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The Mediating Effect of Internet Addiction in The Association Between Adolescent Bully-Victims and Sleep Disorders

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Abstract. Objective: an investigation was carried out to study the relationship between bully-victims and sleep disorders among adolescents, focusing on elucidating the mediating effect of internet addiction in the association between these two variables. Methods: a cross-sectional study was performed, drawing on data from the adolescent health database (dyh), which included 21,824 junior and senior high school students. Data on sleep duration, internet use behaviors, and exposure to bully-victims were gathered through self-reported questionnaires. Binary logistic regression models were employed to discuss the relationship between bullying and sleep disorders, while a single-mediator model was applied to investigate the mediating effect of internet addiction. Confounding factors, including gender, age, household economic status, as well as paternal educational level were controlled for during the analyses. Results: the study findings indicated that the prevalence of sleep disorders within the adolescent sample was identified at 43.1%, while 12.5% of the participants reported experiencing bullying, and 2.7% met the criteria for internet addiction. Analyses demonstrated that among adolescents whose average nightly sleep amounted to fewer than 8 hours, females, older individuals, those with poorer family and interpersonal relationships, and those with lower self-rated health were found to be at significantly elevated risks of both bully-victims and internet addiction. Binary logistic regression analysis demonstrated that, before adjusting for confounding factors, bullying victims exhibited an odds ratio (or) of 1.16 (95% ci: 1.02–1.27, p = 0.023) for sleep disorders. Upon incorporating covariates including gender, age, household economic status, and paternal educational level into the model, this effect was still discovered to be significant (or = 1.10, 95% ci: 1.08–1.25, p = 0.016). Furthermore, a notable interaction between bully-victims and gender was detected concerning the risk of sleep disorders after confounder adjustment (or = 1.15, 95% ci: 1.05–2.41, p = 0.005). The analysis utilizing a single-mediator model analysis demonstrated that internet addiction significantly mediated the relationship between bully-victims and sleep disorders, as evidenced by a standardized mediating effect value of 0.076, constituting 11.4% of the total effect. Conclusion: the relationship between bully-victims and sleep disorders among adolescents is significantly mediated by internet addiction, which further exacerbates mental health issues. Strengthening mental health education, mitigating bullying behaviors, and monitoring internet use patterns could prevent sleep disorders and mitigate associated risks. In future research, the causal mechanisms underlying these relationships should be elucidated, and targeted interventions developed accordingly.

Keywords: Bully-victims; Internet Addiction; Sleep Disorders; Adolescents; Mental Health.

1. Introduction

Sleep is an indispensable physiological process for maintaining normal bodily functions, during which restorative processes occur in the brain and body, playing a pivotal role in maintaining health, promoting orderly daily functioning, and facilitating optimal work performance[1]. However, sleep deprivation remains prevalent among adolescents, with empirical data indicating that their average weekday sleep duration is 6.25 hours—markedly shorter than the recommended 8–9 hours for this age group, while 65% report sleep latency exceeding 30 minutes and 13.6%–23.8% meet diagnostic criteria for insomnia based on varying assessment scales[2]. A meta-analysis revealed that 53% of adolescents exhibit weekday sleep durations significantly below recommendations, with 36% reporting difficulties initiating sleep[3]. Notably, the pivotal role of adequate sleep duration (slp) in adolescent psychosocial development and academic achievement was underscored by a school-based

cross-sectional study in denmark, indicating that sufficient quantity and quality of sleep are crucial for fostering socioemotional functioning and enhancing educational outcomes among adolescents[4].

Internet addiction (ia), with a loss of control over internet use marked by excessive engagement to the extent that individuals neglect real-life interpersonal relationships, work, and academic responsibilities, thus severely impairing daily functioning[5], is a burgeoning concern among chinese adolescents after the widespread adoption of smartphones. As highlighted by the 5th national survey report on internet use among minors published by the china internet network information center, revealed that 20.2% of adolescents self-reported smartphone dependency, reflecting a notable rise in problematic internet use patterns[6]. Studies have demonstrated that prolonged screen time may induce nocturnal light exposure, disrupting circadian rhythm synchronization with natural light-dark cycles and precipitating circadian misalignment, which is a key contributor to sleep disorders among adolescents[7, 8].

However, beyond internet addiction, adolescent sleep disorders may be influenced by other factors like bully-victims[9], which induce significant psychological distress and anxiety in victims, thereby disrupting normal sleep patterns and precipitating issues like difficulty initiating sleep, fragmented sleep, or early morning awakening. Empirical studies have demonstrated that bullied adolescents are more prone to sleep disturbances and insomnia symptoms, with these sleep-related problems being strongly linked to comorbid anxiety and depressive moods[10]. The tendency of bullying victims to engage in repetitive rumination over negative experiences further exacerbates sleep impairments by prolonging hyperarousal states and intensifying emotional distress.

Previous research has indicated that bullying experiences may raise the risk of internet addiction[11–13]. As adolescents, in response to bullying, often resort to social networking platforms as a coping mechanism, they do so to evade environmental conflicts and fulfill unmet psychosocial needs. These needs remain unattainable in real-life contexts, thereby increasing susceptibility to addictive internet behaviors. A cross-sectional study among korean adolescents demonstrated that students exhibiting internet addiction tendencies were 1.34 times more prone to report having been exposed to bully-victims compared to those without such tendencies[14]. This finding is echoed in previous research, where it was observed that those with internet addiction demonstrated poorer peer relationships and were significantly more likely to have experienced bullying[15].

At present, research investigating the relation between ia and sleep disorders among adolescents remains limited, focusing on international contexts, despite ia being acknowledged as a critical risk factor for adolescent sleep disturbances. Meanwhile, the mediating effect of ia in the correlation between sleep disorders and bully-victims remains inadequately understood. This is particularly significant given that adolescence represents a pivotal developmental stage, during which sleep disturbances can have deep adverse influences on physical and mental health. Given the existing gaps in research, it is vital to investigate the risk elements promoting adolescent sleep disorders and identify high-risk populations to foster healthy adolescent development. This study adopts a large-scale cross-sectional design to elucidate the relation between sleep disorders and bully-victims within adolescent populations. Additionally, it investigates the mediating effect of ia in this relationship, thereby providing valuable advice for the identification and timely intervention of high-risk adolescents—a public health priority with profound implications for adolescent well-being.

2. Methods

2.1 Study Design And Participants

A cross-sectional design was utilized in the research, leveraging data from the database of youth health (dyh) project. This project was a multi-wave longitudinal survey conducted during the academic years 2015/2016, 2016/2017, 2017/2018, and 2020/2021 to systematically assess health conditions and healthy behavioral patterns among students from junior and senior high schools in china[16]. This sampling framework followed a stratified random sampling strategy, whereby 90 public secondary schools, including junior and senior high schools, were selected from 13 regions

across shandong province according to geographic distribution, demographic composition, as well as socioeconomic development indicators in a randomized way[17]. Specifically, three senior high schools (each with a sample size of ⩾300 students) and seven junior high schools (with 100 students per grade level) were randomly recruited from each region. Following data cleaning, the final analytical sample comprised 21,824 adolescents. Electronic informed consent was gained from all of the participating students and their parents, and the study was granted ethical approval by the institutional review board of shandong university (ethics approval no.: 20180517)[18].

2.2 MEASUREMENTS

2.2.1 Sleep Disorders.

Sleep duration was evaluated through the question, "How many hours of sleep do you typically get per night?" And responses indicating lower than 8 hours of sleep per night were categorized as indicative of sleep disturbance, aligning with the National Sleep Foundation (NSF) guidelines for insufficient sleep among adolescents[19].

2.2.2 Internet Addiction.

Adolescent internet addiction tendencies were evaluated through the use of a standardized item derived from the youth risk behavior surveillance system (yrbss). The question was: "during the past school semester, on an average school day (monday through friday), how many hours did you spend playing video games or using a computer for non-academic purposes, including time spent messaging or socializing via qq, wechat, ipad, or other social media platforms?"[20]. This question presented 7 response selections, spanning from "i did not watch tv, play video games, or use a computer for non-academic purposes on school days" to "⩾5 hours per day". For analytical purposes, these responses were recoded into two categories: (i) <5 hours/day and (ii) ⩾5 hours/day of internet use[21].

2.2.3 Bully-victims.

Bully-victims were gauged through the question: "In the past 12 months, have you ever been bullied at school?"[20]. Adolescents who responded "Yes" were categorized as Bully-victims.

2.2.4 Confounding Factors.

Based on a review of prior literature[22], we employed a directed acyclic graph (dag) to select the appropriate covariates for adjustment (figure 1). The following covariates were controlled for in statistical models: gender, age, household socioeconomic status, and paternal educational attainment.

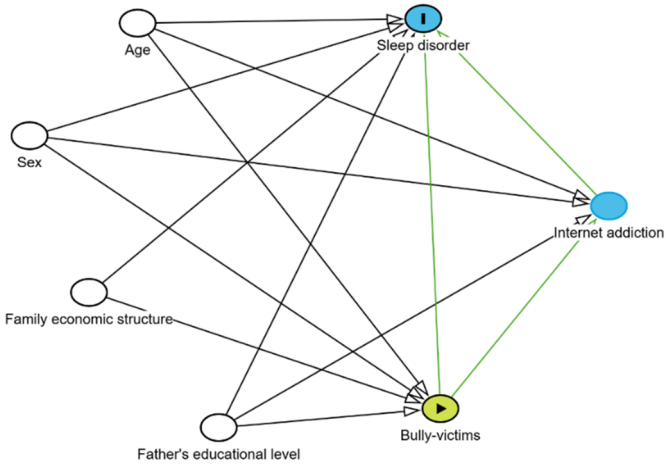

Figure 1. Directed Acyclic Graph (DAG) for bully-victims, sleep disorder, and other covariates. [The minimally sufficient adjustment set was determined using the DAGitty software. The simplified DAG was generated by the online resource DAGitty (http://www.dagity.net/dags.html#)].

2.3 Statistical Analysis

Participants were stratified into distinct groups according to their sleep disorder status. Comparisons of demographic characteristics, internet addiction tendencies, and experiences of bully-victims were conducted across these groups using χ^2 tests for categorical variables, t-tests for continuous variables divided into two groups, and one-way analysis of variance (ANOVA) for continuous variables by SPSS. To explore the correlation between adolescent internet addiction and sleep disorders, logistic regression models were constructed, with internet addiction serving as the independent variable and sleep disorder (a binary outcome) as the dependent variable. Thus, a product-term interaction term incorporating internet addiction and gender was introduced to evaluate the potential moderating influence of gender. Finally, a univariate mediation model was implemented to examine the mediating effect of bully-victims in the relationship between internet addiction and sleep disorder, which was treated as a continuous variable. Mediation effects were examined through 5,000-iteration bootstrap sampling by Stata, with direct and indirect effects being reported. All analyses were adjusted for confounding variables like gender, age, household SES, and paternal education, using a two-tailed test with a significance threshold of $p < 0.05$.

3. Results

3.1 Features Of Participants with Sleep Disorders

Among the 21,824 participants enrolled, 11,167 (51.2%) were identified as male and 10,657 (48.8%) as female, with a mean age of 14.26 ± 1.68. a total of 2,719 participants (12.5%) reported having experienced school bully, while 596 (2.7%) exhibited signs of internet addiction, and 9,408 (43.1%) met the criteria for sleep disturbances (defined as <8 hours of sleep per night). When compared to those with adequate sleep duration, adolescents reporting <8 hours of sleep were found to be disproportionately female, older, and more likely to report poorer family relationships, peer relationships, and teacher-student relationships, as well as lower self-rated health status. They were also dramatically more prone to be victims of bullying (or=1.67, 95% ci: 1.52–1.83) and display internet addiction tendencies (or=2.14, 95% ci: 1.89–2.42).

Table 1. Characteristics of the study participants across sleep disorders.

Character	Sleep disorders, n (%) a			P value b
	Overall (N=21824)	<8 hours (n=9408)	≥8 hours (n=12416)	
Age, mean (SD), y	14.26(1.68)	15.16(1.73)	13.58(1.63)	<0.001
Sex				<0.001
Male	11167 (51.2)	4522 (48.1)	6645 (53.5)	
Female	10657 (48.8)	4886 (51.9)	5771 (46.5)	
Father's educational level				0.028
less than middle school	2831 (13.0)	1294 (13.8)	1537 (12.4)	
Junior middle school/ technical school	11037 (50.6)	4714 (50.1)	6323 (50.9)	
Senior middle school/ vocational high school	4218 (19.3)	1795 (19.1)	2423 (19.5)	
College or more	3738 (17.1)	1605 (17.1)	2133 (17.2)	
Mother's educational level				0.149
less than middle school	4513 (20.7)	1998 (21.2)	2515 (20.3)	
Junior middle school/ technical school	10294 (47.2)	4427 (46.5)	5922 (47.7)	
Senior middle school/ vocational high school	3652 (16.7)	1560 (16.6)	2092 (16.8)	
College or more	3365 (15.4)	1478 (15.7)	1887 (15.2)	
Family economic status				0.002

Low	3610 (16.5)	1630 (17.3)	1980 (15.9)	
Moderate	15889 (72.8)	6735 (71.6)	9154 (73.7)	
High	2325 (10.7)	1043 (11.1)	1282 (10.3)	
Family relationship				<0.001
Poor	3860 (17.7)	1762 (18.7)	2098 (16.9)	
Good	17964 (82.3)	7646 (81.3)	10318 (83.1)	
Classmate relationship				0.397
Poor	1173 (5.4)	518 (5.5)	655 (5.3)	
Average	1959 (9.0)	867 (9.2)	1092 (8.8)	

Table 1. Characteristics of the study participants across sleep disorders (continued).

Good	18692 (85.6)	8023 (85.3)	10669 (85.9)	
Teacher-student relationship				0.240
Poor	1372 (6.3)	610 (6.5)	762 (6.1)	
Average	3150 (14.4)	1389 (14.8)	1761 (14.2)	
Good	17302 (79.3)	7409 (78.8)	9893 (79.7)	
Self-assessment of health status				<0.001
Good	18524 (84.9)	7157 (76.1)	11367 (91.6)	
Average	2960 (13.6)	2003 (21.3)	957 (7.7)	
Poor	340 (1.6)	248 (2.6)	92 (0.7)	
Bully-victims				0.005
Yes	2719 (12.5)	1104 (11.7)	1615 (13.0)	
No	19105 (87.5)	8304 (88.3)	10801 (87.0)	
Internet addiction				0.001
Yes	596 (2.7)	296 (3.1)	300 (2.4)	
No	21228 (97.3)	9112 (96.9)	12116 (97.6)	

A missing data: 2108 for classmate relationship, 1256 for teacher-student relationship, 5084 for family structure, and 15612 for sleep disorders.

B comparing characteristics across whether there is a sleep disorders group, t tests was used for continuous variables and $\chi 2$ tests were applied for categorical variables.

3.2 Correlation Between Bully-Victims and Sleep Disorders Among Chinese Adolescents

As presented in Table 2, the unadjusted binary logistic regression model (Model 1) indicated that adolescents WHO HAD experienced bullying were 1.16 times more inclined to experience sleep disorders, compared to those who had not been victimized (95% CI: 1.02–1.27, P = 0.023). Upon controlling for gender, age, household socioeconomic structure, and paternal educational level in Model 2, the OR slowly declined to 1.10 (95% CI: 1.08–1.25, P = 0.016), displaying that while the relation between sleep disorders and bully-victims was somewhat diminished, it retained statistical significance.

Table 2. Associations of Internet addiction, Bully-victims with sleep disorder among Chinese adolescents.

Characteristics	Model 1		Model 2	
	OR (95% CI)	P-value	OR (95% CI)	P-value
Bully-victims				
No	1.00 (Reference)		1.00 (Reference)	

Yes	1.16 (1.02, 1.27)	0.023	1.10 (1.08, 1.25)	0.016

Abbreviation: OR: odds ratio; 95% CI: 95% confidence interval.
Model 1: Unadjusted model.
Model 2: Adjusted for sex, age, family economic structure, father's educational level.

3.3 Interactive Effect of Internet Addiction and Gender on Sleep Disorders

As illustrated in table 3, the unadjusted binary logistic regression model (model 1) indicated that when an interaction between internet addiction and gender was present, the risk of sleep disorders was 1.09 times higher compared to scenarios where this interaction was absent (95% ci: 1.04–2.15, p = 0.011). In model 2, after adjusting for the same covariates (gender, age, household socioeconomic structure, and paternal educational level), the or rose to 1.15, which indicated that the interactive effect of internet addiction and gender on the risk of sleep disorder was amplified (95% ci: 1.05–2.41, p = 0.005).

Table 3. Interactions between Bully-victims and sex on sleep disorder.

Sleep disorder	Model 1		Model 2	
	OR (95% CI)	P-value	OR (95% CI)	P-value
Sex × Internet addiction	1.09 (1.04, 2.15)	0.011	1.15 (1.05, 2.41)	0.005

Abbreviation: OR: odds ratio; CI, confidence interval.
Model 1: Unadjusted model.
Model 2: Adjusted for sex, age, family economic structure, father's educational level.

3.4 Mediation Analysis of The Relationship Between Adolescent Bully-Victims and Sleep Disorders

Upon controlling for gender, age, household socioeconomic structure, and paternal educational level, a path analysis was undertaken. In this analysis, bully-victims served as the predictor variable, sleep disorders were designated as the outcome variable, as well as internet addiction, was considered as the mediator. Presented table 4, which demonstrated that bully-victims exerted a direct influence on sleep disorders, with a direct effect coefficient of 0.590, occupying 88.6% of the total effect. Bully-victims indirectly impacted sleep disorders through internet addiction, suggesting that internet addiction mediated the correlation between bully-victims and sleep disorders, with an indirect effect value of 0.076, contributing 11.4% to the total effect.

Table 4. Mediating effect analysis of Internet addiction

	β	(95% CI)	P-value	Proportion of Total Effect
Total effect	0.666	(0.415, 0.917)	<0.001	
Direct effect	0.590	(0.323, 0.590)	<0.001	88.6%
Mediated effect	0.076	(0.045, 0.109)	<0.001	11.4%

Model 2: Adjusted for sex, age, family economic structure, father's educational level.

4. Discussion

This cross-sectional study gathered data from 21,824 middle and high school students via multistage stratified random sampling. A significant relation between bully-victims and sleep disorders was unveiled through regression modeling. Mediation analysis indicated that bully-victims acted as a partial mediator between gender nonconformity /incongruence and smartphone dependence in adolescents. Moreover, bully-victims also served as a partial mediator between the two variables via internet addiction. To be specific, the finding indicates that adolescents who experience bullying are at high risk of developing internet addiction, which in turn exacerbates sleep disorders. The finding highlights the potential pathways through which bullying-related stress may compromise adolescent sleep health.

4.1 Bully-Victims And Sleep Disorders In Adolescents

Previous research has established bully-victims as a prominent risk element for sleep disorders in adolescents[23, 24]. Adolescents subjected to bullying display hallmark symptoms of sleep dysfunction, including extended sleep onset latency, fragmented sleep architecture, as well as premature morning awakenings. Drawing on the stress system theory, bullying is recognized as a chronic stressor activating the hypothalamic-pituitary-adrenal (HPA) axis, thereby precipitating dysregulation in cortisol secretion and subsequent disruption of normal circadian sleep rhythms[25]. Given the repetitive nature of bullying and the absence of effective external interventions, victims are chronically exposed to stressful environments, thereby resulting in sustained deterioration of sleep quality. Consequently, bully-victims can be regarded as a critical risk determinant for adolescent sleep disorders.

4.2 The Mediating Effect of Internet Addiction

Internet addiction was identified in this study as a significant mediator between sleep disorders and bully-victims among adolescents, which implies that adolescents, who have experienced bullying, confront an elevated risk of forming internet addiction, which in turn exacerbates sleep dysfunction. Previous research has extensively documented that frequent use of social media was a risk factor for poor mental health and sleep disorder outcomes [26]. Specifically, bullying victims often withdraw from real-world social interactions, channeling increased time and energy into virtual environments. This avoidance behavior, especially before bedtime, significantly shortens their sleep duration. Notably, bullying incidents frequently occur in concealed settings where teachers or parents are unlikely to intervene, resulting in extremely low detection rates. Moreover, victims often hesitate to disclose bullying experiences due to fear of retaliation, leading to underreporting and limited access to effective support. Under such circumstances, internet addiction may emerge as a maladaptive coping mechanism, temporarily alleviating psychological distress caused by bullying. While the virtual world offers transient relief from real-world suffering, the abrupt return to reality exacerbates the psychological trauma inflicted by bullying, perpetuating a cycle of distress for victims[27].

4.3 Strengths And Limitations

This paper boasts certain strengths. First and foremost, it capitalizes on data from the Database of Youth Health (DYH) project, which offers access to a large-scale sample, thereby ensuring ample statistical power for the study. Secondly, through a thorough examination of the intricate interrelationships among bully-victims, internet addiction, and sleep disorders, this analysis reveals the interactive dynamics and underlying mechanisms among these factors, thereby offering crucial theoretical insights into adolescent mental health. However, the study has limitations. First of all, the cross-sectional design confines observations to a single time point, constraining our capacity to ascertain causal directions among the variables. Research should further employ longitudinal designs or behavioral experiments to clarify dynamic relationships and uncover causal mechanisms. Secondly, reliance on self-reported questionnaires introduces subjectivity. Incorporating objective measures, such as physiological monitoring or behavioral observations, could enhance the accuracy and reliability of findings. Finally, the sample's geographic scope is restricted to specific regions, potentially compromising its generalizability to adolescents from diverse cultural backgrounds. Expanding the sample to include multi-regional and multicultural populations would strengthen the external validity of future studies.

5. Conclusion

Drawing on a cross-sectional survey, this study reveals that internet addiction is a significant mediator between sleep disorders and bully-victims among adolescents, which indicates that internet addiction not only shows a close correlation with bully-victims but also worsens adolescents' mental health issues by compromising sleep quality.

The findings suggest that enhancing mental health education and life skills training for adolescents can effectively reduce the incidence of bullying. Simultaneously, parental oversight and guidance regarding adolescents' internet use are critical. Through collaborative efforts by families and schools, the prevalence of adolescent sleep disorders can be mitigated, thereby alleviating their potential harm to physical and psychological well-being. Future research ought to further delve into the causal mechanisms between internet addiction and sleep disorders, to devise targeted interventions aimed at enhancing overall adolescent health outcomes.

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