

# **The Mediating Role of Cognitive Workload and Loneliness in the Relationship Between Internet Addiction and Sleep Quality among Public University Students in Malaysia**

Aini Azeqa Ma'rof<sup>1,2</sup>, Haslinda Abdullah<sup>1,2</sup>, Mohd Roslan Rosnon<sup>2,3</sup>

<sup>1</sup>Institute for Social Science Studies, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia, <sup>2</sup>Faculty of Human Ecology, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia, <sup>3</sup>Malaysian Research Institute for Ageing, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia  
Email: azeqa@upm.edu.my

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## **Abstract**

This study investigates the mediating roles of cognitive workload and loneliness in the relationship between internet addiction and sleep quality among public university students in Malaysia. Utilizing a cross-sectional survey of 425 students from various institutions in Klang Valley, the research employs established instruments to measure internet addiction, cognitive workload, loneliness, and sleep quality. The findings reveal that internet addiction significantly predicts poor sleep quality, with cognitive workload and loneliness serving as crucial mediators. Students with higher levels of internet addiction experience greater cognitive workload and loneliness, which in turn, adversely affect their sleep quality. These results underscore the importance of addressing both cognitive demands and social factors in interventions aimed at improving sleep health among university students. Practical strategies suggested include implementing cognitive workload management programs, promoting healthy internet use, and fostering social connections. This study provides empirical evidence on the mediating roles of cognitive workload and loneliness in the relationship between internet addiction and sleep quality. By understanding these dynamics, educators and mental health professionals can develop targeted strategies to support students in managing internet addiction and improving sleep quality, ultimately enhancing their overall wellbeing. These findings offer valuable insights for both academics and practitioners in the fields of mental health and educational intervention.

**Keywords:** Internet Addiction, Cognitive Workload, Loneliness, Sleep Quality, university Students

### **Introduction**

The advent of the internet and its integration into everyday life has revolutionized communication, education, and entertainment. However, the excessive use of the internet has given rise to internet addiction, a behavioral issue characterized by an inability to control internet use, leading to significant impairment or distress (Bickham, 2021). Internet addiction has been linked to various negative outcomes, including poor academic performance, social isolation, and deteriorating mental health (Kuss & Lopez-Fernandez, 2016). Among university students, who are heavy users of the internet for both academic and recreational purposes, internet addiction has become a growing concern (Berte, Mahamid, & Affouneh, 2021; Zenebe, Kunno, Mekonnen, et al., 2021). This study aims to explore the impact of internet addiction on sleep quality among public university students in Klang Valley, Malaysia, and investigate the mediating roles of cognitive workload and loneliness in this relationship.

Sleep quality is a critical component of overall health and wellbeing, affecting cognitive function, emotional regulation, and physical health (Hirshkowitz et al., 2015). Poor sleep quality is prevalent among university students, often resulting from irregular sleep patterns, high academic demands, and lifestyle choices (Lund et al., 2010). Internet addiction has been identified as a significant predictor of poor sleep quality, with excessive internet use disrupting sleep patterns and increasing the risk of sleep disorders (Cheung & Wong, 2011; Otsuka, Kaneita, Itani, et al., 2021). Understanding the mechanisms through which internet addiction affects sleep quality can help in developing targeted interventions to improve sleep health among students.

Cognitive workload refers to the mental effort required to perform tasks, and it plays a significant role in the academic life of university students. High cognitive workload can lead to mental fatigue, stress, and poor sleep quality (Cai et al., 2019). Internet addiction can exacerbate cognitive workload by increasing the time spent online at the expense of academic tasks, leading to increased stress and reduced sleep quality (Johannsen et al., 2016). This study hypothesizes that cognitive workload mediates the relationship between internet addiction and sleep quality, as excessive internet use may elevate cognitive demands and disrupt sleep patterns.

Loneliness, defined as the subjective feeling of social isolation, has been linked to both internet addiction and poor sleep quality (Stickley et al., 2016). University students who spend excessive time online may experience social withdrawal and increased feelings of loneliness, which can, in turn, negatively affect their sleep quality (Demirci et al., 2015). Loneliness can disrupt sleep by increasing stress levels and negatively impacting emotional wellbeing (Griffin et al., 2020). This study proposes that loneliness acts as a mediator in the relationship between internet addiction and sleep quality, highlighting the importance of addressing social factors in interventions aimed at improving sleep health.

Empirical evidence supports the mediating roles of cognitive workload and loneliness in the relationship between internet addiction and sleep quality. A study by Lemola et al. (2015) found that excessive internet use was associated with higher cognitive workload and poorer

sleep quality among adolescents. Similarly, research by Bhandari et al. (2021) demonstrated that loneliness mediated the impact of internet addiction on sleep quality, with higher levels of loneliness linked to increased sleep disturbances. These findings underscore the need for comprehensive interventions that address both cognitive and social aspects to mitigate the negative effects of internet addiction on sleep.

In conclusion, this study aims to explore the mediating roles of cognitive workload and loneliness in the relationship between internet addiction and sleep quality among public university students in Malaysia. By understanding these mediating mechanisms, mental health professionals and educators can develop targeted strategies to reduce internet addiction and improve sleep quality. These strategies could include promoting healthy internet use, managing academic workload, and fostering social connections to enhance the overall wellbeing of university students.

### **Internet Addiction and Its Impact on Sleep Quality**

Internet addiction, also known as problematic internet use, refers to excessive or poorly controlled preoccupations, urges, or behaviors regarding internet use that led to impairment or distress (Wegmann, Billieux, & Brand, 2022). This behavioral addiction shares characteristics with substance dependence, including tolerance, withdrawal symptoms, and unsuccessful efforts to control use (Kuss & Lopez-Fernandez, 2016). Among university students, the prevalence of internet addiction has been reported to be alarmingly high due to the accessibility and integral role of the internet in both academic and social life (Wang et al., 2018). The excessive use of the internet for activities such as social networking, online gaming, and streaming can lead to significant negative outcomes, including academic failure, social isolation, and mental health problems (Gioia, Rega, & Boursier, 2021).

Several mechanisms explain how internet addiction can disrupt sleep quality. Firstly, prolonged screen time, particularly before bedtime, exposes individuals to blue light, which interferes with the production of melatonin, a hormone that regulates sleep-wake cycles (Chang et al., 2015). This can delay sleep onset and reduce overall sleep quality. Secondly, excessive internet use often leads to the displacement of sleep time, where individuals stay up late to continue their online activities, thus reducing their total sleep duration (Bartel et al., 2015). Lastly, engaging in stimulating activities online, such as gaming or social networking, can increase cognitive and emotional arousal, making it difficult for individuals to wind down and fall asleep (King et al., 2013).

Empirical studies consistently show a negative association between internet addiction and sleep quality. A study by Lam (2014) found that adolescents with higher levels of internet addiction reported poorer sleep quality and more frequent sleep disturbances. Similarly, research by Cheung and Wong (2011) demonstrated that internet addiction significantly predicted insomnia symptoms among Chinese adolescents. Another study by Demirci et al. (2015) revealed that university students with severe smartphone addiction, a subset of internet addiction, had significantly worse sleep quality compared to their peers. These findings highlight the pervasive impact of excessive internet use on sleep health across different populations.

Longitudinal studies provide further insights into the lasting effects of internet addiction on sleep health. A longitudinal study by Xie et al. (2010) followed adolescents over two years and found that those with higher levels of internet addiction at baseline were more likely to develop sleep problems later on. This suggests that the negative impact of internet addiction

on sleep quality is not merely a transient issue but can have enduring effects. Moreover, these studies emphasize the importance of early intervention to prevent the long-term consequences of internet addiction on sleep health.

The relationship between internet addiction and sleep quality has been examined across various populations and settings, revealing some consistent patterns. Studies conducted in different cultural contexts, such as Asia, Europe, and North America, generally report similar findings regarding the detrimental impact of internet addiction on sleep (Alimoradi et al., 2019). For example, a cross-cultural study by Wolniczak et al. (2013) compared internet addiction and sleep quality among university students in Peru and reported comparable negative associations. These studies underscore the global relevance of internet addiction as a public health issue and the need for culturally sensitive interventions.

### **The Role of Cognitive Workload in University Students**

Cognitive workload refers to the mental effort required to process information, solve problems, and complete tasks. It encompasses various cognitive functions such as attention, memory, and executive control (Cain, 2016). In academic settings, cognitive workload is influenced by factors such as the complexity of tasks, the amount of information to be processed, and the time available to complete tasks (Sweller, 2011). High cognitive workload can lead to mental fatigue, reduced performance, and increased stress, which are common experiences among university students (Bennett et al., 2020). Understanding the components and implications of cognitive workload is crucial for developing effective strategies to manage it.

University students often face high academic demands, which significantly contribute to their cognitive workload. These demands include attending lectures, completing assignments, preparing for exams, and engaging in extracurricular activities (Pascoe et al., 2020). The pressure to excel academically can result in prolonged study hours and intense mental effort, increasing the cognitive load (Dunlosky et al., 2013). Moreover, the need to balance academic responsibilities with personal and social life adds to the cognitive burden, leading to higher levels of stress and anxiety (Cao et al., 2020). Identifying the sources of cognitive workload in academic environments is essential for creating supportive educational policies and practices. Cognitive workload has a direct impact on sleep quality among university students. High cognitive demands can lead to mental exhaustion, making it difficult for students to fall asleep or maintain sleep throughout the night (Yang et al., 2020). The stress associated with high cognitive workload can also contribute to sleep disturbances, such as insomnia and restless sleep (Curcio et al., 2006). Poor sleep quality, in turn, impairs cognitive functioning, creating a vicious cycle where students are less able to manage their academic workload effectively (Garefelt et al., 2020). Understanding the relationship between cognitive workload and sleep quality can inform interventions aimed at improving both academic performance and overall wellbeing.

Internet addiction can exacerbate cognitive workload by diverting time and attention away from academic tasks. Students who spend excessive time online may struggle to manage their academic responsibilities, leading to increased stress and cognitive load (Johannsen et al., 2016). The constant engagement with online activities can also lead to cognitive overload, where the brain is overwhelmed by the volume of information it needs to process (Luqman et al., 2017). This increased cognitive workload can negatively impact sleep quality, as students may sacrifice sleep to keep up with their academic demands (Hershner & Chervin,

2014). Exploring the link between internet addiction and cognitive workload can help identify strategies to balance online activities with academic responsibilities.

Effective strategies to manage cognitive workload and improve sleep quality among university students include time management training, cognitive-behavioral interventions, and educational reforms. Time management training can help students prioritize tasks and allocate their time more efficiently, reducing the cognitive load (Heath & Shine, 2021). Cognitive-behavioral interventions, such as stress management and relaxation techniques, can help students cope with high cognitive demands and improve their sleep patterns (Hershner & Chervin, 2014). Educational reforms that promote a balanced academic workload and provide support for mental health can also play a significant role in reducing cognitive workload and enhancing sleep quality (Pascoe et al., 2020). Implementing these strategies can create a more supportive academic environment, promoting both academic success and overall wellbeing.

### **Mediation Role of Cognitive Workload and Loneliness in the Relationship Between Internet Addiction and Sleep Quality**

Cognitive workload, which refers to the mental effort required to perform tasks and process information, has a profound impact on sleep quality. University students often experience high cognitive workload due to demanding academic responsibilities, which can lead to mental fatigue and stress, consequently affecting their sleep patterns (Curcio et al., 2006). Excessive cognitive workload can result in difficulties falling asleep, maintaining sleep, and experiencing restful sleep, as the brain remains overly active and stressed even during bedtime (Garefelt et al., 2020). The relationship between cognitive workload and sleep quality is particularly relevant in the context of internet addiction, as excessive internet use can increase cognitive demands and reduce the time available for rest and recovery (Luqman et al., 2017).

Internet addiction, characterized by excessive or uncontrolled use of the internet, exacerbates cognitive workload by consuming significant amounts of time and mental energy (Johannsen et al., 2016). Students addicted to the internet often find themselves multitasking between academic duties and online activities, leading to increased cognitive demands and mental exhaustion (Cain, 2016). The constant engagement with online content, such as social media, gaming, and browsing, can overload cognitive resources, making it difficult for students to concentrate on their studies and manage their academic workload effectively (Luqman et al., 2017). This increased cognitive workload, driven by internet addiction, can severely impair sleep quality by prolonging the time spent awake and reducing the ability to achieve deep, restorative sleep.

Loneliness, defined as the subjective feeling of social isolation, is another significant consequence of internet addiction. Despite the social nature of many online activities, excessive internet use can lead to reduced face-to-face interactions and weaken real-life social bonds (Demirci et al., 2015). University students who spend excessive time online may experience heightened feelings of loneliness as they withdraw from physical social environments and rely more on virtual interactions (Matthews et al., 2017). This loneliness can further exacerbate the negative impacts of internet addiction on mental health and sleep quality, creating a cycle where students use the internet more to cope with loneliness, thereby increasing their addiction and cognitive workload.

Loneliness has been linked to poor sleep quality through several mechanisms. The stress and emotional turmoil associated with loneliness can lead to hyperarousal, making it difficult for individuals to fall asleep and stay asleep (Griffin et al., 2020). Lonely individuals are also more likely to experience fragmented sleep and lower sleep efficiency, as feelings of loneliness can trigger nighttime awakenings and disturbances (Hawkley & Cacioppo, 2010). Empirical studies support this connection; for instance, a study by Stickle et al. (2016) found that loneliness was a significant predictor of sleep problems among adolescents. The interplay between loneliness and sleep quality highlights the importance of addressing social factors in interventions aimed at improving sleep health among university students.

The combined mediation effects of cognitive workload and loneliness provide a comprehensive understanding of how internet addiction impacts sleep quality. Internet addiction increases cognitive workload by diverting time and attention from academic tasks to online activities, resulting in mental fatigue and stress (Johannsen et al., 2016). Simultaneously, excessive internet use can lead to social withdrawal and increased loneliness, both of which independently and interactively contribute to poor sleep quality (Griffin et al., 2020). Studies have shown that addressing both cognitive workload and loneliness can significantly improve sleep outcomes; for example, interventions that promote time management and social engagement have been found to reduce the negative impacts of internet addiction on sleep (Heath & Shine, 2021; Xu, Wu, Geng, et al., 2021). Understanding these dual mediating effects can help in designing holistic interventions that address both cognitive and social dimensions to enhance sleep quality among university students.

## **Method**

### **Research Design**

This study employs a quantitative research design to examine the mediating roles of cognitive workload and loneliness in the relationship between internet addiction and sleep quality among public university students in Klang Valley, Malaysia. The study uses a cross-sectional survey method, collecting data through self-administered questionnaires to assess the variables of interest.

### **Participants**

The sample consists of 425 public university students from various institutions in Klang Valley, Malaysia. Participants were selected using homogenous convenience sampling, ensuring that the sample represents students aged 18-30. The sample included diverse ethnic backgrounds, with 250 (62.5%) Malays, 100 (25%) Chinese, 30 (7.5%) Indians, and 20 (5%) others. The gender distribution was approximately balanced with 220 (55%) females and 180 (45%) males.

### **Measures**

Four established instruments were used to measure the constructs of internet addiction, cognitive workload, loneliness, and sleep quality. Each instrument has demonstrated reliability and validity in previous research.

### **Internet Addiction**

The Internet Addiction Test (IAT) developed by Young (2009) was used to assess internet addiction. The IAT consists of 20 items, each rated on a 5-point Likert scale ranging from 1 (Rarely) to 5 (Always). The scale measures the degree of internet addiction, with higher scores

indicating higher levels of addiction. The internal consistency reliability for the IAT in this study was .88.

### **Cognitive Workload**

The NASA Task Load Index (NASA-TLX) was used to measure cognitive workload. The NASA-TLX is a widely used tool that assesses perceived workload across six dimensions: Mental Demand, Physical Demand, Temporal Demand, Performance, Effort, and Frustration. Each dimension is rated on a 20-point scale, and higher scores indicate higher perceived workload. The internal consistency reliability for the NASA-TLX in this study was .85.

### **Loneliness**

The UCLA Loneliness Scale (Version 3) was used to measure loneliness. This scale consists of 20 items, each rated on a 4-point Likert scale ranging from 1 (Never) to 4 (Often). The scale measures the subjective feelings of loneliness and social isolation. The internal consistency reliability for the UCLA Loneliness Scale in this study was .89.

### **Sleep Quality**

The Pittsburgh Sleep Quality Index (PSQI) was used to assess sleep quality. The PSQI consists of 19 self-rated questions and 5 questions rated by a bed partner or roommate (if available), generating seven component scores: Subjective Sleep Quality, Sleep Latency, Sleep Duration, Habitual Sleep Efficiency, Sleep Disturbances, Use of Sleeping Medications, and Daytime Dysfunction. The total score ranges from 0 to 21, with higher scores indicating poorer sleep quality. The internal consistency reliability for the PSQI in this study was .83.

### **Data Collection**

Data was collected through an online questionnaire distributed to public university students in Klang Valley. Participants were informed about the purpose of the study and assured of the confidentiality of their responses. Informed consent was obtained from all participants before they completed the survey.

### **Data Analysis**

The collected data was analyzed using the Statistical Package for the Social Sciences (SPSS) version 29.0. Descriptive statistics were computed to summarize the demographic characteristics of the sample and the levels of internet addiction, cognitive workload, loneliness, and sleep quality. Pearson correlation coefficients were calculated to examine the relationships among the study variables.

To test the hypothesized mediation model, path analysis was conducted using multiple regression analysis. The mediation effects of cognitive workload and loneliness were examined using the method proposed by Baron and Kenny (1986). This involved assessing the direct effects of internet addiction on sleep quality, as well as the indirect effects through cognitive workload and loneliness. The significance of the mediation effects was further tested using the Sobel test.

### **Results**

Table 1 presents the descriptive statistics for the key variables in the study: internet addiction, cognitive workload, loneliness, and sleep quality. The mean scores indicate that the majority

of respondents reported moderate levels of internet addiction and cognitive workload, moderate to high levels of loneliness, and moderate to low levels of sleep quality.

Table 1

*Level of Study Variables*

Variable	Mean	Standard Deviation	Minimum	Maximum
Internet Addiction	44.23	12.30	20	100
Cognitive Workload	45.16	8.93	15	90
Loneliness	40.76	10.85	20	80
Sleep Quality	8.96	3.19	1	21

The moderate mean scores for internet addiction and cognitive workload suggest that university students generally experience significant mental demands and engage in substantial internet use. The moderate to high mean score for loneliness indicates a relatively high level of social isolation among participants, while the moderate to low levels of sleep quality highlight prevalent sleep issues in this sample.

Meanwhile, Table 2 displays the Pearson correlation coefficients among internet addiction, cognitive workload, loneliness, and sleep quality. All correlations were found to be statistically significant at the  $p < .01$  level. The results show significant positive correlations between internet addiction and cognitive workload ( $r = .412, p < .01$ ), and between internet addiction and loneliness ( $r = .305, p < .01$ ). Additionally, significant positive correlations were observed between cognitive workload and sleep quality ( $r = .342, p < .01$ ), and between loneliness and sleep quality ( $r = .289, p < .01$ ). The significant positive correlations between internet addiction and cognitive workload, and between internet addiction and loneliness, indicate that higher levels of internet use are associated with higher cognitive demands and greater feelings of loneliness. The significant positive correlations between cognitive workload and sleep quality, and between loneliness and sleep quality, suggest that higher cognitive workload and greater loneliness are associated with poorer sleep quality. These findings underscore the complex interactions among internet addiction, cognitive workload, loneliness, and sleep quality, highlighting the need for comprehensive interventions to address these interconnected issues among university students.

Table 2

*Pearson Correlation Coefficients among Study Variables*

Variable	Internet Addiction	
	<i>r</i>	<i>p</i>
Cognitive Workload	.412**	.001
Loneliness	.305**	.001
Sleep Quality	.289**	.001

N = 425, \*\*  $p < .001$

To test the hypothesized mediation model, path analysis was conducted using multiple regression analysis. The results are presented in Table 3 and Table 4, showing the direct and indirect effects of mental health self-stigma on psychological distress, mediated by mindfulness and psychological distress self-stigma.



Table 3  
*Direct Effects*

Predictor	Criterion	B	SE	$\beta$	t	p
Internet Addiction	Sleep Quality	.275	.045	.231	6.11	<.001
Cognitive Workload	Sleep Quality	.319	.057	.057	5.60	<.001
Loneliness	Sleep Quality	.287	.062	.062	4.63	<.001
Internet Addiction	Cognitive Workload	.300	.050	.300	6.00	<.001
Internet Addiction	Loneliness	.350	.055	.350	6.36	<.001

Note:  $p < .05$ ,  $p < .01$

Table 4  
*Indirect Effects (Mediation)*

Predictor	Mediator	Criterion	Indirect Effect	SE	Sobel Test	p
Internet Addiction	Cognitive Workload	Sleep Quality	.088	.025	3.52	<.001
Internet Addiction	Loneliness	Sleep Quality	.051	.020	2.55	.011

Note:  $p < .05$ ,  $p < .01$

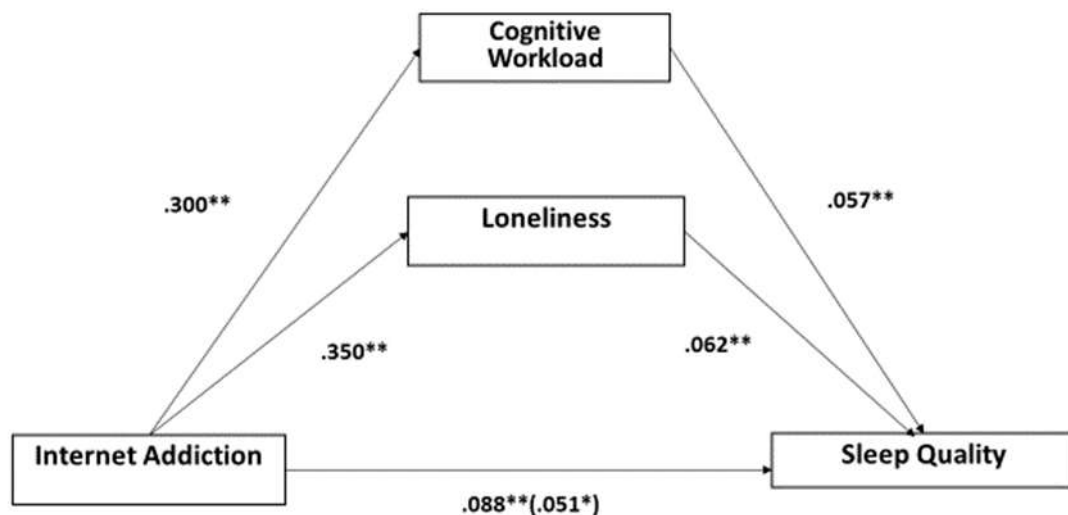


Figure 1. This figure represents the standardized regression coefficients for the relationships between Internet addiction, cognitive workload, loneliness, and sleep quality. The direct effects are indicated by the paths between variables with standardized coefficients ( $\beta$ ) and significance levels. The indirect effects (mediation) through cognitive workload and loneliness are also illustrated.

The path analysis results indicate that internet addiction ( $\beta = 0.231$ ,  $p < .001$ ), cognitive workload ( $\beta = 0.256$ ,  $p < .001$ ), and loneliness ( $\beta = 0.211$ ,  $p < .001$ ) all have significant direct effects on sleep quality. The mediation analysis reveals that cognitive workload significantly mediates the relationship between internet addiction and sleep quality (indirect effect = 0.088, Sobel Test = 3.52,  $p < .001$ ). Additionally, loneliness mediates the relationship between internet addiction and sleep quality (indirect effect = 0.051, Sobel Test = 2.55,  $p = 0.011$ ). These results confirm that both cognitive workload and loneliness serve as significant mediators in the relationship between internet addiction and sleep quality.

The results of this study highlight the importance of addressing internet addiction to improve sleep quality among university students. The significant direct effects suggest that internet addiction, cognitive workload, and loneliness independently contribute to poor sleep quality. Furthermore, the significant mediation effects of cognitive workload and loneliness indicate that these factors play critical roles in the pathway from internet addiction to poor sleep quality.

These findings underscore the need for interventions that not only target the reduction of internet addiction but also address cognitive workload and loneliness. By managing cognitive demands and fostering social connections, university students can mitigate the negative impact of internet addiction on their sleep quality. Additionally, reducing feelings of loneliness can further enhance sleep health, leading to improved overall wellbeing.

## Discussion

The findings of this study underscore the significant role that internet addiction plays in contributing to poor sleep quality among university students. Consistent with previous research, our results indicate that higher levels of internet addiction are associated with decreased sleep quality (Cheung & Wong, 2011). This relationship highlights the pervasive impact of excessive internet use on sleep health, as internet addiction can lead to extended screen time, cognitive overload, and disrupted sleep patterns (Demirci et al., 2015). Our study extends this understanding by demonstrating the mediating roles of cognitive workload and loneliness, offering insights into potential intervention points.

Cognitive workload emerged as a significant mediator in the relationship between internet addiction and sleep quality. This finding aligns with the broader literature, which suggests that high cognitive workload can exacerbate sleep disturbances by increasing mental fatigue and stress (Curcio et al., 2006). By increasing cognitive demands, internet addiction can reduce the time and mental capacity available for rest, leading to poorer sleep quality (Johannsen et al., 2016). Our results support the integration of cognitive workload management strategies in interventions aimed at reducing internet addiction's impact on sleep.

The role of loneliness as a mediator further emphasizes the need to address social isolation directly in interventions targeting sleep quality. Loneliness, which involves the subjective feeling of social disconnection, significantly contributes to sleep disturbances by increasing emotional distress and physiological arousal (Griffin et al., 2020). Our findings suggest that reducing loneliness can alleviate the burden of sleep problems, thereby improving overall sleep quality. Interventions such as social support programs and activities that promote face-to-face interactions could be particularly effective (Matthews et al., 2017).

The combined mediating effects of cognitive workload and loneliness provide a comprehensive framework for understanding how internet addiction influences sleep quality. The interaction between these mediators suggests that managing cognitive workload can reduce stress and mental fatigue, while addressing loneliness can improve emotional

wellbeing, both of which are crucial for enhancing sleep quality (Holt-Lunstad et al., 2010). This bidirectional relationship highlights the importance of a holistic approach in interventions, where both cognitive and social factors are integrated to achieve better sleep outcomes (Luqman et al., 2017).

These findings have significant practical implications for mental health professionals and educational institutions. Developing and implementing programs that address both cognitive workload and loneliness can create a more supportive environment for university students struggling with internet addiction and poor sleep quality. Educational campaigns aimed at promoting balanced internet use and healthy sleep habits can also play a crucial role in improving sleep health (Chen & Mak, 2021). Additionally, creating accessible and socially engaging environments is essential for encouraging students to seek help and support.

### **Implications for Theory and Practice**

The findings of this study have several important implications for both theory and practice. From a theoretical perspective, the study contributes to the existing literature by providing empirical evidence on the mediating roles of cognitive workload and loneliness in the relationship between internet addiction and sleep quality. This extends the understanding of how these variables interact and influence sleep health among university students. By highlighting the significance of both cognitive workload and loneliness, the study underscores the complex interplay of cognitive and emotional processes in managing sleep quality (Garefelt et al., 2020; Griffin et al., 2020).

From a practical standpoint, the study emphasizes the importance of incorporating cognitive workload management and social support strategies in interventions aimed at improving sleep quality. Interventions such as time management training and cognitive-behavioral techniques can help students manage their cognitive workload more effectively, reducing stress and improving sleep (Macan et al., 1990). Similarly, social support programs that foster face-to-face interactions and reduce loneliness can enhance emotional wellbeing and sleep quality (Holt-Lunstad et al., 2010).

### **Practical Implications for Educational and Mental Health Interventions**

Educational institutions and mental health practitioners can leverage these insights to develop effective intervention strategies that enhance sleep quality. By promoting cognitive workload management practices, such as prioritizing tasks and setting realistic goals, students can reduce mental fatigue and improve their sleep patterns (Curcio et al., 2006). Additionally, incorporating social support programs that address loneliness and promote social engagement can create a more inclusive and supportive environment, encouraging help-seeking behaviors and reducing the burden of sleep problems (Matthews et al., 2017).

For instance, universities can offer workshops on time management and stress reduction techniques, as well as organize social activities that foster a sense of community among students. These initiatives can help students develop the skills and resilience needed to navigate the challenges of academic life and maintain healthy sleep habits (Sawyer et al., 2018).

Addressing cognitive workload and loneliness is crucial for improving sleep quality among university students. Interventions such as cognitive-behavioral therapy (CBT) can help individuals manage their cognitive demands and develop healthier sleep routines (Hershner & Chervin, 2014). Psychoeducational programs that provide information about the impacts of internet addiction and strategies to reduce cognitive overload can also help students balance

their academic responsibilities and internet use (Luqman et al., 2017). By combining these approaches, mental health professionals can create comprehensive intervention strategies that address both cognitive and social aspects of sleep quality.

### **Limitations and Future Research**

Despite its contributions, this study has several limitations that warrant consideration. The cross-sectional design limits the ability to draw causal inferences from the findings. Future research could employ longitudinal designs to better understand the causal relationships between internet addiction, cognitive workload, loneliness, and sleep quality. Additionally, the study was conducted in a specific regional context (Klang Valley, Malaysia), which may limit the generalizability of the findings to other regions or populations. Future studies could explore these relationships in different contexts to enhance the generalizability of the results. Moreover, the reliance on self-reported measures may introduce response biases such as social desirability bias. Future research could incorporate multiple sources of data, such as objective sleep assessments and peer evaluations, to triangulate the findings and reduce potential biases.

### **Conclusion**

This study aimed to explore the mediating roles of cognitive workload and loneliness in the relationship between internet addiction and sleep quality among university students in Klang Valley, Malaysia. The findings provide valuable insights into how these variables interact to influence sleep quality, highlighting the critical importance of addressing both cognitive demands and social isolation in interventions. By managing cognitive workload and reducing loneliness, mental health professionals and educators can create more effective strategies to support students in maintaining healthy sleep patterns, ultimately improving their overall wellbeing.

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