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Mediating Role of Problematic Phone Use and Impulsivity in the Relationship between Sleep Quality and Eating Disorders

Uyku Kalitesi ile Yeme Bozuklukları Arasındaki İlişkide Sorunlu Telefon Kullanımı ve Dürtüselliğin Aracı Rolü

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Abstract

Amaç: Ergenlerde psikopatolojinin gelişimi ve seyri üzerinde hem uyku hem de yeme alışkanlıklarının katkısı vardır. Düşünmeden hareket etmek olarak tanımlanan dürtüsellik ile uyku kalitesi ve yeme bozuklukları (YB) arasındaki ilişkiyi inceleyen çalışmalar vardır. Cep telefonu kullanımının hayatımızdaki önemi bilinen bir gerçektir. Ancak son yıllarda problemli cep telefonu kullanımına bağlı psikiyatrik bozukluklar da dikkat çekmektedir. Bu çalışma, uyku kalitesi ve YB arasındaki ilişkiye aracılık edebilecek iki faktör olarak dürtüsellik ve problemli cep telefonu kullanımı incelenmiştir.

Yöntem: Örneklem, yaşları 12 ile 18 arasında değişen 108 ergenden oluşmaktadır. Katılımcılar, uyku kalitelerini, dürtüsel davranışlarını, YB belirtilerini, şiddetini ve problemli cep telefonu kullanımını değerlendiren öz bildirim anketlerini tamamladılar.

Bulgular: Uyku bozukluğu olan ergenlerde tıkınırcasına yeme ve dürtüsellik anlamlı olarak daha yüksekti. Uyku bozukluğu olan ve olmayan ergenlerde problemli cep telefonu kullanımı skorları benzerdi. Problemli cep telefonu kullanımı, motor, plan yapmama ve toplam dürtüsellik puanları yeme problemi olan ve olmayan ergenlerde benzerdi. Doğrusal regresyon analizi, tıkınırcasına yemenin, uyku kalitesi ve dürtüsellik toplam puanları ile önemli ölçüde pozitif ilişkili olduğunu ortaya koydu.

Sonuç: Uyku bozukluğu ve dürtüsellik doğrudan tıkınırcasına yeme bozukluğu ile ilişkiliydi. Uyku bozukluğu, dürtüsellik yoluyla yalnızca tıkınırcasına yeme davranışına aracılık etti. Problemli cep telefonu kullanımı, uyku bozuklukları ve yeme bozuklukları arasında herhangi bir ilişkiye aracılık etmedi.

Anahtar kelimeler: Uyku kalitesi, dürtüsellik, yeme bozuklukları, problemli cep telefonu kullanımı, ergenler

Öz

Objective: Both sleeping and eating habits have a major influence on the development of psychopathology and its course in adolescents. Studies have examined the relationships between sleep quality, impulsivity that is defined as acting without thinking and eating disorders (ED). The importance of using mobile phones in our daily lives is a well-known fact. However, in recent years, psychiatric disorders related to problematic mobile phone use (PMPU) have also attracted attention. The present study examined impulsivity and PMPU as two factors that can mediate the relationship between ED and sleep quality.

Method: The sample comprised 108 adolescents aged between 12 to 18 years. They completed self-report questionnaires that assessed their impulsivity, sleep quality, symptoms and severity of ED, and PMPU.

Results: Binge-eating and impulsivity were significantly higher in adolescents with sleep disorders. The PMPU scores were similar in adolescents with and without sleep disorders. The PMPU scores, motor and non-planning scales of impulsivity, and total scores of impulsivity, were similar in both adolescents with and without eating problems. Linear regression analysis revealed that binge eating was significantly positively correlated with sleep quality and the total impulsivity scores.

Conclusion: Thus, sleep disturbance and impulsivity were associated with binge-eating disorder directly. Sleep disturbance mediated only binge-eating behavior through impulsivity. The PMPU did not mediate any association between sleep disturbances and eating disorders.

Keywords: sleep quality, impulsivity, eating disorders, problematic mobile phone use, adolescents

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Introduction

Eating and sleeping are two of the strongest biological drives in humans. Adolescence is the time when a person grows from a child to an adult. It is also a time when people tend to have poor sleep quality and develop eating disorders (EDs) (1-3). During adolescence, biological changes along with the influence of environmental and social factors may cause sleep problems such as increased sleep time, circadian shifts, increased daytime sleepiness, a change in sleep time preferences, and decreased slow-wave sleep (4).

Dieting and various eating disorders are also common during adolescence (5). EDs in the DSM-5 include anorexia nervosa (AN), bulimia nervosa (BN), binge-eating disorder (BED), avoidant/restrictive eating disorder, and other specified eating disorders (6). Behavioral abnormalities, such as restricting food intake, compensating for overeating, and frequently checking body shape, weight, and general appearance often accompany EDs (5).

Recently, several studies have indicated that sleep problems are more common in individuals with EDs (7-9). One study found that about 57% of individuals with EDs had sleep problems such as difficulty in falling asleep, parasomnia, hypersomnia, early morning awakenings, and waking up in the middle of sleep (8). Both sleeping and eating habits have a major influence on the development of psychopathology and its course in adolescents (10). Individuals with psychiatric disorders and concomitant sleep problems show more severe symptoms and treatment outcomes (such as partial or no remission, rather than complete remission) than individuals without sleep problems (11). Although there are studies on the neurobiological mechanisms underlying the coexistence of EDs and poor sleep quality, they are limited in number (12). Therefore, understanding the relationship between sleep problems and EDs may provide pertinent clues for the development and treatment of EDs.

Several studies have concluded that impulsivity, that is defined as responding to internal or external stimuli without thinking, may be a risk factor for EDs (13, 14). For example, Lowe and Eldredge (1993) stated that impulsive behavioral problems are more common in binge eaters (14) . Some studies found that self-harm (15), theft (16), and substance abuse (17), were associated with binge eating. In one of the studies on the effects of sleep quality on impulsivity, it was found that children aged 8-10 years with sleep disorders had higher impulsivity than children without sleep disorders (18).

Furthermore, there has been an increase in research indicating that sleep quality decreases with uncontrolled mobile phone use by adolescents (19, 20). The relationship between problematic mobile phone use (PMPU) and EDs has been examined in the context of social media and Internet use disorder (21). However, few studies have specifically targeted mobile phone use.

The present study examined impulsivity and PMPU as two factors that may mediate the association between sleep quality and ED (13). Our study examined whether impulsivity and PMPU have indirect effects on the relationship between sleep problems and EDs. According to our hypothesis, there are indirect effects of impulsivity and PMPU on the relationship between sleep problems and EDs besides the direct association with sleep quality and EDs which prior publications have shown.

Methods

Sample

This cross-sectional study consisted of 108 adolescents aged between 12 to 18 years who visited the pediatric outpatient clinic at Izzet Baysal State Hospital in Bolu, Turkey. For the study, 150 adolescents between the ages of 12 and 18 years who had enrolled in the pediatric outpatient clinic were surveyed. The adolescents and their guardians were informed about the purpose of the study, and how to complete the questionnaires. Informed consent was obtained from adolescents and their legal guardians. The exclusion criteria were as follows: the presence of autism spectrum disorder; any neurological, intellectual, or psychotic disorder; submitting a questionnaire with more than 10% of the items missing; and refusing the study. Symptoms of neurological disorder, intellectual disability, and psychotic symptoms, which were among the exclusion criteria for the study, were obtained from face-to-face interviews with a child and adolescent psychiatrist, and adolescents with these symptoms were not included in the study. Of the 150 adolescents interviewed, 22 did not agree to participate in the study. Six adolescents were unable to adapt and were excluded from the study because of possible intellectual disability findings. The questionnaires of 14 adolescents were also excluded from the study because they were not completed sufficiently for analysis. Thus, the study was completed with 108 adolescents.

Procedure

Completion of the questionnaires took approximately half an hour for each adolescent. Twenty minutes were allotted for the preliminary interview and brief sociodemographic information. Although the preliminary interviews were conducted individually, the information for completing the questionnaires was given in groups. It took two months to collect all the data. Bolu Izzet Baysal University ethics committee approved the study protocol by number 225/2021. Data instruments, particularly survey questionnaires, were administered to all the participants.

Measures

Pittsburgh Sleep Quality Index (PSQI)

PSQI is a scale that evaluates sleep quality. It consists of 19 items that measure seven components. These components

are subjective sleep quality, latency, duration, disturbances, efficiency, use of medications, and daytime dysfunction. A score between 0 and 21 can be obtained; scores of 5 and above indicate inadequate sleep quality (22). A Turkish validity and reliability study was conducted on adults (23). Cronbach's alpha of the PSQI was found to be high (0.8) for the scale as a whole.

The Eating Disorder Examination Questionnaire (EDE-Q)

EDE-Q is a 28-item, 7-point Likert scale that evaluates eating habits and behavioral psychopathology. The scale items are categorized into five subscales: restraint, binge-eating, eating, shape and weight concern. Each item ranged from 0 to 6, and subscale scores were calculated as the average of the individual question scores. The final score is typically obtained by averaging the scores of the subscales (24). A Turkish validity and reliability study was conducted on adults before using the EDE-Q. Cronbach's alpha of the EDE-Q was found to be 0.93 for the scale as a whole, 0.63 for the binge eating and 0.70 or above for other subscales (25).

Problematic Mobile Phone Use

Problematic Mobile Phone Use is the 20-item Turkish version of the Mobile Phone Addiction Scale (26). It measures the excessive use of mobile phones, the relationship between mobile phone use and some psychological variables, and the negative effects that can occur from long-term use of mobile phones. All items were rated on a 5-point Likert scale ranging from 1 to 5. The total score ranged from 0 to 100 was obtained by adding the scores. A high score indicated PMPU (27).

The Barratt Impulsiveness Scale (BIS-11)

BIS-11 is a 30-item self-report scale that assesses the occurrence of impulsivity. Items are scored on a 4-point Likert scale. The scale items are categorized into three subscales: attentional impulsivity, motor impulsivity and, non-planning impulsivity. Higher scores indicate higher levels of problem in impulsivity (28). A Turkish validity and reliability study was conducted before using the BIS-11. Although validity and reliability studies have been performed in adults, it has also been used for adolescents in some studies (29).

Statistical Analysis

For linear multiple regression analysis, power analysis was performed by calculating four variables: Pittsburgh Sleep Quality Index (PSQI) score, Barratt Impulsiveness Scale (BIS-11) total score, Eating Disorder Examination Questionnaire (EDE-Q) subscale scores, and PMPU total score. With a power of 95%, four variables, and an effect size of 0.15, the required sample size was calculated as 129. The G power program was used for power analysis.

Descriptive statistical methods, that is, frequency, percentage, mean, and standard deviation, were used when evaluating the study data. The normal distribution of continuous variables was evaluated using the Shapiro-Wilk test; an independent sample t-test was used for data with normal distributions and the Mann-Whitney U test was used for data with non-normal distributions. A Chi-square test was used to compare the categorical variables, and correlational analyses were conducted using the Pearson correlation for normally distributed variables. Spearman correlation was used for qualitative variables and non-normal distributions. Linear regression analyses were performed to determine the relationship between EDE-Q subscales and other scales. We estimated the mediation effects via structural equation modeling (SEM) using AMOS. We used a bootstrapping procedure to test the statistical significance of the paths and the indirect effects of each model. We assessed model fit using several fit indices which included the ratio of chi-square to degrees of freedom ($\chi 2/df$), comparative fit index (CFI), root mean square error of approximation (RMSEA), and standardized root mean square residual (SRMR). The SEM literature suggested that model fit was excellent when $\chi 2/df \leq 3$, CFI ≥ 0.95, RMSEA ≤ 0.05, and SRMR ≤ 0.08 (30, 31).

Results

The sample consisted of 108 adolescents between 12 and 18 years of age (M = 16.8 years, SD = 3.49). Of the 108 adolescents participating in the study, 68 (63.0%) were girls and 40 (37.0%) were boys. The PSQI score of 82 subjects was less than 5, so they were classified as adolescents without sleep disorders. Twenty-six individuals with a PSQI score of 5 or higher were classified as adolescents with sleep disturbance. While comparing adolescents with and without sleep disorders, no difference was found in age or gender ($p>0.05$) (Table 1). When the Restraint, Binge-Eating, Eating Concern, Shape Concern, and Weight Concern subscales of the EDE-Q were examined separately in adolescents with sleep disorders, it was found that the binge-eating score was significantly higher in the adolescents with sleep disorders ($p<0.05$) (Table 1). The PMPU scores were similar in adolescents with and without sleep disorders ($p>0.05$) (Table 1). The scores of the BIS-11 and all its subscales were significantly higher in adolescents with sleep disorders ($p>0.05$) (Table 1). In other words, the impulsivity problem was significantly more pronounced in the group with sleep disorders ($p<0.05$) (Table 1).

The adolescents were divided into groups with and without eating disorders based on the scores obtained in the EDE-Q. When 27 adolescents with eating problems and 81 adolescents without eating problems were compared, no difference was found in age and gender ($p>0.05$); the results are presented in Table 2. When comparing adolescents with and without eating

Table 1. Descriptive statistics and scales of adolescents with and without sleep problems

	Adolescents with sleep problems (26)		Adolescents without sleep problems (82)		
	Mean	**Std. deviation**	**Mean**	**Std. deviation**	**P**
Age	16.27	1.97	15.98	1.91	0.576
Problematic phone usage	33.683	13.424	34.346	14.623	0.830
Binge eating	2.108	1.646	0.083	0.106	<0.001**
Restrain concern	1.322	1.675	1.738	1.820	0.282
Eating concern	1.079	1.345	1.350	1.490	0.386
Shape concern	1.924	2.057	2.221	1.998	0.519
Weight concern	1.482	1.903	1.788	1.839	0.472
İmpulsivity-attention	34.232	3.866	28.462	3.010	<0.001**
Impulsivity-motor	13.329	3.621	10.923	0.628	<0.001**
Impulsivity-non planning	19.878	2.839	14.962	2.807	<0.001**
Impulsivity-total	67.317	6.818	54.308	3.750	<0.001**
	n	**%**	**n**	**%**	
Female	14	53.8	54	65.9	0.352[n]
Male	12	46.2	28	34.1	

*p<0.05 **, p<0.01

[n]P is calculated by Pearson Chi-Square

Other p values were calculated by Independent Samples t-test

problems, the PMPU, BIS-11 total scores and its' motor and non-planning subscales, were similar in both groups (p>0.05) (Table 2). The PSQI total score and the BIS-11-attention subcomponent were higher in the group with eating problems (p<0.05) (Table 2).

The correlations of the scales completed by 108 adolescents were examined with each other. As seen in Table 3, the scores for the BIS-11 and all subscales had significant positive correlations with the PSQI and its subscales (p<0.05). This implies that impulsivity increases with an increase in sleep problems. The BIS-11 total scores and all its subscales did not show a significant correlation with the PMPU (p>0.05) (Table 3). A significant positive correlation was found between the binge eating subscale of the EDE-Q, and the BIS-11 total score and all its subscales (p<0.05) (Table 3). The BIS-11 total score and all its subscales, except attention scores showed a significant negative correlation with the subscales of the EDE-Q (p<0.05) (Table 3). In addition, the PSQI score and the binge eating score showed a significant positive correlation, but negative correlation with other EDE-Q subscales (p<0.05) (Table 3).

The subcomponents of the EDE-Q were used as dependent variables in linear regression analysis. The BIS-11 and its subcomponents, PSQI score, and PMPU score were included as independent variables. In determining the other variables, those with a significant correlation > 0.7 were considered to avoid collinearity [31]. With the exception of binge eating, no significant correlations were found between the different subscales of the EDE-Q and other variables; the results of binge eating are reported in Table 4. Linear regression analysis revealed that binge eating was significantly positively correlated with the PSQI and the total BIS-11 score (p<0.05) (Table 4).

Table 2. Descriptive statistics and scales of adolescents with and without eating disorders					
	Adolescents with eating disorders (27)		Adolescents without eating disorders (81)		
	Mean	Std. deviation	Mean	Std. deviation	P
Age	15.89	2.06	16.11	1.87	0.604
Problematic phone usage	36.593	13.771	32.926	13.577	0.229
Binge eating	2.188	2.399	1.432	1.321	0.042*
Restrain eating	2.978	2.174	0.904	1.137	<0.001**
Eating concern	2.259	1.757	0.773	0.990	<0.001**
Shape concern	3.713	2.355	1.423	1.556	<0.001**
Weight concern	3.185	2.399	1.012	1.297	<0.001**
İmpulsivity-attention	34.667	5.758	32.235	3.729	0.013*
Impulsivity-motor	12.593	3.190	12.802	3.393	0.778
Impulsivity-non planning	19.444	3.796	18.444	3.413	0.203
Impulsivity-total	66.741	11.329	63.333	6.970	0.066
PSQI	5.45	2.13	4.4	2.3	0.032*
	n	%	n	%	
Female	21	77.8	47	58.0	0.066[n]
Male	6	22.2	34	42.0	

*p<0.05 **, p<0.01

[n]P is calculated by Pearson Chi-Square

Other p values were calculated by Independent Samples t test

PSQI Pittsburgh Sleep Quality Index

Table 3. Correlation analysis of scales among all variables (N=108)							
	İmpulsivity-attention (1)	İmpulsivity-motor (2)	İmpulsivity-non-planning (3)	İmpulsivity-total (4)	Problematic phone usage (5)	Binging (6)	Restrain (7)
2	0.205*						
3	0.386**	0.512**					
4	0.838**	0.575**	0.759**				
5	-0.147	-0.040	-0.113	-0.142			
6	0.737**	0.626**	0.693**	0.926**	-0.142		
7	-0.052	-0.288**	-0.245*	-0.220*	0.350**	-0.241*	
8	-0.122	-0.240*	-0.252**	-0.278**	0.334**	-0.306**	0.661**
9	-0.196*	-0.227*	-0.219*	-0.292**	0.379**	-0.315**	0.674**
10	-0.118	-0.287**	-0.246*	-0.267**	0.346**	-0.278**	0.714**
11	0.779**	0.612**	0.749**	0.964**	-0.132	0.935**	-0.221*
12	0.497**	0.450**	0.604**	0.647**	-0.015	0.589**	-0.243*
13	0.566**	0.443**	0.466**	0.686**	-0.072	0.652**	-0.056
14	0.482**	0.284**	0.352**	0.549**	-0.140	0.566**	-0.247**
15	0.356**	0.387**	0.293**	0.431**	-0.067	0.476**	-0.107
16	0.471**	0.512**	0.578**	0.642**	-0.187	0.603**	-0.206*

*p<0.05 **, p<0.01

PSQI Pittsburgh Sleep Quality Index

r is calculated by Pearson correlation analysis

Table 3. continued									
	Eating (8)	Shape (9)	Weight (10)	PSQI (11)	Sleep quality (12)	Sleep latency (13)	Sleep time (14)	Sleep efficiency (15)	Sleep distruption (16)
2									
3									
4									
5									
6									
7									
8									
9	0.830**								
10	0.781**	0.852**							
11	-0.276**	-0.278**	-0.260**						
12	-0.212*	-0.220*	-0.121	0.667**					
13	-0.172	-0.165	-0.134	0.708**	0.359**				
14	-0.134	-0.143	-0.188	0.566**	0.154	0.285**			
15	-0.110	-0.151	-0.107	0.495**	0.333**	0.346**	0.247**		
16	-0.184	-0.180	-0.249**	0.676**	0.496**	0.338**	0.363**	0.316**	

*p<0.05 **, p<0.01

PSQI Pittsburgh Sleep Quality Index

r is calculated by Pearson correlation analysis

Table 4. Linear regression of binge eating scale with other scales (N=108)			
	B	t	p
Impulsivity-attention	-0.165	-1.323	0.189
Impulsivity-motor	0.043	0.705	0.483
Impulsivity-non-planning	-0.151	-1.816	0.072
Impulsivity-total	0.632	2.901	0.005**
Sleep quality	-0.041	-0.430	0.668
Sleep latency	-0.015	-0.132	0.895
Sleep time	0.044	0.519	0.605
Sleep efficiency	0.033	0.444	0.658
Sleep disruptions	-0.047	-0.626	0.533
Functionality	0.033	0.339	0.735
PSQI	0.955	3.378	0.001**

*p<0.05 **, p<0.01

PSQI Pittsburgh Sleep Quality Index

Mediation Model

While many studies that have examined the association between sleep disturbances and EDs, in this study, we examined whether impulsivity (using total impulsivity total scores) and PMPU directly and indirectly influenced the association between sleep disturbances (PSQI total scores used) and EDs (EDE-Q subscales scores used). We followed a stepwise method to construct an optimal model for the mediating effects of impulsivity, and PMPU. First, we assessed the fit of the parallel mediation model.

Model 1 (χ2/df = 0.338, CFI = 1.00, RMSEA = 0.891, and SRMR = 0.001) included the following:

(a) direct pathway of poor sleep quality → binging (b = 0.336, p<0.001), (b) indirect pathway of poor sleep quality → impulsivity → binging, (c) indirect pathway of poor sleep quality → PMPU → binging. Results showed that the path from poor sleep quality → impulsivity → binging was significant (Fig. 1). Poor sleep quality was associated with impulsivity, and impulsivity was associated with binging. There was an indirect (mediated) effect of PSQI on binging through impulsivity (p =0.034 and 95% CI [0.006, 0.472])

Model 2 (χ2/df = 0.338, CFI = 1.00, RMSEA = 0.682, and SRMR = 0.001) included the following: (a) direct pathway of poor sleep quality → restraint (b = -0.091, p=0.634), (b) indirect pathway of poor sleep quality → impulsivity → restraint, (c) indirect pathway of poor sleep quality → PMPU → restraint (Fig. 2). PMPU was associated with restraint. There was no indirect (mediated) effect of PSQI on restraint (p =0.705 and 95% CI [-0.497, 0.330])

Model 3 (χ2/df = 1.6, CFI = 1.00, RMSEA = 0.768, and SRMR = 0.001) included the following: (a) direct pathway of poor sleep quality → eating concern (b = -0.06, p=0.692), (b) indirect pathway of poor sleep quality → impulsivity → eating concern, (c) indirect pathway of poor sleep quality → PMPU → eating concern (Fig. 3). PMPU was associated with eating concern. There was no indirect (mediated) effect of PSQI on eating concern (p =0.614 and 95% CI [-0.461, 0.278]).

Model 4 (χ2/df = 1.555, CFI = 1.00, RMSEA = 0.689, and SRMR = 0.001) included the following: (a) direct pathway of poor sleep quality → shape concern (b = 0.014, p=0.950), (b) indirect pathway of poor sleep quality → impulsivity → shape concern, (c) indirect pathway of poor sleep quality → PMPU → shape

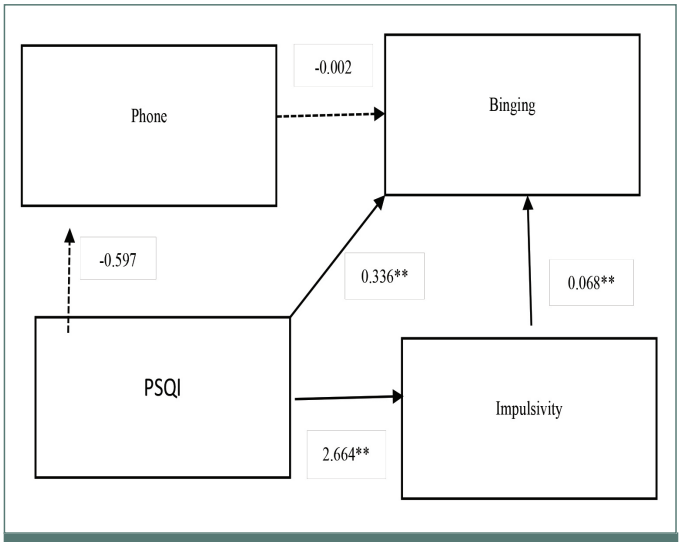

Figure 1. Tests of Model 1 showed parallel indirect effects of impulsivity and problematic mobile phone usage in the association between poor sleep quality and binging

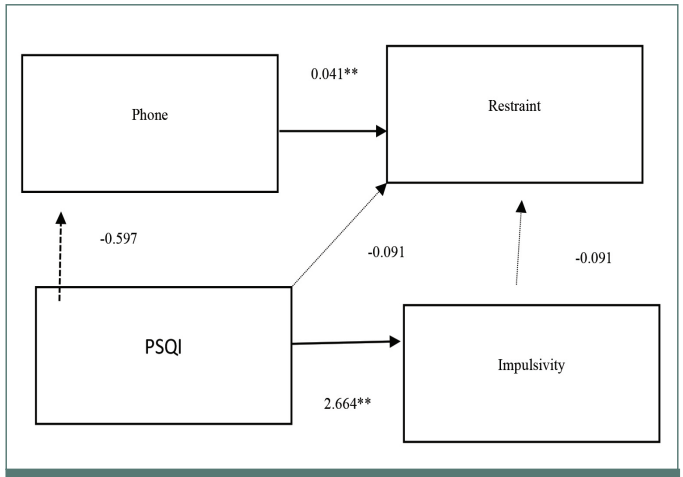

Figure 2. Tests of Model 2 showed parallel indirect effects of impulsivity and problematic mobile phone usage in the association between poor sleep quality and restraint

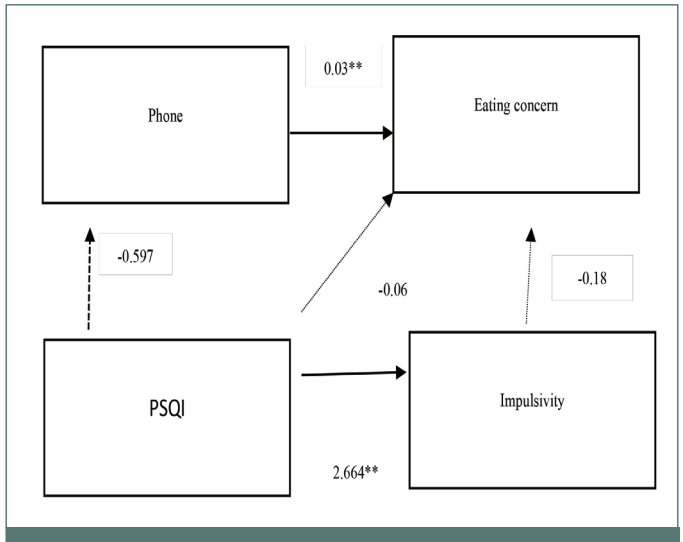

Figure 3. Tests of Model 3 showed parallel indirect effects of impulsivity and problematic mobile phone usage in the association between poor sleep quality and eating concern

concern (Fig. 4). PMPU was associated with shape concern. There was no indirect (mediated) effect of PSQI on shape concern (p =0.308 and 95% CI [-0.842, 0.278]).

Model 5 ($\chi 2$/df = 1.555, CFI = 1.00, RMSEA = 0.684, and SRMR = 0.001) included the following: (a) direct pathway of poor sleep quality → weight concern (b = -0.038, p=0.854), (b) indirect pathway of poor sleep quality → impulsivity → weight concern (c) indirect pathway of poor sleep quality → PMPU → weight concern (Fig. 5). PMPU was associated with weight concern. There was no indirect (mediated) effect of PSQI on weight concern (p =0.473 and 95% CI [-0.718, 0.324]).

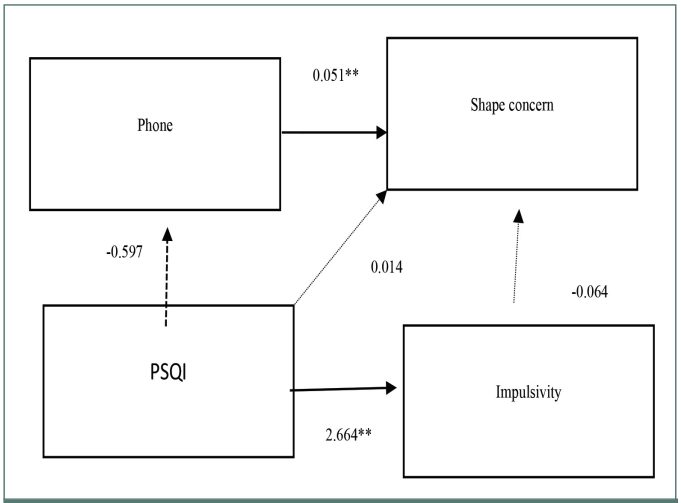

Figure 4. Tests of Model 4 showed parallel indirect effects of impulsivity and problematic mobile phone usage in the association between poor sleep quality and shape concern

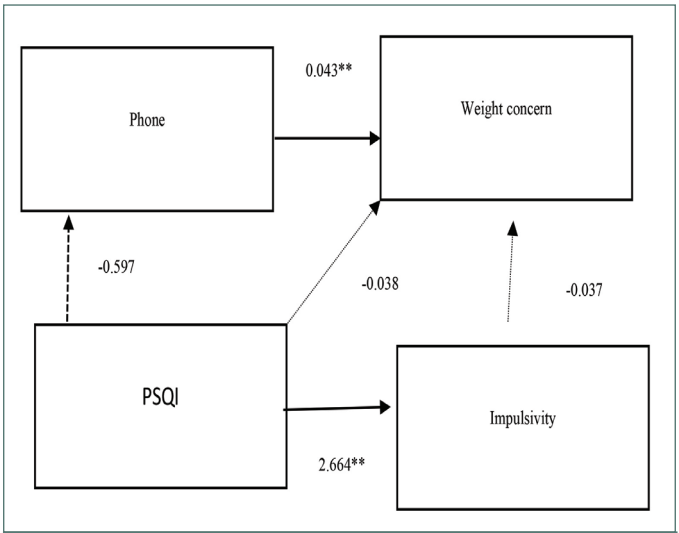

Figure 5. Tests of Model 5 showed parallel indirect effects of impulsivity and problematic mobile phone usage in the association between poor sleep quality and weight concern

Discussion

In addition to many studies examining the relationship between sleep quality and ED, this study aimed to investigate whether impulsivity and PMPU indirectly affect this relationship. In our study showed that binge-eating, and impulsivity were significantly higher in adolescents with sleep disorders. Sleep disturbance encourages risk-taking and thrill-seeking behavior (32, 33). In some studies, including adolescents, it has been suggested that inadequate sleep causes various changes in their decision-making regarding reward. Individuals tend to take more risks with increased insomnia (33). Individuals are less concerned about the possible negative consequences of their behavior. These effects are thought to be mediated by the striatum, which is part of the basal ganglia and is particularly important for motivation and reward-related function (33, 34). In adolescence, risky behaviors such as substance use and self-harming may be related to risk perceptions and the evaluation of risky behaviors' cost/benefit ratio (34-36). Daytime behavioral disinhibition was more than without sleep problems for children and adolescents with sleep disorders. Children with poor quality and insufficient sleep may exhibit more problematic behaviors (33). One of these risky, impulsive behaviors is nonsuicidal self-harming behavior (32, 37).

Nonsuicidal self-harm is the deliberate destruction of body tissue without any death intent (38). Nonsuicidal self-harm occurs at high rates in adolescents and is associated with adverse clinical outcomes such as suicide attempts (39). Nonsuicidal self-harming behavior may appear along with other psychiatric symptoms, including affective dysregulation, negative cognitive style, poor self-esteem, loneliness, disordered eating, risky sexual behaviors, and sleep problems (40, 41). In a meta-analysis of more than 6,000 patients with a median age of 24 that evaluated 28 studies, the prevalence of a history of nonsuicidal self-harm in individuals with eating disorders was found to be 27% (42). In a survey of 612 adolescents with eating disorders, it was determined that nonsuicidal self-harm occurred in 41 percent of cases (43). During the indirect path analysis, sleep disturbance was found to increase binge eating through impulsivity. Many studies have shown the coexistence of impulsivity and binge-eating disorder (14-17). Some studies have found that impulsivity may be present in people with AN, but not to the same degree as in BED. Favaro et al. (2005) found that individuals with AN exhibited impulsive behavior, but at a lower level than individuals with BED (24). In our study, motor, non-planning, and total scores of impulsivity were similar in both adolescents with and without eating problems. Adolescents with EDs had significantly higher scores on the attention subcomponent of impulsivity than those without EDs.

Our study showed that binge-eating, and impulsivity were significantly higher in adolescents with sleep disorders. Many

studies have found an association between short sleep duration, binge eating, and obesity (44, 45). Studies put forward the hypotheses that the relationship between sleep disturbances and obesity occur because of the dysregulation of the leptin-ghrelin hormone. Leptin, that is released by adipocytes, is positively associated with increased fat mass and reduced appetite (46). Ghrelin, stimulates appetite and reduces energy expenditure (47). Sleep deprivation has been associated with decreased leptin and increased ghrelin levels, consistent with a hormone profile that increases appetite and decreases energy expenditure (48). Spiegel et al. found that two nights of sleep deprivation resulted in a decrease in leptin and an increase in ghrelin levels (49).

When the direct and indirect effects of sleep disturbance on ED other than BED were examined, no significant findings were obtained. An estimated 75-85% of patients seeking treatment for AN are diagnosed with a lifetime major depressive disorder (50). Sleep problems are the primary diagnostic feature of major depression (6). Therefore, studies examining the relationship between eating and poor sleep quality should include mood symptoms. In the existing literature, people with AN have been found to have significantly more insomnia, reduced sleep efficiency than both healthy individuals and individuals with major depression (51, 52).

The use of smartphones facilitates social media, messaging, and internet access. Smartphones have rapidly replaced computers in recent years. Although there is no clear definition of smartphone addiction, it can be expressed as a behavioral addiction (53). Many psychiatric problems such as depressive symptoms, anxiety, and low self-esteem may be related to excessive smartphone use (54, 55). A study conducted on 755 university students found a significant relationship between excessive smartphone use and depression, anxiety, obsessive-compulsive symptoms, and impulsivity (56). The literature review on problematic smartphone use in publications provides information that include excessive reassurance-seeking and avoidance behaviors with smartphones and sleep disturbance (57). Sleep disturbances such as poor sleep quality, increased fatigue, and insomnia symptoms in adolescents were closely related to PMPU (19). As an unstructured leisure activity without a fixed start and end point, mobile phone use may lead to prolonged use, take up considerable amounts of time, and thus substitute sleep for other activities (20). However, the association between sleep disturbance and PMPU was not significant in our study. We noted that studies examining the relationship between PMPU and ED are limited. While some found that social media use increased ED, some found it a useful tool in treating ED (58, 59). In this study, we found that the PMPU scores were similar in adolescents with and without EDs. The PMPU did not mediate any association between sleep disturbances and EDs.

Although our study reveals important findings, it has significant limitations. First, because the results of the study were generated through a cross-sectional analysis of the data, causal relationships could not be precisely determined. Additionally, the term “mediation” was used only in the statistical mean. Therefore, we must verify causal mechanisms through longitudinal and experimental studies. Second, the limited sample of adolescents restricts the generalizability of the results. Finally, data collection was based on self-reporting, thus, limiting the results of the study.

In conclusion, our study showed that binge-eating, and impulsivity were significantly higher in adolescents with sleep disorders. The PMPU scores were similar in adolescents with and without sleep disorders. The PMPU scores and motor, non-planning, and total scores of impulsivity were similar in both adolescents with and without eating problems. Adolescents with EDs had significantly higher scores on the attention subcomponent of impulsivity than those without EDs. Sleep disturbance and impulsivity were associated with binge-eating disorder directly. Sleep disturbance mediated only binge-eating behavior through impulsivity. The PMPU did not mediate any association between sleep disturbances and EDs. Behavioral and psychological interventions to manage sleep problems and impulsivity may be helpful in treating binge eating. In addition, PMPU control may also be useful in treating disorders other EDs.

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