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The psychological distress mediates the relationship between electronic devices use and insomnia in adolescents

Maysoun H Atoum [1*], Sami Al-Rawashdeh [1], Sajidah Al-Hawamdih [2], Hadeel Atoum [3], Dina Atoum [3], Souhair Al Atoum [4], Arwa Almwajeh [5]

[1] Department of Community and Mental Health Nursing, Faculty of Nursing, The Hashemite University, P.O. Box 150459, Zarqa 13115, JORDAN
[2] Faculty of Medicine, Al-Balqa university, Al-Salt 19117, JORDAN
[3] Independent Researcher, JORDAN
[4] Department of Basic Sciences, Zarqa College, Al-Balqa Applied University, Al-Salt 19117, JORDAN
[5] AL-Mafraq Governmental Hospital-Ministry of Health, Al-Mafraq, JORDAN
***Corresponding Author:** maysoun_atoum@hu.edu.jo

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ABSTRACT

Introduction: The relationships among electronic devices (e-devices) use, insomnia, and psychological distress are complex. This study aimed to examine the relationships between e-devices use and the outcomes of insomnia and psychological distress with insomnia and psychological as mediators.

Design: This is a correlational study utilized cross-sectional data on hours of e-devices use, insomnia, and psychological distress from 485 randomly selected Jordanian adolescents. The PROCESS macro for SPSS was used for the aim of this study.

Results: The hours of e-devices use predicted psychological distress. The results of mediation analysis showed that the relationship between the hours of e-devices use, and insomnia was mediated by psychological distress scores (indirect effect size=.0462 with 95% confidence interval (CI) .0095 and .0837). However, the relationship between the hours of e-devices use and psychological distress was not mediated by insomnia (indirect effect size=.0247 with 95% CI -.0063 and .0569).

Conclusion: The hours of e-devices use may exert its effect on insomnia through psychological distress, which may lead to insomnia. This data does not support the hypothesis that insomnia may mediate the relationship between e-devices use and psychological distress. Further research on this topic is warranted. The study supports policymakers and a collaborative team of parents, educators, and health professionals to prevent the harmful effects of excessive e-devices.

Keywords: electronic devices, mediation, adolescents, psychological distress, insomnia, sleep

INTRODUCTION

Electronic devices (e-devices), such as computers, smartphones, and tablets, have become a fully integrated part of people's lives. In adolescents, e-devices use has become an essential part of their contemporary life and one of the adolescents' most popular leisure time activities [1]. However, using e-devises improves cognitive skills such as intellectual, attentional control, and problem-solving skills [2-4]. But, in recent years, e-devices use has become a growing concern for the issue of addiction. The findings from a systematic review by [5] support policy action to limit the duration of e-devices because of evidence of harmful effects, which earns attention from healthcare professionals such as nurses to establish long-standing follow-up mental health programs for developing early intervention and prevention strategies among Jordanian adolescent students. The increased duration of time adolescents spends using e-devices has raised concerns from educators and researchers about its possible negative effect on adolescents' physical and psychological well-being health [6,7], as well as in Jordan [8]. Gaming disorders, closely related to excessive e-device use, have recently been included as a new disorder in the World Health Organization (WHO) 11th revision of the international classification of diseases [9]. The WHO reported that excessive e-device use is possibly a type of behavioral addiction that presents as a repetitive pattern of behavioral action, similar to the compulsive-impulsive spectrum disorder [10].

Given the risk of excessive e-device use, experts have suggested controlling e-devices for adolescents for two hours per day [11]. Even the American Academy of Pediatrics guidelines recommends limiting e-derives use to no more than one hour or less per day [12].

Good sleep is essential for learning ability, memory processes, emotional regulation, and related behaviors [13,14]. There are published studies examining the relationship between e-devices use and the development of psychiatric problems, including depression, anxiety, stress, impulsivity, aggression, anger, hostility, social anxiety, and low self-esteem

[5,15-19]. Moreover, systematic reviews and meta-analyses studies showed a significant positive relationship between excessive e-devices use and sleep disorders [20-22]. These symptoms, including irregular sleeping habits [23], delayed bedtimes [24], insomnia [25], and late wake-up times, may additionally lead to rhythm desynchronization and influence school performance [23]. Furthermore, restoring sleep among adolescents is strongly correlated with better physical, cognitive, and psychological well-being [26].

Psychological distress was associated with adverse outcomes from e-devices use and caused sleep problems [18,27-30]. However, no concord on the predictive role of psychological distress in developing sleep disorders, especially in adolescents, with an inadequate number of longitudinal studies [31]. Additionally, insomnia has shown associations with psychological distress [18,27-29], and predicted the onset and relapse of depression [27].

Studies highlight the relationships between e-devices use, sleep disorders, and psychological distress. These relationships are complex, especially among adolescent populations. Research has identified that the onset of puberty is an indicator of the development of both psychological distress and sleep problems [31-33]. Many previous studies have demonstrated that insomnia may be a potential mechanism explaining the relationship between e-devices and psychological distress among adolescents [7,34,35]. The time course of developing psychological distress and insomnia are overlaps, primarily when excessive e-devices are used [14,19,36].

Therefore, psychological distress may mediate the relationship between the duration of e-devices use and insomnia, or insomnia may mediate the relationship between the time of e-devices use and the development of psychological distress. Therefore, this paper aimed to clarify these relationships by examining these possibilities in a random sample of adolescents from Jordan, which will assist in achieving a better understanding and guide the development of early intervention and prevention strategies.

METHODS

Design

This study is a cross-sectional correlational study. A multiple-stage cluster random sampling technique was employed to choose the study participants. The target population of this study was adolescents aged 15-17 years old. Two secondary schools (one for males and one for females) were randomly selected from a list of all government schools in the five educational districts in Amman, Jordan's capital. Then, two classes from each 9th-, 10th-and 11th-grade level in each school were randomly selected.

The final sample consisted of 235 male and 250 female students drawn out of 1,210 males and 1,380 female students in the selected schools. The required sample size was calculated using the G*Power 3.1.9.7 with a small effect size of .05, statistical significance (α) of .05, a power level of 0.90, and seven predictors. The required sample size was about 373 students. We requested 120 additional participants to overcome the expected non-response rate of about 30 % related to having the consent of both students and their parents.

Procedure

Data were collected during the academic year of 2018/2019. Before data collection, the Ethics Committee of the Institutional Review Board (IRB) at the University, where the first author is working approved the study. In addition, the Ministry of Education-Jordan approved this study. The study was briefly explained to the students and their parents, and written consent was obtained from both parties. All participants were assured of their right to participate, refuse, and draw at any time without any consequence.

Measures

Psychological distress: The short form of the Arabic version of the depression anxiety stress scale-21 (DASS-21) was used to measure psychological distress. The scale measures the depression, anxiety, and stress dimensions, with the dimension score calculated by summing the responses of the seven pertinent items [37]. The answers are rated on a scale ranging from 0-to 3, "an example of the item is "I found it difficult to relax. The dimensions' scores are summed and then multiplied by two to represent the total psychological distress score, which could range between 0 and 126. The higher scores represent severe psychological distress. The validity and reliability of the DASS-21 questionnaire in measuring psychological distress among adolescents have been provided in several studies [38-40]. Cronbach's reliability alpha was 0.71, 0.63, 0.67, and 0.83 for the current study's stress, anxiety, depression subscales, and total scale scores.

Sleep and insomnia: Sleep-related measures assessment included the average of hours slept per day (the duration of the nap, if taken during the day, is added to the hours of sleep at night), the perception of the adequacy of the sleep (yes, no), and insomnia. Insomnia was measured using the insomnia severity index (ISI). The ISI is a widely used self-report questionnaire consisting of 7-item to measure insomnia's nature, severity, and effect on a 5-point Likert scale ranging from 0 "not at all" to 4 "very severe." The total scores were calculated by summing the items, and so the total scores range between 0 and 28, with a higher score indicating severe insomnia. The respondents were classified into no signs of insomnia, mild insomnia, moderate insomnia, and severe insomnia based on the cutoff scores of 0-7, 8-14, 15-21, and 22-28, respectively [41]. The ISI showed excellent psychometric properties and was validated in the adolescent population [42,43].

The Arabic version of the ISI has shown excellent psychometric properties [44,45]. In the current study, the ISI had a Cronbach's alpha of 0.717.

Data Analysis

Statistical package for social sciences (SPSS) version 25 was used in analyzing data with 0.05 as the significance level. The descriptive statistics such as frequency (percentage) and mean (±standard deviation) were used to summarize as appropriate to the level of measurement, the subjects' demographic, and clinical characteristics. The PROCESS macro version 3.5.3 for SPSS was used for the mediation analysis in this study. The PROCESS mediation analysis was done while controlling the variables of age, gender (0=male and 1=female), number of family members, income, and body mass index (BMI). The PROCESS mediation analysis was done using bootstrapping of 5,000 samples and 95% as the confidence level for all confidence intervals (CIs) in output.

Table 1. Demographic & clinical characteristics of the subjects (N=485)

Characteristic	Mean±SD or n (%)
Age (years)	16.1±0.77
15 years	111 (22.9)
16 years	230 (47.4)
17 years	132 (27.2)
18 years	12 (2.5)
Gender, female	250 (51.5)
Number of family members	4.76±1.26
3 members	79 (16.3)
4 members	154 (31.8)
5 members	117 (24.1)
≥6 members	135 (27.8)
Family income ($)	1044.3±299.6
≤1140 (below the poverty line)	243 (50.1)
>140	242 (49.9)
BMI	21.38±3.94
Underweight (<19)	122 (25.2)
Normal (19-25)	297 (61.2)
Overweight (>25)	66 (13.6)
Smoking status	
Non-smokers	437 (90.1)
Smokers	48 (9.9)
Hours of e-devices use/day	5.26±4.0
Total psychological distress scores (DASS-21)	42.52±20.29
Total insomnia severity index scores	8.76±4.6
No insomnia (0-7)	222 (45.8)
Subthreshold/mild (8-14)	212 (43.7)
Moderate insomnia (15-21)	48 (9.9)
Severe insomnia (>22)	3 (0.6)
Total hours of sleep time (including naps)/day	8.63±2.01

Note. SD: Standard deviation; DASS-21: Depression anxiety stress scale-21; MSPSS: Multidimensional scale of perceived social support

Table 2. Correlation among subjects' characteristics & main study variables (N=485)

	1	2	3	4	5	6	7
Age	--						
Gender	.176**	--					
NFM	.125**	.048	--				
Income	-.143**	.012	-.038	--			
BMI	.090*	-.021	.086	.057	--		
HEDU	.099*	.074	-.029	.008	.009	--	
Total DASI-21	.202**	.144**	.149**	-.041	.107*	.160**	--
IS	.090*	.026	-.016	-.073	.060	.077	.386**

Note. *Correlation is significant at the 0.05 level (2-tailed); **Correlation is significant at the 0.01 level (2-tailed); NFM: Number of family members; HEDU: Hours of e-devices use; IS: Insomnia scores

RESULTS

Subjects' Characteristics & Scores on Main Study Variables

The subjects' mean age was 16.1 (±0.77) years (**Table 1**). About half of the subjects were females and under the poverty line of about $1,140. The average number of family members was 4.76 (±1.26) members, with the majority having four members. The majority of subjects were non-smokers and had a normal BMI.

The subjects had a high mean of daily e-devices use (5.26 ±4.0 hours, **Table 1**) but moderately low total psychological distress scores (DASS-21, mean was 42.52±20.29) indicating a mild distress level. Regarding the subjects' sleep, subjects had a good mean of total hours of sleep /day (8.63±2.01 hours) and a mean of insomnia scores of 8.76±4.6 indicating a subthreshold insomnia. Most subjects were categorized in either the "no insomnia" group or the "mild insomnia" group.

Table 2 shows correlation among subjects' characteristics and main study variables. The hours of e-devices use had a weak but significant positive correlation with psychological distress scores. There was no significant association between the hours of e-devices and insomnia. The psychological distress scores had a significant positive association with insomnia, indicating an increase in psychological distress scores is associated with increased (worse) insomnia. The other correlations are presented in **Table 2**.

Mediating Effect of Psychological Distress on Relationship Between the Hours of E-Devices Use and Insomnia

The regression analyses indicated that the hours of e-devices use were not a significant predictor of the insomnia scores (model 1, **Table 3**) but a significant predictor of psychological distress (model 2, **Table 3**). Insomnia was significantly predicted by psychological distress only when both psychological distress and e-devices use entered simultaneously into the regression model (model 3, **Table 3**).

Using PROCESS macro for SPSS, we conducted a post-hoc mediation analysis using bootstrapping (the number of

Table 3. Standard multiple linear regression analyses with the psychological distress scores as a mediator of the relationship between the hours of e-devices use (independent variable) and Insomnia scores as dependent variable (N=485)

Model/ predictors	B	SE	β	t	p	LLCI	ULCI
1. Outcome: Insomnia (dependent variable)							
Hours of e-devices use	.0786	.0524	.0684	1.4994	.1344	-.0244	.1816
Age	.4160	.2821	.0696	1.4744	.1410	-.1384	.9703
Gender (ref=female)	.1112	.4244	.0121	.2621	.7934	-.7227	.9452
Number of family members	-.1140	.1675	-.0312	-.6807	.4964	-.4431	.2151
Income	-.0015	.0010	-.0685	-1.4914	.1365	-.0034	.0005
Body mass index	.0696	.0534	.0596	1.3026	.1933	-.0354	.1745
	F(6, 478)	**=1.699**	**R=.1445**	**R^2=.0209**	**p=.1192**		
2. Outcome: Psychological distress (the mediator)							
Hours of e-devices use	.7140	.2223	.1409	3.2124	.0014	.2773	1.1508
Age	3.7958	1.1966	.1440	3.1721	.0016	1.4445	6.1471
Gender (ref=female)	4.2172	1.8001	.1039	2.3428	.0195	.6802	7.7543
Number of family members	1.9645	.7104	.1219	2.7655	.0059	.5687	3.3603
Income	-.0022	.0042	-.0235	-.5325	.5946	-.0104	.0060
Body mass index	.4434	.2265	.0861	1.9571	.0509	-.0018	.8885
	F(6, 478)	**=8.3591**	**R=.3082**	**R2=.0950**	**p=.0000**		

Table 3 (Continued). Standard multiple linear regression analyses with the psychological distress scores as a mediator of the relationship between the hours of e-devices use (independent variable) and Insomnia scores as dependent variable (N=485)

Model/ predictors	B	SE	β	t	p	LLCI	ULCI
3. Outcome: Insomnia (dependent variable)							
Hours of e-devices use	.0152	.0491	.0132	.3096	.7570	-.0813	.1117
DASS-21	.0887	.0100	.3915	8.8738	.0000	.0691	.1084
Age	.0791	.26544	.0132	.2992	.7649	-.4404	.5986
Gender (ref=female)	-.2630	.3959	-.0286	-.6645	.5067	-1.0409	.5148
Number of family members	-.2883	.1566	-.0789	-1.8417	.0661	-.5960	.0193
Income	-.0013	.0009	-.0593	-1.3961	.1647	-.0031	.0005
Body mass index	.0302	.0497	.0259	.6077	.5437	-.0675	.1279
	F(7, 477)	**=12.943**	**R=.3995**	**R^2=.1596**	**p=.0000**		

Note. B: Unstandardized; β: Standardized coefficients; LLCI & ULCI: Lower limit & upper limit confidence interval (CI); CI=95%; SE: Standard error

Table 4. The PROCESS macro post-hoc mediation analysis using bootstrapping of the effect of psychological distress scores as a mediator on the relationship between hours of e-devices use and insomnia scores

Effect	Effect	SE	t	p	LLCI	ULCI
Total effect of X on Y	.0786	.0524	1.4994	.1344	-.0244	.1816
	Effect	**SE**	**t**	**p**	**LLCI**	**ULCI**
Direct effect of X on Y	.0152	.0491	.3096	.7570	-.0813	.1117
	Effect	**Bootstrap SE**	**Bootstrap LLCI**	**Bootstrap ULCI**		
Indirect effect(s) of X on Y	.0634	.0222	.0204	.1081		
Partially standardized indirect effect(s) of X on Y	.0138	.0048	.0044	.0233		
Completely standardized indirect effect(s) of X on Y	.0552	.0190	.0173	.0925		

Note. LLCI & ULCI: Lower limit & upper limit confidence interval (CI); CI=95%; SE: Standard error; The number of bootstrap samples was 5,000

Table 5. Standard multiple linear regression with Insomnia as a mediator of the relationship between the hours of e-devices use (independent variable) and psychological distress as dependent variable (N=485).

Model/ predictors	B	SE	β	t	p	LLCI	ULCI
1. Outcome: Psychological distress (dependent variable): see model 2, Table 3							
2. Outcome: Insomnia (the mediator): see model 1, Table 3							
3. Outcome: Psychological distress (dependent variable)							
Hours of e-devices use	.5886	.2066	.1161	2.8486	.0046	.1826	.9946
DASS-21	1.5965	.1799	.3619	8.8738	.0000	1.2430	1.9501
Age	3.1316	1.1123	.1188	2.8155	.0051	.9460	5.3173
Gender (ref=female)	4.0397	1.6695	.0996	2.4196	.0159	.7591	7.3202
Number of family members	2.1465	.6591	.1331	3.2567	.0012	.8514	3.4416
Income	.0001	.0039	.0013	.0311	.9752	-.0075	.0078
Body mass index	.3323	.2105	.0645	1.5788	.1150	-.0813	.7459
	F(7, 477)	**=19.5796**	**R=.4724**	**R^2=.2232**	**p=.0000**		

Note. B: Unstandardized; β: Standardized coefficients; LLCI & ULCI: Lower limit & upper limit confidence interval (CI); CI=95%; SE: Standard error

bootstrap samples for percentile bootstrap CIs was 5,000 with a CI of 95%, **Table 4**).

The result showed that the relationship between the hours of e-devices use, and insomnia was mediated by psychological distress scores with an effect of .0552, and CI for the completely standardized indirect effect(s) of X on Y were .0173 and .0925, respectively.

Mediating Effect of Insomnia on the Relationship Between the Hours of E-Devices Use and Psychological Distress

The results related to examining the role of insomnia as a mediator of the relationship between the hours of e-devices use and psychological distress are presented in **Table 5** and **Table 6**. The number of hours of e-devices use was a significant predictor of psychological distress (model 1, **Table 5**). The insomnia scores were not predicted by the duration of the hour's adolescents use e-devices hours (model 2). When both insomnia scores and hours of e-devices use were entered simultaneously into the regression model (model 3, **Table 5**), both were significant predictors of psychological distress.

Post-hoc mediation analysis using bootstrapping (**Table 6**) showed that insomnia did not mediate the relationship between the hours of e-devices use and psychological distress with the effect was .0247 and CI for the completely standardized indirect effect(s) of X on Y were (-.0064 and .0578).

DISCUSSION

This study examines the relationship between e-devices use, İnsomnia, and psychological distress with insomnia and psychological as mediators. Our findings revealed that the relationship mediates psychological distress between hours of e-devices use and insomnia. Still, the relationship between the hours of e-devices use and psychological distress scores was not mediated by insomnia. The current findings support adolescents' proper use of e-devices as it has shown that excessive e-devices use associated with more psychological distress as well as İnsomnia [30,46,47]. And in line with the previous study, which indicated that insomnia mediated the relation between excessive e-devices use and psychological distress such as depression, anxiety, and stress [48].

The significant effect of the duration of hours of e-devices use on psychological distress in our study is in line with many

Table 6. The PROCESS macro post-hoc mediation analysis using bootstrapping of the Insomnia as a mediator on the relationship between hours of e-devices use and psychological distress scores

Effect	**Effect**	**SE**	**t**	**p**	**LLCI**	**ULCI**
Total effect of X on Y	.7140	.2223	3.2124	.0014	.2773	1.1508
	Effect	**SE**	**t**	**p**	**LLCI**	**ULCI**
Direct effect of X on Y	.5886	.2066	2.8486	.0046	.1826	.9946
	Effect	**Bootstrap SE**	**Bootstrap LLCI**	**Bootstrap ULCI**		
Indirect effect(s) of X on Y	.1255	.0847	-.0311	.2981		
Partially standardized indirect effect(s) of X on Y	0062	.0042	-.0015	.0148		
Completely standardized indirect effect(s) of X on Y	.0247	.0164	-.0064	.0578		

Note. LLCI & ULCI: Lower limit & upper limit confidence interval (CI); CI=95%; SE: Standard error; The number of bootstrap samples was 5,000

previous studies [49-51]. This study may contribute to a better understanding of the interrelations among modifiable lifestyle factors and potentially guide the development of early intervention and prevention strategies. However, insomnia's insignificant mediation effect on the relationship between the hours of e-devices use and psychological distress scores does not exclude the importance of maintaining good sleep during adolescence. Having a good sleep minimizes psychological problems and prevents the onset of psychological distress. Regarding the pathway, our results revealed that the e-devices activities were indirectly associated with insomnia through psychological distress. Furthermore, two meta-analyses showed a significate negative effect of e-device duration on young adolescents' sleep [21,22]. Additionally, adolescents with insomnia are more likely to report comorbid psychological distress such as depression and anxiety than those without sleep problems [18,36].

The adolescents in our study have a duration of e-devices use (five hours) higher than the recommended duration of a maximum of two hours [52]. This increased duration is consistent with findings of many previous studies among adolescents [5,53] and the dependence of adolescents on e-devices use [36,54-56]. In addition, adolescents in our study have moderate level of psychological distress similar to some previous research studies [57,58] but a higher level than those reported by others [59,60]. It could be from the influence of culture, which may interpret the differences between psychological distress among the population, society, heredity, and environmental factors [61]. For example, subjects in our study had higher psychological distress than Indians [59] and Malaysian adolescents [62] but lower than those reported by [53].

Excessive use of e-devices can provoke adverse psychological problems [5,18,19,63]. In our study, hours of e-devices predicted adolescent psychological distress, similar to findings reported by previous studies [64,65]. Adolescents rely more on e-devices for mood modification as the brain's reward system [66] releases endorphins and dopamine [67]. That can contribute to addictive use and symptoms of psychological disorders [68,69], and cause impulsivity [70], similar to substance addictions to drugs or alcohol in many domains [71].

Excessive e-devices use can cause an imbalance in the gamma-aminobutyric acid brain chemistry, which correlates with developing depression and anxiety [69], as it could be used as a coping mechanism [72-74]. Moreover, e-devices can be solitary activities, reducing adolescents' opportunities to engage in face-to-face social contact. These relieving of social deprivation and isolation have unique effects on the brain and behavioral development, which are also implicated in psychological problems [75]. This cycle could further initiate or worsen psychological wellbeing and trigger other e-devices addictions [76]. Subjects who use e-devices for approximately five hours per day can cause severe trouble with psychological wellbeing and sleeping habits [23], while others indicate that those problems are common among those who use e-devices for more than six hours [30]. One explanation for these mixed effects might be that it is not the frequency of e-devices use itself that disrupts sleep and sleep-related parameters but that the way adolescents experience their e-devices influences the relationship between e-devices and sleep [77]. The reason may be that the use of e-device was not linked to the biological clock of the sample and its effect was not evident in this regard, although those adolescents slept less than recommended [52]. The failure to exert self-control in using e-devices and, more generally, to control adolescents' e-devices use is related to the maladaptive use.

The literature suggests a complex bidirectional relationship between sleep problems, including insomnia and psychological disorders [27,78], adolescents with psychological issues may have difficulty initiating or maintaining sleep and have difficulty awakening in the morning [79,80]. Several possible mechanisms could explain the relationship between insomnia and psychological distress among adolescents. First, screen light emitted from e-devices can affect sleeping patterns by altering adolescents' circadian rhythm and hormone levels of melatonin-suppressing effect, especially during bedtime [6,81]. Using e-devices in the last hour before sleeping for a long time at the onset of latency and increasing the lack of sleep cause a positive correlation between e-device use in bed and insomnia as a study by [82,83]. Second, a short duration of sleep adversely affects levels of neurotransmitters that regulate and express emotions of brain function [84]. It is also resulting differences in brain functions [85], including working memory, inhibitory control, anger, aggression behavior, and development of psychiatric disorders [86,87]. Third, sleep deprivation could be related to increased cortisol response, and dysregulation of cortisol and pubertal hormone levels among adolescents can cause insomnia and psychological disorders [88-90] and indices of physiological hyperarousal [91]. Finally, insufficient sleep can make the preservation of healthy active living more difficult due to subsequent sleepiness, and daytime impairments pose severe health threats [92]. Further, it was suggested that family relationships, economic conditions, and academic school pressure were related to real psychological distress.

In conclusion, to support healthy e-devices usage, strategies to relieve the harmful psychological effect of e-devices use on psychological distress might benefit from enhancing sleep quality. The potential pathways linking e-devices to psychological distress and insomnia have not been fully realized. Therefore, timely diagnosis and management of sleep disorders appear critical for growth and development in

adolescents. There is a need to confirm this relationship in a longitudinal study with a larger sample size in future studies.

Limitations and Implications

Although our study has many strengths, such as using reliable and valid tools, a fairly large sample, and randomized sampling that may help generalize the findings. Nevertheless, the study's cross-sectional design limits inferring of the cause-effect relationship. All variables were evaluated through a self-report questionnaire, which may lead to social desirability bias. It is highly recommended to add objective measures of the variables. Future studies may benefit from comparing findings from subjective and objective measures. Although this study was conducted in two randomly selected secondary schools, it could not represent all Jordan's adolescent students of both genders. Future research should increase the representativeness of the sample. Further, longitudinal and experimental studies are needed to allow attribution of causation. Despite these limitations, our study extends the previous results regarding the relationship between e-devices, sleep problems, and psychological distress by estimating the mediating effects of sleep on the relationship between e-devices and psychological distress among adolescents' students. In our study, we do not specify the used e-devices. At the same time, many authors reported that the positive and negative consequences of e-devices use are contingent on what kind of digital activity is engaged [93].

The study highlights the need for increasing awareness about the effects of e-devices on psychological wellbeing and sleep in adolescents, which should be regularly assessed and monitored, especially in the COVID-19 era and thereafter, where most adolescents become using e-devices more often and owning at least one e-device. It also highlights the need for further research on identifying the effective interventions regarding these issues among adolescents and involving clinicians, teachers, parents, and adolescents to foster proper e-device use and promote psychological wellbeing and healthy sleep habits. Students' curriculum should provide adolescent students with knowledge about the proper use of e-devices and should improve students' self-ability to control or monitor the time they use e-devices, moreover by using psychoeducation training programs and crisis interventions for the high-risk target of psychological problems and the general population, such as time management, problem-solving skills, and finding alternate events to fill the adolescents' free time.

The finding also emphasized the importance of restricting and limiting the total time spent on e-devices using software applications to monitor and prevent e-devices addiction [94]. Although many specific software applications were constructed to help users control their excessive e-devices use, these applications seem to have failed to reduce actual usage [95]. But a natural way maybe by using parental restricting styles intervention [96] and self-regulation as a protective influence on adolescents' excessive e-devices uses [97,98]. Moreover, in a systematic review meeting, the recommendations ensure the combination of physical activity, sedentary time, and sleep duration to improve psychological well-being among adolescents [99]. Additionally, based on the current findings, future research should focus on the interventions related to excessive e-devices use and concentrate on sleeping problems and psychological distress. Given that e-devices use is a novel introduction to the psychological disorder's domain, its significant association with psychological distress requires serious consideration to provide strategies at the community and school levels to avoid excessive e-devices.

CONCLUSION

The results showed that both severities of psychological distress and sleep disruption were positively associated with high e-devices use. This study found that insomnia did not mediate the relationship between excessive hours of e-devices use and psychological distress. The relationship between e-devices use and insomnia was mediated by psychological distress. The hours of e-devices use, psychological distress, and insomnia were mediated. Throughout the consequences of prolonged e-devices, use a strict need to teach healthy habits to limit the total time spent on e-devices, especially knowing that e-devices technology is here to stay and grow with time.

Thus, as recommended in the current study, we should consider both domains of psychological distress and sleep problems when we come across e-devices excessive use, considering the potentially more significant impact of e-devices on psychological distress. We propose that insomnia may become part of the routine evaluation. Higher levels of e-devices use more psychological distress and more considerable sleep problems.

The present study's results emphasize promoting healthy sleep patterns and early detection of sleep problems among adolescents with excessive e-devices. The potential causality between high e-devices use and psychological disorders warrants additional research in the future. The data indicate that insomnia and other psychological distress severely influence adolescents' future health and functioning. There are sudden, pre-significant symptoms of psychological distress among adolescents, which happen when excessive e-devices start coming. Psychological distress can also lead to sleep problems and need to be identified and treated appropriately. Psychological and sleep problems have a complex and bidirectional interrelation. Attentions exist for online gaming disorder.

The findings of our study may raise the points of giving effective collaborative community-based programs to protect this age group. The study supports policymakers and a collaborative team of parents, educators, and health professionals such as school nurses to prevent the harmful effects of excessive e-devices. These data suggest that primary care settings such as schools might provide policies to limit the time spent on e-devices.

Further investigations should also focus on examining the relationship between e-devices use and psychological wellbeing, which could clarify why the excessive use of e-devices use can be the risk of developing sleep problems. Crisis interventions and education programs should target high-risk groups with psychological distress and sleep problems and the well-functioning general population.

Based on the findings of this study, the following recommendations are suggested to avoid the detrimental impacts of hours of e-devices use and psychological distress. First, parents should limit the hours of e-devices use; second, schools should educate students about the effects of e-devices use. Third, conducting further research on e-device effects, psychological and sleep problems. Finally, conducting other

studies on specific interventions to improve health with excessive e-devices used among that age group in Jordan and conducting interventional studies to help adolescents in inappropriate use of excessive e-devices use.

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