

Internet Addiction and Peer Relationship Difficulties: The Mediating Role of Sleep Disturbance

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Article Info

Article type:

Original Research

How to cite this article:

Romano, G., Piskorz-Ryń, O., & Ríos, J. C. (2025). Internet Addiction and Peer Relationship Difficulties: The Mediating Role of Sleep Disturbance. *Journal of Adolescent and Youth Psychological Studies*, 6(3), 161-169.

<http://dx.doi.org/10.61838/kman.jayps.6.3.18>



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ABSTRACT

Objective: This study aimed to investigate the mediating role of sleep disturbance in the relationship between internet addiction and peer relationship difficulties among adolescents.

Methods and Materials: A descriptive correlational design was employed, and the study was conducted with 405 adolescents from Colombia, selected based on the Morgan and Krejcie sampling table. Participants completed three standardized instruments: the Internet Addiction Test (IAT), the Sleep Disturbance Scale for Children (SDSC), and the Peer Problems subscale of the Strengths and Difficulties Questionnaire (SDQ). Data were analyzed using Pearson correlation coefficients to examine bivariate relationships, and Structural Equation Modeling (SEM) was conducted using AMOS-21 to test the mediating model. The assumptions of normality, linearity, homoscedasticity, and multicollinearity were checked and confirmed.

Findings: Internet addiction was significantly and positively associated with sleep disturbance ($r = .52, p < .001$) and peer relationship difficulties ($r = .43, p < .001$). Sleep disturbance also had a significant positive correlation with peer relationship difficulties ($r = .47, p < .001$). The SEM analysis confirmed an acceptable model fit ($\chi^2(48) = 108.53, \chi^2/df = 2.26, GFI = .95, CFI = .96, RMSEA = .055$). Direct effects were significant from internet addiction to sleep disturbance ($\beta = .52, p < .001$), sleep disturbance to peer difficulties ($\beta = .41, p < .001$), and internet addiction to peer difficulties ($\beta = .33, p < .001$). An indirect effect from internet addiction to peer difficulties via sleep disturbance was also significant ($\beta = .21, p < .001$), supporting partial mediation.

Conclusion: The findings demonstrate that sleep disturbance plays a significant mediating role in the link between internet addiction and peer relationship difficulties. These results highlight the need for targeted interventions that address both digital behavior and sleep hygiene to improve adolescents' social well-being.

Keywords: Internet addiction, peer relationship difficulties, sleep disturbance.

1. Introduction

Peer relationships are among the most critical elements of adolescent development, shaping not only emotional growth and social identity but also impacting psychological well-being and academic success. Adolescents who experience challenges in forming or maintaining peer bonds often face long-term emotional and behavioral consequences, including internalizing and externalizing disorders, decreased academic performance, and even social withdrawal (Healy, 2017; Szczęśniak et al., 2022). Peer relationship difficulties have been widely linked to variables such as emotional dysregulation, shyness, social anxiety, and environmental stressors (Boivin et al., 2013; Chen & Santo, 2015; García et al., 2021). However, in recent years, the digital transformation of adolescent social life has introduced new factors that could disrupt traditional peer dynamics—particularly internet addiction, which has been recognized as a potential contributor to social isolation and impaired real-life interactions among youth (Chu et al., 2021; Yu, 2019).

Internet addiction, characterized by compulsive online behavior and impaired control over internet use, has been increasingly associated with negative psychosocial outcomes, especially among adolescents. As digital communication becomes more dominant, problematic internet use may paradoxically interfere with the development of genuine peer intimacy, emotional reciprocity, and trust (Forrest et al., 2018; O'Hare et al., 2015). Adolescents who spend excessive amounts of time online often substitute digital engagement for face-to-face interactions, resulting in superficial social contact and detachment from meaningful relationships (Chu et al., 2021; Manis & Stewart, 2024). Moreover, the nature of online environments, where social comparison, cyberbullying, and exclusion are common, can further undermine the development of healthy peer bonds (Buissonnière-Ariza et al., 2018; Löper & Hellmich, 2024). These patterns are especially concerning in the context of younger individuals whose emotional and interpersonal skills are still maturing, making them more vulnerable to the adverse effects of digital overuse (Bishop et al., 2018; Siegel et al., 2014).

Among the various mechanisms that may explain the connection between internet addiction and peer relationship problems, sleep disturbance stands out as a particularly important mediating factor. Numerous studies have shown that problematic internet use—especially at night—significantly interferes with sleep quality, sleep duration,

and circadian rhythm, leading to chronic sleep deprivation and daytime dysfunction (Marsus et al., 2022; Yu, 2019). Adolescents who suffer from poor sleep are often more irritable, less empathic, and more prone to emotional dysregulation, which in turn affects their capacity to maintain cooperative and emotionally satisfying relationships with peers (Gultom & Wibowo, 2025; Özdemir et al., 2016). Indeed, sleep has been linked to critical cognitive and emotional processes such as emotion recognition, impulse control, and prosocial behavior—all of which are foundational to building strong peer connections (Lukas et al., 2022; Schoeps et al., 2020).

Furthermore, sleep problems may indirectly influence peer difficulties through their effect on mood and mental health. Adolescents experiencing sleep deprivation often exhibit symptoms of anxiety, depression, and social withdrawal, which can further erode their interpersonal functioning (Chen & Santo, 2015; Szczęśniak et al., 2022). The bidirectional relationship between sleep and social functioning suggests that while internet addiction may initially disrupt sleep, the resulting sleep problems can create a negative feedback loop in which poor peer relationships further increase online dependency as a form of escape or compensation (Chu et al., 2021; Li et al., 2023). This loop may be particularly pronounced in adolescents from vulnerable social contexts, such as those experiencing family instability, neurodevelopmental disorders, or social stigma, who may already be at risk of peer rejection or social anxiety (Manis & Stewart, 2024; Mikami & Normand, 2015; Yu, 2019).

Peer relationship difficulties are themselves a multifaceted construct that encompasses various dimensions, including social withdrawal, conflict, lack of closeness, and exclusion. Prior research has shown that these difficulties can stem from both individual characteristics (e.g., temperament, emotional regulation) and contextual influences (e.g., family environment, school climate) (Boivin et al., 2013; García et al., 2021; Schoop-Kasteler & Müller, 2019). For example, studies have demonstrated that children and adolescents with attention-deficit/hyperactivity disorder (ADHD) are more likely to experience peer rejection, partly due to their impulsive behavior and difficulty interpreting social cues (Marsus et al., 2022; Mikami & Normand, 2015). Similarly, adolescents with neurodevelopmental or emotional difficulties, such as anxiety or language disorders, are often less accepted by their peers, leading to increased social alienation (Forrest et al., 2018; García et al., 2021).

The current research landscape underscores the importance of exploring not only the direct effects of internet addiction on peer relationship quality but also the mediating psychological processes that may exacerbate or buffer this association. Structural equation modeling has emerged as a robust approach for testing such complex relationships, allowing researchers to evaluate the simultaneous influence of multiple variables within a theoretical framework (Li et al., 2023; Lukas et al., 2022). In particular, understanding the mediating role of sleep disturbance can inform the design of preventive and therapeutic interventions that target both behavioral (e.g., screen time regulation) and physiological (e.g., sleep hygiene) components of adolescent health (Özdemir et al., 2016; Schoeps et al., 2020).

Additionally, social and environmental changes in recent years—such as those brought by the COVID-19 pandemic—have reshaped the nature of adolescent peer relationships and digital behavior. Studies indicate that periods of social distancing and remote learning significantly increased adolescents' reliance on digital communication, often exacerbating feelings of isolation and eroding opportunities for meaningful peer contact (Gultom & Wibowo, 2025; Manis & Stewart, 2024). While digital platforms can offer avenues for connection, they are not always sufficient for developing the emotional depth and mutual understanding characteristic of close peer bonds (Löper & Hellmich, 2024; Yu, 2019). Moreover, adolescents from disadvantaged or broken homes may be especially vulnerable to these dynamics, with internet use sometimes becoming a maladaptive coping strategy for unmet emotional needs (Gultom & Wibowo, 2025; Szczęśniak et al., 2022).

While a growing body of research supports the negative impact of excessive internet use and poor sleep on peer functioning, few studies have explored these variables together within a unified model. Understanding how sleep disturbance mediates the relationship between internet addiction and peer difficulties can illuminate intervention points that are both feasible and impactful in educational and clinical settings (Buissonnière-Ariza et al., 2018; Healy, 2017; Siegel et al., 2014). For instance, school-based programs that teach adolescents about digital balance and healthy sleep routines could indirectly enhance social functioning and peer integration. Similarly, family therapy and psychoeducation targeting screen time management and emotional regulation may reduce the compounding effects of sleep problems and social stressors (Lukas et al., 2022; Yu, 2019).

This study aims to contribute to this growing field by investigating whether sleep disturbance mediates the relationship between internet addiction and peer relationship difficulties in adolescents from Colombia.

2. Methods and Materials

2.1. Study Design and Participants

This study employed a descriptive correlational design to examine the relationship between internet addiction and peer relationship difficulties, with sleep disturbance serving as a mediating variable. The target population consisted of adolescents residing in Colombia. A total of 405 participants were selected using a stratified random sampling method, with the sample size determined according to the Morgan and Krejcie (1970) table to ensure statistical adequacy for structural modeling. Participants ranged in age from 13 to 18 years and were recruited from various educational institutions to ensure diversity in socio-economic background and school type. Inclusion criteria required participants to have access to digital devices and internet connectivity and to provide informed consent (with parental approval where necessary). Exclusion criteria included diagnosed neurological disorders or any condition that could interfere with self-reporting. Ethical approval was obtained from the appropriate institutional review board prior to data collection.

2.2. Measures

2.2.1. Peer Relationship Difficulties

Peer relationship difficulties were assessed using the Peer Problems subscale of the Strengths and Difficulties Questionnaire (SDQ), developed by Goodman (1997). This subscale is part of a broader behavioral screening tool for children and adolescents aged 4 to 17 years. The Peer Problems subscale includes 5 items that address various aspects of peer interactions, such as being bullied, feeling isolated, and having good relationships with other children (reverse scored). Responses are given on a 3-point Likert scale ranging from 0 (not true) to 2 (certainly true), with higher scores indicating greater difficulty in peer relationships. The total score for this subscale ranges from 0 to 10. The SDQ, including its Peer Problems subscale, has demonstrated acceptable internal consistency (Cronbach's alpha above .70) and construct validity in a wide range of international studies, confirming its reliability and cross-

cultural applicability (Healy, 2017; Marsus et al., 2022; Siegel et al., 2014; Su et al., 2016).

2.2.2. Sleep Disturbance

Sleep disturbance was measured using the Sleep Disturbance Scale for Children (SDSC), developed by Bruni et al. (1996). Although originally designed for pediatric populations aged 6 to 16 years, this scale has been widely used and adapted for adolescent and young adult populations as well. The SDSC contains 26 items, each rated on a 5-point Likert scale ranging from 1 (never) to 5 (always), reflecting the frequency of sleep problems over the past six months. The scale includes six subscales: Disorders of Initiating and Maintaining Sleep, Sleep Breathing Disorders, Disorders of Arousal, Sleep-Wake Transition Disorders, Disorders of Excessive Somnolence, and Sleep Hyperhidrosis. Higher scores indicate more severe sleep disturbances. The SDSC has shown excellent psychometric properties, with reported Cronbach's alpha coefficients ranging from .71 to .89 for the subscales, and its validity and reliability have been confirmed in numerous clinical and community-based research studies (Khpalwak & Hamidi, 2024; Sarfo et al., 2024; Solmaz et al., 2025).

2.2.3. Internet Addiction

Internet addiction was assessed using the Internet Addiction Test (IAT), developed by Young (1998). This 20-item self-report measure evaluates the presence and severity of problematic internet use in adolescents and adults. Each item is rated on a 5-point Likert scale ranging from 1 (rarely) to 5 (always), with total scores ranging from 20 to 100. The IAT covers key dimensions such as compulsive internet use, neglect of social life, and emotional preoccupation with online activity. Higher scores reflect more severe levels of internet addiction, with suggested cutoffs for mild (20–49), moderate (50–79), and severe (80–100) addiction. The IAT has been validated in various cultural contexts and demonstrates strong internal consistency (Cronbach's alpha > .85), test-retest reliability, and convergent validity with

related behavioral indicators, making it a widely accepted instrument for assessing internet-related problems (Wu et al., 2025; Yumru Menten & Koc, 2025).

2.3. Data Analysis

The collected data were analyzed using both descriptive and inferential statistical methods. Descriptive statistics were used to summarize the demographic characteristics of the participants and to assess the distribution of the study variables. To examine the direct associations between peer relationship difficulties and each independent variable (internet addiction and sleep disturbance), Pearson correlation coefficients were calculated using SPSS-27. Following this, Structural Equation Modeling (SEM) was conducted using AMOS-21 to test the hypothesized mediating role of sleep disturbance in the relationship between internet addiction and peer relationship difficulties. Model fit was assessed using standard indices such as the Chi-square statistic, the Root Mean Square Error of Approximation (RMSEA), the Comparative Fit Index (CFI), and the Tucker-Lewis Index (TLI). These analyses allowed for the evaluation of both direct and indirect effects among the study variables, providing a comprehensive understanding of the underlying mechanisms at play.

3. Findings and Results

Of the 405 participants in the study, 212 (52.3%) were female and 193 (47.7%) were male. In terms of age distribution, 89 participants (22.0%) were aged 13, 97 (24.0%) were 14, 83 (20.5%) were 15, 69 (17.0%) were 16, 42 (10.4%) were 17, and 25 (6.2%) were 18 years old. Regarding grade level, 112 students (27.7%) were in seventh grade, 98 (24.2%) in eighth grade, 96 (23.7%) in ninth grade, 61 (15.1%) in tenth grade, and 38 (9.4%) in eleventh grade. As for access to technology, 381 participants (94.1%) reported having regular access to the internet at home, while 24 (5.9%) had limited or no internet access. Additionally, 368 adolescents (90.9%) reported daily use of a smartphone, while 37 (9.1%) used shared or school-provided devices.

Table 1

Descriptive Statistics for Study Variables (N = 405)

Variable	Mean (M)	Standard Deviation (SD)
Internet Addiction	58.73	12.42
Sleep Disturbance	42.89	9.36
Peer Relationship Difficulties	6.14	2.57

The results indicate that participants reported a moderate level of internet addiction ($M = 58.73$, $SD = 12.42$), a moderate to high level of sleep disturbance ($M = 42.89$, $SD = 9.36$), and a somewhat elevated level of peer relationship difficulties ($M = 6.14$, $SD = 2.57$), suggesting social challenges are present in this population alongside problematic internet use and disrupted sleep (Table 1).

Prior to conducting the main analyses, key statistical assumptions for Pearson correlation and Structural Equation Modeling were evaluated. The assumption of normality was examined using skewness and kurtosis values for each variable; all values fell within the acceptable range of -1 to +1, with skewness values ranging from -0.43 to 0.58 and

kurtosis values from -0.62 to 0.77, indicating approximate normal distribution. Linearity was confirmed through scatterplot inspection, showing clear linear trends between variables. Homoscedasticity was assessed using residual plots and found to be satisfactory. Multicollinearity was ruled out as all Variance Inflation Factor (VIF) values were below 2.5 and tolerance values exceeded 0.40. Additionally, no significant outliers were detected based on Mahalanobis distance ($p > .001$), ensuring the suitability of the data for SEM analysis. These results confirmed that all necessary assumptions for conducting Pearson correlation and SEM were met.

Table 2

Pearson Correlation Coefficients and p-values Between Variables

Variables	1	2	3
1. Internet Addiction	—		
2. Sleep Disturbance	.52** ($p < .001$)	—	
3. Peer Relationship Difficulties	.43** ($p < .001$)	.47** ($p < .001$)	—

All correlations were significant at the 0.01 level. Internet addiction was significantly positively correlated with both sleep disturbance ($r = .52$, $p < .001$) and peer relationship difficulties ($r = .43$, $p < .001$). Sleep disturbance was also

positively associated with peer difficulties ($r = .47$, $p < .001$), supporting the hypothesis that these constructs are interrelated (Table 2).

Table 3

Fit Indices of the Structural Model

Fit Index	Value	Acceptable Threshold
Chi-Square (χ^2)	108.53	—
Degrees of Freedom (df)	48	—
χ^2/df	2.26	< 3
GFI	.95	$\geq .90$
AGFI	.91	$\geq .90$
CFI	.96	$\geq .95$
TLI	.94	$\geq .90$
RMSEA	.055	$< .08$

The structural model demonstrated good fit to the data, as indicated by $\chi^2(48) = 108.53$, $\chi^2/df = 2.26$, GFI = .95, AGFI = .91, CFI = .96, TLI = .94, and RMSEA = .055. These

indices fall within acceptable thresholds, confirming that the model is suitable for interpreting the hypothesized relationships (Table 3).

Table 4

Total, Direct, and Indirect Effects in the Structural Model

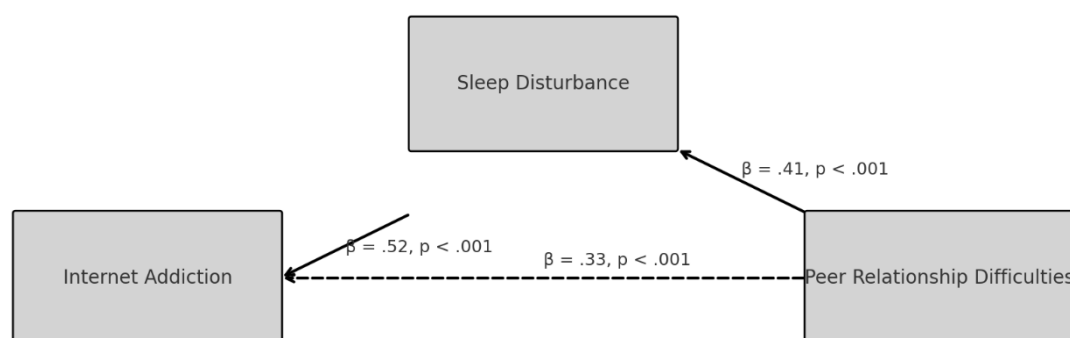
Path	B	S.E.	β	p
Internet Addiction → Sleep Disturbance	0.41	0.06	0.52	$< .001$
Sleep Disturbance → Peer Relationship Difficulties	0.36	0.07	0.41	$< .001$
Internet Addiction → Peer Relationship Difficulties (Direct)	0.29	0.08	0.33	$< .001$
Internet Addiction → Peer Relationship Difficulties (Indirect via Sleep)	0.15	0.04	0.21	$< .001$
Internet Addiction → Peer Relationship Difficulties (Total)	0.44	0.06	0.54	$< .001$

The path coefficients reveal that internet addiction significantly predicted sleep disturbance ($\beta = 0.52, p < .001$), and sleep disturbance in turn significantly predicted peer relationship difficulties ($\beta = 0.41, p < .001$). A significant direct path was also found from internet addiction to peer relationship difficulties ($\beta = 0.33, p < .001$), along with a

significant indirect path mediated by sleep disturbance ($\beta = 0.21, p < .001$). The total effect of internet addiction on peer difficulties ($\beta = 0.54$) reflects both direct and mediated pathways, highlighting the central role of sleep disturbance as a partial mediator (Table 4).

Figure 1

Final Model of the Study



4. Discussion and Conclusion

The results of this study revealed significant relationships among the variables of interest—namely, internet addiction, sleep disturbance, and peer relationship difficulties—among adolescents in Colombia. Pearson correlation analyses demonstrated that higher levels of internet addiction were positively associated with greater sleep disturbance and more severe peer relationship difficulties. Additionally, sleep disturbance itself was positively correlated with peer relationship problems. Structural Equation Modeling further supported the mediating role of sleep disturbance in the relationship between internet addiction and peer relationship difficulties. Specifically, the path from internet addiction to peer relationship difficulties was partially mediated by sleep disturbance, indicating that internet addiction contributes both directly and indirectly (through sleep problems) to challenges in adolescents' social interactions.

These findings confirm the growing body of research emphasizing the negative psychosocial consequences of excessive internet use in adolescence. Internet addiction, often characterized by compulsive engagement in online activities, time displacement, and emotional dependence on digital content, was found in this study to impair adolescents' capacity to sustain healthy relationships with peers. This is consistent with the findings of Chu et al. (Chu et al., 2021), who reported that social networking site addiction is linked to social anxiety and decreased face-to-

face social competence. The displacement of in-person interactions by virtual communication reduces opportunities for practicing empathy, reading non-verbal cues, and engaging in shared real-life experiences, all of which are vital for fostering positive peer relationships (Bishop et al., 2018; Forrest et al., 2018).

Moreover, the partial mediation effect of sleep disturbance suggests that one of the mechanisms through which internet addiction affects peer relationships is through disrupted sleep. Adolescents addicted to the internet often use devices late into the night, delaying bedtime, reducing sleep duration, and impairing sleep quality. These patterns are in line with those reported by Yu (Yu, 2019), who demonstrated that late-night screen use and poor sleep hygiene among children led to interpersonal and emotional difficulties. Poor sleep impairs self-regulation, increases irritability, and reduces social engagement—all factors that can erode peer bonds over time. Our results align with Schoeps et al. (Schoeps et al., 2020), who found that emotional regulation and peer empathy—two functions compromised by sleep deprivation—are strong predictors of peer acceptance and prosocial behavior.

The significant direct path from internet addiction to peer problems also highlights that beyond physiological disruption (e.g., sleep), cognitive and emotional mechanisms may be involved. Internet addiction can lead to withdrawal from real-world interactions, decreased interest in school or extracurricular activities, and increased engagement in

solitary behaviors, which over time hinder the development of social competencies. These observations echo those of Li et al. (Li et al., 2023), who found that difficulties in emotion regulation—often a byproduct of digital overuse—mediate the relationship between negative peer experiences and maladaptive outcomes like self-injury. Similarly, Manis and Stewart (Manis & Stewart, 2024) reported that children's peer relationships declined significantly during the COVID-19 pandemic when internet use increased, underscoring the broader social implications of digital overdependence.

The relationship between sleep disturbance and peer relationship difficulties has been well-documented in earlier studies and is corroborated here. Adolescents with irregular or poor-quality sleep are more likely to experience interpersonal tension, mood instability, and lower social initiative, all of which negatively influence peer interactions (Gultom & Wibowo, 2025; Szczęśniak et al., 2022). The findings of this study mirror those of Buissonnière-Ariza et al. (Buissonnière-Ariza et al., 2018), who observed that youths with chronic health problems and resulting sleep issues reported significantly lower quality peer relationships. Sleep problems compromise the brain's ability to regulate affect and facilitate social cognition, both crucial for engaging in emotionally reciprocal interactions.

This study also supports the broader notion that peer difficulties are not simply the result of external rejection but are often co-constructed through internal cognitive, emotional, and behavioral factors. According to Mikami and Normand (Mikami & Normand, 2015), children with ADHD struggle to form peer relationships not just because of peer bias, but due to their own impaired social awareness and self-monitoring—issues that are similarly exacerbated by both sleep deprivation and compulsive digital engagement. Adolescents with sleep disturbances may lack the social energy or clarity of thought needed to interpret others' emotions accurately, contributing to relational conflict or avoidance (Özdemir et al., 2016).

The observed findings also align with research exploring peer relationship difficulties among adolescents from emotionally or socially vulnerable backgrounds. For instance, youth who have experienced familial instability or adoption are more likely to struggle with peer bonding due to attachment-related anxieties and mistrust (Bishop et al., 2018). These vulnerabilities may be compounded when internet addiction is used as a coping mechanism for loneliness or emotional distress, further distancing the adolescent from real-life social experiences. Similarly, students with neurodevelopmental differences, such as

language disorders or intellectual disabilities, have been found to exhibit increased peer victimization and social rejection, especially when combined with digital disengagement from their surroundings (García et al., 2021; Schoop-Kasteler & Müller, 2019).

Environmental and contextual factors also play a crucial role in the formation and disruption of peer relationships. The classroom environment, for example, significantly shapes social opportunities and norms of interaction. As Löper and Hellmich (Löper & Hellmich, 2024) highlighted, the quality of student–teacher relationships and the teacher's own social behaviors influence how students interact with one another. In classrooms where mutual respect and inclusion are modeled and encouraged, peer difficulties may be mitigated, even among students who face challenges such as sleep disruption or digital dependency. This suggests that intervention programs should not only target individual behavior but also work to cultivate supportive social environments.

Additionally, individual psychological traits such as self-esteem and emotional literacy play a mediating role between sleep and peer relationships. Szczęśniak et al. (Szczęśniak et al., 2022) reported that communication with peers significantly mediated the relationship between adolescents' self-esteem and life satisfaction. This implies that even when adolescents face challenges like poor sleep or internet overuse, strengthening their interpersonal communication skills could protect against peer isolation. Likewise, O'Hare et al. (O'Hare et al., 2015) found that youth with Tourette's syndrome often faced peer rejection not because of the condition itself but due to resulting behavioral patterns and stress—paralleling how digital addiction or disrupted sleep may indirectly harm peer ties.

In summary, this study contributes to a nuanced understanding of the ways in which digital habits and physiological disruptions interact to shape adolescents' social worlds. It confirms that internet addiction not only reduces the quantity of in-person interactions but also influences adolescents' biological rhythms (i.e., sleep) and psychological functioning, ultimately impairing the quality of their peer relationships. The mediating role of sleep disturbance highlights a modifiable pathway, suggesting that improvements in sleep hygiene could mitigate some of the relational damage associated with digital overuse.

5. Limitations & Suggestions

Despite its contributions, this study is not without limitations. First, the cross-sectional nature of the design limits the ability to draw causal inferences about the directionality of the observed relationships. While internet addiction and sleep disturbance were significantly associated with peer relationship difficulties, longitudinal studies are needed to confirm these pathways over time. Second, all data were collected through self-report measures, which may be subject to response bias, particularly social desirability or underreporting of problematic behavior. Third, while the sample size was statistically adequate, it was limited to adolescents in Colombia, which may constrain the generalizability of the findings to other cultural contexts. Lastly, other potentially relevant mediators such as emotional regulation, social support, or family dynamics were not included in the model and may have contributed to the complexity of the observed relationships.

Future studies should employ longitudinal designs to better understand how internet addiction and sleep disturbance evolve over time and interact to influence peer relationships. Such designs would help establish causal links and capture dynamic patterns across developmental stages. Moreover, future research should incorporate multi-informant approaches, including peer, teacher, or parent reports, to provide a more holistic understanding of adolescents' social functioning. Expanding the sample to include diverse geographical and cultural settings would also enhance the external validity of the findings. Finally, examining additional psychological or contextual mediators—such as social anxiety, emotion regulation, or family conflict—would offer a more comprehensive model of how internet use and biological rhythms influence adolescent social adjustment.

In light of these findings, educators and school counselors should incorporate sleep hygiene education and digital literacy programs into the school curriculum to promote healthy technology habits. Structured screen-free time, especially before bedtime, should be encouraged both at school and at home. Schools can also implement peer mentoring programs that support social inclusion and emotional connection, especially for students who may be digitally over-engaged or socially withdrawn. Clinicians working with adolescents should assess both sleep quality and internet use patterns when addressing social or emotional concerns. Families should be guided to set clear and consistent rules about internet use, particularly in the evening, to ensure adequate rest and foster in-person social interactions. By targeting both behavioral and physiological

factors, these interventions can help mitigate peer relationship difficulties and promote healthier adolescent 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.

References

- Bishop, H. K. D., Claxton, S. E., & Manfred, H. M. v. D. (2018). The Peer Relationships of Those Who Have Experienced Adoption or Foster Care: A Meta-Analysis. *Journal of Research on Adolescence*, 29(4), 796-813. <https://doi.org/10.1111/jora.12421>
- Boivin, M., Brendgen, M., Vitaro, F., Forget-Dubois, N., Feng, B., Tremblay, R. E., & Dionne, G. (2013). Evidence of Gene-environment Correlation for Peer Difficulties: Disruptive Behaviors Predict Early Peer Relation Difficulties in School Through Genetic Effects. *Development and Psychopathology*, 25(1), 79-92. <https://doi.org/10.1017/s0954579412000910>
- Buissonnière-Ariza, V. L., Hart, D. L., Schneider, S. C., McBride, N. M., Cepeda, S. L., Haney, B., Tauriello, S., Glenn, S., Ung, D., Huszár, P., Tetreault, L. L., Petti, E. A., Winesett, S. P., & Storch, E. A. (2018). Quality and Correlates of Peer Relationships in Youths With Chronic Pain. *Child Psychiatry & Human Development*, 49(6), 865-874. <https://doi.org/10.1007/s10578-018-0802-z>
- Chen, B. B., & Santo, J. B. (2015). The Relationships Between Shyness and Unsociability and Peer Difficulties. *International*

- Journal of Behavioral Development*, 40(4), 346-358. <https://doi.org/10.1177/0165025415587726>
- Chu, X., Ji, S., Wang, X., Yu, J., Chen, Y., & Lei, L. (2021). Peer Phubbing and Social Networking Site Addiction: The Mediating Role of Social Anxiety and the Moderating Role of Family Financial Difficulty. *Frontiers in psychology*, 12. <https://doi.org/10.3389/fpsyg.2021.670065>
- Forrest, C. L., Gibson, J. L., Halligan, S. L., & Clair, M. S. (2018). A Longitudinal Analysis of Early Language Difficulty and Peer Problems on Later Emotional Difficulties in Adolescence: Evidence From the Millennium Cohort Study. *Autism & Developmental Language Impairments*, 3. <https://doi.org/10.1177/2396941518795392>
- García, I. S., Valera-Pozo, M., Sanchez-Azanza, V. A., Adrover-Roig, D., & Aguilar-Mediavilla, E. (2021). Associations Between Self, Peer, and Teacher Reports of Victimization and Social Skills in School in Children With Language Disorders. *Frontiers in psychology*, 12. <https://doi.org/10.3389/fpsyg.2021.718110>
- Gultom, M. J., & Wibowo, D. H. (2025). Peer Social Support and Career Decision-Making in Adolescents From Broken Homes: A Career Counseling Perspective. *Jurnal Bimbingan dan Konseling Terapan*, 9(1), 47-60. <https://doi.org/10.30598/bkt.v9i1.17109>
- Healy, K. L. (2017). Children With Peer Relationship Difficulties. 97-106. <https://doi.org/10.1093/med-psych/9780190629069.003.0007>
- Khpalwak, A. T., & Hamidi, M. S. (2024). Relationship Between Social Media Use and Sleep Disturbance Among Adults in Afghanistan. *American Journal of Medical Science and Innovation*, 3(1), 27-34. <https://doi.org/10.54536/ajmsi.v3i1.2418>
- Li, J., Gao, Y., Liu, J., Liu, X., & Wang, H. (2023). Impacts of Difficulties With Emotion Regulation on the Longitudinal Relationship Between Peer Victimization and Changes in Adolescent Nonsuicidal Self-injury. *Journal of adolescence*, 96(2), 350-359. <https://doi.org/10.1002/jad.12279>
- Löper, M. F., & Hellmich, F. (2024). Teachers' Role Model Behavior and the Quality of the Student-teacher Relationship as Prerequisites for Students' Attitudes Toward Peers With Learning Difficulties. *Frontiers in Education*, 9. <https://doi.org/10.3389/educ.2024.1400471>
- Lukas, L., Buhl, C., Schulte-Körne, G., & Sfarlea, A. (2022). Family, Friends, and Feelings: The Role of Relationships to Parents and Peers and Alexithymia in Adolescents With Anorexia Nervosa. *Journal of eating disorders*, 10(1). <https://doi.org/10.1186/s40337-022-00661-3>
- Manis, J., & Stewart, S. L. (2024). A Snapshot of Peer Relationships in Children and Youth: Pre- Versus During COVID-19. *International journal of environmental research and public health*, 21(12), 1552. <https://doi.org/10.3390/ijerph21121552>
- Marsus, N. b., Huey, L. S., Saffari, N., & Motevalli, S. (2022). Peer Relationship Difficulties Among Children With Adhd: A Systematic Review. *International Journal of Academic Research in Business and Social Sciences*, 12(6). <https://doi.org/10.6007/ijarbs/v12-i6/13352>
- Mikami, A. Y., & Normand, S. (2015). The Importance of Social Contextual Factors in Peer Relationships of Children With ADHD. *Current Developmental Disorders Reports*, 2(1), 30-37. <https://doi.org/10.1007/s40474-014-0036-0>
- O'Hare, D., Eapen, V., Helmes, E., McBain, K., Reece, J., & Grove, R. (2015). Factors Impacting the Quality of Peer Relationships of Youth With Tourette's Syndrome. *BMC psychology*, 3(1). <https://doi.org/10.1186/s40359-015-0090-3>
- Özdemir, S. B., Cheah, C. S. L., & Coplan, R. J. (2016). Processes and Conditions Underlying the Link Between Shyness and School Adjustment Among Turkish Children. *British Journal of Developmental Psychology*, 35(2), 218-236. <https://doi.org/10.1111/bjdp.12158>
- Sarfo, J. O., Gbordzoe, N. I., Commey, V. D., Tawiah, E. D., & Hagan, J. E. (2024). Gender Differences in Anxiety-Induced Sleep Disturbance: A Survey Among in-School Adolescents in the Republic of Benin. *Social Sciences*, 13(12), 655. <https://doi.org/10.3390/socsci13120655>
- Schoeps, K., Mónaco, E., Cotoí, A., & Montoya-Castilla, I. (2020). The Impact of Peer Attachment on Prosocial Behavior, Emotional Difficulties and Conduct Problems in Adolescence: The Mediating Role of Empathy. *PLoS One*, 15(1), e0227627. <https://doi.org/10.1371/journal.pone.0227627>
- Schoop-Kasteler, N., & Müller, C. M. (2019). Peer Relationships of Students With Intellectual Disabilities in Special Needs Classrooms – A Systematic Review. *Journal of Research in Special Educational Needs*, 20(2), 130-145. <https://doi.org/10.1111/1471-3802.12471>
- Siegel, R. S., Freeman, A. J., Greca, A. M. L., & Youngstrom, E. A. (2014). Peer Relationship Difficulties in Adolescents With Bipolar Disorder. *Child & Youth Care Forum*, 44(3), 355-375. <https://doi.org/10.1007/s10566-014-9291-9>
- Solmaz, S., İnan, M., & Şahin, M. (2025). The Moderating Effects of Physical Activity on Social Anxiety and Sleep Disturbance: Managing Gaming Disorder in Young E-Sports Players. *Frontiers in Public Health*, 13. <https://doi.org/10.3389/fpubh.2025.1544044>
- Su, S., Pettit, G. S., & Erath, S. A. (2016). Peer relations, parental social coaching, and young adolescent social anxiety. *Journal of Applied Developmental Psychology*, 42, 89-97. <https://doi.org/10.1016/j.appdev.2015.11.007>
- Szczeńśniak, M., Bajkowska, I., Czaprowska, A., & Sileńska, A. (2022). Adolescents' Self-Esteem and Life Satisfaction: Communication With Peers as a Mediator. *International journal of environmental research and public health*, 19(7), 3777. <https://doi.org/10.3390/ijerph19073777>
- Wu, J., Wu, X., Tarimo, C. S., Zhao, W., Xia, Q., Xu, X., Wu, C., Feng, H., Miao, Y., Liu, R., & Yang, Y. (2025). Network analysis of Internet addiction and depression among Chinese adolescents. *Journal of affective disorders*, 378, 119-127. <https://doi.org/10.1016/j.jad.2025.02.052>
- Yu, J. H. (2019). A Case Study on Family Therapy for Child With Difficulty in Forming Peer Relationships. *The Journal of Play Therapy*, 23(1), 89-104. <https://doi.org/10.32821/jpt.23.1.7>
- Yumru Montes, H., & Koc, S. (2025). Effects of a nurse-led play-based internet addiction prevention program in early adolescents: A randomized controlled study. *Archives of Psychiatric Nursing*, 151851. <https://doi.org/10.1016/j.apnu.2025.151851>