

Are smartphones and tablets influencing the quality of your sleep? A survey

Bert Fabrizio⁽¹⁾, Gualano Maria Rosaria⁽¹⁾, Giacomelli Sebastian⁽¹⁾, Martorana Maria⁽¹⁾, Siliquini Roberta⁽¹⁾

(1) Department of Public Health Sciences, University of Turin, Italy - via Santena 5 bis 10126, Torino, Italy - tel. +390116705875 - fax +390116705889

CORRESPONDING AUTHOR: Dr. Maria Rosaria Gualano - Department of Public Health Sciences, University of Turin, Italy - via Santena 5 bis 10126, Torino, Italy - tel. +390116705809 - fax +390116705889 - email mariarosaria.gualano@unito.it

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ABSTRACT

Background: Electronic media use may affect sleep health. The present study aimed to estimate the association between technological devices usage, especially mobile phone, during the evening/night and self-reported sleep disorders.

Methods: The survey was conducted between June and September 2016. Anonymous self-reported questionnaire was distributed to the Italian general population and investigated demographic data, presence of sleep disorders and the use of electronic devices.

Results: The analysis was based on 597 questionnaires. Mobile phone exposure has been associated with increased difficulty falling to sleep ($p = 0.018$).

The use of mobile phones at bedtime was significantly related to self-reported sleep disturbance ($p < 0.001$).

Using mobile phone more than 60 minutes before going to sleep, the use of these devices in bed, surfing internet remained statistically significant in the multivariate analysis.

Conclusion: Our results suggest that the use of a mobile phone before going to sleep is associated with reporting sleep disturbances. Public health prevention strategies could comprise promotion of optimum sleep habits and information regarding the effects of an intensive electronic devices use on the sleep status.

INTRODUCTION

Sleep is essential for daily functioning as well as mental and physical health and it is regulated by an interaction between three main factors: a homeostatic factor, an endogenous circadian factor, and a behavioral factor [1,2]. The sleep homeostasis reflects the average level of sleep depth and its activity depends on the duration of prior sleep and wakefulness. The circadian factor mainly affects the timing and overall duration of sleep and it is normally influenced by the environmental light-dark cycle [2]. Finally, lifestyle habits can play an important role and

electronic media use may be represented one of these environmental factors displacing significantly sleep time or sleep quality [3].

A number of mechanisms have been proposed by which technological devices use might affect sleep quality or quantity. Media use may directly displace sleep or other activities related to good sleep hygiene [4]. Evening exposure to bright light from television or computer screens may suppress melatonin and consequently delay the circadian rhythm [5]. Electromagnetic radiation emitted by mobile telephones has been reported to change sleep architecture and delay melatonin production [6].

In the past few decades, we have witnessed a sharp increase in the availability and use of electronic devices, such as mobile phones, video game consoles, DVD players, television, audio players, computers, tablets, and given that they are become more lightweight and portable, are used even in bed [2].

Currently, cell phones are not only used for receiving and making calls, but also allow the user to write messages, listen to music, play games, surf the Internet, send emails and record personal information [7]. Their specific applications (the so called apps) could be applied in the social, educational, entertainment and health field and are often free, very easy to download and to use [8,9].

Given the wide-ranging activities a mobile phone provides, its affordability and its portability, this could become the most frequently used media device (day and night) [4,10] and, thus, it would be important understand its potential impact on the sleep.

Some studies have assessed the impact of technological devices on the sleep health detecting associations between technology use and different sleeping disorders regarding sleep onset latency, sleep maintenance and early morning awakening [7,11], but most of them concern children, adolescents or students [1,11-21] and, furthermore, no study has been conducted in Italy.

Thus, the aim of the present study is to investigate the relationship between electronic devices use and sleep disorders.

MATERIALS AND METHODS

The survey was addressed to the Italian general population with a convenience sampling and it was conducted between June and September 2016. Anonymous self-reported questionnaire was distributed in printed form, by public health resident doctors to the general population, or in electronic form, through on-line social networks (Facebook and Twitter).

In particular, the paper form questionnaires were delivered to the participants through the acquaintances in several contexts following the "snowball" way. Instead, the electronic form questionnaires were publicized posting compilation request on many Facebook pages and groups, regarding for example sports, hobbies, tourism, culture and education. In this case the posts explained the protocol of the research (topic and objectives), the university affiliation and, at the end of the request, indicated the link to connect easily to the questionnaire platform.

These multiple methods were performed because web-sampling tends to over-represent younger populations, and thus the option of completing the questionnaire on paper would provide a better representation of older populations. On the other hand, the electronic form guarantees more variability regarding the social and life context.

So, we perform analysis considered the sample as a whole/ in its entirety, then we evaluated separately the "electronic form" and "printed form" groups and we compared each other.

The participants were informed of the purpose and methods of the study and signed an informed consent statement.

The exclusion criteria were: underage, use of psychiatric drugs and presence of sleep disorder diagnosed before the mobile phone owning.

The questionnaire was developed after a literature review of comparable studies and it was validated by a pilot survey conducted on twenty subjects. It includes 32 questions with multiple-choice and open answers and it is divided in three sections: demographic data, presence of sleep disorders and the use of electronic devices.

Demographic data includes questions about age, gender, profession, education level, quality of life self-evaluation. Other factors, that could have an impact on insomnia, were included into the analysis: bedroom sharing, napping, bedtime caffeine, bedtime smoking and alcoholic consumption (responses ranged from *never to every day*).

The second section concerned the type and strength of sleep problems. Participants were asked to indicate how often they have difficulty falling asleep, waking up too early/ early awakening, repeated awakenings and responded on a scale which contained the following alternatives: *never, once a week, many/several times a week, every night*. The outcome variable "sleep disorders" was constructed by including these most common sleep problems in a single item.

Respondents indicated at what hour they went to sleep and fell asleep on weekdays, at what hour they usually woke and got up on weekdays, how many hours of sleep they usually had per day on weekdays. Further questions assessed sleep quality (*satisfactory, slightly unsatisfactory, very unsatisfactory, totally unsatisfactory*) and perceived daytime functioning (tiredness, sleepiness, difficulties in concentrating).

The last section investigates the routine use of different electronic devices (mobile phone, pc, tablet, kindle). Information about mobile phone exposure included the average duration of electronic media use per day, the frequency and duration of electronic media use in the last hour before going bed, the electronic media use in bed in the last hour before sleep, until the time they usually use them at night.

We distinguished between different types of use for some of the electronic media, such as the use of making/receiving calls, sending/receiving SMS messages, surfing, playing or other, and the frequency per week for each of them.

Finally, respondents were queried to indicate the frequency of the following activities performed in the last hour before going to sleep: watching television, reading a book, using computer, listening to music, working/studying, sporting activities, going out with friends (also in this case answer categories ranged from *never to every day*).

Statistical analysis

All analyses were performed using the statistical software package STATA version 13.

A descriptive analysis is conducted to define demographic characteristics, life habits, the sleep features and the modalities of mobile phone use regarding our sample.

Chi Square test was used to examine associations between the mobile phone exposure variables and sleep disorders and in order to assess the possible relationships between potential factors influencing sleep and sleep disturbances variables. Finally, multivariate analysis was conducted through a logistic regression model with the purpose to identify the principal risk factors for sleep disorders. Particularly, in order to identify the variables to insert in the multiple regression analysis, we conducted the collinearity analysis, so we removed items strongly associated to other items and selected the variables to include in the statistical model. The variables included as covariate in the multiple analysis were the following: gender, age class, education level, self-perceived health, sharing bedroom, nap, caffeine beverages, alcohol beverages, smoking, watching television, reading a book, using the computer, listening to music, working or studying, playing sport, going out with friends, total time using mobile phone, phoning, writing messages, surfing internet, hour as far using mobile phone, using mobile phone in bed. The activities listed above were performed at bedtime.

The significance level used for the statistical tests was set at 0.05.

RESULTS

The sample was constituted by 727 subjects. Eighty-one questionnaires were excluded because incomplete and 49 did not meet the inclusion criteria. Basing on the available variables, there were not differences between the respondents and those who did not completed the questionnaire.

The analysis was based on 597 questionnaires remaining, 127 of them in printed form and 470 in electronic form. Of the selected sample, the proportion of female was about 60%, the majority was 25-39 years old and presented an high education level.

Table 1 shows the demographic characteristics of the respondents. Female gender, unoccupied status and poor self-perceived health were positively associated with problematic sleep.

Comparing the "printed form" to "electronic form" groups, some significant differences resulted about demographic and lifestyle characteristics. Particularly, there were older participants in the "printed form" group than on the "electronic form" one (29% vs 10%, respectively) whereas there were younger than 25 years old people in the second group compared to the first one (33% vs 5%, respectively). Moreover, in the first group there were more

conjugated people than in the second (34% vs 12%). Finally, using mobile phone in bed in the last hour before going to sleep is more frequent in the "electronic form" group than on the "printed form" one ($p < 0.01$).

Sleep habits were described in Table 2. In our sample 50.42% of the participants referred difficulty in falling asleep at least once a week, moreover repeated awakenings were reported in 51.27% and waking up too soon in 48% of them.

The "electronic form" group reported more frequently sleep problems, in term of difficulty in falling asleep and repeated awakenings ($p < 0.05$), compared to the "printed form" group.

Examining lifestyle habits and potential factors influencing sleep, no factor resulted confounding, outlining no significant impact on the sleep hygiene (Table 3). However, considering the "printed group", smoking, watching television, working and using smartphone in the last hour before sleep were significantly correlated to sleep problems.

Mobile phone exposure has been associated with sleep critical issues (Table 4). In particular, the participants who reported using their mobile phone more than 60 minutes before going to sleep referred more sleep problems compared with people using their mobile phone less ($p < 0.01$). The frequent use of these devices during the week resulted significantly associated to a worst sleep status too ($p < 0.001$). Besides, the utilization over 60 minutes was associated with increased difficulty falling to sleep ($p = 0.018$) whereas no significant relationship showed with early awakening episodes ($p = 0.17$) and waking up too soon ($p = 0.2$).

We found a significant relationship between some types of media use and sleep problems. Indeed, both surfing internet and writing messages could negatively affect their sleep condition.

On the contrary, the use of the mobile phone to telephone or to play does not seem to significantly influence their sleep.

When considering use of mobile phones at bedtime, this electronic device exposure in bed was significantly and positively related to self-reported sleep disturbance ($p < 0.001$).

Conversely, the time at which the respondents used these devices had no impact on the sleep.

Table 5 illustrates the results of the multivariate analysis with the sleep disorders as the dependent variable. Media use duration and the use in bed remained statistically significant. Particularly, using mobile phone more than 60 minutes before going to sleep cause a significant worsening of sleep condition (OR=1.77, CI 95%: 1.06-2.96). Moreover, the use of these devices in bed increased of nearly two times the risk of sleep problems (OR=1.98, CI 95%: 1.12-3.5). Considering the different kind of activities, only surfing internet remained statistically significant in the multivariate analysis with an OR of 1.78 (CI 95%: 1.3-2.45), while phoning was nearly significant (OR= 1.12, CI 95%: 0.86-1.46).

TABLE 1. Sample characteristics. Description of the sample according to sleep disorders self-reported (N=597).

		SLEEP DISORDERS		p
		No %(N)	Yes %(N)	
Gender	<i>Male</i>	31.14 (71)	68.86 (157)	0.01*
	<i>Female</i>	21.82 (79)	78.18 (283)	
Age class	<i>18-24</i>	18.59 (29)	81.41 (127)	0.069
	<i>25-39</i>	28.32 (96)	71.68 (243)	
	<i>≥ 40</i>	25.93 (21)	74.07 (60)	
Marital status	<i>Single</i>	22.89 (95)	77.11 (320)	0.113
	<i>Cohabitant</i>	27.14 (19)	72.86 (51)	
	<i>Married</i>	34.69 (34)	65.31 (64)	
	<i>Divorced</i>	27.27 (3)	72.73 (8)	
Education level	<i>Primary school</i>	0.00 (0)	100 (2)	0.067
	<i>Middle school</i>	5.88 (1)	94.12 (16)	
	<i>High school</i>	22.85 (61)	77.15 (206)	
	<i>Degree</i>	29.03 (90)	70.97 (220)	
Occupational status	<i>Occupied</i>	30.56 (99)	69.44 (225)	0.004*
	<i>Unoccupied</i>	11.43 (4)	88.57 (31)	
	<i>Student</i>	20.6 (48)	79.4 (185)	
Self-perceived health	<i>Poor</i>	13.39 (15)	86.61 (97)	0.001*
	<i>Good</i>	28.51 (136)	71.49 (341)	

* Statistically significance values

DISCUSSION

Main finding of this study

The present study aimed to estimate the association between electronic devices usage, especially mobile phone, during the evening/night and self-reported sleep disorders. Our results suggest that the use of a mobile phone, mostly for surfing and texting, in bed before going to sleep is positively associated with reporting sleep disturbances. This finding remained significantly also after controlling for the effects of many variables that may influence the sleep status.

What is already known on this topic

Our finding is in line with previous studies conducted in different groups of population. Some studies have reported the impact of media use on sleep, in children [1,22] and adolescents [2,15], underlying a negative association between media use and sleep [16]. As example, Arora and colleagues found a negative correlation between the weekday use of technology types at bedtime and weekday sleep duration in UK adolescents [19]. Other research regarding children's and adolescents' evening use of electronic media

and its impact on sleep consistently showed an association with delayed bedtime and reduction in total sleep time [4,23] and underlined the role of sleep disturbance as a partial mediator of the relationship between electronic media use at night and depressive symptoms [11].

Relatively few studies have investigated the relationship between electronic media use and sleep in the adult population and the majority of them showed that using electronic media is associated with different types of sleep disturbances [2,7]. One study suggested that the use of computers and mobile telephones in the bedroom is associated with delayed timing of sleep [24]. Other studies observed that internet surfing increased the risk of developing sleep disturbances in the form of repeated awakenings [18] and it was significantly related to a delay in both bedtime and rise time during weekends [25]. This is consistent with our study that outlined how surfing internet has a negatively impact on the sleep.

Finally, we observed that the main effect of the mobile phone use in the last evening hours happened on the falling asleep phase, producing a more difficult initiating sleep, whereas we did not find a significant impact in determining repeated night awakenings and early awakening. This is partly inconsistent with previous studies that reported associations not only with difficulty falling asleep, but also with difficulty maintaining sleep [7] and early awakening episodes [19].

TABLE 2. Sleep disorders. Description of sleep disorders self-reported by the sample.

		ABSOLUTE FREQUENCY	FREQUENCY%
Length of sleep disorders	<i>Never</i>	457	76.81
	<i>1- 6 months</i>	22	3.7
	<i>7 months - 2 years</i>	23	3.87
	<i>> 2years</i>	93	15.63
Difficulty in falling asleep	<i>Never</i>	294	49.58
	<i>≥ 1x/week</i>	299	50.42
Repeated awakenings	<i>Never</i>	288	48.73
	<i>≥ 1x/ week</i>	303	51.27
Waking up too soon	<i>Never</i>	307	51.95
	<i>≥ 1x/ week</i>	284	48.05
Sleep quality	<i>satisfactory</i>	292	48.99
	<i>slightly unsatisfactory</i>	246	41.28
	<i>very unsatisfactory</i>	55	9.23
	<i>I don't sleep</i>	3	0.5
Problems in daily activities	<i>Not interfere</i>	214	36.52
	<i>interfere slightly</i>	258	44.03
	<i>Interfere considerably</i>	114	19.45
Daily sleepiness	<i>No</i>	167	28.07
	<i>Yes slightly</i>	375	63.03
	<i>Yes considerably</i>	53	8.91
Hours slept	<i>≥ 7 hours</i>	394	67.35
	<i>< 7 hours</i>	191	32.65
Minutes to sleep	<i>≥ 30'</i>	502	86.85
	<i>> 30'</i>	76	13.15

What this study adds

This study adds to the field in several ways. First of all, this research benefited from including more covariates known to affect sleep, such as smoke, napping, alcohol and caffeine intake in the evening. A further asset is that we distinguished between different types of use for the electronic media devices.

Besides, we have assessed both the frequency and the duration of electronic media use. Also, previous studies have mainly consisted of participants of quite a young age, instead our study includes people of several ages.

Future research should be conducted to reveal possible causal relations between media use and sleep problems, to analyze the possible 'bidirectional nature' of the relationship between these variables [21,22] and to evaluate the various pathways and mechanisms involved [26].

Given that mobile phone become more and more equipped with several applications [8], the attraction to use it during bedtime is likely to increase forward. Therefore, the individual's capacity to put a limit for the use is important.

Public health prevention strategies could comprise promotion of optimum sleep habits, information regarding the effects of an intensive electronic devices use on the sleep status and on other health problems like somatic complaints, anxiety, depression [18] and advice about a well-balanced and not harmful use of the mobile phone to children, adolescents and adults.

Limitations of this study

The current study presents some limitations. The causal direction is difficult to ascertain because of the cross-sectional nature of this study even if some questions of the questionnaire allowed us to identify and exclude the people presenting sleep disorders diagnosed before the mobile phone owning. This study used self-reported data and it concerned subjective symptom-reports, with all questions being retrospective and presenting a risk of recall bias. Besides, different psychiatric conditions, linked to different effects on sleep-wake rhythm, could not be

TABLE 3. Influencing factors. Potential factors influencing sleep.

		SLEEP DISORDERS		p
		No % (N)	Yes % (N)	
Sharing bedroom	No	22.52% (75)	77.48% (258)	0.063
	Yes	29.23% (76)	70.77% (184)	
Nap	≤ 1/ week	25.45% (127)	74.55% (372)	0.903
	> 1/ week	26.04% (25)	73.96% (71)	
Caffeine beverages^a	≤ 1/ week	24.96% (127)	75.10% (383)	0.474
	> 1/ week	28.57% (24)	71.43% (60)	
Alcoholic beverages^a	≤ 1/ week	25.38% (132)	74.62% (388)	0.812
	> 1/ week	26.67% (20)	73.33% (55)	
Smoking^a	≤ 1/ week	26.69% (134)	73.31% (368)	0.136
	> 1/ week	19.35% (18)	80.65% (75)	
Watching tv^b	No	29.95% (59)	70.05% (138)	0.111
	Yes	23.81% (90)	76.19% (288)	
Reading book^b	No	23.83% (61)	76.17% (195)	0.416
	Yes	26.76% (91)	73.24% (249)	
Using computer^b	No	26.96% (62)	73.04% (168)	0.519
	Yes	24.59% (90)	75.41% (276)	
Listening to music^b	No	25.43% (104)	74.57% (305)	0.95
	Yes	25.67% (48)	74.33% (139)	
Working/studying^b	No	26.64% (77)	73.36% (212)	0.536
	Yes	24.43% (75)	75.57% (232)	
Sport^b	No	25.33% (135)	74.67% (398)	0.776
	Yes	26.98% (17)	73.02% (46)	
Going out with friends^b	No	21.82% (36)	78.18% (129)	0.202
	Yes	26.91% (116)	73.09% (315)	
Using mobile phone in bed^b	No	36.91% (55)	63.09% (94)	0.000*
	Yes	21.7% (97)	78.3% (350)	

^a They were asked if the activity was made in the last two hours before going to sleep.

^b They were asked if the activity was made in the last hour before going to sleep.

* Statistically significance values

taken over using the self-administered questionnaire. In spite of the convenience sampling, the sample could be not completely representative of the general population.

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TABLE 4. Mobile phone use. Description of mobile phone use self-reported by the sample.

		SLEEP DISORDERS		p
		No % (N)	Yes % (N)	
Total time using mobile phone	< 60'	28.71% (120)	71.29% (298)	0.01*
	³ 60'	18.4% (30)	81.6% (133)	
How many times^a	Never	35.71% (25)	64.29% (45)	0.000*
	1/week	45.1% (23)	54.9% (28)	
	Many times/week	23.65% (48)	76.35% (155)	
	Every day	20.59% (56)	79.41% (216)	
Phoning^a	Never	27.23% (113)	72.77% (302)	0.447
	1/week	21.11% (19)	78.89% (71)	
	Many times/week	24.19% (15)	75.81% (47)	
	Every day	17.24% (5)	82.76% (24)	
Writing messages^a	Never	30.15% (41)	69.85% (95)	0.029*
	1 /week	25.45% (14)	74.55% (41)	
	Many times/week	29.22% (64)	70.78% (155)	
	Every day	17.74% (33)	82.26% (153)	
Surfing internet^a	Never	54.84% (17)	45.16% (14)	0.000*
	1 /week	50% (5)	50% (5)	
	Many times/ week	44.68% (21)	55.32% (26)	
	Every day	21.46% (109)	78.54% (399)	
Playing^a	Never	25.54% (142)	74.46% (414)	0.427
	1 /week	33.33% (5)	66.67% (10)	
	Many times/week	11.76% (2)	88.24% (15)	
	Every day	37.5% (3)	62.5% (5)	
Hour as far using mobile phone	Untill 11.00 p.m.	25.83% (62)	74.17% (178)	0.879
	After 11.00 p.m.	25.28% (90)	74.72% (266)	
Using mobile phone in bed^a	No	36.18% (55)	21.17% (94)	0.000*
	Yes	63.82% (97)	78.83% (350)	

^a They were asked if the activity was made in the last hour before going to sleep.

* Statistically significance values

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TABLE 5. Multivariate analysis. Multivariate analysis with sleep disorders as the dependent variable.

SLEEP DISORDERS	ODDS RATIO	STD. ERR	Z	P> Z	[95% CONF. INTERVAL]	
Gender	1.59	0.36	2.06	0.040	1.02	2.49*
Age class (25-39y)	0.89	0.28	-0.36	0.71	0.47	1.65
Age class (≥ 40y)	1.22	0.54	0.46	0.643	0.51	2.94
Education level	0.69	0.15	-1.57	0.11	0.44	1.09
Self-perceived health	0.34	0.11	-3.22	0.001	0.17	0.65*
Sharing bedroom	0.81	0.19	-0.87	0.38	0.51	1.28
Nap	0.74	0.21	-1.04	0.29	0.42	1.29
Caffeine beverages	0.73	0.22	-1.03	0.3	0.4	1.32
Alcol beverages	1.08	0.35	0.25	0.8	0.57	2.04
Smoking	1.25	0.41	0.71	0.48	0.66	2.38
Watching tv	1.52	0.35	1.78	0.07	0.95	2.41
Reading book	0.87	0.19	-0.6	0.54	0.56	1.35
Using computer	0.94	0.22	-0.25	0.8	0.58	1.5
Listening to music	1.1	0.26	0.41	0.68	0.68	1.76
Working/studying	1.26	0.28	1.05	0.29	0.81	1.97
Sport	0.97	0.33	-0.06	0.95	0.5	1.91
Going out with friends	0.68	0.18	-1.41	0.16	0.40	1.16
Total time using mobilephone	1.77	0.46	2.19	0.028	1.06	2.95*
Phoning	1.12	0.15	0.85	0.39	0.86	1.45
Writing messages	1.02	0.12	0.22	0.82	0.8	1.3
Surfing Internet	1.78	0.28	3.57	0.00	1.3	2.45*
Hour as far using mobile phone	0.58	0.15	-2.05	0.041	0.35	0.978*
Using mobile phone in bed	1.97	0.57	2.34	0.019	1.12	3.5*

* Statistically significance values

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