

Problematic internet use and sleep quality in adolescents with major depressive disorder

Çağla Çelikkol Sadiç, Hacer Gizem Gerçek, Aziz Kara & Yekta Özkan

To cite this article: Çağla Çelikkol Sadiç, Hacer Gizem Gerçek, Aziz Kara & Yekta Özkan (2023) Problematic internet use and sleep quality in adolescents with major depressive disorder, Chronobiology International, 40:8, 1049-1058, DOI: [10.1080/07420528.2023.2249557](https://doi.org/10.1080/07420528.2023.2249557)

To link to this article: <https://doi.org/10.1080/07420528.2023.2249557>



Published online: 28 Aug 2023.



Submit your article to this journal [↗](#)



Article views: 64



View related articles [↗](#)



View Crossmark data [↗](#)

ORIGINAL ARTICLE



Problematic internet use and sleep quality in adolescents with major depressive disorder

Çağla Çelikkol Sadiç , Hacer Gizem Gerçek , Aziz Kara , and Yekta Özkan 

Department of Child and Adolescent Psychiatry, Afyonkarahisar Health Sciences University Faculty of Medicine, Afyonkarahisar, Turkey

ABSTRACT

This study aims to compare adolescents newly diagnosed with major depressive disorder (MDD) and healthy controls in terms of problematic internet use (PIU) and sleep quality. The study sample consisted of 50 newly diagnosed MDD patients aged 12–18 years and 50 healthy controls. Schedule for Affective Disorders and Schizophrenia for School-Age Children–Present and Lifetime Version (K-SADS-PL) was administered to all cases by a child psychiatrist and sociodemographic data were collected. Children’s Depression Inventory (CDI), Pittsburgh Sleep Quality Index (PSQI), and Internet Addiction Test (IAT) were administered to all participants. Data of the MDD and control groups were compared using Student’s t-test or Mann-Whitney U test and the total scores of the IAT ($z = -6.23$, $p < 0.001$) and PSQI ($t = -11.42$, $p < 0.001$) scales were found to be significantly higher in MDD cases compared to the control group. The results of analysis of covariance demonstrated that there was a significant positive correlation between CDI and IAT, as well as CDI and PSQI total scores in patients with MDD. While no correlation was observed between the total scores of the IAT and PSQI scales in the MDD group, a significant positive correlation was found between the total scores of the IAT and PSQI scales in the healthy control group. Furthermore, there was a significant difference between the PSQI habitual sleep efficiency subscale score and the IAT total score ($r = 0.36$, $p = 0.009$), and the IAT responsibility ($r = 0.34$, $p = 0.015$), relationship ($r = 0.36$, $p = 0.01$), and mood subscale scores ($r = 0.30$, $p = 0.03$). A significant positive correlation was also found between the IAT duration subscale score and PSQI sleep disorder subscale score ($r = 0.35$, $p = 0.013$). In addition, binary logistic regression analysis showed that PSQI total score ($B = 0.79$, $p < 0.001$) and IAT total scores ($B = 0.08$, $p = 0.001$) could be significant predictors of MDD. The findings of this study indicate that the prevalence of PIU and poor sleep quality is higher in adolescents with newly diagnosed MDD compared to healthy controls. The results of our study indicated that the severity of depression, PIU, and sleep quality were significantly correlated in adolescents with newly diagnosed MDD, while PIU and sleep quality were correlated in adolescents without any psychiatric disorders. In addition, this study suggests that poor sleep quality and PIU may be risk factors for MDD.

ARTICLE HISTORY

Received 24 February 2023
Revised 1 May 2023
Accepted 14 August 2023

KEYWORDS

Adolescents; major depressive disorder; problematic internet use; sleep quality; depression

Introduction

Today, the internet and various social networks are used in many fields such as communication, exchanging information, entertainment, and education, and internet use is becoming more and more widespread each day (Aparicio-Martínez et al. 2020; Wang et al. 2011). It has been reported that internet use has risen significantly in the last decade, especially among adolescents (Lenhart et al. 2010). This dramatic increase in internet use has also raised concerns that internet use may pose a disadvantage on the lives of internet users (Tan et al. 2016; Wang et al. 2011). Although the Internet plays a role in many aspects of life and is easily accessible, excessive and uncontrolled use of the Internet may negatively

affect the person’s functionality, bringing the term “problematic Internet use” (PIU) to the foreground (Shapira et al. 2003; Young 2004). It has been reported that PIU leads to psychological, social, educational, and/or professional difficulties in a person’s life (Wang et al. 2011). At PIU, people who are unable to control their Internet use experience distress and have functional problems with daily activities (Shapira et al. 2003). Adolescence, which is characterized by being a time of intense psychological maturation and change, represents a group that is susceptible to internet overuse and, consequently, PIU (Marin et al. 2021). In addition, adolescents are very active online and the internet plays a big role in their lives because they can access it from

a variety of devices at anytime, anywhere, and in any situation (Kokka et al. 2021). Studies on PIU in adolescents have shown that the rates of PIU generally vary between 1% and 10% (Durkee et al. 2012; Restrepo et al. 2020). Studies have reported that there may be a relationship between PIU and one or more mental disorders (Demirci et al. 2015; Dong et al. 2011). According to studies, PIU is strongly linked to depressive symptoms in adolescents, and those who participate in PIU are more likely to experience psychological disorders like depression (Tan et al. 2016).

As the prevalence of major depressive disorder (MDD) is 2% in children and 4–8% in adolescents and has been reported to increase after adolescence (Birmaher et al. 2007), adolescence is an important period for focusing on depressive symptoms. While it has been reported that multiple factors may play a role in the pathogenesis of depressive disorder, it is difficult to fully explain the pathophysiology of depression (Hasler 2010). Nonetheless, some studies report that PIU may be a factor in increasing the risk of depressive disorder (Chen et al. 2022; Donnelly and Kuss 2016; Lam and Peng 2010). There are some cross-sectional studies that have found a higher rate of PIU in patients with MDD (Alpaslan et al. 2016; Onat et al. 2019). There are many studies in the literature on depression and PIU; however, the nature and causality of the relationship between these two conditions is not fully understood (Tan et al. 2016).

Although it is known that a significant portion of children and adolescents have sleep problems, these problems constitute a serious health problem in adolescents since sleep problems can significantly affect the adolescent's quality of life (Bhargava 2011; Owens et al. 2014; Reiter and Rosen 2014). Sleep problems are known to be an important risk factor for the development of depressive disorder (Baglioni et al. 2011; Ehlers et al. 1988). At the same time, it is known that a significant proportion of adolescents with depressive disorder have complaints regarding sleep (Urrila et al. 2012). A 2018 systematic review involving college students or young adults noted that the relationship between depressive disorder and sleep problems is complex and bidirectional. It is thought that approaches to improve sleep quality will have a significant effect on reducing depressive symptoms (Dinis and Bragança 2018).

It has been reported that exposure to the blue light component emitted by the Light-Emitting Diodes (LED) in screens has a significant effect on circadian rhythm and sleep in adolescents with PIU, as it can delay and slow down the secretion of melatonin, which may lead to reduced sleep duration or delay in the sleep time (Chang

et al. 2015; Touitou et al. 2016). According to one systematic review, PIU may affect the sleep cycle and cause sleep problems such as insomnia and poor sleep quality (Lam 2014). Furthermore, studies have also shown that PIU may lead to delayed sleep and excessive daytime sleepiness (Choi et al. 2009; Van den Bulck 2004).

As noted above, sleep, depression, and PIU are significantly intertwined. However, it has been suggested that the coexistence of depression and PIU may have different effects on sleep quality and may affect each other dynamically and at different rates (Cheung and Wong 2011; Park et al. 2018). As far as we know, there is no study comparing the IAT subscale scores and PSQI subscale scores of adolescents diagnosed with depression after a structured interview by a child psychiatrist with a healthy control group. This study aims to compare adolescents with newly diagnosed MDD with a healthy control group in terms of sleep quality and PIU and to examine the association with depression severity. We hypothesized the following: (1) rates of PIU and poor sleep quality will be higher in the MDD group compared to the control group; (2) the relationship between PIU and poor sleep quality will differ between the MDD group and control groups; and (3) PIU and poor sleep quality will be significantly associated with depressive symptom severity. In this context, when we examine the bilateral relationship between sleep and depression, a significant interaction may be observed.

Material and methods

This study was designed as a single-center, cross-sectional study. Patients who applied to the Afyonkarahisar Health Sciences University Faculty of Medicine, Child and Adolescent Psychiatry outpatient clinic between May 2022 and November 2022 and met the inclusion and exclusion criteria were included in the study. Fifty adolescents aged 12–18 years, who were administered K-SADS-PL by a child psychiatrist (Ç.Ç.S.) and were diagnosed with MDD according to DSM-5 diagnostic criteria were included in the MDD group. The adolescents included in this group were newly diagnosed with MDD, did not receive psychiatric medication, and demonstrated clinically normal intelligence. Exclusion criteria were as follows: presence of accompanying psychopathologies, use of any psychotropic medication, clinical mental retardation, active suicidal ideation, and chronic medical/neurological disorders requiring treatment (eg epilepsy, diabetes, etc.).

The control group consisted of 50 adolescents of similar age and gender who applied to our outpatient clinic with various complaints (routine checkup or counseling for issues such as puberty, school, friendship problems) who were evaluated with K-SADS-PL, did not have any past or present psychiatric disorders, did not have any chronic medical disorders (diabetes mellitus, hypertension, rheumatic and immunological diseases, epilepsy and genetic disorders) and accepted to participate in the study.

After the diagnostic evaluation of the participants who met inclusion criteria, the participants were informed about the research. After oral and written informed consent was obtained from the adolescents and their parents, scales and tests were administered. All participants were assessed using the Schedule for Affective Disorders and Schizophrenia for School-Age Children-Present and Lifetime Version (K-SADS-PL), Children's Depression Inventory (CDI), Pittsburgh Sleep Quality Index (PSQI), and Internet Addiction Test (IAT).

Of the 99 adolescents who presented with depressive symptoms between May – November 2022, 65 adolescents with MDD were included in the study. Nineteen adolescents did not meet the MDD diagnosis, 4 adolescents who did not consent to study participation, and 11 adolescents who were using psychotropic drugs were excluded from the study. Upon evaluation, 15 of the adolescents with MDD were excluded due to comorbidities. As a result, 50 adolescents were included in the MDD study group.

The post hoc power analysis revealed an effect size of 0.71 and a power of 0.94 with an alpha of 0.05.

Ethics approval

Study procedures were performed in accordance with the Declaration of Helsinki. The study received ethics approval from Afyonkarahisar Health Sciences University Faculty of Medicine ethics committee (date: 13.05.2022, ethics committee no. 2022/303).

Data collection tools

Sociodemographic and clinical data form

This form was prepared by the researchers and consisted of questions regarding demographic and clinical characteristics of the adolescents and parents such as age, gender, educational status, family structure, and history of psychiatric disorders.

Schedule for Affective Disorders and Schizophrenia for school-age children-Present and Lifetime version (K-SADS-PL)

A semi-structured interview form prepared by Kauffman et al. to examine current and lifetime psychopathology in children and adolescents aged 6–18 years (Kaufman et al. 1997). In terms of screening scores and diagnosis, intra-observer agreement was found to be 93–100%. The kappa coefficient for test-retest reliability ranges between 0.63–1.00 for various diagnoses. Turkish validity and reliability studies for this interview form have been performed by Gökler et al (Gökler et al. 2004).

Children's Depression Inventory (CDI)

CDI is a 27-item self-assessment scale that can be administered to children aged 6–17. Each item is given 0, 1, or 2 points according to the severity of symptoms. The highest score of the scale is 54 and the higher the scale score, the higher the severity of depression. The cut-off score has been suggested as 19. Turkish validity and reliability studies were performed by Öy et al. The test-retest reliability of the scale was 0.80, and the internal consistency coefficient Cronbach alpha was 0.77 (Kovacs 1985; Oy 1991).

Internet Addiction Test (IAT)

IAT is a 20-item scale developed by Young et al. by adapting the DSM-IV's "Pathological Gambling" criteria and is used to determine the level of internet addiction. Normal internet use between 20–49 points and possible problematic internet use over 50 points were determined as cut-off points for the total IAT score (Young 1998). In the IAT, the participants are asked to mark how often they experience certain situations on a six-point Likert-type scale graded from "never" to "always." Higher scores indicate an increased severity of internet addiction. The validity and reliability study of the Turkish adaptation of the IAT was conducted, and a four-factor (mood, relationship, responsibilities, duration) model of the IAT was developed (Bayraktar 2001; Kaya et al. 2016). The Turkish adaptation of the scale was developed by Bayraktar (2001). In Bayraktar's (2001) study, the Cronbach Alpha internal consistency coefficient was found to be as 0.91 and the Spearman-Brown value as 0.87 (Bayraktar 2001).

Pittsburgh Sleep Quality Index (PSQI)

PSQI was developed in 1989 to assess sleep quality (Buysse et al. 1989). The test includes 24 items under 10 main components to measure sleep quality in the last month, consisting of: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medication, and daytime

dysfunction. Subjective sleep quality is scored with question #6, sleep latency with questions #2 and #5a, sleep duration with inverse scoring of question #4 (how much they slept in the past month), habitual sleep efficiency by dividing the score of question #4 with the amount of time spent in bed multiplied by 100 and inverting the score, sleep disturbances with questions #5b-5j, use of sleeping medication with question #7, and daytime dysfunction with questions #8 and #9 (Buysse et al. 1989). Each component is scored between 0–3 points, and the sum of the component scores yields a global score in which maximum score is 21 points; a score greater than 5 indicates poor sleep quality. The Turkish validity and reliability studies for the PSQI were conducted by Ağargün et al. The Cronbach alpha coefficient of the scale was given as 0.80 (Agargun 1996).

Statistical analysis

Data obtained in the study were statistically analyzed using the SPSS 26.0 (Statistical Package for the Social Sciences) program. The demographic characteristics of the sample were analyzed using descriptive statistics. Shapiro – Wilk test were used to determine normality distribution of the variables. Data of the MDD and control groups were compared according to distributed characteristics using Student's t-test or Mann-Whitney U test. Pearson correlation test was used to assess parametric values and Spearman correlation test for non-parametric data to determine the correlation between variables. For the multivariate analysis, the possible factors identified with univariate analyses were further entered into the binary logistic regression analysis to determine independent predictors of MDD. The significance value was accepted as $p < 0.05$ with a 95% confidence interval.

Results

Sociodemographic data

In our study, there was no difference between the groups in terms of age ($z = -0.590$, $p = 0.555$), gender ($\chi^2 = 2.30$, $p = 0.123$), maternal age ($t = 1.224$, $p = 0.224$),

maternal education level ($\chi^2 = 3.315$, $p = 0.346$), paternal age ($t = 1.085$, $p = 0.281$) and paternal education level ($\chi^2 = 5.245$, $p = 0.155$). According to analyses it was determined that presence of history of psychiatric disorders in the family was statistically significantly higher in the MDD group than in the control group ($\chi^2 = 13.279$, $p < 0.001$).

Children's depression inventory results

CDI scores were found to be significantly higher in the MDD group compared to the control group ($z = -8.624$, $p < 0.001$).

Internet addiction test results

According to IAT total score cut-off value, 26 of the total participants had PIU, and %96.15 of the participants with PIU were in the MDD group. The total IAT score ($z = -6.238$, $p < 0.001$), mood ($z = -6.258$, $p < 0.001$), duration ($z = -5.602$, $p < 0.001$), responsibilities ($z = -4.358$, $p < 0.001$), relationship ($z = -5.861$, $p < 0.001$) subscale scores were found to be significantly higher in the group diagnosed with major depression compared to the control group. The IAT total scores and subscale scores of MDD cases and healthy controls are presented in Table 1.

Pittsburgh sleep quality index results

According to PSQI, 65 of the total participants had poor sleep quality, and 72.3% of the participants with poor sleep quality were in the MDD group. According to the analyses of both groups, there was a significant difference between the groups in terms of PSQI total score ($t = -11.420$, $p < 0.001$) and PSQI subscale scores of sleep quality ($z = -7.26$, $p < 0.001$), sleep latency ($z = -5.709$, $p < 0.001$), sleep duration ($z = -5.326$, $p < 0.001$), habitual sleep efficiency ($z = 4.391$, $p < 0.001$), sleep disturbance ($z = 5.843$, $p < 0.001$) and daytime dysfunction ($z = -6.274$, $p < 0.001$). It was determined that there was no significant difference between the two groups in terms of the PSQI subscale score

Table 1. Distribution of IAT total and subscale scores of the MDD group and control group.

IAT	MDD (n = 50)	Control (n = 50)	z	p
Mood	18.4 ± 1.084	7.64 ± 0.899	-6.258	<0.001
Duration	8.88 ± 0.49	4.558 ± 0.430	-5.602	<0.001
Responsibilities	7.8 ± 0.634	4.1 ± 0.41	-4.358	<0.001
Relationship	12.3 ± 0.74	5.9 ± 0.51	-5.861	<0.001
IAT Total	47.46 ± 2.56	22.24 ± 2.09	-6.238	<0.001

Mann Whitney-U test; MDD: Major Depressive Disorder; IAT: Internet Addiction Test.

Table 2. Distribution of PSQI subscale scores in MDD cases and healthy controls.

PSQI	MDD (n = 50)	Control (n = 50)	t/z	p
Subjective Sleep Quality	1.94 ± 0.096	0.76 ± 0.073	-7.261 ^b	<0.001
Sleep Latency	1.98 ± 0.126	0.84 ± 0.104	-5.709 ^b	<0.001
Sleep Duration	1.54 ± 0.51	0.4 ± 0.0947	-5.326 ^b	<0.001
Habitual Sleep Efficiency	0.76 ± 0.155	0.04 ± 0.027	-4.391 ^b	<0.001
Sleep Disturbances	1.94 ± 0.096	1.1 ± 0.071	-5.843 ^b	<0.001
Use of Sleeping Medication	0.00 ± 0.00	0.00 ± 0.00	0.000 ^b	1.000
Daytime Dysfunction	2.02 ± 0.116	0.7 ± 0.115	-6.274 ^b	<0.001
PSQI Total	10.26 ± 3.32	3.84 ± 2.17	-11.42 ^a	<0.001

^aIndependent Samples t-test; ^bMann-Whitney U Test; MDD: Major Depressive Disorder; PSQI: Pittsburgh Sleep Quality Index

regarding the use of sleep medication ($z = 0.000$, $p = 1.000$). The distribution of PSQI subscale scores of the MDD cases and healthy controls is presented in Table 2. The distribution of total scores of CDI, IAT, and PSQI in patients with MDD and healthy controls is presented in Figure 1.

Spearman's rank correlation was applied to MDD cases to evaluate whether there was a correlation between CDI total score, IAT, and PSQI total scores and subscale scores. According to the results, a significant positive correlation was determined between CDI and IAT total scores ($r = 0.294$, $p = 0.038$), CDI and PSQI total scores ($r = 0.287$, $p = 0.043$), CDI and PSQI daytime dysfunction subscale score ($r = 0.289$, $p = 0.04$), and between CDI and PSQI sleep disturbances subscale scores ($r = 0.426$, $p = 0.002$). A significant positive correlation was found between

PSQI habitual sleep efficiency subscale score and IAT total score ($r = 0.365$, $p = 0.009$), IAT responsibility ($r = 0.343$, $p = 0.015$), IAT relationship ($r = 0.362$, $p = 0.01$), and IAT mood subscale scores ($r = 0.307$, $p = 0.03$). A significant positive correlation was found between the IAT duration subscale score and the PSQI sleep disturbances subscale score ($r = 0.35$, $p = 0.013$). No correlation was found between the IAT total score and the PSQI total score ($r = 0.216$, $p = 0.131$). No correlation was found between other variables. Results of the analyses are presented in Table 3.

Spearman's rank correlation was also applied to healthy control subjects to evaluate whether there was a correlation between IAT and PSQI total scores and subscale scores. According to the analysis, IAT total score was positively correlated with PSQI total score ($r = 0.395$, $p = 0.005$) and PSQI daytime dysfunction ($r = 0.28$, $p = 0.042$), sleep

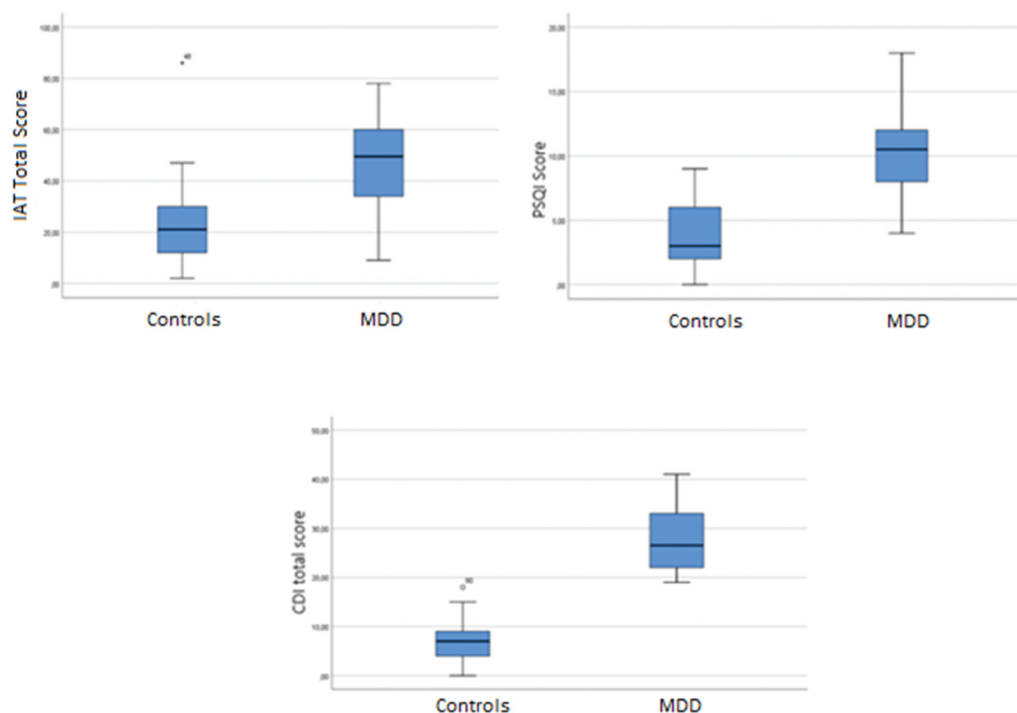
**Figure 1.** Distribution of total scores of CDI, IAT, and PSQI in patients with MDD and healthy controls.

Table 3. Distribution of correlation between IAT, PSQI total scores, subscale scores, and CDI total scores in MDD cases.

	PSQI		Daytime Dysfunction		Use of Sleep Medication		Sleep Disturbances		Habitual Sleep Efficiency		Sleep Duration		Sleep Latency		Subjective Sleep Quality		CDI	
	r	p	r	p	r	p	r	p	r	p	r	p	r	p	r	p	r	p
IAT total	0.216	0.131	0.091	0.52	-	-	0.238	0.096	0.365	0.009	0.18	0.205	0.103	0.476	0.124	0.39	0.294	0.038
IAT responsibility	0.239	0.094	0.095	0.512	-	-	0.101	0.486	0.343	0.015	0.17	0.22	0.11	0.431	0.201	0.162	0.245	0.08
IAT relationship	0.256	0.072	0.232	0.105	-	-	0.116	0.421	0.362	0.01	0.24	0.087	0.046	0.749	0.073	0.616	0.191	0.185
IAT duration	0.006	0.96	0.087	0.54	-	-	0.35	0.013	0.11	0.44	0.17	0.904	0.046	0.751	0.44	0.759	0.235	0.1
IAT mood	0.19	0.183	0.003	0.983	-	-	0.273	0.055	0.307	0.03	0.16	0.24	0.13	0.34	0.17	0.22	0.26	0.06
CDI	0.287	0.043	0.289	0.04	-	-	0.426	0.002	0.061	0.675	0.169	0.24	0.93	0.523	0.084	0.563	1	-

Spearman's correlation; CDI: Children's Depression Inventory, PSQI: Pittsburgh Sleep Quality Index, IAT: Internet Addiction Test.

latency ($r = 0.32$, $p = 0.02$), and subjective sleep quality subscores ($r = 0.317$, $p = 0.02$). A positive correlation was found between the IAT mood subscale score and PSQI total score ($r = 0.354$, $p = 0.012$) and PSQI sleep latency subscale score ($r = 0.351$, $p = 0.012$). A positive correlation was found between the IAT duration subscale score and the PSQI total score ($r = 0.565$, $p < 0.001$), PSQI daytime dysfunction ($r = 0.458$, $p = 0.001$), sleep duration ($r = 0.481$, $p < 0.001$), sleep latency ($r = 0.345$, $p = 0.014$), and subjective sleep quality subscale scores ($r = 0.358$, $p = 0.011$). A positive correlation was found between the IAT responsibility subscale and the PSQI sleep latency scores ($r = 0.322$, $p = 0.023$) and subjective sleep quality subscale scores ($r = 0.305$, $p = 0.03$). A positive correlation was found between the IAT relationship subscale score and the PSQI total score ($r = 0.399$, $p = 0.004$) and daytime dysfunction subscale score ($r = 0.343$, $p = 0.015$). No correlation was found between other variables. The results are presented in Table 4.

The contribution of PSQI and IAT total scores to the explanation of MDD was assessed with binary logistic regression analysis (Table 5). This analysis showed that PSQI total score ($B = 0.79$, $p < 0.001$) and IAT total scores ($B = 0.08$, $p = 0.001$) could be significant predictors of MDD.

Discussion

The results of our study demonstrate that adolescents with newly diagnosed MDD have significantly higher rates of problematic internet use (PIU) and poor sleep quality compared to healthy controls. It was determined that both PIU and poor sleep quality positively correlated with the severity of depression in adolescents with MDD. However, no correlation was found between the IAT and PSQI total scores in the MDD group, while a significant positive correlation was found between the IAT subscale scores and some of the PSQI subscale scores. Contrary to the MDD group, a significant positive correlation was found between the IAT and PSQI total scores in the healthy group, and a significant positive correlation was also found between IAT subscale scores and some of the PSQI subscale scores. In addition, after the regression analysis, it was determined that PSQI total score and IAT total scores could be significant predictors of MDD.

A significant association between depressive disorder and PIU was observed, consistent with the results of other studies on adolescents (Alpaslan et al. 2016; Ko et al. 2014; Lam and Peng 2010; Tokunaga 2017). In addition, after the regression analysis, it was determined that PIU could significantly predict MDD. This study

Table 4. Distribution of correlation between IAT and PSQI subscale scores in healthy subjects.

	PSQI		Daytime Dysfunction		Use of Sleeping Medication		Sleep Disturbances		Habitual Sleep Efficiency		Sleep Duration		Sleep Latency		Subjective Sleep Quality	
	r	p	r	p	r	p	r	p	r	p	r	p	r	p	r	p
IAT Total	0.395	0.005	0.28	0.042	-	-	0.09	0.532	0.11	0.4	0.21	0.12	0.32	0.02	0.317	0.02
IAT Mood	0.354	0.012	0.248	0.82	-	-	-0.04	0.775	0.174	0.22	0.195	0.175	0.351	0.012	0.26	0.06
IAT Duration	0.565	<0.001	0.458	0.001	-	-	0.089	0.558	0.121	0.402	0.481	<0.001	0.345	0.014	0.358	0.011
IAT Responsibility	0.263	0.65	0.162	0.260	-	-	0.097	0.501	0.029	0.84	0.32	0.82	0.322	0.023	0.305	0.03
IAT Relationship	0.399	0.004	0.343	0.015	-	-	0.196	0.173	0.025	0.86	0.259	0.069	0.200	0.164	0.275	0.053

Spearman's correlation; CDI: Children's Depression Inventory, PSQI: Pittsburgh Sleep Quality Index, IAT: Internet Addiction Test.

Table 5. Binary logistic regression analysis results for the prediction of PSQI and IAT total scores on MDD.

	Coefficient	Standard error	Wald	p-value	Odds ratio (95% CI)	Cox & Snell R2
PSQI	0.792	0.183	18.76	<0.001	2.208 (1.543–3.161)	0.617
IAT	0.083	0.025	10.858	0.001	1.086(1.034–1.141)	

PSQI: Pittsburgh Sleep Quality Index, IAT: Internet Addiction Test.

suggests that PIU may be a risk factor for MDD. A recent study conducted using a self-report scale reported that PIU is a risk factor for depressive disorder. It was also stated that PIU weakens social relations, increasing feelings of loneliness, and may therefore cause an increase in depressive symptoms (Chen et al. 2022). In addition, it has been reported that PIU may decrease the academic performance of adolescents and may increase arguments with their parents (Ko et al. 2014; Tan et al. 2016; Yen et al. 2007). In the light of this information, perhaps adolescents with depressive disorder can have a more positive mood by better regulating their internet use in daily life (Alpaslan et al. 2016). Since PIU may lead to risk of depressive symptoms and vice versa, effective treatment of depression in adolescents and/or reducing the time spent on the internet by establishing a screening program for the early diagnosis of PIU may prevent this situation from becoming a “vicious cycle,” forming an important strategy for adolescent mental health (Alpaslan et al. 2016; Lam and Peng 2010).

The results of our study indicated that the rate of poor sleep quality was significantly higher in adolescents in the MDD group compared to the control group. Similarly, previous studies have shown an association between poor sleep quality and depression in the adolescent group (Li et al. 2018; Onat et al. 2019). In addition, after the regression analysis, it was determined that poor sleep quality could significantly predict MDD. This study suggests that poor sleep quality may be a risk factor for MDD. In a study of 166 adolescents aged 12–18 years diagnosed with MDD, sleep disturbance was found to be significantly associated with adolescent depressive disorder, with better individual sleep quality being associated with better treatment response in adolescents with depression (Manglick et al. 2013). In a recent observational study in adolescents, it was found that depressive symptoms were significantly reduced when recommendations were made to increase sleep hygiene to improve sleep quality and to gradually increase sleep duration (Dewald-Kaufmann et al. 2014). Poor sleep quality is known to be associated with several psychiatric disorders, including depression (de Zambotti et al. 2018). These findings suggest that the treatment of sleep-related problems may be significant in terms of preventing and facilitating the treatment of some psychiatric disorders, especially MDD, in adolescence.

The results of our study showed that there was a positive correlation between PIU and poor sleep quality in the healthy group, but there was no significant relationship between these two conditions in the MDD group. Similarly, in a study conducted with a sample

consisting of 766 adolescents aged 12–17 years in 2018, no significant relationship could be observed between PIU and sleep problems, as well as decreased rates of excessive daytime sleepiness in the patient group diagnosed with depressive disorder. In the control group, it was observed that sleep-wake behavior problems, insomnia, and excessive daytime sleepiness increased as PIU increased. Although the reason for this finding cannot be precisely determined considering the cross-sectional nature of the study, it was suggested that the diagnosis of depression plays a regulating role in sleep problems in the presence of concomitant depressive disorder and PIU (Park et al. 2018). In another study which evaluated depression, insomnia, and internet addiction in 719 middle school students, it was found that insomnia and internet addiction affected depression, furthermore, the coexistence of sleeping problems and internet addiction was high, and they can affect each other dynamically and at different rates (Cheung and Wong 2011); while PIU has an indirect effect on depression at a rate of 5% when sleeping problems is a mediator, while the indirect effect of insomnia on depression is 12% when PIU is a mediator, suggesting that PIU is a more effective mediator. In addition, a study that evaluated depression, internet use, and sleep problems in 1772 adolescents, it was shown that the indirect effect of PIU on sleep quality (when depression is a mediator) was more than twice the direct effect of PIU on sleep quality (Tan et al. 2016). This finding leads us to believe that depression plays a more effective role on sleep quality than PIU, indicating that there is a complex and multifaceted interaction between PIU and poor sleep quality in both adolescent patients with MDD and healthy controls.

In this study, the PSQI habitual sleep efficiency subscale score was found to be positively associated with the IAT total score, the IAT mood, relationship, and responsibility subscale scores, and the PSQI sleep disturbance subscale score was positively associated with the IAT duration subscale score in the MDD group. According to the evaluation of PSQI scores in the MDD group, PIU was positively associated with the PSQI habitual sleep efficiency subscale scores. This suggests that as PIU increases, total sleep time may decrease, and/or the time spent in bed may increase. According to these findings, the increase in negative emotions and behaviors of adolescents with PIU (i.e. feeling angry, frustrated when not on the internet, finding life without internet boring, etc.), the increase in online communication (i.e. the desire to spend time on the Internet instead of being with friends, having more new relationships on the Internet, etc.), and the nonfulfillment of duties/

responsibilities (i.e. school attendance, daily household chores etc.) may lead to a decrease in total sleep time and/or an increase in time spent in bed. It was observed that PSQI sleep disturbances subscale scores were positively associated with the IAT duration subscale scores; this finding suggests that sleeping disorders may be positively associated with the duration of internet use in adolescents. To the best of our knowledge, there is no study comparing the IAT subscale scores and PSQI subscale scores in adolescents with newly diagnosed MDD and healthy control groups, who were evaluated by a child psychiatrist using K-SADS-PL.

In a study conducted, first-year high school adolescents were evaluated with self-report questionnaires and it was found that the adolescent's sleep duration decreased as the time spent online increased and this finding was indirectly related to the severity of depressive symptoms (Wang et al. 2021). In a study by Choi et al. in which sleep and internet use were evaluated in 2336 high school students, it was shown that PIU was strongly associated with excessive daytime sleepiness, and sleeping problems increased as PIU increased (Choi et al. 2009). A study by Bulck et al. included 2546 adolescents and it was found that adolescents with PIU were more tired, went to bed later, and spent less time in bed (Van den Bulck 2004). In a study of 4747 university students in which psychiatric problems, including depression, and sleep quality were evaluated, it was reported that excessive screen time was positively associated with depression and poor sleep quality (Wu et al. 2015). Studies suggest that excessive exposure to screen light with PIU may lead to a reduced sleep time and poor sleep quality (Choi et al. 2009; Sukanuma et al. 2007). This information may lead us to believe that further studies are needed to understand the potential effect and interactions of PIU in adolescents with and without MDD diagnosis.

The cross-sectional nature and the small sample size constitute the limitations of our study. Therefore, we believe that this study should be replicated with larger samples. In addition, another limitation of our study was the use of self-report scales to measure PIU and sleep quality. Furthermore, the mental capacities of adolescents could be evaluated with objective intelligence tests. The strengths of our study comprised of examination of the patient and control groups by a pediatric psychiatrist, the administration of K-SADS-PL to both groups, the formation of a patient group newly diagnosed with major depressive disorder (MDD), and the exclusion of comorbidities and psychiatric drug use.

Conclusion

The findings of our study demonstrate that PIU and poor sleep quality are more prevalent in adolescents with newly diagnosed MDD compared to healthy controls. In addition, this study suggests that poor sleep quality and PIU may be risk factors for MDD. The results of our study indicated that the severity of depression, PIU, and sleep quality were significantly correlated in adolescents with newly diagnosed MDD, while PIU and sleep quality were correlated in adolescents without any psychiatric disorders. However, this study demonstrates that the relationship between PIU and sleep quality manifests differently in depressed and non-depressed groups. This suggests that there is a complex and multifaceted interaction between PIU and sleep quality in adolescents with MDD as well as healthy adolescents.

Acknowledgments

The authors wish to thank the patients and families who participated in this study.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

The author(s) reported there is no funding associated with the work featured in this article.

ORCID

Çağla Çelikkol Sadiç  <http://orcid.org/0000-0001-6153-301X>

Hacer Gizem Gerçek  <http://orcid.org/0000-0002-0786-0826>

Aziz Kara  <http://orcid.org/0000-0003-0925-5723>

Yekta Özkan  <http://orcid.org/0000-0003-2220-9967>

References

- Agargun M. 1996. Pittsburgh uyku kalitesi indeksinin geçerliliği ve güvenilirliği. *Türk Psikiyatr Derg.* 7:107–115.
- Alpaslan AH, Soyulu N, Kocak U, Guzel HI. 2016. Problematic internet use was more common in Turkish adolescents with major depressive disorders than controls. *Acta Paediatr.* 105:695–700. doi:10.1111/apa.13355.
- Aparicio-Martínez P, Ruiz-Rubio M, Perea-Moreno A-J, Martínez-Jiménez MP, Pagliari C, Redel-Macías MD, Vaquero-Abellán M. 2020. Gender differences in the addiction to social networks in the Southern Spanish university students. *Telemat Inform.* 46:101304. doi:10.1016/j.tele.2019.101304.

- Baglioni C, Battagliese G, Feige B, Spiegelhalder K, Nissen C, Voderholzer U, Lombardo C, Riemann D. 2011. Insomnia as a predictor of depression: a meta-analytic evaluation of longitudinal epidemiological studies. *J Affect Disord.* 135:10–19. doi:10.1016/j.jad.2011.01.011.
- Bayraktar F. (2001). "Role in the development of adolescent use of the internet." Ege University, Institute of Social Science, Department Of Psychology, Master Thesis, İzmir
- Bhargava S. 2011. Diagnosis and management of common sleep problems in children. *Pediatr Rev.* 32:91–99. doi:10.1542/pir.32.3.91.
- Birmaher B, Brent D, AACAP Work Group on Quality Issues. 2007. Practice parameter for the assessment and treatment of children and adolescents with depressive disorders. *J Am Acad Child Psy.* 46:1503–1526. doi:10.1097/chi.0b013e318145ae1c.
- Buysse DJ, Reynolds CF III, Monk TH, Berman SR, Kupfer DJ. 1989. The Pittsburgh sleep quality Index: a new instrument for psychiatric practice and research. *Psychiatry Res.* 28:193–213. doi:10.1016/0165-1781(89)90047-4.
- Chang A-M, Aeschbach D, Duffy JF, Czeisler CA. 2015. Evening use of light-emitting eReaders negatively affects sleep, circadian timing, and next-morning alertness. *Proc Natl Acad Sci.* 112:1232–1237. doi:10.1073/pnas.1418490112.
- Chen Y, Liu X, Chiu DT, Li Y, Mi B, Zhang Y, Ma L, Yan H. 2022. Problematic social media use and depressive outcomes among college students in China: observational and experimental findings. *Int J Env Res Pub He.* 19:4937. doi:10.3390/ijerph19094937.
- Cheung LM, Wong WS. 2011. The effects of insomnia and internet addiction on depression in Hong Kong Chinese adolescents: an exploratory cross-sectional analysis. *J Sleep Res.* 20:311–317. doi:10.1111/j.1365-2869.2010.00883.x.
- Choi K, Son H, Park M, Han J, Kim K, Lee B, Gwak H. 2009. Internet overuse and excessive daytime sleepiness in adolescents. *Psychiatry Clin Neurosci.* 63:455–462. doi:10.1111/j.1440-1819.2009.01925.x.
- Demirci K, Akgönül M, Akpınar A. 2015. Relationship of smartphone use severity with sleep quality, depression, and anxiety in university students. *J Behav Addict.* 4:85–92. doi:10.1556/2006.4.2015.010.
- Dewald-Kaufmann JF, Oort F, Meijer A. 2014. The effects of sleep extension and sleep hygiene advice on sleep and depressive symptoms in adolescents: a randomized controlled trial. *J Child Psychol Psychiatry.* 55:273–283. doi:10.1111/jcpp.12157.
- de Zambotti M, Goldstone A, Colrain IM, Baker FC. 2018. Insomnia disorder in adolescence: diagnosis, impact, and treatment. *Sleep Med Rev.* 39:12–24. doi:10.1016/j.smrv.2017.06.009.
- Dinis J, Bragança M. 2018. Quality of sleep and depression in college students: a systematic review. *Sleep Sci.* 11:290. doi:10.5935/1984-0063.20180045.
- Dong G, Lu Q, Zhou H, Zhao X, Miles J. 2011. Precursor or sequela: pathological disorders in people with internet addiction disorder. *PloS One.* 6:e14703. doi:10.1371/journal.pone.0014703.
- Donnelly E, Kuss D. 2016. Depression among users of social networking sites (SNSs): the role of SNS addiction and increased usage. *J Addict Preventive Med.* 1:107.
- Durkee T, Kaess M, Carli V, Parzer P, Wasserman C, Floderus B, Apter A, Balazs J, Barzilay S, Bobes J. 2012. Prevalence of pathological internet use among adolescents in Europe: demographic and social factors. *Addiction.* 107:2210–2222. doi:10.1111/j.1360-0443.2012.03946.x.
- Ehlers CL, Frank E, Kupfer DJ. 1988. Social zeitgebers and biological rhythms: a unified approach to understanding the etiology of depression. *Arch Gen Psychiatry.* 45:948–952. doi:10.1001/archpsyc.1988.01800340076012.
- Gökler B, Unal F, Pehlivan Türk B. 2004. Okul çağı çocukları için Duygulanım Bozuklukları ve Şizofreni Görüşme Çizelgesi -Şimdi ve Yaşam Boyu Şekli Türkçe uyarlamasının geçerlik ve güvenilirliği. *Çocuk ve Gençlik Ruh Sağlığı Dergisi.* 11:109–116.
- Hasler G. 2010. Pathophysiology of depression: do we have any solid evidence of interest to clinicians? *World Psychiatry.* 9:155. doi:10.1002/j.2051-5545.2010.tb00298.x.
- Kaufman J, Birmaher B, Brent D, Rao U, Flynn C, Moreci P, Williamson D, Ryan N. 1997. Schedule for affective disorders and schizophrenia for school-age children-present and lifetime version (K-SADS-PL): initial reliability and validity data. *J Am Acad Child Psy.* 36:980–988. doi:10.1097/00004583-199707000-00021.
- Kaya F, Delen E, Young KS. 2016. Psychometric properties of the internet addiction test in Turkish. *J Behav Addict.* 5:130–134. doi:10.1556/2006.4.2015.042.
- Kokka I, Mourikis I, Nicolaides NC, Darviri C, Chrousos GP, Kanaka-Gantenbein C, Bacopoulou F. 2021. Exploring the effects of problematic internet use on adolescent sleep: a systematic review. *Int J Environ Res Public Health.* 18:760. doi:10.3390/ijerph18020760.
- Ko C-H, Liu T-L, Wang P-W, Chen C-S, Yen C-F, Yen J-Y. 2014. The exacerbation of depression, hostility, and social anxiety in the course of internet addiction among adolescents: a prospective study. *Compr Psychiatry.* 55:1377–1384. doi:10.1016/j.comppsy.2014.05.003.
- Kovacs M. 1985. The children's depression, Inventory (CDI). *Psychopharmacol Bull.* 21:995–8.
- Lam LT. 2014. Internet gaming addiction, problematic use of the internet, and sleep problems: a systematic review. *Curr Psychiatry Rep.* 16:1–9. doi:10.1007/s11920-014-0444-1.
- Lam LT, Peng Z-W. 2010. Effect of pathological use of the internet on adolescent mental health: a prospective study. *Arch Pediatr Adolesc Med.* 164:901–906. doi:10.1001/archpediatrics.2010.159.
- Lenhart A, Purcell K, Smith A, Zickuhr K. 2010. Social media & mobile internet use among teens and Young adults. Millennials. Pew internet & American life project.
- Li YI, Starr LR, Wray-Lake L. 2018. Insomnia mediates the longitudinal relationship between anxiety and depressive symptoms in a nationally representative sample of adolescents. *Depress Anxiety.* 35:583–591. doi:10.1002/da.22764.
- Manglick M, Rajaratnam SM, Taffe J, Tonge B, Melvin G. 2013. Persistent sleep disturbance is associated with treatment response in adolescents with depression. *Aust N Z J Psychiatry.* 47:556–563. doi:10.1177/0004867413481630.
- Marin MG, Nuñez X, de Almeida RMM. 2021. Internet addiction and attention in adolescents: a systematic review. *Cyberpsychol Behav Soc Netw.* 24:237–249. doi:10.1089/cyber.2019.0698.

- Onat M, Özyurt G, Öztürk Y, Akay AP. 2019. The relationship between problematic internet use, sleep quality and impulsivity in adolescents with major depressive disorder. *Anadolu Psikiyatri Dergisi*. 20:491–498.
- Owens J, Adolescent Sleep Working Group, Committee on Adolescence, Au R, Carskadon M, Millman R, Wolfson A, Braverman PK, Adelman WP, Breuner CC. 2014. Insufficient sleep in adolescents and young adults: an update on causes and consequences. *Pediatrics*. 134:e921–e932. doi:10.1542/peds.2014-1696.
- Oy B. 1991. Çocuklar için Depresyon Olcegi geçerlik ve güvenilirlik çalışması. *Türk Psikiyatr Derg*. 2:137–140.
- Park M-H, Park S, Jung K-I, Kim JI, Cho SC, Kim B-N. 2018. Moderating effects of depressive symptoms on the relationship between problematic use of the internet and sleep problems in Korean adolescents. *BMC Psychiatry*. 18:1–8. doi:10.1186/s12888-018-1865-x.
- Reiter J, Rosen D. 2014. The diagnosis and management of common sleep disorders in adolescents. *Curr Opin Pediatr*. 26:407–412. doi:10.1097/MOP.000000000000113.
- Restrepo A, Scheininger T, Clucas J, Alexander L, Salum GA, Georgiades K, Paksarian D, Merikangas KR, Milham MP. 2020. Problematic internet use in children and adolescents: associations with psychiatric disorders and impairment. *BMC Psychiatry*. 20:1–11. doi:10.1186/s12888-020-02640-x.
- Shapira NA, Lessig MC, Goldsmith TD, Szabo ST, Lazoritz M, Gold MS, Stein DJ. 2003. Problematic internet use: Proposed classification and diagnostic criteria. *Depress Anxiety*. 17:207–216. doi:10.1002/da.10094.
- Suganuma N, Kikuchi T, Yanagi K, Yamamura S, Morishima H, Adachi H, Kumano-Go T, Mikami A, Sugita Y, Takeda M. 2007. Using electronic media before sleep can curtail sleep time and result in self-perceived insufficient sleep. *Sleep Biol Rhythms*. 5:204–214. doi:10.1111/j.1479-8425.2007.00276.x.
- Tan Y, Chen Y, Lu Y, Li L. 2016. Exploring associations between problematic internet use, depressive symptoms and sleep disturbance among southern Chinese adolescents. *Int J Environ Res Public Health*. 13:313. doi:10.3390/ijerph13030313.
- Tokunaga RS. 2017. A meta-analysis of the relationships between psychosocial problems and internet habits: synthesizing internet addiction, problematic internet use, and deficient self-regulation research. *Commun Monogr*. 84:423–446. doi:10.1080/03637751.2017.1332419.
- Touitou Y, Touitou D, Reinberg A. 2016. Disruption of adolescents' circadian clock: the vicious circle of media use, exposure to light at night, sleep loss and risk behaviors. *J Physiol Paris*. 110:467–479. doi:10.1016/j.jphysparis.2017.05.001.
- Urrila AS, Karlsson L, Kiviruusu O, Pelkonen M, Strandholm T, Marttunen M. 2012. Sleep complaints among adolescent outpatients with major depressive disorder. *Sleep Med*. 13:816–823. doi:10.1016/j.sleep.2012.04.012.
- Van den Bulck J. 2004. Television viewing, computer game playing, and internet use and self-reported time to bed and time out of bed in secondary-school children. *Sleep*. 27:101–104. doi:10.1093/sleep/27.1.101.
- Wang W, Du X, Guo Y, Li W, Zhang S, Zhang W, McIntyre RS, Tamura JK, Guo L, Lu C. 2021. Associations among screen time, sleep duration and depressive symptoms among Chinese adolescents. *J Affect Disord*. 284:69–74. doi:10.1016/j.jad.2021.01.082.
- Wang H, Zhou X, Lu C, Wu J, Deng X, Hong L, Scott JG. 2011. Problematic internet use in high school students in Guangdong Province, China. *PloS One*. 6:e19660. doi:10.1371/journal.pone.0019660.
- Wu X, Tao S, Zhang Y, Zhang S, Tao F. 2015. Low physical activity and high screen time can increase the risks of mental health problems and poor sleep quality among Chinese college students. *PloS One*. 10:e0119607. doi:10.1371/journal.pone.0119607.
- Yen J-Y, Yen C-F, Chen C-C, Chen S-H, Ko C-H. 2007. Family factors of internet addiction and substance use experience in Taiwanese adolescents. *Cyberpsychol Behav*. 10:323–329. doi:10.1089/cpb.2006.9948.
- Young KS. 1998. Caught in the net: how to recognize the signs of internet addiction—and a winning strategy for recovery. John Wiley & Sons.
- Young KS. 2004. Internet addiction: a new clinical phenomenon and its consequences. *Am Behav Sci*. 48:402–415. doi:10.1177/0002764204270278.