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# Nighttime Texting on Social Media, Sleep Parameters, and Adolescent Sadness: A Mediation Analysis

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**ABSTRACT**

**Objectives:** The use of social media during bedtime has increased in the past years among adolescents, contributing to disturbed sleep quality, which could potentially be related to emotional problems. This study aimed to analyze the mediation effects of sleep parameters on the relationship between NightTime Texting (NTT) on social media and adolescent sadness.

**Methods:** We used a cross-sectional study and evaluated a total of 1464 Swedish students aged 15–17 (55.7% girls) to examine their frequency of NTT on social media, sleep parameters, and adolescent sadness. Bivariate and mediation analyses were performed.

**Results:** Approximately 60% (n = 882) of adolescents engaged in nighttime instant messaging, with 37% (n = 330) reporting texting every night. Higher frequency of NTT was significantly associated with later bedtimes ($\eta 2 > 0.12$), extended weekend wake-up times ($\eta 2 = 0.07$), increased social jetlag ($\eta 2 = 0.07$), and reduced sleep duration on schooldays ($\eta 2 = 0.10$). Multicategorical parallel mediation analyses revealed that sleep duration on schooldays had an indirect effect on the relationship between both Occasional NTT ($a_{11}b_1 = 0.05$, $p < .05$) and Daily NTT ($a_{21}b_1 = 0.12$, $p < .05$) with sadness. Mediation effects were not moderated by gender ($p > .05$), however, the association between Occasional NTT and higher sadness was significantly linked to boys ($t = 2.72$; $p = .007$).

**Conclusions:** Findings showed a large percentage of adolescents engaging in nighttime social media use with worse quality of sleep, and underlined sleep duration on schooldays as a mediator associated with emotional problems in adolescents. These insights can aid in developing strategies for healthier habits to address the misuse of social media and prevent related health problems.

## Introduction

Social media use has become a central part of adolescents' lives, with a substantial percentage of teenagers (>80%) between 15 and 17 engaging in daily use (Kreski et al., 2021). However, the misuse of electronic devices and social media has raised concerns about its impact on adolescent well-being and sleep health (Shannon et al., 2022). Research has linked social media use, especially during bedtime, to disrupted sleep quality, delayed sleep onset, reduced sleep time, and increased daytime sleepiness (Levenson et al., 2017; Lissak, 2018).

This relationship can be caused by the alteration of circadian rhythms due to the light emitted by electronic devices, which can suppress the production of melatonin and, consequently, disrupt the circadian clock (Allada et al., 2021; Figueiro & Overington, 2016). The alteration in the sleep-wake cycle can also result from increasing worries and cognitive arousal before sleep (Almeida et al., 2023). Pre-sleep arousal acts as a predictor and maintaining factor for insomnia, and it has been associated with poor sleep quality in non-clinical samples (Arnison et al., 2022; Sancho-Domingo et al., 2020). This is particularly relevant during adolescence, given the biological predisposition to experience a delayed sleep pattern which contributes to poor sleep, as evidenced by studies associating nighttime screen use with increased social jetlag (Lissak, 2018; Mireku et al., 2019; Touitou et al., 2016). In turn, the use of electronic devices at night may compound this effect (Alonzo et al., 2021).Social jetlag occurs when the socially imposed schedules of adolescents, such as early school start times, are misaligned with their biological circadian rhythms (Wittmann et al., 2006). This phenomenon is mainly observed in the variation of sleep patterns between weekdays and weekends, representing a form of desynchronization (Wittmann et al., 2006). Nighttime electronic device use favors this misalignment, which has been associated with conduct problems, hyperactivity (Chen et al., 2022), as well as emotional problems (Mathew et al., 2019). Despite this, adolescents keep prioritizing bedtime social media use over sleep due to their fear of *missing out* real-world relationships, their urge for social connections, and adolescents' commitment to social norms and expectations (Armstrong-Carter et al., 2023; Scott et al., 2019). Some of these unspoken norms include being available online around bedtime interacting and texting on social media (Hena & Garmy, 2020; Pecor et al., 2016; Scott et al., 2019).

The prevalence of messaging (also called texting) every night after lights out is around 70% among teenagers (Garmy et al., 2019; Pecor et al., 2016; Troxel et al., 2015) with the frequency of use increasing over time during adolescence (Vernon et al., 2018). Nighttime texting refers to individuals who receive/send messages during the night before sleep (Troxel et al., 2015). This behavior has been associated with poor academic performance, later bedtimes, social jetlag, daytime tiredness, and insufficient hours of sleep (Garmy et al., 2019; Hena & Garmy, 2020; Pecor et al., 2016; Van den Bulck, 2007). However, there is limited knowledge regarding the relationship between nighttime texting and psychological well-being in adolescents.

Previous studies suggest that the excessive use of social media during both daytime and nighttime use can negatively impact adolescents' mood through worsening sleep (Alonzo et al., 2021). It can reduce sleep duration and quality, which in turn, may increase the likelihood of experiencing early depression symptoms (Hökby et al., 2016; Vernon et al., 2018). Approximately 37% of adolescents globally report depressive symptoms (Shorey et al., 2022), among which sadness may act as a potential risk factor for affective disorders (Folk et al., 2014) and unhealthy behaviors such as substance use (e.g., Dorison et al., 2020). Despite this prevalence and potential risk factors, there is a lack of research on the relationship between nighttime texting and sadness, with some studies showing inconsistent results. For example, Leung and Torres (2021) found that fewer hours of sleep were associated with depression, but had no indirect effect on the relationship between hours of screen use and adolescents' mood. This could indicate that the different social media-related behaviors (e.g., nighttime use, content, duration, etc.) may exhibit different types of associations with sleep, and/or that other sleep parameters besides sleep duration can also affect adolescents' mood, such as social jetlag. A recent cross-sectional study explored how experiencing social jetlag can mediate the relationship between bedtime media use and emotional problems in adolescents and indicated that social jetlag could explain about 10% of this positive relationship (Yue et al., 2023). Nevertheless, more studies are needed to understand the indirect effects of various sleep parameters jointly and their potential role in preventing sadness in teenagers.

In this regard, it seems also relevant to analyze how gender may affect the relationship between social media use, sleep quality, and mood. Previous research suggests that girls are more likely to experience depressive symptoms than boys (Lu, 2019), as well as more sleep disturbances (Galland et al., 2017), and engage more frequently in nighttime use of social media (Vernon et al., 2018). Given these differences, gender has recently emerged as a factor that moderates the relationship between

media use and sleep quality. Specifically, participating in interactive screen time was found to be linked with better sleep in boys but not in girls (McManus et al., 2021). Therefore, the association between sleep, mood, and nighttime texting may vary across boys and girls, hence exploring the effect of gender could provide a more comprehensive understanding of how these variables interact.

Based on previous literature, a deeper examination is needed to further understand the mediation effects of sleep on the relationship between nighttime texting and early depressive symptoms among adolescents. Thus, the study's primary aim was to assess whether social jetlag and sleep duration mediate the association between nighttime messaging and adolescent sadness and to analyze if gender moderates these mediation pathways.

## Participants and methods

### Participants

Participants were students from upper secondary schools located in a municipality in southern Sweden. Inclusion criteria comprised students in 1st year of upper secondary school of any gender. We estimated the sample size needed to achieve 0.8 power and estimate small to large mediation effects, which was > 500 participants (Fritz & MacKinnon, 2007).

The initial sample consisted of 1504 students, of which 2.66% ($n = 40$) were discarded because provided missing values for gender ($n = 13$), nighttime texting ($n = 6$), bed and wake-up times ($n = 8$), and sadness ($n = 13$). The final sample included 1464 adolescents with a range age between 15 and 17 years, of which 55.7% ($n = 816$) identified as girls, 43.4% ($n = 636$) as boys, and 0.8% ($n = 12$) reported other gender (e.g., non-binary). All schools were located in urban areas, and most of the students attended public schools 94.7% ($n = 1387$).

### Procedure

A cross-sectional descriptive design was used to achieve the research objectives. First, we used convenience sampling to contact five upper secondary schools located in a municipality in southern Sweden, of which four agreed to take part in the study. Once access was granted, students and their parents/guardians were informed about the study characteristics, the safeguarding of confidentiality, and the anonymity of gathered data, and we asked them for their written informed consent to proceed with the assessment. Once consent was provided, the teacher assessed the students using a web-based survey that was completed during school hours and had a duration of approximately 20 minutes.

Data were collected between October 2017 and May 2019 and participants did not receive any compensation for their participation. This study was approved by the Regional Ethics Review Board in Lund, Sweden (EPN 2017/600).

### Variables and measures

We evaluated the sociodemographic variables gender, age, and type of school (public vs. private) with a questionnaire created *ad hoc*.

To assess nighttime texting, we used a single item where participants had to indicate the frequency of sending/receiving messages on social media (e.g., Instagram) during the night before going to sleep. Frequency responses were coded into three categories: *no texting or texting a few nights per year* (No nighttime texting), *texting several nights per month* (Occasional nighttime texting), *and texting almost every night* (Daily nighttime texting).

We also assessed adolescents' sadness with the item derived from the international Health Behavior in School-Aged Children (HBSC) survey (Cavallo et al., 2014), and used the adapted versions of item responses from the PsychoSomatic Problems scale (PPS; Hagquist, 2008). The PSP uses a 5-point Likert scale where participants had to report how sad they felt in the past two weeks with scores

ranging from 0 (*never*) to 4 (*always*). The item has previously proven concurrent validity and has convergent validity with other depression-related symptoms (e.g., difficulty concentrating) among adolescents (Garnow et al., 2021).

Sleep duration and social jetlag were assessed with questions that were very similar – and sometimes identical – to other sleep questionnaires used in Sweden (e.g., Hena & Garmy, 2020). We assessed Total Sleep Time (TST), differentiating schooldays and weekends with two different items: "When it is school the next day/When I am free the next day, I usually sleep approximately … " with responses given in hours. We also asked about bed and wake-up times differentiating between schooldays and weekends: "I usually go to bed around … " and "I usually get up around … ". Based on this information we estimated social jetlag as the differences between midpoints of sleep hours on schooldays and sleep hours on weekends (Wittmann et al., 2006).

### *Statistical analysis*

Descriptive and bivariate analyses were performed. For continuous variables, we analyzed means and standard deviation, and performed an Analysis Of Variance (ANOVA) to analyze differences between nighttime texting frequencies. We used the Games-Howell post-hoc test for unequal variances and estimated effect size of adjusted eta squared ($\eta^2$) with values > 0.01 indicating a small effect, >0.06 moderate, and > 0.14 large (Keren & Lewis, 1979). For discrete variables, we estimated frequencies, and distributions, and used Chi-square tests ($\chi^2$). We estimated Cramer's V ($\varphi_c$) effect size, with values > 0.05 representing weak effect size, >0.1 moderate, >0.15 strong, and > 0.25 very strong (Cramér, 1946).

We also analyze the mediation effects of sleep parameters (M) over the relationship between nighttime messaging (X) and sadness (Y) using the macro PROCESS (Hayes, 2013). A mediator is a factor that occurs in the pathway between the variables X and Y, and gives explanations about the X-Y relationship. In our study, X adopted three categories for NightTime Texting (NTT): No NTT ($X_0$), Occasional NTT ($X_1$), and Daily NTT ($X_2$). Therefore, we conducted a multicategorial mediation in which TST and social jetlag were the mediators (M). Since the mediators are two sleep-related variables, we used a parallel mediation model in which we could account for shared associations while allowing for their influence over sadness (Hayes, 2013). Standardized total, direct, and indirect effects were estimated, and gender was included as a covariate due to its association with the models' variables (Galland et al., 2017; Lu, 2019; Vernon et al., 2018). We could only include boys and girls because the number of participants who identified with a different gender was insufficient to compute the analyses. We also include school starting times to control the effect of clustering participants by schools and its impact on social jetlag. Lastly, we examine gender as a moderator of the mediation analysis in order to assess whether indirect or direct effects were conditional to boys and girls.

All analyses in this study were conducted using SPSS software version 26 and the results were interpreted based on a 95% level of significance.

## Results

### *Differences in sleep parameters and sadness according to NightTime Texting (NTT) frequency*

Table 1 provides information on the sample characteristics and the distribution of participants across the three NTT groups, with 39.8% (*n* = 582) referring No NTT, 37.7% (*n* = 552) Occasional NTT, and 22.5% (*n* = 330) Daily NTT. The bivariate test indicated no statistically significant differences between the NTT groups (*p* > .5; $\varphi_c$ <0.1) regarding gender, which suggests that NTT groups had similar percentages of girls, boys, and non-binary teenagers. Regarding sleep parameters, the average TST of

**Table 1.** Sample's characteristics.

| | Total sample | No NTT (A) | Occasional NTT (B) | Daily NTT (C) | | | |
|---|---|---|---|---|---|---|---|
| | 100% (n = 1464) | 39.8% (n = 582) | 37.7% (n = 552) | 22.5% (n = 330) | $F/\chi^2$ | Games-Howell test | $\eta^2/\varphi_c$ |
| Gender | | | | | 3.70 | – | .05 |
| %(n) Boys | 43.4 (636) | 42.1 (245) | 44.2 (244) | 44.5 (147) | | | |
| %(n) Girls | 55.7 (816) | 57.6 (335) | 54.7 (302) | 54.2 (179) | | | |
| %(n) Other | .8 (12) | 0.3 (2) | 1.1 (6) | 1.2 (4) | | | |
| Sadness | 2.6 (1.1) | 2.5 (1.1) | 2.7 (1.1) | 2.5 (1.2) | 6.97** | A,C<B | .01 |
| Sleep parameters | | | | | | | |
| Bedtime schooldays | 22:49 (0:57) | 22:32 (0:49) | 22:47 (0:52) | 23:27 (1:00) | 118.32** | A<B<C | **.14** |
| Bedtime weekends | 01:09 (1:30) | 00:34 (1:24) | 01:16 (1:24) | 2:00 (1:28) | 96.53** | A>B>C | **.12** |
| Wake time schooldays | 06:37 (0:42) | 6:36 (0:42) | 6:35 (0:41) | 6:41 (0:43) | 1.91 | – | 0 |
| Wake time weekends | 9:58 (1:18) | 9:38 (1:14) | 10:00 (1:11) | 10:31 (1:24) | 51.06** | A<B<C | **.07** |
| TST schooldays | 7:06 (1:00) | 7:24 (0.58) | 7:00 (0.58) | 6:30 (1:00) | 81.25** | A>B>C | **.10** |
| TST weekends | 9:06 (1:12) | 9:06 (1:06) | 9:00 (1:06) | 9:18 (1:24) | 4.38* | A,B<C | .01 |
| Social jetlag | 1.1 (.7) | 0.9 (0.6) | 1 (0.6) | 1.4 (0.8) | 58.35** | A<B<C | **.07** |

NTT: Nighttime texting; TST: Total Sleep Time; F: ANOVA F statistic; $\chi^2$: Chi-square tests; Games-Howell: post-hoc test; $\eta^2/$: eta-squared effect size; $\varphi_c$: Cramer's V effect size; *$p < .05$; **$p < .01$; Bold typing indicates moderate to large effect sizes ($\eta^2 > 0.06$; $\varphi_c > 0.1$).

the total sample was 7:06 hours for schooldays (SD = 1) and 9:06 hours (SD = 1.1) for weekends. The bedtimes and wake-up times during schooldays were 10:49 PM and 6:37 AM, respectively. However, on weekends, bedtimes shifted to 1:09 AM, with wake-up times at 9:58 AM, which results in 1.1 hours of social jetlag (SD = 0.7).

When comparing the NTT groups, the results showed a linear association between a higher frequency of NTT and a delayed and shorter sleep pattern (see Table 1). Adolescents engaging in Daily NTT reported later bedtimes during schooldays (mean = 23:27; F = 118.3; $p < .001$; $\eta^2 = 0.14$) with a difference of going to sleep half an hour later than those engaging in Occasional NTT (mean = 22:47), and about an hour later than those in the No NTT group (mean = 22:32). Similar differences were also found for bedtimes on weekends (F = 95.5; $p < .001$), yielding a moderate effect size ($\eta^2 = 0.12$).

Furthermore, the Daily NTT participants also reported later wake-up times during weekends (mean = 10:31; F = 51.1; $p < .001$; $\eta^2 = 0.07$) which might contribute to their significantly higher scores on social jetlag (mean = 1.4; F = 58.4; $p < .001$; $\eta^2 = 0.07$). No significant differences were found for wake-up times during schooldays.

On the other hand, the TST was significantly shorter for the Daily NTT group, who reported 6:30 hours of sleep on schooldays and about 9:00 hours on weekends. In this case, differences in TST on schooldays yielded a moderate effect size ($\eta^2 = 0.10$) compared to the differences found for TST on weekends, which were small ($\eta^2 = 0.01$).

Sleep differences were also found when comparing Occasional NTT and No NTT, which yielded a moderate effect size ($\eta^2 > 0.07$). As observed in Table 1, the Occasional NTT group had later bedtimes, later wake-up times on weekends, and slept fewer hours during schooldays, which increased their social jetlag.

Regarding the levels of sadness, the analysis revealed statistically significant differences among the NTT groups. The results indicate that adolescents in the Occasional NTT group reported higher levels of sadness (mean = 2.7; F = 6.97; $p = .001$; $\eta^2 = 0.01$) compared to the other two groups, which had an average score of 2.5 both, Daily and No NTT groups. Contrary to the results obtained on sleep parameters, the relationship between sadness and the frequency of NTT exhibited a non-linear pattern, as illustrated in Figure 1. Adolescents who engaged in Occasional NTT displayed significantly higher sadness scores and this relationship seemed to follow a curvilinear trend, with a significant and larger effect size ($R^2 = 0.009$; $p = .001$) rather than a linear association ($R^2 = 0.001$; $p = .249$).
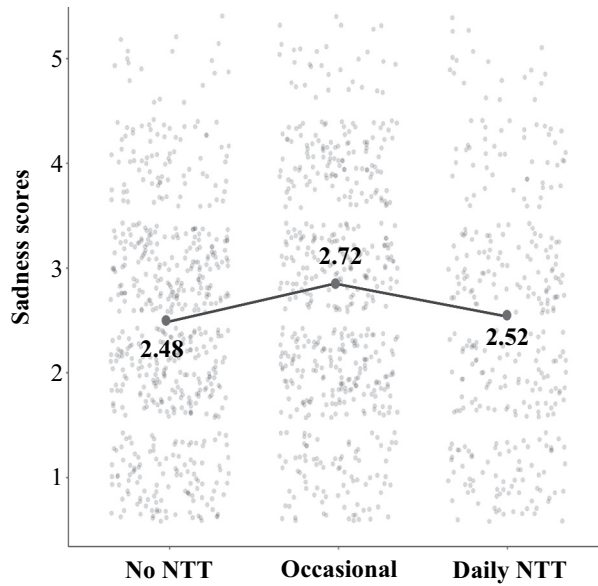
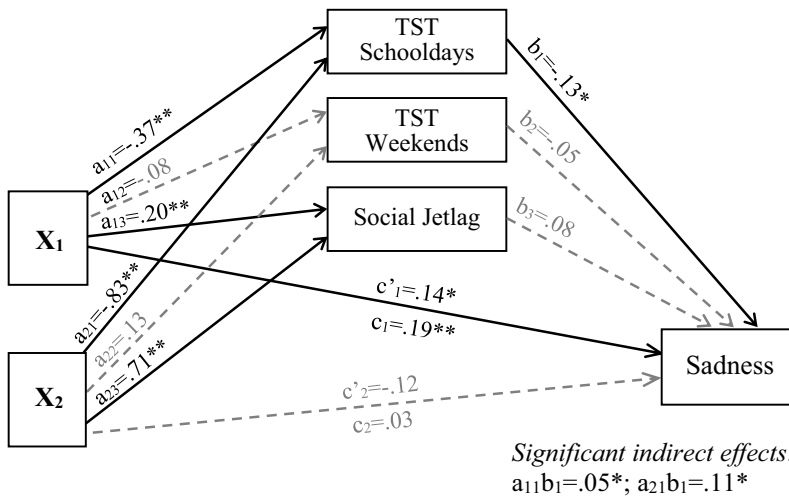**Figure 1.** Sadness means scores between NightTime texting (NTT) groups.



**Figure 2.** Multicategorical parallel mediation of sleep parameters (M) between nighttime texting (X) and sadness (Y). Continuous lines represent significant paths whereas dashed lines non-significant. $X_1$: Occasional NTT vs No NTT; $X_2$: Daily NTT vs No NTT; TST: Total Sleep Time. *a paths*: effects of nighttime texting over sleep parameters; *b paths*: effects of sleep parameters over sadness; *c paths*: total effects of X on Y; *c' paths*: direct effects of X on Y absent the mediators; $a_{11}b_1$ and $a_{21}b_1$ *paths*: indirect effects of weekdays TST over the relationship $X_1$-Y and $X_2$-Y, respectively. Reported effects are standardized. *$p < .05$; **$p < .01$

### *Multicategorical parallel mediation*

Figure 2 shows the standardized mediation effects of TST on schooldays, weekends, and social jetlag over the relationship between nighttime texting and sadness. NTT accounted for 12.8% of the variance in sadness scores (F = 6.1; $p < .001$) and the inclusion of sleep mediators in the model collectively contributed to explaining 22.9% of the observed sadness scores variability (F = 11.6; $p < .001$).

Results indicated that nighttime texting was significantly associated with schooldays TST and social jetlag. The strongest associations were found between Daily NTT and shorter schooldays TST

($a_{21}$ = -0.83; $p < .001$), as well as with higher social jetlag ($a_{23}$ = 0.71; $p < .001$). No significant associations were found for TST on weekends ($p > .5$).

On the other hand, only TST on schooldays showed a significant effect over sadness ($b_1$ = -0.13; $p = .049$), which for every unit decrease in the TST (approximately 30 minutes), there is a corresponding increase of 0.13 units in reported sadness. Regarding this, significant indirect effects were only found for the mediator schooldays TST. The positive relationship between Occasional NTT and sadness ($c = 0.20$; $p = .004$) was partly explained by the indirect effects ($a_{11}b_1 = 0.05$, $p < .05$), which explained 26.3% of the overall positive relationship when compared to No NTT.

In this case, the direct effects of NTT accounted for 73.7% ($c'_1 = 0.14$; $p = .021$) of sadness scores variability. By contrast, results revealed a complete mediation for schooldays TST over the relationship between daily NTT and sadness ($a_{21}b_1 = 0.12$, $p < .05$). In this case, Daily NTT seemed to be related to higher sadness only through the reduction in sleep hours during schooldays.

### Moderated mediation

After parallel mediation analysis, we examined gender as a moderator variable for the indirect effects, as well as for the direct effects of the X-Y relationship. Gender showed no significant moderation effects for any of the indirect paths of sleep parameters ($p > .05$). However, the direct effect of Occasional NTT ($X_1$) over sadness (Y) was conditional to boys ($t = 2.72$; $p = .007$), but not girls ($t = 0.55$; $p = .586$). Conversely, the direct effects of Daily NTT were negatively associated with sadness in girls ($c' = -0.21$; $p = .033$), but not in boys ($c' = -0.04$; $p = .715$). See supplementary material.

### Discussion

For this study, we examined the mediation effects of sleep parameters, sleep duration and social jetlag, over the relationship between nighttime texting and sadness in adolescents. Most adolescents reported staying up late and waking up early, resulting in an average sleep duration of only 7 hours on schooldays that extends to 9 hours on weekends. Concurrent with previous works, we observed that adolescents postpone their bedtime (Norell-Clarke & Hagquist, 2017), and this could be due to engaging in nighttime texting on social media.

Findings indicated that approximately 60% of adolescents were engaged in bedtime messaging, while 40% reported either never or rarely texting after lights out, which concurs with the rates found in prior research (Pecor et al., 2016; Troxel et al., 2015). Accordingly, a higher frequency of nighttime texting was linked to a decline in sleep quality, characterized by delayed bedtimes, extended weekend wake-up times, increased social jetlag, and a reduction in total sleep duration, reaching a discrepancy of up to one hour less on schooldays. As stated in previous research, the social expectation of being digitally accessible during bedtime hours might play a role in worsening sleep issues, which can emerge as a potential form of mobile misuse behavior (Hedin et al., 2020; Levenson et al., 2017; Scott et al., 2019). But this could also be influenced by the content of messaging that could increase cognitive arousal (e.g. cyber bullying) or the exposure to screen lights that can suppress melatonin (Allada et al., 2021).

On the other hand, texting after lights out was found to be linked not only to sleep quality but also to sadness. Despite small differences across the NTT group, significant differences suggest that NTT habits could be clinically relevant for their impact on sadness. Interestingly, we found a nonlinear relationship with sadness in which occasional texting was associated with higher sadness compared with no/rarely texting or texting every night. Although the strength of the curvilinear association was low (potential inverted U-shape association), previous works support this finding (Vuorre et al., 2021). The association between technology use and depressive symptoms has previously exhibited a curvilinear trend, and specifically, the moderate use of social media has been linked to higher levels of depression (Vuorre et al., 2021). However, the form of this nonlinear association has yielded inconsistent findings (e.g., inverted U-shaped vs. non-

inverted) in the literature (e.g., Bélanger et al., 2011) and further research is needed to understand this topic. In this regard, our findings might indicate that adolescents could reduce the frequency of nighttime texting as a means of isolating themselves from peer environment and reducing interaction on social media, which has been associated with depressive symptoms (Alsadoun et al., 2023; Bélanger et al., 2011). Such social isolation seems to be more predominant among boys in online networks and communicating via text messages (Alsadoun et al., 2023), which lends support to the results we obtained in the moderation analysis.

However, despite we found a potential curvilinear association between nighttime texting and sadness, the mediation analysis revealed that texting every night was also associated with elevated levels of sadness. In this case, the association was mainly through the reduction of sleep hours on schooldays. This suggests that sadness might be affected not only by social media use but also by sleep-related factors, as observed in the previous research (Alonzo et al., 2021; Liu et al., 2019). Concurring with our findings, worse sleep patterns during adolescence can play a mediating role in the appearance of depressed mood (Vernon et al., 2018). Through the parallel mediation analysis, we could compare the impact of both hours of sleep and social jetlag and find that the reduction in sleep hours on schooldays had a more pronounced association with sadness. In this case, social jetlag showed no significant effect as opposed to what was found in other studies (Yue et al., 2023). However, given the interconnectedness of the two sleep parameters, future longitudinal studies should examine the sequential mediation effect that could potentially exist between them.

Furthermore, our mediation results may provide clarity regarding inconsistencies previously found in sleep mediation effects. Leung and Torres (2021) found no mediation effect for sleep hours, but this can be due to their assessment approach that did not differentiate between hours slept on schooldays and on weekends. Our findings suggest that there is a clear differentiation in sleep duration between days with no school commitments and schooldays, which should be taken into account in future works.

While this study contributes valuable insights into the mediation effect of sleep parameters in the relationship between nighttime texting and adolescent sadness, several limitations should be acknowledged. Firstly, this study did not use a longitudinal design, and therefore the bidirectionality of relationships and predictive effect could not be explored. Future longitudinal studies would offer a more comprehensive understanding of the potential association between variables. Secondly, we relied on self-reported questionnaires for data collection, increasing the possibility of response bias and recall errors. In this regard, the use of a single item to assess sadness should be also considered since it analyzes a complex emotional construct. However, the item has been well-established when capturing psychosomatic symptoms among adolescents (Cavallo et al., 2014; Hagquist, 2008) and correlates with depression (Garnow et al., 2021). Additionally, although the study aimed to evaluate the indirect effects of sleep parameters, exploring other potential concurrent mediators is encouraged. This also includes the assessment of the emotional content of texting, which may contribute to sadness, and the evaluation of other bedtime activities that may contribute to light and arousal, such as watching videos or playing video games. Future studies should incorporate sleep objective measures and real-time assessment of various types of social media use, as well as depressive symptoms.

Taking into consideration these limitations, this study addresses a gap in the existing literature by examining sleep parameters jointly as mediators of bedtime messaging and levels of sadness in adolescents. The findings of this study highlight the role played by sleep duration on schooldays in affecting the impact of social media use at night on emotional problems in adolescents. If confirmed in prospective studies, this can serve as a basis for developing strategies aimed at promoting healthier habits, such as identifying the adequate time for screen use or the duration of using social media (Leung & Torres, 2021). This can provide a roadmap for educators and health professionals to address habits associated with online social interactions and enhance adolescents' sleep health by mitigating the gradual shift toward delayed bedtimes (Norell-Clarke & Hagquist, 2017).

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## Disclosure statement

## Funding

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## Authors' contributions

All authors have participated sufficiently in the work to take public responsibility for appropriate portions of the content: CSD, PG & AN. Study conception & design CSD, PG & AN: Data collection: PG. Analyzed data: CSD. Wrote the first draft of the manuscript: CSD. Revised the manuscript and approved the final version: CSD, PG & AN.

## Data availability statement

The datasets during and/or analyzed during the current study are available from PI Pernilla Garmy on reasonable request pernilla.garmy@hkr.se.

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