Association of Suicidality, Sleep Duration, Screen Time, and Social Behaviors among U.S. Adolescents

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Abstract

Suicide is a leading cause of death among U.S. adolescents. Short sleep duration and screen time were potential risk factors. This study aims to explore both direct and indirect associations of screen time, sleep, and suicidality. Using the 2019 Youth Risk Behavior Survey data (n=13,677), logistic regression was conducted to examine direct associations of sleep, screen time, and suicidality when controlling demographics and social behaviors. The bootstrapping method was used to test the mediation effects of sleep. Adolescents with excessive screen time (internet, social media) have higher odd ratios in suicide ideation (OR: 1.47, 95% CI: 1.34-1.36, p<0.001), suicide plan (OR: 1.41, 95% CI: 1.26-1.57, p<0.001), and suicide attempts (OR: 1.19, 95% CI: 1.02-1.40, p<0.05), compared to recommended screen time. Short sleep and sleep deprivation have higher odds of suicide ideation (OR: 1.68, 95% CI: 1.46-1.93, p<0.001; OR: 3.78, 95% CI: 3.14-4.55, p<0.001), suicide plan (OR: 1.57, 95% CI: 1.36-1.83, p<0.001; OR: 3.47, 95% CI: 2.86-4.21, p<0.001), and suicide attempts (sleep deprivation: OR: 2.72, 95% CI: 2.08-3.55, p<0.001), compared to optimal sleep duration. Mediation effects of sleep were found on the associations between screen time (TV) and suicidality (β=0.02, p<0.05), and between screen time (internet) and suicidality (β=0.06 for ideation and plan, β=0.05 for attempt, p<0.05). The association between screen time and suicidality is multifaceted. Excessive screen time (internet, social media) is both directly and indirectly associated through sleep with suicidality. Future research could focus on sex differences in the associations.

Keywords: U.S. adolescents, sleep, suicidality, screen time

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Introduction

The suicide rate among adolescents has increased rapidly in the U.S. from 6.8 deaths per 100,000 in 2007 to 11.0 in 2021 (Curtin & Garnett, 2023), and suicide has become one of the top three causes of death among adolescents in the U.S. (CDC, 2023). Therefore, understanding the potential risk factors becomes significant.

One of the risk factors associated with suicide is screen time usage. Previous research has shown a positive association between screen time and mental health problems, including suicide (Stiglic & Viner, 2019; Twenge et al., 2019). However, some studies indicated that the association is small and neglectable (Orben & Przybylski, 2019; Ashton & Beattie, 2019; Tang et al., 2021). One possible explanation was different types of devices and content (Tang et al., 2021;

Twenge & Farley, 2021). A nuanced study showed that among adolescents, TV watching was found to be positively associated with mental health-related issues, while the use of cell phones or computers did not show such an association (Babic et al., 2017). Another study showed that compared to TV watching, internet and social media were more strongly associated with depressive symptoms and self-harm behaviors (Twenge & Farley, 2021). Given the fact that over half of U.S. adolescents spend at least four hours per day on screen time, with an average screen time as high as 5.8 hours per day for 17-year-olds on social media (Gallup Organization, 2023), it is urgent to understand the associations between screen time and suicide behaviors.

Another significant risk factor for suicidality is sleep duration, due to its role in the development of mental and cognitive functioning that might lead to mental health problems (Colrain & Baker, 2011; Zelinski et al., 2014), such as depressive mood and anxiety (Simola et al., 2014; McMakin et al., 2019; Roberts & Duong, 2017) and suicide (Chiu et al., 2018; Kearns et al., 2020). According to the CDC (2020), around 60% of middle school students and over 70% of high school students did not get enough sleep (less than 8 hours) on school nights. The high prevalence of short sleep duration is alarming and one of the leading risk factors for short sleep duration is screen time (Parent et al., 2016; Dube et al., 2017; Cain & Gradisar, 2010).

Overall, the inconsistent results between screen time and suicidality might be caused by differences in types of screen time and the mediation effect of sleep duration on the association between screen time and suicidality. Therefore, to thoroughly understand the association between screen time, sleep, and suicidality, this study aims to explore the direct associations of sleep duration and different types of screen time (e.g. device, content, and various levels) on suicidality among U.S. adolescents, as well as tests the mediation effect of sleep duration on the association between screen time and suicidality.

Methods
Study Design

We used the 2019 Youth Risk Behavior Survey (YRBS) cross-sectional data to test the effects of sleep duration and screen time on suicide-related behaviors and controlled for selected demographic factors and social behaviors. Established by the Centers for Disease Control and Prevention (CDC), the YRBS is one of the largest adolescent health behavioral surveys that monitors the prevalence of health-related behaviors among adolescents in the US.

Participants

The 2019 YRBS data included 13,677 participants enrolled in public and private school between grades 9 through 12. A three-stage cluster sampling was used to select participants from 196 private and public schools, which were systematically selected using a random start in all 50 U.S. states and the District of Columbia. Classes were randomly selected by systematic equal probability sampling from each school that participated.

Measures

Outcome Variables: Suicide Ideations, Suicide Plans, and Suicide Attempts: The YRBS survey measures suicidality through the following three questions: 1) "During the past 12 months, did you ever consider attempting suicide?" (suicide ideation); 2) "During the past 12 months, did you make a plan about how you would attempt suicide?" (suicide plans); and 3) "During the past 12

months, how many times did you actually attempt suicide?" (suicide attempts). For the first two questions regarding ideation and plans, self-reported responses are coded as 1= yes and 2= no. For the third question regarding attempt behaviors, we dichotomized the original codes (1=0 times, 2=1 time, 3=2 or 3 times, 4=4 or 5 times, 5=6 or more times) into two categories (1=have attempted, 2= have not attempted). These three binary variables were used to analyze suicide-related behaviors as outcome variables.

Predictors: Sleep Duration and Screen Time

Sleep Duration: Sleep duration was measured through the question, "On an average school night, how many hours of sleep do you get?" The answers were coded as 1=4 or less hours, 2=5 hours, 3=6 hour, 4=7 hours, 5=8 hours, 6=9 hours, and 7=10 or more hours. Multiple national organizations, including the National Sleep Foundation (Hirshkowitz et al., 2015) and the American Academy of Sleep Medicine (Paruthi et al., 2016), recommend that adolescents get between eight to 10 hours of sleep per night for optimal health and well-being. Furthermore, scholars also indicated that due to physical and mental development needs, it is normal for adolescents to sleep over 10 hours and considered sleep duration less than four hours as severe sleep deprivation (Artner et al., 2013). Based on the aforementioned criteria, we coded sleep duration into three categories (1=optimal sleep duration [8 hours or more], 2=short sleep duration [5-7 hours], and 3=sleep deprivation [less than 4 hours]).

Screen Time: Screen time was recorded through the following two questions: 1) "On an average school day, how many hours do you watch TV?" and 2) "On an average school day, how many hours do you play video or computer games or use a computer for something that is not schoolwork? (Count time spent on things such as Xbox, PlayStation, an iPod, an iPad or other tablet, a smartphone, YouTube, Facebook or other social networking tools, and the Internet)" The answers were coded as 1=I do not, 2=less than 1 hour per day, 3=1 hour per day, 4=2 hours per day, 5=3 hours per day, 6=4 hours per day, and 7=5 or more hours per day.

In cooperating with the recommended recreational daily screen time of two hours by the 24-Hour Movement Guidelines and previous studies (Canadian Society for Exercise Physiology, 2021; Mantey et al., 2023; Barnett et al., 2018), we coded both watching TV and computer/internet/gaming recreational screen time variables into two categories: 1=not excessive (2 hours or less) and 2=excessive (2 hours or more).

Covariates

Demographic features, such as sex (Nahapetyan et al., 2014; Miranda-Mendizabal et al., 2019), race/ethnicity (Chan et al., 2022), and age (Nahapetyan et al., 2014), were associated with suicidality among adolescents. Therefore, sex, race/ethnicity, and age were controlled in the study. The sex variables coded in the 2019 YRBS data were: 1=female and 2=male. Race/ethnicity were coded in the study as: 1=Native/Indian American, 2=APIDA (Asian Pacific Islander Desi-American), 3=Black American, 4=White American, 5=Latino American, and 6=multiple races. Following the guidance of the CDC (2021), age was coded into three categories: 1=young teen (14 years old or younger), 2=teenager (15-17 years old), and 3=young adult (18 years old or older).

Social behaviors, such as current drinking, ever having used substances, and ever having been bullied (cyberbullied and physically bullied), were also associated with suicidality

among adolescents (Iwatate et al., 2023). Therefore, we included these factors as control variables in our data analysis. Additionally, we also included current smoking/vaping as a control variable. To analyze the data, we coded all the social behavior variables as binary variables, with 1 representing "no" (the reference group) and 2 representing "yes."

Statistical Analysis

We conducted descriptive statistics to present the frequencies of each outcome variable (suicide ideation, suicide plans, and suicide attempts) within each level of individual predictors (sleep duration and screen time) and controlled variables (demographics and social behaviors). A binary logistic regression model was used to estimate the odds ratio (OR) between each sleep duration and each suicide-related outcome variable, as well as the odds ratio between screen time (TV and other sources of screen time) and each suicide-related outcome variable. Furthermore, the mediation effect of sleep duration on the association between overall screen time and suicidality is tested by the Bootstrapping method. For statistical data inference, a statistically significant level was indicated by p-value <.05; and 95% confident intervals (CIs) were calculated for point estimates. All statistical data analyses were carried out by Stata BE 17 (College Station, Texas).

Results

Descriptive Statistics

Our final analytical sample comprised 13,677 participants, and sample characteristics are described in Table 1. Both boys and girls make up around half of the population, 50.34% (n=6,885) and 43.36% (n=6,641). Most participants (n=10,203,

74.60%) were teenagers from 15 to 17 years old. Almost half (n=6,668, 48.75%) of the participating adolescents were White, followed by Latino (n=3,038, 22.21%), Black (n=2,040, 14.92%), Asian (APIDA) (n=687, 5.02%), multiple races (n=661, 4.83%), and Native American (n=145, 1.06%). Among participants, only 21.42% (n=2,930) reported having optimal sleep duration, 64.39% (n=8,807) indicated having short sleep durations, and 4.18% (n=1,368) stated having sleep deprivation. Most adolescents surveyed (n=10,200, 74.58%) spend two hours or less watching TV daily, while almost half of them (n=5,573, 43.36%) spend over two hours daily on other screen time, such as internet surfing, social media, gaming, etc. Most adolescents surveyed were not current drinkers (n=8,942, 65.38%) nor smokers/vapers (n=7,874, 57.57%); however, over half of them (n=7,119, 52.05%) have tried substances illegally. As for suicidality, 19.25% (n=2,633) have seriously thought about suicide, 15.73% (n=2,151) have made suicide plans, and 7.80% (n=1,067) have conducted suicide attempts.

Table 2 shows the significant differences in suicide-related outcomes among sleep durations, screen time, demographic features (sex, race, and age), and social behaviors (drinking, smoking, substance use, and being bullied) (ps<0.05).

Logistic Regression Results

Suicide ideation, sleep duration, and screen time: Holding demographics and social behaviors constant, compared to optimal sleep duration, adolescents with short sleep duration and sleep deprivation were significantly more likely to have serious suicide ideations with odds ratios of 1.68 (95% CI: 1.46-1.93, p<0.001) and 3.78 (95% CI: 3.14-4.55, p<0.001), respectively. Holding sleep duration and covariates constant, excessive screen time (social media, internet,

Table 1

Descriptive statistics of predictors, covariates, and outcomes (n=13,677)

	n	%
Main Predictors		
Sleep duration[a]		
Sleep deprivation	1,368	10.00
Short sleep	8,807	64.39
Optimal sleep	2,930	21.42
Missing	572	4.18
Screen time (TV)[b]		
Recommended time	10,200	74.58
Excessive time	2,596	18.98
Missing	881	6.44
Screen time[b] (internet, social media, etc.)		
Recommended time	7,874	52.98
Excessive time	5,573	43.36
Missing	230	3.66
Covariates		
Sex		
Female	6,885	50.34
Male	6,641	48.56
Missing	151	1.10
Age[c]		
Young teen	1,786	13.06
Teenager	10,203	74.60
Young adults	1,616	11.82
Missing	72	0.53
Race/ethnicity		
Native American	145	1.06
Asian (APIDA)[d]	687	5.02
Black	2,040	14.92
White	6,668	48.75
Latino	3,038	22.21
Multiple	661	4.83
Missing	438	3.20
Current smoking/vaping		
Yes	5,573	40.75
No	7,874	57.57
Missing	230	1.68
Current drinking alcohol		
Yes	3,669	26.83
No	8,942	65.38
Missing	1,066	7.79

Ever used substance[e]		
Yes	7,119	52.05
No	6,461	47.24
Missing	97	0.71
Ever being bullied[f]		
Yes	3,439	25.14
No	10,016	73.23
Missing	222	1.62
Outcome Variables		
Suicide ideation		
Yes	2,633	19.25
No	10,804	78.99
Missing	240	1.75
Suicide plan		
Yes	2,151	15.73
No	11,271	82.41
Missing	255	1.86
Suicide attempt		
Yes	1,067	7.80
No	9,453	69.12
Missing	3,157	23.08

Note.

[a] Sleep duration includes three levels: optimal sleep (8 hours or more), short sleep (5-7 hours), and sleep deprivation (4 hours and less).

[b] Screentime has two levels: recommended time (2 hours or less) and excessive time (more than 2 hours).

[c] Age has three groups: young teen (12-14 years old), teenagers (15-17 years old), and young adults (18 years and older).

[d] APIDA refers to Asian Pacific Islander Desi American.

[e] Substance includes marijuana, synthetic marijuana, prescription pain killer without doctor's prescription, cocaine, ecstasy, heroin, and methamphetamines.

[f] Being bullied by both physical bullying and cyberbullying.

etc.) also increased the odds of having suicide ideation by 47% (OR: 1.47, 95% CI: 1.34-1.36, p<0.001) compared to adolescents with recommended screen time on social media, internet, etc. (Table 3).

Suicide plan, sleep duration, and screen time: Holding demographics, screen time, and social behaviors constant, the odds of adolescents with short sleep duration (OR: 1.57, 95% CI: 1.36-1.83, p<0.001) and sleep deprivation (OR: 3.47, 95% CI: 2.86-4.21, p<0.001) were significantly higher in making suicide plans when compared to adolescents with optimal sleep duration. Holding sleep duration and covariates constant, excessive screen time (social media, internet, etc.) had 41% higher odds of having suicide ideation (OR: 1.41, 95% CI: 1.26-1.57, p<0.001), compared to adolescents with recommended screen time on social media, internet, etc. (Table 3).

Suicide attempts, sleep duration, and screen time: Holding demographics, screen time, and social behaviors constant, when compared to optimal sleep duration, adolescents with sleep deprivation had a higher likelihood of conducting suicide attempts (OR: 2.72, 95% CI: 2.08-3.55, p<0.001). Excessive screen time spent on the internet, social media, etc. increased the odds of conducting suicidal attempts by 19% (OR: 1.19, 95% CI: 1.02-1.40, p<0.05) (Table 3).

Sleep duration and screen time: As shown in Table 4, sleep duration has negative associations with excessive screen time on TV (β=-0.08, p<0.05) and excessive screen time on the internet, social media, etc (β=-0.20, p<0.001). indicating that compared to people with recommended screen time, people with excessive screen time (TV) and excessive screen time (internet, social media, etc.) had a 0.08 level decrease and a 0.20 level decrease in sleep duration, respectively.

Sleep duration as a mediator: Sleep duration, despite being small, had significant mediation effects on the association between screen time (TV) and suicidality (ideation, plan, and attempt) and on the association between screen time (internet, social media, etc.) suicidality (ideation, plan, and attempt). While screen time (TV) was not directly associated with suicidality, it was indirectly associated with suicidality through its association with sleep duration (β=0.02, p<0.05). Screen time (internet, social media, etc.) was directly associated with both sleep and suicidality and indirectly associated with suicidality through sleep which works as a mediator (β=0.06 for ideation and plan, β=0.05 for attempt, p<0.05) (Table 5).

Covariates, sleep duration, and suicidality: Lastly, compared to their male counterparts, female adolescents had significantly higher odds of having suicide ideation, making suicide plans, and conducting suicide attempts. Compared to Whites, Asian adolescents had a higher likelihood of having suicide ideation and making suicide plans; Blacks and Latinos had high odds in making suicide plans and conducting suicide attempts; adolescents with multiple races had a higher likelihood in all three aspects. Current tobacco use (cigarette-smoking and vaping), current alcohol drinking, ever having used substances, and ever having been bullied (physically and electronically) all increased the odds of having suicide ideation, making suicide plans, and conducting suicide attempts among U.S. adolescents.

Discussion

To explain the inconsistency of current literature on the association between screen time and suicidality among U.S. adolescents, this study examined the association of screen time, sleep duration, and suicidality among adolescents in the U.S., as well as the

Table 2

Association of demographics, sleep duration, screen time, social behaviors, and suicide

	Suicide Ideation (n, %)[h] n=13,437		Suicide Plan (n, %)[h] n=13,422		Suicide Attempt (n, %)[h] n=10,520	
	Yes n=2,633	No n=10,804	Yes n=2,151	No n=11,271	Yes n=1,067	No n=9,453
Sleep duration[a]						
Optimal sleep	358 (12.4)	2,541 (87.7)	294 (10.2)	2,590 (89.8)	153 (6.9)	2,064 (93.1)
Short sleep	1,370 (15.8)	7,295 (84.2)	637 (9.2)	6,320 (90.8)	1,688 (19.5)	6,979 (80.5)
Severe deprivation	420 (31.7)	905 (68.3)	226 (23.1)	751 (76.9)	493 (37.1)	835 (62.9)
		$p<.001^g$		$p<.001^g$		$p<.001^g$
Screen time[b] (TV)						
Recommended time	1,927 (19.2)	8,108 (80.8)	1,580 (15.8)	8,431 (84.2)	765 (9.7)	7,153 (90.3)
Excessive time	554 (21.7)	2,002 (78.3)	463 (18.1)	2,095 (81.9)	229 (11.9)	1,696 (88.1)
		$p<.01^g$		$p<.01^g$		$p<.01^g$
Screen time[b] (internet, social media, etc.)						
Recommended time	1,198 (16.8)	5,920 (83.2)	983 (13.8)	6,119 (86.2)	516 (9.4)	4,981 (90.6)
Excessive time	1,353 (23.1)	4,498 (76.9)	112 (19.0)	4,739 (81.0)	508 (10.8)	4,717 (89.2)
		$p<.001^g$		$p<.001^g$		$p<.05^g$
Sex						
Male	897 (14.0)	5,627 (86.0)	748 (11.5)	5,772 (88.5)	374 (7.4)	4,656 (92.6)
Female	1,691 (29.9)	5,098 (75.1)	1,366 (20.1)	5,415 (79.9)	644 (12.3)	4,725 (87.7)
		$p<.001^g$		$p<.001^g$		$p<.001^g$
Age[c]						
Young teen	358 (20.6)	1,377 (79.4)	297 (17.2)	1,428 (82.8)	149 (12.0)	1095 (88.0)
Teenager	1,970 (19.6)	8,076 (80.4)	1,607 (16.0)	8,434 (84.0)	799 (10.1)	7116 (89.9)
Young adults	291 (18.3)	1,300 (81.7)	237 (14.9)	1,354 (85.1)	113 (8.7)	1194 (91.4)
		P=.23		P=.19		**$p<.05^g$**
Race/ethnicity						
Native American	40 (28.8)	99 (71.2)	33 (23.4)	108 (76.6)	22 (21.6)	80 (78.4)
Asian[d]	132 (19.6)	541 (80.4)	112 (16.5)	565 (83.5)	42 (8.0)	478 (91.9)
Black	354 (17.7)	1,643 (82.3)	312 (15.7)	1,673 (84.3)	183 (14.6)	1069 (85.4)
White	1,273 (19.3)	5,314 (80.7)	996 (15.1)	5,590 (84.9)	446 (8.2)	5007 (91.8)
Latino	563 (18.8)	2,424 (81.2)	482 (16.1)	2,509 (83.9)	254 (10.6)	2139 (89.4)
Multiple	190 (29.1)	465 (70.9)	147 (22.6)	504 (77.4)	71 (14.2)	428 (85.8)
		$p<.001^g$		$p<.001^g$		$p<.001^g$

Table 2 (continued)

Smoking/vaping						
No	1,170 (15.0)	6,625 (85.0)	970 (12.4)	6,828 (87.6)	360 (6.0)	5,590 (94.0)
Yes	1,414 (25.9)	4,048 (74.1)	1,140 (20.9)	4,308 (79.7)	630 (14.3)	3,769 (85.7)
		p<.001[g]		p<.001[g]		p<.001[g]
Drinking alcohol						
No	1,417 (16.0)	7,419 (84.0)	1,150 (13.0)	7,688 (87.0)	498 (7.2)	6,385 (92.8)
Yes	992 (27.6)	2,608 (72.4)	825 (23.0)	2,763 (77.0)	411 (14.2)	2,486 (85.8)
		p<.001[g]		p<.001[g]		p<.001[g]
Substance use[e]						
No	825 (12.9)	5,574 (87.1)	685 (10.7)	5,716 (89.3)	255 (5.3)	4,585 (94.7)
Yes	1,798 (25.9)	5,152 (74.1)	1,456 (21.0)	5,474 (79.0)	805 (14.3)	4,825 (85.7)
		p<.001[g]		p<.001[g]		p<.001[g]
Being bullied[f]						
No	1,325 (13.3)	8,637 (86.7)	1,074 (10.8)	8,890 (89.2)	470 (6.1)	7,223 (93.9)
Yes	1,266 (37.6)	2,104 (62.4)	1,047 (31.1)	2,315 (68.9)	560 (20.4)	2,180 (79.6)
		p<.001[g]		p<.001[g]		p<.001[g]

Note.

[a.] Sleep duration includes three levels: optimal sleep (8 hours or more), short sleep (5-7 hours), and sleep deprivation (4 hours and less).

[b.] Screentime has two levels: recommended time (2 hours or less) and excessive time (more than 2 hours).

[c.] Age has three groups: young teen (12-14 years old), teenagers (15-17 years old), and young adults (18 years and older).

[d.] APIDA refers to Asian Pacific Islander Desi American.

[e.] Substance includes marijuana, synthetic marijuana, prescription pain killer without doctors` prescription, cocaine, ecstasy, heroin, and methamphetamines.

[f.] Being bullied by both physical bullying and cyberbullying.

[g.] p-values derived from chi-square analyses.

[h.] n represents number of participants, % represents the percentage of people that answers the suicide-related questions within each group population

Table 3

Logistic regression of sleep duration, screen time on suicide-related outcomes

	Suicide Ideation (n=11,055)		Suicide Plan (n=11,056)		Suicide Attempt (n=8,727)	
	OR (95% CI) [h]	p-value [i]	OR (95% CI) [h]	p-value [i]	OR (95% CI) [h]	p-value[i]
Sleep duration[a]						
Optimal sleep	Ref[g]					
Short sleep	1.68 (1.46-1.93)	<0.001	1.57 (1.36-1.83)	<0.001	1.19 (0.96-1.48)	0.17
Sleep deprivation	3.78 (3.14-4.55)	<0.001	3.47 (2.86-4.21)	<0.001	2.72 (2.08-3.55)	<0.001
Screen time[b] (TV)						
Recommended time	Ref[g]					
Excessive time	1.01 (0.90-1.15)	0.80	1.05 (0.92-1.21)	0.80	0.99 (0.82-1.20)	0.96
Screen time[b] (internet, social media, etc.)						
Recommended time	Ref[g]					
Excessive time	1.47 (1.34-1.63)	<0.001	1.41 (1.26-1.57)	<0.001	1.19 (1.02-1.40)	<0.05
Sex						
Male	Ref[g]					
Female	2.00 (1.80-2.23)	<0.001	1.81 (1.62-2.02)	<0.001	1.81(1.54-2.15)	<0.001
Age [c]						
Young teen	Ref[g]					
Teenager	0.93 (0.80-1.08)	0.33	0.94 (0.80-1.10)	0.46	0.89 (0.70-1.13)	0.34
Young adults	0.89 (0.72-1.09)	0.26	0.86 (0.69-1.07)	0.18	0.72 (0.52-1.99)	<0.05
Race/ethnicity						
White	Ref[g]					
Native American	1.26 (0.84-1.89)	0.26	1.36 (0.88-2.08)	0.16	1.55 (0.84-2.86)	0.16
Asian (APIDA)[d]	1.39 (1.10-1.75)	<0.01	1.49 (1.17-1.91)	<0.01	1.22 (0.80-1.85)	0.36
Black	1.04 (0.87-1.22)	0.64	1.22 (1.04-1.44)	<0.05	2.06 (1.62-2.61)	<0.001
Latino	1.05 (0.92-1.20)	0.44	1.15 (1.00-1.32)	<0.05	1.32 (1.09-1.61)	<0.01
Multiple	1.81 (1.47-2.23)	<0.001	1.52 (1.22-1.90)	<0.001	2.11 (1.56-2.86)	<0.001
Current smoking or vaping						
No	Ref[g]					
Yes	1.66 (1.47-1.86)	<0.001	1.58 (1.40-1.79)	<0.001	2.02 (1.70-2.41)	<0.001
Current drinking alcohol						
No	Ref[g]					
Yes	1.39 (1.24-1.56)	<0.001	1.46 (1.30-1.65)	<0.001	1.40 (1.18-1.67)	<0.001
Ever used substance[e]						
No	Ref[g]					
Yes	4.13 (2.33-7.32)	<0.001	3.00 (1.78-5.05)	<0.001	3.08 (1.68-5.65)	<0.001

Table 3 (continued)

Ever being bullied[f]

No	Ref[g]					
Yes	3.78 (3.29-4.34)	<0.001	3.04 (2.64-3.50)	<0.001	3.41 (2.82-4.11)	<0.001

Note.

[a.] Sleep duration includes three levels: optimal sleep (8 hours or more), short sleep (5-7 hours), and sleep deprivation (4 hours and less).

[b.] Screentime has two levels: recommended time (2 hours or less) and excessive time (more than 2 hours).

[c.] Age has three groups: young teen (12-14 years old), teenagers (15-17 years old), and young adults (18 years and older).

[d.] APIDA refers to Asian Pacific Islander Desi American.

[e.] Substance includes marijuana, synthetic marijuana, prescription pain killer without doctors` prescription, cocaine, ecstasy, heroin, and methamphetamines.

[f.] Being bullied by both physical bullying and cyberbullying.

[g.] Ref indicates reference group being compared to.

[h.] OR represents the odds ratio computed by logistic regression analyses. 95% CI means 95% confident interval as point estimates.

[i.] p value is derived from logistic regression analyses.

Table 4

Regression of sleep duration, screentime, and covariates

Sleep Duration[a]	Coefficient	P-value
Screen time[b] (TV)		
Recommended time	Ref[g]	
Excessive time	-0.08	<0.05
Screen time[b] (internet, social media, etc.)		
Recommended time	Ref[g]	
Excessive time	-0.20	<0.001
Sex		
Male	Ref[g]	
Female	-0.13	<0.001
Age [c]		
Young teen	Ref[g]	
Teenager	-0.21	<0.001
Young adults	-0.36	<0.001
Race/ethnicity		
White	Ref[g]	
Native American	-0.29	<0.01
Asian (APIDA)[d]	-0.31	<0.001
Black	-0.33	<0.001
Latino	-0.09	<0.01
Multiple	-0.20	<0.01
Current smoking or vaping		
No	Ref[g]	
Yes	-0.22	<0.001
Current drinking alcohol		
No	Ref[g]	
Yes	-0.24	<0.001
Ever used substance[e]		
No	Ref[g]	
Yes	-0.55	<0.01
Ever being bullied[f]		
No	Ref[g]	
Yes	-0.26	<0.001

Note.

[a.] Sleep duration is treated as a continuous variable (1=4 hours or less, 2=5 hours, 3=6hours, 4=7 hours, 5=8 hours, 6=9 hours, 7=10 hours or more).

[b.] Screen time has two levels: recommended time (2 hours or less) and excessive time (more than 2 hours).

[c.] Age has three groups: young teens (12-14 years old), teenagers (15-17 years old), and young adults (18 years and older).

[d.] APIDA refers to Asian Pacific Islander Desi American.

[e.] Substance includes marijuana, synthetic marijuana, prescription pain killer without doctors` prescription, cocaine, ecstasy, heroin, and methamphetamines.

[f.] Being bullied by both physical bullying and cyberbullying.

[g.] Ref indicates reference group being compared to.

Table 5

Bootstrapping method of sleep duration as a mediator

	Suicide Ideation		Suicide Plan		Suicide Attempt	
	Coef[a]	BC 95% CI[b]	Coef[a]	BC 95% CI[b]	Coef[a]	BC 95% CI[b]
Screen time (TV)-sleep -Y	0.02	0.004, 04	0.02	0.004, 0.04	0.02	0.01, 0.05
Screen time (internet, etc.)-sleep-Y	0.06	0.04, 0.07	0.06	0.04, 0.07	0.05	0.03, 0.05

Note.
[a] Coef refers to coefficient
[b] BC 95% CI refers to the Bia-corrected 95% confident interval

mediation effect of sleep duration on the associations between different screen time types/levels and suicidality. Align with previous studies (Twenge & Farley, 2020; Spiller et al., 2019), adolescents with excessive screen time on social media/internet showed a significant increase in the odds of suicidality, compared to adolescents with recommended screen time. Long exposure to instant rewarding experiences on social media, such as seeing likes and positive comments (Wilmer & Chein, 2016), might harm mental health and cognitive functioning. For adolescents, chronic stimulation of the undeveloped brain reward system could hinder cognitive regulation (Liang et al., 2014) and lead to a decreased capability of delayed gratification (Lembke., 2021; Wilmer & Chein, 2016). Long-term exposure to instant pleasure stimulation disrupts the homeostasis of dopamine secretion, which could engender poor emotion control and lead to mental health problems and their associated risk behaviors, including suicide (Lembke, 2021).

Furthermore, social media has created negative consequences, such as fear of missing out (FOMO) from social engagement, which is associated with psychological dependence on social media (Alutaybi et al., 2020). The attachment to social media is associated with numerous negative consequences, such as lack of sleep, emotional tensions, stress, anxiety, poor impulse control, and poor emotion regulation (Cham et al., 2019; Altuwairiqi et al., 2019).

In addition, adolescents are sensitive to social comparison and connection/rejection on social media (Nesi et al., 2017) and frequently reported being angry and anxious when rejected or experiencing negative social interactions on social media (Ortega et al., 2012; Nocentini et al., 2010). There was also a reluctance to share or report negative social media experiences among adolescents, which could further lead to social isolation and hopelessness (Schneider et al., 2012). Therefore, rather than expressing emotions outward, adolescents might turn negative emotions inward and conduct self-harm behaviors. Lastly, long screen time is the sacrifice of time on exercise, sleep, and interpersonal interaction, which are helpful for mental health among adolescents.

Additionally, this study found that sleep duration is negatively associated with screen time (Parent et al., 2016; Dube et al., 2017; Cain & Gradisar, 2010) and positively associated with suicidality (Chiu et al., 2018; Kearns et al., 2020. The role of sleep duration is pivotal in brain development (Aepli et al., 2015). Insufficient sleep duration hinders the

growth and development of multiple brain regions, such as the cognitive functioning region: the prefrontal cortex (Cheng et al., 2021; Euston et al., 2012). The underdeveloped cognitive brain regions make adolescents more prone to impulsive behaviors, such as suicide, compared to well-developed individuals. In addition, sleep-deprived individuals showed over 60% overactivation of the amygdala, which leads to anger, rage, and inappropriate emotional reactions, and further infringes on the regulatory function of the prefrontal cortex (PFC) on impulsive emotional regulation (Walker, 2017).

Besides the negative impacts of short sleep duration on brain development and functioning, scholars also indicated that short sleep has endocrinological impacts such as increased secretion of stress hormone glucocorticoids, which make people more agitated and stressed (Meerlo et al., 2002). The impaired cognitive functioning and mental state caused by short sleep duration (Colrain & Baker, 2011; Zelinski et al., 2014; Dahl & Lewin, 2002) could engender suicidality, including suicide ideations, plans, and behaviors (Chiu et al., 2018; Kearns et al., 2020).

Previous studies have indicated the mediating effects of sleep duration between screen time and mental health outcomes (Nuutinen et al, 2014; Li et al., 2019; Tao et al., 2017). The results of this study added its mediating effects between screen time and suicidality and the different mediation effects through different screen time types (TV, internet, social media, etc.). Despite screen time on TV not being directly associated with suicidality, the indirect association with suicidality through sleep duration was revealed in this study.

Lastly, there were no differences in suicidality across the various age groups, which is different from previous findings that indicated age was a significant factor in adolescent suicidality (Nahapetyan et al., 2014). Consistent with previous studies (Nahapetyan et al., 2014; Miranda-Mendizabal et al., 2019), our study also revealed sex differences in suicidality, in which girls had higher odds of suicidality. For race/ethnicity, aligned with previous studies (Chan et al., 2022; Iwatate et al., 2023), compared to White adolescents, Black, Latino, Asian, and adolescents with multiple races had higher odds in at least one of the three suicidality components. Like previous findings (Iwatate et al., 2023), substance abuse and being bullied were significantly associated with higher odds in all stages of suicidality. Furthermore, both current alcohol drinkers and current smokers/vapers were more likely to have suicide ideations, make suicide plans, and conduct suicide attempts, compared to non-drinkers and non-smokers/vapers.

Limitations

Limitations of the study need to be realized. The YRBS 2019 data relies on self-report instruments, which are subject to bias. The data only applies to adolescents who attended school on the day when the survey was distributed; therefore, it could not represent all potential participants. The cross-sectional data can only indicate associations instead of causation. There are potential biases in using cross-sectional data for mediation analysis; to compensate, we also use alternative models to test the direct associations across the variables. Furthermore, suicide ideation, suicide plan, and suicide attempt were not clearly stated in the survey; therefore, participants might have different perceptions on the matter, thus, engendering bias. More general limitations are available in the overview report (Underwood et al., 2020).

Conclusion

The association between screen time and suicidality among U.S. adolescents is multifaceted. Excessive screen time on the internet and social media has a direct association with higher odds of suicidality and an indirect association through the mediating effects of sleep duration. Despite having no direct associations with suicidality, screen time on TV is indirectly associated with suicidality through its association with sleep duration. The sex differences in suicidality and sleep have also been revealed in this study. Future research could focus on sex differences in the associations of screen time, sleep, and suicidality.

Implication for Health Behavior Research

Suicidality among U.S. adolescents has become an important public health issue. Screen usage has become one of the risky behaviors that lead to suicidality. To minimize the negative effects on mental health and suicidality, health behavior researchers need to understand the nuanced associations of screen time duration, screen devices, and screen content on mental health and its associated health behavior: suicidality. Furthermore, sleep, as a pillar of health, should be addressed more within adolescent education. Specifically, the significance of sleep to health and guidelines for quality sleep should be covered in education curriculums.

Discussion Questions

The current study indicates that short sleep durations and excessive screen time on social media increased the odds of engaging in suicidal behaviors among U.S. adolescents. What types of interventions can health educators and other professionals use to decrease screen time use on social media and to enhance sleep duration for adolescents?

IRB

References

Aepli, A., Kurth, S., Tesler, N., Jenni, O., & Huber, R. (2015). Caffeine consuming children and adolescents show altered sleep behavior and Deep Sleep. *Brain Sciences, 5*(4): 441–455. doi: 10.3390/brainsci5040441

Altuwairiqi, M., Jiang, N., & Ali, R. (2019). Problematic attachment to social media: Five behavioural archetypes. *International Journal of Environmental Research and Public Health*, *16*(12). https://doi.org/10.3390/ijerph16122136

Alutaybi, A., Dena, A., John, M., & Raian, A. (2020). Combating fear of missing out (FoMO) on social media: The FoMO-R Method. *International Journal of Environmental Research and Public Health,* (17). https://doi.org/10.3390/ijerph17176128

Artner, J., Cakir, B., Spiekermann, J., Kurz, S., Leucht, F., Reichel, H., & Lattig, F. (2013). Prevalence of sleep deprivation in patients with chronic neck and back pain: A retrospective evaluation of 1016 patients. *Journal of Pain Research*, *1*. https://doi.org/10.2147/jpr.s36386

Ashton, J. J., & Beattie, R. M. (2019). Screen Time in children and adolescents: Is there evidence to guide parents and policy? *The*

Lancet Child & Adolescent Health, *3*(5), 292–294. https://doi.org/10.1016/s2352-4642(19)30062-8

Babic, M. J., Smith, J. J., Morgan, P. J., Eather, N., Plotnikoff, R. C., & Lubans, D. R. (2017). Longitudinal associations between changes in screen-time and Mental Health Outcomes in adolescents. *Mental Health and Physical Activity*, *12*, 124–131. https://doi.org/10.1016/j.mhpa.2017.04.001

Barnett, T. A., Kelly, A. S., Young, D. R., Perry, C. K., Pratt, C. A., Edwards, N. M., Rao, G., & Vos, M. B. (2018). Sedentary behaviors in today's youth: Approaches to the Prevention and management of Childhood Obesity: A scientific statement from the American Heart Association. *Circulation*, *138*(11). https://doi.org/10.1161/cir.0000000000000591

Cain, N., & Gradisar, M. (2010). Electronic media use and sleep in school-aged children and adolescents: A Review. *Sleep Medicine*, *11*(8), 735–742. https://doi.org/10.1016/j.sleep.2010.02.006

Canadian Society for Exercise Physiology. (2021). Canadian Society for Exercise Physiology guidelines. https://csepguidelines.ca/

Centers for Disease Control and Prevention. (2020, September 10). *Sleep in Middle and High School Students.* Centers for Disease Control and Prevention. https://www.cdc.gov/healthyschools/features/students-sleep.htm#:~:text=Importance%20of%20Sleep,usually%20got%20on%20school%20nights.

Centers for Disease Control and Prevention. (2023, December 5). *FastStats - suicide and self-inflicted injury*. Centers for Disease Control and Prevention.
https://www.cdc.gov/nchs/fastats/suicide.htm.

Cham, S., Algashami, A., Aldhayan, M., McAlaney, J., Phalp, K., Almourad, M. B., & Ali, R. (2019). Digital addiction: Negative life experiences and potential for technology-assisted solutions. *Advances in Intelligent Systems and Computing*, 921–931. https://doi.org/10.1007/978-3-030-16184-2_87

Chan, K. T.-K., Zhou, S., & Marsack-Topolewski, C. (2022). Race differences in opioid misuse and adolescent suicidality. *Child and Adolescent Social Work Journal*, *39*(2), 167–181. https://doi.org/10.1007/s10560-020-00721-0

Cheng, W., Rolls, E., Gong, W, Du, J., Zhang, J., Zhang, XY., Li, F., & Feng, J. (2021). Sleep duration, brain structure, and psychiatric and cognitive problems in children. *Molecular Psychiatry*, *26*(8), 3992–4003. doi:10.1038/s41380-020-0663-2

Chiu, H.-Y., Lee, H.-C., Chen, P.-Y., Lai, Y.-F., & Tu, Y.-K. (2018). Associations between sleep duration and suicidality in adolescents: A systematic review and dose–response meta-analysis. *Sleep Medicine Reviews*, *42*, 119–126. https://doi.org/10.1016/j.smrv.2018.07.003

Colrain, I. M., & Baker, F. C. (2011). Changes in sleep as a function of adolescent development. *Neuropsychology Review*, *21*(1), 5–21. https://doi.org/10.1007/s11065-010-9155-5

Curtin, S., & Garnett, M. (2023). *Suicide and Homicide Death Rates among Youth and Young Adults Aged 10–24: United States, 2001–2021.* https://doi.org/10.15620/cdc:128423

Dahl, R. E., & Lewin, D. S. (2002). Pathways to adolescent health sleep

regulation and behavior. *Journal of Adolescent Health*, *31*(6), 175–184. https://doi.org/10.1016/s1054-139x(02)00506-2

Dube, N., Khan, K., Loehr, S., Chu, Y., & Veugelers, P. (2017). The use of entertainment and communication technologies before sleep could affect sleep and weight status: A population-based study among children. *International Journal of Behavioral Nutrition and Physical Activity*, *14*(1). https://doi.org/10.1186/s12966-017-0547-2

Euston, D.R., Gruber, A.J., & McNaughton, B.L. (2012). The role of medial prefrontal cortex in memory and decision making. *Neuron, 76*(6), 1057–1070. https://doi.org/10.1016/j.neuron.2012.12.002

Gallup Organization (2023, October 13). *Teens Spend Average of 4.8 Hours on Social Media Per Day*. https://news.gallup.com/poll/512576/teens-spend-average-hours-social-media-per-day.aspx

Hirshkowitz, M., Whiton, K., Albert, S. M., Alessi, C., Bruni, O., DonCarlos, L., Hazen, N., Herman, J., Katz, E. S., Kheirandish-Gozal, L., Neubauer, D. N., O'Donnell, A. E., Ohayon, M., Peever, J., Rawding, R., Sachdeva, R. C., Setters, B., Vitiello, M. V., Ware, J. C., & Adams Hillard, P. J. (2015). National Sleep Foundation's sleep time duration recommendations: Methodology and results summary. *Sleep Health*, *1*(1), 40–43. https://doi.org/10.1016/j.sleh.2014.12.010

Iwatate, E., Atem, F. D., Jones, E. C., Hughes, J. L., Yokoo, T., & Messiah, S. E. (2023). Association of obesity, suicide attempts, and psychosocial wellness among adolescents in the United States. *Journal of Adolescent Health*, *72*(4),

526–534. https://doi.org/10.1016/j.jadohealth.2022.11.240

Kearns, J. C., Coppersmith, D. D. L., Santee, A. C., Insel, C., Pigeon, W. R., & Glenn, C. R. (2020). Sleep problems and suicide risk in youth: A systematic review, Developmental Framework, and implications for hospital treatment. *General Hospital Psychiatry*, *63*, 141–151. https://doi.org/10.1016/j.genhosppsych.2018.09.011

Lembke, A. (2021). Dopamine nation: finding balance in the age of indulgence. [New York, New York], Dutton, an imprint of Penguin Random House LLC.

Li, X., Buxton, O. M., Lee, S., Chang, A.-M., Berger, L. M., & Hale, L. (2019). Sleep mediates the association between adolescent screen time and depressive symptoms. *Sleep Medicine*, *57*, 51–60. https://doi.org/10.1016/j.sleep.2019.01.029

Liang, J., Matheson, B.E., Kaye, W.H., & Boutelle, K.N. (2014). Neurocognitive correlates of obesity and obesity-related behaviors in children and adolescents. *International Journal of Obesity, 38*(4), 494–506. https://doi.org/10.1038/ijo.2013.142

Mantey, D. S., Yockey, R. A., & Springer, A. E. (2023). Digital Screen Time and suicidality during high school: How important is cyberbullying? A mediation analysis using the Youth Risk Behavioral Surveillance Survey, 2011–2019. *Preventive Medicine*, 166. https://doi.org/10.1016/j.ypmed.2022.107330

McMakin, D. L., Ricketts, E. J., Forbes, E. E., Silk, J. S., Ladouceur, C. D., Siegle, G. J., Milbert, M., Trubnick, L., Cousins, J. C., Ryan, N. D., Harvey, A. G., & Dahl, R. E. (2019). Anxiety treatment and targeted sleep enhancement to address

sleep disturbance in pre/early adolescents with anxiety. *Journal of Clinical Child & Adolescent Psychology*, *48*. https://doi.org/10.1080/15374416.2018.1463534

Meerlo, P., Koehl, M., Van Der Borght, K., & Turek, F. W. (2002). Sleep restriction alters the hypothalamic-pituitary-adrenal response to stress. *Journal of Neuroendocrinology*, *14*(5), 397–402. https://doi.org/10.1046/j.0007-1331.2002.00790.x

Miranda-Mendizabal, A., Castellví, P., Parés-Badell, O., Alayo, I., Almenara, J., Alonso, I., Blasco, M. J., Cebrià, A., Gabilondo, A., Gili, M., Lagares, C., Piqueras, J. A., Rodríguez-Jiménez, T., Rodríguez-Marín, J., Roca, M., Soto-Sanz, V., Vilagut, G., & Alonso, J. (2019). Gender differences in suicidal behavior in adolescents and young adults: Systematic review and meta-analysis of longitudinal studies. *International Journal of Public Health*, *64*(2), 265–283. https://doi.org/10.1007/s00038-018-1196-1

Nahapetyan, L., Orpinas, P., Song, X., & Holland, K. (2014). Longitudinal Association of Suicidal Ideation and physical dating violence among high school students. *Journal of Youth and Adolescence*, *43*(4), 629–640. https://doi.org/10.1007/s10964-013-0006-6

Nesi, J., Miller, A. B., & Prinstein, M. J. (2017). Adolescents' depressive symptoms and subsequent technology-based Interpersonal Behaviors: A multi-wave study. *Journal of Applied Developmental Psychology*, *51*, 12–19. https://doi.org/10.1016/j.appdev.2017.02.002

Nocentini, A., Calmaestra, J., Schultze-Krumbholz, A., Scheithauer, H., Ortega, R., & Menesini, E. (2010). Cyberbullying: Labels, behaviours and definition in three European countries. *Australian Journal of Guidance and Counselling, 20*(2), 129–142. https://doi.org/10.1375/ajgc.20.2.129

Nuutinen, T., Roos, E., Ray, C., Villberg, J., Välimaa, R., Rasmussen, M., Holstein, B., Godeau, E., Beck, F., Léger, D., & Tynjälä, J. (2014). Computer use, sleep duration and health symptoms: A cross-sectional study of 15-year olds in three countries. *International Journal of Public Health*, *59*(4), 619–628. https://doi.org/10.1007/s00038-014-0561-y

Orben, A., & Przybylski, A. K. (2019). The association between adolescent well-being and digital technology use. *Nature Human Behaviour*, *3*(2), 173–182. https://doi.org/10.1038/s41562-018-0506-1

Ortega, R., Elipe, P., Mora-Merchán, J. A., Genta, M. L., Brighi, A., Guarini, A., Smith, P. K., Thompson, F., & Tippett, N. (2012). The emotional impact of bullying and cyberbullying on victims: A European cross-national study. *Aggressive Behavior, 38*(5), 342–356. https://doi.org/10.1002/ab.21440

Parent, J., Sanders, W., & Forehand, R. (2016). Youth Screen Time and behavioral health problems. *Journal of Developmental & Behavioral Pediatrics*, *37*(4), 277–284. https://doi.org/10.1097/dbp.0000000000000272

Paruthi, S., Brooks, L. J., D'Ambrosio, C., Hall, W. A., Kotagal, S., Lloyd, R. M., Malow, B. A., Maski, K., Nichols, C., Quan, S. F., Rosen, C. L., Troester, M. M., & Wise, M. S. (2016). Consensus statement of the American Academy of Sleep Medicine on the recommended amount of sleep for Healthy Children: Methodology and discussion. *Journal of*

Clinical Sleep Medicine, *12*(11), 1549–1561. https://doi.org/10.5664/jcsm.6288

Roberts, R. E., & Duong, H. T. (2017). Is there an association between short sleep duration and adolescent anxiety disorders? *Sleep Medicine*, *30*, 82–87. https://doi.org/10.1016/j.sleep.2016.02.007

Schneider, S. K., O'Donnell, L., Stueve, A., & Coulter, R. W. (2012). Cyberbullying, school bullying, and psychological distress: A regional census of high school students. *American Journal of Public Health,* *102*(1), 171–177. https://doi.org/10.2105/ajph.2011.300308

Simola, P., Liukkonen, K., Pitkäranta, A., Pirinen, T., & Aronen, E. T. (2014). Psychosocial and somatic outcomes of sleep problems in children: A 4-year follow-up study. *Child: Care, Health and Development*, *40*(1), 60–67. https://doi.org/10.1111/j.1365-2214.2012.01412.x

Spiller, H. A., Ackerman, J. P., Spiller, N. E., & Casavant, M. J. (2019). Sex- and age-specific increases in suicide attempts by self-poisoning in the United States among youth and Young Adults from 2000 to 2018. *The Journal of Pediatrics*, *210*, 201–208. https://doi.org/10.1016/j.jpeds.2019.02.045

Stiglic, N., & Viner, R. M. (2019). Effects of screentime on the health and well-being of children and adolescents: A systematic review of reviews. *BMJ Open*, *9*(1). https://doi.org/10.1136/bmjopen-2018-023191

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*.

https://doi.org/10.1016/j.cpr.2021.102021

Tao, S., Wu, X., Zhang, Y., Zhang, S., Tong, S., & Tao, F. (2017). Effects of sleep quality on the association between problematic mobile phone use and mental health symptoms in Chinese College students. *International Journal of Environmental Research and Public Health*, *14*(2), 185. https://doi.org/10.3390/ijerph14020185

Twenge, J. M., Cooper, A. B., Joiner, T. E., Duffy, M. E., & Binau, S. G. (2019). Age, period, and cohort trends in mood disorder indicators and suicide-related outcomes in a Nationally Representative Dataset, 2005–2017. *Journal of Abnormal Psychology*, *128*(3), 185–199. https://doi.org/10.1037/abn0000410

Twenge, J. M., & Farley, E. (2021). Not all screen time is created equal: Associations with mental health vary by activity and gender. *Social Psychiatry and Psychiatric Epidemiology*, *56*(2), 207–217. https://doi.org/10.1007/s00127-020-01906-9

Underwood, J. M., Brener, N., Thornton, J., Harris, W. A., Bryan, L. N., Shanklin, S. L., Deputy, N., Roberts, A. M., Queen, B., Chyen, D., Whittle, L., Lim, C., Yamakawa, Y., Leon-Nguyen, M., Kilmer, G., Smith-Grant, J., Demissie, Z., Jones, S. E., Clayton, H., & Dittus, P. (2020). Overview and methods for the youth risk behavior surveillance system — United States, 2019. *MMWR Supplements*, *69*(1), 1–10. https://doi.org/10.15585/mmwr.su6901a1

Walker, M. (2017). *Why we sleep*. Scribner.

Wilmer H. H., & Chein J. M. (2016). Mobile technology habits: Patterns of association among device usage, intertemporal preference, impulse control, and reward sensitivity. *Psychonomic Bulletin & Review,* *23*(5), 1607–1614.

https://doi.org/10.3758/s13423-016-1011-z

Zelinski, E. L., Deibel, S. H., & McDonald, R. J. (2014). The trouble with circadian clock dysfunction: Multiple deleterious effects on the brain and body. *Neuroscience & Biobehavioral Reviews*, *40*, 80–101. https://doi.org/10.1016/j.neubiorev.2014.01.007