The correlation between smartphone usage and depression, mental health and behavioral health

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Introduction and Background

Topic

Our central question we are trying to answer is, how does the relationship between smartphone / social media use and levels of depression, social interactions, and behaviors affect various demographics? Studies have shown that excessive use of smartphones and social media platforms can contribute to feelings of depression and anxiety, particularly among certain demographic groups. For example, adolescents and young adults may be more susceptible to the negative effects of social media due to peer comparisons and cyberbullying, while older adults may experience social isolation if digital communication replaces face-to-face interactions. Studies have also shown that behavioral health is highly affected by excessive smartphone use, such as disrupted sleep patterns, increased screen time, and reduced physical activity. Understanding how these behaviors manifest in different demographics can help psychologists, therapists, and researchers develop strategies to address these needs.

Dataset

Korea Youth Risk Behavior Survey Data Set:

Variable name	**Variable type**	**Description**
Usage	character	Screen time on smartphones grouped by measures of time (hours) determined by the survey
Stress Perception	double	Odds ratio of participants who felt stressed *also recorded as a percentage
Dissatisfaction with sleep	double	Odds ratio of participants who felt dissatisfied with their sleep *also recorded as a percentage
Depressive Symptoms	double	Odds ratio of participants who experience depressive symptoms *also recorded as a percentage
Suicidal Ideation	double	Odds ratio of participants who have suicidal ideation *also recorded as a percentage
Suicidal Plan	double	Odds ratio of participants who have a plan to commit suicide *also recorded as a percentage
Suicide Attempt	double	Odds ratio of participants who have attempted suicide *also recorded as a percentage

Alcohol, Smoking	double	Odds ratio of substance use (alcohol, Smoking) *also recorded as a percentage
Smartphone Overdependence	double	Odds ratio of participants who have a Smartphone Overdependence *also recorded as a percentage
Obesity	double	Odds ratio of participants who are obese *also recorded as a percentage
Day_type	character	Weekday, weekend, daily average, smartphone overdependence
Time on smartphone	character	0-2 hours per day, 2-4 hours per day, 4 or more hours per day
2017 Count(n = 61861)	double	Total number of participants in the survey in 2017
2020 Count (n = 54809)	double	Total number of participants in the survey in 2020

Lebanese University Students Data Set:

Variable name	**Variable type**	**Description**
ExcessveSmrtPhn_use	double	Excessive Smartphone usage
Rstlss_NoSmrtphn	double	Restlessness without smartphone
DcreasdSlpTimeQualty_SmrtPhnUse	integer	Decreased Sleep time quality due to smartphone Use
TotAddiction_Score	integer	Total addiction score
AGE	integer	Age of the participant in the survey
Gender	double	Gender of the participants in the survey
Class	double	Year in college of the participant in the survey
Prsnlty_type	integer	Personality type of the participant in the survey
Smoking, Alcohol_drnk,	integer	Habits of the participant in the survey(smoking, alcohol consumption, religious practices)

Rlgn_Prctes		
AgeStrt_useSmrtPhne	double	Age when the participant started using smartphones
How participants use smartphones	integer	CallFamMem, CallFrnds, Txtng, Entertainment, RdNews, OthRsns, Study_Purposes
Mental/behavior health survey data	integer	SmrtPhnUse_MreTmeMny, SlptLss4HrsMreTh1_SmrtPhnUse, SameTmeIntrnt_Ngtv_Relations UpstStp_SmrtPhnUse, RcntSigIncTime_SmrtPhnUseWk, FailCntrlImplse_smrtphnUse, FavorSmrtPhn_SpndTimefrnds, PainBckEye_ExcSmrtPhnUse, FrstThghtSmrtphnUse_WakeUp NgtveSchlJob_SmrtPhnUse, MissStp_SmrtPhnUse, DcreasdFmlyIntrction_SmrtPhnUse, DcreasdHobbies_SmrtPhnUse, UrgeSmrtPhnUse_OnceStpUse, LifeJoylss_NoSmrtPhn, NgtvePhysHlthEffcts_SmrtPhnUse, Spnd_LsstimeSmrtPhn_EffortsUselss, DcreasdSlpTimeQulty_SmrtPhnUse, IncrsdTimeSmrtPhnUse_SameSatsfction, CannotHveMeal_NosmrtPhn, TiredDaytime_latenightSmrtPhnUse
Compulsive_Behavior	integer	Participants who felt they have a Compulsive Behavior to use their smartphones
Functional_Impairment	integer	Participants who feel they have a Functional Impairment without their smartphones
Withdrawal	integer	Participants who feel they have withdrawal symptoms without their smartphones
Tolerance	integer	Participants diminished response to smartphones as a result of repeated use. (they can go less time without their smartphones)
depression	integer	Lttl_IntrstDoingThngs,Feel_Deprssd,Depression_score,

/anxiety results		Feel_anxious,NotAble_Stpworry,Anxiety_score

Research Questions

Which demographics of people have the highest rates of depression and does it correlate with high cellphone usage?

Is the problem getting worse? Are there more people experiencing these addictions than there were a few years ago?

How much screen time is okay before things start to become a problem?

What are the health risks associated with excessive smartphone and social media use and how does this impact different demographic groups in terms of social interactions and behaviors?

Relevant Research / Findings

A study conducted by Jong Ho Cha, Young-Jin Choi, Soorack Ryu, and Jin-Hwa Moon titled, “Association between smartphone usage and health outcomes of adolescents: A propensity analysis using the Korean Youth risk behavior survey” (2020) looked at the “association between smartphone use and adverse behavioral health outcomes using nationwide Korea Youth Risk Behavior Web-based Survey data for 2017 and 2020.” The study was conducted over three years and had over 54 thousand participants, mostly middle and high school students with an average of 15.5 years old. At the end of the survey, they analyzed the relationships between daily screen time usage with bins of 0-2 hours, 2-4, 4-6, 6-8, and 8 + hours per day. They used these to see the relationship between health outcomes such as stress, sleep depression, suicide, substance use, and smartphone overdependence.

A conducted by Matar Boumosleh and Daniel Jaalouk (2017) on University Students at a school in Lebanon, explored the relationship between excessive smartphone usage, addiction metrics, and mental health outcomes among university students. The study found a significant association between excessive smartphone usage and symptoms of depression and anxiety among university students. This suggests that students who reported spending more time on their smartphones were more likely to experience higher levels of depression and anxiety. The researchers used the Smartphone Addiction Inventory (SPAI) Scale to measure smartphone addiction among participants. They found that higher scores on the SPAI Scale, indicating greater levels of smartphone addiction, were correlated with higher levels of depression and anxiety. The study looked at 688 college students, around 20 years old on average, and found they typically started using smartphones at about 15. Nearly half admitted to using smartphones

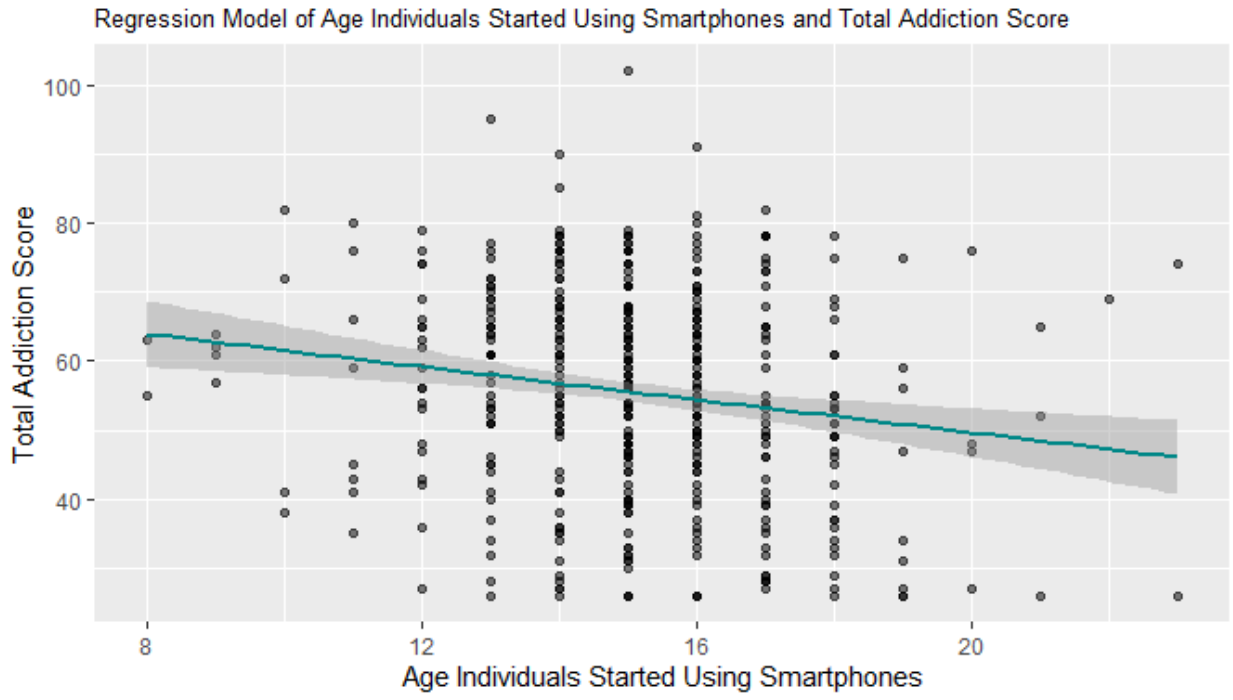
too much, often for texting, entertainment, and calling friends. Many showed signs of being hooked on their phones, like compulsive use and reduced functioning when not using them. The total score measuring smartphone addiction was higher among junior students. Using statistical analysis, the study found that depression and anxiety, along with age, personality type, excessive phone use, not calling family, and using phones for fun, were all linked to smartphone addiction. Spending lots of time on phones had the strongest link, followed by depression and anxiety.

Exploratory Data Analysis

To answer our first research question, which demographics of people have the highest rates of depression and does it correlate with high cellphone usage? We looked at data from the Lebanese university students and observed the relationship between the age in which students started using their smartphones and their total addiction score. As seen in Figure 1, we can see there is a slightly negative correlation between the age in which a person started using their smartphone and their total addiction score.

Figure 1

Linear regression model of the age in which individuals started using their smartphone vs total addiction score.



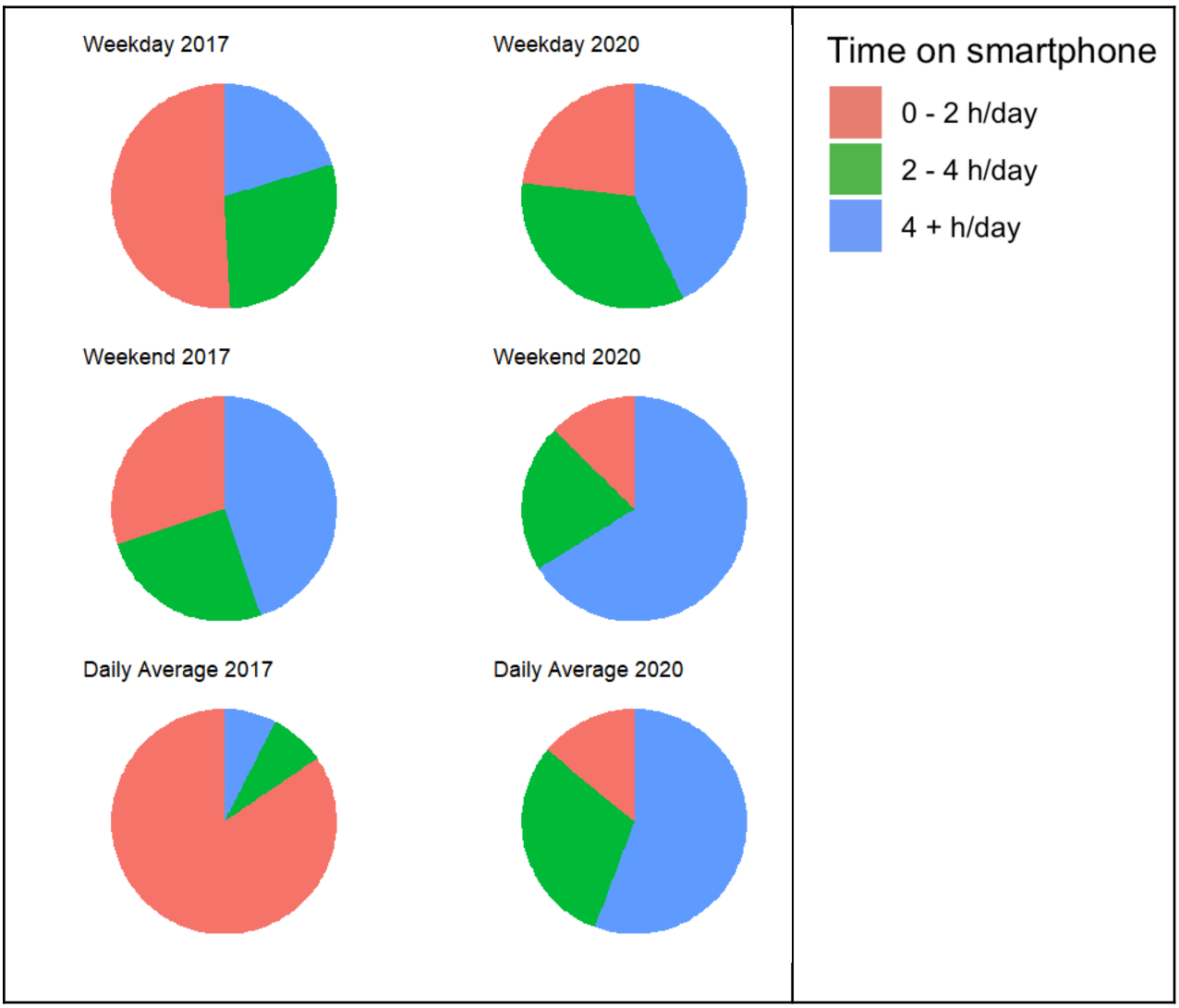
This linear regression model of the age individuals started using smartphones, and their total addiction score is negatively correlated, meaning that the earlier a person started using their smartphone the higher levels of addiction they exhibit according to the survey data. This suggests that younger individuals who have been using their smartphones for longer periods of

time compared to older individuals have worse outcomes as measured by the SIAP total addiction score. We can use this model to predict the likelihood of a person having high addiction depending on the age in which they started using their smartphone.

To answer our second research question, is the problem getting worse? Are there more people experiencing these addictions than there were a few years ago? We used our data from the Korean youth risk behavior survey in which we see how individuals have increased their screen time between the years of 2017 and 2020 substantially. As depicted in Figure 2 we see how the amount of screen time has increased between 2017 and 2020. The size of each section in the pie plot represented the number of students whom belong to each

Figure 2

Pie plots by the number of students spending time who reported their screen time in 2017 and 2020

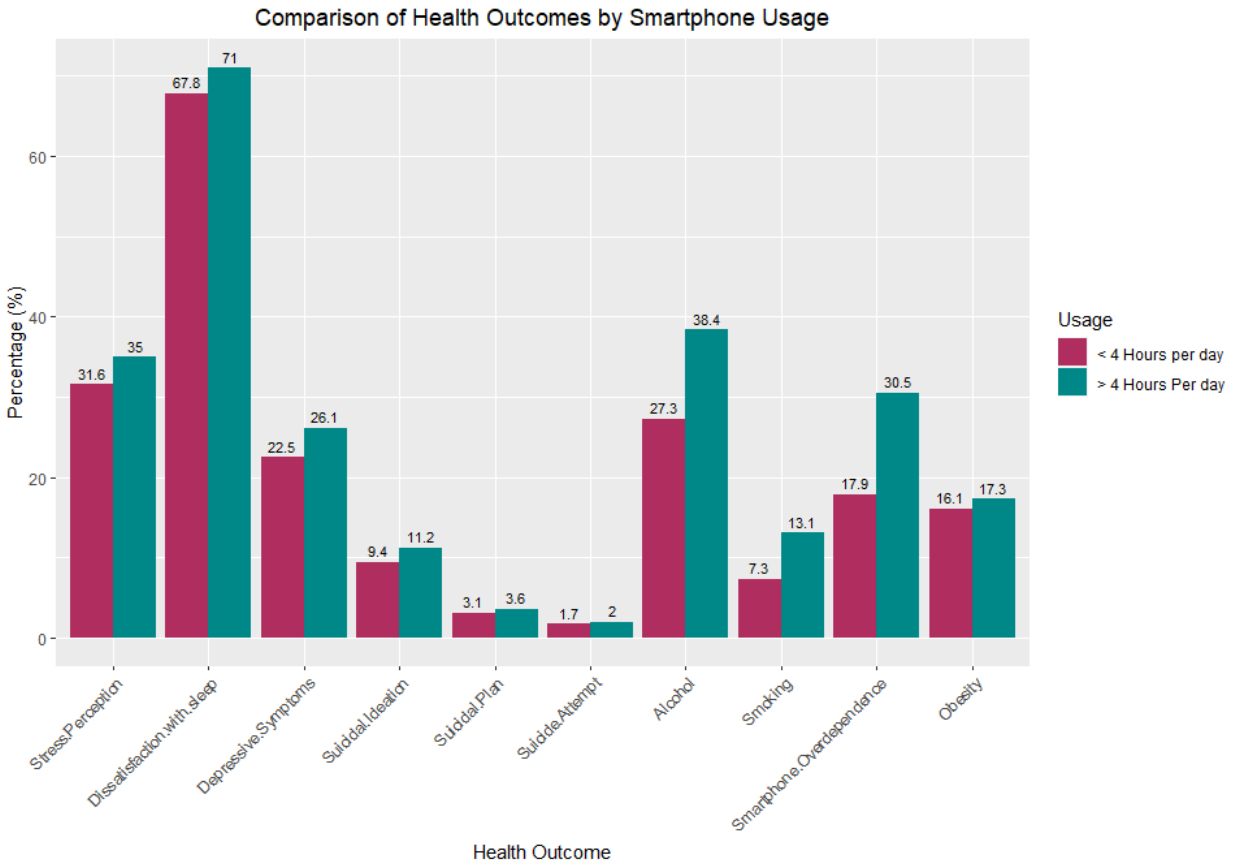


From 2017 to 2020, there was a big jump in how much teens were glued to their phones, even on school nights and weekends. The number of teens spending over 2 hours a day on their phones shot up from 64.3% to 85.7%. On the flip side, those sticking to the recommended limit of less than 2 hours dropped from 35.7% to just 14.4%. What's worrying is that in 2020, 25.5% of teens said they were overly dependent on their smartphones, showing a trend we should be paying attention to, we can see that in the Daily Average pie graph for four plus hours per day.

To answer our third research question, how much screen time is okay before things start to become a problem, we used our data from the Korean youth risk behavior survey in which they quoted 4 hours as an inflection point where screen time starts to become a problem. Based on their research the study looked at how health differs between people who use smartphones for more than 4 hours a day versus those who use them less. It found that the heavy smartphone users had higher rates of mental health issues, substance use problems, and obesity. They were more likely to feel stressed out, have trouble sleeping, feel down, and think about suicide. Also, they tended to drink alcohol more, depend too much on their smartphones, and be obese. Even after they tried to balance things out with propensity score matching (PSM), the connections between smartphone use and health problems were still there. As seen in Figure 3, we can see the percentages of individuals who experienced specific behavioral outcomes and how individuals were more likely to experience these as a result of spending more time on their smartphones.

Figure 3

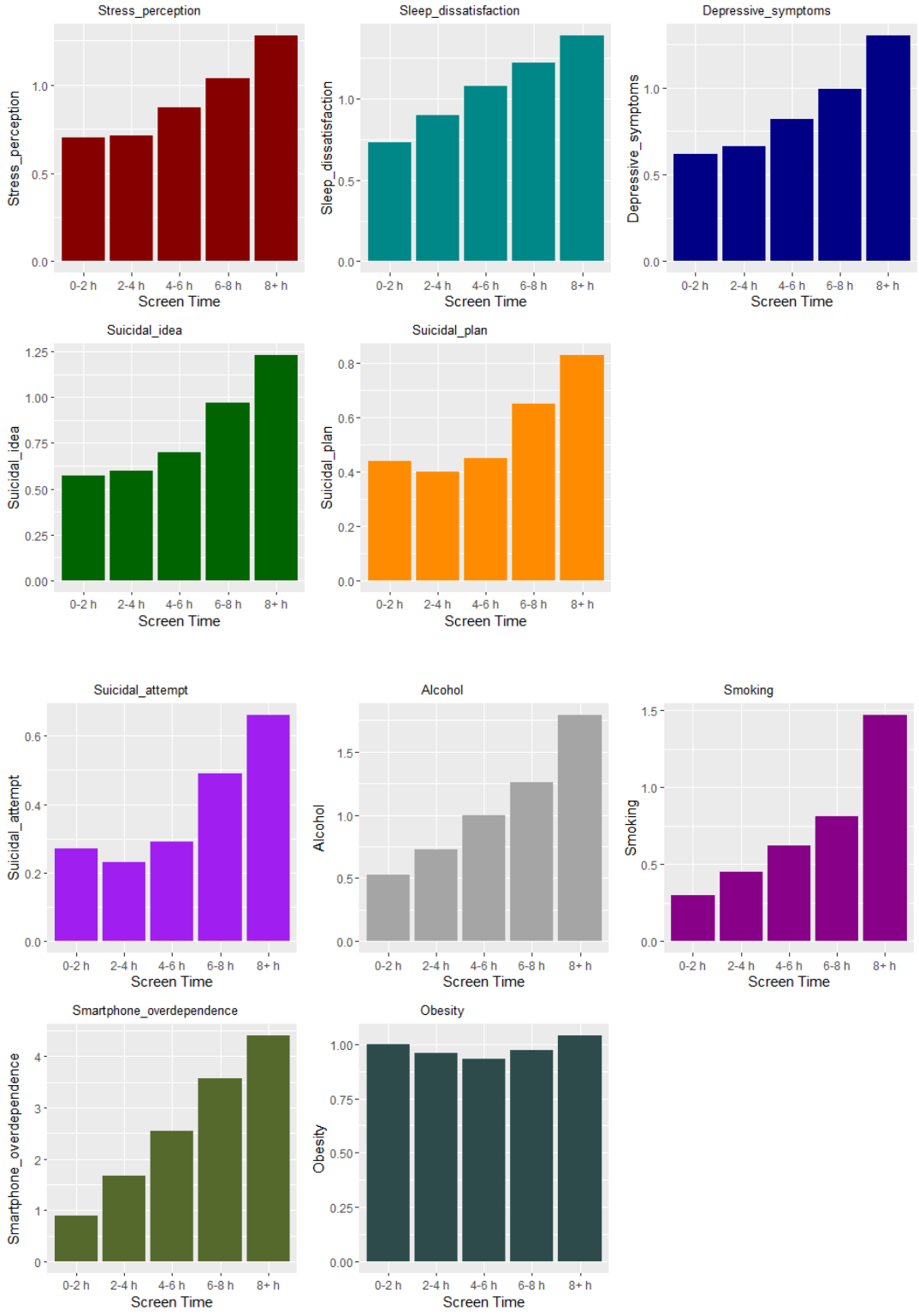
Comparative bar graphs for each of the Health Outcome values by less than four hours and more than four hours.



To expand upon our third research question we looked at the health issues in more detail to show the breakdown of screen time and smartphone usage by 2-hour bins. Those who used their phones for less than 2 hours a day had lower chances of feeling stressed, having trouble sleeping, feeling down, thinking about suicide, or using substances compared to those who didn't use smartphones. This trend continued for those using smartphones for 2-4 hours daily. But once usage went beyond 4-6 hours, the chances of these health problems tended to go up. One interesting thing is that the more time spent on smartphones, the more likely someone was to become overly dependent on their phone, and this relationship went up in a straight line. However, the link between smartphone use and obesity wasn't always clear in all groups.

Figure 4

Bar graphs for each health issue comparing screen time (by two-hour bins, x-axis) by the health issues odds ratio(y-axis).



Inferential Analysis

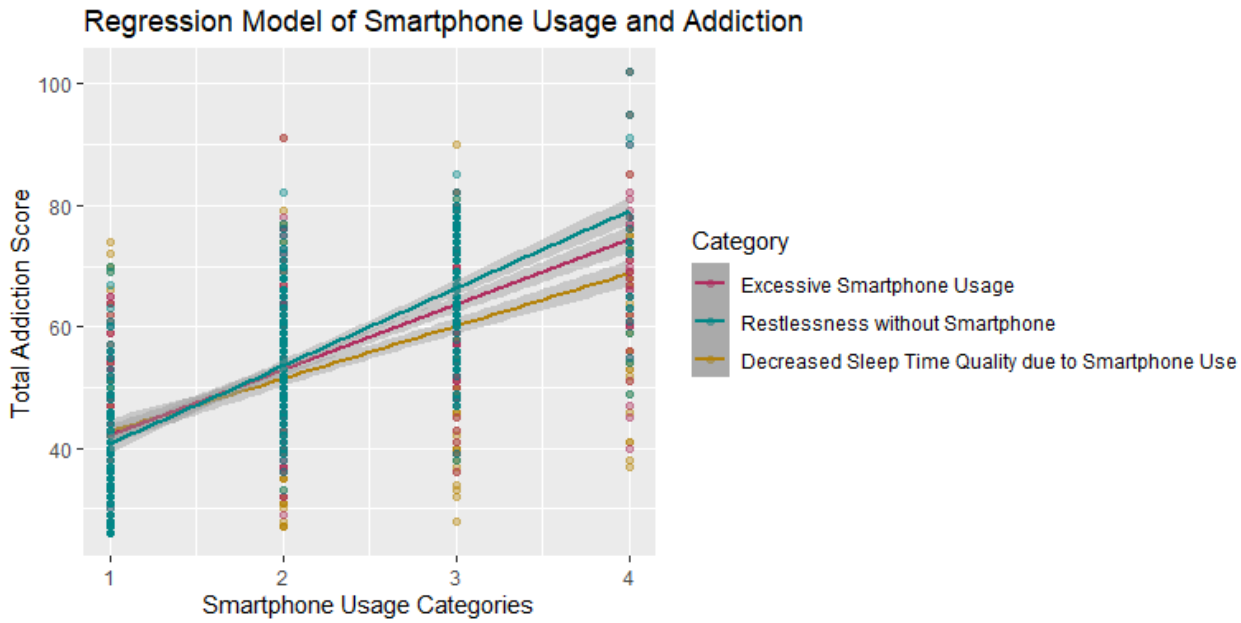
Findings

Boumosleh's (2017) study on university students in Lebanon provided the data to explore how excessive smartphone usage relates to addiction and mental health. The study revealed a strong link between spending a lot of time on smartphones and experiencing depression and anxiety. Those who used their phones more tended to have higher levels of depression and anxiety. The researchers used the Smartphone Addiction Inventory (SPAI) Scale to measure smartphone addiction and found that higher scores on the scale were connected to increased levels of depression and anxiety.

To answer our fourth research question, what are the health risks associated with excessive smartphone and social media use, we decided to create a linear regression model to test a variety of features in our data which we thought would have a strong correlation with addiction, the columns we chose from our data set were, excessive smartphone usage, restlessness symptoms without a smartphone, and decreased sleep time, and quality due to smartphone use.

Figure 5

Linear regression model of smartphone usage categories and addiction score



Why we chose our model

We chose a linear regression model because our data has categorical data represented on a scale from 1 to 4 where 1 is the least extreme, and 4 is the most. We can interpret this as higher levels of X_i leads to higher levels in our Response Variable Y.

Given our response Y and our predictors $X_1, , X_p$ where,

$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \epsilon$ and,

$\epsilon \sim N(O, \sigma^2)$

β_0 is the intercept. β_1 is ExcessveSmrtPhn_Use β_2 is Rstlss_NoSmrtphn β_3 is DcreasdSlpTimeQulty_SmrtPhnUse

What is the model and what are X and Y

The model is a linear regression model that predicts the total addiction score (y) based on one or more independent variables (x), such as excessive smartphone usage, restlessness without a smartphone, and decreased sleep time quality due to smartphone use.

X is our Independent Variable, where Y is our Dependent Variable, or Response Variable.

Interpreting our parameters

β_0, the intercept is 13.8067, meaning when our β_i's are 0 we expect the value of our Total addiction score to be 13.8. β_1, ExcessveSmrtPhn_Use, has a slope coefficient of 3.2675. β_2, Rstlss_NoSmrtphn, has a slope coefficient of 6.2581. β_3, DcreasdSlpTimeQulty_SmrtPhnUse, has a slope coefficient of 9.1674.

Hypothesis testing

For each of our variables, we can get the information from hypothesis testing from the summary here:

Hypothesis testing for linear regression models relies on the following assumptions:
The data is linear, meaning there should be a linear relationship between the independent variable (smartphone usage categories) and the dependent variable (total addiction score). Each of our observations in our sample size are independent of one another, the distribution of the errors are normally distributed, and the variance of errors should be equal or constant.

Figure 6

Summary Statistics for our Linear Regression model

```
Call:
lm(formula = as.numeric(TotAddiction_Score) ~ as.numeric(ExcessveSmrtPhn_Use) +
    as.numeric(Rstlss_NoSmrtphn) + as.numeric(DcreasdSlpTimeQulty_SmrtPhnUse),
    data = wdata, na.action = na.exclude)

Residuals:
     Min       1Q   Median       3Q      Max
-25.4707  -5.0014  -0.0699   4.8364  22.6955

Coefficients:
                                        Estimate Std. Error t value Pr(>|t|)
(Intercept)                              13.6330     1.1687  11.665   <2e-16 ***
as.numeric(ExcessveSmrtPhn_Use)           3.8259     0.3954   9.675   <2e-16 ***
as.numeric(Rstlss_NoSmrtphn)              6.1905     0.4083  15.163   <2e-16 ***
as.numeric(DcreasdSlpTimeQulty_SmrtPhnUse)  8.6597     0.4419  19.599   <2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 7.341 on 456 degrees of freedom
  (228 observations deleted due to missingness)
Multiple R-squared:  0.7644,    Adjusted R-squared:  0.7628
F-statistic: 493.2 on 3 and 456 DF,  p-value: < 2.2e-16
```

Each of our factors is being tested against the dependent variable of the Total addiction score, and we can set up the H_0 and H_A as the following: $H_A^* = H_0^*$, the alternative hypothesis does not propose a different effect, relationship, or outcome compared to what the null hypothesis states. $H_A^* \neq H_0^*$, means our independent variables have a statistically significant effect on the dependent variable. For each of our tests, we have the following results:

1. β_1, ExcessveSmrtPhn_Use has a p value of 6.65e-09, and thus we can reject H_0 in favor of H_A. The slope coefficient of β_1 is 3.82, which suggests that the relationship between excessive smartphone use and the total addiction score is positive meaning as the value of excessive smartphone use increases so does the total addiction score.

2. β_2, Rstlss_NoSmrtphn, has a p value of \< 2e-16, and thus we can reject H_0 in favor of H_A. The slope coefficient of β_2 is 6.19, which suggests that the relationship between restlessness without smartphones and the total addiction score is positive meaning as the value of restlessness without smartphones increases so does the total addiction score.

3. β_3, DcreasdSlpTimeQulty_SmrtPhnUse, has a p value of \< 2e-16, and thus we can reject H_0 in favor of H_A. The slope coefficient of β_3 is 8.66, which suggests that the

relationship between decreased sleep quality and the total addiction score is positive meaning as the value of decreased sleep quality increases so does the total addiction score.

4. Finally the p value for our combined linear regression model with each parameter is \< 2.2e-16, and thus we can reject H_0 in favor of H_A.

Conclusions and Future Questions

In conclusion, our study looked at how using smartphones and social media affects mental health and behaviors across different groups. We found that spending too much time on smartphones can lead to higher levels of depression and anxiety, especially among young people like adolescents and college students. Older adults might also feel lonely if they rely too much on digital communication. Our research showed that more and more young people are using smartphones excessively, which is linked to problems like stress, sleep issues, and substance use. We also found that factors like using phones too much, starting smartphone use at a young age, and having depression or anxiety were linked to smartphone addiction. This information can help experts develop ways to promote healthier smartphone use and reduce its negative impact on mental health.

Some things we were interested in learning more about with future research are the relationship between smartphone use across each state along with the median household income for each state, and to see the changes over a decade. A second idea we were interested in studying, had we been given relevant data to support the argument, is to explore the changes in different demographics of people's social connectedness as a result of smartphone addiction. Seeing articles about how younger generations, like Gen-Z and Gen-Alpha, are the most introverted and socially isolated generations compared to their predecessors; and how strongly the younger generations' smartphone addictions correlated with their social connectedness, virginity rates, and academic excellence.

A limitation of our analysis was that we could not find any data for our research topic conducted in the United States. With data from the United States, we could have merged other data sets to find other correlations with a common variable (states). There were missing data points for the Lebanon University students data set and for the Korean data set the total sample size was slightly smaller from 2017 to 2020 at about a 12% difference which could have skewed the results. Information about the type of technology used (e.g. smartphone, computer, TV, gaming) to get the total picture of screen time because not everyone is only using their smartphones.

References

Cha, J. H., Choi, Y. J., Ryu, S., & Moon, J. H. (2023). Association between smartphone usage and health outcomes of adolescents: A propensity analysis using the Korea youth risk behavior survey. *PloS one*, 18(12), e0294553. https://doi.org/10.1371/journal.pone.0294553

Matar Boumosleh J, Jaalouk D (2017) Depression, anxiety, and smartphone addiction in university students- A cross sectional study. *PloS one* 12(8): e0182239. https://doi.org/10.1371/journal.pone.0182239

Code Appendix

Figure 1 code block:

```r
```{r, fig.height = 7, fig.width = 10, warning=FALSE}
h <-
"https://raw.githubusercontent.com/ryanfernald/MATH167R-Final-Project/main/
DATA/Percentages%20stats%20health%20outcomes.csv"
data <- read.csv(h)

data_long <- data |>
  pivot_longer(cols = -Usage,
               names_to = "Health_Outcome",
               values_to = "Percentage")

data_long$Health_Outcome <- factor(data_long$Health_Outcome,
                                   levels =
unique(data_long$Health_Outcome))

ggplot(data_long, aes(x = Health_Outcome,
                      y = Percentage,
                      fill = Usage,
                      label = Percentage)) +
  geom_bar(stat = "identity",
           position = "dodge") +
  geom_text(position = position_dodge(width = 0.9),
            size = 3, vjust = -0.5) +  # Add labels directly on top of bars
with dodge position
  scale_fill_manual(values = c("< 4 Hours per day" = "maroon",
                               "> 4 Hours Per day" = "darkcyan")) +
  labs(
    title = "Comparison of Health Outcomes by Smartphone Usage",
    x = "Health Outcome",
    y = "Percentage (%)"
  ) +
  theme(
    axis.text.x = element_text(angle = 45, hjust = 1),
    plot.title = element_text(hjust = 0.5)
  )
```
```

Figure 2 code block:

```
```{r, warning=FALSE, fig.height = 4, fig.width = 8}
w <-
"https://raw.githubusercontent.com/ryanfernald/MATH167R-Final-Project
/main/DATA/Depression%2C%20anxiety%2C%20and%20smartphone%20addiction%
20in%20university%20students-%20A%20cross%20sectional%20study.csv"
wdata <- read.csv(w)
wdata[wdata == "."] <- NA

ggplot(wdata, aes(y = as.numeric(TotAddiction_Score),
                  x = as.numeric(ExcessveSmrtPhn_Use))) +
  geom_point(aes(color = "maroon"), alpha = 0.4) +
  geom_smooth(aes(color = "maroon"), method = "lm") +

  geom_point(aes(x = as.numeric(Rstlss_NoSmrtphn),
                 color = "darkcyan"), alpha = 0.4) +
  geom_smooth(aes(x = as.numeric(Rstlss_NoSmrtphn),
                  color = "darkcyan"), method = "lm") +

  geom_point(aes(x = as.numeric(DcreasdSlpTimeQulty_SmrtPhnUse),
                 color = "darkgoldenrod"), alpha = 0.4) +
  geom_smooth(aes(x = as.numeric(DcreasdSlpTimeQulty_SmrtPhnUse),
                  color = "darkgoldenrod"), method = "lm") +

  labs(
    title = "Regression Model of Smartphone Usage and Addiction",
    x = "Smartphone Usage Categories",
    y = "Total Addiction Score",
    color = "Category"
  ) +
  scale_color_manual(values = c("maroon", "darkcyan",
"darkgoldenrod"),
                     labels = c("Excessive Smartphone Usage",
                                "Restlessness without Smartphone",
                                "Decreased Sleep Time Quality due to
Smartphone Use")) +
  theme(legend.position = "right")
```
```

Figure 3 code block:

```
```{r, warning=FALSE, fig.height = 4, fig.width = 7}
w <-
"https://raw.githubusercontent.com/ryanfernald/MATH167R-Final-Project
/main/DATA/Depression%2C%20anxiety%2C%20and%20smartphone%20addiction%
20in%20university%20students-%20A%20cross%20sectional%20study.csv"
wdata <- read.csv(w)
wdata[wdata == "."] <- NA

ggplot(wdata, aes(x = as.numeric(AgeStrt_useSmrtPhne),
                  y = as.numeric(TotAddiction_Score))) +
  geom_point(alpha = 0.5) +
  geom_smooth(method = "lm", color = "darkcyan")+
  labs(
    title = "Regression Model of Age Individuals Started Using
Smartphones and Total Addiction Score",
    x = "Age Individuals Started Using Smartphones",
    y = "Total Addiction Score"
  ) +
  theme(plot.title = element_text(size=9.5))
```
```

Figure 4 code block:

```
```{r, fig.height = 8, fig.width = 7}
df <-
read_csv("https://raw.githubusercontent.com/ryanfernald/MATH167R-Fina
l-Project/main/DATA/Student%20usage%20time%20adolescence.csv")

df <- df[,-c(4,6)]
df <- df[1:(nrow(df)-1), ]
names(df)[3] <- "count2017"
names(df)[4] <- "count2020"

Weekday_df <- head(df, 3)

Weekend_df <- df[4:6, ]

Daily_avg <- df[7:9, ]
```
```

```
wk2017_pie <- ggplot(Weekday_df, aes(x = "", y = count2017, fill =
`Time on smartphone`)) +
  geom_bar(stat = "identity", width = 1, show.legend = FALSE) +
  coord_polar("y") +
  theme_minimal() +
  theme_void() +
  labs(title = "Weekday 2017")

wk2020_pie <- ggplot(Weekday_df, aes(x = "", y = count2020, fill =
`Time on smartphone`)) +
  geom_bar(stat = "identity", width = 1, show.legend = FALSE) +
  coord_polar("y") +
  theme_minimal() +
  theme_void() +
  labs(title = "Weekday 2020")

we2017_pie <- ggplot(Weekend_df, aes(x = "", y = count2017, fill =
`Time on smartphone`)) +
  geom_bar(stat = "identity", width = 1, show.legend = FALSE) +
  coord_polar("y") +
  theme_minimal() +
  theme_void() +
  labs(title = "Weekend 2017")

we2020_pie <- ggplot(Weekend_df, aes(x = "", y = count2020, fill =
`Time on smartphone`)) +
  geom_bar(stat = "identity", width = 1, show.legend = FALSE) +
  coord_polar("y") +
  theme_minimal() +
  theme_void() +
  labs(title = "Weekend 2020")

da2017_pie <- ggplot(Daily_avg, aes(x = "", y = count2017, fill =
`Time on smartphone`)) +
  geom_bar(stat = "identity", width = 1, show.legend = FALSE) +
  coord_polar("y") +
  theme_minimal() +
  theme_void() +
  labs(title = "Daily Average 2017")
```

```
da2020_pie <- ggplot(Daily_avg, aes(x = "", y = count2020, fill =
`Time on smartphone`)) +
  geom_bar(stat = "identity", width = 1, show.legend = FALSE) +
  coord_polar("y") +
  theme_minimal() +
  theme_void() +
  labs(title = "Daily Average 2020")

plot_grid(wk2017_pie, wk2020_pie, we2017_pie, we2020_pie,da2017_pie,
da2020_pie, ncol=2)
```

Figure 5 code block:

```
```{r, fig.height = 7, fig.width = 10, warning=FALSE}
colors <- c("darkred", "darkcyan", "darkblue", "darkgreen",
"darkorange", "purple", "darkgray", "darkmagenta", "darkolivegreen",
"darkslategray")
vars_set1 <- names(filtered_data)[-1][1:5]
vars_set2 <- names(filtered_data)[-1][6:10]

create_plots <- function(vars, title_prefix) {
  plots <- lapply(vars, function(var) {
    ggplot(data = filtered_data, aes_string(x = "Usage", y = var)) +
      geom_bar(stat = "identity", fill = colors[match(var,
names(filtered_data)[-1])]) +
      labs(x = "Screen Time",
           y = var) +
      theme(plot.title = element_text(hjust = 0.3, size = 10)) +
      ggtitle(paste(var))
  })
  multiplot <- wrap_plots(plots, nrow = 2, width = 10, height = 10)
  return(multiplot)
}
multiplot_set1 <- create_plots(vars_set1, "Set 1:")
multiplot_set2 <- create_plots(vars_set2, "Set 2:")
multiplot_set1
multiplot_set2
```
```

Linear Regression Model from Figure 2 code block:

```
lm_model_combined <- lm(as.numeric(TotAddiction_Score) ~
                        as.numeric(ExcessveSmrtPhn_Use) +
                        as.numeric(Rstlss_NoSmrtphn) +
                        as.numeric(DcreasdSlpTimeQulty_SmrtPhnUse),
                        data = wdata, na.action = na.exclude)
summary(lm_model_combined)
```