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Article

Gender differences in social media, sleep, and cognition in U.S. teens

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SUMMARY

Social media usage has become so pervasive among adolescents that it directly affects their cognitive functioning. A popular belief is that women multitask using social media more than men, which sparked our interest in investigating whether there exists a significant gender difference in the relationships between social media usage, sleep, and attention during writing-shift tasks among American adolescents. Previous research has shown that if multitasking is sufficiently practiced, it will become so automatic that it will not require a significant use of cognitive resources. Other studies have emphasized that excessive social media usage leads to anxiety, depression, and diminished cognitive performance. Therefore, we explored the relationships among these three variables — social media usage, sleep, and attention — in American adolescent boys and girls. Our hypothesis was that increased social media usage and poor sleep quality would lead to diminished cognitive functioning and that both genders would exhibit a greater decrease in attention. For our approach, we delivered a voluntary four-part quantitative survey through an online Google form. We discovered that sleep quality was not significantly associated with intensity of social media usage and that there was no clear association between sleep quality and cognitive performance across gender. We also found that social media usage was not significantly associated with cognitive functioning, independent of gender. These findings may help teachers, parents, and policymakers focus less on screen time alone and more on broader behavioral patterns when addressing adolescent wellbeing and academic performance.

INTRODUCTION

Since its advent, social media (SM) has occupied a significant role in people's behavior and cognitive control (1). As media expanded beyond just games, they increasingly started to play more invasive roles in everyday life. For example, social media platforms have continued to gain popularity since the early 2000s coinciding with advancements in smartphone technology. Similar to video games, SM has been associated with interfering with academic performance, driving, sleep, and other cognitive tasks (1). Some researchers even proposed a theory that an increased use of SM contributes to the development of the "attention deficit trait" which decreases efficiency and increases chances of making mistakes, due to being constantly pulled away from one goal (2). SM addiction, however, falls under the broader umbrella of Internet addiction. Consequently, researchers in the field suggest considering the differences between activities online when assessing the degrees of their compulsive behavior (3). For example, pathological gaming has been recognized as a disorder by the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition, while differences between different SM applications make it challenging to devise a universal social media addiction scale (3, 4).

While ample research has been conducted on the effect of SM on sleep alone or on self-image, body-image, and on health-related problems such as anxiety or depression, there is still a lack of robust research that has looked specifically at gender differences in how the three variables — SM use, sleep quality, and attention — interact with each other among American adolescents under typical circumstances. Previous studies looking at the effects of SM and other sources of media have had varying conclusions on their effects on young people's cognitive function and academic success (5–8). Much of the research was conducted in different countries and under atypical conditions like the COVID-19 pandemic. Cultural factors are relevant since Americans report the highest media use and multitasking rates globally (9).

While the differences in previous conclusions can be attributed to how the studies were conducted and what types of media were studied, significant gaps in our understanding of the effects of SM remain.

A particularly important gap lies in understanding whether chronic SM use affects cognitive function differently for young boys and girls and whether they have the same ability to switch between tasks. Task switching (also defined as cognitive flexibility) requires brain capacity to actively shift attention and focus, and is known to engage different brain regions than those involved in sustained, focused attention (1). Although some researchers have suggested that habitual multitasking can become automatic and less cognitively demanding, others have noted that task-switching can still result in superficial processing (1). Prior studies conducted on multitasking and attention have reported mixed results. Some found no link between habitual multitasking and deficits in sustained attention (10). Studies from Israel, Iran, and Taiwan have shown that girls tend to multitask more, use more SM, and show greater sleep disruption or smartphone addiction than boys (11–13). Some researchers associated higher cognitive flexibility with better performance on task-switching measures (14, 15). Others noted that with increasing age, individuals could gain better control over their attention allocation (16). Our decision to use task-switching

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as a measure of cognitive functioning was influenced by these findings as well as by adolescent-focused studies that reported correlations between high media multitasking and reduced working memory and attention through self-report questionnaires (17).

Understanding that adolescents' attention operates differently than in adults — not merely as mental effort but as a response to rewards — is also crucial when looking at the effects of SM. Some researchers have challenged the classical view that equates attention with effort (18). Others have pointed out that newer models distinguish between effortful and effortless attention, highlighting that even high-attention activities like sports can feel restorative. In the context of adolescents, attention was often diverted not by cognitive overload but by intentional engagement with rewarding stimuli such as SM (19). Compulsive checking behaviors have been linked to neural sensitization to external rewards like "likes," reinforcing patterns of SM addiction (20). Moreover, peer influence played a significant role in shaping adolescents' motivation to engage with social platforms (21). These dynamics are essential to understanding how attention functions in real world and digitally-saturated environments, especially among American adolescents.

Most studies examining SM have taken a chain mediation approach, without differentiating between genders, and emphasized how excessive usage indirectly affects attention and cognitive functioning through mediators like sleep quality, self-control, and psychological well-being (22–24). Since SM consumes a significant amount of time, it often reduces sleep duration — an essential factor for learning, memory, and cognitive processing (13, 23). Therefore, sleep was a central component in many models that explored the link between media use and attention (22–24). Several international studies, including those conducted in China, the U.K., the Netherlands, and Taiwan, supported this framework by demonstrating how factors such as fear of missing out, self-control failure, and smartphone dependence were associated with poor sleep quality and increased distractibility in adolescents (13, 22–24). In light of these findings, cause-effect relationships need to be continually re-evaluated in helping to establish a cut-off point between addictive and high-engaging non-disordered SM usage as social platforms develop and change.

We aimed to investigate if there is a significant gender difference in the relationships between excessive SM usage, sleep, and attention during writing shifting tasks among American adolescents. It is important to mention that this study did not consider psychological and motivational factors that influence attention and task efficiency. We hypothesized that increased SM usage and poor sleep quality would lead to a greater decrease in attention in boys and girls, which would impact their cognitive performance on a task requiring shifting attention. Contrary to our hypothesis, which we tested through a quantitative survey, the degree of SM usage and sleep quality did not directly correlate to performance in writing tasks, independent of gender. However, consistent with some earlier studies, girls spent more time on SM and had a poorer sleep quality than boys. Our findings revealed that adolescent media use impacts cognition in complex ways. Educators and parents should consider not just screen time, but also individual differences when addressing attention and academic performance in teens, and use more targeted interventions that go beyond general restrictions on usage limits.

RESULTS

In this study, we looked at the relationships between SM usage, sleep, and attention during cognitively demanding tasks, while exploring if they might be different depending on gender. We conducted a voluntary, four-part quantitative survey among 558 American adolescents, 272 girls and 262 boys, to examine these variables (**Figure 1**).

To explore participants' SM habits, the first question on the questionnaire asked them to indicate what platforms they use by checking all that applied. The selection included Facebook, Instagram, Snapchat, and TikTok as they are the most widely used, particularly among younger demographics (4). On average, girls declared that they spent more time on SM than boys during a typical school day, with girls averaging approximately 173 minutes per person compared to 144 minutes for boys — a difference of about 29 minutes (**Figure 1**). Girls tended to select more platforms than boys, while boys tended to gravitate towards just one or two.

Questions #2–6 asked the participants to self-report time they spend daily on each particular social media platform. The largest gender gap appeared on TikTok, where girls averaged 84.44 minutes and boys 54.74 minutes (two-tailed t-test, $t(532) = 3.00$, $p = 0.003$), followed by Snapchat (girls: 62.33 min, boys: 44.5 min; $t(532) = 2.10$, $p = 0.036$). In contrast, time spent on Instagram ($t(532) = 0.07$, $p = 0.94$) and Facebook ($t(532) \approx 0.40$, $p > 0.50$) did not significantly differ between genders (**Figure 2**). The numbers obtained for each individual platform were estimations and did not necessarily add up to the overall time spent on SM per school day reported in question #1.

Questions #7–10 related to the habits concerning SM usage and applied a 5-point Likert scale, with "Strongly agree" given 1, "Agree" given 2, "Somewhat agree" given 3, "Disagree" given 4, and "Strongly disagree" given 5 (**Appendix**). The values of 1 and 2 indicate the degree of support for the statement, "Somewhat agree" is considered neutral, and the values of 4 and 5 indicate the degree of disagreement with the statement. Lower numbers indicate positive attitudes while higher numbers demonstrate negative attitudes. We used the affirmative statements such as "I constantly refresh social media sites," "I sleep less than normal because of

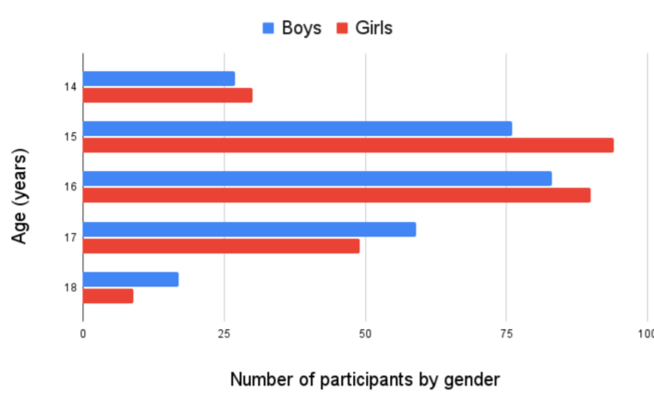

Figure 1: Age distribution of adolescent boys and girls (G=272, B=262). 558 participants across different age groups (14 to 18 years) participated in the study, with the largest representation occurring between ages 15 and 16 for both genders.

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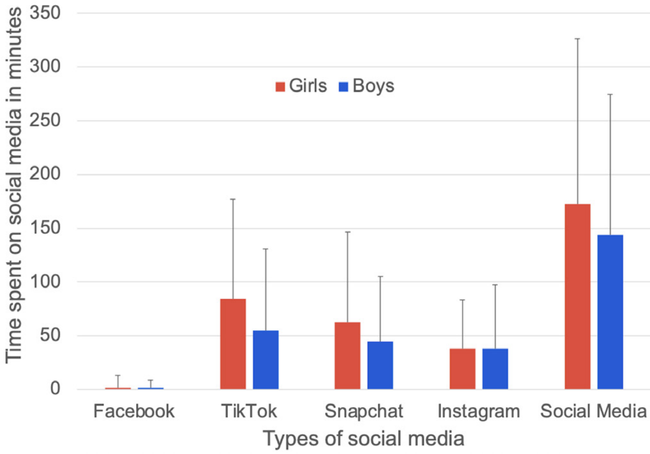

Figure 2: Self-reported estimations of time spent on social media (SM) by gender (n=534). Mean values of self-reported time in minutes (min) spent on SM overall and on individual platforms on an average school day were reported through questions #2–6 on the Google form questionnaire. Independent samples t-tests indicated that girls (n =272) spent significantly more time than boys (n = 262) on overall SM use (t(532) = 2.31, p = 0.021), TikTok (t(532) = 3.00, p = 0.003), and Snapchat ((532) = 2.10, p = 0.036). No significant differences were found for Instagram (t (532) = 0.07, p = 0.94) or Facebook (t(532) ≈ 0.40, p > 0.50). Error bars represent one standard deviation above the mean for each value.

social media usage," "I'd rather spend an evening on social media than on any other activity," and "I feel uncomfortable or anxious when unable to use social media," and assessed how boys and girls responded to them. When comparing the responses of boys to those of girls, the mean values of responses to each question were higher for boys, indicating greater disagreement with these statements. In contrast, girls had lower mean scores, suggesting that they were more likely to agree or strongly agree with the statements (**Figure 3**). For "Constantly refreshing SM," boys scored higher with a mean of 3.2 points, compared to 2.6 points for girls (independent two-sample t-test, $t(532) = -8.67$, $p < 0.00001$). For "Sleeping less due to SM," boys again scored higher with a mean of 3.3 points, compared to 2.9 points for girls (two-sample t-test, $t(532) = -5.78$, $p < 0.000001$). For "Preferring SM over other activity," boys scored higher with a mean of 4.1 points than girls whose mean was 3.8 points (two-sample t-test, $t(532) = -3.85$, $p < 0.00013$). For "Feeling uncomfortable without SM," boys consistently scored higher than girls, with a mean of 4.1 points compared to 3.7 points for girls (two-sample t-test, $t(532) = -5.14$, $p < 0.000001$).

The next part of the questionnaire adapted Pittsburgh Sleep Quality Index (PSQI) questions related to sleeping habits to gauge the relationship of sleep to SM usage. The questions were marked as #11–19 (25) (**Appendix**). PSQI contains seven sleep component scores. Each component received a subscore on a scale of 0-3 by combining self-rated items. In all cases, a score of "0" indicates no difficulty sleeping, while a score of "3" indicates severe difficulty sleeping. The global PSQI score with a range of 0-21 points was obtained by adding all seven subscores.

Across all seven components of the PSQI, girls reported higher mean scores than boys, indicating poorer sleep quality (**Figure 4**). Girls had slightly higher scores than boys in subjective sleep quality, with a mean of 1.09 points compared to 0.97 points for boys (two-tailed t-test, $t(532) = 2.14$, $p = 0.032$), sleep latency, with a mean of 1.15 points compared to 0.99 points for boys (two-tailed t-test, $t(532) = 2.00$, $p = 0.046$), and sleep duration, with a mean of 1.02 points compared to 0.86 points for boys (two-tailed t-test, $t(532) = 2.50$, $p = 0.013$), suggesting more difficulty falling asleep and shorter sleep times. Similarly, girls scored marginally higher on sleep efficiency, with a mean of 0.33 points compared to 0.28 points for boys (two-tailed t-test, $t(532) = 1.02$, $p = 0.307$), and sleep disturbances, with a mean of 1.18 points compared to 1.04 points for boys (two-tailed t-test, $t(532) = 3.27$, $p = 0.001$), reflecting more fragmented or less restful sleep. The largest difference emerged in daytime dysfunction, with girls scoring significantly higher than boys, with a mean of 1.43 compared to 0.97 for boys (two-tailed t-test, $t(532) = 6.59$, $p < 0.001$), indicating greater daytime fatigue. Overall, these findings reflect a consistent pattern of poorer sleep outcomes for girls across all PSQI dimensions.

When we compared overall sleep quality with the amount of time spent on SM, both genders lacked a linear pattern (**Figure 5**). Girls' sleep scores tended to be more spread out, with some scores reaching higher values, while boys' data points were more compact and clustered around lower values. For girls, there was a statistically significant but very weak positive correlation between time spent on SM and PSQI score (Pearson's correlation, r = 0.115, $p < 0.001$), suggesting that increased SM usage was modestly associated with poor sleep (**Figure 5A**). For boys, there was also a statistically significant but negligible positive correlation (r = 0.051, $p < 0.001$) (**Figure 5B**). Although both results reached statistical significance, the effect sizes were small, with R^2 values of 0.013 for girls and 0.003 for boys, indicating that SM explained only 1.3%

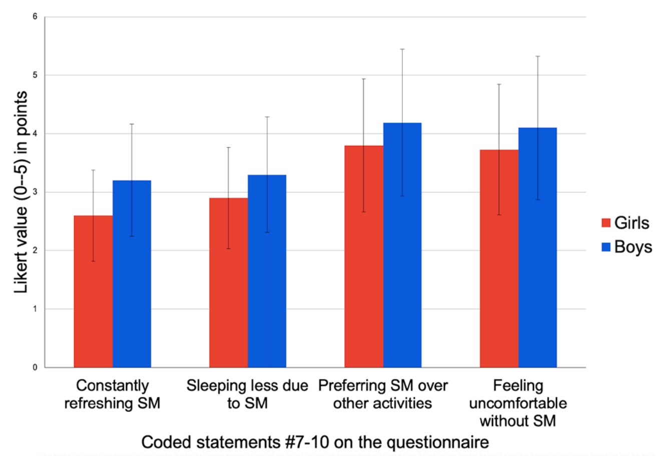

Figure 3: Self-reported attitudes on SM usage by gender (N=534). Mean values of self-reported attitudes towards SM were reported through questions #7–10 on the Google form questionnaire. On a 5-point Likert scale, "Strongly agree" is given 1, "Agree" is given 2, "Somewhat agree" is given 3, "Disagree" is given 4, and "Strongly disagree" is given 5. There existed statistically significant differences between girls (n =272) and boys (n = 262) across all four statements (Independent samples t-tests, p<0.001 for all). Boys reported significantly higher agreement than girls on Constantly refreshing SM (Statement #7: t(531.97) = -6.11), Sleeping less due to SM (Statement #8: t(529.56) = -3.83), Preferring SM over other activities (Statement #9: t(527.24) = -5.48), and Feeling uncomfortable without SM (Statement #10: t(529.83) = -4.71). Error bars represent one standard deviation above and below the mean for each value.

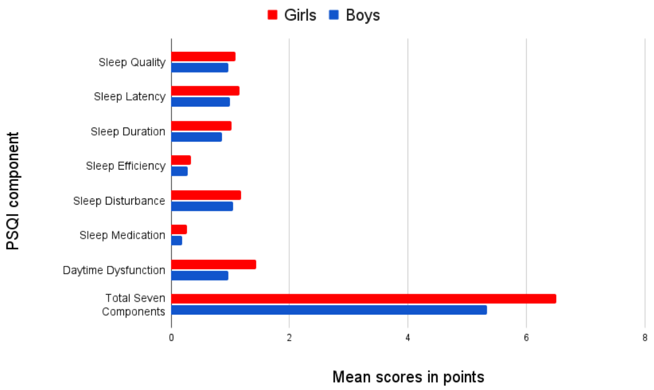

Figure 4: Mean Pittsburgh Sleep Quality Index component scores in points by gender (N=553). PSQI consists of 7 self-rated questions that are grouped into subscores. Each group of questions applied a 5-point Likert scale with responses "Strongly agree" (a value of 1), "Agree" (a value of 2) "Somewhat agree" (a value of 3), "Disagree" (a value of 4) and "Strongly disagree" (a value of 5). The global PSQI score, summing all subscores (range 0-21), was significantly higher for girls (two-sample t-test, t(532) = 4.74, p < 0.001). Girls (n =272) reported significantly higher (worse) scores than boys (n = 262) in overall sleep quality (p < .001), with significant differences in Subjective Sleep Quality (p = .032), Sleep Latency (p = .046), Sleep Duration (p = .013), Sleep Disturbance (p = .001), and Daytime Dysfunction (p < .001). No significant differences were found for Sleep Efficiency (p = .307) or Sleep Medication (p = .139).

and 0.3% of the variance in sleep quality, respectively. These findings suggest that SM use was not a meaningful predictor of sleep quality for either gender. On average, girls spent more time on SM than boys and reported poorer sleep quality, with statistically significant differences found for both media usage time (paired t-test, $t(532)$ = value, $p < 0.05$) and PSQI scores (paired t-test, $t(532)$ = value, $p < 0.05$) .

However, girls appeared to be impacted more quickly in terms of variability in sleep quality. At 20 minutes of social media usage, some girls had a PSQI sleep score of 15 (**Figure 5A**). For boys, at the same time, the scores were clustered around 5-7 (**Figure 5B**).In the range 30-45 min, there were several data points for girls with PSQI sleep scores ranging from 5 to 15. In the same time frame, boys' sleep scores mostly clustered again in the 5-7 range. While the trend was not definitive, it might suggest that some girls may experience a quicker negative impact on sleep quality even with short durations of SM usage.

Overall, the majority of all participants fell into the PSQI range of 3-8. For reference, a global score over 5 indicates poor sleep (25). Additionally, the United States National Sleep Foundation recommends the requirement of 8 to 10 hours of sleep per day for adolescents from 14 to 17 years of age (25, 26). Based on question #14 on the PSQI scale, out of 262 boys, only 83 reported sleeping 8 hours or more per night, compared to 61 girls out of a cohort of 272 (**Appendix**). Among all participants, 32.6% scored between 0 and 4, and 16.4% had a sleep quality score of exactly 5, reflecting relatively good sleep. Within this 0-5 range, boys made up the majority, as only 22.8% of these good sleepers were girls. In comparison, 51% of all participants scored on a range of 6-19, comprising 57% of the girls' cohort and 47% of the boys' cohort. The higher the score on a 21-point scale, the more girls appeared, displaying worse sleep quality than boys. In a PSQI score range of 0-5 (good quality), boys outnumbered girls, with the opposite trend in a range of 6-19 (bad quality), suggesting that boys had a better sleep quality than girls.

The last part of the questionnaire asked the participants to perform a writing task in order to assess their attention and explore a possible correlation between sleep and cognitive flexibility. This was measured by comparing the fold change between the pre-test and post-test, where the pre-test indicates the time taken for writing a phrase on one line and writing separately the numbers 1-21 on another line, while the post-test required writing the same phrase on one line, alternating each letter with a number from 1 to 21. Both boys and girls showed nearly a threefold increase in writing time (girls: mean = 2.72; boys: mean = 2.62). Boys seemed to complete tasks faster on average in both pre-test and post-test times, as evidenced by the tight clustering mostly below 200 seconds compared to a broader range of girls' times and

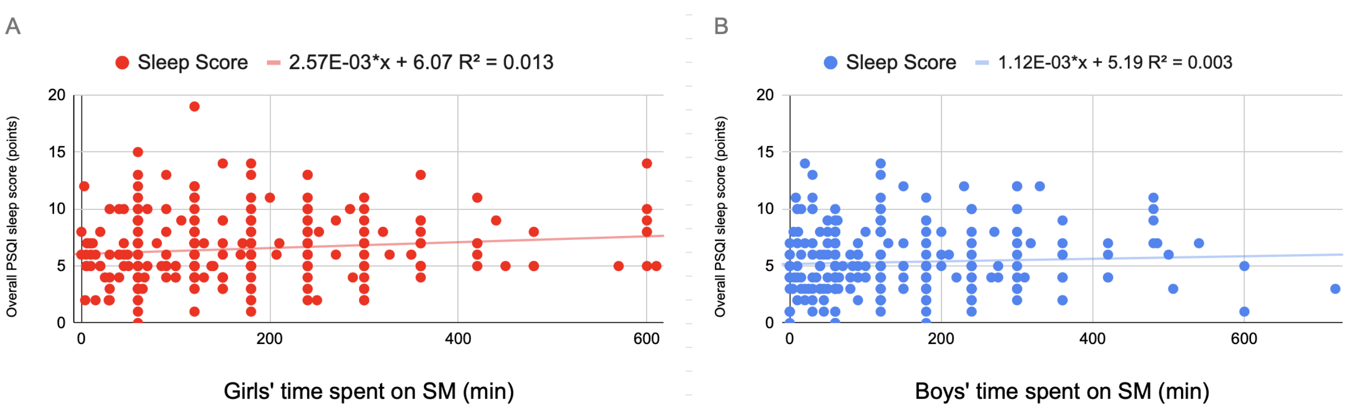

Figure 5: Correlation between overall PSQI sleep scores and time spent on SM by gender. (A) Self-reported time spent on SM in minutes on an average school day with the overall PSQI sleep score (0-21) for girls (G=272). There was a statistically significant but very weak positive relationship between time spent on SM and PSQI score for girls (Pearson's correlation, r = 0.115, p < 0.001). **(B)** Self-reported time spent on SM in minutes on an average school day with the overall PSQI sleep score (0-21) for boys (B=262). There was also a statistically significant but negligible positive correlation for boys (Pearson's correlation, r = 0.051, p < 0.001). PSQI total score was calculated by summing up seven sleep subcategories, each question in all categories scored 0 (no difficulty) to 3 (severe difficulty). The SM usage and average PSQI sleep scores of both genders were significantly different (Paired t-tests for differences in media time usage, r = 0.033, p < 0.05 and in PSQI sleep scores, r = 0.000004, p < 0.05).

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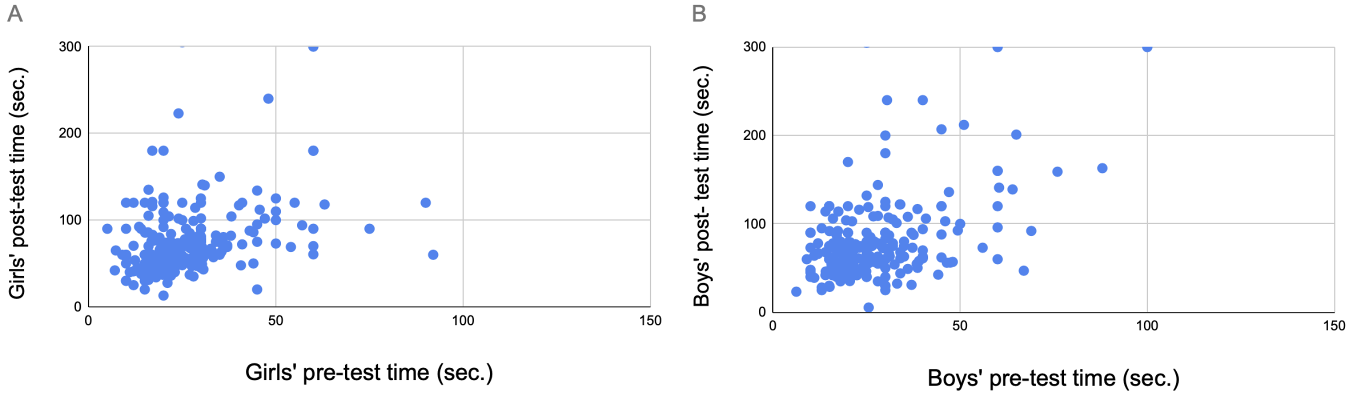

Figure 6: Comparison of writing task completion times by gender. (A) Time spent on pre-test and post-test (seconds) for girls (G=272). **(B)** Time spent on pre-test and post-test (seconds) for boys (B=262). Boys seemed to complete tasks faster on average on both tests.There was no significant difference between the times taken to complete a writing task across gender (Paired t-test, r = 0.959, p > 0.05).

some clustering below 300 seconds (**Figure 6**). Boys showed smaller and more consistent gaps in time. Girls took on average about 3.2 seconds longer on the post-test than boys (**Figure 7**). There was no statistical difference between the times taken to complete a writing task across gender (paired t-test for differences in percentage change, r = 0.959, p > 0.05).

Lastly, we compared the PSQI overall sleep score with the percentage of change on a writing task across gender in a paired t-test to see if there is a significant association between sleep quality and attention-switching (**Figure 8**). There was no correlation between these two variables (Pearson's correlation, r = 0.000004, p < 0.05) and, therefore, no clear association between sleep quality and cognitive performance. Both genders exhibited a wide range of percent changes, with boys slightly more concentrated around the 0-200% range and girls displaying greater variability. For example, for girls with PSQI scores around 2-3 points, most percent changes occurred between 0% and 100%, with a few outliers. In the same range, boys' changes concentrated between 50% and 100%, with fewer outliers compared to girls. At a PSQI score of 5, girls' changes ranged from -50% to 200%, while boys' stayed between 0% and 150%.

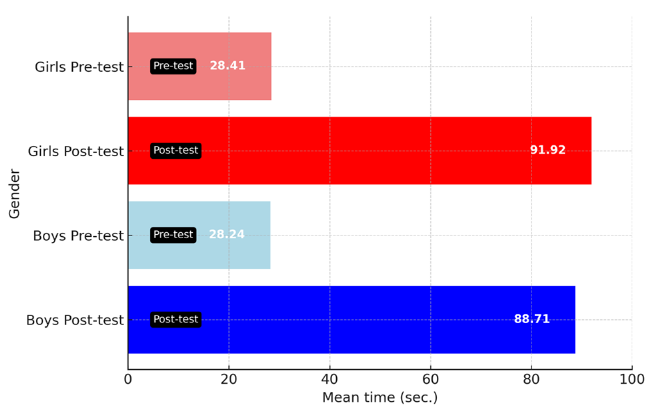

Figure 7: Comparison of mean pre-test and post-test times (seconds) by gender. Girls (272) took an average of about 3.2 seconds longer on the post-test than boys (262). Both boys and girls showed nearly a threefold increase in writing time (girls: mean = 2.72; boys: mean = 2.62). Despite the slightly higher fold change for girls, there was no significant difference between the mean pre-test and post-test times to complete a writing task across gender (Paired t-test, r = 0.959, p > 0.05).

DISCUSSION

This study allows us to better understand the relationship between adolescent SM intensity usage, sleep quality, and task-shifting attention across gender. Since poor sleep quality has already been strongly associated with media addiction, the data from this study provides further evidence to determine if a correlation exists between these two variables and cognitive performance. We hypothesized that increased media usage would be correlated with a poor sleep quality and that both increased SM and decreased sleep would lead to decreased attention in both boys and girls.

Contrary to our hypothesis, the degree of SM usage and sleep quality did not correlate, independent of gender. However, consistent with some earlier studies, girls spent more time on SM and had poorer sleep quality than boys (13). This finding does not necessarily mean that boys spend less time in the digital environment. Boys, for example, prefer to use technology to play games (27). Platform preferences often vary by gender and could therefore skew the way we interpreted engagement levels. We chose the platforms designed around frequent sharing of photos and short videos. However, platforms like Reddit and Twitch, which were not included in our study, lean toward text-based discussion or live streaming for gaming communities. Once popular platform Facebook turned out to be completely obsolete, representing only miniscule daily SM usage time for girls. It would be of interest to researchers to investigate if the ephemeral nature of these SM platforms leads to a better adaptation for girls to multitasking. While girls spent more time on SM and had a poorer sleep quality than boys, there was no correlation between increased SM usage and a PSQI global score. Also, research indicates that PSQI scores might be more indicative of subjective perceptions (28). Previous studies that attempted to correlate PSQI scores with objective electroencephalography (EEG) data did not find PSQI reliable as a comprehensive evaluation of sleep quality by itself (29).

When we explored the possible pathway from SM usage to sleep quality, and then to cognitive functioning, we noticed that girls tended to take slightly longer time on writing tasks than boys despite worse sleeping habits and higher usage of SM. This longer time might be explained by factors outside of the

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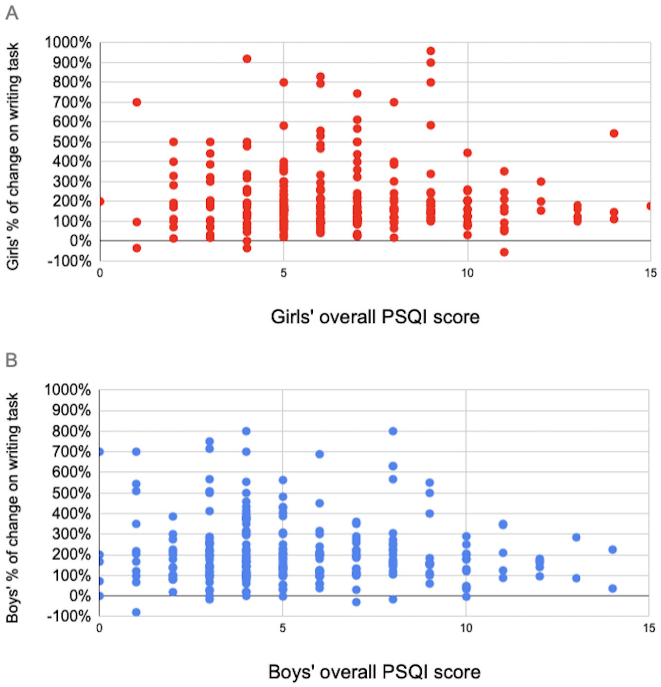

Figure 8: Comparison of overall PSQI score and percent change on writing task by gender. (A) Overall sleep PSQI score and percent change for girls (G = 272). **(B)** Overall sleep PSQI score and percent change for boys (B = 262). PSQI total score (0-21) was calculated by summing up seven sleep subcategories, each question in all categories scored 0 (no difficulty) to 3 (severe difficulty). The writing task consisted of comparing the difference in time taken between pre-test and post-test and recording it as a percent change. Based on the extremely weak correlation observed ($r = 0.000004$) in the PSQI sleep scores, there was no clear association between sleep quality and cognitive performance between boys and girls, despite the statistical significance (Paired t-tests for differences in PSQI sleep scores, $r = 0.000004$, $p < 0.05$ and in percentage change, $r = 0.959$, $p > 0.05$).

variables in this study, such as a closer attention to detail or accuracy. Common errors that all genders reported included errors related to spelling "thief" in a phrase, technical difficulties with autocorrect that separated the words, and errors related to not following the directions, such as not using spaces between numbers. Girls' difference in cognitive processing is consistent with some previous research that indicates that girls outperform boys in writing fluency and in overall quality of writing because they tend to focus more on coherence, thoroughness, and meticulousness in academic tasks – factors that could also explain why they took longer to complete the writing task (30). Similarly, another study that investigated the writing disparities across gender concluded that girls dedicate more time to writing due to greater engagement and motivation (31). Likewise, multitasking is related to structural differences in the brain between boys and girls (32). The brains of boys activate more areas across hemispheres and use more resources because they optimize motor and spatial skills (32). The brains of girls show more connectivity between the left and right hemispheres and thus have an advantage in intuitive processing and analytical tasks (32). These variations could influence how boys and girls approached task-switching and might not be related to cognitive ability.

Our study contained several other limitations. First, due to the self-reported nature of our data collection, some results may have been exaggerated or altered. Participants might have felt embarrassed about revealing certain details of their lives or about accurately reporting their performance, particularly in recording the correct sequence of letters and numbers, or in properly logging the start and end times of the writing tasks. Second, most of our participants came from two schools, which limits the diverse representation of American youth. Third, the description of "somewhat agree" on the Likert scale for questions #7–10 was considered neutral, but participants did not have this clarification when taking the survey. Lastly, since our study only explored the associations between variables, we could not infer cause-and-effect relationships. Future research could investigate and validate the relationships between SM usage, sleep quality, and task-switching to identify predictors of cognitive functioning in writing tasks. As suggested by our study, the investigation of constantly changing SM platforms might also help clarify which of the platforms alter sleeping habits due to their potentially addictive nature.

MATERIALS AND METHODS

A structured questionnaire combining the quantitative survey and semi-experimental design delivered through an online Google Form was administered to adolescents in two Midwest suburban high schools. We aimed to measure media habits, sleep patterns, and attention during writing tasks in order to examine how SM usage, sleep quality, and cognitive functioning correlates across gender in American adolescents. We recruited 558 participants aged from 14 to 18 to complete the questionnaire over a period of four weeks (**Figure 1**). After excluding five incomplete questionnaires, a total of 553 valid questionnaires were collected, with a fairly equal gender distribution between girls (n = 272) and boys (n = 262). Nineteen (n = 19) respondents identified as "gender nonconforming." Due to a comparatively small number of gender nonconforming participants, our data analysis focused on responses from those who identified as male or female.

For the purpose of obtaining roughly equal participation from both boys and girls, we conducted the survey in co-ed classes. The participation was strictly voluntary and the questionnaire was posted and distributed through the Learning Management System of Schoology to students and teachers who acted as facilitators. The study conformed to the schools' ethical principles. The questionnaire consisted of four parts. The first part included the basic demographic data of age and gender. The extent to which excessive media use impacts a respondent was assessed in part two by the questions adapted from the 2014 social media addiction scale compiled by Milosevic-Dordevic and the 2016 social media disorder scale by Van den Eijinden (3, 33). As proposed by these researchers, the participants were asked to indicate which SM they are using, how often they use them on a typical school day and how often they check postings on each site, as well as the degree to which some of the statements related to their SM use were true on a 5-point Likert scale ranging from "Strongly agree" (1) to "Strongly disagree" (5).

Quality of sleep was assessed in the third part of the questionnaire using the PSQI. The PSQI constitutes a standardized measure of sleep quality in cognitive research and assesses usual sleep habits during the most recent one-month period (25). It was adapted to the age group of the participants, meaning that only the first nine items of the scale were used. Item 10 and its subsequent subpoints in the original scale that asked participants to record their bed partner or roommate's responses were excluded from the questionnaire. In scoring the PSQI, item 10 does not contribute to the overall score, and therefore our adaptation of the scale has no impact on its replication. According to the creator of the scale, the PSQI is designed to produce seven scores: Subjective Sleep Quality, Sleep Latency, Sleep Duration, Sleep Efficiency, Sleep Disturbance, Sleep Medication, and Daytime Dysfunction, each scored 0 (no difficulty) to 3 (severe difficulty). The component scores were added to produce a total score (0-21), with a higher score indicating worse sleep quality.

In the fourth part of the questionnaire, the participants were asked to perform a writing task that required shifting their attention (34). The form instructed them to log their start and end times for the duration of each round of the task and report any difficulties such as lack of focus, frustration, errors, etc. First, after logging their time on the line labeled A, the participants were asked to write the phrase "Switchtasking is a thief." Then, on the next line labeled B, the participants wrote the numbers 1-21. They wrote down their end time after the completion of both lines. In the second round of the exercise, the participants were instructed to log a fresh starting time. On the line labeled C, they wrote the phrase "Switchtasking is a thief" but for every letter they wrote, they had to switch to the next line labeled D and write the corresponding number 1-21. After the completion of the last number of 21, the participants were asked to record their end time.

We then conducted Pearson's correlation analyses, using Microsoft Excel, for frequency of SM usage and quality of sleep for both boys and girls. We carried out two-tailed t-tests for differences between the two genders. Similarly, we performed statistical analyses for differences in percentage change on a writing task between boys and girls and compared their sleep scores with the percentage of change.

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APPENDIX

The following #2-10 questions relate to SM usage assessment on the questionnaire:

2) How much time do you spend on SM on an average school day in minutes?

3) How much time do you spend on Facebook on an average school day in minutes?

4) How much time do you spend on Tik Tok on an average school day in minutes?

5) How much time do you spend on Snapchat on an average school day in minutes?

6) How much time do you spend on Instagram on an average school day in minutes?

7) "I constantly refresh social media sites, expecting new messages and notifications."

8) "I sometimes sleep a lot less than normal because I'm spending more time on social media."

9) "I'd rather spend an evening on social media than spend that time on any other activity"

10) "I feel uncomfortable, anxious, and uneasy when I can't use social media."

The following #11-19 questions relate to the PSQI assessment on the questionnaire:

11) During the past month, what time have you usually gone to bed at night?

12) During the past month, how long (in minutes) has it usually taken you to fall asleep each night?

13) During the past month, what time have you usually gotten up in the morning?

14) During the past month, how many hours of actual sleep did you get at night? (This may be different than the number of hours you spent in bed.)

15) During the past month, how often have you had trouble sleeping because you

a. Cannot get to sleep within 30 minutes
b. Wake up in the middle of the night or early morning
c. Have to get up to use the bathroom
d. Cannot breathe comfortably
e. Cough or snore loudly
f. Feel too cold
g. Feel too hot
h. Have bad dreams
i. Have pain
j. Other reasons not described here

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16) During the past month, how often have you taken medicine to help you sleep?

17) During the past month, how often have you had trouble staying awake while driving, eating meals, or engaging in social activity?

18) During the past month, how much of a problem has it been for you to keep up enough enthusiasm to get things done?

19) During the past month, how would you rate your sleep quality overall?