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Original Article

The correlation between smart device usage & sleep quality among UAE residents

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A B S T R A C T

Background: The usage of smart-devices has increased considerably both globally and specifically in Middle Eastern countries. Recently, it has been shown that 65% of United Arab Emirates (UAE) residents lack proper sleep. Several health aspects of the relationship between over usage of smart-devices and poor sleep quality have not been thoroughly investigated. This study aims to determine the correlation between smart-device overuse and sleep quality among UAE residents.
Methods: This is a cross-sectional, self-administered questionnaire-based study. Our sample comprised 494 participants, from the three major cities in the UAE. Statistical and regression analyses were conducted using SPSS.
Results: Overall, 47.5% of the population were considered heavy users of smart-devices, of which 81% were poor sleepers. Furthermore, the physical proximity of the smart-device at night affected sleep quality; as the distance decreased, the sleep quality worsened, reaching a value of 86.8%. It was also found that 74.5% of the participants used their smart-device at bedtime.
Conclusion: Poor sleep is strongly correlated with smart-device overuse. Specifically, poor sleepers were five times more likely to be overusers. The intensity and duration of smart-device usage during the whole day impacted sleep quality more drastically than just before bedtime usage. With the increasing dependence and inappropriate use of smart-devices, future studies are needed to further understand the short and long term impact of this trend on the health and wellbeing of younger individuals as well as the whole community.

1. Introduction

Smart-device usage has increased significantly worldwide in the last decade, according to recent ICT (Information and Communication Technologies (ICT) and World Health Organization (WHO) reports [1], coinciding with total cell phone subscriptions reaching to 6.9 billion in 2014. As of June 2017, 77% of American adults own a smart-device, leading to smart-devices being the most quickly acquired product in recent history. It was also found that 92% of young adults (ages 18 through 29) owned a smart-device, and 42% of adults over the age of 65 owned a smart-device [2]. Although the share of digital contribution to gross domestic product (GDP) is lowest in the Middle East (4.1%) compared to Europe (6.2%) and the United States (8%), there is a fast-growing interest and investment in digital technology [3]. In the Middle East alone, the cross-border data flow to the world has increased 150-fold in the past decade, with each country contributing differently to this digitalization. The United Arab Emirates (UAE) itself is one of the top countries in the world for digital consumption with 100% smartphone penetration and more than 70% social media adoption [3]. The average daily use of the mobile phone is 3 h and 45 min, with 7.27 million out of the 9.58 million people in the UAE using the internet on their mobiles [4].

It is known that smart-devices produce electromagnetic fields, although their adverse effect on human health has yet to be thoroughly explored. The brain is the organ most affected by cell phone radiation, which is thought to be connected to higher risk of brain tumors, as established in multiple research studies [5–7], although

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these conclusions are still controversial. Other effects of cell phones on brain activity include psychological repercussions. A cohort study showed that high mobile phone use was associated with symptoms of depression at a one-year follow-up [8]; the same research also showed a cross-sectional correlation between frequent use of mobiles and stress. The central nervous system (CNS) regulates sleep, which is vital for proper cognitive, metabolic, and immune functions. The blue light emitted from the mobile screen, specifically in the 460-nm range, delays the release of melatonin and, as a result, sleeping hours are shortened [9,10].

Proper sleep is defined as having uninterrupted sleep for an adequate time and waking up refreshed. On the other hand, poor sleep is defined as having difficulty in falling asleep and waking up tired [11]. Currently, reduced sleep quality is increasing dramatically. A study in the UAE showed that 67.2% of the students in the UAE have poor sleep quality [12], based on the Pittsburgh Sleep Quality Index (PSQI). Reduced sleep quality can be both a risk factor and a sign of other psychological diseases (DSM-V), which may lead to psychological and physical problems. That is why it is critically important to investigate the causes of reduced sleep quality among the population.

The objectives of this study are to determine: (a) the purpose and the amount of time spent using smart-devices and the time of the day they are mostly used; (b) whether the impact of smart-device usage on sleep varies from one age group to another, and what the typical coping mechanisms of inadequate sleep are to maintain daily functional activities; (c) the frequency of sleep disturbances and its impact on lifestyle, academic performance, sport, and social activities, as well as the contributing factors that affect sleep quality; and (d) the level of awareness UAE residents have of smart-device overuse and sleep quality satisfaction.

2. Methodology

2.1. Study design

A cross-sectional study was used in the form of a self-administered questionnaire. Demographics, behavioral, and outcome variables were measured in the form of a questionnaire that was written in both the Arabic and English languages.

2.2. Setting

Following a short pilot study, the questionnaires and the proposal were approved by the Research Ethics Committee of the University of Sharjah. The data collection was conducted by research group members using the same standardized methods.

2.3. Participants

Our target population was the three major cities in the UAE: Sharjah, Dubai, and Abu Dhabi. The three cities comprise 90% of the UAE population, which is known for its diversity in nationalities, particularly in the city of Dubai. The questionnaires were distributed among the UAE residents who were from 18 to 50 years of age, from different public places, who understood Arabic or English and have owned a smart-device for more than a year. Participants were selected based on a Non-Randomized Quota sampling method, where our target of 500 subjects was divided, using the UAE census according to the size of the cities and gender ratios [13–15].

Thus, 210 participants were from Abu Dhabi (66% males and 34% females), 185 were from Dubai (70% male and 30% female), and 105 were from Sharjah (65% male and 35% female).

2.4. Study size

The formula used to determine the required sample size was based on the expected prevalence ($\boldsymbol{p}$) of sleep deficiency among individuals who use their smart-devices excessively before sleeping. Other research articles conducted on the same topic were in regions with different economic, social, and cultural statuses; thus, the expected prevalence in this study was taken to be 50%. Therefore, we used the following formula:

$$\boldsymbol{n} = \frac{4\boldsymbol{p}(1-\boldsymbol{p})}{\boldsymbol{SE}\hat{}2}$$

With p = 50% and sampling error (SE) = 5%, our sample size would have been 385. However, the sample size was increased to 500 to take into consideration possible missing/corrupted data, no responses, as well as to decrease the margin of error. A total of 542 questionnaires were collected; however, as missing data would have disrupted scoring the most important scale, the PSQI, 48 questionnaires were partially discarded, due to the fact that the PSQI segment of these questionnaires was not completely answered by participants and therefore could not be counted as completed questionnaires to use for data analysis.

2.5. Variables

The questionnaire (Appendix A) covered our three main objectives: smart-device usage, sleep quality, and impact of smart-devices on sleep. Our questionnaire contained both open-ended and close-ended questions as well as other scales and validated tools. It was constructed of 52 questions divided into five sections: Demographics (four questions), Smart-device Usage details [Cell phone Overuse Scale] (24 questions), which is our main exposure, Sleep Quality (15 questions) and Impact of Device Usage on Sleep (five questions), which are our main outcomes, and lastly, Knowledge and Attitude (four questions). In order to ask about modifiers of smart-device usage, the screen size, the total number of and the number of years since owning a smart-device, were addressed. To eliminate potential confounders, we asked the participants, “Which of these factors do you think could affect your sleep?” and also provided them with exhaustive categories. The participants could add to the list as well. We controlled for the age and gender of participants while analyzing the results. Ages were grouped into three categories according to Erikson's stages of psychological development [16] as follows: 18 to 23 were classified as “Adolescents,” 24 to 32 as “Early Adulthood” while people whose ages were between 33 and 50 were placed in the “Middle Adulthood” group.

2.6. Data sources

2.6.1. Pittsburgh sleep quality index (PSQI)

The PSQI is composed of 19 self-rated questions that are designed to measure the sleep quality of participants over one month. It specifically measures the following through seven component scores: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medication, and daytime dysfunction. The sum of the scores is calculated, and subjects whose scores are above 5 are considered poor sleepers [17].

2.6.2. Cell phone Overuse Scale (COS)

The cell phone Overuse Scale consists of 21 questions and was developed and reported earlier [18] to have a validity of 0.903, calculated using Cronbach's alpha and a reliability of 0.714, with a significance of 0.001. Each question measures the use of cell phone devices with a score between 1 and 5. Whether the person is an overuser or a light user is based on the 75th and 25th percentiles, respectively.

2.7. Statistical analysis

Our statistical analysis used SPSS (Windows Version 23, SPSS Inc., Chicago, IL, USA). We used various functions of the program to analyze the results, such as frequencies to validate our Quota sample, Pearson Chi-square cross tabulation to link the interaction between sleep quality and smart-device users, odds ratio to estimate the risk of smart-device overuse, as well as logistic regression for the correlation between sleep quality and smart-device and bedtime usage. Moreover, the relationships among different subgroups were also studied, such as age, gender, smart-device overuser, and poor sleepers. Missing data were not included in the analysis.

3. Results

3.1. Demographics

A total of 542 participants answered the questionnaire; however, 48 of these did not complete the PSQI. Thus their questionnaires were not included in the analysis, leaving 494 PSQI completed questionnaires. The mean age of the participants was 29.45 (SD = 8.348), for males 29.26 (SD = 8.340), and for females 29.82 (SD = 8.378). Refer to Table 1 for a more detailed portrayal of demographic data.

3.2. Light users and heavy users

The majority (68.6%) of heavy users were from the early adulthood age group [χ^2 (1, N = 255) = 8.476, p = 0.014]. Nearly half (47.5%) of the population were considered heavy users according to our smart-device usage scale, with the majority being males, accounting for 62.0% of the total participants. At the same time, it was found that in the male population, 44.6% were heavy users compared to 52.9% of females [χ^2 (1, N = 255) = 1.557, p > 0.05]. It was also found that from the participants who use their smart-device most of the time, 58.1% were heavy users [χ^2 (1, N = 255) = 8.456, p = 0.003].

Out of the total participants, 75.5% used their smart-device at bedtime, of which 58.4% were heavy users [χ^2 (1, N = 255) = 35.974, p = 0.000]. In addition, 85.1% of heavy users left their device “ON” while they were sleeping. [χ^2 (1, N = 253) = 1.344, p = 0.246, OR = 0.680, 95% CI (0.353; 1.309)].

It was found that most of the participants who use their smart-devices at bedtime (63.5%) were within the early adulthood age group [χ^2 (2, N = 494) = 20.107, p < 0.001]. Of these, most of the usage (57%) was for social media, 54.5% for communication, 39.5% for multimedia, 35.7% for internet surfing, and 25.2% for games.

There was a strong relationship between poor sleepers and the proximity of their phone while they were sleeping [χ^2 (2, N = 406) = 21.583, p < 0.001]. Out of the participants that put their smart-devices under their pillow, 86.8% were poor sleepers. This number decreased as the smart-device was placed further from the participant, as shown in Fig. 1. In addition, it was found that out of the participants that would always wake up in the middle of the night, 94.1% were poor sleepers [χ^2 (3, N = 408) = 30.533, p < 0.001]. Of the participants that never had their sleep interrupted by a smart-device, 51.8% were poor sleepers; of those who would sometimes have their sleep interrupted, 67.2% were poor sleepers, while those who would often have their sleep interrupted, 87% were poor sleepers and of those who would always have their sleep interrupted, and 100% were poor sleepers [χ^2 (3, N = 406) = 29.252, p < 0.001]. Moreover, of the participants that never noticed changes in their sleep when they used their smart-devices excessively, 48.2% were poor sleepers, while those who sometimes noticed changes in their sleep, 65% were poor sleepers, and of those who often noticed changes in their sleep, 81.1% were poor sleepers, and of those who always noticed changes in their sleep, 92.7% were poor sleepers [χ^2 (3, N = 493) = 47.356, p < 0.001].

Table 2 shows the cross-tabulation of selected variables with the PSQI (Poor vs. Good sleepers) and the Odds ratio (OR) of each. At the same time, we found a relationship between each of the following components of PSQI (Table 3) and usage of smart-devices: The scores of the first component – subjective sleep satisfaction – (p-value = 0.004) of PSQI correlate with the state of the heavy use of a smart-device. As the score increases, the percentage of heavy users increases, of the second component – sleep latency – (p-value = 0.000), the fourth component - sleep efficiency - (p-value = 0.000), the fifth component - Sleep disturbances - (p-value = 0.000) and the seventh component – Daytime dysfunction – (p-value = 0.020) is also related to smart-device overusers.

A binary logistic regression model was conducted using the enter method to predict among a group of 494 subjects their sleep quality according to two predictor variables (All times Usage and Bedtime Usage). The model explained between 14% and 19% of the variance in the outcome variable. Overall, the model was able to predict 67.8% of all cases. Using the enter method, one of the two predictors significantly predicted subjects' poor sleep quality, where the overuse of smart-devices was associated with an increased likelihood of having poor sleep quality (OR = 5.178, 95% CI 2.834–9.463, p = 0.000) (Table 4).

When asked about what has been affected by their poor sleep, 46.3% of people responded that their performance at work was what was most negatively affected, while 34.9% said that their social life suffered the most. Further, 28.5% mentioned physical activity as the most significantly affected area, 41.6% identified their health as the area of most concern, and 11.4% identified a variety of different areas that were affected (eg, driving and difficulty in concentration).

The coping mechanisms for poor sleepers were as follows: 12.3% smoked, 47.2% drank coffee, 32.7% napped, 13.9% showered, 11% exercised and 12.7% did other things (eg, washing their faces, drinking hot beverages and energy drinks, watching movies, etc.). When we inquired about what factors affect people's sleep, poor sleepers identified the following: 55.2% chose work/homework, 19.1% had medical conditions, 25.4% answered home responsibilities, 9.7 selected transportation and traffic, 58.9% answered worries and stress, 18.8% stayed up as a result of hunger, and 5% chose others (gaming, smart-devices, social life, noise… etc.). Regarding participant's satisfaction, 20.6% of poor sleepers were not satisfied with their sleep, 32.2% of them were slightly satisfied, 34.1% were moderately satisfied, 9.1% were very satisfied, and 3.8% were extremely satisfied. Of 67% of those who thought they suffered from poor sleep quality were actual poor sleepers. Regarding the knowledge section of the questionnaire, 59.4% of people thought that smart-devices affected their sleep, 62.3% thought that prolonged use of smart-devices can cause health-related issues, 67.1% are worried about the risks of using smart-devices, and 77.2% think about the adverse effects of smart-devices.

4. Discussion

In the current study, we aimed to investigate the relationship between smart-device usage and sleep quality among UAE

Table 1
Shows the demographic data organized into age subgroups depending on Erikson's stages of psychological development and represented as frequencies.

Demographics	Erikson's Age Group				
	Adolescent *No. (%)*	Early Adulthood *No. (%)*	Middle Adulthood *No. (%)*	Total *No. (%)*	P-value
Cities					
Dubai	40 (8.10%)	114 (23.10%)	18 (3.60%)	172 (34.8%)	>0.05
Abu Dhabi	33 (6.70%)	132 (26.70%)	33 (6.70%)	198 (40.1%)	
Sharjah	36 (7.30%)	68 (13.80%)	20 (4.00%)	124 (25.1%)	
Gender					
Male	76 (15.4%)	203 (41.1%)	46 (9.3%)	325 (65.8%)	>0.05
Female	33 (6.7%)	111 (22.5%)	25 (5.1%)	169 (34.3%)	
Duration of smart-device usage					
<1 year	2 (0.4%)	4 (0.8%)	0 (0.0%)	6 (1.2%)	>0.05
1–3 years	9 (1.8%)	15 (3.0%)	3 (0.6%)	27 (5.4%)	
4–5 years	23 (4.7%)	51 (10.3%)	9 (1.8%)	83 (16.8%)	
>5 years	75 (15.2%)	244 (49.5%)	58 (11.8%)	76.5%	
Number of smart-device					
1	36 (7.3%)	118 (24.0%)	26 (5.3%)	180 (36.6%)	>0.05
2	41 (8.3%)	129 (26.2%)	31 (6.3%)	201 (40.8%)	
3	17 (3.5%)	37 (7.5%)	9 (1.8%)	63 (12.8%)	
>3	15 (3.0%)	29 (5.9%)	4 (0.8%)	48 (9.7%)	
Usage of smart-device at bedtime					
Yes	95 (19.2%)	237 (48.0%)	41 (8.3%)	373 (75.5%)	>0.05
No	14 (2.8%)	77 (15.6%)	30 (6.1%)	121 (24.5%)	

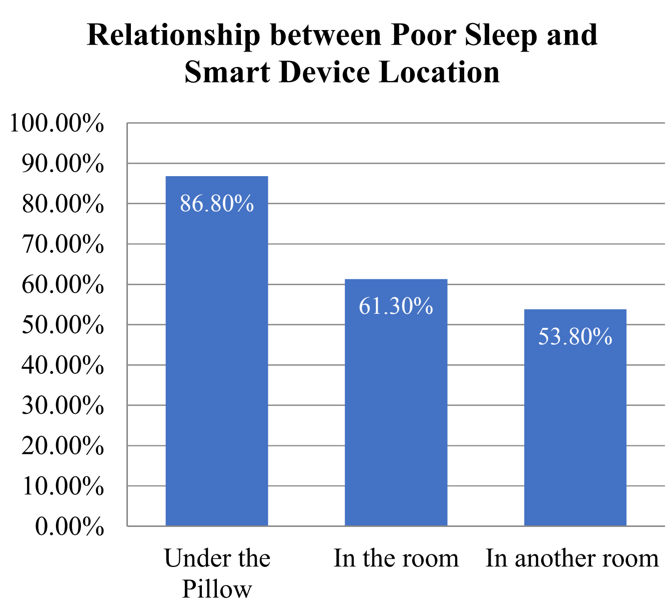

Fig. 1. The prevalence of poor sleep among people who put their device under their pillow was 86.8%, while 61.3% of people who put their device in their room while sleeping had poor sleep and 53.8% of people who put their device in another room had poor sleep [χ^2 (2, N = 406) = 21.583, p < 0.001].

residents, using a questionnaire in a cross-sectional study. The following five points are the primary outcomes of our study:

First, participants who were considered smart-device overusers were five times more likely to have poor sleep quality than regular users. This relationship was concluded in other research studies that were focused mainly on medical students [19,20]. Our study, however, encompassed participants from a broader age group (18–50 years old) and therefore described the majority of the age groups of the population. Two other articles reported comparable results to our study showing the presence of a negative correlation between cell phone addiction and sleep quality [21,22]. The rationale of this result could be due to the smart device's radio frequency electromagnetic field daytime exposure, which may negatively affect the circadian rhythm by decreasing night-time melatonin secretion [23].

Second, there was a strong correlation between sleep quality and the physical proximity of the smart-device to the person. Moreover, another recent report concurs with our results [19]. This correlation is mostly attributed to changes in sleep latency. However, sleep efficiency and duration were not correlated with the location of the smart-device in research done by Regel et al., [24]. It was found that there is a dose-dependent effect of pulsed radiofrequency electromagnetic fields emitted from cell phones on non-REM sleep EEG. The strength of both electric and magnetic fields increases as the distance decreases [25]. This may be a possible explanation as to why the distance from cell phones during sleep is correlated with sleep quality. Third, sleep disruption, whether the participants were interrupted by a smart-device or waking up by themselves to check it is positively correlated with the increasing number of poor sleepers, to the extent that participants who were "always interrupted" are all poor sleepers. This poor sleep due to interruptions could be the result of leaving the smart-device ON during sleep, as demonstrated with borderline significance by more than half of the participants.

Fourth, the correlation between bedtime usage and sleep quality was found and proven by many researchers [20,26–28]. However, our analysis showed that although this is correct, the smart-device usage in the whole day impacted sleep quality more than just-before-bedtime use; this can be attributed to the fact that heavy users will, most likely, be bedtime users. The early adulthood age group was significantly related to bedtime usage; however, there was no significant correlation between age/gender and sleep quality or smart-device usage. Furthermore, it was found that social media was the main reason for smart-device bedtime use.

Fifth, the knowledge and attitudes of the participants showed that they are aware of how excessive use of smart-device is negatively impacting their sleep. It was also observed that stress was a major factor that affected their sleep. Work was found to affect sleep quality and be affected by poor sleep. Drinking coffee was the primary coping mechanism for daytime sleepiness used by the participants, and it is worth mentioning that this could also lead to further sleep disturbances later at night.

Table 2
Cross-tabulation analysis of selected variables from the questionnaire with the main dependent variable, Sleep Quality, and their corresponding *p*-Value (χ2: Pearson Chi-square value, df: degree of freedom).

Variables	Sleep Quality		OR	(95% CI)	χ2	df	*p*-Value
	Poor *No. (%)*	Good *No. (%)*					
COS							
Heavy users (n = 121)	98 (81.0%)	23 (19.0%)					
Light users (n = 134)	59 (44.0%)	75 (56.0%)	5.416	(3.069, 9.558)	36.712	1	<0.001
Gender							
Male (n = 325)	209 (64.3%)	116 (35.7%)					
Female (n = 169)	111 (65.7%)	58 (34.3%)	1.062	(0.719,1.569)	0.092	1	0.762
Do you use smart-device at bedtime?							
Yes (n = 373)	254 (68.1%)	119 (31.9%)					
No (n = 169)	66 (54.5%)	55 (45.5%)	0.562	(0.370,0.855)	7.353	1	0.007
Is it on or off while you are sleeping?							
On (n = 405)	270 (66.7%)	135 (33.3%)					
Off (n = 87)	49 (56.3%)	38 (43.7%)	0.645	(0.402, 1.033)	3.362	1	0.0670

Table 3
A more detailed analysis of selected variables, their means, and cross-tabulation values, with each component of the PSQI.

Variables	PSQI $\bar{x} \pm$ SD	Pittsburgh Sleep Quality Index (PSQI) Components[a]						
		C1	C2	C3	C4	C5	C6	C7
Location of smart-device (N=406)								
Under the pillow	8.88 ± 0.35	1.51 ± 0.08	1.75 ± 0.10	1.19 ± 0.10	1.19 ± 0.12	1.41 ± 0.06	0.42 ± 0.09	1.43 ± 0.10
Away from the bed	6.93 ± 0.19	1.11 ± 0.05	1.25 ± 0.05	1.15 ± 0.05	0.87 ± 0.06	1.23 ± 0.03	0.27 ± 0.04	1.04 ± 0.05
In another room	5.69 ± 1.05	1.00 ± 0.20	0.85 ± 0.27	1.08 ± 0.29	0.69 ± 0.31	1.15 ± 0.15	0.23 ± 0.17	0.69 ± 0.13
χ2[b]	80.852	18.714	29.298	2.938	8.198	10.929	5.751	20.071
df[b]	54	6	6	6	6	6	6	6
p Value[b]	0.010	0.005	<0.001	0.817	0.224	0.091	0.452	0.003
Waking up in the middle of night to check smart-device (N=408)								
Never	6.37 ± 0.23	1.07 ± 0.06	1.10 ± 0.06	1.12 ± 0.06	0.70 ± 0.07	1.15 ± 0.04	0.20 ± 0.05	1.04 ± 0.05
Sometimes	7.74 ± 0.26	1.20 ± 0.06	1.56 ± 0.08	1.18 ± 0.06	1.10 ± 0.09	1.32 ± 0.04	0.33 ± 0.06	1.06 ± 0.07
Often	9.27 ± 0.53	1.59 ± 0.13	1.59 ± 0.15	1.06 ± 0.19	1.47 ± 0.21	1.50 ± 0.11	0.50 ± 0.14	1.56 ± 0.16
Always	10.18 ± 0.94	1.82 ± 0.21	1.53 ± 0.26	1.47 ± 0.24	1.12 ± 0.26	1.68 ± 0.15	0.94 ± 0.29	1.65 ± 0.28
χ2[b]	134.274	28.359	31.236	21.816	31.341	27.667	31.962	20.850
df[b]	54	9	9	9	9	9	9	9
p Value[b]	<0.001	0.001	<0.001	0.009	<0.001	0.001	<0.001	0.013
Sleep interruption by a smart-device (N=406)								
Never	6.12 ± 0.34	1.00 ± 0.08	1.04 ± 0.09	1.11 ± 0.08	0.62 ± 0.09	1.11 ± 0.05	0.30 ± 0.07	0.94 ± 0.09
Sometimes	7.32 ± 0.20	1.20 ± 0.05	1.41 ± 0.06	1.11 ± 0.06	0.97 ± 0.07	1.31 ± 0.03	0.24 ± 0.04	1.08 ± 0.06
Often	9.22 ± 0.52	1.41 ± 0.11	1.63 ± 0.15	1.37 ± 0.13	1.50 ± 0.19	1.35 ± 0.09	0.46 ± 0.13	1.50 ± 0.14
Always	9.79 ± 0.36	1.79 ± 0.20	1.53 ± 0.18	1.53 ± 0.26	1.16 ± 0.27	1.42 ± 0.12	0.79 ± 0.27	1.58 ± 0.26
χ2[b]	106.713	28.928	30.916	13.929	33.354	18.088	15.027	24.586
df[b]	54	9	9	9	9	9	9	9
p Value[b]	<0.001	0.001	<0.001	0.125	<0.001	0.034	0.090	0.003
Noticed sleep changes when started to excessively use smart-device (N=493)								
Never	5.73 ± 0.26	0.88 ± 0.06	0.96 ± 0.07	1.13 ± 0.07	0.57 ± 0.07	1.13 ± 0.05	0.20 ± 0.05	0.86 ± 0.07
Sometimes	7.09 ± 0.23	1.18 ± 0.06	1.35 ± 0.06	1.08 ± 0.06	0.93 ± 0.08	1.26 ± 0.04	0.31 ± 0.05	1.03 ± 0.06
Often	8.16 ± 0.37	1.38 ± 0.08	1.62 ± 0.12	1.26 ± 0.11	1.14 ± 0.13	1.30 ± 0.07	0.34 ± 0.10	1.14 ± 0.11
Always	9.66 ± 0.44	1.73 ± 0.12	1.73 ± 0.12	1.07 ± 0.12	1.47 ± 0.17	1.47 ± 0.08	0.40 ± 0.11	1.78 ± 0.13
χ2[b]	123.552	66.774	45.123	5.726	41.993	25.296	10.373	56.747
df[b]	54	9	9	9	9	9	9	9
p Value[b]	<0.001	<0.001	<0.001	0.767	<0.001	0.003	0.321	<0.001

(χ2: Pearson Chi-square value, df: degree of freedom).
[a] C1: Subjective Sleep Quality, C2: Sleep Latency, C3: Sleep duration, C4: Habitual Sleep Efficiency, C5: Sleep Disturbances, C6: Use of Sleeping Medication, C7: Daytime Dysfunction.
[b] *p*-Value from cross-tabulation with each variable.

Table 4
Binary logistic regression showing the All times usage is affecting sleep quality more significantly than bedtime usage.

Predictor	Exp (B)	95% CI		p
		Lower	Upper	
All times Usage	5.178	2.834	9.463	<0.001
Bedtime Usage	1.150	1.150	0.608	0.668

Hosmer and Leme show test [$\chi^2(2) = 2.825$, p = 0.244] showed that the model adequately fit the data and significantly predicted the outcome variable, sleep quality [Omnibus test $\chi^2(2) = 38.370$, p = 0.000]. Assumption of linearity and collinearity were satisfied.

5. Limitations

Although our study showed reliability by concurring with other published reports, there are a few limitations when considering its validity. First, our PSQI data depended mostly on individuals remembering their sleep patterns throughout the last month, which is subject to recall bias. A more controlled experimental research environment where the participants sleep with attached EEGs would be a better predictor of sleep quality and its relationship to smart-device use. Second, several questions from the two main scales used (ie, the PSQI and COS scale) may have been ambiguous to some participants as had been noted in the Pilot study. In an effort to resolve this, we performed a face-to-face self-administered questionnaire study in case some participants needed questions clarified. Nonetheless, some may have answered incorrectly based on their misunderstanding. Third, some of the variables had a bidirectional relationship with poor sleep. One of the mentioned coping mechanisms used by participants was drinking coffee, which would also lead to poor sleep; coffee can be a significant cause of participants' poor sleep quality. Likewise, participants waking up to check their notifications can cause poor sleep, but it can in turn be a result of their poor discontinuous sleep. As a result of these bidirectional relationships, further studies should be done to determine the primary relationship between those variables and poor sleep. Fourth, the results yielded by the binary regression analysis are rather weak, and further research must be conducted to confirm these results. Thus, this study is an epidemiologic study, and additional experimental studies are needed to establish causality.

6. Generalizability

The results of the current study can be generalized to other countries in the Middle East, and possibly internationally, as the UAE is considered a melting pot setting in which multiple nationalities are present, and thus by default, a variety of ethnicities were covered during the data collection.

7. Conclusion

In conclusion, our results have shown a strong correlation between poor sleep and smart-device overuse. In particular, we suspect that it is the intensity and duration of smart-device usage throughout the day, rather than the timing, that negatively affects one's sleep. Furthermore, poor sleep triggers harmful coping mechanisms to maintain daily functioning, which leads to an unhealthy vicious cycle. With the increasing dependence, inappropriate and unnecessary use of smart-devices, health complications might arise, endangering the user's life, particularly since smart-device usage is not limited to an age group. Toddlers and children nowadays are more dependent on smart-devices [29], which means that further studies need to be done to study the effect of this overuse on the younger age group and to understand how parents' behaviors may contribute to these unhealthy habits.

Conflict of interest

The ICMJE Uniform Disclosure Form for Potential Conflicts of Interest associated with this article can be viewed by clicking on the following link: https://doi.org/10.1016/j.sleep.2019.04.017.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.sleep.2019.04.017.

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