8. doi:0.1136/bmjopen-2015-009089.

Neophytou, E., Manwell, L.A. & Eikelboom, R. (2021). Effects of Excessive Screen Time on Neurodevelopment, Learning, Memory, Mental Health, and Neurodegeneration: a Scoping Review. *Int J Ment Health Addiction* 19, 724–744. doi:10.1007/s11469-019-00182-2

Orben, A., & Przybylski, A. K. (2019). The association between adolescent well-being and digital technology use. *Nature Human Behaviour, 3, 173–182.* doi:10.1038/s41562-018-0506-1

Radloff, L. S. (1977). *The CES-D Scale: A Self-Report Depression Scale for Research in the*

General Population. Applied Psychological Measurement, 1(3), 385–401. doi:10.1177/014662167700100306

RIDEOUT V (2015). *The Common Sense Census: Media Use by Tweens and Teens*. San Francisco: Common Sense Media.

Robak, R. W., & Griffin, P. W. (2000). Purpose in life: What is its relationship to happiness, depression, and grieving? *North American Journal of Psychology, 2*(1), 113–119.

Roberts R. E. (1980). Reliability of the CES-D Scale in different ethnic contexts. *Psychiatry research*, *2*(2), 125–134. doi:10.1016/0165-1781(80)90069-4

Russell, D. W. (1996) UCLA Loneliness Scale (Version 3): Reliability, Validity, and Factor Structure. *Journal of Personality Assessment*, *66*(1), 20-40. doi:10.1207/s15327752jpa6601_2

Selfhout, M., Branje, S., Delsing, M., ter Bogt, T., & Meeus, H. (2009). Different types of internet use, depression and social anxiety: the role of perceived friendship quality. *Journal of Adolescence, 32*(4), 819–833. doi:10.1016/j.adolescence.2008.10.011.

Shakya, B., & Christakis, N. (2017). Association of Facebook use with compromised well-being: a longitudinal study. *American Journal of Epidemiology, 185*(3), 203–211. https://doi.org/10.1093/aje/kww189

Song, H., Zmyslinski-Seelig, A., Kim, J., Drent, A., Victor, A., Omori, K., & Allen, M. (2014). Does Facebook make you lonely?: A meta analysis. *Computers in Human Behavior, 36,* 446–452. doi:10.1016/j.chb.2014.04.011

Smith, D., Leonis, T., Anandavalli, S. (2021) Belonging and loneliness in cyberspace: impacts of social media on adolescents' well-being. *Australian Journal of Psychology, 73*(1), 12-23. doi: doi.org/10.1080/00049530.2021.1898914

Statista (2021) *Number of smartphone users in Germany from January 2009 to 2020*. Retrieved from https://www.statista.com/statistics/461801/number-of-smartphone-users-in-germany/

Stevic, A., Schmuck, D., Karsay, K., Matthes, J. (2021) Are Smartphones Enhancing or Displacing Face-to-Face Communication With Close Ties? A Panel Study Among Adults. *International Journal Of Communication, 15(*15), 792-813.

Tang, S., Werner-Seidler, A., Torok, M., Mackinnon, A. J., & Christensen, H. (2021). The

relationship between screen time and mental health in young people: A systematic review of longitudinal studies. *Clinical Psychology Review, 86*(5), 102021*,* doi:10.1016/j.cpr.2021.102021

Teychenne, M., Ball, K., & Salmon, J. (2010). Sedentary behavior and depression among adults: a review. *International journal of behavioral medicine*, *17*(4), 246–254. https://doi.org/10.1007/s12529-010-9075-z

Twenge, J. M., & Campbell, W. K. (2018). Associations between screen time and lower psychological well-being among children and adolescents: Evidence from a population-based study. *Preventive medicine reports*, *12*, 271–283. doi:10.1016/j.pmedr.2018.10.003

Twenge, J. M., Joiner, T. E., Rogers, M. L., & Martin, G. N. (2018). Increases in depressive symptoms, suicide-related outcomes, and suicide rates among U.S. adolescents after 2010 and links to increased new media screen time. *Clinical Psychological Science, 6*, 3–17. doi:10.1177/2167702617723376

Appendix

Appendix A

Informed Consent

I consent voluntarily to participate in this study and understand that I can refuse to answer questions and withdraw from the study at any time without having to give a reason.

- ○ Yes
- ○ No

I understand that taking part in the study involves filling out an online questionnaire and encompasses questions about my demographic information, mental health (subjective well being and depression), screen-time usage, and other psychological factors (self-control, neuroticism, sleep quality, perceived social support, and loneliness).

- ○ Yes
- ○ No

I understand that information I provide will be used for academic purposes regarding the bachelor theses at the University of Twente.

- ○ Yes
- ○ No

I understand that personal information collected about me that can identify me will not be shared beyond the study team.

- ● Yes
- ○ No

I give permission for the anonymized answers that are derived from the survey to be archived in the University of Twente Research Information repository so it can be used for future research and learning.

- ● Yes
- ○ No

If you have any concerns, questions, complaints, or remarks, do not hesitate to contact us:

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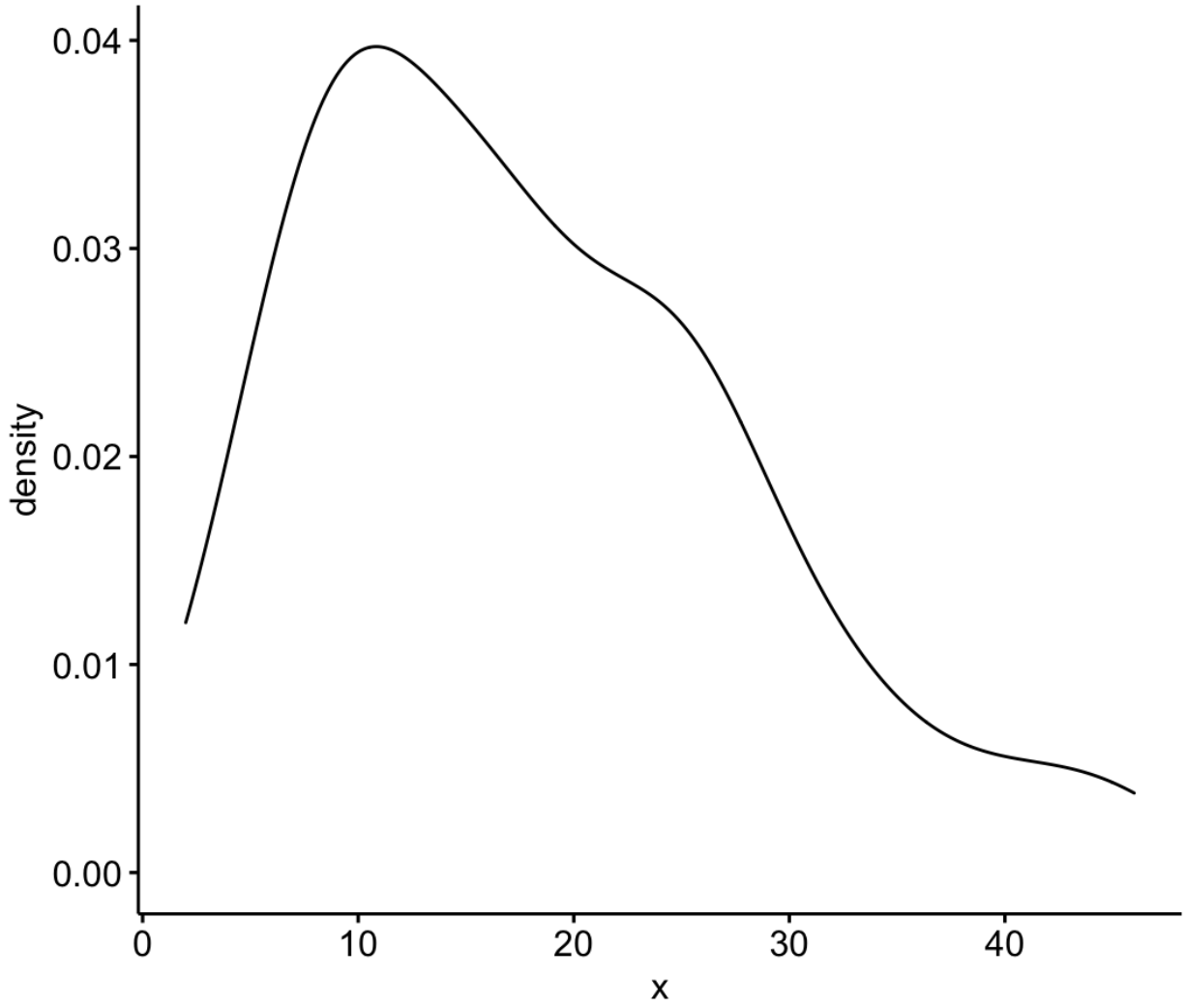
K. Duarte, k.d.duarte@utwente.nl (supervisor)

I declare that I have read the information and agree to participate in this study.

- ○ Yes
- ○ No

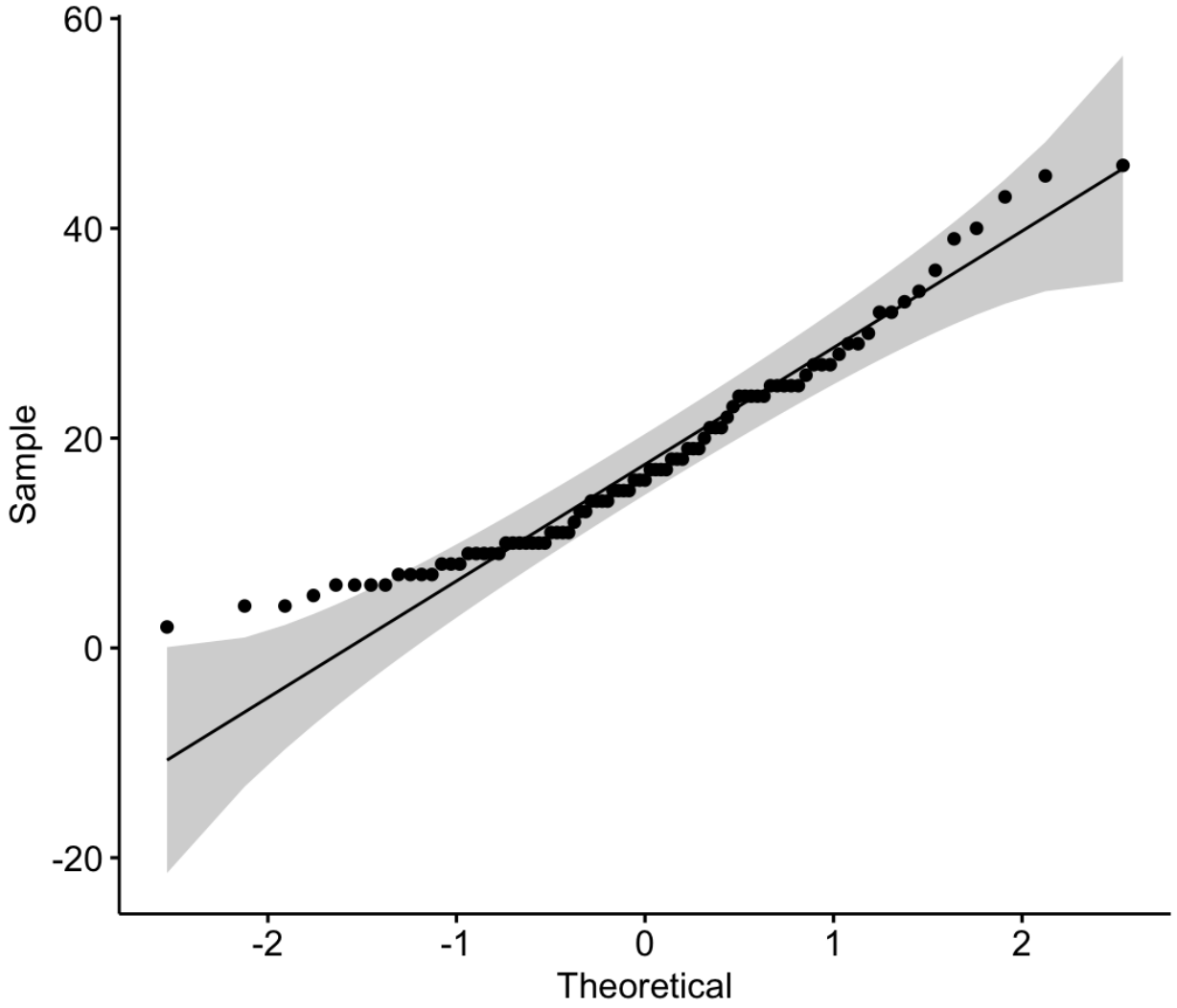
Appendix B

Density Plot - Depression



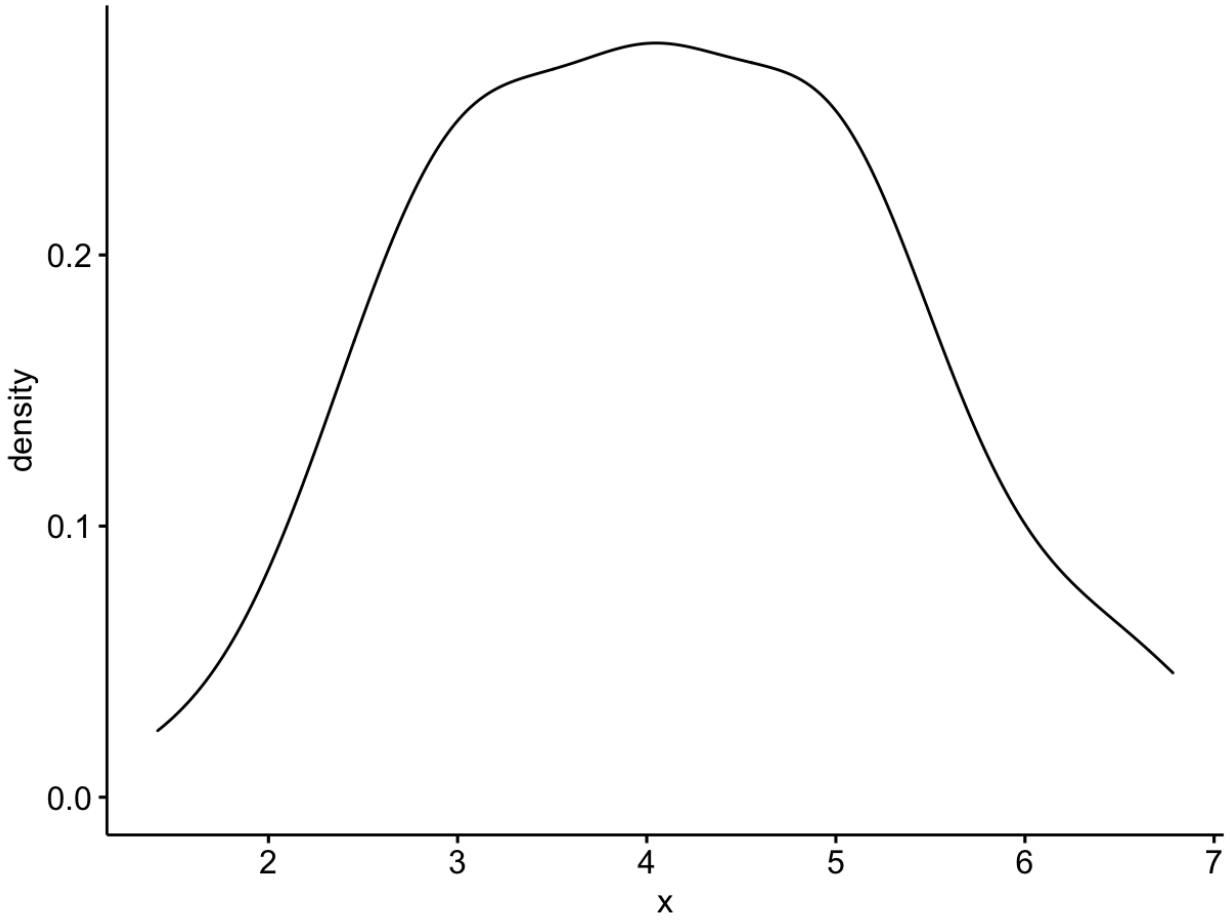
Appendix C

q.q. Plot Depression



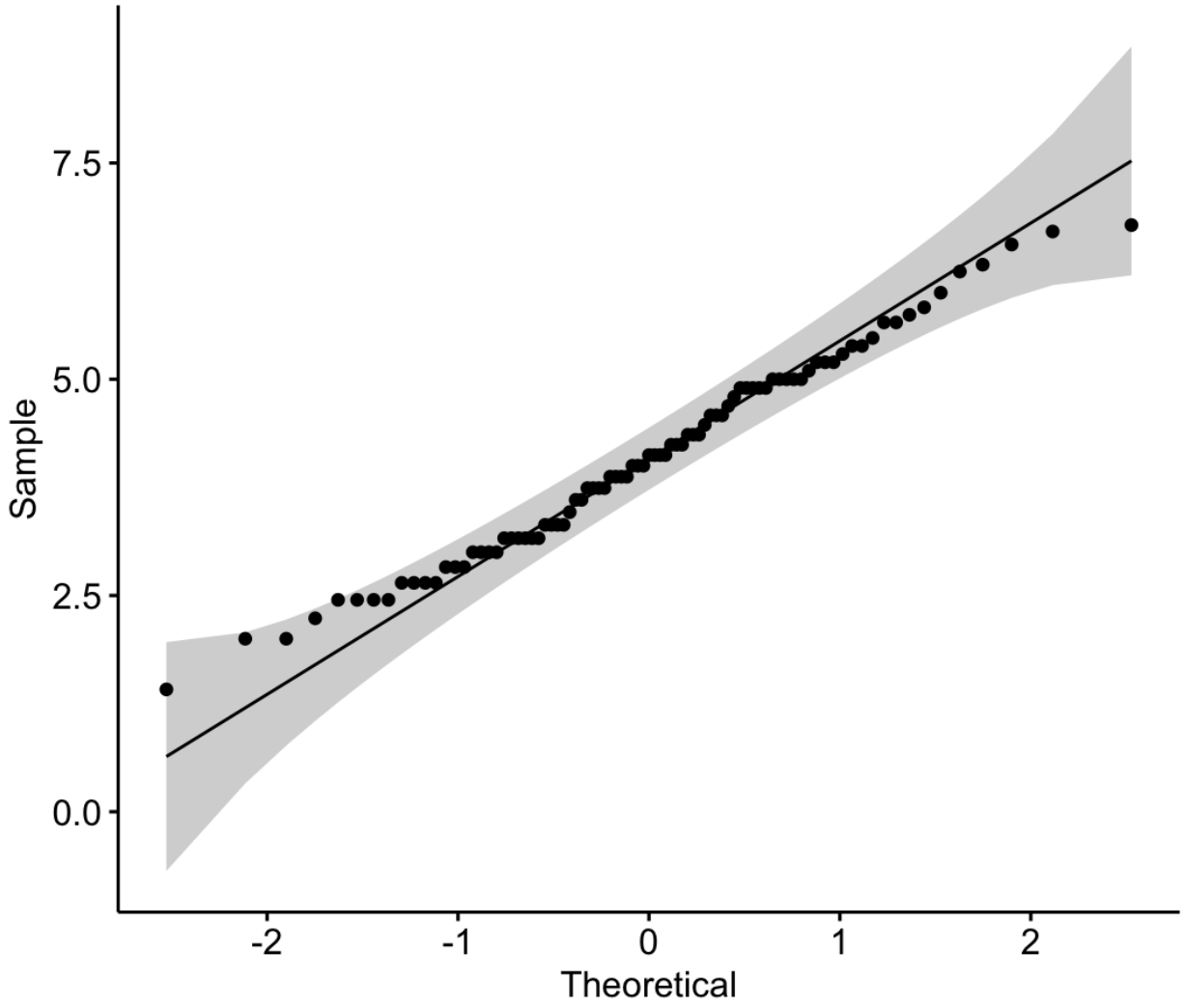
Appendix D

Density Plot – Depression Square Root



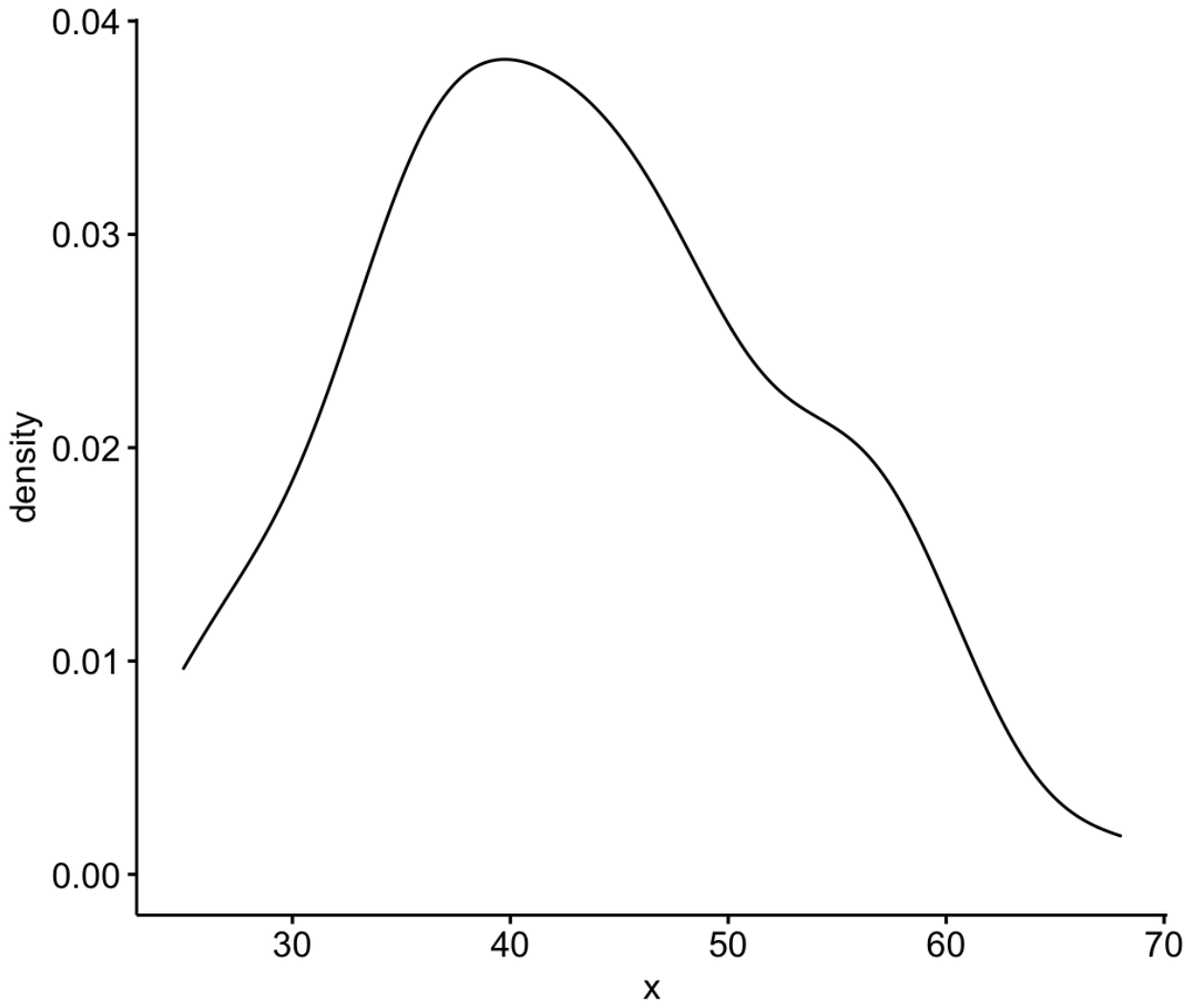
Appendix E

q.q. plot – Depression Square Root



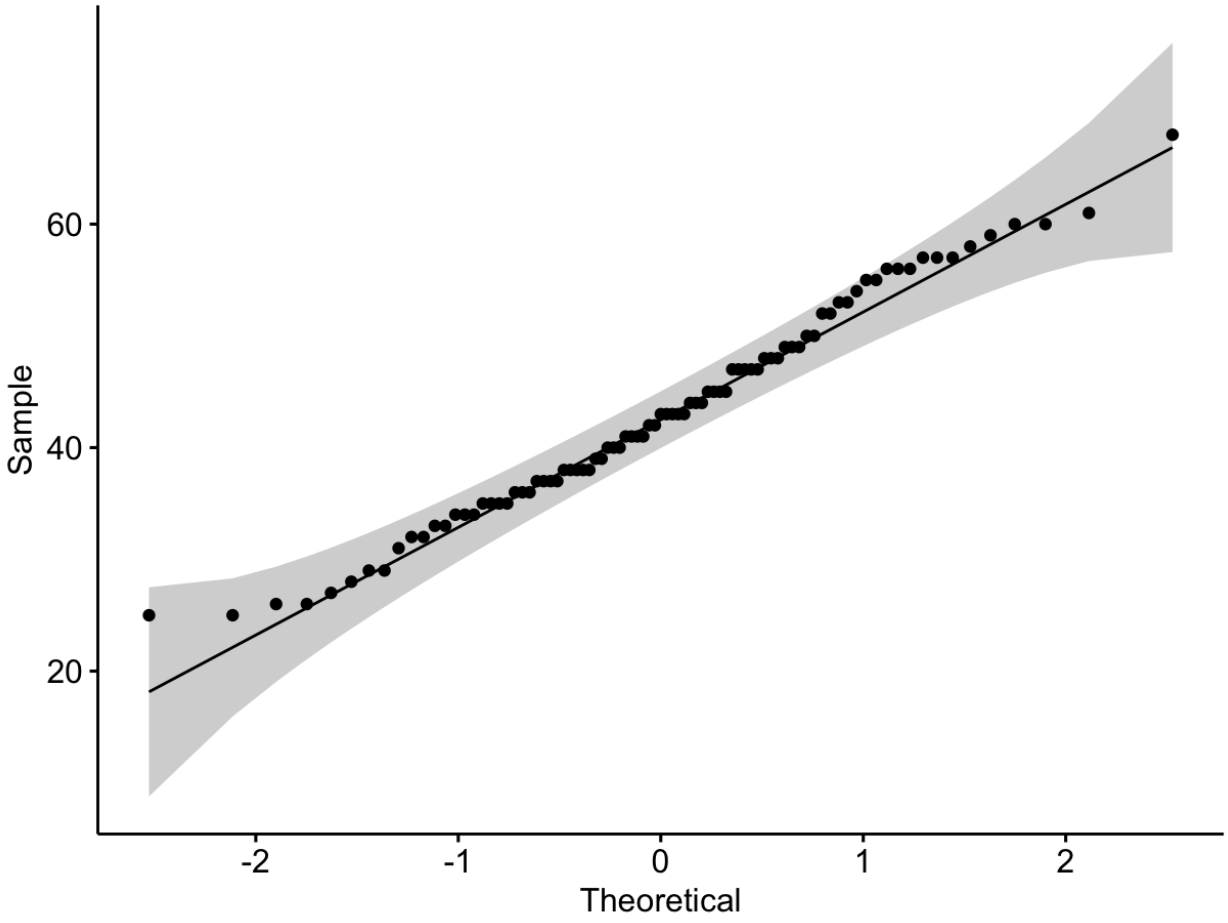
Appendix F

Density Plot - Loneliness



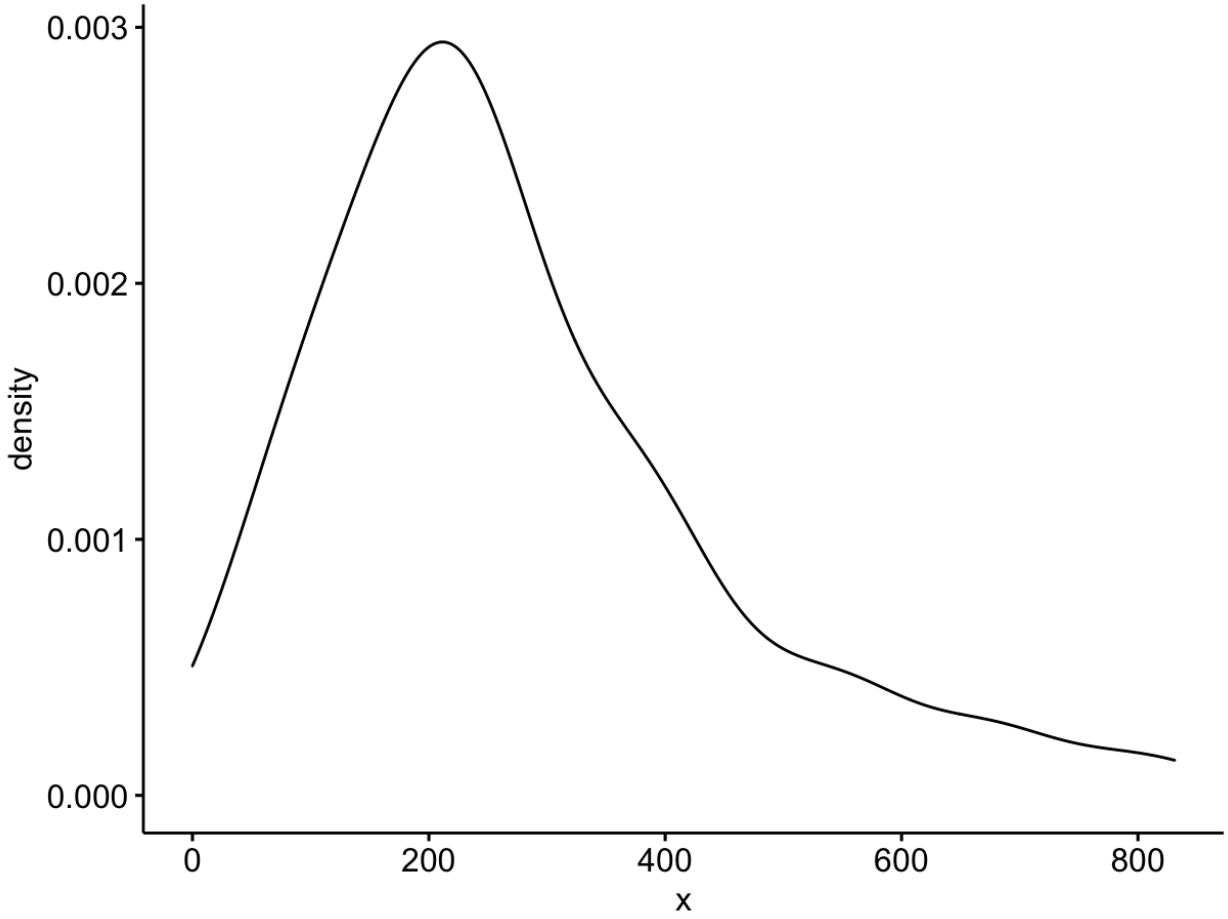
Appendix G

q.q. Plot - Loneliness



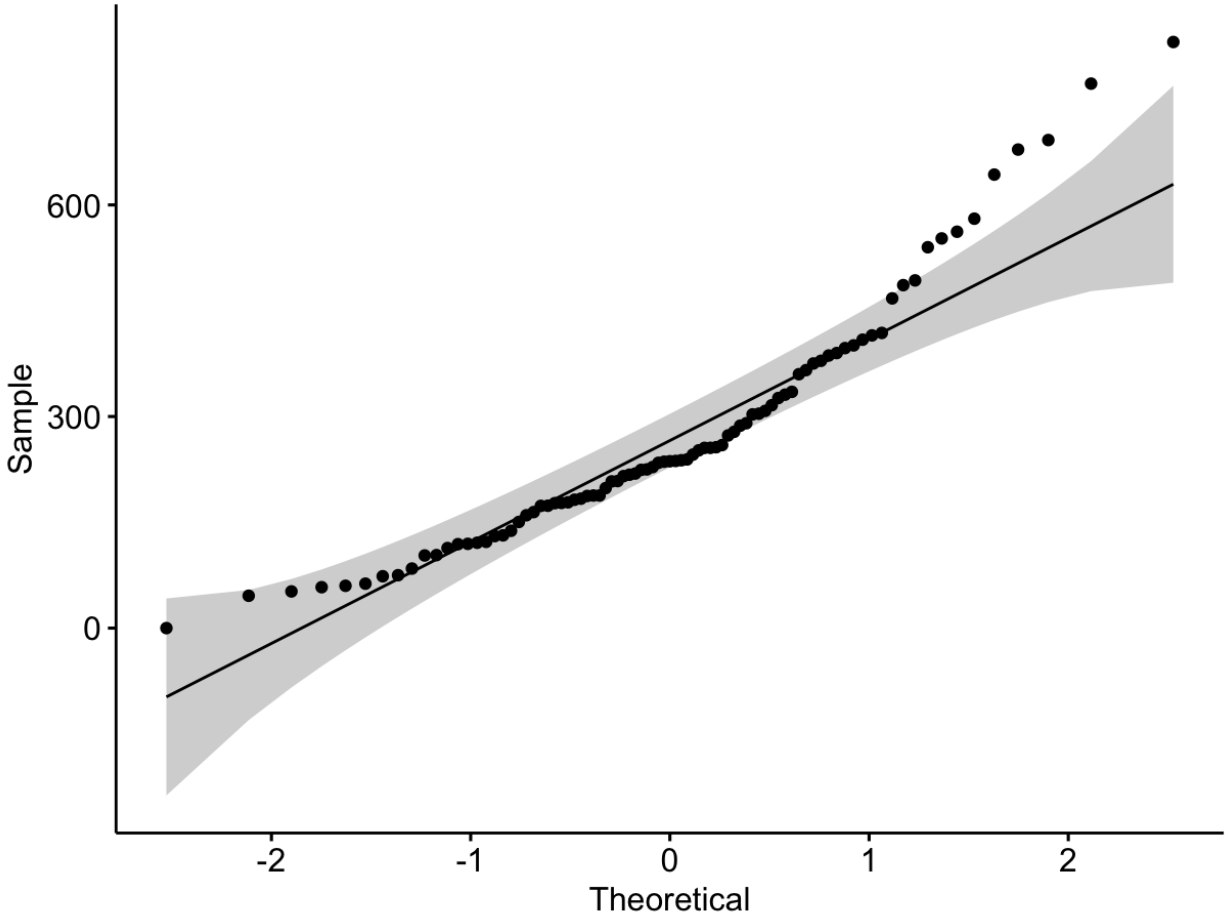
Appendix H

Density Plot - Social media screen time on all devices



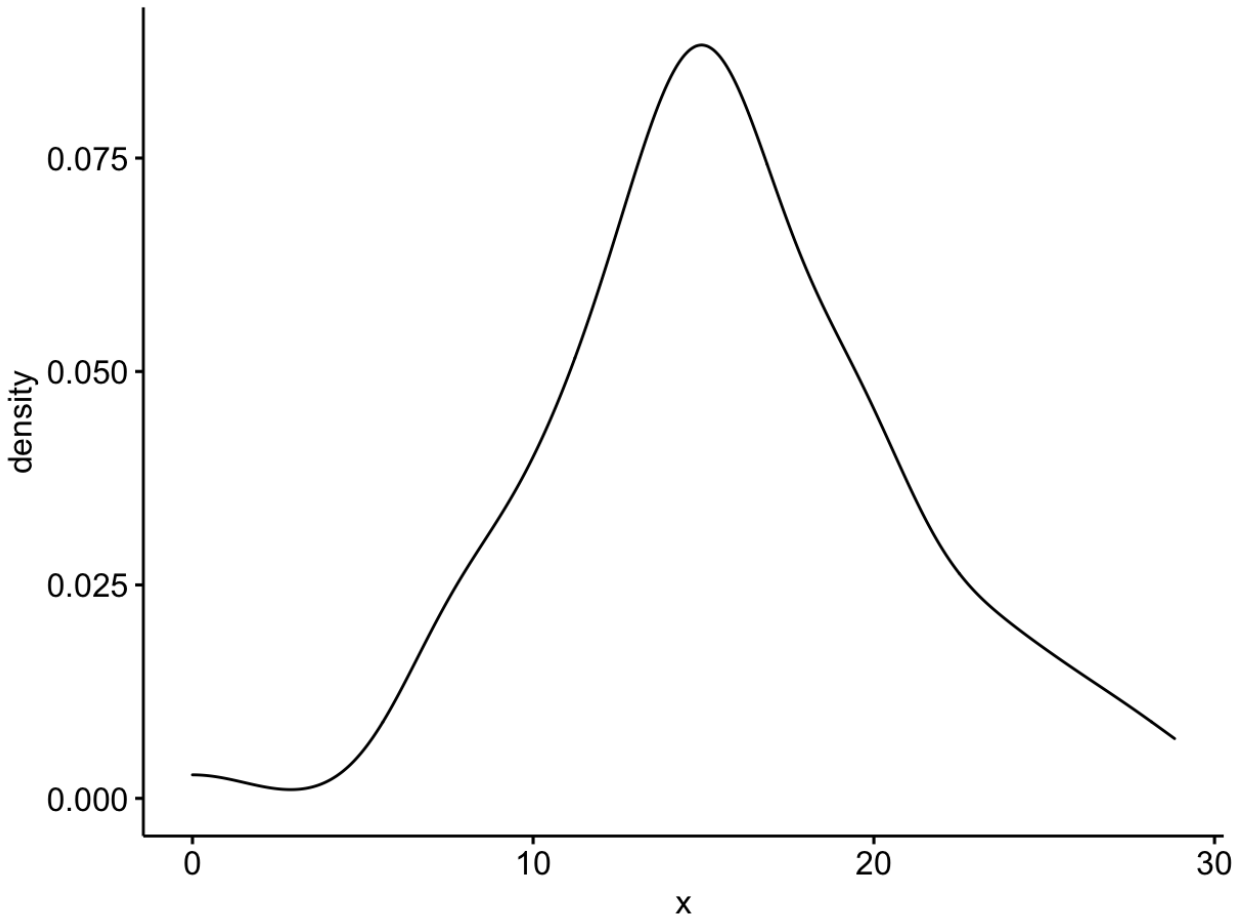
Appendix I

q.q. Plot - Social media screen time on all devices



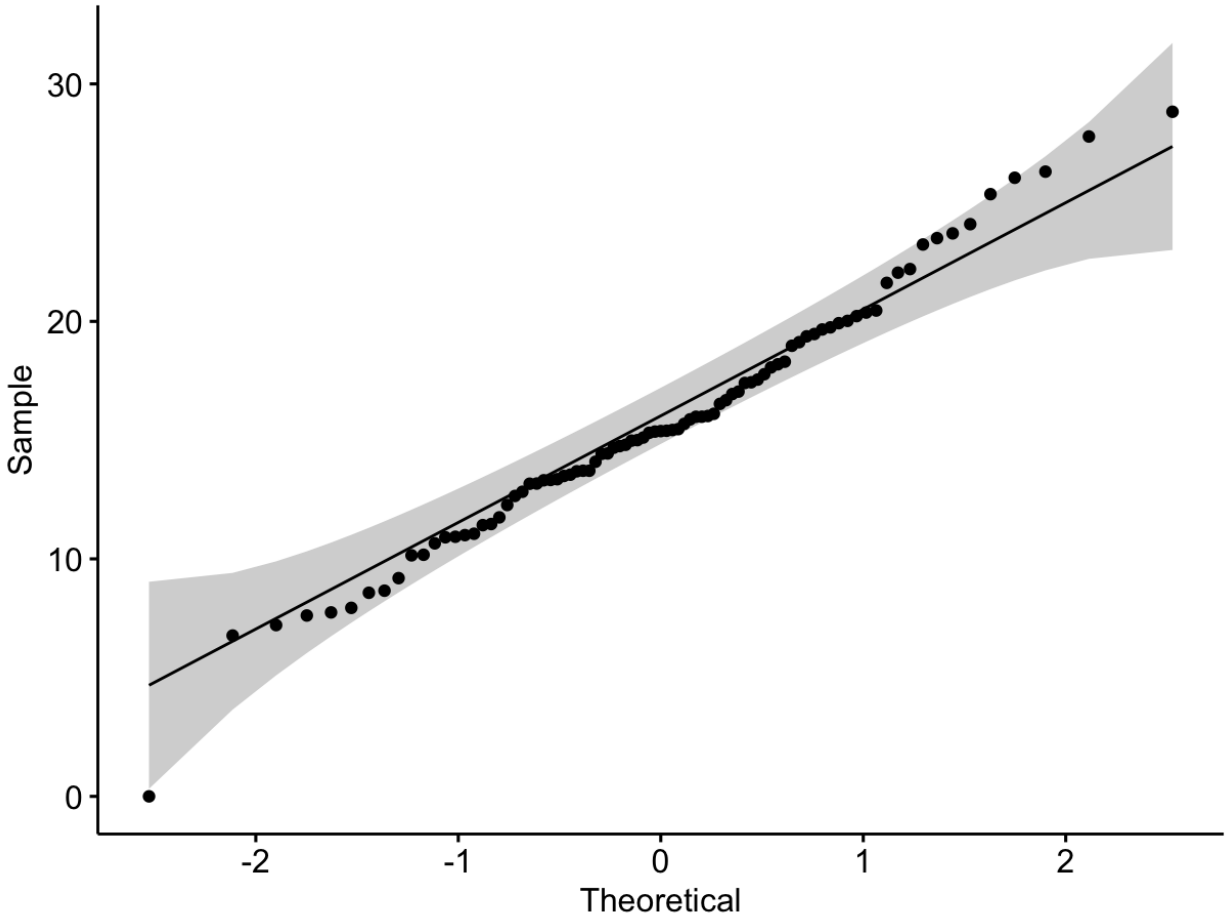
Appendix J

Density Plot – Square root of social media screen time on all devices

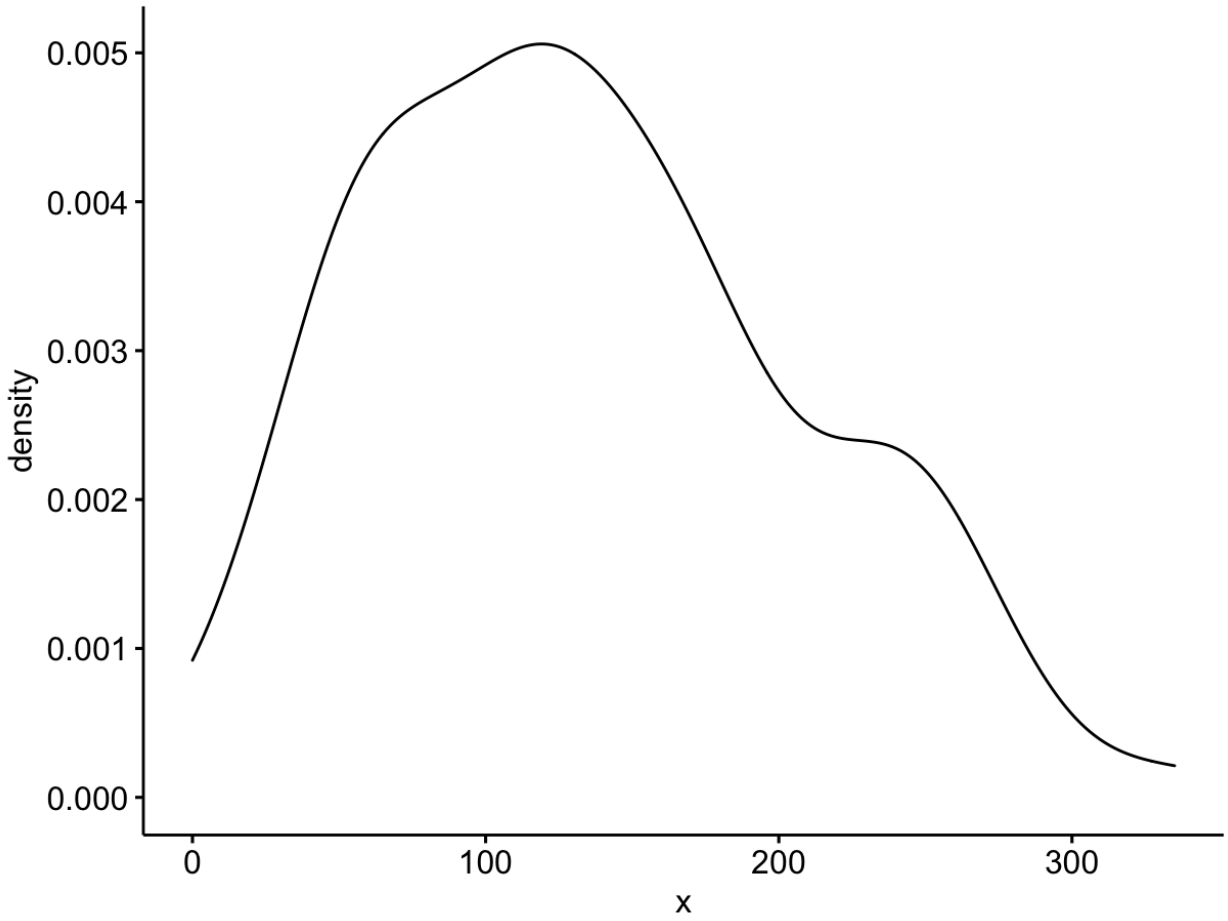


Appendix K

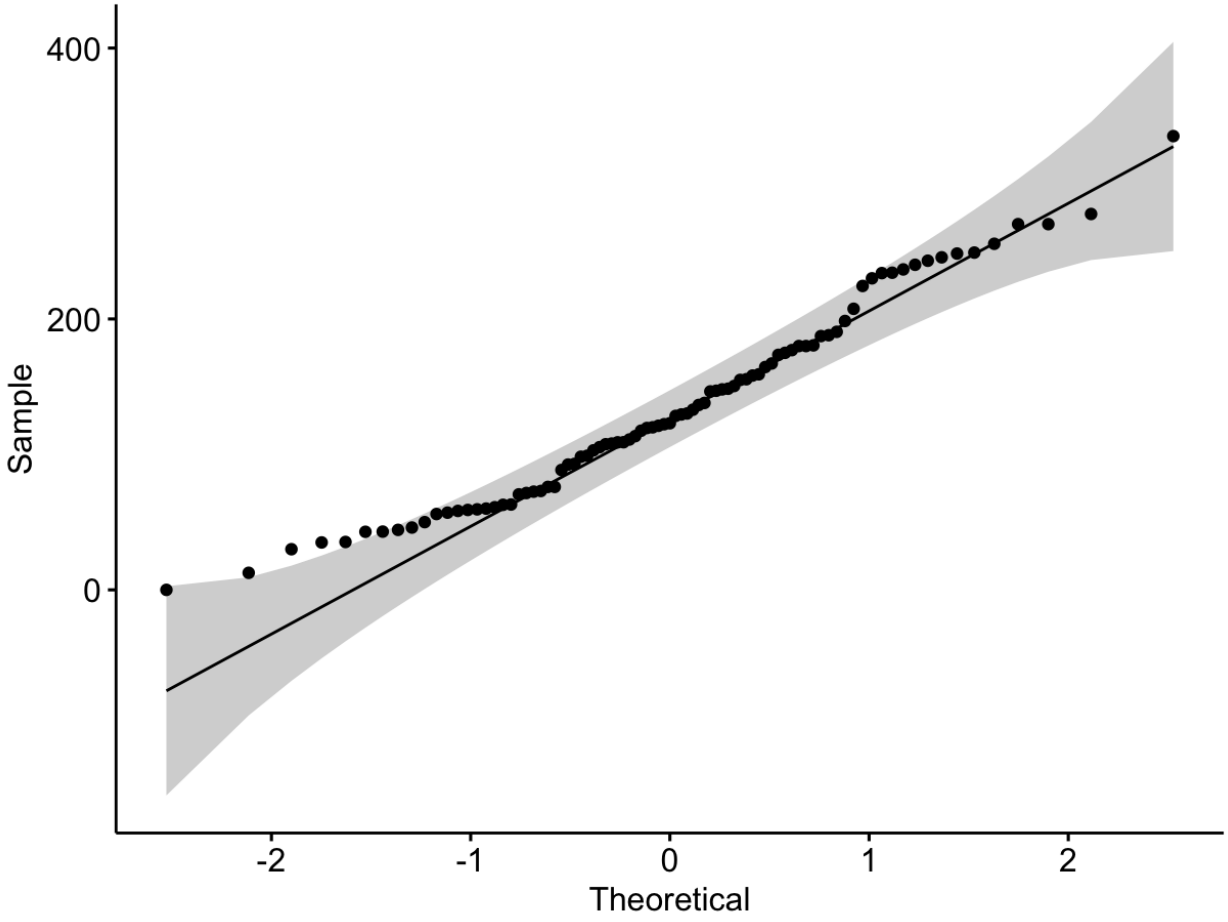
q.q. plot – Square root of Social media screen time on all devices Square root



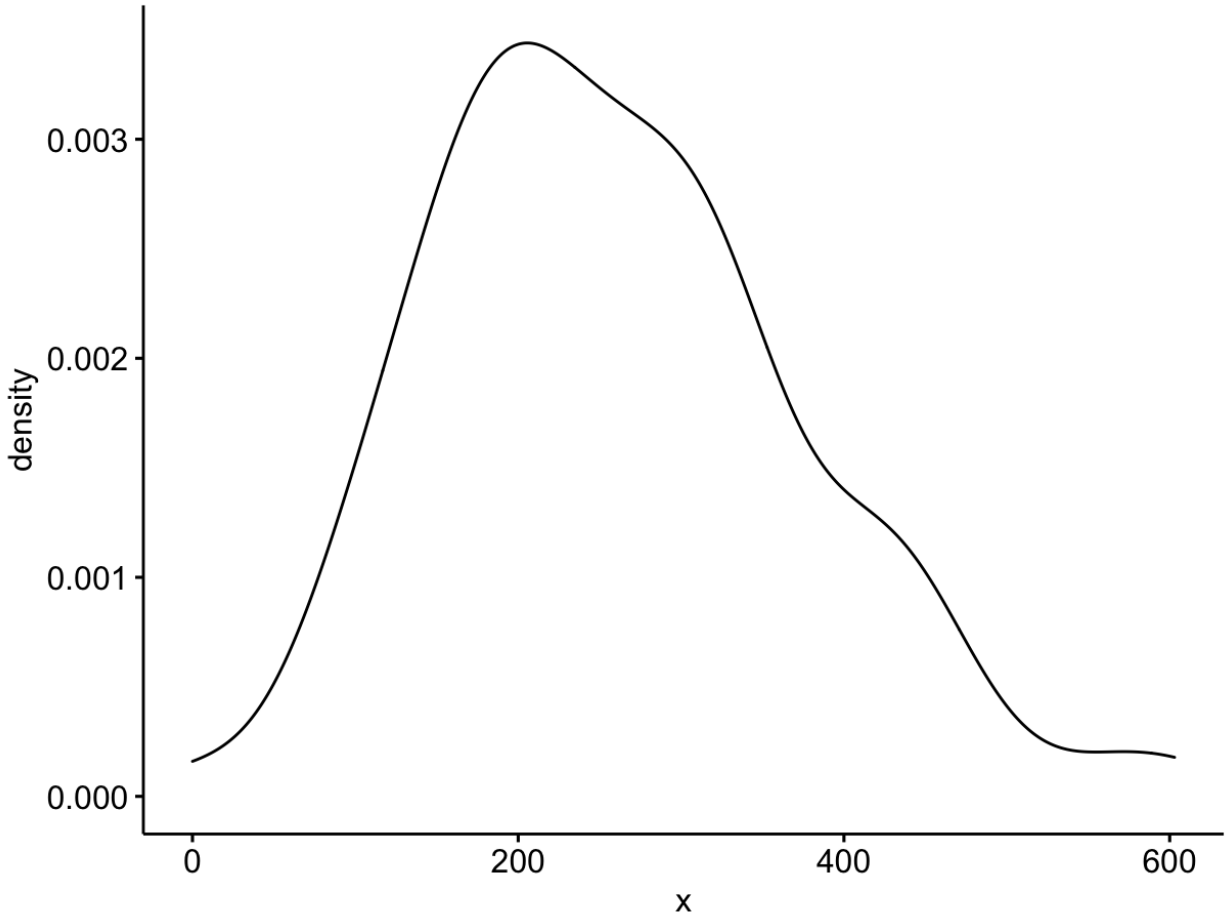
Appendix L
Density Plot - Smartphone Social Media



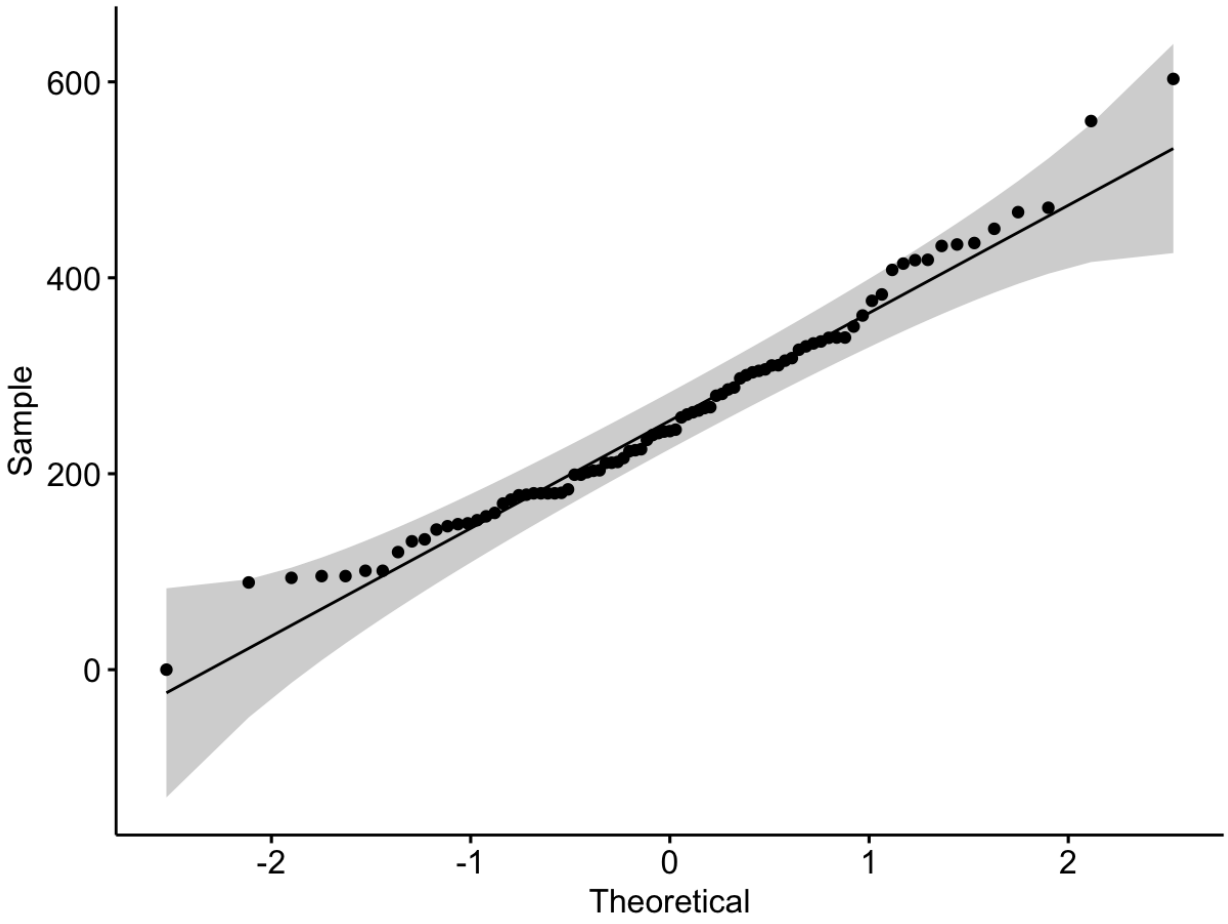
Appendix M
q.q. Plot - Smartphone Social Media



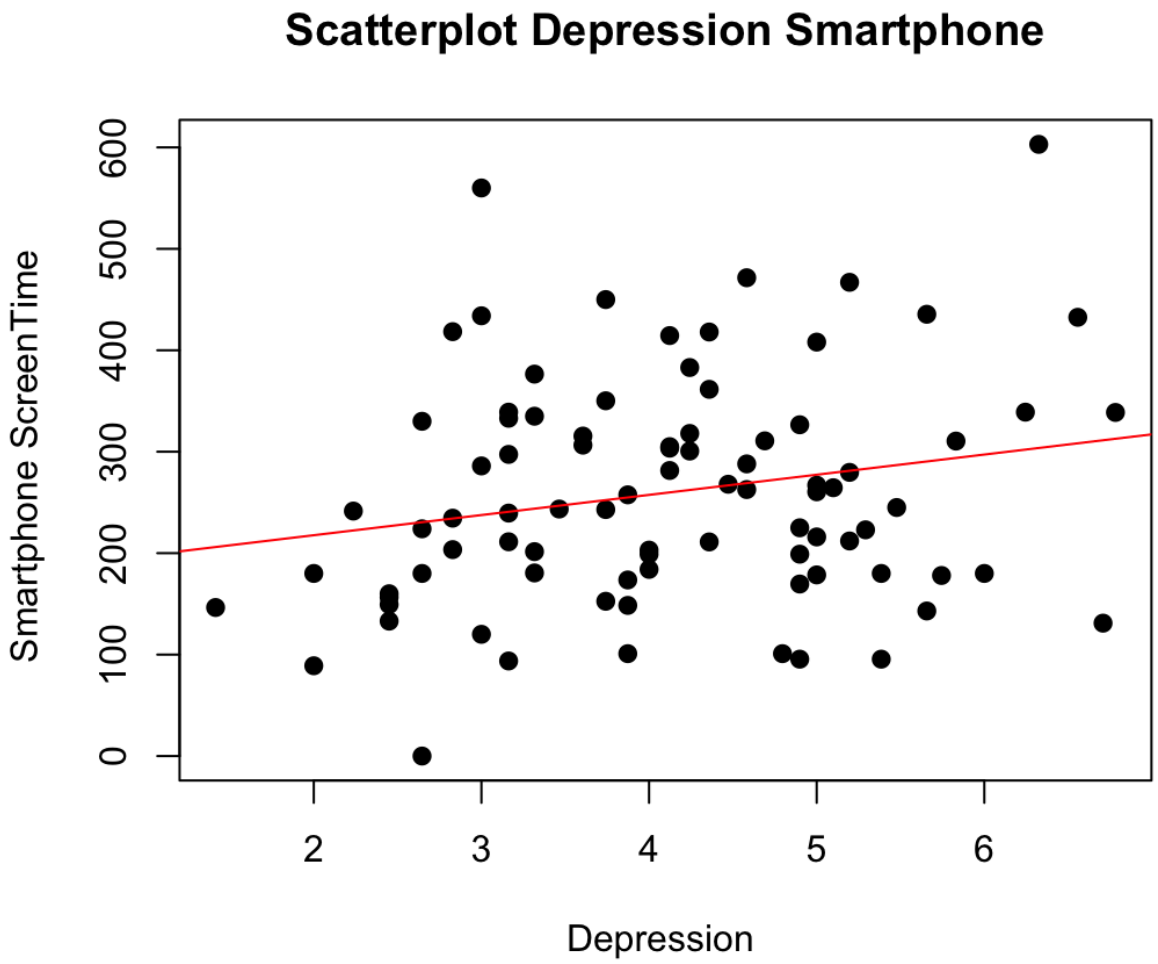
Appendix N
Density Plot - total smartphone screen time



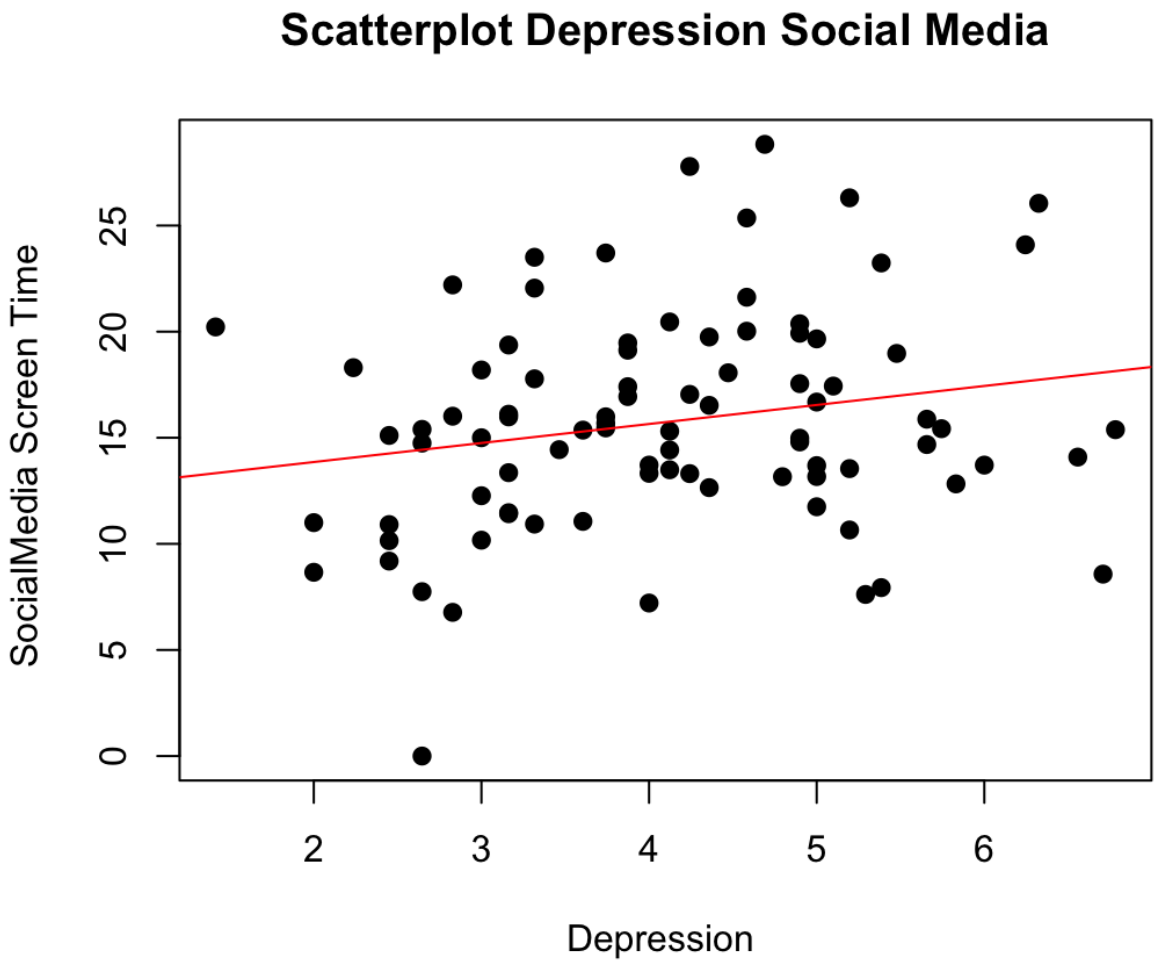
Appendix O
q.q. plot - total smartphone screen time



Appendix P
Scatterplot – Depression X Smartphone Screen Time



Appendix Q
Scatterplot – Depression X Social Media screen time



Appendix R

Scatterplot – Depression X Social Media Smartphone Screen time