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Social Media Use and Sleep Outcomes among Adolescents at High Risk for Suicide

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Abstract

Sleep is a modifiable risk factor for suicidal thoughts and behaviors in adolescents, and social media use may be one factor linked to sleep outcomes. The current study examined self-reported subjective daytime and nighttime social media use (SMU) as a predictor of both subjective and objectively- captured sleep (timing, duration, and quality) among adolescents at high risk for suicide in an intensive outpatient program (IOP) for depression and suicidality. Data from two studies were used to evaluate these relationships for one month; Study 1 as part of standard clinical care among adolescents ($N=95$, 75% female) and Study 2 as part of an intensive monitoring study among adolescents and young adults in the IOP ($N=30$, 67% female). Multilevel modeling indicated that adolescents with more nighttime subjective SMU experienced later self-reported sleep timing and daily SMU predicted poorer sleep quality (Study 1). Both daytime and nighttime subjective SMU predicted later sleep timing as assessed by actigraphy (Study 2). Subjective SMU did not predict sleep duration or quality in Study 2. Findings suggest that SMU may be one actionable factor to improve sleep timing, which has implications for suicide prevention among individuals at high risk for suicide.

Keywords Subjective social media use · Sleep · Actigraphy · Adolescence · Suicide risk

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Introduction

Poor sleep health is a significant risk factor for depression and suicide-related outcomes in adolescents and young adults, including suicidal thoughts, suicidal behaviors, and even death by suicide (e.g., Goldstein & Franzen, 2022; Goldstein et al., 2008; Liu et al., 2020; Roberts et al., 2009). Sleep is a promising target for suicide prevention and interventions because it is dynamic (i.e., fluctuates on a day-to-day basis) and actionable, as there are existing and effective sleep interventions (e.g., Griggs et al., 2020; Åslund et al., 2018; Dong et al., 2020). Understanding factors that affect sleep health is critical to improve sleep and suicide-related outcomes in youth, particularly among adolescents and young adults who are at high risk for suicide.

One factor that may impact sleep is social media use (SMU), particularly in adolescents and young adults. In recent years, there has been a significant increase in SMU, with the majority of adolescents having at least one SMU account and 95% owning a smartphone (Vogels et al., 2022). SMU can benefit teens' mental health and well-being, such as facilitating social connectedness and identity development (Hamilton et al., 2020b). Yet, recent research also suggests that SMU may interfere with sleep (e.g., Scott & Woods, 2019), including *when* teens fall asleep (i.e., sleep start timing), *how much* sleep teens receive (i.e., sleep duration), and *how well* teens sleep (i.e., perceived sleep quality). Indeed, more SMU on a typical day has been found to be associated with insufficient sleep (e.g., Charmaraman et al., 2021), poor sleep quality (Levenson et al., 2016), daytime sleepiness (Hamilton & Lee, 2021), later sleep timing (e.g., Scott & Woods, 2018; Scott & Woods, 2019; LeBourgeois et al., 2017), and variability of sleep timing and duration among adolescents (Hamilton et al., 2020a, b). Nighttime SMU may be particularly important to consider when evaluating its effects on sleep given its potential to displace sleep (i.e., take away time spent sleeping), suppress the release of melatonin indirectly through light exposure at night, and induce positive and/or negative experiences to SMU, either of which could induce arousal and interfere with sleep onset (e.g., Carter et al., 2016; Hale & Guan, 2015). Studies of nighttime SMU on sleep are mixed; some research indicates that more SMU at nighttime is associated with poorer perceived sleep quality and sleep disturbance (Levenson et al., 2017), shorter sleep duration (Scott & Woods, 2018), later bedtime (Orzech et al., 2016), lower sleep efficiency (Fobian et al., 2016), later sleep onset (Hale et al., 2018), and poorer sleep health (i.e., habits which promote or inhibit sleep; Tandon et al., 2020) among adolescents and young adults. However, other studies have found no effects of nighttime SMU on sleep outcomes (Orben & Przybylski, 2020), which may be due to different methodological designs and assessment of SMU and sleep domains.

Despite recent advances in our understanding of SMU and sleep, there continue to be key methodological and design limitations upon which this study seeks to improve. Most research to date uses cross-sectional designs, which limit conclusions regarding temporality (e.g., those with poor sleep may be more likely to have nighttime SMU), and only include self-report measures of sleep and SMU. There are a few notable exceptions using daily measures or actigraphic methods in adolescents (e.g.,Burnell et al., 2021; Harbard et al., 2016). For instance, a large, nationally- representative study in the United Kingdom used time-use diaries and found no association between bedtime digital media use and sleep outcomes in adolescents (Orben & Przybylski, 2020). One study found that daily digital technology for non-academic purposes and messaging with peers was associated with shorter objective and subjective sleep duration over a 3-day period (Burnell et al., 2021), though neither specifically evaluated SMU. Further, a daily diary study of SMU and sleep in adolescent girls found only cross-sectional associations between SMU and sleep timing over 10 days during COVID-19, with no effect on sleep duration or quality (Hamilton et al., 2022). These findings highlight the importance of evaluating SMU and sleep outcomes on a more fine-grained scale and with objective metrics of behavioral sleep.

Further, most studies of SMU and sleep have focused on community samples of adolescents. While the SMU-sleep associations are important to understand in general adolescent and young adult populations, the consequences of poor sleep may be particularly dire among adolescents who are at high-risk for suicide (Kearns et al., 2020; Liu et al., 2020). For example, one study using actigraphy and daily reports of affective reactivity and suicidal ideation found that individual nights of shorter or poorer sleep affected the occurrence and intensity of suicidal thoughts the next day through emotional responses to interpersonal events (Hamilton et al., 2023). Further, a recent cross-sectional study of psychiatrically hospitalized adolescents found that teens who had more frequent negative emotional responses to SMU also had greater sleep disturbance and higher clinical symptom severity (Nesi et al., 2021b). Thus, youth who have depression or suicidal thoughts may experience heightened emotions in response to experiences during SMU (Nesi et al., 2021a, b), which may disrupt sleep and further exacerbate risk for suicidal thoughts and behaviors (e.g., Liu, 2004; Liu et al., 2020). These findings highlight the importance of studying SMU and sleep among adolescents who are at high-risk for suicide (as well as depression and other adverse mental health outcomes), who may be particularly vulnerable to the negative effects of SMU (e.g., Das-Friebel et al., 2020). Further, identifying the extent to which *nighttime* SMU may affect sleep in a youth population at high risk for suicide may provide more concrete recommendations for intervening on SMU in ways that are evidence-based and actionable, as well as specific time recommendations when teens and parents can implement change around SMU to potentially reduce risk for suicide.

The Current Studies

The current manuscript examines the associations between SMU during the day and at nighttime (assessed at baseline) and subsequent sleep outcomes over the next month (30 days) of an intensive outpatient program (IOP) among adolescents and young adults. Secondary data analyses were conducted with two data sources to evaluate these associations among adolescents and young adults from the IOP programs. Data for Study 1 were collected as part of standard clinical care in the IOP from any IOP patient who provided consent for their research to be used (i.e., those who enrolled in a research registry within the clinic). Study 2 included individuals enrolled in the IOP and recruited to participate in a separately-funded intensive monitoring study for up to three months. Subjective SMU was assessed using self-reported surveys at baseline in both studies, which may not accurately reflect SMU (Parry et al., 2021, 2022) and may be biased by depression symptoms (Sewall et al., 2020). Despite this, an individuals' estimate of SMU may be helpful in clinical settings if associated with risk factors for suicide, such as sleep, and provide a relatively accessible clinical tool for assessment. Sleep outcomes were assessed daily or weekly over the first month after the initial evaluation, and objective methods for behavioral sleep were used in Study 2. Given the dynamic nature of SMU (Hamilton et al., 2022), the first month after completion of baseline SMU was selected to identify the more proximal effects of SMU on sleep outcomes. It was hypothesized that nighttime SMU, but not daytime SMU, would be associated with shorter, later, and poorer sleep as assessed via self-report (Study 1; Study 2) and actigraphy (Study 2).

Method

Participants and Recruitment for Study 1 and Study 2

Adolescents at high risk for suicidal behavior were recruited from two Intensive Outpatient Programs (IOP)— one serving adolescents in secondary school (age 13–18) and one for college students (age 18–25) with depression and suicidality in separate sessions. Study 1 included only adolescents (13–18 years), whereas Study 2 included both adolescents and college students (18–25 years). This IOP often serves as a hospital diversion and/or as a step-down from inpatient care (see Hamilton et al., 2021 for more details), and includes 9 h of treatment per week (3 h each/ 3 days per week) consisting of skills groups, individual psychotherapy, and medication management. The Institutional Review Board approved both study procedures. More detail is provided below about the specific methods of each study.

Study 1: IOP Treatment Study

Participants and Procedure

Participants included 95 adolescents (13–18 years) who were enrolled and participated in the specialized IOP program during the period of data collection from March 2019- March 2020 (prior to COVID-19 shutdown). Study measures were completed as a part of standard clinical care within the IOP for youth who agreed to enroll in the research registry (i.e., signed informed consent forms granting permission for their data to be used in research). This included intake (baseline) measures, followed by weekly measures completed during the participant's scheduled IOP sessions.

Measures

Subjective Social Media Use At the baseline assessment, participants responded to items about SMU, including daily SMU (e.g., Instagram, Facebook, etc.) on a typical day over the past month. Participants responded on a scale from 0–5: "Less than 30 min", "30 min to 1 h", "more than 1 h to 2 h", "more than 2 h to 3 h", "more than 3 h to 4 h", and "more than 4 h". In addition, participants reported how much social media they used before sleep: "On a typical night, how much time do you use social media in bed before falling asleep at night? ". Participants responded on a scale from 0–5: "Less than 30 min" (0), "30 min to 1 h", "more than 1 h to 2 h", "more than 2 h to 3 h", "more than 3 h to 4 h", and "more than 4 h" (5). Due to limited responses for more than 2 h for nighttime SMU, responses were recoded from 0–3, with responses of more than 2 h in one category.

Sleep Subjective sleep quality was measured using the Pittsburgh Sleep Quality Index (PSQI), which asks participants to rate their sleep quality and disturbance (Buysse et al., 1989). The PSQI includes subjective measures of sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medication, and daytime dysfunction. In the current study, participants reported their perceptions of sleep over the past week during weekly follow-up assessments. The global PSQI scores were used for sleep quality, and we calculated sleep onset timing and sleep duration from the sleep start and wake time items.

Depressive Symptoms The abbreviated version of the Mood and Feelings Questionnaire (MFQ-short) was used to examine depressive symptoms at baseline and weekly visits (Angold et al., 1995). Participants responded to each of the 13-items (e.g., 'I felt miserable or unhappy') on a scale of 0 ('not true'), 1 ('sometimes true'), and 2 ('true'), for a maximum score of 26 with higher scores reflecting more depressive symptoms.

Analytic Plan

All analyses were conducted in R 4.2. First, hierarchical linear regressions were used to evaluate the associations between baseline subjective social media use (SMU) and baseline global PSQI scores and sleep duration and sleep timing derived from the PSQI. Then, two-level multilevel modeling was used to examine whether subjective SMU at baseline predicted sleep timing, duration, and quality (average in a week) over the next month, with Restricted Estimation Maximum Likelihood (REML) given the smaller sample size. In these models, we calculated the within-person fluctuations and between-person means using the EMATools package in R. The Level 2 (between-person) predictor was SMU (daily and nighttime). Level 2 (between-person) covariates included age, gender, baseline PSQI, number of IOP sessions, and average depression symptoms over the course of the study (based on weekly measures). Random intercept and slopes for sleep outcomes were included in these models to account for clustering effects and slopes at the individual level.

Study 1 Results

Descriptives

A total of 95 individuals between the ages of 12–18 (75% female identifying; Mean age = 15.19, SD = 1.43) were included in the study who completed at least one PSQI prospectively over the first 30 days of IOP treatment. A total of 86% of participants identified as White, 9% as Black/African American, 4% as Asian American, and 1% as biracial (4 participants did not answer the race/ethnicity question). In addition, 32% of participants identified as lesbian, gay, or bisexual. On average, participants started their course of IOP treatment within 9 days of baseline evaluation (range 1–28 days) and completed between 2–7 weekly sessions in the month following the baseline evaluation (M = 4.29 sessions; SD = 1.39). Only sleep data collected during the first month after the baseline evaluation was included to assess more proximal sleep outcomes to SMU. Correlations between primary study variables are included in Supplemental Table 1.

In terms of SMU during the day, 57% of participants self-reported having more than 2 h of SMU per day with 28% having more than 3 h per day. In terms of nighttime SMU, 45% of participants reported SMU for less than 30 min before sleep, 26% used social media between 30 min to 1 h before sleep, 18% used social media for between 1 and 2 h, and 12% used social media for more than 2 h before falling asleep. The average amount of self-reported sleep across the first month of IOP was 7.18 h (SD = 1.89) and sleep start times were 11:43PM (M = 23.71; SD = 1.74 h). Mean global PSQI was 8.65 (SD = 3.33) on average across the first month, with 82% of participants having an average PSQI score greater than 5 indicating clinically significant poor sleep (Buysse et al., 1989). Overall, there was significant variability of sleep outcomes, with most variability occurring between people (Sleep Quality: 65%; Sleep Timing: 75%; Sleep Duration: 62%).

Nighttime SMU and sleep timing, duration, and quality

Linear regressions indicated that baseline self-reported nighttime SMU was significantly associated with baseline sleep scores. Specifically, more nighttime SMU was associated with later sleep timing (B = 0.75, SE = 0.18, t = 4.17, $p < 0.001$), shorter sleep duration (B = -0.56, SE = 0.22, t = -2.53, p = 0.01), and poorer sleep quality (higher PSQI scores; B = 1.07, SE = 0.44, t = 2.44, p = 0.02).

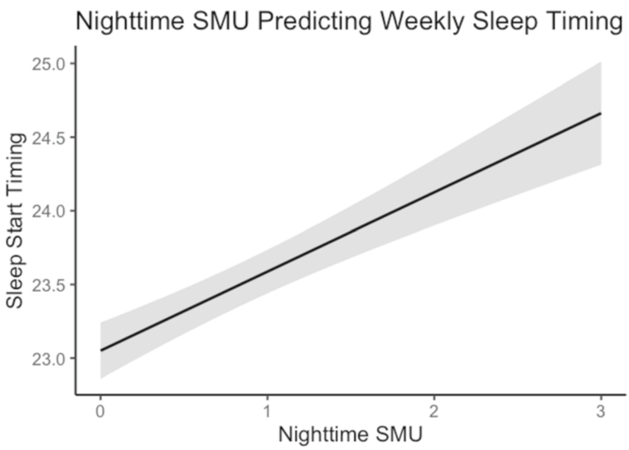
Prospective results of self-reported nighttime SMU predicting sleep outcomes over the next month after beginning IOP treatment are presented in Table 1. Findings indicate that more nighttime SMU at baseline predicted later sleep timing over the first 30 days of the IOP program (B = 0.51, SE = 0.16, t = 3.12, p = 0.002), covarying for age, gender, depression, and time in study (number of IOP visits). Nighttime SMU did not predict shorter sleep duration (B = -0.30, SE = 0.21, t = -1.44, p = 0.15) or poorer sleep quality (B = -0.21, SE = 0.35, t = -0.59, p = 0.56). Of note, there was significant variability in the effects of self-reported nighttime SMU and sleep outcomes, based on random slopes. Figure 1 presents the relationship between nighttime subjective SMU and prospective self-reported sleep timing.

Table 1 Subjective Nighttime SMU Predicting Self-reported Sleep Outcomes in Study 1

	Sleep Timing			Sleep Duration			Sleep Quality		
Predictors	*Estimates*	*SE*	*p*	*Estimates*	*SE*	*p*	*Estimates*	*SE*	*p*
Intercept	23.91 (22.09–25.14)	0.77	**< 0.01**	6.94 (4.99–8.89)	0.99	**< 0.01**	6.78 (3.54–10.02)	1.64	**< 0.01**
NSMU	0.51 (0.19-0.83)	0.16	**0.002**	-0.30 (-0.72-0.12)	0.21	0.15	-0.21 (-0.91-0.50)	0.35	0.56
Age	0.29 (0.08-0.50)	0.11	**0.01**	-0.06 (-0.33-0.20)	0.14	0.64	-0.24 (-0.69-0.22)	0.23	0.31
Female sex assigned at birth (1)	0.38 (-0.29-0.50)	0.35	0.27	0.02 (-0.82-0.87)	0.42	0.95	0.78 (-0.74–2.29)	0.76	0.31
Mean Depression	-0.03 (-0.08- 0.04)	0.03	0.37	-0.002 (-0.08-0.08)	0.04	0.95	0.14 (0.01-0.27)	0.07	**0.04**
IOP Visits	-0.13 (-0.33-0.13)	0.11	0.24	0.16 (-0.72-0.12)	0.21	0.15	-0.26 (-0.76-0.24)	0.25	0.31
Random Effects									
σ^2 (Residual)	0.75			1.68			4.55		
τ_{00} (Intercept)	1.88			2.05			10.46		
τ_{11} (Slope)	0.28			0.07			2.28		

*Bold significance of the *p*-values

NSMU = Nighttime Social Media Use; IOP = Intensive Outpatient



Note: SMU = Social Media Use. Nighttime SMU indicates categories of 0–3: “Less than 30 min” (0), “30 min to 1 h” (1), “more than 1 h to 2 h” (2), and “more than 2 h” (3). Sleep start times indicate hours, with 24.00 reflecting 12:00AM (midnight)

Fig. 1 Subjective nighttime social media use and self-reported sleep timing among adolescents in Study 1

Daily SMU and sleep timing, duration, and quality

Linear regressions indicated that baseline self-reported daily SMU was only significantly associated with baseline sleep timing (B = 0.24, SE = 0.12, t = 2.04, p = 0.04), but not sleep duration (B = -0.02, SE = 0.14, t = 0.15, p = *0.8*8) or sleep quality (B = 0.12, SE = 0.27, t = 0.44, p = 0.66). In contrast, prospective multilevel models indicated that daily subjective SMU reported at baseline also did not predict sleep timing or sleep duration over the next month (See Supplemental Table 2), but there was a significant effect of daily SMU on sleep quality (B = -0.58, SE = 0.21, t = -2.81, p = *0.0*1), covarying for age, gender, depression, and time in study (number of IOP visits).

Study 2: Intensive Monitoring Study

Participants and Procedure

This study included 30 adolescents and young adults (13–22 years) who were enrolled in the same IOP program for adolescent depression and suicidality as described in Study 1 and were recruited to participate in an intensive monitoring study. Participants first completed a baseline assessment which included a clinical interview and self-report questionnaire of subjective SMU. Participants then completed daily subjective ratings of sleep quality and mood via SMS text messaging of links to a secure website. During this same period, participants wore wrist actigraphs to capture activity to measure behavioral sleep/wake patterns. During an initial visit, study staff provided the participants with the Actigraphs and explained proper use of the device. The current study includes only the first month (after baseline) of actigraphy data. Of note, only 30 of the total 59 participants in this study were included due to the later inclusion of self-reported SMU assessment in the baseline questionnaires. There were no demographic differences in those who participated in this study and the full sample (Hamilton et al., 2022).

Baseline Measure

Subjective Social Media Use At the baseline assessment, participants completed a measure of subjective social media use, which included daily SMU: “On average, how many minutes do you spend on social media per day?” and nighttime SMU: “How many minutes did you use social media in the two hours before falling asleep?”. Response options included increments of 10 min with 0–1440 min (0–24 h) for daily SMU and 0–120 min (0–2 h) for nighttime SMU. For calculating daytime SMU (outside of nighttime SMU), nighttime SMU was subtracted from total SMU and converted to hours to hours per day. Note that this measure was different from that administered in Study 1.

Sleep Quality Baseline subjective sleep quality was measured using the Pittsburgh Sleep Quality Index (PSQI), described above. Total sleep quality score was included as a covariate for prospective analyses.

Intensive Monitoring Measures

Objective Daily Sleep Assessment Objective daily behavioral sleep data were collected through Actigraph watches. Actigraphs are wristwatch-like devices that assess participant sleep and circadian rhythm disruptions over time within an individual's natural environment and are considered the gold standard method of ambulatory objective sleep data collection (Meltzer et al., 2012). Participants wore GT9x Link actigraph devices (ActiGraph Corp, Pensacola, FL) for the duration of their involvement in the study (up to three months). Actigraphs estimate sleep factors (e.g., sleep timing, sleep quality, sleep duration, etc.) by measuring average activity in 60-s epochs. The Cole-Kripke algorithm was used to compute sleep epochs, as implemented by ActiLife software (ActiGraph Corp, Pensacola, FL), with software settings of sleep period detections using a 10-min bedtime definition and a 20-min wake time definition. In other words, low participant activity for 10 consecutive minutes was defined as bedtime sleep detection, and 20 min of increased activity was defined as wake time detection. In the current study, the primary objective sleep outcomes of interest, as measured by actigraphy, were sleep duration and sleep timing.

Subjective Daily Sleep Quality Daily diary ratings included a sleep diary in the morning of sleep quality from the Pittsburgh Sleep Diary (Monk et al., 1994). Each morning, participants rated their perceived sleep quality on a Visual Analog Scale of 0 ("very bad") to 100 ("very good"). Participants were prompted to complete their daily sleep diaries 30 min following their reported habitual times on weekdays and weekends.

Daily Mood Each night, participants reported their daily mood by responding to the following statement: "The worst my depression was today." Scores ranges from 0 ("I didn't feel depressed at all") to 100 ("Horrible, the worst it gets"). The average mood over the first month was used as a study covariate.

Analytic Plan

Multilevel modeling was conducted to examine whether self-reported SMU at baseline (daytime and nighttime) predicted sleep timing, duration, and quality (using daily actigraphic and self-reported sleep) over the next month, with REML given smaller sample size. Level 2 (between-person) predictor was SMU (daytime and nighttime) and between-person covariates included age, gender, baseline PSQI, average depression, and whether it was a weekday or weekend. Random intercepts and slopes were included in models with nighttime SMU to account for clustering effects and slopes at the individual level. Due to singular fit and non-convergence with daytime SMU models, only random intercept was included in daytime SMU models.

Study 2 Results

Descriptives

A total of 30 individuals between the ages of 13–22 (67% female-identifying; Mean age = 16.97, SD = 2.71) who completed a measure of baseline self-reported SMU were included in this study, with a total of 750 observations for sleep timing and duration across the study and 695 observations for sleep quality. On average, participants had 25 days of actigraphic sleep days (range = 7–31 days). Participants in the sample included 63% who identified as White, 10% as Black/African American, 20% as Asian American, and 7% identified as biracial or as another race. Correlations between primary study variables are included in Supplemental Table 3.

For subjective daytime SMU, participants reported spending an average of 2.48 h per day on SMU (SD = 1.29; range = 0–5.33 h). For nighttime SMU, participants reported SMU before bed for 46.00 min (SD = 31.36; range = 0—100 min before going to bed). For actigraphy, 87% of possible nights were completed, and 81% of sleep diaries were completed. The average amount of time spent sleeping was 6.65 h (SD = 0.86) and the average sleep start time was 12:01 AM (24.03 h; SD = 1.30) as indicated by actigraphy. For sleep quality, participants had an average score of 56.15 (SD = 14.79) out of 100 across the daily ratings of sleep quality and a score of 8.24 (SD = 3.00) on the baseline PSQI. In terms of intraclass correlations (ICCs), there was significant variability in sleep outcomes, with most variance at the within-person level compared to between-person levels. Within-person variances for 82.15% for sleep start timing, 80.69% for actigraphy-derived sleep duration, and 58.31% for self-reported sleep quality.

Nighttime social media use and sleep timing, duration, and quality

Table 2 presents results with self-reported nighttime SMU predicting prospective daily self-reported and actigraphic-derived sleep outcomes. Higher levels of nighttime SMU predicted later sleep timing over the first 30 days of the IOP program (B = 0.02, SE = 0.01, $t = 2.52$, $p = 0.02$), covarying for age, gender, depression, baseline PSQI, and whether it is a weekday or weekend. While significant, effects in this study are small, with a 10-min increase in nighttime SMU associated with 1.2 min later sleep timing within-person. However, nighttime social media did not predict shorter sleep duration (B = 0.002, SE = 0.01, $t = 0.39$, $p = 0.70$) or poorer sleep quality (B = -0.03, SE = 0.09, $t = -0.31$, $p = 0.76$). Of note, there was significant variability in individual slopes of self-reported nighttime SMU and sleep outcomes. Figure 2 graphically presents the relationship between self-reported nighttime SMU and actigraphy-derived sleep timing.

Daily SMU and sleep timing, duration, and quality

Table 3 presents results with self-reported daytime SMU predicting actigraphic and self-reported sleep outcomes. Higher levels of subjective daytime SMU also predicted

Table 2 Subjective nighttime SMU (NSMU) as a predictor of daytime sleep outcomes in Study 2

	Sleep Timing			Sleep Duration			Sleep Quality		
Predictors	*Estimates*	*SE*	*p*	*Estimates*	*SE*	*p*	*Estimates*	*SE*	*p*
Intercept	17.07 (13.78–20.37)	1.67	**< 0.01**	6.80 (3.36–10.25)	1.75	**< 0.01**	65.22 (21.18–109.25)	20.96	**< 0.01**
NSMU	0.02 (0.00-0.03)	0.01	**0.02**	0.002 (-0.01-0.01)	0.01	0.70	-0.03 (-0.21-0.15)	0.08	0.61
Age	0.30 (0.13-0.48)	0.09	**< 0.01**	0.06 (-0.11-0.23)	0.08	0.46	-0.44 (-2.82–1.94)	1.06	0.66
Female sex assigned at birth (1)	0.47 (-0.35–1.28)	0.40	0.25	-0.01 (-0.77-0.74)	0.36	0.97	4.14 (-7.16–15.45)	4.96	0.46
PSQI	0.03 (-0.13-0.18)	0.07	0.73	-0.11 (-0.24-0.02)	0.08	0.09	-2.36 (-4.46–0.26)	0.92	0.02
Mean Depression	0.01 (-0.03-0.04)	0.01	0.66	-0.01 (-0.04-0.02)	0.01	0.43	0.30 (-0.16-0.76)	0.20	0.09
Weekend (1)	0.67 (0.25-0.1.10)	0.22	**< 0.01**	0.77 (0.51–1.02)	0.13	**< 0.01**	5.08 (2.52–7.65)	1.31	**< 0.01**
Random Effects									
σ^2 (Residual)	6.90			1.95			244.54		
τ_{00} (Intercept)	0.58			2.57			134.76		
τ_{11} (Slope)	0.58			< 0.01			0.01		

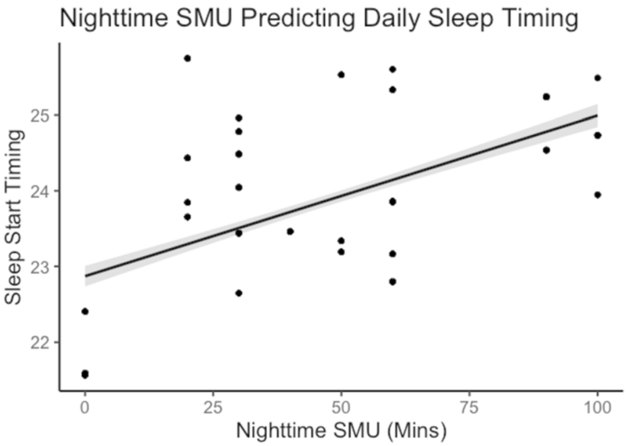
*Bold significance of the *p*-values

NSMU = Nighttime Social Media Use; PSQI = Pittsburgh Sleep Quality Index at baseline

later actigraphy-derived sleep timing (B = 0.01, SE = 0.002, $t = 3.71$, $p = 0.001$) over the first 30 days of the IOP program, covarying for age, gender, depression, baseline PSQI, and whether it is a weekday or weekend. Specifically, a 10-min increase in daily SMU was associated with later sleep timing by 27.36 min. Daily subjective SMU did not predict actigraphy-derived sleep duration (B = -0.25, SE = 0.12, $t = -2.00$, $p = 0.06$) or self-reported sleep quality (B = 0.03, SE = 0.38, $t = 1.11$, $p = 0.28$).

Discussion

Growing research has linked self-reported or subjective SMU with poor sleep outcomes among adolescents and young adults (e.g., Scott & Woods, 2019). Yet, limited research has examined this relationship using prospective designs, using both self-report and actigraphic methods to assess sleep, or among adolescents and young



Note: SMU = Social Media Use. Nighttime SMU indicates increments of 10 min with 0–120 min for nighttime SMU. Sleep start times indicate hours, with 24.00 reflecting 12:00AM (midnight)

Fig. 2 Subjective nighttime social media use and actigraphic sleep timing among adolescents in Study 2

adults who are at high risk for suicide. This may be a particularly important population to study given that poor sleep is a proximal risk factor for suicidal thoughts, behaviors, and death by suicide (Goldstein & Franzen, 2022; Liu et al., 2020). Specifically, factors including sleep duration (getting both too little sleep *and* too much sleep) and insomnia have been linked to increased rates of suicidal thoughts and

Table 3 Subjective daytime SMU as a predictor of daily sleep outcomes in Study 2

	Sleep Timing			Sleep Duration			Sleep Quality		
Predictors	*Estimates*	*SE*	*p*	*Estimates*	*SE*	*p*	*Estimates*	*SE*	*p*
Intercept	16.60	1.40	**< 0.01**	7.11	1.41	**< 0.01**	63.42	20.64	**< 0.01**
Daytime SMU	0.46	0.12	**< 0.01**	-0.25	0.12	0.06	2.00	1.80	0.28
Age	0.33	0.07	**< 0.01**	0.04	0.07	0.54	-0.79	1.01	0.44
Female sex assigned at birth (1)	0.05	0.34	0.88	0.24	0.35	0.57	1.80	5.18	0.73
PSQI	0.03	0.06	0.68	-0.11	0.06	0.08	-1.97	0.90	**0.04**
Mean Depression	0.00	0.01	0.74	-0.00	0.01	0.98	0.29	0.20	0.15
Weekend (1)	0.67	0.22	**< 0.01**	0.76	0.13	**< 0.01**	5.07	1.31	**< 0.01**
Random Effects									
σ^2 (Residual)	6.88			2.56			244.15		
τ_{00} (Intercept)	0.32			0.50			118.93		

*Bold significance of the *p*-values

SMU = Social Media Use; PSQI = Pittsburgh Sleep Quality Index at baseline behaviors in youth (Goldstein & Franzen, 2022). The current study is the first to examine the prospective relationships between both daily and nighttime subjective SMU and sleep timing, duration, and quality among adolescents and young adults in an intensive outpatient program (IOP) for depression and suicidality using both self-report (Study 1) and actigraphic methods to assess behavioral sleep (Study 2). Findings from both studies indicate that more self-reported nighttime SMU prospectively predicts later sleep timing after the first month of an IOP intake evaluation based on self-report (Study 1) and actigraphy (Study 2), though effect sizes were relatively small. Self-reported daily SMU also was prospectively associated with self-reported sleep quality in Study 1 and daytime SMU with actigraphy-derived later sleep timing in Study 2, with larger effects on sleep timing than nighttime subjective SMU. In contrast to hypotheses, there were no associations between subjective SMU (daytime/daily or nighttime) and sleep duration in either study.

Importantly, these findings have significance for adolescents and young adults at high risk for suicide. Being awake later at night may be an important period of risk for individuals who are already at high risk for suicide, as research shows that suicidal ideation increases at night (Tubbs et al., 2021), and recent findings also point to increases in suicidal behavior at night (Perlis et al., 2016; Ploderl, 2021). Thus, SMU during the day and at nighttime may delay bedtimes and contribute to adolescents and young adults being awake late at night when others are asleep, heightening feelings of loneliness and limiting availability of natural social supports (e.g., Chu et al, 2016; Hom et al., 2017). Even more, negative emotions and rumination levels are higher at night (Takano & Tanno, 2011), which may impact how individuals are using and experiencing social media and increase the likelihood of negative experiences (Radovic et al., 2017). Better understanding the timing of SMU among high-risk individuals may be an important target for depression and suicide-focused interventions to improve sleep outcomes, which may have downstream effects on improving treatment outcomes. Although daytime subjective SMU was more strongly associated with later sleep timing in Study 2, nighttime SMU may be more actionable than total self-reported daytime or overall SMU since it is more specific, concrete, and proximal to bedtime, which may elicit actual behavior change as a starting place. However, it is important to acknowledge that nighttime SMU may not necessarily always have negative effects for high-risk youth (Hamilton et al., 2021), such that SMU may serve as a distraction, coping strategy, source of support, or crisis resource when youth have suicidal thoughts.

Overall, our findings highlight the importance of assessing SMU in association with *when* adolescents and young adults fall asleep, but may be less critical in the duration or potentially day-to-day quality of sleep in this high-risk population. There are several reasons why daytime and nighttime subjective SMU might specifically be associated with sleep onset start times. First, SMU, especially before bedtime, may displace time that individuals would otherwise be sleeping, thereby delaying the times at which individuals try to fall asleep. Second, SMU may heighten psychological and physiological arousal, thereby delaying feelings of sleepiness or making it harder for individuals to fall asleep (e.g., LeBourgeois et al., 2017). While we might expect these factors to disrupt sleep and impact sleep quality, only Study 1 found an association between daily SMU and weekly-repprted sleep quality, which may be due to the more comprehensive measure of sleep quality (PSQI) used in Study 1 compared to the single item of perceived daily sleep quality used in Study 2. Further, the absence of significant effects of SMU on sleep duration is surprising given prior research linking SMU with shorter sleep duration (Sampasa-Kanyinga et al., 2018), though it is consistent with other research not finding effects using daily designs (Hamilton et al., 2022). It is possible that individuals enrolled in the IOP have less regimented schedules due to their involvement in IOP (e.g., not having a wake-up time based on early school start times), thereby granting them more agency over their wake times than other youth in the community. However, it is also possible that SMU provides young people with social connection and support, as well as distraction or coping strategies that reduces stress or distress (Biernesser et al., 2022) and promotes some sleep outcomes (Matthews et al., 2017). Further, most individuals in the current studies reported poor sleep quality on average, with the majority of adolescents in our studies having clinically significant poor sleep. Given that the sample is comprised of individuals enrolled in an IOP for depression and suicidality, these high rates of poor sleep are not surprising since sleep disruption is a common symptom of depression and a known risk factor for suicidal thoughts and behaviors (Liu et al., 2020). Thus, it is possible that subjective SMU has less of an effect on perceived sleep quality, depending on how it is measured, or that other components of SMU may impact sleep duration or sleep disturbances (e.g., Nesi et al., 2021a, b). Given the potential benefits of SMU (Hamilton et al., 2020a, b), it is important for further research to explore the nuanced relationship between SMU and sleep outcomes and examine whether its potential benefits on mental health (including buffering effects against suicidal thoughts and behaviors in high-risk youth) outweigh its negative effects on sleep.

Although our study is strengthened by its prospective design and multi-method approach, there are several key limitations that could be enhanced in future research. First, while our findings highlight the importance of considering *when* adolescents are using social media, it is also critical to consider *how* social media is being used, which also may impact sleep (Scott & Woods, 2019). For instance, youth who are more emotionally invested in social media or place greater emphasis on social media for social belonging are more likely to be affected (Hamilton & Lee, 2021) and potentially have poorer sleep (Scott & Woods, 2019). Further, negative (or positive) emotional responses to SMU may be particularly important to consider at nighttime (Nesi et al., 2021a, b), which may exacerbate the effects of nighttime SMU. The current study also only evaluated SMU using self-report methods, at bedtime, and at a single timepoint (e.g., baseline), which may not accurately reflect the fluctuating nature of SMU (Hamilton et al., 2022). Using a self-reported and retrospective measure of SMU may bias estimates of SMU across the day and subjective SMU may not reflect actual usage patterns of SMU that would be captured using objective measure. Prior research has found significant differences between individual's self-reported compared to objectively measured SMU, and studies using objective metrics have not found significant effects on mental health (Sewall et al., 2020). Though we covaried for depression symptoms in the current study, it also is possible that estimates of SMU are biased by current symptoms (Sewall et al., 2020), or that some participants may have underreported SMU due to fear of judgement or negative perceptions about their SMU. The limitations of self-reported SMU, compared to objective SMU metrics, may partially explain demonstrated effects of SMU on sleep timing. It also is likely that our findings reflect individuals' perceptions of SMU rather than actual SMU. Future studies that objectively assess SMU using smartphone sensing and intensive monitoring designs would be better suited to investigate the dynamic and temporal associations between SMU patterns and sleep outcomes, including the ability to better isolate daytime and nighttime SMU prior to sleep.

This study also did not evaluate the mediational or longitudinal effects of SMU to suicidal thoughts or behaviors. Yet, sleep disruption may be a critical mechanism linking social media and mental health outcomes among adolescents and young adults who are at high risk for suicide, which has only been investigated in community samples or using cross-sectional designs (Nesi et al., 2021b; Scott & Woods, 2019; Vernon et al., 2017). Examining the potential link of later sleep timing remains an important next step of the current research. Further, our sample was relatively homogeneous with regard to racial and ethnic identity. This, in part, highlights important differences in access and utilization of mental health treatment (e.g., IOP programs) in the United States (e.g., Cook et al., 2017). Given known disparities in sleep outcomes (e.g., Ahn et al., 2021), as well as elevated rates of suicide in some racial/ethnic minority populations (e.g., youth who identify as Black, Hispanic/Latine, Indigenous; Ramchand et al., 2021), sexual minority youth, and gender expansive youth (The Trevor Project National Survey, 2021), future research should focus on these complex relationships between nighttime SMU, sleep, and suicide among adolescents and young adults with minoritized identities (Dolsen et al., 2022; Johnson et al., 2022).

Overall, findings of both studies suggest that daytime and nighttime subjective SMU may be a prospective predictor of later sleep timing for adolescents and young adults who are at risk for suicide. Two prospective studies with adolescents and young adults in an intensive outpatient program for depression and suicidality document the association between nighttime subjective SMU and sleep start timing as assessed via self-report and actigraphy over one month, and Study 2 found effects of daytime SMU on later sleep timing as well. Given the importance of sleep timing for mental and physical health (Bei et al., 2017), and potentially for suicidal ideation and behavior (Tubbs et al., 2021), interventions targeting depression and suicidality may benefit from considering the timing of SMU as a means of prevention. Interventions targeting SMU may promote earlier bedtimes, which may protect against suicidal thoughts, feelings, and behaviors, specifically in individuals at elevated risk of STBs. However, this study focused only on the effects of sleep as an important outcome, without examining its potential effects on subsequent suicidal thoughts or behaviors. Given the strength of relationships between sleep and suicidal thoughts and behaviors, sleep may be a prime target for suicide prevention research and treatment. Given the behavioral components of both SMU and sleep, and based on the empirical evidence behind behaviorally-based interventions for suicide prevention, treatment that focuses on SMU and sleep may be particularly actionable and effective (McCall, 2022). Future research is needed to fully explore how and when individuals are using social media during treatment, and whether reducing SMU at specific times impacts sleep and suicide-related outcomes to inform prevention programs.

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Data Availability The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Conflict of Interest The authors have no conflicts of interest.

References

Ahn, S., Lobo, J. M., Logan, J. G., Kang, H., Kwon, Y., & Sohn, M.-W. (2021). A scoping review of racial/ethnic disparities in sleep. *Sleep Medicine, 81*, 169–179. https://doi.org/10.1016/j.sleep.2021.02.027

Angold, A., Costello, E. J., Messer, S. C., Pickles, A., Winder, F., & Silver, D. (1995). The development of a short questionnaire for use in epidemiological studies of depression in children and adolescents. *International Journal of Methods in Psychiatric Research, 5*, 237–249.

Åslund, L., Arnberg, F., Kanstrup, M., & Lekander, M. (2018). Cognitive and Behavioral Interventions to Improve Sleep in School-Age Children and Adolescents: A Systematic Review and Meta-Analysis. *Journal of Clinical Sleep Medicine, 14*(11), 1937–1947. https://doi.org/10.5664/jcsm.7498

Bei, B., Seeman, T. E., Carroll, J. E., & Wiley, J. F. (2017). Sleep and physiological dysregulation: A closer look at sleep intraindividual variability. *Sleep*, *40*(9), zsx109. https://doi.org/10.1093/sleep/zsx109

Biernesser, C., Bear, T., Brent, D., Mair, C., Zelazny, J., & Trauth, J. (2022). Development of An Ecological Momentary Assessment of the Impact of Social Media Use Among Suicidal Adolescents. *Archives of Suicide Research, 26*(4), 1847–1861. https://doi.org/10.1080/13811118.2021.1943581

Burnell, K., George, M. J., Jensen, M., Hoyle, R. H., & Odgers, C. L. (2021). Associations Between Adolescents' Daily Digital Technology Use and Sleep. *Journal of Adolescent Health*. https://doi.org/10.1016/j.jadohealth.2021.09.033

Buysse, D. J., Reynolds, C. F., Monk, T. H., Berman, S. R., & Kupfer, D. J. (1989). The Pittsburgh sleep quality index: A new instrument for psychiatric practice and research. *Psychiatry Research, 28*(2), 193–213. https://doi.org/10.1016/0165-1781(89)90047-4

Carter, B., Rees, P., Hale, L., Bhattacharjee, D., & Paradkar, M. S. (2016). Association Between Portable Screen-Based Media Device Access or Use and Sleep Outcomes: A Systematic Review and Meta-analysis. *JAMA Pediatrics, 170*(12), 1202–1208. https://doi.org/10.1001/jamapediatrics.2016.2341

Charmaraman, L., Richer, A. M., Ben-Joseph, E. P., & Klerman, E. B. (2021). Quantity, Content, and Context Matter: Associations Among Social Technology Use and Sleep Habits in Early Adolescents. *Journal of Adolescent Health, 69*(1), 162–165. https://doi.org/10.1016/j.jadohealth.2020.09.035

Chu, C., Hom, M. A., Rogers, M. L., Ringer, F. B., Hames, J. L., Suh, S., & Joiner, T. E. (2016). Is Insomnia Lonely? Exploring Thwarted Belongingness as an Explanatory Link between Insomnia and Suicidal Ideation in a Sample of South Korean University Students. *Journal of Clinical Sleep Medicine : JCSM : Official Publication of the American Academy of Sleep Medicine, 12*(5), 647–652. https://doi.org/10.5664/jcsm.5784

Cook, B. L., Trinh, N.-H., Li, Z., Hou, S.S.-Y., & Progovac, A. M. (2017). Trends in Racial-Ethnic Disparities in Access to Mental Health Care, 2004–2012. *Psychiatric Services, 68*(1), 9–16. https://doi.org/10.1176/appi.ps.201500453

Das-Friebel, A., Lenneis, A., Realo, A., Sanborn, A., Tang, N. K. Y., Wolke, D., von Mühlenen, A., & Lemola, S. (2020). Bedtime social media use, sleep, and affective wellbeing in young adults: An experience sampling study. *Journal of Child Psychology and Psychiatry, 61*(10), 1138–1149. https://doi.org/10.1111/jcpp.13326

Dolsen, E. A., Byers, A. L., Flentje, A., Goulet, J. L., Jasuja, G. K., Lynch, K. E., Maguen, S., & Neylan, T. C. (2022). Sleep disturbance and suicide risk among sexual and gender minority people. *Neurobiology of Stress, 21*, 100488. https://doi.org/10.1016/j.ynstr.2022.100488

Dong, L., Dolsen, M. R., Martinez, A. J., Notsu, H., & Harvey, A. G. (2020). A transdiagnostic sleep and circadian intervention for adolescents: Six-month follow-up of a randomized controlled trial. *Journal of Child Psychology and Psychiatry, 61*(6), 653–661. https://doi.org/10.1111/jcpp.13154

Fobian, A. D., Avis, K., & Schwebel, D. C. (2016). The Impact of Media Use on Adolescent Sleep Efficiency. *Journal of Developmental and Behavioral Pediatrics : JDBP, 37*(1), 9–14. https://doi.org/10.1097/DBP.0000000000000239

Goldstein, T. R., & Franzen, P. L. (2022). A Comprehensive Review of the Literature on Sleep Difficulties and Suicidality in Youth to Inform an Integrative Developmental Model and Future Directions. *Current Sleep Medicine Reports, 8*(1), 1–19. https://doi.org/10.1007/s40675-022-00222-9

Goldstein, T. R., Bridge, J. A., & Brent, D. A. (2008). Sleep disturbance preceding completed suicide in adolescents. *Journal of Consulting and Clinical Psychology, 76*(1), 84–91. https://doi.org/10.1037/0022-006X.76.1.84

Griggs, S., Conley, S., Batten, J., & Grey, M. (2020). A systematic review and meta-analysis of behavioral sleep interventions for adolescents and emerging adults. *Sleep Medicine Reviews, 54*, 101356. https://doi.org/10.1016/j.smrv.2020.101356

Hale, L., & Guan, S. (2015). Screen time and sleep among school-aged children and adolescents: A systematic literature review. *Sleep Medicine Reviews, 21*, 50–58. https://doi.org/10.1016/j.smrv.2014.07.007

Hale, L., Kirschen, G. W., LeBourgeois, M. K., Gradisar, M., Garrison, M. M., Montgomery-Downs, H., Kirschen, H., McHale, S. M., Chang, A. M., & Buxton, O. M. (2018). Youth screen media habits and sleep: Sleep-friendly screen behavior recommendations for clinicians, educators, and parents. *Child and Adolescent Psychiatric Clinics of North America, 27*(2), 229–245. https://doi.org/10.1016/j.chc.2017.11.014

Hamilton, J. L., & Lee, W. (2021). Associations Between Social Media, Bedtime Technology Use Rules, and Daytime Sleepiness Among Adolescents: Cross-sectional Findings From a Nationally Representative Sample. *JMIR Mental Health, 8*(9), e26273. https://doi.org/10.2196/26273

Hamilton, J. L., Biernesser, C., Moreno, M. A., Porta, G., Hamilton, E., Johnson, K., Poling, K. D., Sakolsky, D., Brent, D. A., & Goldstein, T. G. (2021). Social media use and prospective suicidal thoughts and behaviors among adolescents at high risk for suicide. *Suicide and Life-Threatening Behavior, 51*(6), 1203–1212. https://doi.org/10.1111/sltb.12801

Hamilton, J. L., Chand, S., Reinhardt, L., Ladouceur, C. D., Silk, J. S., Moreno, M., Franzen, P. L., & Bylsma, L. M. (2020a). Social media use predicts later sleep timing and greater sleep variability: An ecological momentary assessment study of youth at high and low familial risk for depression. *Journal of Adolescence, 83*, 122–130. https://doi.org/10.1016/j.adolescence.2020.07.009

Hamilton, J. L., Coulter, R. W. S., & Radovic, A. (2020b). Mental health benefits and opportunities. In Technology and Adolescent Health (305–345). Elsevier https://doi.org/10.1016/B978-0-12-817319-0.00013-X

Hamilton, J. L., Hutchinson, E., Evankovich, M. R., Ladouceur, C. D., & Silk, J. S. (2022). Daily and average associations of physical activity, social media use, and sleep among adolescent girls during the COVID-19 pandemic. *Journal of Sleep Research*, *n/a*(n/a), e13611 https://doi.org/10.1111/jsr.13611

Hamilton, J. L., Tsypes, A., Zelazny, J., Sewall, C. J. R., Rode, N., Merranko, J., Brent, D. A., Goldstein, T. R., & Franzen, P. L. (2023). Sleep influences daily suicidal ideation through affective reactivity to interpersonal events among high-risk adolescents and young adults. *Journal of Child Psychology and Psychiatry, and Allied Disciplines, 64*(1), 27–38. https://doi.org/10.1111/jcpp.13651

Harbard, E., Allen, N. B., Trinder, J., & Bei, B. (2016). What's Keeping Teenagers Up? Prebedtime Behaviors and Actigraphy-Assessed Sleep Over School and Vacation. *Journal of Adolescent Health, 58*(4), 426–432. https://doi.org/10.1016/j.jadohealth.2015.12.011

Hom, M. A., Hames, J. L., Bodell, L. P., Buchman-Schmitt, J. M., Chu, C., Rogers, M. L., Chiurliza, B., Michaels, M. S., Ribeiro, J. D., Nadorff, M. R., Winer, E. S., Lim, I. C., Rudd, M. D., & Joiner, T. E. (2017). Investigating insomnia as a cross-sectional and longitudinal predictor of loneliness: Findings from six samples. *Psychiatry Research, 253*, 116–128. https://doi.org/10.1016/j.psychres.2017.03.046

Johnson, D. A., Reiss, B., Cheng, P., & Jackson, C. L. (2022). Understanding the role of structural racism in sleep disparities: A call to action and methodological considerations. *Sleep, 45*(10), zsac200. https://doi.org/10.1093/sleep/zsac200

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

LeBourgeois, M. K., Hale, L., Chang, A.-M., Akacem, L. D., Montgomery-Downs, H. E., & Buxton, O. M. (2017). Digital Media and Sleep in Childhood and Adolescence. *Pediatrics, 140*(Suppl 2), S92–S96. https://doi.org/10.1542/peds.2016-1758J

Levenson, J. C., Shensa, A., Sidani, J. E., Colditz, J. B., & Primack, B. A. (2016). The association between social media use and sleep disturbance among young adults. *Preventive Medicine, 85*, 36–41. https://doi.org/10.1016/j.ypmed.2016.01.001

Levenson, J. C., Shensa, A., Sidani, J. E., Colditz, J. B., & Primack, B. A. (2017). Social Media Use Before Bed and Sleep Disturbance Among Young Adults in the United States: A Nationally Representative Study. *Sleep, 40*(9), zsx113. https://doi.org/10.1093/sleep/zsx113

Liu, R. T., Steele, S. J., Hamilton, J. L., Do, Q. B. P., Furbish, K., Burke, T. A., Martinez, A. P., & Gerlus, N. (2020). Sleep and suicide: A systematic review and meta-analysis of longitudinal studies. *Clinical Psychology Review, 81*, 101895. https://doi.org/10.1016/j.cpr.2020.101895

Liu, X. (2004). Sleep and adolescent suicidal behavior. *Sleep, 27*(7), 1351–1358. https://doi.org/10.1093/sleep/27.7.1351

Matthews, T., Danese, A., Gregory, A. M., Caspi, A., Moffitt, T. E., & Arseneault, L. (2017). Sleeping with one eye open: Loneliness and sleep quality in young adults. *Psychological Medicine, 47*(12), 2177–2186. https://doi.org/10.1017/S0033291717000629

McCall, W. V. (2022). Targeting insomnia symptoms as a path to reduction of suicide risk: The role of cognitive behavioral therapy for insomnia (CBT-I). *Sleep, 45*(12), zsac260. https://doi.org/10.1093/sleep/zsac260

Meltzer, L. J., Montgomery-Downs, H. E., Insana, S. P., & Walsh, C. M. (2012). Use of actigraphy for assessment in pediatric sleep research. *Sleep Medicine Reviews, 16*(5), 463–475. https://doi.org/10.1016/j.smrv.2011.10.002

Monk, T. H., Reynolds, C. F., Kupfer, D. J., Buysse, D. J., Coble, P. A., Hayes, A. J., MacHen, M. A., Petrie, S. R., & Ritenour, A. M. (1994). The Pittsburgh Sleep Diary. *Journal of Sleep Research, 3*, 111–120.

Nesi, J., Burke, T. A., Lawrence, H. R., MacPherson, H. A., Spirito, A., & Wolff, J. C. (2021a). Online Self-Injury Activities among Psychiatrically Hospitalized Adolescents: Prevalence, Functions, and Perceived Consequences. *Research on Child and Adolescent Psychopathology, 49*(4), 519–531. https://doi.org/10.1007/s10802-020-00734-4

Nesi, J., Rothenberg, W. A., Bettis, A. H., Massing-Schaffer, M., Fox, K. A., Telzer, E. H., Lindquist, K. A., & Prinstein, M. J. (2021b). Emotional Responses to Social Media Experiences Among Adolescents: Longitudinal Associations with Depressive Symptoms. *Journal of Clinical Child & Adolescent Psychology*, 1–16. https://doi.org/10.1080/15374416.2021.1955370

Orben, A., & Przybylski, A. K. (2020). Teenage sleep and technology engagement across the week. *PeerJ, 8*, e8427. https://doi.org/10.7717/peerj.8427

Orzech, K. M., Grandner, M. A., Roane, B. M., & Carskadon, M. A. (2016). Digital media use in the 2 h before bedtime is associated with sleep variables in university students. *Computers in Human Behavior, 55*, 43–50. https://doi.org/10.1016/j.chb.2015.08.049

Parry, D. A., Davidson, B. I., Sewall, C. J. R., Fisher, J. T., Mieczkowski, H., & Quintana, D. S. (2021). A systematic review and meta-analysis of discrepancies between logged and self-reported digital media use. *Nature Human Behaviour, 5*(11), 1535–1547. https://doi.org/10.1038/s41562-021-01117-5

Parry, D. A., Fisher, J. T., Mieczkowski, H., Sewall, C. J. R., & Davidson, B. I. (2022). Social media and well-being: A methodological perspective. *Current Opinion in Psychology, 45*, 101285. https://doi.org/10.1016/j.copsyc.2021.11.005

Perlis, M. L., Grandner, M. A., Chakravorty, S., Bernert, R. A., Brown, G. K., & Thase, M. E. (2016). Suicide and sleep: Is it a bad thing to be awake when reason sleeps? *Sleep Medicine Reviews, 29*, 101–107. https://doi.org/10.1016/j.smrv.2015.10.003

Ploderl, M. (2021). Suicide risk over the course of the day, week, and life. *Psychiatria Danubina, 33*(3), 438–445. https://doi.org/10.24869/psyd.2021.438. Scopus.

Radovic, A., Gmelin, T., Stein, B. D., & Miller, E. (2017). Depressed adolescents' positive and negative use of social media. *Journal of Adolescence, 55*, 5–15. https://doi.org/10.1016/j.adolescence.2016.12.002
Ramchand, R., Gordon, J. A., & Pearson, J. L. (2021). Trends in Suicide Rates by Race and Ethnicity in the United States. *JAMA Network Open, 4*(5), e2111563. https://doi.org/10.1001/jamanetworkopen.2021.11563
Roberts, R. E., Roberts, C. R., & Duong, H. T. (2009). Sleepless in adolescence: Prospective data on sleep deprivation, health and functioning. *Journal of Adolescence, 32*(5), 1045–1057. https://doi.org/10.1016/j.adolescence.2009.03.007
Sampasa-Kanyinga, H., Hamilton, H. A., & Chaput, J.-P. (2018). Use of social media is associated with short sleep duration in a dose-response manner in students aged 11 to 20 years. *Acta Paediatrica (Oslo, Norway: 1992), 107*(4), 694–700. https://doi.org/10.1111/apa.14210
Scott, H., & Woods, H. C. (2018). Fear of missing out and sleep: Cognitive behavioural factors in adolescents' nighttime social media use. *Journal of Adolescence, 68*, 61–65. https://doi.org/10.1016/j.adolescence.2018.07.009
Scott, H., & Woods, H. C. (2019). Understanding Links Between Social Media Use, Sleep and Mental Health: Recent Progress and Current Challenges. *Current Sleep Medicine Reports, 5*(3), 141–149. https://doi.org/10.1007/s40675-019-00148-9
Sewall, C. J. R., Bear, T. M., Merranko, J., & Rosen, D. (2020). How psychosocial well-being and usage amount predict inaccuracies in retrospective estimates of digital technology use. *Mobile Media & Communication, 8*(3), 379–399. https://doi.org/10.1177/2050157920902830
Takano, K., & Tanno, Y. (2011). Diurnal variation in rumination. *Emotion, 11*(5), 1046–1058. https://doi.org/10.1037/a0022757
Tandon, A., Kaur, P., Dhir, A., & Mäntymäki, M. (2020). Sleepless due to social media? Investigating problematic sleep due to social media and social media sleep hygiene. *Computers in Human Behavior, 113*, 106487. https://doi.org/10.1016/j.chb.2020.106487
The Trevor Project National Survey. (2021). Retrieved January 11, 2022, from https://www.TheTrevorProject.org/survey-2021/
Tubbs, A. S., Fernandez, F.-X., Johnson, D. A., Perlis, M. L., & Grandner, M. A. (2021). Nocturnal and Morning Wakefulness Are Differentially Associated With Suicidal Ideation in a Nationally Representative Sample. *The Journal of Clinical Psychiatry, 82*(6), 36963. https://doi.org/10.4088/JCP.20m13820
Vernon, L., Modecki, K. L., & Barber, B. L. (2017). Tracking Effects of Problematic Social Networking on Adolescent Psychopathology: The Mediating Role of Sleep Disruptions. *Journal of Clinical Child & Adolescent Psychology, 46*(2), 269–283. https://doi.org/10.1080/15374416.2016.1188702
Vogels, E., Gelles-Watnick, R., & Massarat, N. (2022, August 10). Teens, Social Media and Technology 2022. Pew Research Center: Internet, Science & Tech. https://www.pewresearch.org/internet/2022/08/10/teens-social-media-and-technology-2022/