Original Article

Problematic Internet Use, Mental Health, and Sleep Quality among Medical Students: A Path-Analytic Model

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ABSTRACT

Background: There is a close association between problematic Internet use (PIU), sleep quality, and mental health problems. To evaluate which mental health problem is more associated with coexistence of both PIU and poor sleep quality, we hypothesized a model in which PIU influences sleep quality directly and also through the mediation of three different mental health problems. **Methods:** A total of 402 medical students completed the Persian versions of the Internet Addiction Test, 21-item Depression Anxiety Stress Scale, and Pittsburgh Sleep Quality Index. A maximum likelihood structural equation model was used to assess the hypothesis. For assessment of the indirect effects, bootstrapping was conducted. **Results:** PIU predicted poor sleep quality through indirect pathways by the mediation of mental health problems ($P < 0.001$). Poor sleep quality were associated with depressive symptoms ($P < 0.001$), anxiety ($P = 0.035$), and stress ($P < 0.001$); however, the direct pathways from stress and anxiety to poor sleep quality were not statistically significant ($P > 0.05$). **Conclusion:** Findings extend our previous knowledge about the interrelationships between PIU, sleep disturbances, and mental health problems by unveiling the key role of depressive symptoms.

Key words: *Internet, Iran, medical students, mental health, sleep*

Key messages: *Depressive symptoms are the most prevalent mental health problems in co-occurrence of both problematic Internet use and poor sleep quality among medical students. The critical point to prevent poor sleep quality as a consequence of problematic Internet use and mental health problems is to prevent depressive symptoms.*

The Internet has become an essential and inseparable part of the modern lifestyle. However, "problematic behavior of human interactions with information and communication technologies" has made it a long-term concern.[1] The term "Internet addiction," which is defined as "a psychological dependence on the internet, regardless of the type of activity once

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logged on," describes this problematic behavior.[2] The prevalence of problematic internet use (PIU) varies from 0.8% to 26.7% in different populations, with higher prevalence in adolescents and young adults.[3] Even in developing countries like Iran, the prevalence of 10.8%–28.7% has been reported in medical students.[4-6]

The negative impact of PIU on both sleep duration and sleep quality is shown in the literature.[7] PIU leads to irregular sleep patterns and excessive day-time sleepiness,[8,9] and those with PIU experience more sleep disturbances.[10] Those with PIU are 1.7 times more likely to experience poor sleep quality in comparison to those with non-PIU.[11]

PIU is one of the influential factors predicting psychiatric and psychosocial problems.[12] According to a longitudinal study, in those with PIU, in comparison to those with non-PIU, the risk of developing depressive symptoms is about 2.5 times higher.[13] PIU also increases the risk of anxiety and stress.[14] Adolescents and young adults with PIU are more susceptible to develop symptoms of depression and anxiety.[14]

In addition, different mental health problems such as depressive symptoms,[15,16] anxiety,[1] and stress[17] can separately account for negative sleep outcomes. In more than 70% of people suffering from both insomnia and anxiety, poor mental health anteceded the onset of insomnia.[18] Besides, adolescents and young adults are more prone to both mental health and sleep problems.[17,19]

Study aims and hypotheses

We hypothesized a model in which different mental health problems, including depression, anxiety, and stress, lead to poor sleep quality. PIU influences sleep quality not only through the direct pathway but also through the mediation of mental health problems. In other words, we assessed the direct and indirect influences of PIU on sleep quality through the mediators of the three mental health problems (depression, anxiety, and stress). This study was done to evaluate which of the three mental health problems is more associated with the coexistence of PIU and poor sleep quality.

Because the health of the community is influenced by medical students' health, consequent to their important role in the health system in the early future, assessment of the relationship between PIU, mental health, and sleep quality may yield new information leading to better planning of preventive services for this group.

METHODS

Participants

A cross-sectional study was conducted from May to August 2018. The study population was the first- to the seventh-year medical students of Shiraz University of Medical Sciences, where a total of 1,568 students were studying general medicine at the time of the study. To obtain adequate sample size for conducting the structural equation modeling,[20] near one-third of the whole group of medical students were selected to participate in the study. The sampling population was stratified into three educational levels of basic sciences, physiopathology, and clinical stage. Then, sampling was done using a random number table, based on the student identification number, in proportion to the size of each educational level.

A total of 487 medical students were asked to participate in the study. After being informed about the study, 67 students refused to participate. After applying the exclusion criteria, 18 students were excluded from the study, leaving the final sample of 402 students. This study was approved by the ethics committee of Shiraz University of Medical Sciences, and all participants provided written informed consent while completing the questionnaires.

Exclusion criteria

Participants who had one of the following criteria were excluded:

A. Students who did not answer more than three questions (four students)
B. Students who did not answer one of the first to fourth questions of the Pittsburgh Sleep Quality Index (PSQI) (14 students).

Because each of the first to four questions of the PSQI has a basic role in creating the domains of the global sleep quality, criterion B was defined to prevent data misanalysis.

Measures

Problematic Internet use

PIU was assessed using the Internet Addiction Test (IAT).[21] The Persian version of the IAT, which is a validated and reliable questionnaire, was used in this study.[22,23] IAT includes 20 questions that are scored on a 5-point Likert scale ranging from 1 (rarely) to 5 (always). These scores are summed to calculate the final global score, which ranges from 20 to 100. A higher global score represents more problematic internet behavior. Moreover, Mohammadsalehi *et al*. showed that the Persian version of the questionnaire can be divided into three reflecting factors, including personal activities disorder (PAD), emotional and mood

disorder (EMD), and social activities disorder (SAD), with good discriminant validity between the items of different factors and high convergent validity among the items in each factor.[23] Thus, we considered the PIU as a latent factor consisting of PAD, EMD, and SAD as the observed variables. In accordance with the suggestions of Alavi *et al*., a total score of 46 was considered as the PIU cut-off point.[22]

Mental health

The Depression Anxiety Stress Scale (DASS-21) is able to differentiate between symptoms of different mental health problems.[24] The questionnaire includes three subscales of depression, anxiety, and stress, each one being assessed by seven items (21 items in total). Response options range from 0 (did not apply to me at all) to 3 (applied to me very much), and higher scores indicate poorer mental health on their particular dimensions. Scores of each subscale must be doubled because the DASS-21 is the short form of the 42-item questionnaire.[24] Because DASS-21 assesses the mental health problems during the previous week, sleeping behaviors do not confound the information yielded by the questionnaire, and it prevents the conceptual overlap with the sleep quality scale. In this study, the Persian version of the DASS-21 was used to measure the different aspects of mental health problems.[25] As suggested by Samani and Jokar on the basis of the Lovibond and Lovibond's study,[24] we classified the participants into three levels for each subscale of depression (normal: scores 0–9, moderate: scores 10–20, and severe: scores 21–42), anxiety (normal: scores 0–7, moderate: scores 8–14, and severe: scores 15–42), and stress (normal: scores 0–14, moderate: scores 15–25, and severe: scores 26–42).[25]

Sleep quality

The PSQI[26] is a 19-item questionnaire which is used to assess different "domains" of the global sleep quality, including sleep duration, sleep latency, habitual sleep efficiency, sleep disturbances, sleeping medications, day-time dysfunction, and subjective sleep quality. In each domain, scores range from 0 to 3. The final global score varies from 0 to 21 and is calculated by the summations of the scores of these seven domains. A higher global score represents a poorer sleep quality. Acceptable validity and reliability of the Persian version of the PSQI, which was used in this study, has been previously shown.[27] We considered the total score of 6 as a cut-off point to identify the participants with poor sleep quality.[27]

Background variables

Participants were asked about their age, sex, whether living in a dormitory or not, marital status, and educational level: basic sciences, physiopathology, or clinical stage. In the corresponding university, medical students study basic sciences such as physiology, anatomy, and pathology during the first 30 months of university admission (basic sciences level). In the second level, which lasts 12 months, students learn the physiopathology of internal diseases as well as the pediatric and gynecologic diseases (physiopathology level). It is then followed by clinical stage, which lasts 42 months. In this level, besides a daily visit of patients, the students must fulfill at least seven 24-h hospital shifts in each month as a standby doctor.

Statistical analysis

First, we calculated descriptive statistics of the sample characteristics. The total score of each questionnaire among the participants based on demographic characteristics was compared using Mann–Whitney *U*-test or Kruskal–Wallis test. Pearson's correlation coefficient was used for assessing the correlation between each pair of continuous variables. We used Chi-square test to compare the prevalence of all main variables among different demographic groups. This test was also used to evaluate the prevalence of mental health problems and poor sleep quality on the basis of whether a student is a problematic Internet user or not.

Durbin–Watson test was used to evaluate the autocorrelation in residual before the conduction of structural equation modeling. The test acceptance level is for the values of 1.5–2.5. Multivariate normality assumption on residuals was evaluated by normal P-P plot of regression standardized residual. Cook's distance index was used for data screening if there were an outlier or influential. The values of less than 1 were considered for acceptance level of the index. Multicollinearity of predictor variables was evaluated by variance inflation factor (VIF), with the values of less than 3 as the acceptance level.

Using a maximum likelihood structural equation model, we assessed the hypothesis that three indicators of PAD, EMD, and SAD represent the PIU as a latent factor. PIU then predicts poor sleep quality directly and also with the mediation of different mental health problems. To evaluate how well the hypothesized model fits the observed data, we used Chi-square test (χ^2), root mean square error of approximation (RMSEA), and goodness-of-fit index (GFI). Because of the dependency of χ^2 *P* value on sample size, minimum discrepancy divided by its degrees of freedom (CMIN/DF) was calculated to solve this problem. To correct the effects of the number of indicators of latent variables on GFI, adjusted goodness-of-fit index (AGFI) was used. We also used the comparative fit index (CFI), normed fit index (NFI), and non-normed fit index (NNFI) as incremental fit tests to assess the relative position of

the model between the worst fit to the perfect fit. After ensuring the model fit, for assessment of the indirect effects, we conducted bootstrapping, which provides accurate results.[28,29] Finally, to establish the mediatory role of mental health problems, the model was run by rotatory deletion of each mental health variable. RMSEA <0.07, CMIN/DF <2, χ^2 *P* value >0.05, GFI >0.95, AGFI >0.95, CFI >0.95, NFI >0.95, and NNFI >0.95 were considered for acceptance of the model fit.[30] All the analysis was performed by SPSS Statistics and SPSS Amos version 24.

RESULTS

Descriptive and comparative information

Half of the participants (50.3%) were female. Most of the students were single (93.5%) and living in a dormitory (62.8%). Their mean age (±standard deviation) was 22.4 (±2.18) years. About 44% were studying at the basic science level, 15.5% at pathophysiology, and 40.5% at the clinical stage. PIU was present in 38.6% of the participants, and 40% experienced poor sleep quality. Moderate to severe levels of mental health problems were documented in 48.8% of the participants for depression, 50.5% for anxiety, and 48% for stress. Higher rates of poor sleep quality (49% vs. 34.4%, $P = 0.004$), depression (69% vs. 36%, $P < 0.001$), anxiety (67.7% vs. 39.7%, $P < 0.001$), and stress (66.5% vs. 36.4%, $P < 0.001$) were documented in those with PIU. Chi-square test revealed statistically significant higher prevalence of depression (51% vs. 19.2%, $P = 0.007$) and stress (50.4% vs. 19.2%, $P = 0.007$) among the single students. Statistically significant higher prevalence of poor sleep quality was also seen among the students living in a dormitory (46.2% vs. 29.5%, $P = 0.001$).

Table 1 shows the results of Mann–Whitney *U*-test and Kruskal–Wallis test. The stress scores of basic science students were significantly higher than those of the clinical students ($P = 0.005$). The PSQI scores of clinical students were significantly higher than those of both the basic science ($P = 0.004$) and the pathophysiology ($P = 0.031$) students. In addition, the IAT scores of basic science students were higher than those of both the pathophysiology ($P = 0.011$) and the clinical ($P = 0.013$) students. The correlation matrix of variables is shown in Table 2.

The results confirmed the applicability of structural equation modeling. Durbin–Watson test value was 1.9, and residuals were normally distributed. The residual mean was 0, and the standardized residuals were scattered between −2.7 and +2.9. The maximum Cook's distance index was 0.04, and the maximum VIF was 2.6.

Predictive model

The hypothesized model did not fit the data [Table 3]. Modification indices of the software suggested that all the different mental health problems are probably connected to each other in a direct pathway. Accordingly, based on the literature, three direct pathways were added to the model.[31-34] The second model exhibited significant improvement in model fit indices [Table 3]. The results of bootstrapping clarified the different relationship pathways between the variables [Table 4]. As shown in Figure 1, PIU is directly and positively connected to each of the mental health problems. PIU also predicts poor sleep quality only through the indirect pathways by the mediation of mental health problems. All the mental health problems are totally associated with one another and poor sleep quality; however, the direct pathways from stress and anxiety to poor sleep quality were not statistically significant.

DISCUSSION

This study reestimated the prevalence of PIU, mental health problems, and poor sleep quality in Iran. In

Table 1: Mean score±standard deviation of each questionnaire based on the background variables

Background variable / Questionnaire	Sex		Married		Dormitory		Educational Level		
	Male	Female	Yes	No	Yes	No	B.S	P	C
Depression score	11.40±8.74	10.85±10.11	6.08±7.05	11.44±9.48	11.53±9.63	10.05±8.83	11.40±8.85	13.19±11.68	9.91±8.95
	0.158		0.002*		0.152			0.138	
Anxiety score	8.72±7.31	8.82±7.96	6.46±7.09	8.96±7.64	9.21±7.91	7.86±7.17	9.49±7.46	8.74±8.38	7.93±7.45
	0.781		0.071		0.098			0.078	
Stress score	14.51±8.72	15.05±9.60	10.31±7.93	15.07±9.15	15.24±9.27	13.74±8.92	15.91±8.80	14.77±10.34	13.29±8.91
	0.581		0.009*		0.106			0.022*	
PSQI score	6.09±3.22	6.24±3.60	6.27±3.52	6.19±3.46	6.69±3.66	5.35±2.93	5.75±3.25	5.74±3.62	6.77±3.53
	0.940		0.769		<0.001*			0.008*	
IAT score	44.98±13.86	43.41±12.95	42.69±15.91	44.40±13.27	44.75±13.30	43.33±13.84	46.26±13.36	41.58±13.28	42.85±13.27
	0.351		0.332		0.228			0.009*	

B.S – Basic sciences; P – Physiopathology; C – Clinical; PSQI – Pittsburgh sleep quality index; IAT – Internet addiction test. Doubled score of each subscale of DASS-21 is shown in the table; *P* of each Mann-Whitney *U*-test or Kruskal-Wallis test is shown beneath the mean scores. *Significant *P*

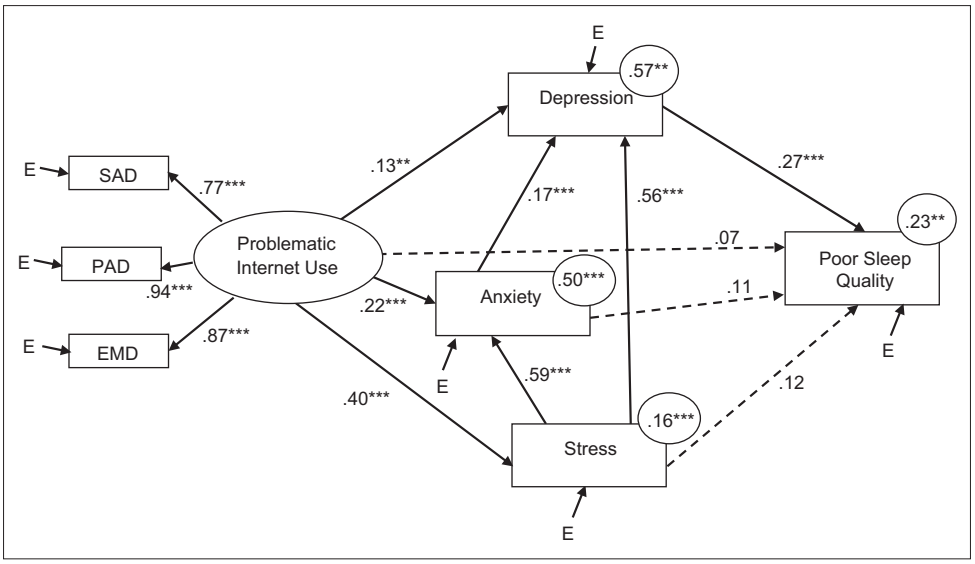

Figure 1: The final model of problematic Internet use to poor sleep quality. Squared multiple correlations (R^2) are presented in circles; standardized regression weights are presented on vectors; E – Error; SAD – Social activities disorder; PAD – Personal activities disorder; EMD – Emotional and mood disorder; **P* < 0.05; ***P* < 0.01; ****P* < 0.001

Table 2: Descriptive statistics and correlation matrix of observed variables

Variable	M	SD	1.	2.	3.	4.	5.	6.
1. Personal activities disorder	23.60	7.73						
2. Emotional and mood disorder	13.32	4.18	0.80					
3. Social activities disorder	7.24	2.60	0.72	0.67				
4. Depression	11.07	9.42	0.41	0.36	0.29			
5. Anxiety	8.74	7.61	0.43	0.40	0.30	0.61		
6. Stress	14.67	9.15	0.37	0.34	0.27	0.73	0.67	
7. Poor sleep quality	6.16	3.45	0.27	0.21	0.22	0.45	0.38	0.41

M – Mean; SD – Standard deviation. All correlations are significant at *P*<0.01

Table 3: Model fit indices

Index	First model	Second model
χ^2 *P*	<0.001	0.56
CMIN/DF	38.88	0.85
RMSEA	0.31	<0.001
GFI	0.75	0.99
AGFI	0.37	0.98
CFI	0.72	>0.999
NFI	0.72	0.99
NNFI	0.47	>0.999

χ^2, Chi-square; CMIN/DF – Minimum discrepancy divided by its degrees of freedom; RMSEA – Root mean square error of approximation; GFI – Goodness-of-fit index; AGFI – Adjusted goodness-of-fit index; CFI – Comparative fit index; NFI – Normed fit index; NNFI – Non-normed fit index

addition, this is the first study on the effects of PIU on both mental health and sleep quality simultaneously. The prevalence of PIU in this study (38.6%) was considerably higher than that found in the previous studies.[35,36] Even similar studies among Iranian medical students had reported a prevalence of PIU up to 30%.[4-6] The prevalence of poor sleep quality in our study was about 10% more than what was reported in Chinese adolescents from Hong Kong (40% vs. 30.7%).[35] The higher prevalence of poor sleep quality in our study might be attributed to the higher prevalence of PIU. Surprisingly, with a lower prevalence of PIU (17.2%) in Tan *et al*.'s research, the prevalence of depression (54.4%) and poor sleep quality (40%) in that study was similar to that of our study.[36] The difference might be due to different patterns of PIU between these two populations. Nevertheless, the increasing rate of PIU and consequently its negative outcomes now have turned an important issue which needs special attention by not only the health system but also the whole society.

We also found that being male or female makes no difference in susceptibility to PIU, poor sleep quality, or different mental health problems. But students living in dormitory experienced more sleep disturbances, and single participants suffered from stress and depression more than the married ones. Higher rates of stress and PIU were observed in the basic science students; this might be due to maladaptation to a new lifestyle not experienced before. In addition, poorer sleep quality in clinical students is probably due to multiple and long hospital shifts as a standby doctor.

This study provides support to the hypothesis that PIU is directly related to each of the mental health problems. In our model, total correlations between PIU and each of the mental health problems did not exceed 0.5, which was similar to the results of previous studies.[37-39] Moreover, the total correlation between PIU and poor sleep quality was lower than that. These

Table 4: Results of bootstrapping: Standardized regression weights

Variable	Total effect				
	1.	2.	3.	4.	5.
1. Problematic Internet use		0.40***	0.45***	0.44***	0.28***
2. Stress			0.59***	0.66***	0.36***
3. Anxiety	0.23***			0.17***	0.15*
4. Depression	0.30***	0.10***			0.27***
5. Poor sleep quality	0.21***	0.24***	0.05***		
	Indirect effect				

*$P<0.05$; **$P<0.01$; ***$P<0.001$

amounts of correlations between these variables show that a noticeable proportion of the experience of the mental health problems and sleep quality cannot be explained by PIU alone; however, the role of PIU in the existence of both mental health problems and poor sleep quality cannot be ignored. In other words, it is a clue indicating that there should be more fundamental variables that come before and predicts the coexistence of all the PIU, mental health problems, and poor sleep quality. An example of such a variable is well-demonstrated in a large population-based study in Singapore where "impulsivity" was reported as a risk factor of pathological gaming and mental health problems.[40]

The results also revealed that PIU and different mental health problems predicted poor sleep quality positively. Previously, studies had indicated a close association between PIU and poor sleep quality,[7-11] and also between mental health problems and sleep quality.[15-17] Nonetheless, the mediatory role of the mental health problems between PIU and sleep quality is less discussed in the literature. This study represents that PIU is related to poor sleep quality through the full mediation of mental health problems. Previously, Cheung and Wong claimed that PIU does not affect sleep duration.[35] On the other hand, it seems that sleep duration is the most important domain of sleep quality which is disturbed among medical students. This might be the reason why, in our model, PIU is not related to poor sleep quality in a direct pathway.

In addition, according to Cheung and Wong, PIU does not have a simple direct impact on sleep quality; rather, it may be through a psychological process.[35] Interestingly, stepwise backward deletion of variables in our models revealed that only in the absence of both depression and anxiety, PIU is directly related to sleep quality. According to Yuan *et al*., in those with PIU, abnormal metabolism rate in specific brain regions (basal ganglia) can trigger symptoms of depression and anxiety.[41] Besides, poor sleep quality is associated with reduced serotonergic function in basal ganglia.[42] It seems that depressive and anxiety symptoms are the said psychological process that links PIU and poor sleep quality.

Our results were somehow different from Tan *et al*.'s who showed that depressive symptoms partially mediated the association between PIU and sleep problems.[36] This again reminds that the pattern of being a problematic internet user was probably different in that study. Probably, different factors predispose medical and nonmedical students to PIU. As an example, the use of Internet-based mobile applications for learning diagnostic and treatment algorithms as well as the use of medical calculators is too prevalent among medical students.[43] Even so, the high percentage of the association (70.6%) between PIU and sleep quality through the indirect pathway (by the mediation of depressive symptoms) in that research suggests that basically the process of being a problematic Internet user in medical students has overlaps with that of the other population. Similarly, we found out that both anxiety and stress can lead to the experience of sleep disturbance only by full mediation of depressive symptoms.

In our model, the direct correlation between PIU and depression was less than half of its total effect (0.13 vs. 0.44). This means that the indirect pathways between PIU and depression via the mediation of anxiety and stress are more probable pathways than the direct one. These results imply that when people suffer from depressive symptoms as a consequence of PIU, they probably suffer from other mental health problems too. Moreover, comparison of the direct effect between depression and sleep quality separately (0.45) and in the model (0.27) connotes that when depression is a consequence of PIU and other mental health problems, it has less correlation to poor sleep quality. This explains why all PIU and mental health problems can only predict 23% of poor sleep quality changes, while more than half of the depressive symptom changes (57%) are predicted by its previous variables in the model. All these findings suggest that the relationship between these variables is more complicated than has been thought and it necessitates conducting longitudinal studies to better understand these complex relationships.

Limitation

Although DASS-21 evaluates the symptoms of mental health problems in a standard manner, it is a self-reported questionnaire, and consequently lacks a clinical evaluation component for mental health problems. In addition, because this was a cross-sectional study, it does not have the temporal criterion for the causal pathway. In this study, we localized the variables in a simple model only on a lead-lag relationship based on the literature. Accordingly, to discover fundamental

variables and to clarify their complex relationships, longitudinal research is recommended.

CONCLUSION

Besides the high rates of co-occurrence of PIU, different mental health problems, and poor sleep quality among medical students, the findings extend our previous knowledge about the interrelationships between these abnormal human activities and behaviors by unveiling the key role of depressive symptoms. Therefore, the critical point to prevent insomnia and sleep disturbance as a consequence of PIU and mental health problems is to prevent depressive symptoms.

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Conflicts of interest
There are no conflicts of interest.

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