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Screen Time, Sleep, and Anxiety

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Abstract

Prior literature has found evidence for a connection between screen time and a variety of negative health outcomes. These negative health outcomes include symptoms of both generalized and social anxiety, as well as sleep issues involving poorer sleep quality and less sleep overall. There is also evidence that screen time has dramatically increased as a result of the COVID-19 global pandemic. The present research project investigated the relationship between smartphone screen time and anxiety, both generalized and social, as well as sleep duration and sleep quality. This research project breaks down screen time into four separate domains, social media, video streaming, video games, and general phone use. The results indicated that there was a statistically significant positive correlation between screen time and social anxiety, and a significant negative correlation between amount of time using social media and amount of sleep. There was not a statistically significant correlation between total screen time and amount of sleep, sleep quality, or generalized anxiety. Multiple regression results indicated that amount of sleep, sleep quality, age, and sex were all unique significant predictors of social anxiety, and that sleep quality and sex are unique significant predictors of generalized anxiety. The present research project has both practical and clinical implications for addressing the psychological impact of the pandemic, and adapting to an increasingly online world.

Keywords: screen time, anxiety, sleep, sleep quality, smartphones

MONTCLAIR STATE UNIVERSITY

Screen Time, Sleep, and Anxiety

by

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Background

When investigating the contemporary world, and the United States in particular, three noteworthy observations can be made. First, the vast majority of individuals, and young people specifically, have in their possession a smartphone device with which they spend an amount of time using each day. For instance, one study estimated that university students used their smartphones for approximately five hours each day (Ataş & Çelik, 2019). Second, a substantial percentage of the population experiences and suffers from symptoms of anxiety, and evidence suggests this is one of the most prevalent mental disorders (Bandelow & Michaelis, 2015). Lastly, and quite simply, all human beings necessitate an amount of sleep. It is important to explore and deepen our collective understanding of the relationship between these variables due to the clear practical and clinical implications. These implications range from reducing symptoms of anxiety and promoting better sleeping habits to potential treatment options. While research has been conducted on how these three variables are interrelated and interact with one another, signifying there is a relationship worth investigating, that relationship is not yet fully understood (Elhai, Levine, Dvorak & Hall, 2017; Xu, Adams, Cohen, Earp & Greaney, 2019).

The primary objective of the present research project was to investigate and quantify the associations between average daily screen time, sleep duration and quality, and symptoms of both generalized and social anxiety, in addition to expanding the current literature pertaining to this topic. This is imperative because at this moment in time the world has been grappling with an unprecedented global pandemic since early 2020, which has consequently increased our collective screen time as a civilization (Colley, Bushnik & Langlois, 2020; Majumdar, Biswas & Sahu 2020), demonstrating an immediate need for a better understanding of the relationship

between these variables. This increase in screen time was a result of numerous factors, be that from educational and occupational work making the transition from in-person to an online format, as individuals continue to need to learn and earn a living wage, to even just utilizing social media to occupy free time and connect with friends and family without being in close physical proximity. Even before the pandemic, evidence suggested that excessive screen time use was correlated with a range of negative mental health outcomes such as increased anxiety and depression (Allen, Walter & Swann, 2019; Huang et al., 2020).

On a similar note, a meta-analysis of 67 studies put forward evidence that indicated that screen time, which encompassed time spent using computers, mobile devices, television, and video games, is negatively correlated with sleep outcomes, predominantly shortened durations of sleep in total and postponing attempts to fall asleep, in 90% of the studies that were examined (Hale & Guan, 2015). This evidence indicates there was already a concerning problem that may have only been exacerbated by the pandemic, further emphasizing that this is an imperative time to investigate and quantify the possible effects of screen time on sleeping habits, and subsequent mental health outcomes.

Furthermore, some of the variables examined in this study, screen time and amount of sleep, are also important to examine due to their documented high correlation with a variety of negative health outcomes such as anxiety, depression, and less physical activity (Yinjian et al., 2019; Guerrero, Barnes, Chaput & Tremblay 2019; Li, Buxton, Lee, Chang, Berger & Hale, 2019). Congruently, as younger individuals regularly engage in screen time for a variety of reasons, it is rather concerning that significant correlations between screen time and symptoms of anxiety and depression, in addition to other negative health indicators, have been documented among this demographic (Khouja et al., 2019; Costigan, Barnett, Plotnikoff, & Lubans, 2013).

Despite top scientific organizations and researchers studying the global pandemic since its very onset, the research regarding the impact a dramatic increase in collective societal screen time might have is limited. An unprecedented global pandemic is unquestionably an extremely unfortunate situation that has resulted in the loss of human life; however, it does provide both a unique and rare opportunity to research the potential psychological impact of such a phenomenon.

As previously stated, the current research concerning the potential psychological impact of increased screen time as a result of the global pandemic on individuals has been limited at best due to the delayed time it can take for research to enter the peer-reviewed literature. Regardless, the evidence which is currently obtainable does suggest a significant correlation between increased screen time and poor mental health outcomes in younger individuals resulting from time spent in COVID-19 related isolation, even when controlling for conceivable confounding factors such as marital status, employment status, and annual income (Smith et al., 2020). This study asked its 932 participants to report how long they have been in COVID-19 related isolation in order to connect their findings to the pandemic, and used a measure of anxiety, the Beck Anxiety Inventory, that was also used in the current research project. While this study provides valuable insight, one important consideration to be made is that this research, along with Khouja et al. (2019), was conducted in the United Kingdom, and so the generalizability to other countries such as the United States should be made with caution. This correspondingly emphasizes the need to conduct similar research in the United States focusing on younger individuals, as they appear to be the most affected by the psychological impact of the pandemic, to either provide supportive evidence or bring to light some interesting differences between various populations.

While the psychological effects are likely to vary among different populations it is unquestionable that collective screen time has increased around the globe, even among children. This can be seen in the evidence presented by one study that determined that on average, children aged 3 to 7 years old engaged with screens for more than 50 minutes longer during the pandemic than before it (Ribner et al., 2021). The authors concluded that this was largely driven by increases in screen use for entertainment purposes and the use of educational applications. This study collected data by contacting the parents of 2,516 children from a variety of countries including the United States, the United Kingdom, Sweden, Italy, China, and Australia. This research emphasizes how widespread the effects of the pandemic are, and how even the youngest members of the population are susceptible to increasing screen times. While this can be troubling it is also important to note that moderate use of digital technology is not intrinsically harmful (Przybylski & Weinstein, 2017).

Yet another study that is particularly relevant to the present research project is Rozgonjuk et al. (2018). In this study, the researchers were examining the relationship between problematic smartphone use and depression and anxiety symptom severity, using an objective measure of smartphone use. Typically, measures of smartphone use are simple self-report measures, which are subject to response bias. Having an objective measure of smartphone use increases both the reliability and validity of the data obtained. The researchers were able to achieve this by having participants download a smartphone application titled “Moment” which automatically tracked their smartphone use over the course of a week. While the results did not find a statistically significant correlation between problematic smartphone use and depression or anxiety symptom severity, this is still noteworthy as it highlights some inconsistencies with other current literature. There were some limitations with this study that should be considered as well, such as having a

relatively limited sample size of 101 participants, and that the application used was only available on Apple IOS, making users of other smartphone brands ineligible to participate. Although the present study does not utilize an application, it does improve on some of these limitations by having a somewhat larger sample size, and being available to a wider range of smartphone users while still maintaining a reasonably objective measure of screen time by having participants activate and report data directly from the screen time function already present in the vast majority of smartphone devices.

Another piece of research worth mentioning is Maras et al. (2015) which aimed to examine the relationship between screen time, depression, anxiety, and physical activity. The researchers hypothesized that a longer duration of screen time would be associated with more severe symptoms of depression and anxiety, after controlling for possible confounders. The participants were comprised of 2,482 middle to high school students from both public and private schools in Ontario and Ottawa, Canada. The variables were measured using a variety of self-report questionnaires, which again do have their limitations but seem reasonable given the logistical concerns of using such a large sample size. Ultimately, the results indicated that total screen time was significantly associated with the severity of anxiety and depressive symptoms among Canadian youth. Additionally, screen time was broken down into four categories: TV, video games, and computer use, with video games and computer use being more significant than TV.

It is also important to reiterate that anxiety is complex and multidimensional. In addition to generalized anxiety, Social Anxiety Disorder (SAD) is correspondingly an issue worth considering with regards to screen time. One study had the specific aim of examining the relationship between adolescent screen time and social anxiety, and the results indicated that

both male and female adolescents who reported engaging in more screen time also reported higher levels of social anxiety (West, Puszczynski, & Cohn, 2021). The results also found that female participants scored higher on the social anxiety scale when reporting more than three hours daily using social media, and that males on average spent less time on screens (West, Puszczynski, & Cohn, 2021). Data was collected from 83 participants using self-report measures, and screen time consisted of any time spent using or watching television, iPads, computers, video games, and cellular devices. The vast majority of participants reported using some type of screen while in bed, that it affected their sleeping habits, and that their parents implemented no restrictions on their screen time use (West, Puszczynski, & Cohn, 2021).

Now concerning sleep quality, screen time has been shown to have a significant negative influence pertaining to it (Xu et al., 2019; Christensen et al., 2016). Specifically, Christensen et al. (2016) concluded that longer average screen time was associated with shorter sleep duration and worse sleep efficiency. This study also found that longer average screen times before bed were associated with poorer sleep quality, decreased sleep efficiency, and longer sleep onset latency. This research highlights the fact that simply the amount of sleep an individual gets is not the only aspect influenced by screen time, and thus makes sleep quality equally important to consider and investigate in the present research project.

Moving beyond associations and correlations, the ability to construct predictive statistical models in order to determine what and how much specific factors can predict negative health outcomes is both valuable and has important clinical implications. As an example, one study performed a regression analysis finding that pre-COVID sleep onset latency, the structural integrity of a section of the brain composed of white matter (the posterior limb of the internal capsule), gender, and change in sleep quality explained a significant 47% of the variance in

COVID-specific anxiety in adolescence, with pre-COVID sleep onset latency being one of the most significant predictors (Jamieson et al, 2021). This research demonstrates the relationship and potential predictive power of sleep quality for anxiety within this specific context, which is relevant to the present research project in formulating its regression hypothesis. Relatedly, another study provided evidence that suggests sleep problems both predict and are predicted by a diagnostic cluster that includes generalized anxiety disorder (GAD), depression, and oppositional defiant disorder (ODD) in children ages 9 to 16, concluding that screening children for sleep problems could offer promising opportunities for reducing the burden of mental illness during the early life (Shanahan et al, 2014). From a more treatment-based clinical perspective, the findings of another study suggest that poor sleep quality diminishes the effects of cognitive-behavioral therapy (CBT) in the treatment of social anxiety disorder, and that attention to sleep quality before the initiation of CBT and during treatment is of clinical importance (Zalta et al, 2013). Similarly, this research provides evidence for the predictive power of sleep quality on the efficacy of treatments for social anxiety in younger individuals, which again is relevant to the present research project for formulating its regression hypothesis.

Hypotheses

With consideration of all the prior literature mentioned above, hypothesis 1 of the present research project was that more smartphone screen time would be associated with fewer hours of sleep per night on average and poorer sleep quality, and hypothesis 2 was that more smartphone screen time would be positively associated with higher levels of both generalized and social anxiety. These hypotheses build on the prior literature previously discussed, but are novel as well considering that the majority of studies do not focus on smartphone screen time specifically, and instead include any screen time such as watching television or computer use. In addition,

hypothesis 3 was that smartphone screen time, sleep duration, sleep quality, age, and sex can all significantly predict both generalized and social anxiety when tested using a regression analysis, and hypothesis 4 was that the relationship between smartphone screen time and social anxiety is mediated by sleep duration. Finally, an exploratory analysis was performed to determine which, if any, type of smartphone screen time use, be that social media use, streaming videos, playing video games, or general phone use (texting, calling, email), correlates with either levels of anxiety or amount and quality of sleep. While prior research has broken down smartphone screen time use by slightly different categories (Ohme et al., 2021) the breakdown utilized in the present research project encapsulates the overwhelming majority of smartphone use, and is sufficient for the purposes required. This further adds to the novelty of the present research project as no other found study, to the best of our knowledge, has examined how the various types of smartphone screen time by domain might influence sleep or anxiety.

Methods

Participants

This research project was conducted using a sample of 198 undergraduate participants from Montclair State University using Montclair's SONA recruitment system. The participant sample included 157 (79.3%) females, 29 (14.6%) males, 2 (1%) who prefer not to say, 1 (.5%) nonbinary individual, and 9 (4.5%) did not indicate their sex. The participant sample also had a mean age of 19.14 (SD = 1.73). The participant sample used was both representative and diverse consisting of 86 (43.4%) White individuals, 63 (31.8%) Hispanic/Latino, 22 (11.1%) Black or African American, 9 (4.5%) other, 8 (4%) Asian, 1 (.5%) American Indian or Alaska Native, and 9 (4.5%) did not indicate their race. Eighteen participants were excluded from the analysis due to the participant either failing to indicate they used the screen time function on their smartphone

when completing the survey and/or completing the survey in under three minutes (180 seconds), leaving a final sample of 180 participants included in the analysis. This research project received ethical approval from the Montclair State University IRB Ethics Committee (IRB#: IRB-FY21-22-2459), and all participants provided informed consent prior to participation in the research project.

Materials

Screen Time. The primary independent variable for this research project was the average number of hours of smartphone screen time per day over the preceding week. This independent variable was operationally defined by participants reporting via a self-report survey their daily average screen time use which they obtained directly from their smartphones. A full calendar week prior to taking the survey participants were asked to activate the screen time function on their smartphone device to obtain a more objective measurement of their average screen time, and then report that information while completing the survey. Additionally, participants were asked to report their top most-used applications on their smartphone devices and the average time spent on those applications. Top applications reported by participants were then categorized into one of four categories, those being either Social Media, Video Games, Video Streaming, or General Phone Use. Applications such as Twitter, Instagram, TikTok, Snapchat, Tinder, Pinterest, Reddit, GroupMe, WhatsApp, and Facebook were categorized as Social Media. Applications such as Pokémon GO, Clash of Clans, Among Us!, and Candy Crush Saga were categorized as Video Games. Applications such as YouTube, Netflix, Hulu, HBO Max, Amazon Prime Video, Disney+, and Twitch were categorized as Video Streaming. Finally, applications such as Messages, FaceTime, Phone, Safari, Maps, and Mail were categorized as General Phone Use.

Anxiety. Anxiety is a primary dependent variable that was divided into generalized anxiety and social anxiety. Generalized anxiety can be conceptually defined as an emotion characterized by feelings of tension, worried thoughts, and physiological changes such as increased blood pressure. Generalized anxiety was operationally defined by using the Beck Anxiety Inventory (BAI; Beck, Epstein, Brown & Steer, 1988), which is a 21-item self-report measure that was developed specifically to assess generalized anxiety. The BAI uses a 4-point Likert-type scale that ranges from 0 (Not at all) to 3 (Severely – it bothered me a lot) and asks participants to indicate how much they have been impacted by a specific symptom of anxiety in the past week, including today. Symptoms include "fear of losing control" and "heart-pounding/racing." The responses for each item were then averaged to create a mean score, with higher scores indicating a higher level of generalized anxiety. This inventory is regarded as a reliable measure of generalized anxiety (Cronbach's a = .92, one-week test-retest reliability coefficient = .75) (Beck et al., 1988). Cronbach's alpha for the current data set was .94. The instructions for completing the measure are as follows, "below is a list of common symptoms of anxiety. Please carefully read each item in the list. Indicate how much you have been bothered by that symptom during the past week, including today, by selecting the number in the corresponding space in the column next to each symptom."

Social Anxiety. Social anxiety can be conceptually defined as an emotion characterized by feelings of tension, worried thoughts, and physiological changes such as increased blood pressure resulting from social interactions. Social anxiety was operationally defined by using the Liebowitz Social Anxiety Scale – Self Report (LSAS-SR; Liebowitz, 1987), which is a 24-item self-report measure that was developed specifically to assess social anxiety. The LSAS-SR asks participants to imagine various social situations such as "going to a party" and how much they

fear and avoid those situations using two 4-point Likert scales for each item that ranges from 0 (None) to 3 (Severe) for fear, and 0 (Never) to 3 (Usually) for avoidance. Responses to each question are then averaged to create a mean score with higher scores indicating a higher level of social anxiety. This scale is regarded as a valid measure of social anxiety (Rytwinski et al., 2009). Cronbach's alpha for the current data set was .96. The instructions for completing the measure are as follows, "read each situation carefully and answer two questions about that situation. The first question asks how anxious or fearful you feel in the situation. The second question asks how often you avoid the situation. If you come across a situation that you ordinarily do not experience, we ask that you imagine what if you were faced with that situation, and then rate the degree to which you would fear this hypothetical situation and how often you would tend to avoid it."

Average Amount of Sleep Per Night. Sleep duration can be conceptually defined as any time spent sleeping, and was operationally defined by the average number of hours of sleep a participant gets per night. This was obtained through a self-report survey question.

Sleep Quality. Sleep quality can be conceptually defined as the overall quality of sleep a participant is receiving, and was operationalized by using the Sleep Quality Scale (SQS; Yi, Shin, & Shin, 2006) which is a 28 item self-report measure developed to assess the quality of the sleep a participant is getting. The SQS uses a 4-point Likert-type scale that ranges from 0 (Rarely: None or once a week) to 3 (Almost always: 6-7 times a week) and asks participants questions about their sleep and how it has impacted them in the past week, including today. Questions include "I toss and turn" and "I feel refreshed after sleep." The responses for each item are then averaged to create a mean score, with higher scores indicating poorer quality of sleep. This inventory is regarded as a reliable measure of sleep quality (Cronbach's a = .92, test-

retest reliability coefficient = .81) (Yi et al., 2006). Cronbach's alpha for the current data was .89. The instructions for completing the measure are as follows, "The following section concerns the quality of sleep you had for the last week. Read the following questions carefully and select the closest answer."

Procedure

First, prior to participating in the research project, all participants were required to go into the settings of their smartphone device and activate the Screen Time function found in most smartphones for one full calendar week if they did not already have the function activated. This can be done on the iPhone IOS with the following path by selecting Settings -> Screen Time -> Turn On Screen Time -> Continue. A similar path exists and can be followed on Android devices. Once participants had the Screen Time function activated for one full calendar week they were able to complete an online Qualtrics survey. The online Qualtrics survey took approximately twenty minutes to complete and was a culmination of the measures listed above. After completion of the survey participants received one SONA credit for their participation.

The target sample size was 200 participants, and once the deadline for completing the survey (e.g., March 1st 2022) was reached the data was downloaded and analyzed, providing 198 participants. Data analysis was conducted using IBM SPSS Statistics (Version 28). Due to some participants indicating their daily screen time was over 24 hours, SPSS Statistics was also used to identify and exclude any outliers within those responses, leaving a total of 149 valid responses for that variable. There were no significant differences between the included and excluded participants on either anxiety measure, sleep duration, or sleep quality. Assumptions were checked for all regression analyses presented below. Specifically, there was no evidence of

multicollinearity (all VIF values less than 1.5), and there appeared to be no noticeable non-normality or heteroskedasticity in the residual errors.

Results

Descriptive statistics for all the primary variables are presented in Table 1. As can be seen, the average screen time was 436.69 minutes (*SD* = 149.29, *N* = 149). This equates to approximately 7 hours and 16 minutes of screen time per day. The average generalized anxiety score was .84 (*SD* = .66, *N* = 180), again this scale ranged from 0 to 3 with higher scores indicating more generalized anxiety. The average social anxiety score was 1.27 (*SD* = .63, *N* = 180), this scale also ranged from 0 to 3 with higher scores indicating more social anxiety. The average sleep quality score was 1.25 (*SD* = .46, *N* = 180), also ranging from 0 to 3 with higher scores indicating poorer sleep quality. Lastly, the average amount of sleep per night was 6.92 hours (*SD* = 1.4, *N* = 180), or approximately 415 minutes.

Table 1

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Screen Time (Minutes)	149	129	888	436.69	149.285
Generalized Anxiety	180	.00	2.86	.8406	.65689
Social Anxiety	180	.00	3.00	1.2700	.63161
Sleep Quality	180	.21	2.75	1.2454	.46327
Amount of Sleep (Hours)	180	3	10	6.92	1.396
Valid N (listwise)	149				

Note. Descriptive Statistics for the primary variables of the present study.

The two primary hypotheses were that more phone screen time would be correlated with fewer hours of sleep per night on average and poorer sleep quality, and that more screen time

would be positively correlated with a higher level of both generalized and social anxiety. The correlations can be seen below (Table 2). For hypothesis 1, the correlation between phone screen time and sleep duration did not reach the traditional threshold for statistical significance (r = -.108, p = .190), but was in the predicted direction with more screen time being associated with less sleep on average. Similarly, the correlation between phone screen time and poor sleep quality was also not statistically significant (r = .097, p = .237). For hypothesis 2, the correlation between phone screen time and generalized anxiety was approaching but did not reach statistical significance (r = .129, p = .116), yet was still in the predicted direction; however, there was a statistically significant correlation between screen time and social anxiety experienced (r = .168, p = .04), indicating that more screen time was associated with more social anxiety.

In addition, while this was not an explicit hypothesis of the research project, the correlations in Table 2 revealed that sleep duration was significantly correlated with both generalized anxiety (r = -.193, p = .009) and social anxiety (r = -.274, p < .001), demonstrating that less sleep, in general, is associated with worse symptoms of both types of anxiety. Sleep quality was also significantly correlated with both generalized anxiety (r = .546, p < .001) and social anxiety (r = .415, p < .001), with medium to large effect sizes, indicating that poorer sleep quality is also related to worse symptoms of both types of anxiety. Taken together, these correlations provide further evidence for how important good restful sleep is for mental health.

Table 2

Correlations of Primary Variables

		Screen Time (Minutes)	Generalized Anxiety	Social Anxiety	Sleep Quality	Amount of Sleep (Hours)
Screen Time (Minutes)	Pearson Correlation	--				
	N	149				

Generalized Anxiety	Pearson Correlation	.129	--			
	Sig. (2-tailed)	.116				
	N	149	180			
Social Anxiety	Pearson Correlation	.168*	.552**	--		
	Sig. (2-tailed)	.040	<.001			
	N	149	180	180		
Sleep Quality	Pearson Correlation	.097	.546**	.415**	--	
	Sig. (2-tailed)	.237	<.001	<.001		
	N	149	180	180	180	
Amount of Sleep (Hours)	Pearson Correlation	-.108	-.193**	-.274**	-.335**	--
	Sig. (2-tailed)	.190	.009	<.001	<.001	
	N	149	180	180	180	180

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

A follow-up regression analysis was performed for hypothesis 3, the results of which are presented in Table 3. As can be seen below, the model included screen time, amount of sleep, and sleep quality as predictors of social anxiety. The model explained a significant 19.1% of the variance in social anxiety ($F(3, 145) = 11.43$, $p < .001$). Sleep quality ($b = .491$, $\beta = .348$, $t = 4.418$, $p < .001$) was the only unique significant predictor of social anxiety. The beta value indicates that one standard deviation increase in poor sleep quality is associated with a .348 standard deviation increase in social anxiety, adjusting for the other predictors included in the model. The other predictors, screen time ($b = .001$, $\beta = .12$, $t = 1.6$, $p = .112$) and amount of sleep ($b = -.059$, $\beta = -.129$, $t = -1.634$, $p = .104$), were not unique significant predictors of social anxiety.

Table 3

Coefficients of Model 1[a]

Model	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
(Constant)	.839	.357		2.348	.020
Screen Time (Minutes)	.001	.000	.120	1.600	.112
Amount of Sleep (Hours)	-.059	.036	-.129	-1.634	.104
Sleep Quality	.491	.111	.348	4.418	<.001

a. Dependent Variable: Social Anxiety

Prior literature mentioned above notes that age and sex are related to social anxiety (West, Puszczynski, & Cohn, 2021), and so the regression analysis was conducted again, this time including age and sex as covariates. The results of which can be seen in Table 4. The new model explained a significant 30.8% of the variance in social anxiety ($F(5, 142) = 12.67$, $p < .001$). Amount of sleep ($b = -.074$, $\beta = -.16$, $t = -2.179$, $p = .031$), sleep quality ($b = .391$, $\beta = .276$, $t = 3.622$, $p < .001$), age ($b = -.088$, $\beta = -.236$, $t = -3.338$, $p = .001$), and sex ($b = .367$, $\beta = .251$, $t = 3.457$, $p < .001$) were all unique significant predictors of social anxiety. The only predictor that did not reach statistical significance was screen time. What is also interesting between these two models is that the addition of age and sex led to amount of sleep becoming a significant predictor. These results indicate that less sleep, poorer sleep quality, being younger, and being female were associated with higher social anxiety.

Table 4

Coefficients of Model 2[a]

Model	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
(Constant)	2.143	.647		3.310	.001
Screen Time (Minutes)	.000	.000	.076	1.073	.285

Amount of Sleep (Hours)	-.074	.034	-.160	-2.179	.031
Sleep Quality	.391	.108	.276	3.622	<.001
Age	-.088	.026	-.236	-3.338	.001
Sex	.367	.106	.251	3.457	<.001

a. Dependent Variable: Social Anxiety

Furthermore, another regression analysis was conducted. This model was the same as the previous model (model 2) except that the dependent variable was generalized anxiety, as opposed to social anxiety, to see if similar trends were found for general anxiety. The results can be seen in Table 5. This model explained a significant 31.9% of the variance in generalized anxiety ($F(5, 142) = 13.33$, $p < .001$). In this model only sleep quality ($b = .689$, $\beta = .476$, $t = 6.29$, $p < .001$) and sex ($b = .29$, $\beta = .194$, $t = 2.687$, $p = .008$) were unique significant predictors of generalized anxiety. Screen time, amount of sleep, and age were not significant predictors of generalized anxiety (all p's > .05).

Table 5

Coefficients of Model 3[a]

	Unstandardized Coefficients		Standardized Coefficients		
Model	B	Std. Error	Beta	t	Sig.
(Constant)	-.466	.657		-.710	.479
Screen Time (Minutes)	.000	.000	.061	.870	.386
Amount of Sleep (Hours)	.013	.034	.028	.385	.701
Sleep Quality	.689	.110	.476	6.290	<.001
Age	-.015	.027	-.039	-.563	.575
Sex	.290	.108	.194	2.687	.008

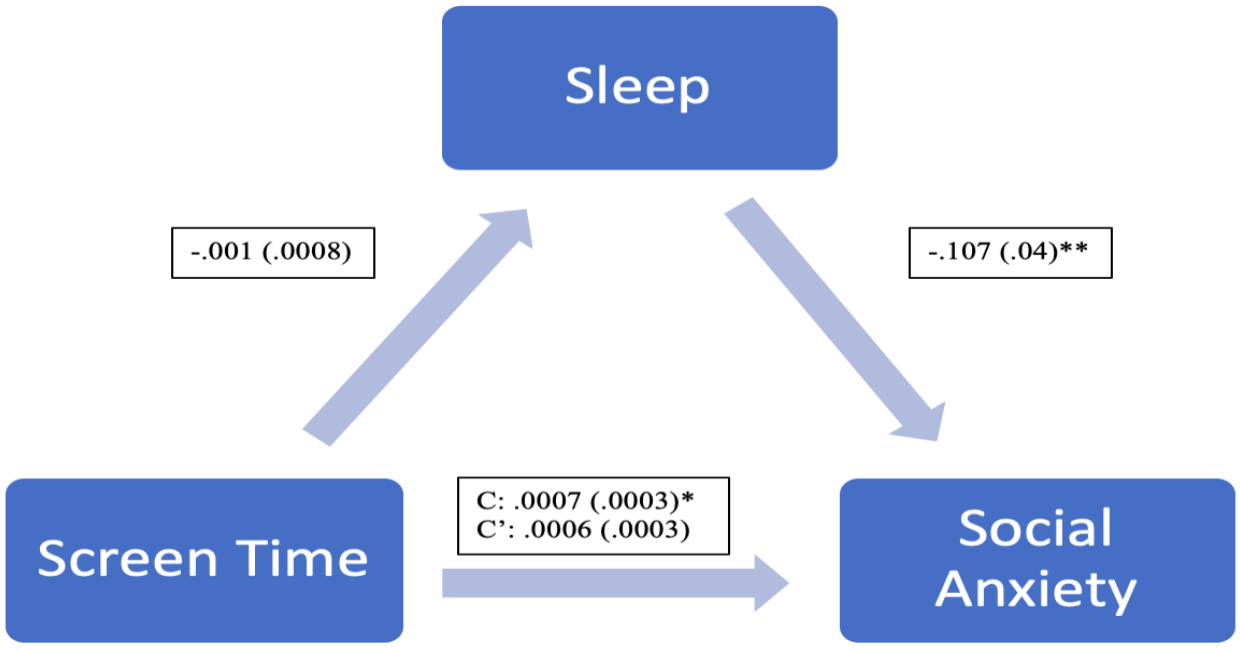
a. Dependent Variable: Generalized Anxiety

Lastly, for hypothesis 4 mediation was tested using PROCESS 4.0 (Hayes, 2021) to determine if an indirect effect of screen time on social anxiety through amount of sleep was

present. The analysis of the indirect effect of screen time on social anxiety via sleep was computed in 5,000 bootstrapped samples and the 95% confidence interval for the estimate is provided. The results of the mediation analysis are presented in Figure 1. As shown, participants who had higher screen time did not have significantly less sleep (p = .19). Less sleep was associated with significantly higher social anxiety (p = .004), adjusting for screen time use. Additionally, screen time was not significantly associated with social anxiety, controlling for the indirect effect via sleep duration (p = .075). Screen time and sleep duration together accounted for 8% of the variance in social anxiety, which was statistically significant ($F(2, 146) = 6.56$, p = .002). The indirect effect of screen time on social anxiety via sleep duration was estimated at .0001 (SE = .0001; 95% Bootstrapped CI: -.0001 - .0004). The 95% CI does contain zero, indicating it did not reach statistical significance.

Figure 1

Mediation Model



Note. Results of the model predicting Social Anxiety. Unstandardized estimates are listed.
* p < .05, ** p < .01, *** p < .001

As for the exploratory analysis, the results of which can be seen in Table 6, none of the four types of screen time domains (social media, video streaming, video games, and general phone use) were significantly correlated to generalized or social anxiety specifically (all *p*'s > .05), and none of the four types of screen time domains were significantly correlated with sleep quality (all *p*'s > .05). Additionally, video streaming, video games, and general phone use times were not significantly correlated with sleep duration (all *p*'s > .05); however, time spent on social media did have a significant negative correlation with amount of sleep (r = -.166, p = .034) indicating that the more time spent using social media applications was associated with less sleep in general.

Table 6

Pairwise Correlations between Screen Time Domains and Study Variables

		Social Media	Video Streaming	Video Games	General Use	Generalized Anxiety	Social Anxiety	Sleep Quality	Amount of Sleep (Hours)
Social Media	Pearson Correlation	--							
	N	163							
Video Streaming	Pearson Correlation	.196*	--						
	Sig. (2-tailed)	.039							
	N	111	111						
Video Games	Pearson Correlation	.305	.779**	--					
	Sig. (2-tailed)	.204	.003						
	N	19	12	19					

General Use	Pearson Correlation	.486**	.067	.228	--				
	Sig. (2-tailed)	<.001	.521	.363					
	N	138	94	18	138				
Generalized Anxiety	Pearson Correlation	.052	-.044	.441	-.021	--			
	Sig. (2-tailed)	.511	.648	.059	.803				
	N	163	111	19	138	180			
Social Anxiety	Pearson Correlation	.024	-.023	.230	.034	.552**	--		
	Sig. (2-tailed)	.757	.810	.343	.691	<.001			
	N	163	111	19	138	180	180		
Sleep Quality	Pearson Correlation	-.023	-.076	-.148	-.040	.546**	.415**	--	
	Sig. (2-tailed)	.773	.427	.544	.640	<.001	<.001		
	N	163	111	19	138	180	180	180	
Amount of Sleep (Hours)	Pearson Correlation	-.166*	.123	.202	-.066	-.193**	-.274**	-.335**	--
	Sig. (2-tailed)	.034	.198	.407	.440	.009	<.001	<.001	
	N	163	111	19	138	180	180	180	180

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Discussion

The primary objective of the present research project was to investigate and quantify the associations between average daily screen time, sleep duration and quality, and symptoms of both generalized and social anxiety. Participants completed a variety of self-report measures

including ones for both generalized and social anxiety as well as sleep duration and quality. Participants were also asked to report their daily average screen time directly from the screen time function on their smartphones, and the average number of hours of sleep per night for the previous week while completing the survey. This research project had several hypotheses. The first hypothesis was that smartphone screen time would be negatively correlated with sleep duration and sleep quality. The results did not support this hypothesis as there was not a statistically significant correlation between smartphone screen time and sleep duration or sleep quality, although the correlations were in the predicted direction. While these null results are not in concurrence with other published research (Hale & Guan, 2015; West, Puszczynski, & Cohn, 2021), this could be for a variety of reasons such as different samples of participants or slightly different measures used. It is also possible that the relationship between screen time and sleep is more complex and influenced by other variables not yet investigated.

The second hypothesis was that smartphone screen time would be positively correlated with generalized and social anxiety. This hypothesis was partially supported as the results did not show that smartphone screen time was significantly correlated with generalized anxiety, but the relationship was in the expected direction; however, the results did demonstrate that smartphone screen time was significantly positively correlated with social anxiety. This correlation between screen time and social anxiety agrees with prior literature (West, Puszczynski, & Cohn, 2021), and provides further evidence for their documented connection. Taken in sum, these results are important as it emphasizes a potential difference between generalized and social anxiety. Being that people commonly utilize their smartphones to connect and socialize with others, it stands to reason that screen time could be more associated with social anxiety rather than generalized anxiety.

The third hypothesis was that smartphone screen time, sleep duration, sleep quality, age, and sex can all significantly predict both generalized and social anxiety together in regression models. This hypothesis was also predominantly supported concerning social anxiety as the only not statistically significant predictor was screen time. Sleep duration, sleep quality, age, and sex were all unique significant predictors of social anxiety. These results are generally in consensus with prior research (Jamieson et al, 2021; Zalta et al, 2013), and provide further supporting evidence for the notion that sleep duration and sleep quality can predict and are connected to social anxiety, in addition to pointing out some interesting sex and age differences, as younger females appeared to be the most affected by social anxiety. Only sleep quality and sex were unique significant predictors of generalized anxiety. The fourth and final hypothesis was that the relationship between smartphone screen time and social anxiety was mediated by sleep duration. This hypothesis was not supported by the results, indicating that the relationship is either direct or perhaps mediated by another variable.

The purpose of the exploratory segment of the analysis was to determine which, if any, type of smartphone screen time use has a stronger correlation with either type of anxiety, or sleep duration and quality. While none of the four different categories of smartphone screen time use significantly correlated with generalized anxiety, social anxiety, or sleep quality, social media did have a significant negative correlation with amount of sleep, which indicates that more time spent using social media applications was associated with less sleep in general. A possible explanation for this might be because people, and younger individuals in particular, often utilize social media before bed resulting in less overall sleep, but further research would be needed to confirm this suspicion. Another interesting result from the exploratory analysis was that both sleep duration and sleep quality were significantly correlated with both generalized anxiety and

social anxiety, indicating that less sleep and poorer sleep quality are associated with worse symptoms of both types of anxiety. This is noteworthy because while prior research has investigated sleep and anxiety (Shanahan et al, 2014), these results expand upon those by connecting both sleep duration and sleep quality to both generalized and social anxiety. This has important implications for clinical research by further emphasizing how interconnected mental health is with healthy sleep.

The present research project is not without its limitations. One important limitation to consider is that this research project utilized self-report measures that were distributed online. As previously stated, self-report measures are subject to response bias. Additionally, because the measures were distributed online, the researchers were not available to answer any clarifying questions participants might have had. For example, when analyzing the data, it appeared that some participants reported the total amount of screen time use for the week rather than the daily average that was asked of them. Another limitation worth noting is that, while participants were asked, there was no way to confirm participants actually utilized the screen time function on their smartphone devices. Future research can improve upon these limitations by having participants submit a screenshot of their screen time, or by collecting data in person and recording screen time directly from the participant's smartphone. Yet another aspect to consider is that the present research project is a correlational one, and so no causal claims can be made based on the data obtained. The question if screen time causes more social anxiety or vice versa remains unanswered. Moreover, the present research project did not investigate when smartphone screen time took place, and there is evidence that suggests that links between screen time and mental well-being can vary as a function of when the digital technology is used such as during the week compared to the weekend (Przybylski & Weinstein, 2017).

Future research can aim to answer this causal question through the use of a true experimental design. For example, it is possible to manipulate the exact amount of screen time a participant is allotted per day for a set period by utilizing the parental controls found in the screen time function and allowing different groups of participants various amounts of time, and also administering pre and post measures of anxiety and sleep quality. Additionally, exact measures of sleep duration could be obtained through the use of devices such as an Apple Watch or something similar. If a causal claim can be established with data, then merely limiting screen time could have some important implications for a rather simplistic and low-cost strategy for clinicians to incorporate into treatment plans.

Regardless, the present study has significant implications for future directions of research being that it is in consensus with some prior research and not with others. This highlights some inconsistencies with the current literature, as well as the need for more research to be conducted regarding this multifaceted topic. Evidently, in the contemporary world limiting screen time is a task easier said than done, being that a plethora of life's necessities have now not only moved to an online format but can also be accessed through a smartphone: even more so now as a result of the COVID-19 pandemic. Everything from banking, grocery shopping, receiving an education, or making a living, can all now be done with a smartphone. The internet, and smartphones specifically, are extremely new and powerful tools that have unambiguously allowed for a great amount of productivity, advancements, and convenience, but in being so new and powerful it is no surprise we have not yet fully understood all the potential effects and consequences which accompany it. Nevertheless, there should be confidence and optimism that with time a greater and more complete understanding will follow.

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