

# THE EFFECT OF TECHNOLOGICAL DEVICES IN A TEEN'S BEDROOM ON THE AMOUNT AND QUALITY OF SLEEP

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## **Personal Section:**

How many times does a child hear his or her parent say, “turn your phone off before going to bed” or “don’t sleep with your phone on next to you” or “stop texting at night because you won’t get enough sleep”? I know *I’ve* heard those words countless times. But, I’ve always wondered if using my phone, or any other technological device, could actually hinder me from getting the best quality sleep I can get. This is what led me to develop my present study for the Intel Science Talent Search competition. I was curious as to whether or not there was truth to what my parents had been saying to me for all these years.

The research for my study was performed during my Social Science Research class periods at Jericho High School. My classmates and I diligently scoped out articles, scientific journals, books, and all types of literature pertaining to our individual studies. I worked on my Intel paper for a total of a year and a half. I used all the resources available at my high school such as databases and my extremely knowledgeable research teacher, Mr. Scarnati. My study encompassed mathematics as well as science. There was mathematics involved when analyzing results from my surveys; luckily, I had the program SPSS to do the math for me. Then, there was science involved when I had to learn about sleep and the factors that could affect it before I actually began my study.

I really learned so much from completing this study. Besides the obvious academic and intellectual benefits of this research, I was also able to gain a sense of responsibility and perseverance. It's not easy to work diligently through a year and a half's worth of research. There were many steps that I had to take in completing this Intel paper. One word of advice for those who are interested in undertaking a project combining science and mathematics would be to choose a topic of interest. What kept me going and helped me to focus on my task was the fact that I was eager to find out if my hypotheses were true – I was genuinely interested in my topic. I think that having a firm interest in one's research is the best way to ensure success.

**Research Section:**

**ABSTRACT**

There have been previous studies conducted in order to test for a correlation between the number of technological devices in a teen's bedroom and his or her sleeping pattern. In the last four decades, there has been an increase in adolescents sleeping fewer than seven hours per night, which may relate to the use of electronics. Dobson did a study in 2003 which showed that sleep disturbances may be linked to the presence of a TV set in a child's bedroom and to computer game play. Calamaro, Mason, and Ratcliffe's study revealed that those who watched television after nine pm were engaged in other stimulating activities, which delayed sleep. Text messaging may also be linked to the amount of sleep that a teen is able to attain. According to Dobson, evidence is growing that the number of children with mobile phones is increasing and that some take them to bed so that they do not miss any incoming text messages. Van den Bulck's study showed

that the risk of being tired was higher in those who used, or slept with, their mobile phone than those who did not. He conducted an additional study that assessed the prevalence of the use of mobile phones by adolescents after lights out and its relationship to levels of tiredness after one year. He was able to conclude that mobile phone use after lights out is very prevalent and that it is related to increased levels of tiredness. Calamaro, Mason, and Ratcliffe also found that melatonin production is delayed by the light exposure from computer screens. Melatonin is a hormone that plays a major role in when we fall asleep and when we wake up. These previous studies have led to the conclusion that using electronics at night may contribute to difficulty falling asleep.

### **LITERATURE REVIEW**

As the twenty-first century progresses, technology has increasingly become a major part of our lives. Excessive texting and use of technological devices has recently become a habit for many people, especially teenagers. Along with this change, it has also been evident that many Americans' sleep durations have decreased one to two hours over the last four decades, with a twofold increase in adolescents sleeping fewer than seven hours per night (Calamaro, Mason, Ratcliffe, 2009). This problem may correspond to the use of electronics such as mobile phones, televisions, computers, game systems, etc. According to Calamaro, Mason, and Ratcliffe, the combined use of several technologies may lead to an additional delay in sleep onset in adolescence as well (2009). A myriad of studies have been conducted in order to test the relationship between the ownership of technological devices and sleeping patterns. To build upon previous studies, this present

study will be testing the following hypotheses: (1) As the number of technological devices in a teen's bedroom increases, amount of sleep declines, (2) teens that sleep with their mobile phones get fewer hours of sleep than those who don't, (3) As the number of technological devices in a teen's bedroom increases, daytime sleepiness increases as well, (4) As the number of technological devices that one uses two hours prior to sleep increases, the number of hours of sleep he or she gets decreases, and (5) Those who sleep with their phones turned on have a higher level of daytime sleepiness.

One purpose of this study is to test for a correlation between the number of technological devices in a teen's bedroom and his or her sleeping pattern. Many adolescents have at least one electronic item such as a television, computer, telephone, or music device in their bedroom (Calamaro, Mason, and Ratcliffe. 2009). If having one or more of these devices effect the level of sleep that a teen is able to acquire, there could be a possible solution to preventing or mitigating sleep deprivation, insomnia, and other sleep related issues. Studies show that lack of sleep and nightmares have been linked to television viewing. Also, sleep disturbances have been linked to the presence of a TV set in the child's bedroom and to computer game play (Dobson, 2003). In addition, eighty-two percent of adolescents in Calamaro, Mason, and Ratcliffe's study watched television after nine o'clock pm and were engaged in several other activities that were potentially stimulating and delayed sleep (2009). This could show that having different electronic devices in one's bedroom can become a distraction to sleep. This is what inspired me to hypothesize about the level of daytime sleepiness that one feels based on the amount of technological devices in the bedroom and how many are used prior to going to bed.

Another purpose of this study is to see if teens that sleep with their cell phones next to them get fewer hours of sleep than those who don't have their phones within reach. According to Dobson, evidence is growing that the number of children with mobile phones is increasing and that some take them to bed so that they do not miss any incoming text messages (2003). Parents have also reported that their children take their phones to bed with them and leave them switched on for the same reason (Van den Bulck, 2003). Van den Bulck's study showed that the risk of being tired more than doubled in those who used, or slept with, their mobile phone less than once a week, tripled in those who used them weekly, and was more than five times higher in those who used, or slept with, their mobile phones several times a week or more. Van den Bulck surveyed 2,546 adolescents asking them "how often are you woken up at night by incoming text messages on your mobile phone?" The answer categories were: (1) Never; (2) one to three times a month; (3) about once a week; (4) several times a week; (5) every day. A year later, he followed up the study by using a scale to measure how tired his respondents were. Based on this Leuven study on media and adolescent health that originated in Flanders, Belgium, 13.4% of first year secondary school students reported being woken up one to three times a month, 5.8% were woken up once a week, 5.3% were woken up several times a week and 2.2% were woken up every night. Of the fourth year secondary school students, 20.8% were woken up between one and three times a month, 10.8% were woken up at least once a week, 8.9% were woken up several times a week, and 2.9% were woken up every night. These percentages were based on a sample size of about 2,500 adolescents from fifteen randomly selected secondary schools. This study also asked teenagers to indicate how tired they felt (1) Generally speaking, (2) in the morning

when they got up, (3) at school, (4) after a day at school, and (5) after the weekend. These answers were on a scale ranging from -5 to 5, -5 being “not tired at all” and +5 being “extremely tired.” The respondents who reported being woken up were significantly more tired than those who were never woken up by text messages (Van den Bulck, 2003). Therefore, I will be studying the differences between the two groups of people in my pool of respondents, those who sleep with their phones on and those who sleep with them off, and how tired they feel on a daily basis. Van den Bulck also conducted a similar study called “Adolescent Use of Mobile Phones for Calling and for Sending Text Messages after Lights Out: Results from a Prospective Cohort Study with a One-Year Follow-Up,” in which he assessed the prevalence of the use of mobile phones by adolescents after lights out and its relationship to levels of tiredness after one year. For this study, he used first and fifth year secondary school students in Belgium. In order to measure the prevalence of mobile phone use after lights out, Van den Bulck asked respondents to indicate on a five-point scale how frequently they A) received or B) sent text messages and C) received or D) made phone calls after lights out. The five categories given to the participants to choose from were: (1) Never; (2) one to three times a month; (3) once a week; (4) several times a week; (5) every day. Respondents were also told to indicate how many messages they A) received; B) sent; and calls they C) received; D) made after lights out. They were allowed to answer in an open-ended form, giving answers in numbers. In addition, Van den Bulck asked respondents to indicate at what time of the night they sent or received messages and when they either made or received phone calls. The answer categories were A) immediately after lights out; B) between midnight and 3 am; C) between 3 am and 6 am; D) after 6 am; and E) at any time of the

night. As a follow-up, respondents were to indicate their level of tiredness based on the same scale as his previous study. Through this study, Van den Bulck was able to conclude that “mobile phone use after lights out is very prevalent among adolescents. Its use is related to increased levels of tiredness. There is no safe dose and no safe time for using the mobile phone for text messaging or for calling after lights out” (Van den Bulck, 2007).

It has been shown that electromagnetic fields produced by mobile phones, may have an effect on the sleep electroencephalogram, and evening exposure to mobile phone emissions may affect melatonin production. In addition, playing computer games has also be shown to shorten REM sleep and many adolescents report dreaming about what they saw on TV or in a computer game (Van den Bulck, 2003). Another factor that may delay melatonin production is the light exposure from computer screens. Therefore, the use of technological devices by teens such as holding a cell phone closely or using an iPod while sitting at a computer could easily delay melatonin release (Calamaro, Mason, and Ratcliffe, 2009). Melatonin is a hormone secreted by the pineal gland in the brain. It helps regulate other hormones and maintains the body's circadian rhythm, which plays a role in when we fall asleep and when we wake up (Melatonin, 2006). Therefore, decreased levels of melatonin would result in less sleep. This would explain why using electronics at night would, in a way, prevent a person from falling asleep as easily as he or she normally would.

## **METHODOLOGY**

The present study was conducted in order to test five different hypotheses: The first states that as the number of technological devices in a teen's bedroom increases, amount of sleep declines. Second, teens that sleep with their mobile phones get fewer hours of sleep than those who don't. The third hypothesis states that as the number of technological devices in a teen's bedroom increases, daytime sleepiness increases as well. Fourth, as the number of technological devices that one uses two hours prior to sleep increases, the number of hours of sleep he or she gets decreases. Lastly, those who sleep with their phones turned on have a higher level of daytime sleepiness. These hypotheses take into account three variables: daytime sleepiness, number of technological devices, and sleep.

Daytime sleepiness is the level of tiredness that one experiences during the day. This was measured through the use of the Epworth Sleepiness Scale. Questions include:

“How likely are you to doze off or fall asleep in the following situations, in contrast to feeling just tired? This refers to your usual way of life in recent times. Even if you have not done some of these things recently try to work out how they would have affected you. Use the following scale to choose the *most appropriate number* for each situation.”

The Epworth Sleepiness Scale presents a number of scenarios such as sitting and reading, watching TV, sitting inactively in a public place or as a passenger in a car, lying down to rest, sitting and talking to someone, sitting after a lunch, and sitting in a car stuck in traffic with a scale from 0 through 3. Respondents were to determine how likely they would be to doze off in each of the given situations – 0 being unlikely and 3 being very likely.

The second variable, the number of technological devices, is defined as the number of electronic objects used for entertainment or for communication purposes in the



bedroom, such as mobile phone, television, computer, iPod, or game system.

Respondents were asked to check off the devices they had in their bedroom from a list of that I provided. This part of my survey included an option called “other,” where the respondents were asked to name, specifically, any other devices that were relevant to the question asked. The number of checked-off items and the devices listed in the “other” category were summed to create a measure of the devices variable.

The third variable, sleep, refers to the number of hours of sleep that one gets overnight. This variable was measured solely based on the responses to two questions related to sleep: “On a typical school night, how many hours of sleep do you get?” and “On a typical non-school night, how many hours of sleep do you get?” The questions were very straightforward and asked for a specific number. The responses were summed to create a measure of the sleep variable.

For my first hypothesis - as the number of technological devices in a teen’s bedroom increases, amount of sleep declines – I ran a Pearson’s Correlation between the number of technological devices and amount of sleep. This would show whether or not there is a relationship between the two variables. For this hypothesis, a negative correlation was expected because as the number of technological devices increased, sleep was expected to decline. My second hypothesis stated that those who sleep with mobile phones get less sleep than those who don’t. In order to test for this relationship, I created two groups: Respondents who answered “yes” to the question asking whether or not they slept with their mobile phones turned on next to them and the respondents that answered “no”. I ran a T-test in order to compare the mean hours of sleep each group got. For my third hypothesis, I ran a Pearson’s correlation to test the strength of the correlation

between the number of technological devices and daytime sleepiness. My fourth hypothesis was tested with a Pearson's correlation to determine the strength of the relationship between using technological devices two hours prior to falling asleep and amount of sleep. Like the first hypothesis, a negative correlation was expected. For my last hypothesis, I ran a T-test in order to compare the level of daytime sleepiness between the two groups of people – those who slept with their phones on and those who slept with them off.

For this study, I used high school students from Jericho High School and other high schools that I had access to. I distributed the link to my survey that I created on Question Pro via Facebook by creating a group and inviting all my friends. I instructed them to invite their friends as well. Using email, text messages, Twitter and other available electronic means I distributed the link to my survey as broadly as possible to my target population – high school students. I also used word-of-mouth to invite people in person. This multi-pronged approach created a 'snowball sample.' Ultimately, I was able to gather data from 138 respondents.

## **RESULTS AND DISCUSSION**

I found data supporting each of my five hypotheses. My first hypothesis was tested using a Pearson's Correlation. There is in fact a correlation between the number of technological devices that a teenager owns and how much sleep he or she is able to obtain on an average night. This allowed me to reject the null hypothesis that the number of technological devices does not affect the amount of sleep a teen gets. The greater the

number of technological devices present in a teen's bedroom, the less sleep he or she slept on an average night.

**Correlations**

		Total number of technological devices	sleep
Total number of technological devices	Pearson Correlation	1	-.672**
	Sig. (2-tailed)		.000
	N	139	139
sleep	Pearson Correlation	-.672**	1
	Sig. (2-tailed)	.000	
	N	139	139

For my second hypothesis, which stated that teens who sleep with their mobile phones get fewer hours of sleep than those who don't, I ran an Independent samples T-test to compare the two groups of respondents. There were a total of 56 respondents who answered that they slept with their phones on, and 83 who did not. The mean difference in the hours of sleep that each group got on school nights and non-school nights combined was 4.096 hours. This difference was statistically significant (Sig. (2-tailed) = .000). Once again, I was able to reject the null hypothesis. It appears that having a phone turned on while sleeping does take away from the amount of hours that one sleeps on an average night. This could be due to the fact the people who sleep with their phones are awakened by incoming text messages and/or calls throughout the night. Nonetheless, my hypothesis is supported by the following output:

**Group Statistics**

phone on		N	Mean	Mean Difference	Sig. (2-tailed)
sleep	Yes	56	12.48	-4.096	.000
	No	83	16.58		

The third hypothesis, as the number of technological devices in a teen’s bedroom increases, daytime sleepiness increases as well, I ran a Pearson’s correlation to discover whether or not there was a relationship between the two variables. According to my results, there is a very strong correlation between the two. This once again allowed me to reject the null hypothesis that the number of technological devices does not affect daytime sleepiness. According to my data, those who have a large number of technological devices present in their bedrooms feel more tired during the day. This makes sense because the larger the number of technological devices, the less sleep people got, which would inevitably cause them to experience a higher level of daytime sleepiness.

**Correlations**

		TECH DEVICES	DAYTIME SLEEPINESS
Total number of technological devices	Pearson Correlation	1	.944**
	Sig. (2-tailed)		.000
	N	139	139
Daytime Sleepiness	Pearson Correlation	.944**	1
	Sig. (2-tailed)	.000	
	N	139	139

For the fourth hypothesis, I ran another Pearson’s Correlation. This hypothesis stated that as the number of technological devices that one uses two hours prior to sleep increases, the number of hours of sleep he or she gets decreases. My results show that there is a statistically significant correlation between the two variables. The null hypothesis that using technological devices prior to going to bed does not have an affect

on the amount of sleep can be rejected based on my results. Those who had a larger number of devices that they used before going to sleep ended up having fewer hours of sleep each night. Being preoccupied with many different devices may hinder a person's sleep. Referring back to my literature review, people that sleep after using a larger number of electronic devices may produce less melatonin compared to those that don't use as many because of factors such as electromagnetic fields produced by mobile phones and light exposure from computers. Melatonin is essential to sleep because it controls a person's circadian rhythm, and therefore, the number of technological devices used two hours prior to going to bed would have an effect on amount of sleep.

**Correlations**

		2 HOURS	sleep
Number of technological devices used 2 hours prior to sleeping	Pearson Correlation	1	-.203*
	Sig. (2-tailed)		.017
	N	139	139
sleep	Pearson Correlation	-.203*	1
	Sig. (2-tailed)	.017	
	N	139	139

For my final hypothesis, I ran an independent samples T-Test to compare the two groups of respondents once again (those who slept with their phones on and those who slept with them off). This time I compared the means of daytime sleepiness for the two groups. The mean difference came out to be 4.336, in their level of daytime sleepiness. This difference was statistically significant, lending support for my hypothesis. This

allowed me to reject the null hypothesis that there is no difference in the level of daytime sleepiness between those who sleep with their phones on and those who sleep with them off. My results show that those who sleep with their phones on feel more tired during the day than those who sleep with their phones off. Again, people that have their phones on may receive text messages or calls, which would keep them up, reduce the number of hours of sleep, and cause them to be more tired during the day.

**Group Statistics**

	phone on	N	Mean	Mean Difference	Sig. (2-tailed)
Daytime Sleepiness	Yes	56	20.63	4.336	.000
	No	83	16.29		

### **CONCLUSION AND SUGGESTIONS FOR FUTURE RESEARCH**

Based on my findings, I can conclude that all of what I had predicted at the beginning of this project can be held true. My five hypotheses, which I had formed from my research based on use of mobile phones and the effects of technological devices on teenagers prior to conducting this study, can be supported by my data. The present study suggests that sleep is affected by use and presence of technological devices in one's bedroom. When there was a larger number of technological devices in a respondent's bedroom, generally, that person was not able to obtain as much sleep as another respondent who had fewer technological devices. The quality of sleep is also affected by the number and use of technological devices, which is shown by the levels of daytime sleepiness reported by the respondents.

For further research, a larger sample size should be used to ensure that the results are more accurate. In addition, using a sample population consisting of people outside of the metropolitan area would diversify the results of this study. Using people from different areas could change up the results or even make the findings of this study stronger.

### **APPENDICES**

Please complete the attached anonymous survey. Your responses will be strictly confidential and can never be linked to you. You may stop at any time. The data you provide will be part of an Intel National Science Talent Search entry. Please answer each question directly and honestly. Your effort is greatly appreciated.

#### **Thank You**

1. Check off whatever technological devices are in your bedroom when you are in your bedroom.

\_\_\_ Mobile Phone

\_\_\_ Television

\_\_\_ Xbox/Playstation/Wii/Nintendo/etc.

\_\_\_ IPOD

\_\_\_ Computer

\_\_\_ Other (Specify: \_\_\_\_\_)

2. Which of the following do you normally use within 2 hours before going to bed?

\_\_\_ Mobile Phone

\_\_\_ Television

\_\_\_ Xbox/Playstation/Wii/Nintendo/etc.

\_\_\_ IPOD

\_\_\_ Computer

\_\_\_ Other (Specify: \_\_\_\_\_)

3. In the past 30 days, how many times were you woken up at night by incoming text messages on your mobile phone? \_\_\_\_\_

4. In the past 30 days, how many times did you receive or send text messages after lights out? \_\_\_\_\_

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**Sleep:**

5. On a typical **school night**, how many hours of sleep do you get? \_\_\_\_\_

6. On a typical **non-school night**, how many hours of sleep do you get? \_\_\_\_\_

7. On a typical night, do you sleep with your phone on? (Yes or No) \_\_\_\_\_

**THE EPWORTH SLEEPINESS SCALE**

How likely are you to doze off or fall asleep in the following situations, in contrast to feeling just tired? This refers to your usual way of life in recent times. Even if you have not done some of these things recently try to work out how they would have affected you. Use the following scale to choose the *most appropriate number* for each situation:



- 0 = would *never* doze
- 1 = *slight* chance of dozing
- 2 = *moderate* chance of dozing
- 3 = *high* chance of dozing

Situation:	Chance of Dozing:
Sitting and reading	_____
Watching TV	_____
Sitting, inactive in a public place (e.g. a theater or a meeting)	_____
As a passenger in a car for an hour without a break	_____
Lying down to rest in the afternoon when circumstances permit	_____
Sitting and talking to someone	_____
Sitting quietly after a lunch	_____
In a car, while stopped for a few minutes in the traffic	_____

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