

The Mediating Role of Fear of Missing Out (FoMO) in the Relationship Between Social Media Engagement and Sleep Disturbance in Teenagers

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Article Info

Article type:

Original Research

How to cite this article:

Radu, E., & Rahman, F. (2025). The Mediating Role of Fear of Missing Out (FoMO) in the Relationship Between Social Media Engagement and Sleep Disturbance in Teenagers. *Journal of Adolescent and Youth Psychological Studies*, 6(6), 1-9.

<http://dx.doi.org/10.61838/kman.jayps.6.6.13>



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ABSTRACT

Objective: This study aimed to investigate the mediating role of Fear of Missing Out (FoMO) in the relationship between social media engagement and sleep disturbance among adolescents in Bangladesh.

Methods and Materials: A descriptive correlational research design was employed, involving 450 high school students aged 13 to 18 years, selected based on the Morgan and Krejcie sampling table. Standardized questionnaires were used to assess social media engagement, FoMO, and sleep disturbance. The Pittsburgh Sleep Quality Index (PSQI), the Fear of Missing Out Scale (FoMOS), and the Social Media Engagement Questionnaire (SMEQ) served as the primary instruments. Data were analyzed using Pearson correlation coefficients in SPSS-27 and Structural Equation Modeling (SEM) in AMOS-21 to test direct and indirect relationships among the variables and to evaluate the model's goodness-of-fit.

Findings: Results revealed that social media engagement was significantly and positively associated with FoMO ($r = .52, p < .001$) and sleep disturbance ($r = .43, p < .001$). Additionally, FoMO was strongly related to sleep disturbance ($r = .49, p < .001$). The SEM analysis confirmed that FoMO partially mediated the relationship between social media engagement and sleep disturbance. The structural model demonstrated good fit indices ($\chi^2/df = 2.17$, CFI = 0.97, RMSEA = 0.051). Direct, indirect, and total effects were all statistically significant, highlighting the psychological mechanism through which excessive social media use impacts adolescent sleep quality.

Conclusion: These findings underscore the need for interventions targeting digital habits and FoMO to promote healthier sleep among youth.

Keywords: Social Media Engagement; Fear of Missing Out (FoMO); Sleep Disturbance; Adolescents; Mediation; Structural Equation Modeling; Digital Behavior

1. Introduction

The rapid expansion of digital communication platforms has reshaped the social behavior of adolescents, particularly in the context of emotional and psychological well-being. Among these changes, the intense engagement of teenagers with social media has attracted scholarly attention due to its potential impact on mental health, daily functioning, and particularly, sleep patterns. One emerging construct that bridges this interaction is the *Fear of Missing Out* (FoMO), which has been identified as a psychological mediator connecting social media behaviors and adverse health outcomes, including sleep disturbance (Fioravanti et al., 2021; Koç et al., 2023; Türk & Koçyiğit, 2025).

Social media platforms are designed to encourage constant connectivity, peer interaction, and immediate feedback, making them especially appealing to adolescents who are developmentally more susceptible to peer comparison and validation (Bright & Logan, 2018; ÇİFÇİ & Kumcağız, 2023). Teenagers spend significant portions of their day navigating content on platforms like Instagram, TikTok, and Snapchat, fostering a digital ecosystem in which *social engagement* becomes not only a leisure activity but also a core component of social identity (Blackwell et al., 2017; Elhai et al., 2016). However, this persistent interaction with digital media has been linked to various psychological issues, such as anxiety, depression, and behavioral dysregulation, often arising from the pressure to remain socially visible and involved at all times (Durak & Seferoğlu, 2020; Jia & Yan, 2023; Shen et al., 2020).

One of the most studied psychological outcomes associated with excessive social media use is *sleep disturbance*. Sleep plays a vital role in adolescent development, yet numerous studies have highlighted that digital hyperconnectivity negatively affects both sleep quality and duration (Ibrahim, 2021; Yu & Gen, 2023). Excessive screen time, irregular usage patterns, and emotional arousal from online interactions often result in delayed bedtimes, nocturnal awakenings, and daytime fatigue. Adolescents' susceptibility to online feedback, constant notifications, and social pressure contributes to cognitive hyperarousal, which impairs the natural transition to restful sleep (Elhai et al., 2020; Wolniewicz et al., 2018). The digital landscape, while offering unprecedented access to information and relationships, paradoxically disrupts the natural circadian rhythms of young users (Yu & Gen, 2023).

An important mechanism through which social media affects adolescents' sleep is the phenomenon known as *Fear of Missing Out* (FoMO). FoMO refers to a pervasive anxiety stemming from the perception that others might be having rewarding experiences in one's absence, often exacerbated by real-time social media content (Chakrabarti, 2024; Fabris et al., 2020). It manifests as an urge to stay perpetually connected to others' lives online, leading to compulsive checking behaviors, sleep procrastination, and emotional instability (Aldbyani, 2024; Taj et al., 2025). In adolescent populations, FoMO is particularly pronounced due to developmental needs for peer acceptance and identity exploration (Anggrainy et al., 2024; Gao et al., 2023). The more adolescents engage with social media, the more vulnerable they become to FoMO, which in turn mediates the relationship between their digital habits and psychological stress (Chi et al., 2022; ÇİFÇİ & Kumcağız, 2023; Koç et al., 2023).

The link between social media engagement and FoMO has been well-documented across diverse cultural and demographic groups. Blackwell et al. (2017) found that personality traits such as neuroticism and attachment anxiety predicted higher social media usage through the mediation of FoMO (Blackwell et al., 2017). Similarly, Bayrami et al. (2019) demonstrated that the intensity of social media use was positively associated with FoMO among Iranian university students (Bayrami et al., 2019). Adolescents who are more emotionally reactive or have lower self-regulatory capacities are more likely to experience FoMO as a response to their online experiences (Fioravanti et al., 2021; Shi et al., 2022). Furthermore, Bissell and Chou (2024) reported that increased social media usage and FoMO were both significantly associated with lower life satisfaction and poor self-image among adolescent girls (Bissell & Chou, 2024).

FoMO not only exacerbates psychological distress but also disrupts behavioral routines that are essential to well-being, particularly sleep. Several studies have supported the mediating role of FoMO between social media use and sleep disturbances (Elhai et al., 2020; Fabris et al., 2020; Yu & Gen, 2023). Adolescents preoccupied with online interactions often experience difficulties disengaging from their devices at night, leading to delayed sleep onset and reduced total sleep time. This behavioral pattern is further reinforced by anticipatory anxiety regarding potential social exclusion, making sleep interruptions more likely (Chi et al., 2022; Villegas et al., 2025). In a recent meta-analysis, Fioravanti et al. (2021) concluded that FoMO was consistently associated with problematic social media use,

which had downstream effects on sleep and emotional regulation (Fioravanti et al., 2021).

Moreover, FoMO is interrelated with other psychological constructs such as loneliness, low self-esteem, and social comparison, which intensify its effect on sleep-related outcomes (ÇİFÇİ & Kumcağız, 2023; Sommantico et al., 2023; Taj et al., 2025). Adolescents with higher FoMO levels are more likely to experience nocturnal awakenings to check notifications and messages, compromising the quality of their sleep (Safdar Bajwa et al., 2023; Yu & Gen, 2023). This behavioral dysregulation has long-term consequences for cognitive performance, emotional stability, and overall life satisfaction. Furthermore, FoMO has been identified as a critical risk factor in developing addictive patterns of technology use, which cyclically reinforce the emotional distress they initially aim to mitigate (Elhai et al., 2016; Koç et al., 2023; Shen et al., 2020).

Gender, personality, and cultural context also shape the manifestation of FoMO and its effects. For example, Anggrainy et al. (2024) observed that teenage girls with high neuroticism scores were more prone to FoMO, which in turn influenced their phubbing behaviors—a proxy for smartphone overuse and social disengagement (Anggrainy et al., 2024). Similarly, Türk and Koçyiğit (2025) showed that emotion dysregulation and social media addiction significantly mediated the link between FoMO and loneliness among Turkish adolescents (Türk & Koçyiğit, 2025). These findings emphasize the need to consider sociocultural and individual difference variables when assessing FoMO's role in sleep and psychological health.

Given this background, the current study seeks to extend existing knowledge by specifically exploring the *mediating role of FoMO* in the relationship between *social media engagement* and *sleep disturbance* among Bangladeshi adolescents.

2. Methods and Materials

2.1. Study Design and Participants

This study employed a descriptive correlational design to examine the mediating role of Fear of Missing Out (FoMO) in the relationship between social media engagement and sleep disturbance among teenagers. A total of 450 adolescents from various secondary schools across Bangladesh participated in the study. The sample size was determined based on the Morgan and Krejcie (1970) table, ensuring adequate statistical power and representation.

Participants were selected using stratified random sampling to account for demographic variables such as gender, grade level, and urban/rural distribution. Inclusion criteria consisted of adolescents aged between 13 and 18 years who had active social media accounts and consented to participate in the study.

2.2. Measures

2.2.1. Sleep Disturbance

To assess sleep disturbance in teenagers, the Pittsburgh Sleep Quality Index (PSQI) developed by Buysse et al. (1989) was employed. The PSQI is a widely used and validated instrument designed to measure subjective sleep quality over a 1-month period. It consists of 19 self-rated items that generate seven component scores: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medication, and daytime dysfunction. Each component is scored on a scale from 0 (no difficulty) to 3 (severe difficulty), resulting in a global score ranging from 0 to 21, with higher scores indicating worse sleep quality. The PSQI has demonstrated good internal consistency (Cronbach's alpha = 0.83) and has been validated in adolescent populations across diverse cultural settings.

2.2.2. Fear of Missing Out

Fear of Missing Out was measured using the Fear of Missing Out Scale (FoMOS) developed by Przybylski et al. (2013). This 10-item self-report questionnaire is designed to capture individuals' apprehension that others might be having rewarding experiences from which they are absent. Respondents rate their agreement with each item on a 5-point Likert scale ranging from 1 (not at all true of me) to 5 (extremely true of me). The scale does not include distinct subscales, but the total score is used to reflect the overall level of FoMO, with higher scores indicating stronger feelings of missing out. The FoMOS has shown excellent psychometric properties, including high internal consistency (Cronbach's alpha > 0.85), and its reliability and validity have been confirmed in both adolescent and adult samples.

2.2.3. Social Media Engagement

Social media engagement was assessed using the Social Media Engagement Questionnaire (SMEQ) developed by Salcines-Talledo, González-Fernández, and Briones (2020). The SMEQ is a standardized tool comprising 9 items that

measure the frequency and intensity of engagement with social media platforms such as Instagram, TikTok, and Snapchat. Respondents indicate their usage on a 5-point Likert scale ranging from 1 (never) to 5 (very often). The tool includes three dimensions: emotional engagement, behavioral engagement, and cognitive engagement. Scores from the items are summed to generate a total engagement score, where higher scores represent greater involvement with social media. The SMEQ has demonstrated solid psychometric validity, with reported Cronbach's alpha values exceeding 0.80 in studies with adolescent populations, confirming its reliability and suitability for research involving teenagers.

2.3. Data Analysis

Data analysis was conducted in two stages. First, descriptive statistics were calculated to summarize participants' demographic characteristics. Pearson correlation coefficients were computed using SPSS version 27 to explore the bivariate relationships between social media engagement, FoMO, and sleep disturbance. Next,

Structural Equation Modeling (SEM) was carried out using AMOS version 21 to test the hypothesized mediating model. SEM was used to evaluate both direct and indirect effects and to assess the model fit using standard indices including the Chi-square test (χ^2), Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), and Root Mean Square Error of Approximation (RMSEA). Statistical significance was set at $p < .05$.

3. Findings and Results

Among the 450 participants, 239 (53.11%) were female and 211 (46.89%) were male. The age of the participants ranged from 13 to 18 years, with the majority aged between 15 and 16 years ($n = 186$, 41.33%), followed by 17–18 years ($n = 149$, 33.11%) and 13–14 years ($n = 115$, 25.56%). Regarding academic level, 208 participants (46.22%) were in grade 9, 159 (35.33%) in grade 10, and 83 (18.44%) in grade 11. Most of the participants ($n = 265$, 58.89%) reported living in urban areas, while 185 (41.11%) resided in rural areas.

Table 1

Descriptive Statistics for Study Variables (N = 450)

| Variable | Mean (M) | Standard Deviation (SD) |
|----------------------------|----------|-------------------------|
| Social Media Engagement | 32.47 | 6.38 |
| Fear of Missing Out (FoMO) | 31.82 | 7.14 |
| Sleep Disturbance | 9.71 | 3.46 |

The descriptive statistics in Table 1 show that the mean score for social media engagement was 32.47 ($SD = 6.38$), suggesting moderately high usage among participants. The mean FoMO score was 31.82 ($SD = 7.14$), indicating that many adolescents experience moderate to high levels of FoMO. The average sleep disturbance score was 9.71 ($SD = 3.46$), reflecting notable issues with sleep quality within the sample.

Prior to conducting the main analyses, assumptions for parametric tests and SEM were checked. The normality of data was verified by assessing skewness and kurtosis values,

all of which fell within the acceptable range of ± 2 (e.g., sleep disturbance skewness = 0.61, kurtosis = -0.73). Linearity and homoscedasticity were confirmed by inspecting scatterplots of residuals. Multicollinearity was ruled out, as all Variance Inflation Factor (VIF) values were below 2 (e.g., social media engagement VIF = 1.38; FoMO VIF = 1.51). Additionally, the Mahalanobis distance test was used to detect multivariate outliers, and no extreme cases exceeded the critical value ($\chi^2(3) = 16.27$, $p < .001$). These findings confirmed that the data met the assumptions for correlation and SEM analyses.

Table 2

Pearson Correlation Coefficients Between Study Variables

| Variable | 1 | 2 | 3 |
|----------------------------|----------------------|----------------------|---|
| 1. Social Media Engagement | — | | |
| 2. FoMO | .52** ($p < .001$) | — | |
| 3. Sleep Disturbance | .43** ($p < .001$) | .49** ($p < .001$) | — |

Table 2 presents the Pearson correlation coefficients among the three key variables. Social media engagement was positively correlated with FoMO ($r = .52, p < .001$) and sleep disturbance ($r = .43, p < .001$), suggesting that more frequent engagement is associated with higher FoMO and

poorer sleep. Additionally, FoMO was strongly associated with sleep disturbance ($r = .49, p < .001$), indicating that adolescents who fear missing out on social content tend to experience greater sleep problems.

Table 3

Goodness-of-Fit Indices for the Structural Model

| Fit Index | Value | Recommended Threshold |
|-------------------------|--------|-----------------------|
| Chi-square (χ^2) | 104.38 | – |
| Degrees of Freedom (df) | 48 | – |
| χ^2/df | 2.17 | < 3.00 |
| GFI | 0.96 | ≥ 0.90 |
| AGFI | 0.92 | ≥ 0.90 |
| CFI | 0.97 | ≥ 0.95 |
| RMSEA | 0.051 | ≤ 0.08 |
| TLI | 0.95 | ≥ 0.95 |

The fit indices shown in Table 3 indicate that the proposed structural model had a good fit to the data. The χ^2/df ratio was 2.17, which is below the recommended cutoff of 3.00. Other indices such as GFI (0.96), AGFI (0.92), CFI

(0.97), TLI (0.95), and RMSEA (0.051) also fell within acceptable ranges, confirming the overall adequacy of the hypothesized mediation model.

Table 4

Total, Direct, and Indirect Effects of the Structural Model

| Path | B | S.E. | β | p |
|---|------|------|---------|----------|
| Social Media Engagement \rightarrow FoMO | 0.58 | 0.07 | 0.52 | $< .001$ |
| FoMO \rightarrow Sleep Disturbance | 0.21 | 0.04 | 0.41 | $< .001$ |
| Social Media Engagement \rightarrow Sleep Disturbance (Direct) | 0.19 | 0.06 | 0.28 | $< .01$ |
| Social Media Engagement \rightarrow Sleep Disturbance (Indirect via FoMO) | 0.12 | 0.03 | 0.21 | $< .001$ |
| Social Media Engagement \rightarrow Sleep Disturbance (Total) | 0.31 | 0.07 | 0.49 | $< .001$ |

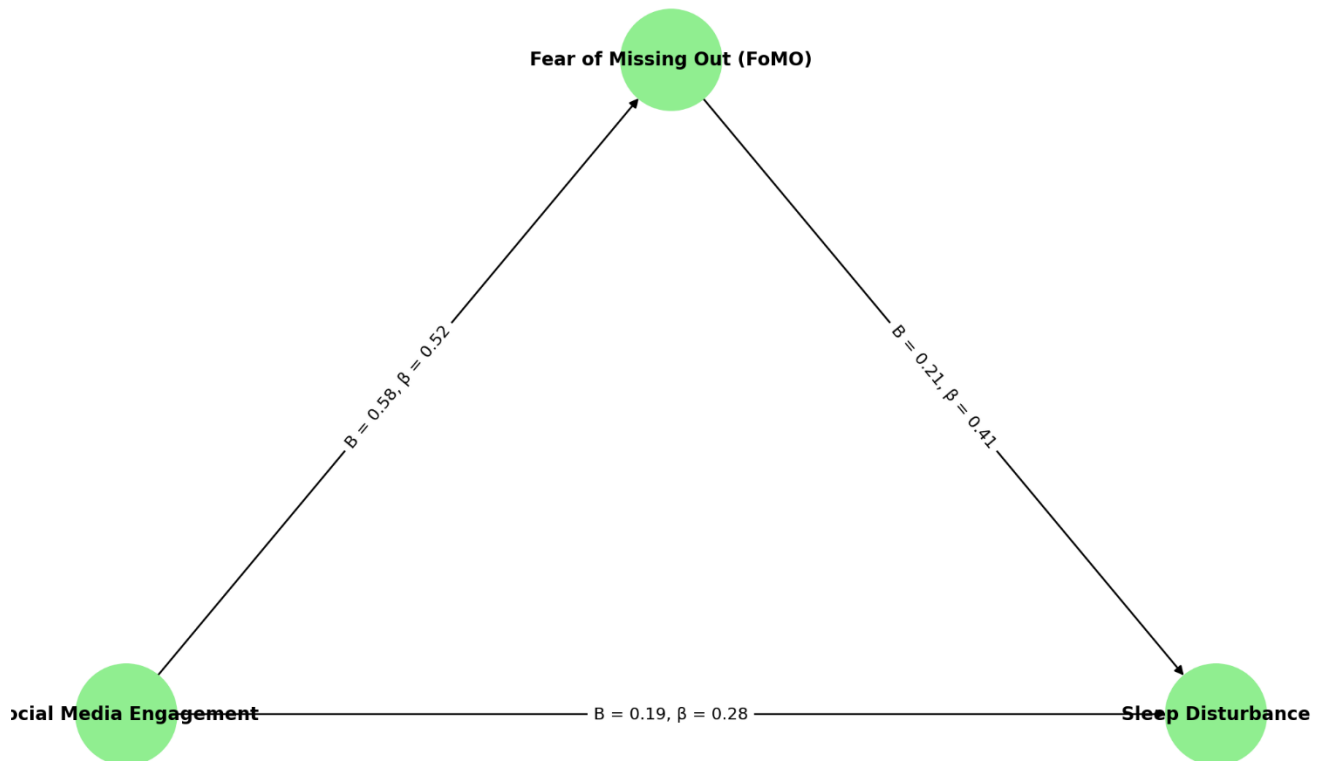
Table 4 outlines the direct, indirect, and total effects of social media engagement on sleep disturbance, with FoMO as a mediator. The direct path from social media engagement to FoMO was significant ($B = 0.58, \beta = 0.52, p < .001$). In turn, FoMO significantly predicted sleep disturbance ($B = 0.21, \beta = 0.41, p < .001$). The direct effect of social media engagement on sleep disturbance was also significant ($B =$

$0.19, \beta = 0.28, p < .01$). Furthermore, the indirect effect of social media engagement on sleep disturbance via FoMO was significant ($B = 0.12, \beta = 0.21, p < .001$), confirming partial mediation. The total effect of social media engagement on sleep disturbance (direct + indirect) was strong and significant ($B = 0.31, \beta = 0.49, p < .001$).

Figure 1

Structural Model of The Study

Structural Model of Social Media Engagement, FoMO, and Sleep Disturbance



4. Discussion and Conclusion

The current study aimed to examine the mediating role of Fear of Missing Out (FoMO) in the relationship between social media engagement and sleep disturbance among teenagers in Bangladesh. The findings revealed several noteworthy patterns. Firstly, a significant positive correlation was found between social media engagement and sleep disturbance, suggesting that higher levels of social media use are associated with poorer sleep quality. Secondly, FoMO was significantly correlated with both social media engagement and sleep disturbance. Most importantly, the structural equation modeling analysis confirmed that FoMO partially mediates the relationship between social media engagement and sleep disturbance, indicating that adolescents who frequently engage with social media platforms are more likely to experience sleep disturbances, at least in part due to elevated levels of FoMO.

These findings support and extend previous research suggesting that excessive engagement with social media can compromise sleep patterns among adolescents by disrupting behavioral routines and increasing cognitive arousal before

sleep onset (Durak & Seferoğlu, 2020; Elhai et al., 2020; Yu & Gen, 2023). When adolescents spend extended time on digital platforms, especially during late-night hours, they are more prone to delayed sleep onset and frequent awakenings. This study aligns with the results of Bissell and Chou (2024), who noted that social media involvement, driven by a desire for social validation, negatively affects emotional regulation and sleep satisfaction in adolescent females (Bissell & Chou, 2024). Similarly, the work of Bright and Logan (2018) highlighted how social media fatigue, resulting from constant digital exposure, contributes to both psychological exhaustion and sleep-related issues (Bright & Logan, 2018).

The mediating role of FoMO in this relationship reveals the underlying psychological mechanism that links behavioral patterns of media use with physiological health outcomes. Adolescents with higher levels of social media engagement may be more vulnerable to FoMO due to increased exposure to curated social content, peer comparison, and the urgency to remain socially connected (Blackwell et al., 2017; Koç et al., 2023). These findings are in line with studies by Fioravanti et al. (2021), who conducted a meta-analysis and concluded that FoMO was a

strong predictor of both social networking overuse and sleep disturbance in youth (Fioravanti et al., 2021). This mediating process is further validated by Fabris et al. (2020), who identified FoMO as a psychological stressor arising from negative experiences on social media, which leads to emotional hyperarousal, thus delaying sleep and impairing restfulness (Fabris et al., 2020).

The present findings also reflect the notion that FoMO functions as both a motivator and a consequence of excessive social media use. Adolescents with high FoMO may stay awake to check notifications, monitor online conversations, or post content in real-time to avoid social exclusion. This supports the work of Türk and Koçyiğit (2025), who found that FoMO and emotion dysregulation together predicted heightened social media addiction and associated mental health concerns such as loneliness and sleep impairment among adolescents (Türk & Koçyiğit, 2025). In a similar vein, Shen et al. (2020) demonstrated that extrinsic academic motivation could intensify FoMO and problematic social media use, thereby increasing social media fatigue and reducing sleep quality (Shen et al., 2020).

Furthermore, this study provides evidence consistent with the framework proposed by Chi et al. (2022), who emphasized the interaction between personality traits and digital behavior in shaping FoMO and phubbing habits (Chi et al., 2022). Our findings resonate with the study of Anggrainy et al. (2024), which found that teenage girls with high neuroticism levels exhibited higher FoMO, which subsequently predicted problematic phone use and sleep disturbance (Anggrainy et al., 2024). The present study enriches this discourse by confirming that FoMO is not merely an outcome of personality or digital behavior, but also a cognitive mediator that links engagement and health disruptions.

Importantly, the findings are consistent with the work of Yu and Gen (2023), who reported a chain mediation model in which social media addiction increased FoMO and nocturnal media use, ultimately worsening sleep outcomes (Yu & Gen, 2023). Likewise, Gao et al. (2023) demonstrated that FoMO predicted depressive symptoms via phubbing and feelings of social exclusion, further supporting the mediating influence of FoMO in the psychosocial consequences of social media use (Gao et al., 2023). These studies affirm the validity of our model and highlight how digital behaviors, psychological vulnerabilities, and health outcomes are intricately connected.

Interestingly, our results also echo the findings of Villegas et al. (2025), who emphasized that adolescents

experience FoMO not only as a digital impulse but also as a lived emotional reality characterized by persistent anxiety, which often disrupts routines such as studying and sleeping (Villegas et al., 2025). The narrative accounts of adolescents in their study closely align with our statistical findings, reinforcing the multidimensional nature of FoMO as a personal, social, and technological construct. Additionally, the work by Taj et al. (2025) underscores that FoMO mediates the link between phubbing and loneliness, again supporting the broad psychosocial reach of this phenomenon (Taj et al., 2025).

Moreover, our findings fit well within the theoretical framework presented by ÇİFÇİ and Kumcağız (2023), who proposed that FoMO mediates the relationship between social comparison and subjective well-being (ÇİFÇİ & Kumcağız, 2023). Our study confirms that FoMO not only impairs subjective well-being by inducing anxiety and restlessness but also translates into observable disruptions in behavioral health domains, such as sleep. The relationship between digital behavior, cognitive distortions like FoMO, and psychosomatic symptoms thus emerges as a critical area for continued exploration.

Although our study was conducted in the Bangladeshi context, the findings echo global trends. For example, Chakrabarti (2024) found that FoMO significantly shaped the daily routines and emotional stability of Gen Z youth in India, particularly in relation to sleep and screen time (Chakrabarti, 2024). Similarly, Ibrahim (2021) noted that digital engagement in professional contexts also affects subjective well-being through mechanisms such as job engagement, which could be conceptually linked to FoMO-like behaviors in adults (Ibrahim, 2021). These cross-cultural parallels suggest that the role of FoMO as a digital-age stressor is not geographically bound, reinforcing the urgency for transnational research in this domain.

Finally, our results align with the serial mediation model presented by Safdar Bajwa et al. (2023), in which FoMO and social comparison predicted smartphone addiction and phubbing, ultimately affecting interpersonal well-being and emotional balance (Safdar Bajwa et al., 2023). As our findings demonstrate, the presence of FoMO amplifies the psychological cost of social media engagement, rendering adolescents more vulnerable to sleep disturbances and the associated negative outcomes such as fatigue, irritability, and academic underperformance.

5. Limitations & Suggestions

Despite its contributions, this study has several limitations. First, the use of self-report questionnaires may introduce response biases, including social desirability and recall bias. Participants may have underreported or overreported their social media usage and sleep patterns. Second, the study's cross-sectional design limits causal inferences; while SEM modeling suggests mediation, longitudinal data would be required to confirm temporal order. Third, the sample, though adequate in size, was geographically limited to adolescents in Bangladesh, which may constrain the generalizability of the results to other cultural or national settings. Additionally, the study did not control for potential confounding factors such as academic stress, family environment, or screen time related to non-social media purposes, which may also impact sleep quality.

Future research should adopt a longitudinal design to better understand the temporal dynamics of FoMO, social media engagement, and sleep disturbance. Experimental studies could assess the efficacy of interventions aimed at reducing FoMO, such as digital detox programs, cognitive behavioral strategies, or mindfulness training. It would also be beneficial to explore moderating variables such as gender, socioeconomic status, and personality traits to determine for whom and under what conditions FoMO is most impactful. Furthermore, researchers should consider integrating objective measures such as actigraphy or screen-time tracking to validate self-reported sleep and usage data. Expanding the demographic scope to include preteens and older adolescents from diverse cultural backgrounds would also enhance the external validity of findings in this area.

Educational institutions and parents should be informed about the impact of excessive social media engagement and FoMO on adolescent sleep quality. Schools can implement awareness campaigns that promote healthy digital habits and discourage the compulsive use of social media before bedtime. Counselors and educators should incorporate FoMO-related content into emotional and behavioral wellness programs. Parents can play a crucial role by modeling balanced media use and setting appropriate boundaries around device use at night. Digital platforms themselves should consider implementing features that promote user well-being, such as bedtime reminders, screen-time limits, or content curation to reduce social comparison triggers. A multi-level, collaborative approach involving schools, families, and digital designers is necessary to mitigate the negative effects of FoMO on adolescents' health and development.

Acknowledgments

We would like to express our appreciation and gratitude to all those who cooperated in carrying out this study.

Declaration of Interest

The authors of this article declared no conflict of interest.

Ethical Considerations

The study protocol adhered to the principles outlined in the Helsinki Declaration, which provides guidelines for ethical research involving human participants.

Transparency of Data

In accordance with the principles of transparency and open research, we declare that all data and materials used in this study are available upon request.

Funding

This research was carried out independently with personal funding and without the financial support of any governmental or private institution or organization.

Authors' Contributions

All authors equally contributed to this article.

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